ABSTRACTS

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International Symposium on Horticulture: Priorities and emerging trends, 5-8 September 2017, Bengaluru, India

ABSTRACTS

(Oral presentations, Poster Presentations and Students' Oral/Poster Presentations)

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Abiotic Stress Management

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Session –I

Global Scenario

(Production and Consumption, Trade, Marketing and Policy Issues, Nutrition and Health)

Oral papers

S1O1 A15

Horticulture: Opportunities and Challenges

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The world population is predicted to increase from the current 7 billion to 9.5 billion by the year 2050. The population of South East Asia is expected to rise from 4.3 billion to 5.2 billion by 2050 and in India from 1.2 billion to 1.6 billion. This will put enormous pressure on resources, including land, fresh water and food. Global warming also has the potential to reduce available land areas, particularly for low lying parts of the country. More land will also be required for housing, and thus there will be a need for a marked intensification of crop production on the remaining land. In many countries (such as Japan and ROC (Taiwan)) the average age of farmers is over 60 years. A similar pattern is likely to occur throughout India. Who will then produce the food?. Horticulture is essentially harvesting the sun. Vegetable plants do this extremely inefficiently, because for much of their life they are surrounded by bare soil. Mobile gulley systems offer a means of using natural radiation (sunlight) more efficiently. Fresh water is an essential resource in the future. Re-circulating hydroponic systems under protected cultivation are about 3-4 times more water efficient than conventional irrigation. Two major fertilizers (potassium and phosphorous) are essentially non-renewable. We must also learn to use these much more efficiently also through re-circulating hydroponics. It is suggested that protected cultivation and hydroponics will need to be used in order to increase productivity particularly close to the centers of consumption and that eventually (inevitably) there will be a need for "Plant factories" (vertical farming).

S1O2 A13

Global food Security and enhancing production

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This synthesis talk abstract contains a necessarily rapid appraisal of human food safety and security in the recent century and, based on that evidence, provides a summary analysis of horticulture production strategies and sustainable trends under climate change impacts and mitigation measures. Worldwide, declining food safety and security will almost certainly contribute to social disruptions or large-scale political instability or conflict, amplifying global concerns about the availability of food and nutritious values. It can be judged that augmenting traditional approaches to horticultural development with lesser used strategies such as reducing crop and food waste, generating off-farm income activities, conducting research in minor crops, and fostering technical education in agriculture, would formulate a road map for increasing productivity and profitability in horticultural crops and would improve the resilience of national, regional and global food systems. Approximately one-third of the food produced globally does not get consumed due to losses. The greatest potential to relieve food scarcity will be through investments in infrastructure, technology, and education to improve the food supply chain while conserving natural resources. We need strategies in agricultural R&D technologies, improving water,

soil, and land management, expanding and modernizing trade infrastructure, and enhancing agricultural policies and institutional capacities. To be sustainable, an agro ecosystem requires production protocols that are resilient to natural stressors such as disease, pests, drought, wind and salinity, and to human constructed stressors such as economic cycles and trade barriers. Climate change including CO_2 emission is predicted to induce percentage changes in global food supply-demand-trade production and in the sustainability of agriculture including food quality and quantity in this century.

S1O3 IS41

Condition and perspectives of a horticulture development in the South of Russia

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The works with fruit cultures in the Nikitsky Botanical Gardens were led off by Christian Steven. The orchard was established in 1812, and 74 cultivars of fruit and berry cultures were grown in the nursery. By 2017 the genome-fund includes 5,729 cultivars and forms. It is presented by 21 cultures: peach (952 cultivars and forms), a decorative peach(98), nectarine (156), apricot (586), cherry – plum (180), plum (238), sweet-cherry (363), cherry (140), apple (771), pear (348), quince (204), almond (476), walnut (69), hazel-nut (66), jujube (127), pomegranate (325), fig (269), persimmon (123), olive (229), kiwi (7), feijoa (2). As the result of study of stone fruit cultures genome-fund and breeding in 2017 153 cultivars of the NBG breeding were listed in the State Register of Russia. In the "NBG-NSC" agronomical technologies, which provide 20-30 per cent decrease of investments to create and use plants in comparison with foreign ones, were worked. In the Crimea the main types of orchards must be trellis undersized ones with the use of weak stocks in combination with rate of fruit cultivars. The schemes of tree planting 4-3.5×2-1 мeters should be used with orbed compact krones like shapely spindle, gruzbeck, pillar, Crimean column and others. Acknowledgements: this study was funded by the research grant no. 14-50-00079 of the Russian Science Foundation.

S1O4 A765

Horticulture and human health: Brief note on aspects of human health affected by horticultural research

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The topic Horticulture and Human Health has vast ramifications. Fruits, vegetables, flowers, and the related products like herbs, mushrooms, medicinal plants, etc need to not only be increased in availability using modern technology, they need to be fortified and modified to attain optimum nutrient quality. Research along the lines of species which are disease resistant, having longer shelf life and rich in antioxidants and minerals is the requirement of the day. We are looking for 'super foods' which not only provide nourishment but heal, and reverse pathology. Use of papaya leaf in dengue patients to increase platelet and white blood cell counts has been authenticated by studies. In the ancient system of Ayurveda, plants form the primary resource for preparation of potent medicines to treat all types of ailments, minor and major. Over 50 % of modern medicines use compounds derived from plants. These are then synthetically modified to be used as pills, injectibles, solutions, topical gels etc. Some famous ones are anti-malarial drugs from cinchona bark and digoxin a life saving drug used in heart conditions derived from a herb foxglove, or *Digitalis lanata*. There are hundreds of such examples. Newer applications of horticultural research are vast and much required in the field of probiotics which are now considered essential for developing immunity right from birth. Newer flavours in food industry like hibiscus, elderflower, etc in place of the traditional vanilla, use of turmeric and *Aloe vera* in skin products have given exciting results. Post-harvest technology has unlimited scope. Probiotics used in toddlers can improve their immunity against rota virus and others that can cause life-threatening diarrhoea. Studies on reducing risk of prostate cancer have been conducted in persons with high PSA (prostate stimulating antigen) using watermelon seed products. Pomegranate seeds reduce platelet aggregation and act as blood thinners, good for ischemic heart patients. An informal study of data on staff working predominantly in the field and in labs showed the former had better physiological vitals and psychological stress management, implying that being surrounded by nature while working has a more positive impact on health. It is used as primary source of nutrition, secondary use in disease combating and treatment as in pharmacological preparations, and tertiary use to improve quality of life without endangering environment. Awareness is important so as to introduce horticultural products from early age as part of normal food and supplements to improve the health of future generations.

Session –II

Genetic Improvement

(Plant genetic resource management, Conventional breeding, Biotechnology)

Oral papers

S2O1 A552

Diversity of wild and traditional mango genotypes of north-eastern region using morphological characterization

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The North East region has its own unique combination of living species, habitats and ecosystems, which together make up for its rich diversity. The North Eastern region of India comprising of eight states *viz.,* Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim has vast physiographical variations. It is one of the richest reservoir of genetic variability and diversity of local and traditional mango genotypes and species. India has about 1000 genotypes of mango including the genotypes from North-Eastern region. A total of 125 local, wild and traditional mango genotypes were evaluated for their morphological characters like leaf (leaf length, leaf breadth and petiole length), inflorescence, flowering and fruit morphometric traits as per IPGRI Mango Descriptor. In all the genotypes, full bloom was observed in the last week of January to second week of February, while fruit set started from first week of February to third week of February; but some of the genotypes were found to have very early flowering (last week of December) and fruiting (mid January). Wide variability among the wild and traditional mango genotypes was observed with respect to leaf length, breadth, petiole length, fruit length/breadth ratio, fruit weight and TSS and other characters. The variability in the existing germplasm can be exploited for future mango improvement programmes.

S2O2 IS7

Crimean autochthonous grape varieties and the effect of using them in breeding

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The existence of different centres of origin of cultivated plants and grapevine in particular suggests formation of specific biological features in the autochthonous varieties in those centres in the process of evolution. The biological specificity of the autochthonous grape varieties was to gain a foothold at the genetic level. At the same time, expression of these traits in the progeny should also be specific. The conducted research has shown that hybridization capacity of the Crimean autochthonous grape varieties with the varieties and forms of different species and eco-geographical origin has a specific character,

and proves that hybridization capacity can be perceived as an independent genetically determined biological feature.

S2O3 A376

Assessment of genetic variability for bunch compactness and berry size in grapes

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In addition to the popularity of grape as one of the fruit for export market, it is also known for intensive cost involved in its cultivation. Mainly the cost of cultivation includes labour cost for bunch/berry thinning and application of growth regulators and insecticides-fungicides. Further, to increase the profit, growers applies gibberellic acid to increase the berry size as bolder berry fetches higher price. But excess use of giberrelic acid, thickens the berry skin which is not desirable by the consumers. Therefore, need raised for breeding a variety with naturally loose bunches and bold berries. In order to select the parents for breeding programme, eighty grape accessions were screened for nine bunch and berry traits such as bunch compactness (berries/cm), bunch length (cm), bunch weight (gm), berries/bunch, berry length (mm), berry diameter (mm), 10 berry weight (gm), total soluble solids (^{O}Brix) and acidity (gm/l).All parameters showed highly significant differences. Loose bunches were observed in TsimlyanskiiChernyi, Benzuhio, CarolinaBlackrose, Clone2A, BlackMuscat, FantasySeedless, Jahfari, KishmishBelyi, Sekirei, Pierce, Dilkush, and Isabella. Similarly bold berries were recorded in accessions such as Sundekhani, Olympia, Benzuhio, Sekirei and Rizamat.Also correlation of all nine traits were measured. Bunch compactness showed significant correlation with number of berries/bunch (-0.29), berry length (-0.29), berry diameter (-0.31) and berry weight (-0.44). Berry diameter was significantly correlated with bunch length (0.27), bunch compactness (-0.31), bunch weight (0.28), number of berries/bunch (-0.32), berry length (0.83) and berry weight (0.72). Utilization of varieties with loose bunches and bold berries as one of the parent in breeding programme for improving the commercial variety will significantly reduce the cost of cultivation in grapes.

S2O4 A608

Diversification of Temperate Fruits in Western Himalayas: Alternate to Climate Change

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Variation in climatic conditions and short-term abrasions in weather parameters has raised levels of uncertainty, vulnerability and risk of investments in horticulture. Horticultural production and horticultural science are both intimately involved with the debate and the policy shifts that are occurring around the factors that are closely associated with climate change. Aside from greenhouse crops, where knowledge about plant responses to environmental factors are generally well defined, our knowledge about the responses of field crops in general and perennial crops in particular is very poorly developed. Improved understanding of the consequences of inadequate winter chilling, and the means to counter that, are critical to the continued growth and survival of many temperate perennial crops – and yet our current knowledge is quite inadequate to deal with the changes that are occurring. The same can be said for knowledge about climatic factors and the development of maturity of different fruit crops. In the face of warmer temperatures due to climate change, winter chill requirements will become harder to meet in many important temperate-fruit and nut-producing areas. There is large scope for diversification of temperate fruits which can fit in to changing climatic situations and can tolerate biotic and abiotic stress under fragile Himalayan ecosystem. The identification of new species, their characterization, conservation and sustainable utilization is the key to improve agricultural productivity and sustainability, therefore contributing to national development, food security and poverty alleviation. Future fruits like black berries, blue berries, sour cherry, raspberries, persimmon, rose hips, Chinese jujube, cape gooseberries, Red currants, kiwi fruit, nectarines, olive, apricot and un tapped nuts like hazel nut, chest nut having nutraceutical, ecological and economical importance special attention in respect of introduction, collection, evaluation, production technology, sustainable exploitation.Majority of these future fruits contain phyto chemicals of nutraceutical importance. These phytochemicals, either alone and/or in combination, have tremendous therapeutic potential.

S2O5 A41

A new pummelo cultivar NRCC Pummelo – 5 released for cultivation

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Pummelo (*Citrus grandis*) is one of the cultivated citrus groups, which is mainly consumed for its medicinal properties. Rich antioxidant profile makes it highly suitable for kidney and heart ailments. Though both white and coulored fleshed pummelo cultivars are available, the red flesh coloured are more appealing, preferred by consumers and demanded in markets. ICAR-CCRI, Nagpur has released a new red flesh coloured pummelo viz., NRCC Pummelo-5. The soft tendered segment new variety has an average fruit weight of 800 - 850 g with high juice content, 115-120 mm fruit length, 114-120 mm fruit diameter and 17-18 mm fruit axial diameter. The rind thickness of fruit is 9-11 mm and it contains 11-12 segments with avg. 25-35 seeds/ fruit. It has a good acid: TSS blend with 0.90 to 0.98% acidity and TSS 11 to 13° Brix. Its yield potential is very high, a fifteen year old tree bears about 400-500 fruits with avg. yield of 80-90 ton/ha at 6 x 6 m spacing plantation. The NRCC Pummelo-5 contains higher total flavonoids content in peel (152.04 mg/l) and juice (22.14 mg/l). The antioxidant capacity in terms of TEAC (Trolox equivalent antioxidant capacity) of NRCC Pummelo-5 was found to be very high in. No new insect pest and diseases were observed on this variety.

S2O6 A564

Underutilized *Allium* resources: A substitute to onion & garlic in India

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The genetic resources of *Allium* in India are potential source of genes for widening the crop genetic base. Genus *Allium* is widely distributed in the northern temperate and Alpine regions of the world. National Bureau of Plant Genetic Resources & Directorate of Onion & Garlic Research has undertaken plant exploration and collection activities in different regions of India and assembled wide diversity in cultivated (*A. cepa* L.) and wild *Allium* species. ICAR-DOGR is the National Active Germplasm Site (NAGS) for onion and garlic germplasm. The present collection exceeds 2250 accessions of red, white and yellow Alliums from different parts of the country including exotic introductions. *Allium* species collected from within the country (15 species) as well those (13 species) imported from USA, Netherlands and Germany are being maintained vegetatively under field conditions. These constitute in total 139 accessions of 30 species. Underutilized and wild *Allium* species are being multiplied and characterized for flowering, number of tillers/plant, foliage characters, shape, presence of wax etc, diseases as well as at molecular level for utilization in breeding programmes. Nine

of these were evaluated for their foliage palatability and *A. tuberosum* found to produce foliage year round which can be harvested at monthly interval after about 2 months of establishment. A total of 36 lines of wild accessions were screened for natural incidence to Leek Yellow Stripe Virus (LYSV), Iris Yellow Spot Virus (IYSV) and Onion Yellow Dwarf Virus (OYDV). *A. angulosum* was found positive for IYSV. Five accessions of *Allium fistulosum* L., *A. cepa* L. (Common Onion Group Uzbekistan), *A. schoenoprasum* NR-6 and *A. oschaninii* werefound positive for LYSV.Two accessions *viz. A. altaicum* Pall. and *A. fistulosum* L. (HP-1) were found positive for OYDV. Further it was possible to force to flower non-flowering lines under Indian plains by inductive photoperiod and GA3 for its maintenance and possible utilization in breeding programme. Pollen cryoconservation has been attempted in *Allium cepa* and *Allium clarkia* at -80ºC storage. In vitro regeneration was explored using root tip explants of *A. tuberosum*. In brief, these underutilized *Allium* species can be exploited as a substitute to onion & garlic as food, condiment/flavor, medicinal use besides its ornamental value.

S2O7 A341

Agro-morphological characterization and genetic divergence studies in garlic germplasm during *kharif* season

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Garlic (*Allium sativum*) is the most important *Allium* species grown in India, after onion. It spite of its exclusive propagation through the vegetative method, the crop shows a wide variation in agro-morphological traits. Inability to form seeds becomes a barrier for using techniques of introgression for breeding. In India, its growth is restricted to the *rabi* season. This study covers characterization and adaptation of garlic genotypes under *kharif* season. ICAR-DOGR serves as the National Active Germplasm Site (NAGS) for garlic, where 700 garlic lines of germplasm collected from different parts of India are maintained. For testing the agro-climatic adaptability of these garlic genetic resources, the present experiment was laid out. In all, 625 accessions were evaluated during the *kharif* season for nine quantitative and five qualitative traits, in two replications, for two years. Through pooled analysis, only 68 bulb-forming accessions were selected for further study. Average values of different traits were used for secondary analysis, as, a non-significant difference found between year-to-accession interaction. Cluster analysis (Ward 1963 method) based on 14 agro-morphological traits assorted 68 genotypes into five main groups as: Cluster 1 (11 accessions), Cluster 2 (7 accessions), Cluster 3 (3 accessions), Cluster 4 (33 accessions) and Cluster 5 (14 accessions). A dendrogram developed based on hierarchal clustering grouped the genotypes as per morphological traits, but this grouping did not correspond with geographic origin of the genotypes. Characters like marketable yield, polar diameter, equatorial diameter, average bulb-weight, number of cloves per bulb and TSS were the major traits for distinguishing major clusters of garlic genotypes at a phenotypic level. Highest genetic distance (14.44) was found between Accession No. 202 and DOGR-499. Accessions ‘695’ and ‘14’ were found to be the most similar, showing minimum genetic distance (0.95). Principal component analysis revealed that the first five components contributed a maximum of 95% of the variability.

S2O8 A72

Exploration of tuber crops in southern districts of Assam

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An Exploration was conducted in the Southern districts of Assam comprising of Karbiyanglong, Dima Hansao, Hailakandi and Karimgunj regions. These regions has tremendous potential for cultivation of tuber crops like sweet potato, colocasia, cassava, dioscorea, amophophallus, etc. With diverse agro climate coupled with varied soil and rainfall, the region is suitable for tuber crops cultivation and provides food and nutritional security. Tapioca, colocasia and dioscorea are common crops grown in the jhum or shifting cultivation fields. Sweet potato and colocasia are grown not only in the hills but also in the plains areas. In dioscorea, both *Dioscorea alata* and *D. esculenta* are grown mostly in the backyards and the tubers are even collected from the nearby forests. Similarly, different types of *Colocasia, Xanthosoma, Amorphophallus* are found to grow both in nature and in kitchen gardens of the natives. The crops being vegetatively propagated, selective sampling method was practiced. But in few cases random sampling was made from farmer's field where crops were grown in large number. Most of them are grown as mixed crop with ginger, chilli, brinjal, beans, etc. Since these crops do not require much attention and no serious disease or insect damages are observed, they get preference as risk aversion crops. A total of 89 crop species comprising of 35 yam, 28 taro, 8 sweet potato, 6 xanthosoma, 5 cassava, 4 arrow root, 2 elephant yam and a *Stemona tuberosa* were collected. Out of four districts covered, diversity in yam and taro was observed in Karbianglong and Dima Hasao offering scope for taxonomic studies. Typical to the North East tribal culture, women play leading role in all the farm activities. There is excellent scope for multi-crop explorations combining crop wild relatives and landraces diversity. It would be worthy to explore these regions for crops such as cucurbits, leafy vegetables, brinjal, cowpea and maize.

S2O8A A589

Elite clones of nutmeg from Kerala, India

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Nutmeg (*Myristica fragrans* Houtt.) is unique among other tree spice crops, as the donor of two distinct spices namely the nutmeg and the mace. Being a cross pollinated crop, there exists tremendous variability in the nutmeg population in Kerala which is the major nutmeg growing state in the country. Systematic crop improvement work is yet to gain momentum in his crop. Present production and productivity of the crop are far from required. An explorative survey was taken up by Kerala Agricultural University to locate super trees of nutmeg from farmer's holdings in Kerala during 2013-2017. Thirty distinct accessions were located and were subjected to mother tree characterization for three consecutive years. Morphological as well as biochemical characterization was carried out in full bearing trees of uniform age. Wide variability was observed among the accessions for tree, leaf and flower characters, fruiting pattern and number of fruits produced. Significant variation for fruit, nut and mace characters was also recorded. Biochemical characterization showed variation in volatile oil, fixed oil and oleoresin content of nut and mace and also in the content of the principle compounds *viz* myristicin, elemicin, safrole and sabinene. Based on yield and quality parameters five accessions have been found promising. These elite clones were characterized by 100% female flowers, 1-3 fruits/cluster, producing 1500-2500 fruits/tree/year. Single mace weight (dry) ranged from 1.36g -3.02g and single nut weight (dry) ranged from 10.85g-13.85g. Nut oil content was in the range of 4.5-6.9%, mace oil 9.00-12.06%, nut oleoresin 24.80-41.75%, mace oleoresin 14.30 to 28.7% and nut fat 22.63-34.63%. Myristicin content ranged from 1.00 to 12.42% in nut oil and 0.73 to 17.17% in mace oil. Elemicin was present to the level of 0.48-12.25% in nut oil and 0.49-6.93% in mace oil. Sabinine content also varied in the nut oil (27.27-38.39%) and mace oil (22.94- 30.81%). These clones are now recommended for commercial cultivation which can contribute to a great extent in improving the productivity of nutmeg in Kerala, India.

S2O10 I42

Realization of *Ficus carica* L. morphogenic capacity through organogenesis and somatic embryogenesis *in vitro*

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Common fig (*Ficus carica* L., *Ficus*, Moraceae) is a valuable food and medical subtropical plant. The aim of our investigations was to study various ways of *in vitro* morphogenesis in *F. carica* for its

cultivars micropropagation and gene pool conservation. Fig microshoots from the meristems on WPM and MS culture media with 0.5-2.0 mg/l BAP, 5-2.0 mg/l kinetin, 0.1-0.5 mg/l NAA, 0.1-0.5 mg/l IAA, 0.1-0.5 mg/l GA_3 were regenerated. WPM medium with 0.5-2.0 mg/l BAP and 0.1-0.5 mg/l NAA was optimal for direct organogenesis and microshoot multiplication. Among ten studied cultivars eight was characterized by a high regeneration capacity (15-25 microshoots/explant). Shape of the leaf blades in the cultivars 'Smena', 'Figue Jaune' and 'Die Dalmatie' in its morphological features *in vitro* was similar to the donor plants *ex situ*. Single regenerant has 3-12 leaves. Leaf blades were thin, bifacial, hypostomatic. Cover tissues were represented by a single-layer epidermis and thin cuticle, with multiple trichomes. Stomatal apparatus were of anomocyte type. The mesophyll was differentiated, consisted of 3-5 cell layers. The total volume of intercellular spaces did not exceed the volume of chlorenchyma cells. The values of photosynthetic activity indicated the normal functioning of the assimilation apparatus. Total water content in regenerants was 83-88%. An effective way of morphogenesis realization was somatic embryogenesis from the leaf segments of juvenile fig plants *in vitro*. Induction of morphogenic callus, somatic embryos formation and seedlings development in the cultivars 'Belyiy Ranniy', 'Sabrutsiya Rozovaya' and 'Violette' was observed on MS medium with 1.5-3.0 mg/l 2,4-D and 3.0-4.0 mg/l TDZ. 60-90% of seedlings were regenerated from somatic embryos. Histological analysis of morphogenic structures in some fig cultivars was carried out. At the base of microshoots spontaneous and induced rhizogenesis was observed.

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S2O11 A213

In vitro screening of grape root stock genotypes for NaCl tolerance and molecular characterization of grape rootstock genotypes with EST SSRs for salinity

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In vitro screening of nine grape rootstocks under graded doses of NaCl supplemented in culture medium revealed that all the genotypes tolerated upto 50 mM of NaCl, except 110 R and 1613 C, which tolerated 25 mMNaCl.Tolerance rate calculated based on the shoot anddry weight showed that 140 Ruggeri &Salt Creek and 1616C & 1103 P had the highest shoot and root tolerant respectively as againstlowest shoot tolerance in 1613C and 110 R . The photosynthetic pigments in the cultures with 100 mMNaCl were reduced 1.07-2.3-folds compared to control and Dogridge recorded the highest total chlorophyll content (2.296 mg/gFW).The increase of total phenols and total sugars upto 50mM was about 0.42- and 0.10-fold, respectively, whereas, proline and total soluble proteins upto75 mM was about 6.5- and 1.25-fold compared to the control.The rootstocks 110 R and 140 Ruggeri had 9.45- and 9.16-fold increase in proline content, 1616C, 1103 Paulsen had 0.96- and 0.85-fold increase in total phenols content, Salt Creek, 140 Ruggeri had 0.26- and 0.19-fold increase in the total soluble sugars compared to the control.The enzyme like catalase, superoxide dismutase and ascorbate peroxidase activities increased upto 50 mMNaCl, further elevated concentration showed decline trend.The enzymes such as catalase,

superoxide dismutase, ascorbate peroxidase activities were maximum in rootstock genotypes like Salt Creek (6.65 mM H_2O_2 reduced /min /mg protein), 1103 P (317.3 unit per mg protein per min.) and 1103 P (22.40 unit per mg protein per min.) as lowest in rootstock genotype *V. parviflora*(3.92 mM H_2O_2 reduced /min/mg protein), 1613C (100 units per mg protein per min.) and 110 R (13.7 unit per mg protein per min.), respectively.The shoot Na content was 4.5 times higher at 100 mMNaCl, while in root tissues 2.1 times higher at 75mM NaCl as compared to control. K content in the shoot and root tissues were reduced by 1.2 times at 100mM and 3.1 times at 75 mM, while Cl^- content increased by 0.67 times at 100mM in shoottissue ,Cl^- content was elevated by 2.5 times in root tissue as against control. The rootstocks 110R, 1613C and St.George were found as potential Na^+ excluder as they retained higher Na^+ in their roots.The rootstocks 140 Ruggeri, 1103P and Salt Creek accumulated significantly less Cl^-, indicating their capacity to exclude Cl^- at higher NaCl levels.Thus,the genotypes weregrouped into three categories, namely, (i) Tolerant type (1103P, Salt Creek & 140 Ruggeri), (ii) Moderately tolerant (Dogridge, 1616C &St.George), and (iii) Sensitive type (110R,1613C &*V. parviflora*). Screening of parental lines (15 genotypes) with EST SSRs specific for salinity trait produced 308 reproducible putative alleles with an average of 1.67allele/locus, indicating their efficient transferability and presence of greater magnitude of diversity. Maximum number of alleles (26 alleles) with 19 EST SSRs were produced in the rootstock 140 Ruggeri and 1103 Paulsen (24 alleles) indicating maximum salinity tolerance compared to lowest in Degrassete and Perlette (17 alleles) each.Thus, the *in vitro* screening and molecular analysis confirmed that 140 Ruggeri and 1103P are as tolerant genotypes for salinity.

S2O12 A340

Loop-mediated isothermal amplification for rapid and sensitive detection of *Xanthomonas axonopodis* pv. *punicae* infecting pomegranate

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Xanthomonas axonopodis pv. *punicae* (Xap), a gram negative, host-specific bacterium causing bacterial blight of pomegranate (*Punica granatum*), is a serious threat to pomegranate cultivation in India. Diagnosis of this infection is usually done by conventional PCR techniques and qualitative ELISA. In the present study, loop-mediated isothermal amplification (LAMP) assay, based on amplification of *Gyrase*β (gyrβ) gene, was developed for detecting Xap infection in plants. Sensitivity of the LAMP assay was evaluated and effectiveness of this method was compared to real-time PCR. Detection limit with LAMP assay was 1fg/µl of purified Xap DNA compared with the conventional PCR that showed amplification at only upto 1pg/µl concentration of DNA. Time limit for detection was found to be 45 and 60 min of incubation, respectively. Sensitivity of the LAMP assay was determined as 10 copies per reaction-mixture, against single-copy detection using real-time PCR. The LAMP assay was able to detect Xap from the crude extract of infected samples collected from different locations, without isolating the pathogen or purifying genomic DNA. Pathogen extract from infected leaf was visualized as increase in turbidity and colour-change from violet to sky-blue, with pre-addition of HNB. Thus, the LAMP method shows great potential for monitoring disease incidence and could prove to be a powerful tool for supplementing current diagnostic methods.

S2O13 A231

Screening of SSR Markers in Acid lime (*Citrus aurantifolia* Swingle) accessions in India

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Acid lime (*Citrus aurantifolia*Swingle) is an important commercial fruit crop, cultivated in our country. India is a leading producer of acid lime in the world followed by Mexico. Fruits are used for culinary and non-culinary purposes. Juice, pickles, whole fresh or dry fruit and slices of acid citrus are widely used in Indian dishes. It has wide sexual compatibility among Citrus and related genera. Besides, high frequencies of bud mutation, a high level of genetic erosion and narrow genetic base have also been reported in acid lime. High variation of acid lime fruits is observed in existing varieties due to crossing within crossing within the other citrus species. Determination of genetic variation is important to the plant breeders for development of high yielding variety and hybrids. In the present study, Simple Sequence Repeats (SSR) were selected for screening the Acid lime accessions collected from different parts of the country. A total of 76 Acid lime accessions along with 10 cultivars were taken for this study. Based on initial screening, 110 EST-SSR primers were selected and 45 Genic-SSR markers were also randomly selected from *Citrus sinensis*genome. By combining both EST-SSR and Genic-SSR, eight markers showed polymorphism in all the selected accessions. Some primers showed polymorphism in dominance patter also. The identified set of polymorphic markers can further be used for the genetic variation assessment of acid lime accessions collected from across the country. These can also use to remove the redundant accessions and develop a core germplasm collection of Acid lime for future utilization

S2O14 A26

Production of triploids and tetraploids in sweet orange by innovative *in vitro* and *ex vitro* propagation techniques

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Citrus is one of the most important fruit crop worldwide and plays a major role in the economic development of some areas. Seedlessness is an elite horticultural attribute for fresh fruit and success of processing industry. Therefore, development of seedless commercial varieties of Citrus spp is an important objective of breeding program worldwide. Citrus triploids are usually seedless due to abnormal meiosis and embryo abortion. Heading in this direction CCRI, Nagpur explored a novel method of creating triploid plants from hybrid endosperm tissue via somatic embryogenesis. Further, developed a new methodology based on a novel microbudding technique combined with treatment of minute micro bud with colchicines to achieve chromosome doubling. Complete plantlet regeneration

obtained via somatic embryogenesis from hybrid endosperm of sweet orange with different concentrations of Gibberellic acid. Stable tetraploids of sweet orange have been obtained directly from microbudding combined with colchicines treatment. Successfully surviving plantlets of triploids from endosperm rescue and tetraploids with colchicines treatment via microbudding were tested for ploidy by flow cytometry with Partek ploidy analyzer. The results demonstrated recovery of stable triploids and tetraplopids. These stable tetraploids will be used in future 4x X 2x hybridization, to recover triploids in 3-4 years, which is first of its kind in the field of citrus triploid breeding in India that can overcome the barriers to sexual hybridization towards breeding seedless citrus scion cultivars.

S2O15 IS64

Cashew Enhancement Project Of The Department Of Agriculture-Palawan Agricultural Experiment Station (Da-Paes) In Palawan, Philippines.

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The Cashew Enhancement Project is a comprehensive multi-agency initiative aimed specifically to increase the production of cashew nuts through provision of seedlings and farm input, good agricultural practices in strategic locations, and the organization of cashew farmers to strengthen management and entrepreneurial capabilities. The study was conducted in the established cashew farms in the Municipality of Roxas, Taytay, and El Nido, Palawan. The 375 respondents categorized as beneficiaries, non-beneficiaries; organization officers were randomly selected and interviewed. All the respondents have formal education, 53.52% are women while most of them are engaged in farming for at least 10 years and their mean farm area is 3.0 hectares. The respondents' main source of income is farming and 6 of the existing organizations are engage in processing of cashew as an enterprise. Mean annual income of beneficiaries is Php 161,716.36 while the non-beneficiaries and organization officers have annual income of Php 115,015.03 and Php 108,591.10, respectively. The sufficiency of access to buyers significantly predicts the mean yearly income of the respondents while sufficiency of production support predicts the non-beneficiaries' mean yearly income. The organizational strength with respect to access to facilities and ownership to resources and sustainability analysis in the areas of marketing are significant predictors of application of gained knowledge in farming system. Result revealed increase in the degree of participation of the farmers to the project enhancement and management capability of officers of the existing organizations is attributed by their active involvement in the organizational activities. Thus, study revealed that the strength of the organization and sustainability analysis of the project are associated with the enhancement in farming system established in farmer's farms and the impact on production and income.

S2O16 A346

Identification of polymorphic SSR markers for genetic diversity and mapping studies in oil palm (*Elaeis guineensis* Jacq.)

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Oil palm (*Elaeis guineensis* Jacq.) belongs to the family Arecaceae. It is a rich source of perennial vegetable-oil in the country. To sustain edible oil requirement in the country, oil palm is one of the best options due to its high oil-yield (4-6 t/ha) potential compared to other annual oil-yielding crops. Polymorphic SSR markers play a very important role in genetic diversity and mapping studies in a crop like the oil palm. With this aim, we screened 110 SSR markers in eight oil palm genotypes. Of these, 44 were found to be polymorphic and 66 were monomorphic. Number of alleles ranged from two to six. Highest PIC (Polymorphism Information Content) value was observed with the primer, mEgCIR0779 (0.76), while the lowest was observed with mEgCIR3288 (0.11), at an average value of 0.38. Genetic diversity ranged from 0.12 (mEgCIR3288) to 0.79 (mEgCIR0779), with an average value of 0.45. Based on PIC and other genetic parameters, four highly-polymorphic markers, *viz.*, mEgCIR0779, mEgCIR0782, mEgCIR2347 and mEgCIR2595 were identified. These can be used in further breeding programmes. The 44 polymorphic SSRs identified grouped the eight genotypes into two major clusters and it turned out that the clustering pattern was not based on geography. These 44 polymorphic SSRs are being used by us to study genetic diversity and to map the Indian and exotic collections of oil palm in our germplasm.

S2O17 A347

Genome-wide association study (GWAS) of oil-yield related traits in oil palm (*Elaeis guineensis* jacq.) using SNPs and SSR markers

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Oil palm (*Elaeis guineensis* jacq.), a perennial crop of the family Arecaceae, is a major source of edible vegetable-oil in the world. Genome-wide association study (GWAS) has emerged as a powerful tool, particularly in human populations, to identify a broad range of complex diseases, now widely used in annual plants. In perennial crops like oil palm, it can be gainfully employed to identify quantitative loci influencing important traits, and, to look for their potential use in marker-assisted selection (MAS). We carried out GWAS in oil palm (*Elaeis guineensis* Jacq.) using SNPs by genotyping

through sequencing and genome-wide SSRs. Genotyping by sequencing was done using Illumina NextSeq500 platform, through paired-end libraries on 96 well-structured germplasm collections. SNP calls for over 80% only, to be considered for association-mapping analysis. A total of 4031 significant SNPs were used for association-mapping of oil-yield related traits, and a short stature of the palm. Three major QTLs were identified for height increase on Chromosomes 6, 7 and 9, which together explained 41% of the phenotypic variance. Two QTLs were identified for bunch-weight on Chromosome 1, which accounted for 24% of phenotypic variance each. Five QTLs were identified for per cent oil-to-bunch ratio. Association mapping of SSR marker data with phenotypic data in eight oil-yield related traits resulted in identification of four significant QTLs, by the MLM approach, at a significant threshold (P) level of 0.001. Significant QTLs were identified for fruit-to-bunch and oil-to-bunch traits, which explained R^2 values of 12.9% and 11.5%, respectively. This is the first report on association mapping in oil palm germplasm using SNPs and SSR markers. Significant markers linked to the above traits will be used in forthcoming MAS programmes

S2O18 I34

Assessing the genetic diversity of South African sweetpotato germplasm using DNA markers

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Sweetpotato is one of the most important food crops in developing countries including South Africa. Currently two major types of cultivars are grown in South Africa: one is the orange-fleshed sweetpotato (OFSP) which has high β-carotene content, a precursor of vitamin A. The second type is the cream-fleshed sweetpotato (CFSP) which has low β-carotene content but is high in dry matter. Most South Africans prefer the CFSP although the OFSP offers more advantages. This presents a challenge to plant breeders to develop new varieties that will combine the desirable qualities of both the cultivars. To achieve this goal, plant breeders need knowledge about the genetic variation of the crop to develop an efficient breeding programme. This study assessed the genetic relationships of 28 orange- and cream-fleshed sweetpotato accessions by (i) examining the variation in leaf proteins, (ii) using random amplified polymorphic DNA (RAPD) and, (iii) using variation of the ITS region. The analysis of proteins, RAPD and variation of the ITS region polymorphism levels were 55.6%, 98% and 16.5%, respectively. Dendrograms generated from all the analyses generally clustered the accession according to their flesh colour and country of origin. Analysis of molecular variance (AMOVA) found a significant difference between OFSP and CFSP and a significant difference between the South African and non-South African germplasm. The high genetic diversity in the South African sweetpotato germplasm is a positive indicator for a breeding programme that has a number of targets such as breeding for nutritional improvement, disease resistance and drought tolerance.

S2O19 A445

Feasibility of commercial scale micropropagation of papaya (*Carica papaya* L.)

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Papaya is an important fruit crop of the tropics and sub-tropics of the world. It is propagated mainly using seeds. This makes the propagation approach reliant on seed production with various, associated issues. Further, seed population shows segregation into different sex forms – male, female and hermaphrodite. In the absence of standard methods for vegetative propagation in papaya, micropropagation offers a scope for rapid clonal multiplication. Several reports are available on micropropagation in papaya but, so far, commercial production has not been as successful as in the banana tissue culture industry. For commercial viability, the multiplication rate needs to be quite high and cost-effective. Threat from microbial contamination, low culture-establishment, poor multiplication rate, recalcitrance to rooting and difficulty at the hardening/ acclimatization phase are major limiting factors in the micropropagation of papaya. Of these, a crucial factor limiting sustained micropropagation in papaya is interference from endophytic microorganisms at culture initiation, and during the course of micropropagation. A novel and robust method for rapid, clonal multiplication of papaya through multiple shoot induction, from seedling explants or axillary shoot explants from field-established individuals, with modifications in medium composition and management of interfering endophytes has now been optimized at our laboratory. This protocol works across papaya cultivars, with annual multiplication potential of >1 million plantlets from a single proliferating stock. This protocol allows long-term culture maintenance and continuous multiplication for several years, without a need for recurrent culture-initiation. Further, it enables selective clonal propagation of hermaphrodite papaya types through marker-assisted selection of cultures.

S2O20 I50

Research Status and Improvement for supply of Seed bulb induced by Meristem culture on Garlic in Korea

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In Korea, garlic (Allium sativum L.) is one of the important vegetable crops. Viral diseases of garlic in Allium plants have became widespread, causing serious losses in Korea. GLV, LYSV, SLV, OYDV and Allexi are main causative virus that leads to destruction of garlic plant. To solve with this phenomenon, the virus-free seed bulb supply system is developed and disseminated. However, to produce the yield-stable seed garlic against the continuous cultivation, induced-meristem-culture cultivation technique is

necessary. This research was conducted to investigate the incidence of viral infection, preservation for seed bulb ability and yield change during annual cultivation using virus-free seed bulb after meristem culture. The used materials were tested by meristem culture garlic produced from 2007 to 2015 as 1st to 9th yearly in the field. Virus infected rate were 25% before spouting and 52.8% after sprouting. 15.0 - 20.0% of the most common infection was caused by Allexi virus and more than 5 kinds of plants have mosaic symptoms. The bulb weight of the meristem culture was 72.3g in the 1st year and 57.1 in the 7th year against the 43.9g of the convention alone. The 9th year in bulb weight are now in harvest and will be available at the time of presentation. That means the meristem one can show higher yield but the yield is decreasing by the years. The rates of viral infections were 3.3% at 2nd years, 10% at 5th years and 26.7% at 7th years in LYSV(leek yellows tripe virus). The rates of multi-viral infections such as LYSV and OYDV(onion yellow dwarf virus) showed a similar trend as 6.7% at 2nd years, 115.0 at 5th years and 23.3% at 7th years in the field after the meristem culture.

S2O21 A328

Study on cross-species transferability and DNA fingerprinting in *ashwagandha*(*Withania somnifera* (L.) varieties, morphotypes and chemotypes using SSR markers

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Ashwagandha [*Withania somnifera* (L.) Dunal., Solanaceae] is a dicotyledonous plant of high repute in the Indian system of medicine, finding use as an anti-inflammatory, anti-tumour, anti-stress, antioxidant, mind-boosting, immune-enhancing, aphrodisiac, liver tonic, astringent and, more recently, to treat ulcers, bacterial infections, venom toxins and senile dementia. Its therapeutic value is ascribed to various bioactive molecules (withanolides) synthesized and accumulated in its leaves and roots. Since intra-specific variations are a frequent phenomenon in the Solanaceae, it is observed that considerable morphological and chemotype variations occur in this species, leading to development of several morphotypes and chemotypes. Lack of sequence information in *ashwagandha*has hindered development of SSR markers in this species. In breeding programmes, to avoid ownership conflicts and protect farmers'/ plant breeders' rights, there is a need to identify unambiguously different varieties, morphotypes and chemotypes using DNA fingerprints. In view of this, cross-transferability of SSR markers from related species was studied. Cross-species amplification of 85 SSR markers from eggplant (29), potato (17) and pepper/ capsicum (39) was tested in 186 accessions of *ashwagandha*. Forty primers of the 85 produced specific and scorable PCR products. In our study, 48.35% of eggplant markers, 47.1% of potato markers and 51.3% of capsicum markers showed amplification and these were transferable to *ashwagandha*. For DNA fingerprinting, 14 *ashwagandha* genotypes comprising three varieties, four chemotypes and seven morphotypes were selected. Eighty-five SSR primers were initially screened and 40 primers were selected based on amplification. A total of 74 alleles were detected and, except for 4 primers, all were 100% polymorphic among genotypes. Number of alleles detected ranged from 1 to 6, with an average of 1.85 alleles per primer-pair. Number of polymorphic bands varied from 1 to 6.

Polymorphic information content (PIC) value ranged from 0.138 to 0.995, and was at an average of 0.639. Among the 74 alleles detected, 7 were specific to the variety Arka Ashwagandha, while, one allele was specific to the variety JA-20. As for the morphotypes, three alleles each were specific to IIHR-WS-25 and IIHR-WS-74, four to IIHR-WS-110, and one allele each to IIHR-WS-107 and IIHR-WS-139. Similarly, four genotype-specific alleles were obtained for each of the chemotypes, IIHR-WS-V3 and IIHR-WS-111. Thus, this study, for the first time, reports the use of cross-species SSR markers showing adequate amplification in *ashwagandha* for genotype DNA fingerprinting.

S2O22 A407

Towards cloning nematicidal *cry* genes from Indian isolates of *Bacillus thuringiensis*

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A total of 50 Bt isolates, collected from various sources, were used for screening for presence of nematicidal crystal protein genes. Both *cry5* and *cry55* specific screening primer-pairs were used for PCR screening, along with a reference strain which was positive for both *cry5* and *cry55* genes. Crystal morphology studies revealed a majority of the crystal proteins as being amorphous and bipyramidal in nature. SDS-PAGE analysis of the crude protein-mixture showed a prominent crystal-protein band. PCR analysis revealed 13 isolates to be positive with *cry5* specific primers and 23 isolates positive with *cry55* specific screening-primers. Further, five PCR fragments were sequenced, and two PCR products were found identical to *cry5B* while three were found identical to *cry55a* genes, with 99% similarity.

S2O23 A297

Genetic diversity analysis of Asiatic lily genotypes through morphological and Sequence Related Amplified Polymorphism (SRAP) markers

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Sequence Related Amplified Polymorphism analysis was applied in studying the diversity and genetic relationships of 15 Asiatic lily genotypes. Ten morphological traits and Sequence Related Amplified Polymorphism (SRAP) analysis were carried out using eighteen primer combinations out of

which, ten primer combinations revealed a total of 122 scorable bands, among which 86 were polymorphic with an average of 8.6 polymorphic bands per pair of primers. The percentage of polymorphism ranged from a maximum of 81.82 per cent in Me 1 + Em 13 primer combination to a minimum of 40.00 per cent by Me 2 + Em 2. For morphological analysis, an unweighed pair-group method using an arithmetic average was used to construct a dendrogram. The genotypes with superior commercial characters, such as stalk length, bud length, bud diameter and based on colour were clustered together. The SRAP profiles generated were evaluated for studying the Jaccard's similarity coefficient. The similarity matrix coefficient ranged from 00 to 67 percent, suggesting a low to moderate genetic variation within lily genotypes. On comparing the genetic diversity as revealed by the dendrogram, it was evident two genotypes were identified quite distinct from other genotypes.

S3O23a A403

Genetic variability, heritability and genetic advance in mango for nutraceutical compounds

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Mango is a major fruit crop of India, with a lot of variability for fruit colour, size, shape, and quality. It is also known that genotypic variability exists for nutraceutical compounds in mango. Mango is a rich source of dietary antioxidants such as phenolic compounds and carotenoids. Profiling of mango genotypes for nutraceutical compounds was carried out to evaluate genotypic / phenotypic variance, GCV, PCV, heritability, genetic advance other genetic parameters to identify superior parents for use in developing nutritionally-rich hybrids. Results revealed significant variance among genotypes for all the traits studied. Phenotypic coefficient of variation (PCV) for all the characters was slightly higher than the genotypic coefficient of variation (GCV), indicating presence of, to some degree, an environmental influence on phenotypic expression of characters. Among the genotypes, variability for total phenolics varied from 24.44 to 148.33mg $100g^{-1}$ of pulp, total flavonoids 10.33 to 49mg $100g^{-1}$, total carotenoids 0.48 to 7.50mg $100g^{-1}$ and total antioxidants 0.14 to 1.59µmol Trolox $100g^{-1}$ of pulp. Thus, results reveal presence of a wide genetic variability in the mango gene-pool for nutritional compounds. Future genetic estimates showed broad-sense heritability (H^2) for all the compounds to be high, as did total carotenoids (98.17 %), total antioxidants (98.09 %), total phenolics (95.85 %) and total flavonoids (93.54 %). Our study provides information on nutritional status of various genotypes, and for identification of superior parents for developing nutritionally-rich hybrids.

S2O24 A409

Hybridization for improvement in quality and disease resistance in apple (*Malus domestica* Borkh.)

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ICAR-Central Institute of Temperate Horticulture, Srinagar, has the largest field gene-bank of temperate fruit crops in India, representing about 253 indigenous and exotic cultivars of apple. Apple cultivars commercially grown in India have a good color and taste, but low shelf-life and aroma. Also, most of the commercially grown cultivars are susceptible to scab. Apple cultivars used for pollination, like Golden Delicious, have lower acceptability in the market due to poor fruit quality. A breeding programme for developing superior varieties in apple was initiated in 2009, at Central Institute of Temperate Horticulture, mainly with the aim of transferring traits like disease resistance, regular bearing, higher shelf-life, earliness, fruit quality, pollinizer ability, etc. into commercially acceptable apple cultivars. Trait-specific varieties in apple (Firdous, Mayan, Mollies Delicious, Red Spur, Star Crimson, Golden Delicious, Granny Smith, etc.) were used as the source for trait-transfer to elite cultivars like Winter Commercial, Top Red, Gold Spur, Well Spur, Oregon Spur, Cooper IV, Red Delicious, etc. Hybrids obtained have been evaluated for quality traits after top-working, and six hybrids have been identified that are superior in fruit-quality traits. These are being multiplied on a large scale for further evaluation and commercialization. Molecular markers specific to traits like scab resistance, S-allele typing, etc. have been used for screening these hybrids.

S2O25A534

Prospects of Induced Mutations for Genetic Improvement of Thompson Seedless

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Until the 20th century, spontaneous mutations were the only source of novel genetic diversity that could be exploited in selecting superior plant types. Some of the economically superior spontaneous mutants/chimeras in grapes are: Tas–A–Ganesh, Sonaka, Manik Chaman, A 17/3 and Clone 2A from Thompson Seedless; Pinot Noir, Pinot Gris, Pinot Blanc, Pinot Meunier, Pinot Tenturier and Pinot Noir

Precoce from original variety Pinot; and Sharad Seedless a mutant of Kishmish Chorni. However, frequency of such spontaneous mutations is extremely low in the nature. A leap in plant breeding came when physical mutagens (ionizing radiations) and chemical mutagens were shown to modify the genetic make-up of organisms. Physical and/or chemical mutagens cause random changes in the nuclear DNA or cytoplasmic organelles, resulting in gene, chromosomal or genomic mutations. Induced mutagenesis is an established method for plant improvement, wherein, plant genes are altered by treating seeds or other plant parts with chemical or physical mutagens. Development of "self-thinning" variety of Perlette through radiation induced translocation is one of the important examples. Colchicine has also been extensively documented as a potent ploidy inducer and this chemical has been widely used to induce polyploidy in several crop plants using *ex vitro* and *in vitro* methods. Polyploids are generally vigorous and produce large sized leaves and fruits. Research on creating gene and ploidy variations in Thompson Seedless for economically important traits was initiated at ICAR-NRCG and the investigations are under progress. LD_{50} doses for gamma-rays and ethyl-methane sulphonate (EMS) were determined in stem segments of Thompson Seedless. LD_{50} concentrations for colchicine are also being determined using *in vitro* methods.

S2O26 A766

Paradigms of Indian Citrus Improvement Programme

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Citrus comprises mandarin, sweet orange, acid lime, lemon, pummelo and grapefruit as important commercial fruit. After mango and banana, citrus is the third most important fruit crop of India. India is fourth largest producer of citrus in the world with 1.07 million ha area with 11.1 million tonnes production. Mandarin (*Citrus reticulata* Blanco) is the largest commercial citrus cultivar in India (35% share), followed by sweet orange (*Citrus sinensis* Osbeck.) with 30%, acid lime (*Citrus aurantifolia* Swingle) with 25% and others with 10% share.India harbours enormous wealth of citrus diversity as it is indigenous to India. *Citrus* species like *C. indica, C. ichangensis, C. macroptera, C. latipes* and *C. assamensis* are found growing in the wild and semi-wild state in the North-Eastern region. Also, progenitors of citron, lemon and some mandarins have been originated in Assam. Number of improved varieties has also been released in different varietal improvement programmes through clonal selections. So far in India, promising/ released varieties of citrus during last 5-6 decades include 13 of acid lime, 2 of sweet orange, 2 of mandarin, 1 root stock and 4 of lemon. Some hybrids for rootstock have also been developed and are being evaluated. Several introduced varieties have also been released for cultivation in mandarin, sweet orange and grapefruit. Harnessing tissue culture technology putative triploids have also been developed for seedlessness. ICAR – Central Citrus Research Institute has more than 600 accessions to its National Active Germplasm Site including exotic collection. The said review focuses on citrus improvement endeavours *vis-a-vis* constraints in the country and discusses the future perspectives.

S2O27 A484

Elite genotypes of bael (*Aegle marmelos*) identified in sub-tropical, sub-humid climatic zone of Eastern India

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Aegle marmelos Correa. (Bael, Wood-apple) is an indigenous minor fruit tree which is distributed mainly in tropical areas of India, Pakistan and Sri-Lanka. Despite of its adaptability to varying environmental conditions, immense cultural, medicinal and economic importance, particularly in nutritional and livelihood securities of native communities, its potential as an orchard crop is not fully utilized. The eastern part of India comprising the states of Bihar, Jharkhand, Eastern Uttar Pradesh, Odisha and Chhattisgarh, is natural range for diversity in this important tree. Collection and evaluation of its genetic resource would be the best approach to find elite trees and source for desirable traits. In present study, 133 accessions of *bael* collected from its natural range were evaluated for ten fruit characters under sub-humid, sub-tropical climatic zone of Jharkhand, geographically known as Chotanagpur plateau. Large variability was recorded among the accessions (133) for number of fruits per tree (3-99), fruit length (6.75-28.91 cm), fruit girth (16.11-43.85 cm), seeds per fruit (16-211), fruit weight (129.53-1537.71 g), pulp weight (30.15-1280.55 g), rind weight (38.32-409.20 g), fresh seed weight/fruit (5-44 g), rind thickness (2-6 mm) and percent ratio of rind/fruit (9.59-53.04 %). Analysis also revealed presence of unique, desirable fruit traits in some of the genotypes. The best genotype for number of fruits per tree (IC 594250), fruit length (IC 594266), fruit girth (IC 331738), seeds/fruit (IC 594263), fruit weight and pulp weight (IC 594264), rind weight (436501), fresh seed weight/fruit (IC 209918) and percent ratios of rind/fruit (IC 285269) were identified. Among these, six genotypes (IC 594250, IC 594266, IC 594263, IC 594264, IC 209918 and IC 285269) are from Jharkhand while one each (IC 331738 and IC 436501) belongs to Uttar Pradesh and Bihar, respectively, indicating the importance of agro-climatic condition in naturalization and superior performance of genotypes/species. Further breeding and introgression of desirable traits of these genotypes would help in development of varieties.

S2O28 A453

Studies on genetic variability in quantitative traits in cashew (*Anacardium occidentale* L.)

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Genetic variability of eleven elite cashew genotypes was studied from 2013 to 2015 in a field experiment laid out during the year 2003 under All India Coordinated Research Project on Cashew of Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India, The grafted plants of genotypes collected from different co-operating centres were planted at a spacing of 7.5 x 7.5m following Randomised Block Design (RBD) having four plants per treatment replicated thrice. Recommended package of practices were adopted uniformly to raise a good crop. In general, PCV was higher than GCV for all the traits under study which implies the impact of environmental factor influencing the expression of characters. However, the pooled results also showed that there was a very close difference between PCV and GCV for parameters such as plant height, trunk girth, canopy spread(both in E-W & N-S), nut weight(g), shelling %, flowering duration and above all nut yield(kg plant^{-1}), hence these parameters are least influenced by environment. Hence, there is a scope of direct selection. Heritability in broad sense indicated higher values ranging from 85.71% in nuts panicle^{-1} to 98.01% in nut yield plant^{-1}. High heritability with relatively higher GA as % mean were recorded for the traits such as canopy spread in N-S direction (40.06), canopy spread in E-W direction(42.48), trunk girth(43.88), sex ratio (79.65) and nut yield(68.16) which showed that these parameters were governed by additive gene and therefore their improvement through selection is possible. From the present study it may be concluded that in cashew improvement programme, the traits such as canopy spread (both E-W & N-S), trunk girth, sex ratio and nut yield plant^{-1} should be considered for effective selection of better types not only for growth parameters but also for nut yield and yield attributing parameters.

S2O29 A587

Breeding for high yield in oil palm: early performance of advanced breeding lines

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The oil palm (*Elaeis guineensis* Jacq.), is the highest oil yielding crop which yield on an average 5 times oil compared to most oil seed crops. As the crop is capable of bridging the shortage in edible oil in India, cultivation of oil palm in the country has got support from planners, researchers and farmers. With the increase in area of the crop under diverse environments, it has become essential to develop oil palm varieties with high yield, compactness / dwarfness, high oil extraction ratio and tolerance to low moisture regimes. Of late, reports from India and Malaysia recorded oil palm bunch yield as high as 50 MT equivalent to 10 MT oil/ ha/year, which revealed the enormous potential the crop holds for edible oil self sufficiency. Oil palm breeding in India mainly revolve around higher yield. Oil palm being a wide spaced crop requires large land area and other resources for field evaluation. Moreover, single generation evaluation takes 8-10 years for completion. Hence it is imperative to screen at early stages based on indicator traits that can help early selection and reduce the population to be taken to field evaluation. Twenty eight advanced Dura x Dura crosses evolved from elite parents are assessed for twenty parameters for early screening. The maximum height was 59.36 cm and the least 33.8cm, recorded by TP14D and TP24D respectively. TP28D, PL17D and TP16D were vigorously growing and crosses, TK 5D, TP2D and TP31D were less vigorous as measured by height. Collar girth is an indicator of healthy seedlings and the maximum collar girth was recorded in TP15D followed by TK5D, TP4D, TP31D and TP29D. Leaf length is another indicator trait in early stages and compact leaf types were TP16D, TP31D, TP11D and TP 18D. Leaf area which is important for interception of solar radiation and photosynthesis, was maximum in TP15D followed by TP17D, TP19D and TP2D. Good root development indicates better establishment, faster growth, survival under adverse climate conditions. Root volume was maximum in TP21D followed by TK4D and TP32D. TP 11D produced maximum number of primary roots followed by TP24D, TK1D and TP31D. Hence, the crosses which exhibited desirable parameters were selected for further field evaluation and final selection.

S2O30 A758:

Development of Indian gynoecious cucumber lines through marker assisted selection (MAS) – Title is not matching

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The gynoecious and parthenocarpic inbred line, Pant ParthenocarpicCucumber-2 (PPC-2) was crossed with Indian monoecious and non-parthenocarpic cultivar Pusa Uday to develop F_1, F_2, BC_1P_1 and $BC_1P_2$to determine the inheritance of parthenocarpy. The crop was grown under insect proof net house of 40 mesh and pistillate buds were also covered using butter paper bags before anthesis to prevent from out-crossing. The observations were recorded separately for the development of early parthenocarpic fruits (*i.e.*1-7th nodes), late parthenocarpy (8th and above nodes) and non-parthenocarpic fruits. In F_1generation,out of 40 plants screened2 plants produced parthenocarpic fruits at lower nodes (1-7th nodes) and 37 plants produced parthenocarpic fruits at upper nodes (8th and above) whereas only 1 plant did not produced any fruits was considered as non-parthenocarpic fruit development. The segregation of F_2 population (PPC-2 × Pusa Uday) and test crosses for parthenocarpic fruit development suggests that parthenocarpy in gynoecious and partthenocarpic cucumber line PPC-2 is under the control of incomplete dominant gene. Therefore, the information generated on inheritance of parthenocarpy from this study would be of immense importance in the context of developing parthenocarpic cultivars/hybrids in cucumber suitable for protected cultivation.

S2O31 A282

Improving onion through introgression of genes from long day and short day hybridization

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Onion market is volatile in India due to the fact that the demand is uniform round the year, but production is restricted mainly from Nov-May. Onion is a biennial crop which is grown for its edible bulbs in first season. Bulbs are planted in next year in same season for seed production. The growth and development are strictly orchestrated by the temperature and light regimes of latitude and season. Varieties differ in

photo-thermal requirement depending on the latitude for which it is adapted and are classified as long day (LD), short day (SD) and intermediate types based on light requirement. Indian onions are grouped under short day onion and are grown in three seasons*kharif*, late *kharif* and *rabi*. Improvement in Indian short day onion reached plateau due to narrow genetic base within the Indian short day onion germplasm. The yield difference between the short day (SD) and long day (LD) varieties are substantial. Thus it is imperative to introgress the genes from LD varieties into the short day lines for improving yield by transfer of traits like high yield and non-bolting**.**Introgression breeding program at ICAR-DOGR was initiated in collaboration with ICAR-CITH, Srinagar. A total of 127 crosses were made between available exotic onion hybrids/ varieties with short day varieties. From the progenies, selection was carried out on the basis of bulb colour, shape, size and storability at ICAR-DOGR as well as at ICAR-CITH. Selected bulbs of each crosses were also sent to CITH for seed production beside ICAR-DOGR. Currently, about 93 populations are being evaluated in fourth generation and few are performing well under short day condition with desirable traits. The preliminary work done on this aspect indicated that we may get major breakthrough in the yield improvement of onion under short day conditions.

S2O32 (IS11)

Preliminary evaluation of Taro (*Colocasia esculenta* (L.) Schott) germplasm collection in South Africa

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Taro, locally known as Amadumbe is one of the most important staple food crops in the world. In South Africa, it is especially popular among farmers with limited resources. Amadumbe is used as a staple food and is rich in carbohydrates, protein, minerals and vitamins. Information on genetic variability among the existing Amadumbe genotypes will increase the efficiency of the Amadumbe improvement production program. The field experiments were conducted at the Owen Sitole College of Agriculture (OSCA) research farm in South Africa in 2013/2014 cropping season to estimate the level of genetic variability among a collection of 29 Amadumbe genotypes. The experiment was laid out in a randomised complete block design, with three replications. Nine quantitative morphological traits were recorded. Analysis of variance for the traits revealed that differences among Amadumbe genotypes were highly significant for all traits. This indicated that there was a high level of genetic variability among the genotypes studied. Genetic and phenotypic coefficient of variation, and broad sense heritability were estimated for all phenotypic traits. The principal component analysis also showed the total variability among the genotypes. Cluster analysis of the phenotypic traits resulted in different distinct groups of genotypes. The quantitative traits, therefore, provide a useful measure of genetic distances among the Amadumbe genotypes and will enable the identification of potential parental materials for future breeding efforts for increased production, which will contribute towards a direct economic benefit for

the community and an increase in the status of the crop. The Amadumbe genotypes AM-43, UM-3, Amzam3053/5118, UM-1, and Um-2 provided the highest yield compared to the rest of the genotypes and are recommended as suitable parental lines for crop procution improvement in South Africa.

S2O33 (IS23)

Utilization of diversity within traditional African leafy vegetables to address nutritional and food security challenges

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Many people in Eastern and Southern Africa suffer from severe poverty, malnutrition and diet-related diseases, which are likely to increase as the continent's population grows. Food production and security depend on the appropriate conservation and use of agricultural and in particular horticultural diversity, and associated genetic resources. There is an urgent need to conserve genetic diversity and better utilize genebank accessions in order to improve horticultural production and meet the growing demand for food and nutrition. Traditional African vegetables have been grown for centuries on the African continent. Some crops like amaranth, African nightshade, spider plant, cowpea and pumpkin contribute considerably to the daily diets of African populations. This study demonstrates the potential of traditional leafy vegetable genetic resources to help address the demand of micronutrients and vitamins, and reduce poverty by creating new jobs and provide new sources of income. The World Vegetable Center's germplasm collection is a vital source for the public sector, private companies, and local, regional and international research organizations. Every year, more than 1,000 accessions are distributed from the regional office to different beneficiaries. Standardizing germplasm characterization methods, measuring nutritional content, and investigating physiological responses to abiotic and biotic stresses are some of the essential elements for assuring optimal utilization of germplasm accessions. Plant breeders use accessions to select superior traits for the development of improved vegetable lines. The interest for traditional vegetables is increasing, and these crops already contribute substantially to the food and nutrition security of local populations. Increased production and marketing is a source of income, and one way to enhance preservation of traditional leafy vegetables through increasing their commercial utilization.

S2O34 A337

Cut-style pollination: a method for temporarily suppressing self-incompatibility in tuberose (*Polianthestuberosa* L.)

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Tuberose (*Polianthestuberosa* L.) is an important ornamental plant of the family Asparagaceae. The flowers remain fresh for a long time and are suitable for long-distance transportation. These are highly fragrant and contain 0.08 to 1.4 % of concrete and have a high demand in the international market. Tuberose flowers never set seed upon self-pollination and the plant is reported to exhibit self-incompatibility because of which inbreeding and production of homozygous is not possible. Overcoming self-incompatibility in tuberose can pave the way for production of inbred lines with distinct advantages like generating completely uniform varieties of bi-parental origin, effective exploitation of rare traits, and expression of hidden, recessive genetic variation. The present study was undertaken to identify methods to overcome or to temporarily suppress self-incompatibility in the tuberose variety, Arka Nirantara. The experiment was conducted in Randomized Block Design and replicated thrice, with 13 treatments. Among the different methods studied for improvement in seed-set through self-pollination, cut-style pollination (just above the ovary) with or without application of chemicals showed fruit and seed set. Per cent fruit set was highest in the cut-style method + application of 1% NaCl on the stigmatic surface at self-pollination (10.67%), followed by cut-style method + 3% NaCl (8.89%), and cut-style method + 2 % sucrose (8.89%). Number of seeds (18.00/pod) and number of filled-seeds (15.67/pod) was highest in the cut-style method + 3% NaCl. Number of incompletely-filled seeds was highest in the cut-style method (3.33/pod) and the lowest in cut-style method + 1% NaCl (1.00/pod). Seeds were harvested and stored for further studies.

S2O35 IS43

Breeding the flower crops cultivars which are resistant to discoloration from solarinsolation

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In the Nikita Botanical Gardens introductory and breeding studies are conducted with eight flower crops: a rose, a chrysanthemum, a canna, a tulip, an iris, a daylily, a clematis and a lilac. Nowadays, the collections of these crops include 1822 cultivars, species and forms. One of the most important decorative qualities of a cultivar for flower crops is the color of the flower. The climatic conditions of

Southern Russia are characterized by high solar insolation. In these conditions, resistance to discoloration from solar insolation (maintaining the basic tone) is very important to the cultivars. When the discoloration occurs, the flower petals become pale and dull during the flowering process, therefore often losing their decorative characteristics. Long-term studies of introduced cultivars and breeding pool allowed us to identify cultivars of each flower crop with resistance to discoloration from solar insolation. It has been established that the color discoloration effect is a cultivar feature. This effect is not always determined by the type of coloration. In some cases, even a sufficiently stable white color is prone to discoloration to a non-decorative yellowish shade. The number of resistant cultivars is different for different flower crops. Thus, in the lilacs collection discoloration resistance is characterized by only about 40% of the cultivars and in the clematis collection - 35%. It has also been revealed that for some cultivars of roses and tulips, discoloration during flowering can lead to the appearance of an additional decorative effect. As a result of the modern breeding pool research, prospective cultivars and breeding forms with discoloration resistance have been selected – 10 for garden rose, 1 for lilac, 16 for tulip, 2 – for iris, 4 – for daylily, 18 – for chrysanthemum, 7 – for clematis, 5 – for canna.

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S2O36 A721

Evaluation of soybean germplasm for vegetable types and molecular characterization for rust resistance

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Soybean is mainly grown as pulse cum oil seed crop. It can be consumed as vegetable, if it is harvested at green pod stage. Green seeds are highly nutritious and are rich in protein, cholesterol free fat, fiber, micro-minerals, vitamins and anti-oxidants. It is more nutritious than vegetable green peas. However, the ideal vegetable type soybean should posses pleasant flavor, sweeter, nuttier texture and easy to cook. The variety should be a short duration, resistant to pest and diseases and higher yielding to fit into crop rotation. With this background present study was initiated during *kharif* 2016-17 at ICAR-IIHR, Bengaluru with objectives of evaluating suitability of soybean germplasm for vegetable purpose and their molecular characterization for rust resistance. A total of 82 soybean germplasm were evaluated for eight yield and its attributing traits (pods/plant, pod length, pod width, seeds/pod, green pod yield/plant and shelling %) and three qualitative traits (pod color, seed color and taste). Same set of germplasm were tested with 7 microsatellite markers linked to rust resistant genes (locus Rpp1: Satt191; locus Rpp2: Sat_255, Sat_165 and Satt622; locus Rpp3: Satt708; locus Rpp4: Satt612; locus Rpp5:

Sat_166). The results revealed that, all yield and its attributing traits were highly significant and for qualitative traits, germplasm were highly diverse. This indicated that, selected germplasm harbors huge variability both for qualitative and quantitative traits. Five germplasm *viz.*, EC 771178, EC771168, EC 771197, EC 771230, EC 771206 showed polymorphism for 6 microsatellite markers linked to *Rpp1, Rpp2, Rpp3, Rpp4 and Rpp5* indicating the presence of rust resistant genes. Out of 82 germplasm, four germplasm namely, AGS 461, AGS 610, AGS457, AGS 459 were dark green and sweet.

S2O37A 557

Potato Research and development for improving food and income security in South West Asia

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Asia, with the predicted highest level of global population growth in the 21st century, faces a tremendous food security challenge to feed its people. Potato is grown in diversified cropping systems, often in rotation with cereals in plains or as monoculture in the highlands. In the SWA region, India is the largest potato producer (46.4 million tonnes), followed by Bangladesh, Pakistan, Nepal, Afghanistan, Sri Lanka and Bhutan. The constraints to enhance potato production in the region are similar but are agro-ecology and country specific. The shortage of healthy seed is one of the major limiting factors to increase production. The seed is the most expensive input for potato cultivation and sometimes it accounts up to 60%. Potato research and development strategy for SWA should include the following: Development of abiotic stress tolerant varieties mainly for heat and drought and biotic stresses tolerance for late blight and economically important viruses and earliness for staggered harvesting and for planting successive crop timely. Developing farmer based potato system in non-traditional seed producing areas to benefit farmers of non-seed producing states of Karnataka, Maharashtra & West Bengal of India. Enhancement of processed potatoes from today's 3–6% in the SWA region to 20% by 2020. Participatory variety selection to accelerate the release of varieties of stakeholder choice. Regional networking to facilitate the exchange of information and material. Capacity building: Create regional training hubs for NARS, farmers associations and NGOs. Increasing PPP for contract farming for processing and seed production. Increasing women's role in project design and targeting, evaluation and dissemination.

S2O37aA142

The Protection of Plant Genetic Resources in North East India: A legal perspective

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Plant genetic resources are considered as invaluable assets of any nation. It constitutes unique heritage and their conservation and proper utilization is of immediate concern. Several conventions tried to address the pressing problem of degradation of plant genetic resources internationally. Growing concern about the vulnerability of the agricultural production, food security and environmental stability has moved the conservation and sustainable use of plant genetic resources to the top of the development agenda of several nations. The Indian legislation of the Protection of Plant Varieties and Farmers' Rights Act aims at securing the plant genetic resources of the country. The Indian scenario, with special focus to North East India, on plant genetic resources and the related provisions under the said Act are focussed in this paper. This paper tries to find out new suggestions for effective protection towards plant genetic resources with special emphasis on North East India, keeping in view the rich ecology and the diverse environmental conditions.

S2O38 A215: Studies on inter specific and inter varietal hybridisation in Mango (*Mangiferaindica*)

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Interspecific and inter -varietal crosses were performed in mango by using Amrapali as female parent and *Mangiferaododrata* and Vanarajas male parents. In Amarapali male flowers (%) varied from 16.31 to 18.42 and bisexual flowers (%) from 45.34 to 53.89. In the species*Mangiferaodorata* male flowers (%) varies from 20.19 to 22.29 and bisexual flowers between 65.69 and 77.70.In the interspecific hybridization (Amrapali x *M. odorata*) more than 1860 panicles and about 6690 flowers crossed. Among crossed flowers 5345 flowers showed signs of fruit set. Fruit set (%) was calculated at 10, 20, 30, 40 and 50 days after pollination and it was observed to be 77.91, 75.51, 66.75, 52.71 and 43.71 respectively.In inter-varietal hybridisation programme (Amrapali x Vanaraj), more than 635 panicles and 2420 flowers were crossed. Among the crossed flowers, 1972 flowers showed signs of fruit set. Fruit set (%) was recorded at 10, 20, 30, 40 and 50 days after pollination, which was observed to be 81.51, 15.62, 5.98, 2.60 and 2.30 respectively.

S2O39 IS35

Alleviating in vitro shoot tip necrosis in grape cv. Red Globe

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Shoot tip necrosis (STN) can be major impediment in the successful propagation of crop species by tissue culture. This physiological disorder commonly observed at different stages of *in vitro* culture *viz*. multiplication, elongation or at rooting and its severity depends on stage of *in vitro* culture and crop species. STN causes severe loss in woody crop species like grapes. The early visible symptoms of STN are browning of the tip followed by basipetal necrosis. Senescence and death of the apical buds results in typical necrosis of the upper portion and continues to complete plant. STN is associated with the nutrient deficiency (Ca and B), concentration of cytokinins, medium type and its nutrient concentration, aeration, gelling agent, pH of the medium and subculture period. During the course of micropropagation protocol refinement of grape cv. 'Red Globe' for *in vitro* mutation breeding experiment severe loss of cultures was observed immediately after first subculturing due to STN. Thus, in order to prevent STN, in this study the experiment was set up with different concentrations of Ca (1, 1.5 and 2 times of MS medium composition), B (1, 2 or 3 times of MS medium composition) and BA (1, 2 mg/L) treatments with full and half strength MS media and its combinations. The observations revealed that half strength MS medium supplemented with 1.5 times of MS medium with calcium chloride and 2 mg/L BA was the optimum concentration for lowering incidence of STN in shoot cultures to 38 % in grape cv. Red Globe.

S2O40 A12

Qualitative characterization of Kerala collections of rambutan (*Nephelium lappaceum* L.)

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Hundred variable types of rambutan collected from major rambutan growing tracts of Kerala were evaluated for various qualitative traits as per IPGRI crop to record the existing variability. All the collections were invariably of rough trunk surface with irregular branching pattern. Four types of crown

shape were observed viz., oblong (36%), pyramidal (28%), spherical (25%) and semi-circle (11%). All the collections had an elliptic leaflet shape with no pubescence in which 90 per cent of the collections were of green leaves. Most of the collections (97%) were born with only HF flowers which in turn set fruits. Three types of inflorescences were observed namely pyramidal (73%), conical (14%) and obtriangular (13%) born terminally with light green colour. More than half of the collections (57.14%) had oblong fruit shape, a characteristic feature of most of the Asiatic cultivars. The collections varied in rind colour from light greenish yellow (5.1%) to pale yellow (11.22%) to strong yellowish pink (14.29%), from strong reddish orange (31.63%) to strong red (17.35%) to vivid red (12.24%) and from dark red (3.06%) to deep purplish red (5.1%) when described with UCL. The predominant spine colour observed was red with light green tip followed by red, yellow, light green, light green with pink base and pink with light green tip. The collections varied in aril taste from insipid to sweet and in aril juiciness from very juicy to non-juicy. Free seed aril was observed only in 19.39% of the collections. Clustering of elite selections of rambutan based on qualitative traits using dendrogram gave rise to ten distinct clusters at the similarity coefficient status of 60%.

S2O41 IS40

Evaluation of selected jackfruit (*Artocarpus heterophyllus* L.) accessions/varieties for quality attributes

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The study on evaluation selected accessions/varieties of jackfruit (*Artocarpus heterophyllus* L.) accessions was carried out at College of Horticulture, Vellanikkara, Kerala from August 2013 to June 2015. Variation was observed with respect to fruiting season, fruit clustering habit, fruit number (21 to 135), shape, surface, fruit weight (1.65 kg to 20.00 kg), fruit yield (41.25 kg/ plant to 1593 kg/ plant), latex exudation, rind colour and thickness, core length (10.20 cm to 50.50 cm) and thickness (2.50 cm to 13.90 cm), number of flakes (bulbs) per kg of the fruit (12.61 to 71.15), weight of flake (16.69g to 33.91g), flesh thickness (1.26 mm to 7.8 mm), bulb diameter (6.08 cm to 10.11 cm), shape, pulp flavour, colour and consistency, number of seeds (44 to 482), 100-seed weight (240g to 800g) and rind, flake and seed ratio (2.30 to 7.31). Variations was also observed in biochemical characters *viz*., TSS (20.30 ^{0} Brix to 33.80 ^{o} Brix), reducing sugars (6.61 to 13.16 %) and non-reducing sugars (5.16 to 13.29 %) and β carotene (0.99 to 12.94 mg/100g). Based on yield and quality attributes of the fruits, the accessions 1, 3, 5, 7, 10, 14 and 15 were found promising.

S2O42 A196

Heterosis and combining ability studies in tomato for yield and quality traits

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The present investigation on "Heterosis and combining ability studies in tomato (*Solanum lycopersicum*)" was carried out at Department of Vegetable Science, College of Horticulture, Mudigere, during *kharif* and *rabi* season of the year 2015-16. Twenty four F_1 hybrids were produced by crossing 8 lines and testers by using line x tester design. The mean sum of squares due to various sources of variation showed significant difference for all the characters studied except days to 50 per cent flowering in the parents and hybrids. Among the parents, testers exhibited significant differences for all the characters except days to 50 per cent flowering, number of fruits per cluster, number of fruits per plant and days to fruit maturity, while lines showed the significant difference for all the characters except days to 50 per cent flowering. The line x tester analysis revealed that no single line or tester was superior for all the traits under consideration. Among the parents, good gca for yield was exhibited by the Bony Best, Black Prince, AR-29 and UK Local-2 whereas, for quality traits the line Black Prince and the tester UK Local-2 were good general combiners. Maximum standard heterosis for yield per plant was observed in Podlandt Pink x Sioux (24.40%) followed by Tommy Toe x UK Local-2 (21.26%) and Black Price x UK Local-2 (21.26%). The predominance of sca variance over gca variance for most of traits indicated the predominance of non-additive gene action. The cross Podlandt Pink x Sioux exhibited desired significant sca effect for yield contributing traits like total fruit yield per plant, number of fruits per plant and fruit quality traits like pericarp thickness, TSS, and ascorbic acid content. The present study revealed that heterosis breeding is useful for improvement of tomato crop through exploitation of additive/ non-additive gene action.

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S2O43 A533

Study of combining ability in diallel crosses of hot pepper(*Capsicum annuum* L.) for horticultural traits

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Ten F_1 crosses (excluding reciprocal) involving five parents were generated in a half way diallel design and grown to estimate combining ability effects in RBD with three replications for two seasons. The pooled ANOVA indicated that the mean squares due genotypes were highly significant ($P \leq 0.01$) for all the characters indicating potential genetic differences among genotypes. ANOVA for general and specific combining ability (GCA, SCA) revealed that the MS were highly significant for all the characters studied. The ratio of σ^2SCA/σ^2GCA was more than unity for all traits. For ascorbic acid, capsaicin and fruits per plant, the ratio was less than unity indicating the greater role of additive gene effects. Based on the GCA effects, the parent CA 3 was identified as good general combiner for Fruit length, seeds per fruit and capsaicin; CA 5 for fruit girth and ascorbic acid; CA 8 for days to first flower and harvest; CA 32 for primary branches, fruits per plant, fruit weight, flesh thickness, flesh to seed ratio, green and dry fruit yield, plot yield, driage, seed yield, oleoresin and color. The crosses identified on the basis of high SCA effects included CA 3×CA 5 for plant height and ascorbic acid; CA 3 × CA 6 for capsaicin; CA 3 × CA 8 for fruit length and color; CA 3× CA 32 for flesh to seed ratio; CA 5 × CA 32 for fruit length, flesh thickness, seeds per fruit, oleoresin and color; CA 6 × CA 8 for days to first flower and harvest and flesh thickness; CA 6 × CA 32 for driage, primary branches, fruit girth and fruit weight; CA 8 × CA 32 for green and dry fruit yield, seed yield and plot yield. These crosses involved parents with low × high and high × high GCA effects indicating the presence of non-allelic interactions and additive genetic effects, respectively.

S2O44 A414

Genetic variability, correlation and path coefficient studies in okra [*Abelmoschus esculentus* L. Moench.] genotypes

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Okra [*Abelmoschus esculentus* L. Moench.] is one of the important vegetable crops, grown throughout tropical, sub-tropical and warmer-temperate parts of the world. It is commonly known as *bhindi* in India and belongs to the Mallow, or, Malvaceae family. In any breeding programme, estimation of genetic parameters and association analyses is of prime importance to assess the relative contribution of various growth and yield related traits. Therefore, 20 okra genotypes were evaluated to study genetic diversity. Highest PCV was exhibited by the first branching node, followed by number of branches per plant, number of seeds per fruit, first fruiting-node and first flowering-node. Maximum GCV was observed for traits like number of branches per plant, first branching-node, number of seeds per fruit, first fruiting-node and plant height. High heritability was found for plant height, stem diameter, fruit length and fruit weight. High heritability, coupled with high genetic advance, was seen in plant height, stem diameter, fruit weight, number of branches per plant and the first branching-node. Nature and extent of correlation among different characters varied. Highest and positive correlation was observed between number of fruits per plant and yield per hectare, followed by number of flowers per plant, and yield per hactare. Path coefficient analysis of various yield-contributing characters revealed that number of fruits per pant, fruit length, number of seeds per fruit, number of branches per plant, plant height, fruit weight and number of flowers per plant had a direct positive effect on yield.

S2O45 A398

Study on pollen morphology and germination of Lilium (*Lilium Longoflorum*) cv. Pavia

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Lilium is one of the horticulturally most important genera belongs to family Liliaceae, native to temperate regions of northern hemisphere.Used for cut flower production, pot plant production and landscaping purposes.Each year the interest for lilium increasing around the globe, presently it holds 4thpositoin among top 10 cut flower in World Flower Trade.Pollen is a unique plant tissue that potentially can be used and manipulated to the advantage of the geneticist, breeder, physiologist and germplasm curator. The pollen morphology and pollen germination study of Lilium cv. Pavia was carried out at ICAR-Indian Institute of Horticultural Research, Bengaluru. Various morphological characteristics like pollen shape, size of pollen and exine ornamentation were studied. Shape of pollen was elliptical to ellipsoid with reticulateexine. The ability of pollen to germinate before and after anthesis was tested. *In vitro* germination test of pollen was conducted by wet room method, nutrient medium for pollen inoculation had different concentration of sucrose, poly ethylene glycol (PEG) and Brewbaker&Kwack's Salt. The pollen germination capacity was determined from time to time, thereby establishing the dynamics of this process for 3 days. The germination initiated within 45 minute and the highest germination(70%)wasrecorded on medium with 3% sucrose, 1.5% PEG and Brewbaker&Kwack's Salt after 24 hours. The pollen harvested(9.00 am) after1 hour of anthesis (8.00 am) gave maximum germination (70%). The pollen germinated poorly (5-10%) when harvested before the anthesis or one day after anthesis. During the first 24 hours after inoculation, pollen showed significantly improved germination. Based on this investigation it was concluded that pollen harvested one hour after the anthesis is better for hybridization work.

S2O46 A369

Effect of cold pretreatment on improving anther culture response of marigold cultivar 'Pusa Narangi Gainda'

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Marigold an ornamental plant is also recognized as potential source of carotenoids that are currently being used as food colorants, nutritional supplements, poultry feed additives and in ophthalmology. Improvement of this valuable species is hampered by its high heterozygosity. Production of doubled haploid (homozygous true breeding line) through anther culture is one of the most efficient and time saving innovative technology in varietal improvement.Different factors affect the outcome of the anther culture techniques to produce haploid plants. Pretreatment of anther with coldtemperature is one of them.The aim of the experiment was to investigate the effect of cold pretreatment on the proliferation of

anther-derived embryogenic callus, and its subsequent embryo regeneration in marigold cultivar PusaNarangiGainda.Inflorescence bud of size 15 mm were harvested from the field and they were subjected to cold pretreatment (4 °C and 7 °C for 1, 3 and 5 days). Anthers withmicrospores at early- to late-uninucleate stages were excised from floret of these pretreated capitula and inoculated on MS basal medium containing 3%sucrose, 1.0 mg/l BAP and 0.2 mg/l NAAin the dark forcallus induction. The highest levels ofembryogenic callus induction (96.67%) were achieved when thedonor buds had been cold pretreated at 4 °C for 3 days.The callus (5 mm) was transferred to same media composition under a 16 h photoperiod for multiplication.Anther-derived shootsrooted readily on MS medium containing 0.1 mg/l IBA. The plantlets with sufficient roots thus obtained were acclimatized andtransferred to the soil. Regenerated plantlets will be randomly selected for ploidy observation bychromosome counting and stomata analysis. This protocol will provide a useful foundation for further research toward the development of homozygous marigold line for heterosis breeding and crop improvement.

S2O47 A395

Commercial multiplication of gerbera (Gerbera jamesoniiBolus ex. Hooker F.) from young capitulum explant

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Gerbera is one of the most popular cut flower in the world. Gerbera contributes production of 17,500mt, and stands fourth important cut flower in India with total area 820 ha. Micropropagation is the commercial way for its large scale multiplication. Even though several explants like leaves, petioles, shoot tips and flower buds were tried for *in vitro*propagation, successful protocols were reported only from shoot tip. However shoot tip is highly prone for contamination since it has high pubic hair. Hence, we standardized a successful protocol for large scale propagation of gerbera by using young capitulum explant as explant across different varieties of gerbera. Media for culture establishment, shoot regeneration, multiplication and rooting were standardized. MS Supplemented with BAP 3mg/l in combination with NAA 0.1 mg/l was found most effective for culture establishment and propagule multiplication. By repeated sub culturing of the capitulum explant a high frequency of shoot multiplication was established in MS medium supplemented with kinetin 1mg/l. For root morphogenesis, MS medium supplemented with IAA 0.1mg/l was effective with more number of roots and longer roots. Regenerated plantlets were successfully hardened in sand soil coir pith mixture, thus we established different steps initiation, proliferation, multiplication, rooting and hardening of gerbera which can be taken commercially.

S2O48 A171

Genome editing technologies and its applications in horticultural crop breeding

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The goals of horticultural crop breeding have always focused on the improvement of the unique qualities of these plants. Despite the enormous diversity of horticultural crops, many breeding goals are similar, for example, increasing the concentrations of some unique secondary metabolites, extending the shelf life of fruits, vegetables, altering the plant architecture, improving yield potential; and enhancing plant pest and disease resistance. Some fruits and vegetables contain high contents of secondary metabolites such as anthocyanins, carotenoids and chlorophylls. In petunia, R2R3-MYB and MYB27 function as anthocyanin synthesis repressors, and MYB27 RNAi lines exhibit an obvious pigmented phenotype compared with the wild type and MYB27 over expression lines. Breeding of semi-dwarf statured fruit/nut trees could also revolutionize horticultural crop industries because these trees have the potential to increase productivity via higher density plantings. Disruption of the function of the genes in the GA or SL biosynthetic or signaling transduction pathway could result in various phenotypes such as dwarf 6 and excessive outgrowth of axillary buds, respectively. Thus, the new horticultural crops with semi-dwarf phenotypes be generated by the disruption of the functions of these gene homologs using genome-editing technologies such as Crispr-cas9. Inhibition of ethylene biosynthesis and blocking ethylene signal transduction can delay flower senescence in carnation and petunia, respectively. Powdery mildew, which is one of the most common plant diseases, is caused by different fungal species of *Erysiphales*. Recently it was reported that antisense expression of the peach MLO gene in strawberry conferred cross-species resistance to *Fragaria*-specific powdery mildew. The essential prerequisite of genome editing is the availability of precise genomic information and gene functions. Many horticultural crops have been whole-genome sequenced. The reference genomes, along with transcriptome data in many horticultural crops, may also offer unlimited targets for genome editing for characterizing the potential functions of these genes, which in turn, can help to design better gene/genome-editing strategies.

S2O49 A724

Pollen viability and storability of sugar apple (*Annona squamosa* L.) cv. Balanagar

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Annona hybrid Arka Sahan (*Annona atemoya x Annona squamosa*) essentially needs assisted pollination to improve fruit set, shape, size and produce good quality fruits. Pollen transfer from cultivar Balanagar (*Annona squamosa* L.) on Arka Sahan gives better fruit set and fruit quality due to its pseudo-xenic effect on Arka Sahan. As there is no perfect synchronization in flowering of both these cultivars naturally, storage of Balanagar pollen collected during its normal season (March-April) was attempted to enhance its availability as and when Arka Sahan need to be pollinated. Fresh pollen was collected on first and second day of anthesis by 6:30 AM. *In vitro* pollen germination and viability were studied using different concentrations of sucrose (5%, 10% and 15%) in combination with boric acid (100 ppm). Pollen collected on the second day of anthesis showed highest germination (43.47%) in 5% sucrose + 100 ppm boric acid combination. Pollen collected on first day of flower opening did not show any germination. On storage at varying temperatures, it was observed that the pollen lost viability after 1, 2 and 3 months of storage at both 4°C as well as liquid nitrogen (-196ºC) and did not show any germination. Structure of stored pollen examined after 1, 2 and 3 months using SEM (Scanning Electron Microscope), revealed that pollen got deformed and desiccated following above treatments. The results of this study suggested that stored pollen cannot be used for pollinating Arka Sahan, which calls for exploring alternative approaches to make available Balanagar pollen as and when needed for pollinating Arka Sahan.

Session –III

Production Management

(Cropping systems, Resource Conservation and Use Efficiency, Climate resilience, Mechanization and use of non - conventional energy resources)

Oral Papers

S301 A410

Crop regulation using chemicals for flowering, fruit-set and yield in mango (*Mangifera indica*l.) cv. Alphonso under ultra-high density plantation

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A field experiment was conducted to assess the effect of various chemicals on flowering, fruit-set and yield in mango (*Mangifera* indica L.) cv. Alphonso under ultra-high density planting, during 2013-2014 at Jain Irrigation Systems Limited (JISL) Farms, in Tamil Nadu. Eleven treatments with various combinations were imposed on five-year-old, uniform-sized Alphonso trees grown under a spacing of 3m x 2m. Highest number of panicles per m^2 canopy area and number of panicles per tree were recorded in Paclobutrazol treatments, with or without application of Ethephon and in Uniconazole (1.5 g/l) foliar spray. The treatments Paclobutrazol + KNO_3, Uniconazole @1.5 g/l and ethephon @500 ppm recorded highest flowering intensity. However, Paclobutrazol, combined with Ethephon or KNO_3 and, Uniconazole alone, recorded advancement in flowering. Per cent hermaphrodite flowers was higher in treatments where Paclobutrazol was combined with 1000ppm Ethephon and KNO_3 spray. However, Paclobutrazol when alone or with KNO_3, and Uniconazole alone, recorded highest per cent fruit-set on the tree. Higher concentration of Uniconazole recorded highest yield and number of fruits.

S302 A220

Leaf litter decomposition and nutrient mineralization in mango, guava and litchi orchards of eastern plateau and hill region of India

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Leaf litter from plants, particularly trees, is a major source of organic matter and energy to soil and is important for nutrient cycling in an ecosystem. Leaf litter decomposition is a critical step in nutrient cycling and providing nutrients to plants. Various factors control leaf litter decomposition, including climate, topography, chemical characteristics of leaf litter and terrestrial microbiota.

Decomposition of dry matter, lignin, ligno-cellulose, cellulose and polyphenols was investigated in relation to nitrogen (N), phosphorus (P) and potassium (K) dynamics in leaf litter of mango, guava and litchi orchards under hot and dry sub-humid climate. The leaf litter of mango and guava decomposed more rapidly than that of litchi with decay constants of 1.97, 1.07 and 0.5 year^{-1}, respectively. The leaf litter organic substances like polyphenol lost more rapidly followed by cellulose, lignin and ligno-cellulose throughout the period of decomposition. The release of nutrient elements from the decomposed leaf litter was faster for N followed by K and slower for P. The N was released faster both in mango and guava with decay constant of 3.53 and 3.83 year^{-1}, respectively while litchi leaf litter released slowly with decay constant of 1.40 year^{-1}. The release of K was faster in mango followed by guava and litchi with decay constant of 2.86, 2.03 and 1.50 year^{-1}, respectively. The leaf litter decomposition was significantly positively correlated with soil fungal and bacterial biomass, rainfall and air temperature in all the orchards. The initial lignin, cellulose, ligno-cellulose, polyphenol, N, P and K content of leaf showed significant negative correlations with decay rate.This study suggests that, mango and guava leaf litter constitutecomparatively readily available sources of nutrients and they could be suitablefor short-term nutrient correction. However, leaf litterfrom litchi caused noticeable slow decay rate and is worthy to be used for organic matterbuild up in hot and dry sub-humid climate.

S3O3A 555

Standardization of plant species and growing medium for vertical garden system: A new urban horticulture concept

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Vertical gardens are becoming a common component in contemporary garden designs at urban living space because of shrinking land spaces. Successful growing of plants in vertical garden systems depends upon growing container, plants chosen, growing media, etc. Hence a study was carried outin orchard unit of the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, during 2013. The objective was to study the influence of coir pith, stockosorb and geohumus as components of growing media along with FYM, vermicompost and leaf mould compost on growth and performance of ornamental plants for establishment of vertical garden and to study the performance of ornamental plants *viz.,Philodendron erubescens* Cv. 'Gold', *Chlorophytum comosum* Cv. 'Variegatum' and *Polyscias fruticosa* plants in wooden containers for establishment of vertical garden. The experiment was laid out in completely randomized design (CRD) in wooden containers, replicated thrice with ten treatment combinations of various growing media mixtures comprising red soil, river sand as basic components in combination with organic manures (FYM, vermicompost, leaf mould compost, coir pith) and hydrogels (stocksorb and geohumus). The plant growth characters and ornamental value index were observed. Among the three ornamental plants used, *Polyscias fruticosa* and *Philodendron erubescens* were suitable as ornamental plants for establishment of vertical garden system with the growing media consisting of Red soil : River sand : Vermicompost @ 1:1:1/2 + stockosorb (25g).

S3O4 IS 12

Growing Greener Cities: the FAO's Programme on urban and periurban horticulture

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Towns and cities in the world's developing countries are growing on an unprecedented scale. Fifteen years ago, an estimated 40 percent of the developing world's population – or 2 billion people – lived in urban areas. Between now and 2050, the urbanization process will accelerate and reach 60 % at world level and will result in an increase in urban poor to reach 900 000 linked to a degradation of the living environment. The challenge is to steer urbanization towards sustainable, ***greener*** cities that offer choice, opportunity and hope to counteract high levels of poverty and food insecurity, the persistence of malnutrition especially among children, high unemployment and under-employment and associated increases in crime and the risk of social disorder.As an emerging key component in strategies to meet the challenges of massive and rapid urbanization in the 21st century, horticulture and especially urban and periurban horticulture within cities and towns and in their surrounding areas, can make an important contribution to urban food and nutrition security and improved living environment. The FAO's Programme on urban and periurban horticulture is an approach based on its recognition and integration into urban development policy and planning. It is a starting point for growing greener cities and its core principles are *Resilience and self-reliance, Economic development, Environmental sustainability, Social inclusion.*

S3O5 A 64

Improving planting value of vegetable seeds through seed enhancement

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Low and erratic emergence of vegetable seeds is a major problem under low temperatures and poor stand establishment leads to low productivity. Vegetable growers currently prefer to use high seed rate during early spring plantings to achieve good plant stands. Pre-sowing treatments promote uniform and optimum stand under wide range of conditions. We have standardized different priming treatments namely osmopriming (using PEG 6000 and mannitol, 0.5- 1.0 MPa), solid matrix priming (vermiculite with *Trichoderma viride*), halopriming(30-60 mM KNO_3 or KH_2PO_4 or $CaCl_2$ and hydropriming treatments for wide variety of vegetable seeds in our laboratory. In capsicum, osmo- and solid matrix priming improved laboratory seed germination at 15 ^oC, 20 ^oC, and 25 ^oC temperature. Solid matrix priming improved germination by 36 % over nonprimed seed at 15^0 C whereas at 25^0 C the improvement

in germination was only 13 %. Priming reduced mean days to germination (MDG) significantly over control. In okra, solid matrix priming improved laboratory germination at suboptimal temperatures (15^{o}C) and reduced mean days to germination from 12.0 days (non-primed) to 8.5 days. At optimal temperatures (25^{o}C) solid matrix priming improved germination but had no effect on mean days to germination. However, under sub-optimal temperatures, solid matrix priming in combination with *Trichoderma viride* improved field emergence by 19% over the non-primed control. Solid matrix priming alone or in combination with *Trichoderma viride* also significantly improved final marketable pod yield under sub-optimal temperaturebutnot under optimal temperatures in okra. Priming had no effect on the number of pods per plant and pod yield per plant under either environment. The seed leachate from primed seed had low electrical conductivity, total free amino acids and water soluble sugars, suggesting better integrity of membranes. Imbibed primed seeds also showed greater activities of twoenzymes of the glyoxylate cycle, isocitrate lyase and malate dehydrogenase, which are involved in lipid to sugar conversion during germination. The results suggest that different seed enhancement treatments can be successfully used to improve seedling emergence and productivity of vegetable crops under low temperatures.

S3O6 A18

Effects of plant density and planting pattern on growth and flowering of tulip cv. 'Sprying'

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Tulip flower (*Tulipa* spp.) is a bulbous and monocotyledon plant from Liliaceae family. It has the maximum cultivated area among this family. To evaluate the effect of planting pattern and density on growth and flower characteristics of tulip cv. 'Spryng ', a study was conducted as factorial experiment based on RCBD with 3 replications in 27 plots. First factor was 3 planting patterns (square, triangle and rectangle) and 3 planting densities (65, 45 and 25 plants per square meter) as the second factor. The result showed that square pattern with 45 plants/m^2 density had plants with highest diameter of stem and display life, while the minimum duration of flowering were obtained in the triangle pattern with density of 45 plants/m^2. Also, the triangle pattern with 65 plants /m^2 density had the highest stem height and number of cut flowers. Maximum leaf length was observed in plants grown under the square pattern with 45 plant /m^2. Interaction of planting pattern and density treatments did not show significant effect on leaf width and flower diameter.

S3O7 A 22

Application of Pranic agriculture protocol to enhance cucumber production

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ranic agriculture works on holistic concept of environment-friendly farming practice. It involves projection of pranato plants to enhance their growth. Prana is the vital energy required by the living organism to survive. It consists of the entire invisible subtle energy which are an essential part of nature system. The present study aimed to understand application of pranic agriculture protocol on cucumber plants to enhance their production. The pranic treated cucumber plants were compared with non treated cucumber plants. Measurements of cucumber plant length, cucumber plant diameter and cucumber yield were recorded and compared with the control. Pranic treated cucumber plants had significantly ($p<0.001$) more plant length (28.7 inches) than the control (14.6 inches). Similarly, a higher stem diameter of 7.4 inches was noticed in pranic treated cucumber verses the control having a diameter of only 5.6 inches ($p<0.001$). Overall yield was also found to be very significant ($p<0.001$) in pranic cucumber (20.9 kg) against the control (17.1 kg). This indicates that pranic agriculture protocol could help in enhancement of cucumber production. Further studies are needed to study the difference in nutritional composition and also storage studies of pranic and control cucumber.

S3O8 A210

Response of micronutrients on fruit yield and quality of mango (*Mangifera indica* L.) cv. Dashehari

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Mango is one of the important fruit crop grown in Uttar Pradesh. Dashehari is widely cultivated in Uttar Pradesh particularly in Malihabad region, Lucknow because of attractive fruit size, quality, taste, flavour and early maturity. Presently the productivity of mango cv. Dashehari is facing a threat which is being attributed in undersized deformed shape fruit with uneven ripening, fruit drop, fruit cracking resulting into lower productivity may be due to imbalance of soil nutrients. Application of micronutrients *viz* zinc, copper and boron may improve the fruit size, shape and quality and thereby sustain productivity and quality. An experiment on micronutrients ($ZnSO_4$, $CuSO_4$ andBoron) and their application have been initiated on 15 years old mango cultivar Dashehari at 6m x 5m spacing during 2015-16 at experimental farm of ICAR- CISH, Lucknow. The soil of the experimental orchard was well drained sandy loam having 222.65 kg N, 33.43kgP and 279.88kgK/ha. Eight treatment combinations along with Recommended Dose of Fertilizer (RDF) and micronutrients ($ZnSO_4$, $CuSO_4$ and Boron) were applied

in Randomized Block Design with three replications. The experimental results indicated that maximum fruit yield (14.30t/ha) and yield efficiency (0.39 kg/m^3) was recorded in the treatment of RDF along with 100 g Zinc sulphate, 50 g Copper sulphate, 50 g Borax applied in basin after harvest and foliar spray of 0.2% Zinc sulphate, 0.1% Copper sulphate, 0.1% Boric acid at just before flowering and marble stage. The fruit weight (200.56 g) was recorded in thetreatmentofRDF along with 100 g Zinc sulphate, 50 g Copper sulphate, 50 g Borax applied in basin after harvest and foliar spray of 0.2 % Zinc sulphate, 0.1% Boric acid at just before flowering and marble stage. Total Soluble Solids (TSS) was maximum in the treatment of RDF along with foliar spray of 0.4% Zinc sulphate, 0.2% Boric acid at just before flowering and marble stage.

S3O9 A585

Effect of calcium nitrate treatments in germination and seedling vigour of papaya (*Carica papaya* L.)

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Papaya is one of the important tropical fruit crops cultivated in India. It is a delicious fruit with high nutrient content and high production. As seeds are the propagating materials in papaya and seed germination and seedling vigor in the nursery stage are major factors that determine the crop performance. In nursery stage seedlings are raised in potting mixture which contains soil, sand and farmyard manure in 1:1:1 proportion. The vast span of germination period, usually 8-20 days followed by 45 days in nursery bags before transplantation deprive the seedlings of the required major nutrients. Application of chemical fertilizers in the early establishment stage can affect the young soft roots of the papaya plants. Hence, seed treatment is an effective method to enhance germination and vigour of seedlings. In an experiment, local open pollinated papaya was soaked for 24 hours in $CaNo_3$ and KNo_3 at different levels (1%, 1.5% and 2 %) along with the control (water). The least days taken for germination (4.33), the highest germination percentage (82.56), shoot length (14.31 cm), fresh biomass (1.36 g) and dry biomass (0.174 g) were recorded in 1% $Ca(NO3)_2$ treatment one month after germination. In another experiment, three varieties of papaya (Arka Surya, Arka Prabhat and Madhu Bindhu) were treated with $Ca(NO3)_2$ at different levels (1%, 1.5% and 2 %) along with control. Arka Prabhat treated with 1% $Ca(NO3)_2$recorded the lowest number of days for germination with (4.75) and highest shoot length (25.2 cm) after one month of sowing. The experiment proved the significant effect of calcium ions at low concentration in the papaya seed germination and seedling vigour.

S3O10 A612

Withdrawal of P and K fertilizer and its impact on yield, petiole and soil nutrient status of grape (var Thompson Seedless)

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A fertilizer (P and K) withdrawal trial was established during 2016-17 in an experiment previously fertilized for 6 years, in a plot laid out in randomized block design with ten treatments, *viz* fertigation with different levels of recommended dose (500,500 and1000kg/ha N, P_2O_5 and K_2O respectively) through drip (80, 50 and 30% RDF) two different fertigation schedules i.eschedule 1 (T1, T2 and T3 respectively) and schedule 2 (T4, T5 and T6 respectively) and different levels (80, 50 30 and 100 % RDF) applied through soil (T7, T8, T9 and T10 respectively) and each treatment was replicated four times. In the year 2016-17,P and K fertilizers were not applied in any of the 10 treatments since, thebuildup of P and K in soilas well as the petiolePand K status was high in all ten treatmentsduring the previous 6 years. FYM @ 6 kg /vine andN@ 100g N/vine was applied common to all treatments.Thus the soil was converted into a fertilizer (P and K) withdrawal trial during 2016-17 to monitor the residual effects of previous fertilizer applications on the petiole nutrient content, soil nutrient status and yield of grape (var Thompson Seedless). Petiole P and K content was optimum at bud differentiation and full bloom stages at allresidual soil levels even after withdrawal of P and K content for one year while the N content was slightly low with N applied @ 100g/vine.The soil sample collected before foundation and fruit pruning and also after harvest of grapes revealed that there was no decline in soil N with N was applied @ 100g/vine when compared to previous years which received N @ 200g/vine for 100% RDF. The treatment differences with respect to soil Nwere non significant. The treatment differencesreflected in petiole N content at bud differentiation stagehowever,got nullified at full bloom stage. In case of P there was a decline in mean soil P by about 150 kg/ha after ceasing P fertilizer application for one year. Treatments with higher doseof fertilizer applied during previous years recordedsignificantlyhigher residual soil P, which was much higher with soil application when compared to fertigation. Unlike P, there was no significant decline in mean residual soil K even after ceasing of K fertilizer application for one year. The treatment differences in soil K were more significant than soil N but less than soil P. This was paralleled by the treatment differences in the petiole P and K content and yield of grape. Significantly higher yield and P, K content of grape was recorded with higher residual levels of P and K in soil.

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S3O11 A232

Development and performance of India's first customized fertigation products for Pomegranate

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India is one of the leading producers of Pomegranate (*Punica granatum* L.), and is currently producing about 21.98 lakh ton pomegranates from 1.93 lakh Hac area annually. In last two decades, sharp increase in production and productivity have been observed owing to increased availability of quality plating material and adoption of fertigation. In India use of water soluble fertilizer has CAGR of 20%, mainly driven by fertigation in selected fruit crops in Western and Southern India, Pomegranate being an important crop. Selection of inputs, rates and application time is critical for successful fertigation, since it is important to simulate physiological demand and ensure compatibility. Also, crop specific balanced application of nutrients seems to be a potential tool in sustainable farming. In our survey, we found wide variability in nutrient application and consequent yield and quality; with low resemblance to physiological demand. Thus, development of stage specific fertigation product offers huge scope of value addition for the growers. The present paper describes the performance of theoretically calculated three nutrient grades, which were calculated based on nutrient requirement for targeted yield, nutrient uptake and its distribution dynamics as per growth stages, and were found to meet the nutrient requirements of five distinct physiological stages identified for Pomegranate. These were tested on the farmer's field through a series of experiments during 2013-14 to 2015-16 to develop customized fertigation products for Pomegranate. A yearly nutrient management schedule was standardized, adoption of which led to up to 25 per cent yield increase over the current farmer's practice of that area, along with significant improvement in various quality parameters like TSS, fruit size and color.

S3O12 A309

Performance of exotic sweet orange on raised-bed under black-clay soils of Central India

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The new method of planting on raised bed is proving to have several advantages over the conventional system. The main effect is on the use of fertilizer which, in this case, is only used on the soil where plants are grown. Plants on raised beds are more crowded, and nutrients can be depleted in a shorter time than in a conventional orchard. Another important aspect is that water stagnation problem is solved; and, thereby, the problem of *Phytophthora* can be minimized. Pre-bearing and bearing performance was recorded in six cultivars (each on two rootstocks) of sweet orange budded on rootstocks and planted in August 2014. Plants of 'Hamlin' on 'Volkameriana' rootstock recorded maximum plant growth with respect to height and canopy spread (2.49m & 3.42m^3, respectively). Compatible bud-union was also seen in 'Volkamariana' rootstock along with stock-scion growth, compared to that in the others; whereas, dwarfing was noted with 'Westin' on 'Swingle' rootstock for plant height and canopy spread (1.65m and 1.02m^3, respectively). The stock-scion success and plant spread in N-S & E-W directions was also highest in 'Hamlin' on 'Volkameriana' rootstock, whereas, minimum growth was seen in

'Westin' on 'Swingle' rootstock, compared to that in the other combinations used in this experiment. This year, flowering has been recorded in 'Pera', 'Hamlin', 'Valencia' and 'Natal sweet orange'. Maximum plant growth was seen in all the treatments this year. Leaf macronutrients varied significantly in all the treatments. Highest leaf N was observed in 'Lane late' + 'Rough lemon', while P was highest in *Mosambi* + 'Rangpur lime'; K was highest in 'Pera' + 'Limocrova'. Lowest psylla population was recorded in 'Hamlin' + 'Volkameriana' (5.92/ 5cm twig) and 'Hamlin' + 'Cleopatra (1.41/ 5cm twig); whereas, % leaf miner infestation was minimum in 'Westin'+ 'Limocrova' (25.37%), 'Westin' + 'Swingle' (27.47%) and *Mosambi* + Rangpur lime (25.17%). This may also prove to be the most appropriate method for replanting citrus under black-clay soils.

S3O13 A321

Precision citriculture through fertigation on black clay soil

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Input use efficiency is central to any precision-based cultivation. A field experiment on precision citriculture was conducted during 2014-2017 in four-year-old non-bearing trees of Nagpur mandarin spaced 6m apart standing on black clay-loam soil (Typic Ustochrept). In all, 144 trees were geo-referenced using GPS and the initial growth was quantified by canopy volume (m^3) for developing canopy-based *variogram* as a decision-support-system (to delineate management zones for different levels of irrigation and fertigation). Accordingly, three production management zones (High, Medium and Low) were delineated and variable rates of fertigation were experimented as: T_1 (High production zone: Irrigation with 80% (water requirement) on ET_{crop} basis along with 60 % RDF as fertigation); T_2 (Medium production zone: Irrigation with 90% WR along with 80% RDF as fertigation), and T_3 (Low production zone : Irrigation with 100% WR along with 100 % RDF as fertigation). Quantity of the irrigation water computed on per plant basis varied as follows: 10.6 to 31.6 litres/plant, 11.9 to 35.5 litres/plant, 13.3 to 39.5 litres/plant for High, Medium and Low management zones, respectively. Fertilizers used in fertigation were: urea (46:0:0), diammonium phosphate (18:46:0) and Muriate of Potash (0:0:60). Response of variable rates of fertigation was tested through changes in plant canopy volume. Mean canopy volume of plants in High, Medium and Low production zones was found to be $4.87m^3$, $4.22m^3$ and $2.19m^3$, respectively, on average. Availability of different nutrients was partitioned across the three management zones. The available-to- plant nutrients in soil within each management zone were: $KMnO_4$-N 101.9-191.2 mg/kg, DTPA-Fe 7.19-19.7 mg/kg, DTPA-Mn 8.03-10.5 mg/kg, DTPA-Cu 1.44 - 7.84 mg/kg, and DTPA-Zn 0.88 - 2.14 mg/kg (High management zone); $KMnO_4$-N 108.1 -197.5 mg/kg, DTPA-Fe 9.11 - 17.8 mg/kg, DTPA-Mn 8.02 - 10.2 mg/kg, DTPA-Cu 1.20 - 6.46 mg/kg, and DTPA-Zn 0.70 - 1.93 mg/kg (Medium management zone) and $KMnO_4$-N 109.7 -124.4 mg/kg, DTPA-Fe 8.10 -12.1 mg/kg, DTPA-Mn 7.43 -10.1 mg/kg, DTPA-Cu 0.57 - 5.91 mg/kg and DTPA-Zn 0.07 - 2.30 mg/kg (Low management zone). Soil fertility *variograms* for each nutrient were superimposed over plant canopy *variograms* under each of the three production management zones, to quantify the magnitude of crop response.

S3O14 A570

Efficacy of defoliating chemicals in Nagpur mandarin (*Citrus reticulata* Blanco)

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In order to standardise the effective and safe concentration of defoliation chemicals for imposing physiological stress for forcing the plants in to *Hasta bahar* (October-November flowering), the present investigation was carried out on eight years old Nagpur mandarin (*Citrus reticulata* Blanco) plants of uniform size, growth and age, budded on rough lemon planted at a spacing of 6 m x 6 m. The defoliation treatments included foliar applied urea (4, 6 & 8%), naphthalene acetic acid (NAA) (500, 1000 & 1500 ppm) and ethephon (500, 1000 & 1500 ppm) applied on 15th September, 2015. The results indicated that ethephon at 1500 ppm concentration gave 98.59% leaf fall 14 days after foliar application which was significantly higher than any other defoliation treatment. After 21 days of application ethephon 1000 ppm resulted in 98.56% leaf drop which was on par with ethephon 1500 ppm (99.96%). Ethephon at 500 ppm took 28 days for 100% leaf drop which was on par with 1000 and 1500 ppm at same time interval. Urea at 8% could affect defoliation only up to 27.18% 28 days after foliar application, the percentage remaining same till 49 days. There were only toxicity symptoms in the form of laminar burning observed in leaves of treated plants. Naphthalene acetic acid (NAA) at 1500 ppm recorded 28.8 % defoliation 28 days after foliar application which was significantly higher over 500 and 1000 ppm NAA concentration. No adverse effects were observed in any of the concentrations of NAA used in this study. No flowering could be observed in any of the treatments till the end of November 2015 although the critical weather parameters *viz*. maximum and minimum temperature, RH, soil moisture content % and leaf water potential (MPa) were in optimal ranges for flowering (maximum temperature 27.20 to 35.20 ^{0}C, minimum temperature 15.20 to 23.40 ^{0}C, Relative humidity 60.20 to 89.60, soil moisture content per cent 9.08% to 37.65% and leaf water potential -0.61 to -2.63). The data showed that whenever the moisture content was maintained between available range (18-26 %), the leaf water potential of the plant was more (MPa values being less negative) and as the soil moisture content fell down below the 18% level, the leaf water potential of the plants was less (MPa values being more negative).

S3O15 A423

Hand-pollination and partial protection for organic production of kiwifruit under high-rainfall, mid-hill conditions

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Prolonged wet seasons with high rainfall intensity, along with frequent hail storms in the North-Eastern Hill Region (NEHR) induce several biotic and abiotic stresses under open cultivation and have a serious, negative effect on fruit-set and yield in kiwifruit (*Actinidia deliciosa*). Kiwifruit flowers are extremely susceptible to damage by heavy rainfall and hailstones. Provision of adequate shelter is essential to protect this crop from heavy rainfall/ hail and successful organic production in Sikkim. Organic packages of practice have been standardized for maximizing 'A' grade kiwifruit production by partial protection of kiwifruit vines with 50% agro-shade net. Studies were undertaken on effect of hand-pollination (HP) on per cent fruit-set, fruit growth, fruit yield and fruit quality under partial protection, besides setting up a Control (C). Hand pollination significantly increased the rate of 'A' grade fruit production (70-80%) under partial protection. The best time for hand-pollination was 10 am to 12 Noon, to obtain maximum fruit-set (80-90%). Pollen was viable up to 72h for effective hand-pollination; however, maximum (100%) fruit-set was observed with hand-pollination done within 24h of anther harvest, and 90% fruit-set was observed with 48h from anther harvest for pollinating. Hand-pollination and organic nutrient (ON) management showed significant effect on fruit length [55.46mm (C) to 70.26mm (HP&ON)], fruit breadth [40.20mm (C) to 42.47mm (HP&ON)], fruit weight [50-60g (C) to 100-120g (HP&ON)], and quality parameters, *viz*., acidity [0.63% (HP&ON) to 1.35% (C)], total sugars [8.23% (C) to 14.05% (HP&ON)] and Total Soluble Solids (TSS) content [10.54°Brix (C) to 18.67°Brix (HP&ON)]. For maximizing 'A' grade organic kiwifruit production, vines should be mounted with 50% agro-shade net at the end of March for about sixty days (to be removed around end of May).

S3O16 A542

Effects of leaf-fruit ratio, bioregulator, pruning and nutrient spray on fruit grade and yield of kiwi fruit.

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Kiwifruit (*Actinidia deliciosa* Chev.) is the most suitable diversified crop among temperate fruit crops in India and has emerged as an alternate crop after apple. In India, kiwi can be successfully grown at an elevation of 800-1500 m above mean sea level. This fruit holds a great promise for commercial cultivation due to its biochemical properties particularly to fight against Dengue disease, suitable for diabetic patients and better keeping quality. Sitofix or CPPU (N-(2-chloro-4-pyridyl)-N-phenylurea) greatly stimulated fruit growth indicating that it could be a powerful tool for improving kiwi fruit yield. CPPU at 10 ppm were applied to fruits (10 days after anthesis) by dipping them for about 10 seconds. Sitofix application increased fruit size by 30-75 g over the control. A higher proportion of the crop was in the large size grade and there was no loss of response as the crop load on the vine increased. CPPU produced a darker skin colour and some changes in appearance, increased fruit size, advanced ripening by one week, reduced flesh firmness, increased soluble solids and decreased titrable acidity. Fruit yield also increased by the application of foliar nutrient spray. Average fruit weight was further increased by light summer pruning ($1/5^{th}$ of new growth) in fruiting branches and $1/3^{rd}$ pruning in non-fruiting branches at monthly intervals till harvest. Fruit size and weight has also been increased by maintaining leaf-fruit ratio of 2:1. Maximum A-grade fruit (above 75 gm in wt.) were recorded in nutrient spray, summer pruning and CPPU application alone or in combination, in addition to winter pruning (during dormancy) at four node level.

S3O17A446

Variation in leaf morphology and physiological characters among selected *Annona* species

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Annona plantations of the present owe their origin to vast populations of seedlings that have originated in nature from seed-scattering. A majority of species in the *Annonaceae* family are reckoned as under-utilized, hence, information on these is scarce.However, very few of the studies reported describe photosynthetic and leaf morphological characters of *Annona* species. To expedite any crop improvement program, morphological and physiological characterization is effective and can trace true genetic variation in divergent genotypes. Therefore, the present study aimed at investigating various morphological and physiological parameters that could be related to yield increase in the genus, *Annona*. Among the various accessions studied, viz., *Annona cherimola* Mill. (cherimoya), *A. muricata* L. (soursop), *A. squamosa* L. cv. Balanagar (sweetsop), *A. glabra* L. (pond apple), *A. reticulata* L.(custard

apple) and *A.* x *atemoya* (atemoya),*A. cherimola* had the highest photosynthetic rate (6.46µmol m^{-2} s^{-1}) and leaf area (71.46cm^2), but the lowest leaf-mass:area ratio. Intrinsic water use efficiency (A/g_s), stomatal conductance (g_s) and transpiration (*E*) were lowest in *A. squamosa* cv. Balanagar. Significantly higher stomatal densitywas seen in *A. glabra* (4.79), suggesting stomatal regulation flexible to water deficit conditions. *A. glabra* also recorded the highest iWUE and WUEi. However, total chlorophyll content did not differ among the genotypes studied.

S3O18 A621

Seed priming studies in Cashew

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Cashew, the dollar earning cash crop is mainly propagated through soft wood grafting. The vigour of the root stock has got a profound influence on the grafting success and production of healthy grafts. Seed priming has been reported as an effective technique to produce vigorous seedlings in many crops. Hence, a study was conducted at Regional Agricultural Research Station, Pilicode to know the influence of different seed priming agents on the growth and vigour of the rootstock seedlings using the popular cashew variety of the region, Priyanka. The germination percentage showed significant differences with the seeds primed with KCl 0.5% being the highest and Urea 5% and 10% being the least. Germination index was highest for KNO_3 3%. At 15 days after sowing (DAS), seed vigour index (SVI) was highest with the treatments KNO_3 1% and 3%, though the differences among the treatments regarding seedling length, girth and number of leaves were insignificant. At 30DAS the seedling length was highest with KCl 1% and stout plants were observed with those seeds primed with distilled water for 24 hours and non-primed seeds. The number of leaves was highest with Urea 5% and 10%, KNO_3 3% and non-primed seeds. SVI was highest with KCl 0.5% and Distilled water 12 hours primed seeds. At 45 DAS treatments, Urea 5 and 10%, $KNO_3$3% and non-primed seeds have resulted in taller seedlings whereas control seeds and those primed with distilled water for 12 hours had higher girth. Higher number of leaves was observed with priming using distilled water for 24 hours Urea 10%, KNO_3 3%. SVI was highest with KNO_3 3%, non-primed seeds, distilled water for 12 hours and urea 10%. Since KNO_3 3% resulted in seedlings with higher SVI, seedling length and more number of leaves, it could be recommended for obtaining good quality rootstocks in cashew.

S3O19A209

Effect of fertigation on Growth, Yield, Fruit Quality and Fertilizer use efficiency of Strawberry *(Fragaria × ananassa* Duch.) cv. Chandler

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Strawberry *(Fragaria × ananassa* Duch.) an aggregate fruit is grown in varied agro-climatic conditions and gives quickest return in shortest possible time. The fruits are good source of vitamins, minerals and also good source of natural antioxidants. It is a shallow rooted plant, thus requires nutrients more frequently for normal plant growth and production. Therefore, fertigation allows an accurate and uniform application of nutrients to the wetted area, where the active roots are concentrated. Fertigation also increases the efficiency in the application of the fertilizers, thus reduces the production cost as well as lessens the potential of ground water pollution caused by the fertilizers leaching. Therefore, the investigation was carried out to study the effect of different levels of fertigation on growth, yield and fruit quality of strawberry and to work out its fertilizer use efficiency over soil fertilization. The experiment was laid out in randomized block design with five fertigation treatments *viz.*, recommended dose of NPK through soil, recommended dose of NPK through drip, ¾ of recommended dose of NPK through drip, ½ of recommended dose of NPK through drip and 1/3rd of recommended dose of NPK through drip and each treatment was replicated five times. The maximum plant height (24.23 cm) was recorded in recommended dose of NPK through drip. Recommended dose of NPK through drip also resulted in the production of maximum number of leaves (26.40/plant), fruit yield (35.64 t/ha), berry length (42.49 mm), berry breadth (31.74 mm) and weight (19.87 g). The values of TSS (9.88^{o}B), total sugar (9.44%), reducing sugar (6.52%), anthocyanin (0.249 OD) and ascorbic acid (53.39 mg/100g) was significantly higher in fertigation with recommended dose of NPK treatment. Fertigation with ¾ of recommended dose of NPK registered higher fertilizer use efficiency over soil fertilization with full recommended dose of NPK, and also resulted in 25 per cent saving of fertilizers without any adverse effect on growth, yield and fruit quality.

S3O20 A447

Effect of water-soluble fertilizers on growth and nutrient uptake and economics in brinjal (*Solanum melongena* L.) hybrids

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An investigation was carried out to study the effect of water-soluble fertilizers on growth and nutrient uptake in brinjal (*Solanummelongena* L.) hybrids at the University Orchard, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu in 2015. Foliar feeding of water-soluble fertilizer NPK (19:19:19) at 0.5% and 1%, together with 100% or 75% of recommended dose of fertilizer (RDF), viz., NPK (200:150:100 kg ha^{-1}) comprising 5 or 7 sprays, each starting with 30 DAT at 10-day intervals, constituted 20 treatments in two hybrids, Ravaiya and Supriya. Experimental plots were laid out in Randomized Block Design, and replicated thrice. Observations on various growth parameters and uptake of major nutrients were recorded and subjected to statistical analysis. Results obtained showed that among the two concentrations of foliar-application

of nutrients, 7 sprays of 1% NPK (19:19:19) along with 100% RDF (200:150:100 kg ha^{-1}) recorded maximum plant height, number of primary branches/ secondary branches, stem girth, number of leaves per plant, leaf area, chlorophyll content and dry matter production. Uptake of major nutrients was highest in foliar application of 1% water-soluble fertilizer ((19:19:19, 7 sprays) together with 100% RDF was found to be the best with higher benefit:cost ratio compared to the other treatments.

S3O21 A698

Propagation Techniques in Kartoli (*Momordica dioica* Robx)

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The present investigation was undertaken at Horticulture Section, College of Agriculture, Kolhapur during August 2016. The experiment was laid out in Factorial Completely Randomized Block Design with forty five treatment combinations suchas different concentrations of IBA (0, 250, 500, 750, 1000 ppm), three types of cutting (tip, middle and basal) and three types of rooting media such as Soil + Sand + FYM, Soil + Sand +Vermi-compost and Soil + Sand + Coco peat in 1:1:1 proportion replicated for two times. The common dose of bio-fertilizer was added during the preparation of mixture of rooting media. It was found that, the survival percentage of cuttings, length and number of roots, and further growth of cuttings of kartoli were clearly indicated the superiority of IBA at 750 ppm application. The highest survival percentage (70.56, 68.33 and 61.11) was observed in the cuttings treated with IBA @ 750 ppm followed by IBA @ 500 ppm (67.62, 65.56, and 57.78) at 30, 60 and 90 DAP, respectively. It also observed that the types of cutting of kartoli, showed significant influence on rooting and further growth of cutting. The maximum survival percentage (61.67, 58.67 and 55.00 at 30, 60 and 90 DAP, respectively), and the maximum shoot and root growth was observed in tip cuttings while middle cutting (53.00, 49.00 and 44.33 at 30, 60 and 90 DAP, respectively) and basal cuttings (45.67, 43.00 and 39.67 at 30, 60 and 90 DAP, respectively) recorded the low survival per cent and further growth of cutting. The data revealed that rooting media such as Soil + Sand + FYM (1:1:1) was found to be the best media for rooting to the cuttings of kartoli. Maximum number of roots (15.44, 77.05 and 113.02) and length of root (5.49,15.45 and 22.53 cm) at 30, 60 and 90 DAP, respectively were observed in cuttings planted in rooting media such as Soil + Sand + FYM (1:1:1) The data revealed that the tip cutting treated with 750 ppm IBA and planted in Soil + Sand + FYM (1:1:1) was found to be the best treatment for increasing number of roots (19.35, 94.28 and 132.80) and leaves per cutting (12.05, 48.15 and 75.38) per cutting at 30, 60 and 90 DAP, respectively. Among all the treatment combinations, IBA at 750 ppm + tip cutting planted in Soil + Sand + FYM (1:1:1) media was found to be the best treatment of induction for rooting to the cuttings , survival percentage and further growth of cuttings of kartoli.

S3O22 A71

Mineral content of potatoes of Eastern India

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Varietal breeding depends on consumer preference or climatic conditions. Eastern plain region of India constituting states of Bihar, UP, MP and Orissa contributes 50% total potato acreage and production of country.In potato tuber colour is an important factor that influences consumer decision-making. Consumers in this region preferred skinned medium sized varieties. Growing awareness for nutrient rich food created a niche market for nutritious potatoes. Potato is a choice crop for mineral biofortification owing to better mineral bioavailability due to high ascorbic acid and minimal phytate content. Iron and zinc are the essentially required minerals for good health. Considering the nutritional importance of these elements and wider prevalence of their deficiency in Indian sub-continent, thirteen Eastern region red skinned advanced hybrids and indigenous varieties were evaluated to find the genetic diversity for iron and zinc content under uniform growing conditions. A significant variation was observed for both the elements. The iron content was highest in indigenous variety Rajendra-II (63.94 ppm) followed by P/6-24 (43.04 ppm) whereas the zinc content was high in P/6-24 (39.19 ppm) followed by 30.61ppm in Rajendra-II. High heritability of both mineral (H^2 =93.68, 88.56) suggests feasibility of selecting genotypes for breeding nutrient rich varieties. Identified genotypes can be utilised as parental lines for future breeding programme and can be released as nutrient rich potato variety.

S3O23IS 55

Chitosan-urea nano-formulation: Synthesis, characterization and impact on tuber yield of potato

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Conventional mineral N-fertilizers suffer from greater losses and have attendant negative impacts on environment. The agronomic and economic loss of applied N-fertilizers particularly 'urea' accounts for low use efficiency. Potato (*Solanum tuberosum* L.), the third important food crop after rice and wheat considering total global production, is one among the most N-responsive crops. However, the shallow root system and poor uptake efficiency compounds the low NUE in this major non-grain food crop. The 'nano-N fertilizers' can enhance potato productivity besides mitigating N-losses and perhaps fertilizer application rates. The present study investigated the effect of application of degradable polymer encapsulated urea fertilizer on soil enzyme activity and yield and component traits of potato cv. Pukhraj. Nanoencapsulation of five different concentrations of granular urea (3, 7, 10, 30 and 50% w/v) in chitosan (1.5% w/v) hydrogel through ionotropic gelation resulted in formation of spherical nano-chitosan-urea particles varying in size from 75 to 250 nm. The nanoparticle sizes varied in accordance to the concentration of the supplemented urea. Likewise, the functional group characterization by FT-IR spectroscopy showed increase in amide peak intensity with increase in urea concentration. A pot

study performed using four urea/ nano-urea application rates (0, 50, 75 and 100% RDF) enhanced soil dehydrogenase activity, shoot height, root length, tuber size and yield of potato cv. Pukhraj in chitosan-urea treatment. This study showed potential of encapsulation of urea in chitosan polymer and its beneficial effects for enhancing yield in potato.

S3O24 A21

Studies on growth, tubers yield and mineral content of Indian potato cultivars under elevated CO_2

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Climate change is a global phenomenon due to natural and anthropogenic activities. CO_2 concentration in the atmosphere is escalating every year, and is estimated to touch 550 ppm by the middle of this century and to exceed 700 ppm by the end of 21st century. Increased CO_2 would affect physiological traits such as growth, yield and mineral content of potato. An experiment was conducted under transparent walled open-top chambers (OTCs) with ambient (400 ppm) and elevated CO_2 levels (550 & 700 ppm) during rabi season of 2015-16 using two potato cultivars *viz.* Kufri Surya (heat tolerant and medium maturity) and Kufri Pukhraj (high yielding and early bulking). Plant height increased linearly from emergence till about 60 DAP under all the conditions. It was 12% higher in Kufri Surya and 7% higher in Kufri Pukhraj at 700 ppm CO_2 compared to ambient condition. Leaf area per stem was increased by 50% per cent in K. Surya and only 10% in K. Pukhraj at 700 ppm CO_2. Photosynthesis increased with increasing CO_2 concentration in both the varieties and there was no significant difference between them. Tuber yield increased substantially in Kufri Surya with 38% increase at 550 ppm and 70% increase at 700 ppm, whereas, in Kufri Pukhraj it was 5% at 550 ppm and 24% at 700 ppm. Elevated CO_2 did not significantly affected nutrient (NPK) concentration in tubers and leaves (NP) but potassium increased significantly. The results indicate that Kufri Surya was more responsive to CO_2 concentration as compared to Kufri Pukhraj.

S3O25 IS 13

Effect of Mulching Materials on Soil Temperature, Soft Rot Incidence, Growth, Flowering, and Bulb Yields of Calla Lily (Zantedeschia aethiopica)

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The effects of various mulching materials on soil temperature, incidence of calla lily soft rot, growth, flowering, and bulb yields of calla lily (*Zantedeschia aethiopica* var. 'wedding March') were determined in the greenhouse conditions. Mulching materials included wood chip (WC), rice hull charcoal (RHC) and perlite (No. 1) and soil was covered by 3 cm of each material. No mulching control was also added to the treatments. The highest leaf number occurred in RHC (12.2), followed by perlite treatment (11.5). Leaf length was greatest in RHC (142.9 cm), while floral stem length was highest in the perlite mulching (112.2 cm), which was longer than control by 7.3 cm. The weight of cut flower was highest in perlite and WC treatments (210.4 g and 201.9 g, respectively), while RHC produced 176.9 g of cut flower, compared to 144.4 g in the control. The yield of cut flowers, as expressed flower number per plant, was highest in RHC (5.1), which was higher than control (3.7) by 37.8%. Increases in the soil temperature were delayed by the mulching treatments: soil temperature in the control approached >20C starting from the end of April and increased to higher than 25C in mid-May, while in the mulching treatments about 20C of soil temperature was achieved in mid-May. The incidence of calla lily soft rot became obvious starting from May, which corresponded to the time when soil temperature substantially increased: the incidence rate was highest in the control (29.4%), while 11.1% in RHC, and 14.3% and 15.4% in WC and perlite, respectively. Bulb yields were significantly promoted by RHC and perlite mulches (270.5 and 247.0 kg per 10 a, respectively) compared to the control and WC (199.0 and 211.5 kg per 10 a, respectively). Therefore it is concluded that a mulching treatment with RHC promoted the yields of both cut flowers and bulbs, while soft rot incidence was considerably declined.

S3O26 A602

Elevated carbon dioxide and temperature efects on rooting of grape cuttings: with OTC, FATE and FACE facilities

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The global climate is changing by increase in GHG's mainly CO_2 and temperature. It is important to quantify and understand the consequences of increased CO_2 and Temperature. The experiment was carried out to study the effect of eCO_2 (550ppm), eT (+3ºC) and interaction (eCO_2+eT) on rooting of cuttings of three grape varieties (Thompson Seedless, Bangalore Blue, and Dogridge). Destructive sampling was done at two intervals i.e. 50 and 80 Days After Planting and the data on root growth was recorded by scanning and analysis of roots using winRHIZO software. Analysis of data revealed that there was a significant difference between varieties and treatments for the characters under study. Under eCO_2 Thompson Seedless stem cuttings has shown highest number of roots, fresh weight of roots, root

biomass and root volume, While, the root length and root length density was higher under eCO_2+ eT. Bangalore Blue stem cuttings have shown highest number of roots, fresh weight of roots, root volume and root length under eCO_2, whereas root biomass, was higher under eCO_2+ eT. Dogridge stem cuttings have shown highest number of roots under eCO_2, while fresh weight of roots, root biomass, root volume and root length was higher under eCO_2+ eT. The number of days for bud break was lowest under eCO_2+eT followed by eT and eCO_2 for all the three varieties. The percentage of rooted cuttings was higher under eCO_2+eT in all the varieties. Overall, eCO_2, eT and eCO_2+eT increased root parameters as compared to ambient, while eT reduced the effect. Increase in atmospheric CO_2 concentration and temperatures associated with future climate are expected to affect positively on rooting of grape cuttings.

S3O27 A44

Standardization of planting geometry for multiplication of small aeroponic tubers under protected conditions

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In mitigating the shortage of good quality seeds, strategies to rapidly multiply the seed tubers such as tissue culture in conjunction with hydroponic and aeroponic systems have been tried. For improving the size of extremely small sized aeroponic tubers for making them worth planting under field conditions, a study was envisaged to standardize the planting geometry for their multiplication under protected conditions with five planting geometries *viz.*,30 x 10 cm, 30 x 15 cm, 30 x 20 cm, 40 x 10 cm and 40 x 20 cm. The results revealed that plant emergence varied significantly among the treatments at both observation periods of 40 and 60 DAP. Final emergence was maximum (97.1%) at 40 x 20 cm spacing and minimum (90.6%) at 30 x 10 cm. Number of shoots and compound leaves didn't vary significantly among various planting geometry treatments. Number of tubers/m^2 was significantly higher at the narrowest intra-row spacing of 10cm in both inter-row spacings of 30 and 40 cm. However, total tuber yield/ m^2 was significantly higher at 40 x 10 cm followed by 30 x 10 cm. Average tuber weight was maximum (26.6g) at. 40 x 20 cm closely followed and at par with 30 x 20 cm and 40 x 10 cm spacings. Thus, for improving the size of extremely small sized aeroponic tubers, one time multiplication during the autumn season under protected conditions in high hills can be successfully practiced. For obtaining 15g progeny tubers, small aeroponic tubers should be planted at 30 x 10 cm, whereas, for obtaining >20g tubers, planting should be done at 40 x 10 cm.

S3O28 IS20

Diurnal fertilizer application affected nitrogen uptake in Vanda via roots and leaves

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Vanda is an important commercial tropical orchid in Thailand. Orchid growers generally apply spray fertilizer via both foliar and aerial roots to promote plant growth and flower quality. However, nutrient uptake and utilization in *Vanda* is unclear. This study was conducted to determine how leaves or roots of *Vanda* and time of fertilizer application affect nitrogen uptake. The ^{15}N tracer (5 mM $^{15}NO_3^-$ + 5 mM NH_4^+) is fed to plant once via leaves or roots with different timing. The experimental designed was 2 × 4 factorial in CRD, combination of two application methods (via leaves or roots) and four application times (8 am, 12 pm, 4 pm and 8 pm). The results showed that, regardless of diurnal, applied only foliar fertilizer caused higher ^{15}N uptake with 47.42 µg/gDW of concentration in leaves. Whereas, applied fertilizer via roots obviously gave the higher ^{15}N concentration in stem and roots as 41.40 and 162.38 µg/gDW, respectively. For all application times, applied fertilizer via roots resulted in greater amount of ^{15}N content in roots, highly at 12 pm and 4 pm (4.87 and 4.69 mg/plant, respectively). Thus, our results suggested supply fertilizer via aerial roots of *Vanda* during 12 pm and 4 pm could stimulate nutrient uptake and accumulation in *Vanda*.

S3O29IS21

Effects of Nitrogen Concentration on Growth of Hippeastrum

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N is an important element for plant growth and development by increasing the vegetative growth, producing good quality foliage, and promoting carbohydrate synthesis. Growing *Hippeastrum* as pot plant usually face to the N deficiency problem. The objective of this study was carried out to determine the optimum nitrogen contration for *Hippeastrum*growth. Bulbs of *Hippeastrum*were grown in a 10-14 cm. diameter in 15.24 x 30.48cm. of plastic bags using soil and rice husk at 1:1 ratio as growing media. Three nitrogen concentrations were applied to plant i.e. 75, 150, and 225 mg/L of N using $NH_4H_2PO_4$ and $Ca(NO_3)_2$ as N source. Other essential elements are applied equally in each treatment i.e. 50 mg/L of P, 300 mg/L of K, 490 mg/l of Mg, 0.48 mg/l of B, 0.25 mg/l of Mn, 0.035 mg/l of Zn, 0.008 mg/l of Cu, 0.004 mg/l of Mo and 30 mg/l of Fe.Fertilizer were applied to plant every 2weeks until harvest (6 months after planting). The result showed that nitrogen concentration at 75 mg/l was optimum for *Hippeastrum* growth. IT could give the highest plant height,

73.1 cm. The highest number of leaves per plant (7.6) at 6 months after planting was found from in plants receiving 75 mg/l and 225 mg/l and the lowest number of leaves (6.3) per plant was found in plant without any fertilizer. The highest chlorophyll content was observed in the treatment of 75 mg/l N and significantly different from the other N concentration treatments.

S3O30 A186

Influence of foliar application of GA_3 and KNo_3 on flower yield and quality of Tuberose

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An experiment was laid out to study the influence of foliar application of GA_3 and KNO_3 on flower yield and quality of tuberose during the *kharif* season of 2010-11. It is evident from experimental findings that, minimum days required for first spike initiation (98.00 days) was obtained with the foliar spray of GA_3 200 ppm with KNO_3 1.5% at 30 and 60 days after planting as compared to the control. Flower quality parameters in terms of number of florets/spike (38.00), length of spike (112.86 cm), length of rachis (34.46 cm), diameter of spike (0.946 cm), length of fully opened florets (6.71 cm) and diameter of floret (3.92 cm) were found maximum with the foliar application of GA_3 200 ppm with KNO_3 1.5%. Vase life of spike (12.54 days) was also found maximum with foliar application of GA_3 200 ppm with KNO_3 1.5%. The yield and yield contributing characters in respect of number of spikes per plant, per plot and per hectare were obtained maximum under the treatment T_8 (GA_3 200 ppm + KNO_3 1.5%). High net monetary returns and high benefit cost ratio was obtained with foliar application of GA_3 200 ppm in combination with KNO_3 1.5% as compared to the other treatments.

S3O31 A108

Effect of foliar application of GA_3 and chemicals on yield and quality of gladiolus cv. American Beauty

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The present investigation was carried out at the farm of Horticulture Section, College of Agriculture, Nagpur during winter season of 2014-2015 to study the effect of foliar application of GA_3 and chemicals (19:19:19 and KNO_3) on yield and quality of gladiolus cv. American Beauty. The experiment was laid out in randomized block design with three replications and nine treatments of foliar application of GA_3 and chemicals with different concentrations alone and in combinations viz., GA_3 - 150 ppm, GA_3 - 200 ppm, KNO_3 - 1.5%, 19:19:19 - 1.5%, GA_3 150 ppm + KNO_3 1.5%, GA_3 150 ppm +19:19:19 1.5%, GA_3 200 ppm + KNO_3 1.5%, GA_3 200 ppm + 19:19:19 1.5% and control. It is evident from the experimental findings that, superior performance in terms of yield parameters viz., no. of spikes plant^{-1}, no. of spikes plot^{-1}, no. of spikes ha^{-1}, no, of corms plant^{-1}, no. of corms plot^{-1}, no. of corms ha^{-1}, no. of cormels plant^{-1} and quality parameters viz., spike length, rachis length, spike diameter, no. of florets spike^{-1}, corm diameter,weight of corms plant^{-1} and weight of cormels plant^{-1} was found in interaction treatment of GA_3 at 200 ppm + 19:19:19 at 1.5% which was significantly superior over all other treatments. Whereas maximum vase life of floret was found in foliar application of KNO_3 at 1.5%.

S3O32 A492

Evaluation of nutritional status and yield limiting nutrients in oil palm plantations of eastern Tamil Nadu, India

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Oil palm (*Elaeisguineensis* Jacq.) is being grown in many countries of the world to mitigate vegetable oil requirement. Assessment of soil properties and leaf nutrient concentration in oil palm plantations is required for effective nutrient management and obtaining higher crop yield. Therefore the present study was carried out by making a survey of oil palm plantations of eastern Tamil Nadu of India and collecting 104 soil samples and 52 leaf samples. Collected soil and leaf samples were processed and analyzed for different parameters. The values of studied soil properties like pH, EC, OC, available N, P, K, exchangeable Ca and Mg and available S and B in 0 to 20 cm and 20 to 40 cm soil depth varied widely with having CV values ranging from 7.44 to 89.4%. Leaf nutrient concentration values varied from 1.11 to 3.17, 0.05 to 0.18, 0.21 to 0.98, 1.24 to 2.23, 0.17 to 0.86, 0.08 to 0.22% and 21.8 to 77.7 mg kg^{-1} for N, P, K, Ca, Mg, S and B respectively. DRIS norms and indices were derived from different nutrient expressions. The order of requirement of leaf nutrients was found to be K > P > N > Mg > B. Optimum leaf nutrient rangers estimated to be 1.61 to 2.11 %, 0.10 to 0.12%, 0.33 to 0.81

%, 0.23 to 0.73 % and 30.6 to 54.8 mg kg^{-1} for N, P, K, Mg and B respectively. It was found that 15, 31, 2, 8 and 10 % samplers were having less than optimum concentration for N, P, K, Mg and B respectively. The information regarding soil nutrients status and nutrient requirement order and optimum leaf nutrient ranges can be used for effective nutrient management in the study area.

S3O33 A494

Micronutrient availability affected by organic and inorganic nutrient sources in cashew (*Anacardium Occidentale* L.) orchard soils

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Micronutrients are essential for plant growth and play an important role in overall crop nutrition. Micronutrient availability is influenced in a characteristic way by several factors in the soil environment.A field experiment has been initiated in 2012 at ICAR-Directorate of Cashew Research, Puttur, Karnataka to develop organic nutrient management modules for sustainable cashew productivity. The treatments imposed include T_1: FYM to supply 500 g N/tree; T_2: T_1 + biofertilizer consortia (Azospirillum, PSB and AMF at a rate of 50 g each/tree/year); T_3: T_1+ Rock phosphate to supply 125 g P_2O_5/tree and wood ash to supply 125 g K_2O/tree; T_4: Poultry manure to supply 500 g N/tree; T_5: *In situ* composting using recyclable cashew biomass (RCB) and weeds; T_6: T_5 + Green manuring (Growing glyricidia between two rows of cashew); T_7: Vermicomposting of RCB; T_8: T_2 + Organic cakes + RCB; T_9: Recommended NPK fertilizer; T_{10}: T_9 + 10 kg FYM/tree; T_{11}: Control. The experiment was laid out in randomized block design with cashew variety 'Bhaskara' and planting was done at a spacing of 7.5 x 7.5 m. The present study highlights the influence of organic and inorganic sources of nutrients on soil micronutrients in cashew orchards. Results showed that, available Iron (Fe) and Manganese (Mn) content in soil were recorded highest in the treatment T_8 and lowest in T_9 and T_{11} respectively. Similarly available Zinc (Zn) and Copper (Cu) recorded highest in T_8, lowest values recorded in the treatment T_6 and T_{11} respectively. It was noticed that availability of all the four micronutrients analyzed were observed highest under the treatment 'FYM + Organic cakes + Recyclable cashew biomass + biofertilizer consortia' (T_8)and this may be due to solubilisation and mobilization by enhanced microbial action aided by the application of biofertilizer consortia and organic sources in the root zone.

S3O34IS61

A quantitative analysis of wild herbaceous plant species for medicinal uses in four Regional Parks in Sicily (Italy) A quantitative analysis of wild herbaceous plant species for medicinal uses in four Regional Parks in Sicily (Italy)

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This paper illustrates the results of a study carried out in four Regional Parks in Sicily (Italy), Madonie Regional Park, Nebrodi Regional Park, Sicani Regional Park and Etna Regional Park. It specifies the medicinal uses of wild herbaceous plants species which were quantitatively analyzed. The study area covers a surface of 2269 km^2, includes 90 towns and it is characterized by a high degree of plant biodiversity and low level of urbanization. The aim of the study was to analyze, through quantitative indicators, the extent of the current knowledge on medicinal uses of plants in the area, evaluating also the features of uniqueness and commonality of this knowledge in comparison with other Mediterranean areas. The information were obtained using semi-structured interview format performed on a sample of 802 people over the age of 60 who were considered experts in rural and agricultural traditions. Local medicinal plant uses were evaluated using quantitative indices (e.g. cultural importance index, informant consensus factor). The results highlight that most of the species are used against general health and metabolic and gastrointestinal disorders. Only very few medicinal uses are widely known by all the informants and a specific medicinal use is often known by only very few people. The level of knowledge on medicinal uses of the plants is not found to be high within the population, demonstrating an ongoing process of cultural erosion.

S3O35 A625

Soil enzymes and microbial populations in mono and multi varietal Mango orchards of Chitoor district

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Soil enzymes are biologically significant as they participate in various transformations and influence the availability of plant nutrients. As micro organisms are one of the important source of soil enzymes, the measurement of these enzymes helps in measuring microbial activity in soil. In the present study, rhizosphere soil samples were collected from both mono (9 samples) and multi (12) varietal orchards of Mango in Chitoor district and estimated for soil enzymes and microbial populations. The mean soil dehydrogenase activity (9.75 µg TPF/gm/day) and acid phosphatase activity (13.90 µg p nitrophenol/gm of soil/hour) was found highest in multi varietal samples, whereas mono varietal samples recorded highest amount of alkaline phosphatase activity (42.06 µg p nitrophenol/gm of soil/hour). General and beneficial microbial populations of soil samples show that multivarietal samples recorded highest population of bacteria (32.76 X 10^5/gm dry soil) and zinc oxide solubilizers (11.55 X10^4/gm dry soil), whereas monovarietal samples recorded higher population of fungi (63.92 X 10^3/gm dry soil),

Actinomycetes (34.38 X 10^5/gm dry soil), free nitrogen fixers (25.66 X 10^3/gm dry soil), P solubilizers (25.66 X 10^4/gm dry soil), zinc carbonate (21.21 10^4/gm dry soil) and zinc phosphate solubilizers (18.78 10^4/gm dry soil). The results of our study indicated that multivarietal mango orchards have got highest amount of dehydrogenase activity which is one of the most adequate and sensitive indicators of soil health and overall soil microbial activity.

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S3O36 A644

Foliar fertilization for enhancing yield and fruit quality of apple under rain-fed conditions of mid-Himalayas

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Apple (*Malus domestica*) is the leading temperate fruit crop of North-Western Himalayan states of India. In Himachal Pradesh, apple was grown on an area of 1.11 Lac ha and producing 7.77 Lac MT crop during the year 2015-16 (hpagrisnet, 2017). The average productivity (7.02 MT/ha) is much lower than the potential yield of the crop due to several reasons. One of the major constraints is that most of the apple plantations are grown over hilly slopes subjected to huge loss of productive soil due to soil erosion. This reduces the soil fertility and subsequently the crop productivity. In addition modern fruit cultivation practices like high density plantation, obtaining higher yields from relatively young plants and obtaining high quality fruits requires more attention to plant nutrition (Bright, 2005).Nitrogen is a major element, required by all plants. Adequate nitrogen is essential for tree growth, leaf cover, blossom formation, fruit set and fruit size, all of which combine to determine crop yield (Bright, 2005). The application of micronutrient fertilizer in the cultivation zone may not meet the crop requirement for root growth and nutrient use. Therefore, a participatory experiment was conducted to assess the effect of foliar application of urea and Agromin on apple. Agromin is a commercial formulation of micronutrients containing mineral elements comprising of optimum proportion of zinc, copper, manganese, boron, molybdenum and magnesium. The experiment was conducted at three different sites at altitudes between 1800 to 2200 m above mean sea level. 13-15 years old, uniform trees of cultivar Royal Delicious were applied with treatments *viz.* Urea @ 0.5%, Agromin @ 0.25%, Urea @ 0.5% + Agromin @ 0.25%, Urea @ 1.0% and Urea @ 1.0% + Agromin @ 0.25%. Urea and Agromin sprays were done between tight to pink cluster stage of growth. These treatments were compared to control plants which were applied the recommended doses of Nitrogen. Results obtained from the experiment showed that vegetative growth was significantly influenced by the application of Urea and Agromin. Application of Urea @1.0% + Agromin 0.5% (T_5) resulted in highest plant height (29.17 cm), girth (1.10mm), shoot

extension growth (45.25cm) and tree spread (14.23 cm) which was at par with treatment T_4. Maximum fruit length (6.71cm) , diameter (5.57cm), fruit weight (88.41g) and total yield per plant were recorded in the treatment T_5 (Urea @1.0% + Agromin 0.5%)which was closely followed by the treatments T_3(Urea @0.5% + Agromin @ 0.25%) and T_1 (Urea 0.5 %). The highest benefit: cost ratio (2.80) was obtained in the treatment T_5 (Urea 1.0 % + Agromin 0.25 %). The lowest B:C ratio (2.45) was observed in Control due to the lowest number of large and medium grade fruits.

S3O37 A314

Plant nutrient imbalance and interactions in pomegranate under semi-arid region of Peninsular India

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Pomegranate (*Punica granatum* L.) is an important commercial crop of Peninsular India. Intensive cultivation practices in recent years have resulted in severe imbalance of nutrients in pomegranate. Foliar analysis has been frequently used for monitoring nutrient status in a plant. The present study was undertaken for developing nutrient norms and to understand interactions among various essential and non-essential elements in pomegranate in the northern part of Karnataka. Mean N, P and K concentration in leaf samples were found to be in the optimum range. Potassium to nitrogen (K/N) ratio was relatively wide (1.71). Calcium concentration was generally high, while Mg was optimum in a majority of the orchards, compared to norms developed elsewhere. Among micronutrients, Fe was low. Boron concentration showed wide variation in the leaf, ranging from 6 to 59 ppm. Many nutrients exhibited mutual interaction. Significant intreactions were observed among the 21 essential and non-essential elements determined. Nitrogen showed no significant relation with the other elements. Phosphorus concentation was influnced by that of Ca, Mg and Sr, while K concentration was influenced by that of Mo. Boron exhibited significant and positive relationship with Fe and Zn. Among the non-essential elements studied, Cd, Co, Cr, Ni, Pb and Se showed signinificant and postivie relatiosship. Concentration of Sr with Ca and Mg was highly related. Fe showed very close relation with Se. However, Ni did not show any relation with N. Interaction among nutrients poses a problem in interpretation. Reasoned application of Principal Component Analysis (PCA) resulted in greater understanding of nutrient interactions in the plant. PCA was performed on log transformed nutrient concentration data, as, raw data was not amenable to interpretation. PCA indicated significant and postive loadings (for PC2) among Fe and some non-essential elements. Further, the data was projected into multi-dimentional space with application of Compositioanl Nutritionl Diagnosis (CND), which indicated overall imbalance of a given nutrient in relation to the other nutrients, and dry matter accumulation. CND norm for N was V_N (3.69). P (V_P 1.80) and K (V_K 3.09) were not yield-limiting factors in the region. CND indices were low for Zn in a majority of the samples tested. Nutrient deficiency or yield-limiting nutrient was not identified in isolation; and, all the nutrients showing interaction among each other were

considered when developing diagnostic norms. CND norms exhibited a high diagnostic sensitivity for identifying yield-limiting nutrients in pomegranate.

S3O38A429

Effect of pre-harvest spray of forchlorfenuron and boron on fruit cracking and quality in pomegranate (*Punica granatum* L.) cv. Kandhari

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An investigation on pre-harvest spray of forchlorfenuron (CPPU) and boron together with *in-situ* soil moisture conservation techniques was carried out on seven-year-old plants of pomegranate cv. Kandhari trained as four stems, grown under rain-fed conditions of Himachal Pradesh. Experimental plants were subjected to 11 treatments, *viz*., mulching, CBOC (crescent bund with open catchment pits), CPPU at 5 or 10 ppm; H_3BO_3 @ 0.2 or 0.4%; mulching + CPPU at 5ppm or H_3BO_3 at 0.2%; CBOC + CPPU at 5 ppm or H_3BO_3 at 0.2%; and, Control. These treatments were applied separately in mid-March (*in-situ* soil moisture conservation) and in mid-May (forchlorfenuron and boron). Growth parameters like plant height, plant spread, trunk girth and annual shoot-growth were highest under the treatment CBOC + H_3BO_3 at 0.2%. However, leaf area and leaf chlorophyll content was maximum under the treatment CBOC + CPPU at 5ppm. Physiological characteristics such as photosynthetic rate and transpiration rate were higher in plants under crescent bund with open catchment pits. Extent of fruit-cracking was reduced to the lowest level (2.8%) from 11.67% in the Control, and highest fruit yield (26.8kg/plant) recorded with foliar application of CPPU @ 5ppm, under CBOC. Least russet formation (1.33 on a 10-point scale) occurred in fruits of plants treated with CPPU at 5ppm + CBOC. Maximum fruit length (86.2cm), fruit breadth (88.3cm), fruit weight (419.74g), aril weight (279.21g), aril percentage (66.52), juice content (67.93ml/100g) and ascorbic acid content (16.84mg/100g) were seen in plants applied with CPPU at 5ppm +CBOC. Lowest titrable acidity (0.49%), highest TSS (15.21^0B) and TSS/acid ratio (31.07) was recorded in fruits of plants treated with H_3BO_3 @0.2% with mulching. Total sugars and reducing sugars were highest under H_3BO_3 @0.2% with CBOC, and were lowest in the Control.

S3O39A588

Influence of zinc oxide nanoparticles on zinc uptake, biomass production and yield of cabbage (*Brassica oleracea* var. capitata)

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Zinc plays an important role in nutrition of horticultural crops and its deficiency is now known to be widespread in soils of India. The corrective measures involve application of zinc fertilizers ($ZnSO_4$) to the soils or to foliage as sprays. One of the new technologies that have recently emerged is nanotechnology and the development of nanoparticles is beginning to open up novel applications in crop production. Applications of nanoparticles have received considerable attention due to its high surface area to volume size ratio, exhibit improved uptake by plants and have potential to boost crop production. In the present investigation, nanoscale zinc oxide particulates (ZnO NPs) were synthesized using an oxalate decomposition method and characterized for confirmation of size, shape, stability, surface structure and crystalline nature. The synthesized ZnO NPs (150 and 250ppm) were used as source of zinc fertilizer to study its effect on cabbage on overall growth and translocation of zinc along with bulk $ZnSO_4$ (a common source of Zn supplement) and control. Results indicate that foliar application of ZnO NPs irrespective of doses recorded significantly higher plant height and biomass production both at 45 DAP and crop maturity. These particles proved effective in increasing stem and root growth. The total chlorophyll (0.63 mg g^{-1}) and carotenoid (0.0.39 mg g^{-1}) contents were significantly increased by application of ZnO NPs at 250 ppm. Significantly higher head yield (32.8%) was obtained due to foliar application of 250 ppm ZnO NPs over the control. Zinc contents were partitioned into leaves, stump and roots and it was found that the uptake of zinc was substantially higher in plants sprayed with ZnO NPs compared to control. The present study addresses the positive effect of ZnO NPs and opens new door for its potential use as future 'Nanofertilizers' in plant nutrition of vegetable crops.

S3O40 A85

Effect of irrigation methods and mulching on growth, yield, quality and profitability of Chilli (*Capsicum annum* L.) in arid condition

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Studies were conducted at Agricultural Research Station, Mandor, Jodhpur during July, 2016 to February, 2017 to study the impact of varied irrigation methods and mulching on production, quality and profitability of chilli cv. RCh 1. The results of surface irrigation were compared with drip irrigation system under no mulch and in conjunction with black plastic mulch. The results revealed that the crop raised by drip irrigation on raise bed with 100µ black Linear Low Density Poly Ethylene plastic mulch exhibited significantly higher seedling survival at 15 and 30 days after transplanting (95.16% and 91.70%), highest plant height (47.10 cm at 45 DAT and 54.60 cm at harvest), highest number of branches (14.93) plant^{-1}, maximum stem girth (2.32 cm) number of roots plant^{-1} (138.5), highest fruit set (38.47%), length of fresh fruit (12.56 cm), diameter of fruit (3.52 cm) and fresh weight of fruit^{-1} (8.42g) was observed. The maximum number of fruits plant^{-1}(125), highest yield plant^{-1} (1052.5g), yield ha^{-1} (337.63q) and premier fruit quality score (9.11) with maximum net return (Rs.326407.28) and benefit: cost ratio (3.41) was also recorded in same treatment. Comparatively minimum time (15 hours) required for one hectare irrigation was reported in drip irrigation on raise bed with black plastic mulch. This led to lower population of white fly plant^{-1} (4.53), minimum weed infestation (1.53 weed m^{-2}), leaf curl (5.50%) and fruit rot (5.0%) incidence than other treatment combination. The minimum growth, yield and profitability were reported in check basin method of irrigation without mulch.

S3O41 A547

Physio-biochemical responses of polyembryonic mango (*Mangifera indica* l.) genotypes to varying levels of salinity

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Among different abiotic stresses salinity stress through soil and irrigation water is one of the serious issue, which is restricting the mango cultivation especially in semi-arid and arid regions.Salt affected soils are spread widely in the Indo-Gangetic plains, arid regions and coastal areas, covering about 6.73 million ha land. Common symptoms associated with salinity stress includes scorching of leaf tips and margins, leaf curling, and in severe cases increased abscission of leaves and death of trees, during early stages of growth. For sustainable growth and production of mango under saline soils, the use of salinity tolerant rootstocks could be an option. The present work was carried out to study the effects of salinity on physio-biochemical changes in polyembryonic mango genotypes in order to identify tolerant rootstock. Five months old rootstock seedlings of polyembryonic genotypes namely EC-95862, Bappakkai, Vellaikolamban, Nekkare, Turpentine, Muvandan, Kurukkan, Kensington, Manipur, Deorakhio, Vattam, Mylepelian, Sabre and Kitchner were grown in polybags filled with soil sand and FYM (1:1:1) and irrigated with salt solution of NaCl+$CaCl_2$ (1:1) at 0 mM, 25 mM, 50 mM and 100 mM

concentrations at periodic interval. The physio-biochemical parameters viz., Relative Water Content (RWC), lipid peroxidation, contents of chlorophyll, carbohydrates and proline, and activities of catalase superoxide dismutase (SOD), peroxidase and polyphenol oxidase (PPO) were determined in leaves. There were significant differences in the various physio-biochemical parameters due to salt stress. Salinity stress effectively decreased the RWC and chlorophyll contents, whereas it increased lipid peroxidation, carbohydrates, proline, catalase, SOD, peroxidase and polyphenol oxidase activities. Variation in physio-biochemical responses of different genotypes under salinity can be an indication for selecting salt tolerant rootstocks in mango.

S3O42 A100

Effect of foliar application of micronutrients on yield of mandarin orange (*Citrus reticulata* blanco.)

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Experiment on effect of foliar application of micronutrients (Zn, Fe, B, Mn and Cu) on mandarin orange yield was carried out during 2015-16 at lower pulney hills of Tamil nadu. Fifteen treatments are used alone or in combination with control (water spray) as foliar spray solution at vegetative, flowering and fruit set stage. The experiment was laid out in randomized block design (RBD) with three replication and two trees under each replication. In T_{15} treatment significant increase in the fruit set (52.49 per cent), number of fruits per tree (81.05) and yield (7.82Kg/tree) was recorded. The result revealed that foliar application of micronutrients found to be very effective for increased mandarin orange yield.

S3O43 A674

Effect of gamma ray irradiation and cryopreservation on pollen stainability, *in vitro* germination and fruit set in Pomegranate

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Pollen stainability, *in vitro* germinability and fruit set are used to examine the effect of gamma ray irradiation on pollen set in pomegranate of cv. Bhagwa. Pollen cryopreservation also carried out in pomegrante cv. Bhagwa. Fruit set after pollinating 200 flowers with irradiated and non-irradiated (control) fresh and cryopreserved pollen was assessed. Results showed that in solid and liquid media the highest *in vitro* germination profiles were recorded in fresh (91.45% and 96.53%, respectively) as well as cryopreserved (60.17% and 75.36%, respectively) non-irradiated pollen. However, at a higher irradiation dose of 500 Gy in both culture media, the germinability of fresh (28.55% and 31.87%) and cryopreserved pollen (26.07% and 30.06%) was reduced. Contrary to *in vitro* germination, the stainability of fresh and cryopreserved pollen, as assessed by Alexander's stain (37.51% and 31.85%, respectively) and acetocarmine (32.81% and 27.68%, respectively), was recorded. Fruit retension after 30 days of pollination decreased as irradiation doses increased from 100 to 500 Gy, and over 500 Gy no fruit set was obtained when it was pollinated with fresh and cryopreserved pollen. The effect of irradiation and cryopreservation of pollen of Pomegranate cv. Bhagwa will be discussed in this presentation.

S3O44 A102

Study on the comparative performance of drip irrigation and basin irrigation on soil moisture content, water requirement and water use efficiency of peach (*Prunus persica* (L.) Batsch.) cv. Redhaven.

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A field experiment was conducted during the year 2015-2016 at Dr Y S Parmar University of Horticulture and Forestry, Solan, to study the comparative performance of drip irrigation and basin irrigation on soil moisture content, water requirement and water use efficiency of peach cv. Redhaven. The experiment was **laid out in completely randomized block design with five treatments viz.**drip irrigation at 100 % ETc, 80 % ETc, 60 % ETc, basin irrigation at 100 % ETc and rainfed (control) **and each treatment were replicated five times.** The results suggested that trees irrigated with drip irrigation at 100 % ETc recorded highest average soil moisture content (23.09 and 23.25 %, during 2015 and 2016, respectively), followed by trees irrigated with basin irrigation at 100 % ETc, in comparison to other drip irrigation treatments and control. The total quantity of irrigation water applied per tree was maximum (76.35 and 96.64 cm during 2015 and 2016, respectively) in trees subjected to drip and basin irrigation at 100 per cent ETc treatment in comparison to control and the highest total water requirement (93.23 and 108.78 cm/tree) was in trees subjected to basin irrigation at 100 % ETc treatment in comparison to control. However, the maximum water-use-efficiency (0.15 and 0.20 Kg/tree/cm during 2015 and 2016, respectively) was found in trees irrigated with drip irrigation at 80 % ETc and the minimum water-use-efficiency of 0.11 Kg/tree/cm was observed in control during the year 2015 and 0.14 Kg/tree/cm in trees irrigated with basin irrigation at 100 % ETc during the year 2016.

S3O45 A145

Use of plant growth regulators in onion

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Onion is one of the important crops widely used both as condiment and as vegetable. The important principle like allicin, ajoene, allixine thiosulfinates and sulphites present in onion makes it a potential herb. Productivity of onion can be enhanced with use of improved varieties, proper nutrition and irrigation management, pest and disease management. Different PGRs in little concentration enhance growth, yield and were also found to improve the production as well as quality. Gibberellin is such a compound that has a gibbane skeleton and stimulates cell division or cell elongation or both. Gibberellins promote shoot growth by accelerating the cell elongation and cell division in sub apical meristem region. Application of GA_3 @ 50 mg/l increases plant height and improved leaf length and number of leaves per plant while GA_3 @ 100 mg/l increases weight and volume of bulb. The primary physiological effect

of auxins on growth of plant is elongation of cells. Cell elongation is activated by auxin in three ways by increasing osmotic solutes by decreasing wall pressure, by increasing permeability of cytoplasm to water. When the concentrations of GA_3 and NAA increased from 150 to 300 ppm it increases plant height, number and size of leaves and umbels per plant as reported by several workers. The highest bulb yield can be obtained with 200 ppm GA_3 followed by 200 ppm of IAA. Storability of onion can be improved by pre-harvest application of 3000 ppm of maleic hydrazide plus storage at 3^0C.

S3O46 A78

Sustainable production of ridge gourd (*Luffa acutangula* Roxb.) as influenced by organic inputs

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Performance of ridge gourd (cv. 12-patta) as influenced by organic inputs has been studied during kharif 2015 at experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat. The experiment was conducted in Randomized Block Design with three replications. Different organic manures such as compost, vermicompost and enriched compost were applied in two different doses, *i.e.*, 2.5 t/ha & 5 t/ha along with rock phosphate as per SSP dose & microbial consortium. One treatment consisted of recommended dose of fertilizers was grown in separate field.Growth & yield attributing characters such as highest number of fruits per vine (19.92), yield per vine(2 kg/vine), fruit length(19.79 cm), average fruit weight (97.86g), vine length (6.02m) were recorded in inorganic treatment (T1:Recommended dose of fertilizers). Whereas highest fruit girth (12.78 cm) was recorded in rock phosphate + microbial consortium + vermicompost @ 5 t/ha (T5). Least days for male flower production (35.5 days) was found in rock phosphate + microbial consortium + compost @ 5 t/ha (T3) and for male flower production (37.28 days) was recorded in enriched compost @ 5 t/ha (T7). Treatment consisted of organic source of nutrients recorded better performance as compare to inorganic source of nutrients. The highest ash content (7.62 %), total sugar (5.43 %), reducing sugar (4.02 %) were recorded in enriched compost @ 5 t/ha (T7) while the highest ascorbic acid content (4.51 mg/100 g) was found in enriched compost @ 2.5 t/ha (T6).

S3O47 A174

Effect of different planting times and mulching materials on flower quality and yield of China aster cultivars

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The current investigation was carried out at the experimental farm of Department of Floriculture and Landscape Architecture, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2015-2016. The experiment was laid out in a Randomized Block Design (factorial) consisting of 48 treatment combinations of four planting dates *viz*., D_1-mid of March, D_2 -mid of April, D_3-mid of May and D_4-mid of June and two cultivars namely V_1-Kamini and Poornima-V_2 with six mulching materials *i.e.*, M_0-without

mulch, M_1-Black plastic mulch (100 µ),M_2-Silver plastic mulch (100 µ),M_3-Transparent plastic mulch (100 µ),M_4-Pine needle (1 inch) and M_5-Grass (1-inch layer). Among different planting times, D_1 i.e. mid-March planting obtained best results for plant height (107.70 cm), plant spread (55.54 cm), number of flowers per plant (72.54), flower yield per plant (198.70 g). However, number of days taken for flower bud formation (108.24 days), 50 per cent flowering (124.46 days), flower diameter (5.47 cm), duration of flowering (55.90 days), fresh flower weight (301.67 g), were recorded to be best in mid of June. Among the cultivars, cv. 'Poornima' gave best results for plant height (89.34 cm), Plant spread (47.99 cm), flower diameter (4.77 cm), flowering duration (51.83 days) and fresh weight of 100 flower (291.64 g) whereas minimum number of days taken for flower bud formation (99.04 days), 50 per cent flowering (118.25 days) and were recorded in cv. 'Kamini'. However, cv. 'Kamini' recorded the maximum number of flowers (57.16), flower yield per plant (158.62 g). Silver plastic obtained best results for plant height (84.48 cm), plant spread (48.39 cm), number of flowers per plant (47.89), flowering duration (51.53 days), flower diameter (4.73 cm), fresh weight (291.67 g), flower yield per plant (134.73 g) and minimum days taken for flower bud formation (115.91 days) and 50 per cent flowering (136.60 days).

S3O48 A182

Effect of pinching and gibberellic acid on floral and yield attributes of African marigold under summer conditions

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A field experiment was conducted with an objective to find out the effect of pinching and gibberellic acid on floral and yield attributes of African marigold cv. Local Selection under summer conditions at Experimental orchard of Department of Horticulture, College of Agriculture, CCS HAU, Hisar. The experiment was laid out in factorial Randomized Block Design with sixteen treatment combinations replicated thrice. Treatments comprised of four levels each of pinching viz., P_1 - No pinching, P_2 - Pinching at 2 WAT (Weeks After Transplanting), P_3- Pinching at 3 WAT, P_4 - Pinching at 4 WAT and gibberellic acid viz., G_0 - Control, G_1 - 150 ppm, G_2 - 250 ppm, G_3 - 350 ppm. Foliar spray of gibberellic acid in the respective treatment combinations was done at 4 weeks after transplanting. The maximum number of flowers per plant (47.70) and flower yield per hectare (9.05 t) was significantly recorded in plants pinched at 2 weeks after transplanting, whereas, the maximum fresh weight of flower (3.29 g) was observed in un-pinched plants. Foliar spray of GA_3 250 ppm was found beneficial in maximizing number of flowers per plant (48.29) and flower yield per hectare (9.93 t) however fresh weight of flower (3.35 g) was recorded superior in plants sprayed with GA_3 350 ppm.

S3O49 A24

Quality performance of turmeric transplants (*Curcuma longa* L.) under fertigation system

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An experiment was carried out at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2014 – 2016 to study the effect of fertigation of N and K on quality performance of turmeric transplants. The experiment consisted of nine treatments replicated thrice in a Randomized Block Design. Raised beds of 25m length, 1m breadth, 20-25cm height were formed and protray raised turmeric transplants (var. CO 2) of one month old having two fully opened leaves produced from single bud rhizomes were planted during first week of August in paired row system. Various quality parameters such as curing percentage, oleoresin, essential oil, curcumin and protein content of the rhizomes were recorded after harvest at 240 days of planting. Among the treatments, fertigation of N+K @ 125% through water soluble fertilizers, once in a week recorded higher quality attributes *viz.*, curing percentage (18.12%), curcumin (4.43%), essential oil (4.82%) and protein content (4.93%) whereas fertigation once in a weekof N+K @ 100% through water soluble fertilizers recorded maximum oleoresin content (10.12%). Hence, considering the overall performance in terms of quality it could be concluded that the fertigation of N+K @ 125% through water soluble fertilizers once in a week was adjudged as the best fertigation schedule for turmeric transplants.

S3O50 A73

Bush Pepper-An emerging trend in pepper cultivation.

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Black pepper (*Piper nigrum)* an important spice crop of India and is a major producer, consumer and exporter in the world. It is usually cultivated by allowing them to climb on either living or non living supports. Bush pepper production a new technology which makes the pepper to grow in homesteads and provides yield through out the year in it's different forms. It is a miniature pepper in the form of bush, which is raised from lateral branches (fruiting branches) of vines using a rooting hormone keradix. This is usually grown as a potted plant for ornamental purpose. Some of the suitable varieties are Karimunda, Panniyur-1, Kuthirvally, Kalluvally, Aimpiriyan and Kottandan. It is ideal under story crop in coconut plantation. It's advantage is that, it doesn't need standards for traling and climbers for the harvest. A large number of plants can be accommodated under commercial cultivation.This can be grown in situations where the land is the limiting factor and also in the non-traditional areas where black pepper is not generally cultivated. It is easy to manage and provides additional income under homested condition.

S3O51 A137

Variable Rate Application (VRA) in Precision Horticulture: Need of the Hour

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As of now, we achieved self-sufficiency in food production but, with the exponential increase in population, which is expected to exceed 1.35 billion by 2020, we have to increase our food production to feed the nation. Further area expansion is not possible due to population burst and industrialization resulting in declining availability of per capita land. To achieve higher productivity by maximizing the input use, precision or site-specific farming with Variable Rate Application (VRA) is one of the ways forward. This technology aims to manage soil and crops through better understanding of both spatial and temporal variability by utilizing the site-specific information such as soil and plant characteristics at the particular point within the same piece of land. Its main goal is to apply the right inputs i.e. seeds, irrigation water, fertilizers, pesticides etc. in right amount at right time at right place and in a right manner. Among the two major classes, map based VRA needs the prior grid sampling followed by preparation of prescription map, which is to be fed before the field application, whereas, sensor based VRA works *on the go* i.e. it does not require prior prescription data. Both of these types are in operation in the western countries for macro nutrients as well as for lime applications, weed management, estimation of soil organic carbon and electrical conductivity etc. Although the initial investment is high in this technology, it will maximize the net return to the farmers by minimizing the losses and over application of the basic and costly inputs. Furthermore, this technology is environmentally sound, minimizes the groundwater pollution and sustains soil health. Therefore, implementation of this technology in horticultural crops can be the future step for ensuring food and health security as well as for doubling the income of the farmers.

S3O52 A143

Bioprospecting: a strategy to mitigate future challenges of Indian agriculture

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India accounts to only 2.4% of the world's land area and yet it harbours 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals (CBD, 2014). Agricultural biodiversity is the foundation of sustainable agricultural development and is an essential natural resource to ensure current and future food as well as nutritional security. As we are facing challenges, such as global malnutrition, climate change, decreasing agricultural productivity and shrinking food security, we need everyone's attention and concern for the conservation and use of these precious resources. These can be accomplished easily with the help of bioprospecting which is the exploration of biological material for valuable genetic and biochemical properties so that they can be commercially useful to humans. The underlying aim of bioprospecting is to find new resources and products from nature that can be used by humans. Improving human health, through both medicine and better nutrition are key focal areas. Bioprospecting plays a dominant role in crop improvement, screening of natural resources for useful traits, such as disease resistance with an emphasis on improving performance and farming

efficiency of modern crop varieties. Although bioprospecting can happen wherever there is biodiversity, it tends to be focused where biodiversity is at its richest, as this raises the chances of finding something useful. The CBD recognizes the need for conservation, sustainable use and equitable benefit sharing as corner stones, and for the first time, acknowledged the sovereign rights of countries over their natural resources. It meant that biodiversity could no longer be regarded as common property and that the origin of the material used was recognized.

S3O53 A464
Evaluation of Garlic (*Allium sativum* L.) genotypes in the plains of Kerala

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Kerala having a tropical wet climate with high humidity and rainfall and is popular for tropical spice crops like pepper, cardamom, nutmeg etc. Garlic an important foreign exchange earner of India prefers cool moist period during growth and relatively higher temperature during bulbing. In Kerala, it is grown commercially in two unique rain shadow pockets, Kanthalloor and Vattavada regions of Devikulum block of Idukki district. The area lies in the high ranges with annual temperature of 23.7^{o}C and rainfall 1276mm. Major garlic genotypes grown in this region are Singapore and Mettupalayam. Its cultivation in plains is not evaluated so far. Generally, garlic in plains is grown during October – March. Hence the present study was conducted to evaluate the performance of two genotypes Singapore and Mettupalayam in the plains. The two garlic types were grown as pot culture during the period 2016-17, October – February in the plains of Thrissur district, the central part of Kerala. Among the two types Mettupalayam recorded high Bulb weight (14.53gms) and average number of cloves per bulb (4.2), but it was less compared to that in the high ranges (17.19gm bulb weight and 11.9 average number of cloves). But the individual clove weight was more in Singapore grown in the plains (4.99gm) compared to that in high ranges (2.04gm). The study revealed the possibilities of garlic cultivation in the plains of Thrissur district of Kerala with some refinements in agro techniques.

S3O54 IS67
VERTISCAPING - a new dimension of horticulture for environmental sustainability

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In today's age of shrinking urban green spaces in mega cities, in the name of urbanization, poses a threat to environmental integrity. Urbanization is consuming vast volumes of natural greenery, replacing with concrete-built jungles leading to the 'urban heat island effect'. An innovative, environment-friendly solution to combat concrete jungles is through 'vertiscaping' - an idea to embrace concrete buildings with greening systems, through clinging/climbing plants, or, with living-plant-wall systems to harness socio-ecological and environmental benefits. Vertiscaping is growing as a major horticulture science in 'green/living architecture' that combines the fields of landscape - building architecture and horticultural science. Vertiscaping is seen as the new language of landscape designs in contemporary architecture in relation to environmental sustainability. Vertical greenery systems are

increasing their presence in building designs, providing a range of ecosystem services to cities, ranging from reduced urban heat-island effects and energy costs, to increased psychological well-being, besides providing social and aesthetic value. Integration of greenery into urban landscape will improve perception about that area and will help regenerate our crowded mega-cities. Championing for 'green' living will inspire a positive change for a healthier/ sustainable world, and the future of vertiscaping seems encouraging to green-up our blue planet for building aesthetic eco-cities.

S3O55 A574

Mango cultivation on trellis system: Potential and limitations

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Training strategy ensures better utilization of sunlight, manipulation of canopy microclimates, higher yield efficiency, better fruit quality and efficient pest and disease management. In tree fruit crops like mango the idea of training system remains unexplored. In order to exploit the advantages of training system, the possibility of trellising was assessed at the Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. As such, mango var. ArkaNeelachalKesarihas been trained on 'Y-shaped trellis system' (YSTS) and 'vertical trellis system' (VTS) and their efficacies are being compared with the conventional open centre training system (OCTS). Planting has been done at the spacing of 3m x 4m with a planting density of 833 plants per hectare. Plants have been trained with 6 cordons with the regulation of fruiting terminals along the wires on either side of trellis, annual pruning (forward pruning) performed in June –July and paclobutrazol was applied at optimized dose of 0.25g a. i. /m canopy spread.Data indicated that, light interception (LI)was optimal under YSTS (56.3%) and VTS (58.8%), whereas under OCTS, light interception was relatively high (71.7%). YSTS had more intensity of productive shoots (76.3%), less prone to fruit drop (<10%), advancement (10-12 days) and synchronization in flowering. This system also had better fruit size (212.5g) and yield potential (13.5 – 14.5 t/ha). The yield efficiencywas found to be maximum under YSTS (0.22 kg/cm^2) than VTS and OCTS. YSTS and VTS had fruitswith better TSS (18.3 °B), low incidence of jelly seed disorder (5.7%), low incidence of mango hopper and mealy bug and more B: C ratio and less breakeven point.It has been observed that, though the training systems are efficacious in mango in terms of light interception and distribution, intensity of productive shoots, yield efficiency, fruit quality and profitability, however the cost of training system and manipulation of plant architecture as per training system are important limitations.

Session –IV

Products and Value-addition

(Post harvest management, Processing and product development, Nutraceuticals and Bio-fortification)

Oral papers

S4O1 IS31

Effect of methyl jasmonate on physico-chemical properties of mango fruits cv `Dashehari´ during cold storage

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Mango fruits are climacteric in nature and have a very limited shelf life thereby it is a challenge for prolong storage. Use of cold storage is alternative approach to enhance the shelf life of mango. Therefore, an integrated approach the shelf-life extension of fruits is done by pre-treatment with safe chemicals and storage at low temperature. Mature fruits of mango Dashehari were treated with methyl jasmonate (0.01%) and control (normal tap water) for 3 minutes and stored at low temperature (12±2^{o}C and 85 to 90 % R.H). Fruits were withdrawn at weekly interval and assessed for physico-chemical parameters. The cumulative physiological loss in weight (CPLW) was 10.26 per cent in control fruits, while it was 5.12 per cent in fruits treated with methyl jasmonate on 28 day of storage. The CPLW were 13.95 and 8.64 per cent for control and methyl jasmonate treated fruits, respectively on 28+3 days under ambient conditions. The TSS:acid ratio in untreated fruits was 7.39 whereas, treated fruits had 7.65 on 28 day of storage. The acidity of the fruits decreased with increase in storage. Total carotenoids content of the treated and control fruits on 28 days of storage were 2.42 and 1.44 mg/100g, respectively. The fruits of mango cv Dashehari on the day of harvest had antioxidant content of 0.54 mili moles trolox equivalent, while it was 2.57 mili moles trolox equivalent compared to control on the 21 day of storage under cold storage (12±2 ^{o}C and 85 to 90 % R.H.). Conclusively methyl jasmonate 0.01% treated fruits of 'Dashehari' could be stored for 28 plus 3 days than normal shelf life of 21 days under cold storage (12±2^{o} C and 85-90% R.H.).

S4O2 A392

Effect of Anti-Browning and Anti-Softening Chemicals on Quality and Shelf Life of Minimally Processed Papaya Cv. Arka Prabhat

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An investigation was conductedto find out the best chemical treatment to improve the quality and shelf life of minimally processed papayaCv. Arka Prabhatat Horticultural College and Research Institute, Anantarajupeta, during the years 2013-14 and 2014-15.The papaya fruits cut into cubes and were treated with different combinations of anti browning and anti softening chemicals viz.,Calcium chloride 1%,Calcium chloride 2%,Citric acid 2.5%,Citric acid 5%,Calcium chloride 1% + Citric acid 2.5%,Calcium chloride 1% + Citric acid 5%,Calcium chloride 2% + Citric acid 2.5% and Calcium chloride 2% + Citric acid 5%. Among the treatments, the mean physiological loss in weight and browning score were at highest in the control samples and lowest in the cubes treated by calcium chloride 2% + citric acid 5%. The mean values increased from 4th day to 12th

day of storage but enormously between 8th and 12th day of storage. The mean values of sugars, ascorbic acid, total carotenoids and organoleptic score were found to decrease from 4th day to 12th day of storage, but more significantly between 8th and 12th day of storage.Among the treatments the above quality parameters were at highest in the cubes treated with calcium chloride 2% + citric acid 5%. The microbial count was found to be at highest on 12th day in the control samples whereas those treated by the above combination of chemicals recorded least microbial count on the same day among all the treatments. There was spoilage even from 4th day of storage in the non-treated samples whereas the treated samples had no spoilage up to 8th day of storage and on 12th day least spoilage was recorded in the samples treated with calcium chloride 2% + citric acid 5%. Similarly maximum shelf life (14.70 days)was obtained with the cubes treated with calcium chloride 2% + citric acid 5% whereas the lowest shelf life was recorded by the untreated control samples.

S4O3 A700

Effect of pretreatments and modified atmosphere packaging on the physicochemical, microbial, sensorial attributes and postharvest life of minimally processed pomegranate arils cv. Bhagwa stored at 4-8^{0}C.

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The present study investigated the effects of pretreatments and modified atmosphere packaging on the postharvest life including physicochemical attributes, microbiological quality and sensorial attributes of the minimally processed pomegranate arils (*Punica granatum* L.) cv. Bhagwa. Minimally processed ready-to-eat pomegranate arils of cv. *Bhagwa* were pretreated with five different antioxidants and surfactant solutions and packaged in punnets with four different modified atmospheres including one packaging treatment with micro perforations (5% vents). The pretreated and modified atmosphere packaged arils were stored at low temperature (4-8^{0}C) in thermocole boxes for 12 days. Untreated arils in perforated punnets and in those flushed with air (control) gave shelf life up to 6 days only. Minimally processed pretreated arils stored at 4-8^{0}C, recorded decrease in *L** value, pH, levels of non-reducing and total sugars, polyphenols, antioxidant activity and marketable acceptability and increase in soluble solid content, titratable acidity, total microbial and yeast and mould count. Rapid discolouration with decrease in *a** value and increase in *b** value was recorded in pomegranate arils stored at 4-8^{0}C due to decrease in anthocyanins. Pretreatments of arils with 0.1 per cent solution of nano silver stipulated food grade hydrogen peroxide for one minute alone, and with 10 per cent honey solution for 5 minutes were adjudged as the best treatments to enhance the shelf life of fresh arils. Modified atmosphere packaging

with 100 per cent nitrogen followed by 85 per cent nitrogen plus 15 per cent CO_2 plus 5 per cent Oxygen recorded minimum changes in physicochemical and sensorial parameters with minimum microbial growth and extended the shelf life of arils up to 12 days when stored at 4-8^{0}C. As regards the interaction of pretreatments and modified atmosphere packaging, arils dipped in 10 per cent honey solution for five minutes plus 0.1 per cent solution of nano silver stipulated food grade hydrogen peroxide for one minute and packed in punnets with 100 per cent nitrogen recorded minimum changes in chemical parameters, restricted microbial and yeast and mould growth, maintained quality and enhanced acceptability of fresh arils up to 12 days when stored at 4-8^{0}C.

S4O4 A19

CFB box wrapping of vegetables- a new shrink wrapping technology

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Vegetables lose water very rapidly after harvest and the moisture loss causes severe shriveling making them unmarketable within 2 to 3 days. Moisture loss occurs even under low temperature conditions, though at lesser rates. To reduce the moisture loss and maintain freshness, different vegetables viz., capsicum (green, yellow and red varieties), beans, okra, chillies, and English cucumber were packed in CFB boxes and over wrapped with different semi-permeable films by shrink wrapping technology. This box shrink wrapping significantly reduced the weight loss and maintained firmness in different vegetables and at different storage temperatures. Green, yellow and red colour capsicums packed in this way could be stored respectively for 10, 11 and 8 days at ambient temperature (26-33°C & 25-63% RH) with a weight loss of 5-6% as compared to 14-20% loss in non-wrapped capsicum for the same period. The storage life could be further extended to 4-5 weeks by storing these shrink wrapped capsicum boxes at 8°C without any shriveling and with a weight loss of <5%. Similarly both green chillies and beans could be stored for 3 weeks at 7-8°C while okra and English cucumbers could be stored at 13°C for 2 and 3 weeks respectively. However, at ambient temperature the shelf life of these vegetables could be extended to 3-4 days only. In addition to maintaining high humidity, the higher CO_2 and lower O_2 levels maintained around the produce in the wrapped boxes helped to avoid shriveling and to maintain/retain the quality in terms of surface colour, firmness and other nutrients.

S4O5 A579

Eco friendly packages for freshness retention and shelf life extension of tuberose flower

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Tuberose is one among the important commercial flower crops popular for its pleasant fragrance in domestic as well as export market. Packaging material plays an important role in retention of freshness of tuberose flowers. At present tuberose flowers are packaged in bulk in wet gunny bags and sold in whole sale market. For retail market, polyethylene covers are largely used for packaging of tuberose flowers which is not eco friendly. Hence an attempt is made to standardise alternate eco friendly packages which will retain freshness and extend the shelf life of tuberose flowers. Experiments were conducted by packaging loose tuberose flowers (cv. Local Single) in areca nut sheath cup, banana leaf cup and peepil leaf cup. The samples were stored in both ambient (Temp 25-26°C, RH 52%) and low temperature (Temp 10^0C, RH 86%). Periodical observations on colour index, freshness index and fragrance index were done using standard procedures. It was found from the studies that areca nut sheath cup was suitable for retail packaging of tuberose with higher freshness (82.26%), fragrance (71.21%) which had shelf life up to 2 days in ambient storage condition when compared to those packaged in banana leaf cup and peepil cup. In low temperature storage also tuberose flower packaged in areca nut sheath cup had higher freshness index (87.84), colour index (79.63) and fragrance index (71.21) and shelf life of 7 days as compared to those packaged in banana sheath cup and peepil leaf cup.

S4O6 A641

Effect of various packaging materials on shelf-life and quality in tuberose (*Polianthes tuberosa* L.)

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Tuberose *Polianthes tuberosa* L.) is an important tropical ornamental bulbous flowering plant. Tuberose occupies a very important position among the ornamental bulbous plants for its beauty, elegance and pleasant fragrance. It is also gaining popularity as a loose-flower. For prolonging the shelf life, tuberose florets were harvested and shelf life of the harvested buds was studied with different packaging material.The fully developed unopened florets of locally grown single tuberose Cultivar were packed in Foldable crates with ventilation with inner lining of cotton, poly-propylene (PP) box with inner lining of cotton and Foldable crates without ventilation with inner lining of cotton. All the packages containing buds were stored at room temperature. The physiological loss in weight (PLW %) of Tuberose loos flower buds was evaluated. It was found that florets packed in PP box showed lesser decline of

physiological loss in weight (PLW %). The freshness index was better and at par in case of flower buds packed in Foldable crates with inner lining of cotton.

S4O8 A422

Study on the effect of a commercial product for obtaining quality dried grapes

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Grape growing in India is confined mainly to the tropical regions including Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh. As per an estimate, approximately 95% of the total grape production is from Maharashtra and Karnataka. About 72% of all the grapes produced in the country are consumed fresh, with 26% being converted into raisins. Grape drying is mainly practised in Sangli, Solapur and Nashik districts of Maharashtra, and, Vijayapura and Bagalkot districts of Karnataka. The Australian cold-dipping process is adopted in India, and grapes dry within 10-12 days. Various commercial products other than ethyl oleate are currently being used by processors in different combinations to obtain quality raisins. Considering the importance of dipping-oil and practices followed during the drying process, the present investigation was carried out on 'Thompson Seedless' grapes to compare ethyl oleate with a commercial product. Besides dipping of grape bunches in different combinations, sprays were also made on grapes subjected to drying. Observations were noted on drying dynamics, quality parameters such as browning, colour intensity, content of phenols and tannins, sensory properties and effect on quality parameters at storage for four months. Treating Thompson Seedless grapes with (i) 18ml of solution of the commercial product + 24g potassium carbonate per litre of water for 2 minutes, (ii) spray of 12ml solution of the commercial product + 16g potassium carbonate per liter water on the 3rd day, and (iii) 6ml commercial product + 8g potassium carbonate per litre of water on the 5th day, was suitable for obtaining quality raisins.

S4O9 A699

Colourimetric and anthocyanin changes in pretreated and modified atmosphere packaged Ready-to Eat Pomegranate arils cv. Bhagwa

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Minimally processed ready-to-eat pomegranate arils of cv. *Bhagwa* were treated with different antioxidants and surfactant soloutions and packed in punnets with different modified atmospheres.

Modified atmosphere packed arils were stored in cold storage at 1^0C for 16 days and observed for changes in colourimetric values and anthocyanins. Initial anthocyanin content in pomegranate arils recorded was 86.33 mg/100g while *L**, *a** and *b** colour values recorded on colour scanner were 24.56, 16.423 and 4.187 respectively. Before storage, dipping of arils in different antioxidant and surfactant solutions showed no change in colour values as well as anthocyanin pigment concentration. Slow changes in colour pigments as well as colour values of pretreated arils packed in punnets with MAP were recorded. Minimum changes in *L**, *a** and *b** values were associated with luminosity, dark red colour and less browning of arils. With the advancement of storage period, slow decrease in *L** and *b** values and increase in *a** value of arils was recorded in all antioxidant, MAP treatments and their interactions. The anthocyanin content was increased in pretreated arils stored in cold stoarge at 1^0C. At the end of storage period i.e. after 16 days, minimum change in *L** (24.335), *a** (16.893), *b** (2.856) values and anthocyanins (95.04 mg/100g) was recorded in arils treated with 10 percent honey solution for 5 minutes and 0.1 percent solution of nanosilver stipulated food grade hydrogen peroxide for one minute and packed in punnets with 100 percent nitrogen flushing followed by in arils treated with 0.1 percent solution of nanosilver stipulated food grade hydrogen peroxide for one minute and packed in punnets with 100 percent nitrogen flushing.

S4O10 IS33

Freeze drying of sapota fruit slices cv. Kallipatti

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Sapota, a crop of tropical region, having native to tropical America - South Mexico or Central America, needs warm (10-38 ºC) and humid (70 % relative humidity) climate where it flowers and fruits throughout the year. The suitable climate in south Gujarat region of India, encourage the farmers to grow this crop for regular income genration. It is popularly known in India as *'Chiku'*. In India, it is cultivated for fruits which are liked all over the country. There are about 41 varieties spread all over the country. However, commercially sapota industry is based on a few varieties and in some areas it is only monoculture like 'Kalipatti' in Gujarat and Maharashtra. The 'Kalipatti' sapota fruit is a fleshy berry, round to oval in shape, size and weight (50-115g). The skin is thin, rusty brown somewhat scurfy looking like Irish potato, and the pulp soft, melting, crumbling with a sandy or granular texture with 1-5 hard, black seeds. The fruit is a good source of digestible sugar (12-18%) and an appreciable source of protein, fat fibre ad minerals, Calcium and Iron. The fruits are very hard at the time of harvest but very soft and pulpy when ripened. It ripened within 24 to 48 hours and have shelf life up to 4-5 days, thus considered to be one of perishable fruit crop. During summer ripe fruit fall from the tree and farm labour peel that fallen fruit, half slice it and dry it under the sun. The dried sapota slices are very popular among NRI of south Gujarat region. The sun dried slices are not uniform in moisture, colour, shape, thickness and size also. The powder of sundried sapota doesnt rehydrate properly and leave lumpy clot in 'chiku milk sahke'. It can fetch better price if dehydrated to most advance technique like freeze drying. An experiment was conducted at Center of Excellence on Post Harvest Technology, Navsari Agricultural University, Navsari of Gujarat in concernwith standardization of freeze drying parameters for 'Kalipatti'

sapota fruit slices using RSM technique with factorial CRD analysis. The (D) days after harvest - 4, 5 and 6; (S) slice thickness - 3mm, 5mm and 7mm; (T) temperature of freeze drying - 40ºC, 50ºC, 60ºC and 70ºC were the treatment factors for the study.The result indicated that there were significant effect of slice thickness and drying temperature on drying characteristics on sapota slices and its rehydration properties. The days after harvest and drying temperature significantly affect on taste and flavour of dehydrated sapota slices where as slice tickness affects on textural propeties of sapota. The best combination of sapota maturity in terms of days after harvest, slice thickness and freeze drying temperature were optimised on the basis of minimum energy consumption with best oraganoleptic parameters.

S4O11 A296

Development of spiced aonla squash

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Aonla (*Emblica officinalis* Gaertn), despite being fruit of immense therapeutic importance, has limited potential as food due to its acidic-astringent taste unsuitable for fresh consumption. An attempt has been made to develop a novel product of aonla in the form of spiced squash. Fresh aonla juice was pasteurized at 95 ^{0}C. The filtered extract of fresh mint leaves, roasted cumin seed and black pepper alongwith salt and sugar were mixed in specific ratio with aonla juice and added with 500 ppm sodium benzoate. The squash was filled in clean brown glass bottles, sealed and stored at room temperature (30 ± 5 ^{0}C) (RT) and low temperature (10 ± 2 ^{0}C) (LT). The prepared squash has 23.7 ^{0}B TSS, 1.31 per cent titratable acidity, 144.5 mg 100 g^{-1} ascorbic acid, 2.07 per cent total phenolics and 82 mg 100 g^{-1} reducing sugars. After 6 months of storage, ascorbic acid decreased more sharply (97.2 mg 100 g^{-1})in RT samples than LT samples (141.5 mg 100 g^{-1}). Total phenolics also decreased to 1.5-1.6 per cent in both the samples. RT samples exhibited more browning (OD value 0.250) than LT samples (OD value 0.117). The sensory evaluation was done by serving the squash in 1:3 dilution with chilled water. The squash scored 8.0 (out of 9) during sensory evaluation at zero day. During 6 month storage, sensory score of RT samples declined slightly (score 6.64) while it remained almost unchanged in LT samples (score 7.94), which was characterized by better colour, flavour and taste. It may be concluded from the study that a good quality of spiced squash could be prepared from aonla that can be stored at both room as well as low temperature for 6 month without any appreciable loss in its chemical and sensory qualities. The product may have immense potential for utilizing glut of fruit production with better economic return.

S4O12 A517

Antioxidant activity of underutilized and ethno-medicinally important fruit crops of North-East India.

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North-eastern hill (NEH) regionof India is considered as an agro-biodiversity hotspot, which has rich diversity of less-known, underutilized and ethno-medicinally important fruit crops. Since these fruits are ethno-medicinally and nutritionally important, we attempted to quantify the bioactive and antioxidant compounds of these underutilized fruit crops. Hlingsi (*Sapindus mukorossi* Gaertn.), Belthei (*Aegle marmelos* (Correa) Linn.), Kawrthindeng (*Dillenia indica* L.), Pangkai (*Baccaurea ramiflora* Lour.), Sunhlu (*Emblica officinalis* Gaertn.) and Tatkawng (*Artocarpus chama* Buch.–Ham.) were high source of total phenolic (TP) content; Kawrthindeng(*Dillenia indica* L.) and Sunhlu (*Emblica officinalis* Gaertn.) were found to be high source of total flavonoids (TF). Highest diphenyl-2-picrylhydrazyl (DPPH), azinobis ethylbenzothiazoline-6-sulphonic acid (ABTS) and ferric reducing antioxidant power (FRAP) activity of different underutilized fruit crops were estimated. Significantly positive correlation was detected among TF-FRAP, TF-ABTS, ABTS-FRAP, DPPH-FRAP and DPPH-ABTS assays. Principal component analysis (PCA) was found an effective technique in grouping the local underutilized fruits based on their antioxidant contents. Results signify that, these underutilised fruits must be promoted for cultivation, processing, pharmaceutical and processing use on large scale.

S4O13 A258

Development of leaf powder andspray dried powder from *Moringa oliefera* as a potential source of phytochemicals

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Moringa oleifera is an important multi purpose tree known for its high nutritional value and medicinal properties. It contains high protein, minerals and phytochemicals. Therefore an experiment was conducted to develop moringa leaf powder by subjecting fresh leaves to different drying conditions and to evaluate the effect of drying conditions on phytochemical values. Moringa leaves of cv. Bhagya was harvested from the ICAR-IIHR farm, leaves were separated manually and subjected to washing with potable water. Water was drained from leaves and subjected to hot-air drying (45±1°C), solar-tunnel drying (30 - 43.2^{0}C, 28.2 -46% RH) and shade drying at room condition. The samples were powdered and analyzed for phytochemicals. The results revealed that solar-tunnel dried samples retained ascorbic acid (72.41%), total carotenoids (29.31%), total chlorophyll (31.95%) and polyphenols (16.84%) more than hot-air and shade dried samples. To extract bioavtive compounds, solar dried moringa leaf powder was subjected to extraction using 80% ethanol with sample to solvent ratio of 1:60. The 30% extractant

in 15% maltodextrin aqueous solution was prepared. The feed solution was spray dried with an inlet air temperature of 170±2° C , an outlet temperature of 70±1° C, pump speed of 30%, feed rate of 2.9 ml/min, and aspirator rate of 100%. Analysis of spray dried powder revealed that about 25.56 (mg GAE/g) and 2.5 (mg/100g) of polyphenols and total carotenoids, respectively were found. Hence, from the study it can be concluded that solar tunnel dried and spray dried powder of moringa leaves can become a potential source of phytochemicals to use in processed products.

S4O14 A454

Studies on value addition in floral products through production of potpourri

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In the era of eco-consciousness, use of natural products has become premier choice of people in their lifestyles for interior decoration. Dry decorative materials are globally accepted as natural, eco-friendly and long lasting.Surplus produce of floriculture farms can be turned into value-added natural products like Potpourri. Potpourri acts as a natural air/room freshener and can be placed in living room in our houses and buildings, cupboards, drawers, vehicles etc or can be given as gifts. In the present experiment, studies were carried out to evaluate the ability of rose-petals to obtain and retain different colour shades for production of potpourri. Tinting the rose-petals with edible dyes can enhance the aesthetic value of potpourri by providing a great variety of colours and it helps the farmers in earning more returns from their produce. Different dyes viz., Tartrazine, Sunset yellow + Carmosine, Tartrazine + Brilliant blue , Tartrazine + Carmosine + Sunset yellow and Royal blue were used as colouring agents at 1 % concentration and rose petals were immersed in dyes for 24 hours. It has been recorded that tinting of rose-petals with various colouring agents successfully induced colours in rose petals ranging from lemon yellow, Orange red, Green, orange and blue. Further the tinted rose-petals along with left outs from spices like cinnamon and nutmeg were used for potpourri production and its blending with different scents was standardized. Finished product was subjected to sensory evaluation for quality attributes like colour, appearance, aroma, design and uniqueness and overall acceptability.

S4O15 A662

Effect of varieties, dehydration and brewing on quality of rose herbal tea

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Herbal tea is gaining popularity as a health drink. Rose is one of the important commercial flower crop hence in order to double the income of the farmers there is a need to develop a diversified products especially its utility beyond aesthetic. Therefore under the present investigation petals were dried and herbal tea was prepared and its antioxidant content was estimated in *Rosa damascene,* rose cv. Local

Cream and var. Arka Parimala which were grown pesticide free. Influence of varieties, dehydration methods, duration and number of brewing on rose herbal tea quality and antioxidant content was studied. Results revealed that rose herbal tea of dried petals of A. Parimala had higher antioxidant content of 240mg/g dry weight followed by 224mg/g dry weight in *R. damascena*. Control was *Camellis chinensis* green tea which had 105mg/g dry weight of antioxidants. Among three brewing durations viz. 5, 10 and 15 minutes tried, 10 minutes of brewing and up to two infusions was found optimum for higher antioxidant content (224-240 mg/g dry wt.) and higher acceptability with sensory score of 4.5 for rose herbal tea was obtained as compared to 3.8 sensory score for green tea. Maximum shelf life of six months was recorded for shade dried rose petals stored at room condition (24^{o}-28^{o}C & RH of 45-62 %) in 300 gauge polyethylene package which gave good colour herbal tea without the loss in antioxidants. During the subsequent storage the antioxidant content decreased. Number of infusion on antioxidant and acceptability of rose herbal tea revealed that 10 minutes duration for two times infusion was found optimum for antioxidant content and acceptability.

S4O16 A427

Quantification of juice-yield and processing-waste in pomegranate fruit and nutritional composition of peel

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Pomegranate (*Punica granatum* L.) is an important crop grown in the arid regions of Maharashtra, Karnataka, Gujarat, Telengana, Madhya Pradesh and Tamil Nadu. It is grown in an area of 1.81 lakh hectares, with production of 1.789 million tonnes (NHB, 2015). 'Bhagwa', 'Ganesh' and 'Mridula' are the predominant varieties grown across these states. Pomegranate is largely processed into juice and concentrates by the beverage industry and fresh juice kiosks, besides export of its arils. In a study made to quantify juice-yield and waste in pomegranate cv. Bhagwa during processing, it was found that from fruit weighing 132.44g on average, about 58.89% goes as waste in the form of peel, floral-end and pomace. The arils constitute 59.39%, while peels and floral ends account for 40.60%. Juice-yield is 41.10%, on a whole-fruit basis, and 69.21% on aril-weight basis. In the present study, the peel was dried, powdered and analyzed for physico-chemical / nutritional composition. It was found to contain substantial amounts of phenolics, flavonoids, water soluble vitamins like ascorbic acid (Vitamin C), and a small amount of sugars. A method was standardized for crude extraction of these compounds from the dried peel, first into an ethanol-water base and then, into a water base. The extract showed total antioxidant activity of 709µg GAE/g. This extract was used for fortification of juice blends with *noni* (*Morinda citrifolia*) and pomegranate (*Punica granatum*) juices in different proportions. Physico-chemical and nutritional-quality analysis was performed in these blends for total soluble solids, titrable

acidity, ascorbic acid/ total sugars/ phenols/ flavonoid content, antioxidant activity (FRAP) and free-radical scavenging activity (DPPH). Sensory evaluation was carried out for product acceptability. Results showed that *noni* and pomegranate juices blended in 1:2 ratio and fortified with 2% pomegranate peel extract was the best accepted, based on sensory-quality evaluation (colour, flavour, consistency and taste). It had also significantly higher antioxidant and free-radical scavenging activity compared to *noni* or pomegranate juice alone.

S4O16a A152

Hesperidin: A Promising bioflavonoid in Indian Citrus fruits

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Citrus fruits are important fruit trees grown throughout the world and are well appreciated for their refreshing juice and health benefits. Citrus fruits have been attributed with numerous therapeutic properties like anticancer, antiviral, anti-tumor, anti-inflammatory activities, and effects on capillary fragility as well as an ability to inhabit platelet aggregation. More recently, therapeutic values related to cardiovascular diseases and age related muscular degeneration have also been reported. These numerous health benefits of citrus fruits are attributed to the high amounts of phytochemical and bioactive compounds such as flavonoids, carotenoids, vitamins and minerals available in citrus fruits. Among the bioflavonoids, hesperidin is the most active bioflavonoid in citrus fruits and is mainly responsible for the promising effects. Since, no report is available for the Indian citrus fruits in this regard, a study was undertaken to identify and quantify the hesperidin content in Nagpur mandarin (*Citrus reticulata* Blanco). Dry fruits of varying sizes of different growth stages were collected from ICAR-CCRI experimental blocks and crushed/ grinded to fine powder using 50 microns sieve. The grinded powder of samples were digested with DMSO and passed through 0.2 microns and used for HPLC analysis (Agilent 1260 Infinity model). The hesperidin content ranged from 13.39-28.01 % on dry weight basis. This experiment proves citrus fruits as a potential source of bioflavonoids especially hesperidin for pharmaceutical as well as nutraceutical industry.

S4O17 A388

QuEChERS based LC -MS/MS method for Simultaneous determination of aflatoxin B_1, B_2, G_1 and G_2 in economically important medicinal herb senna *(Cassia angustifolia*) and kalmegh (*Andrographis paniculata*)

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Although a lot of work has been conducted in the contaminants analysis in food matrices but the quality determination (with respect to major contaminants such as aflatoxins) in medicinal plant matrices has a

long way to go. Hence a study was conducted to determine aflatoxins contamination in two important medicinal herbs, which are highly traded commodities in international market. An accurate and rapid analytical method was developed and validated for the simultaneous determination of aflatoxins B1, G1, B2, and G2 in economically important medicinal herb senna (*Cassia angustifolia*) &kalmegh(*Andrographis paniculata*). Aflatoxins have been extracted from herb matrix using a QuEChERS-based extraction procedure (quick, easy, cheap, effective, rugged and safe) followed by applying PSA and a C18 further clean-up step, then detection by high performance liquid chromatography (HPLC) coupled to tandem mass spectrometry (MS/MS) using an electrospray–ionization interface (ESI) in positive ion modes. Matrix-matched calibration was used for quantification in order to reduce the matrix effect. Validation of the method was carried out in herbs by recovery experiments. Recoveries of the spiked samples were in the range between 61.9-111.5 % with an interday and intra-day relative standard deviation lower than 20.0%. Limits of quantification (LOQ) ranged from 1.2-3.8 µg/kg. The proposed method was successfully applied to determine aflatoxin residues in commercial market samples of kalmegh and senna obtained from different locations in India.

S4O18 A559

Effect of different extraction process on yield and quality of banana pseudostem fibre

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In India, area under and production trend for banana has increased steadily in the past two decades. India is the largest producer of banana in the world and about 50-60 million tonnes of banana pseudostem are dumped as waste at the farm-level after harvest of the bunch. At present, this biomass (the pseudostem) is re-circulated by some into the soil for enrichment; but, in most cases, it goes as a waste. On an average, the yield of pseudostem ranges from 60 to 80 t/ha. Farmers often face the problem in disposing-off pseudostems, spending about Rs. 8000-10,000/ha. Presently, fibre extraction from pseudostem is being done mostly by hand, on a very small scale, in villages of Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Maharashtra. This is marketed for the purpose of making handicraft items. Banana fibres are embedded in the biological matrix of the pseudostem consisting mainly of cellulose, hemicelluose, lignin and pectinaceous material. For the fibre to be of fine quality for use in textile manufacture, it should mainly consist of cellulose. Fibre yield is also an important criterion for economy of scale during extraction and marketing. An investigation was carried out to study the effect of different fibre extraction methods on yield and chemical changes during retting the banana pseudostem. Five methods were employed to study the effect, of which chemical retting using hot alkali yielded fine-quality fibre with 79% cellulose, 1.71% pectin and 12.54% lignin. This was of superior quality compared to the other

methods used *viz.*, mechanical, underground water, microbial or enzymatic processes. This process reduced the time required for completion of retting (30-60 minutes) compared to other methods (other than mechanical). Microbial retting took the longest time (22 days), followed by enzymatic and underground-water based processes. Changes in chemical composition and quality will also be discussed.

S4O19 A177

Lutein and antioxidants estimation in five marigold (*Tagetes erecta* L.) cultivars of north India

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Apart from ornamental purposes, African marigold is also widely consumed as edible flower. The present study is aimed to forecast the antioxidant and phytochemical components of five African marigold cultivars viz. Pusa Narangi Gainda, Seracole, Inca Orange, Craker Jack Orange and Sunshine Orange, grown under north Indian condition. Cv. Pusa Narangi Gainda recorded highest yield per plant (66.97 flowers/plant) followed by Seracole (51.72 flowers/plant). Antioxidant activity assays were performed by the Ferric Ion Reducing Antioxidant Power (FRAP) and the cultivar Pusa Narangi Gainda (0.84 mmol of trolox/g) recorded highest amount in flower petals. The lutein content was estimated by HPLC. The cultivar Pusa Narangi Gainda also recorded highest lutein content (3.43 mg of LT/g) followed by Seracole (2.93 mg of LT/g). The total phenol content was found to be highest in cultivar Pusa Narangi Gainda i.e., 1.08 mg of GA/g. Besides that, vitamin C content was also found to be higher in the variety Pusa Narangi Gainda (105.29 mg/100g) followed by the Seracole (90.96 mg/100grespectively).

S4O20 A273

Antioxidant activity in orange cultivars of temperate carrot

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Carrot is one of the most important root vegetables in the world. The consumption of coloured carrots is increasing rapidly due to their high antioxidant activity and nutrient content. Cultivars and agro climatic conditions play an important role in affecting the contents of antioxidant activity. Identification of the potential genotype is of immense importance for both breeders and consumers. Twenty two cultivars of temperate carrot grown under mid hill conditions of Himachal Pradesh at Naggar farm of ICAR-IARI, Regional Station, Katrain in 2016-17 to determine the ascorbic acid, total carotenoids, b-carotene and lycopene contents. The genotypes KS-3 (10.55mg/100g) contained the highest amount of ascorbic acid contents followed by KCS-21-1 (8.66 mg/100g) and KS-50 (5.283mg/100g). Whereas, the genotypes KS-22-1 was found to have maximum contents of total carotenoids and beta carotene (2.26mg/100g &

4.853µg/100g)) followed by KS-73-1 (1.684mg/100g & 3.61 µg /100g) and KS-50 (1.67 mg /100g & 3.57 µg /100g). The genotypes NK-1 (4.55mg/100g), KS-22-1 (4.28mg/100g) and KS-21 (3.76mg/100g) were recorded with highest contents of lycopene. Thus, it is of paramount importance to determine antioxidant content and activity of genotypes in order to find potential genotypes having high amount of antioxidants. These genotypes with high antioxidant activity could be utilized in the breeding programmes for developing new high-quality, antioxidant-rich varieties/hybrids.

S4O21 A460

Water stress induced stage specific variation in andrographolide content in *Andrographis paniculata* (Kalmegh)

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Andrographis paniculata (kalmegh) is one of the most important and popular medicinal plants of India and is widely used as a medicine in countries like India, China and Thailand. It exhibits anticancer, antidiabetic, anti-HIV, antibacterial, anti-malarial, antiinflammatory, anti-angiogenic, hepatoprotective and cardio protective properties, which are credited to diterpene lactone compounds such as andrographolide, 14-deoxyandrographolide, neoandrographolide and andrograpanin. The present study is aimed to investigate the potential of water stress to enhance the accumulation of bioactive compounds in *Andrographis paniculata*. A pot experiment was carried out to identify the right stage of plant for stress imposition and level of water stress to enhance the contents of bioactive compounds. The water stress was imposed at different stages [(vegetative-50 DAT), (flowering-80 DAT) & (fruiting-110 DAT)] of plant growth for different durations (3, 6, 9 and 12 days) by withholding water supply, were irrigated for recovery from stress conditions. The stressed, stress recovered and control plants were harvested and four terpenoid compounds, including andrographolide, 14-deoxyandrographolide, neoandrographolide and andrograpanin were analyzed. The results indicated that water stress had a significant effect ($P \leq 0.05$) on total andrographolide content in term of increase (36 to 44%) after 6 days stress conditions at vegetative and flowering stages, but not at fruiting stage. Stress recovery resulted decline in the metabolic content of secondary metabolites to the level of control. For water stress mediated amelioration of total andrographolide content, best stage for stress treatment is flowering stage (80 DAT) by withholding water for more than 6 days. This indicated that water stress played a key role in increasing the contents of secondary metabolites and the effect of stress is dependent upon the phenological stages of the plant.

S4O22 A286

Development of a mango dipping tool to control spongy tissue

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A mango dipping tool was developed to treat the Alphonso mangoes in the tree itself with ArkaSakaNivirak to control spongy tissue. ArkaSakaNivirak is the environmentally safe formulation developed at IIHR to prevent internal break down disorders (spongy tissue) in mango. It has to be diluted @ 100 ml per litre of water. The mango fruit has to be dipped once with this solution between 40-60 % maturity stage of fruits. The tool has a long SS pipe for holding a plastic container filled with the solution and supported by a circular holder and a 'U' shaped frame fitted in the pole. It is designed and fitted in such a way that the plastic container is hinged and positioned always horizontal during operation. It helps in avoiding spilling of the solution and dip the mangoes conveniently at different height. The pole can reach upto a height of 15 – 18 feet. A six feet pole is also provided to treat the mangoes at the lower and peripheral level. About 10 seconds of exposure is required to treat one or two mangoes at a time. The cost of the tool is about Rs.3000.

S4O23 A327

Chipping bucket – A feasible approach for oil palm trunk disposal

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Oil palm (*Elaeis guineensis*) is a high value vegetable-oil crop introduced into India to meet the domestic demand and to attain sustainability in vegetable oil production. Oil palm produces a huge amount of biomass, with the total above-ground biomass amounting to about 85T ha^{-1}. The trunk alone contributes a major portion (about 48% to 50 %) of oil-palm standing biomass. With area expansion under this crop, associated unutilized plant parts need to be disposed off. This concomitant increase in biomass was considered for the purpose of landfill, thus having an impact on the environment. Most of the Oil Palm trunk (OPT) was dumped along the fringes of the plantation for *in situ* composting, for seasoning, and for adding organic matter to the substrate. Owing to the bulky nature of OPT, this is one of the easiest and common practices followed by farmers. However, biological conversion of compost is a long-term process, acting as an active breeding site for pest and disease inoculums, raising environmental concerns, *i.e.,* a change in the Biological Oxygen demand (BOD) and releases of the undesirable greenhouse gases in theto atmosphere. Composting also occupies a large space. With these concerns in view, a chipping bucket was designed and fabricated for Hitachi 200 model JCB, to improvise and attain rapid decomposition of the biomass, to safeguard the environment. The experiment was carried out in the oil palm plantation at ICAR-IIOPR, Pedavegi, Andra Pradesh. Palms of various heights ranging from 6m to10m were used in this study. Average felling time per palm demonstrated by

the chipping bucket was 4.53 sec. In general, oil-palm trunk girth is greater at the base (3.03m) than at the middle or crown regions (2.19m and 2.39m, respectively). This requires more time to chip yielding an average piece sized 20cm. Irrespective of the trunk region, palm height positively correlated with the number. of strokes, number of pieces, and total chipping time (15-55 numbers, 17-58 numbers, and, 2.46 min. and 9.00 min., respectively) which was required for complete chipping of a whole palm. These results can be utilized for further modification for enhancing the efficiency of the chipping bucket and for biological decomposition in oil-palm trunk chips.

S4O24 A153

Design and development of a power operated onion de-topper

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Onion (*Allium cepa* L.) is an important vegetable crop grown throughout India. De-topping is an important operation during harvesting of onion crop. It refers to the removal of onion leaves from the harvested cured onion bulbs. It is tedious, laborious and a time consuming operation. Onion de-topping demands huge labour to the extent of 12.5 man-hrs/t. Mechanization of this operation will ensure timeliness and reduction in drudgery. Keeping these points in view, a power operated onion detopper was designed and developed. It consisted of a feed chute for feeding cured onion crop, de-topping rollers for shearing the leaves, separate collection chutes for the de-topped onion bulbs and leaves, main frame, power and power transmission system. The onion de-topper is powered by a three phase, 2 hp and 900 rpm electrical motor with necessary speed reduction gear box. Experiments were conducted to optimize the slope (0°, 1°and 2°) and rotational speed (150, 200 and 250 rpm) of de-topping rollers. The performance parameters were analysed statistically and the maximum de-topping efficiency and capacity were found to be at 1^0 degree slope and at 200 rpm rotational speed of the de-topping rollers. The performance parameters of onion de-topper were found to be 90.58 % de-topping efficiency, 92.0% effectiveness of de-topping, 8.68 % damage and 371.2 kg/h capacity. Cost of operation of onion de-topping was estimated at Rs. 0.18/kg against manual de-topping of Rs. 0.46/kg.

S4O25 A240

Mechanization of dry cleaning of sapota

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Cleaning of Sapota is an important unit operation to be carried out after harvesting. Harvested fruits should be cleaned of latex and scurf by washing in clean water to make them look attractive. Sapota is exclusively cleaned not by water but by manually rubbing with cloth to make them more attractive and also for the removal of latex and scurf from the skin. Mechanization of this dry cleaning was carried out by power operated sapota cleaner to reduce the time and the drudgery of the labour. This mechanized dry

cleaning was compared with manual cleaning. Cleaner was made of a drum with inside jute cloth layer and arranged on frame. The electrical motor (0.5 hp) with belt, pulley and shaft was used for rotating the drum. Sufficient hopper and outlet were provided on the frame. The drum was rotated at different speed (25, 30 and 35 rpm). The angle of drum was varied at 2, 4 and 6 degree from ground floor. The cleaning efficiency and damage percentage were calculated. It was found that highest cleaning efficiency could be achieved at 35 rpm rotational speed of drum at 2-degree angle of drum. At this optimized condition, there was no damage of sapota fruits. The cost of the cleaner was Rs. 18000/-.

S4O26 A581

Design, development and performance evaluation of foldable transportation container for sapota fruit

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A transportation container of 10 kg capacity was designed and developed to minimize transportation losses of sapota fruit. The container was made from plastic sheet. The container is completely foldable, reusable and enclosed condition for protecting produce from adverse climate. The adjustable cells were made to enhance the safety of fruits. Separation sheets were provided in a container to support the fruits and to minimize load of the fruits of upper layers. Perforation was provided for aeration to the fruits. Velcro feature was provided to erect and fold the container. Freshly harvested and uniformly matured sapota fruits were graded and sorted out manually for transportation. For performance evaluation, the fruits were transported in seven types of containers or bags with 10 kg capacity stacked in six layers viz.; gunny bag, gunny bag lined with bubble sheet, perforated poly propylene bag, foldable plastic container, egg tray in CFB carton, plastic crate and CFB carton. The fruits were transported from Junagadh to Jamnagar and returned from Jamnagar to Junagadh by road approximately 350 km in goods rickshaw. Effect of different containers on quality parameters of sapota fruits *viz*., hardness (30.09 kg/cm^2), firmness (12.63 kgf) and rupture force (100.2 kgf) were found maximum and weight loss (1.01%), deformation (10.9 mm) and total soluble solids (16.40^{0}Brix) were found minimum in the fruits transported in foldable plastic container. Bruising, cracking and impact damage were not observed on the fruits transported in foldable plastic container. Maximum marketable fruits (98.38%) were observed in foldable plastic container. Transportation losses of sapota fruits in foldable plastic container were minimized as compared to gunny bag and plastic crate (8.65% and 2.85%) respectively.

S4O27 A229

Appemidi: A tiny house nutraceuticals

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Appemidi (Kappemaavu) or midi maavu are the tender mango grown on river banks and forest areas which have uniqueappemidi aromaprofile compared to other mango types. Western Ghats of Karnataka are the hot spots of this appemidi diversity.These pickle types have high potential for marketing, needs attention for conservation. The appemidi pickle has a huge demand in India because of its aroma and taste, whereas these pickles can be stored for number of years without any spoilage. These special tiny fruit sap has a unique aroma profile which helps to preserve for longer periods and these fruits are rich in Vitamin C, vitamin B complex, total phenols, total flavonoids and rich in total antioxidant activity etc. There is an increasing demand for the nutritionally rich cultivars from the society, for consumption of low volume high value foods;appemidi is one of the best example among those foods. Appemidi is our Indian traditional wealth needs attention for well-planned conservation and creating awareness among global consumers as these midis are small packs of nutrients.

S4O28 A242

Effect of chlorine dioxide, polyhexamethylene guanidine and 1-methylcyclopropene on shelflife of banana fruit (*Musa paradisiaca*L.) cultivar Grand naine during cold storage

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Banana (*Musa paradisiaca*L.) fruit is highly perishable in nature. Harvest and postharvest losses of banana is reported to be 7.74 per cent. To reduce these losses and to extend the shelf life of the fruits a study was conducted. Two experiments were carried out to observe the individual and combined effect of 1-MCP, PHMG and ClO_2. In first experiment freshly harvested stage-2 banana fruits *cv*.Grand naine were treated with disinfectant polyhexamethylene guanidine (1, 1.5 and 2 per cent) and chlorine dioxide (100, 150 and 200 ppm) along with control. Among these treatments 2.0 per cent PHMG and 200 ppm ClO_2 recorded best results. The best treatments of PHMG and ClO_2 along with 1-MCP were studied in the second experiment. Banana fruits (*cv*. Grand naine) treated with 1-MCP at 20 ppm and PHMG at 2.0 per cent showed, higher firmness(0.98N), total soluble solids(20.32^0B), ascorbic acid(12.23 mg $100g^{-1}$) and pectin(1.60%) content and retained maximum chlorophyll content, reduced fruit respiration rate, lower PLW and low decay loss at the end of the experiment in cold storage conditions. The storage life was extended up to30 days andretained the acceptable quality when pre-treated with 1-MCP and stored under cold storage (13±1°C) condition.

S4O29 A255

Antioxidant and phytochemical characterizations of Custard apple (*Annona squamosa* L.)

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From 30 genotypes of custard apple were evaluated on the basis of physiological parameters like fruit shape, fruit length, fruit weight and biochemical parameters like total phenol, total carbohydrates, free amino acids, total alkaloids in the present study. Based on various physiological parameters, K-2, Aml-8, Aml-7, Aml-8 and N-1 showed highest weight, volume, girth, length and pulp to seed ratio, respectively. Total soluble solids, total carbohydrates, free amino acids, total dietary fiber, ascorbic acid, and total carotenoids measured as fruit quality parameters and were found to be better in Aml-2, Aml-8, B-1, B-2, DS-1. The maximum free amino acids were found in Sindhan genotypes. Total phenols, alkaloids, glycosides and flavonoids, and anthocyanins from leaves extract were found higher quantity in K-2, Lok-1, K-1, Aml-2, Aml-6, Aml-7 and N-1 genotypes hence these genotypes exhibited antioxidant and antidiabetic activities. Betwixt the 30 genotypes, the phenolic content in leaves extract of K-2 genotypes had salicylic and the some genotypes also been evaluated to have antidiabetic activity. Through HPLC profiling it was concluded that among 30 genotypes, ferulic acid was present only in S-3 genotype having antioxidant and anti cancer properties.

S4O30 A135

Effect of gamma radiation on off-season guava at ambient storage condition

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Guava is one of the well known edible tree fruits grown throughout India. Despite having wider cultivation area of Guava, a shorter shelf life at ambient temperature due to its climacteric nature and fungal rotting, farmers face serious problem by distress selling of their produce. Many technologies have been developed for increasing shelf life but effect of gamma irradiation on shelf life of guava at ambient storage (10°C) condition was not studied in detail though irradiation proved extremely beneficial in terms of prolonging the shelf life. Keeping these facts in view, an experiment was conducted at Bidhan Chandra Krishi Viswavidyalaya during February, 2016 in guava cultivar 'Khaza' collected from bended orchard generally used for getting off season guava in West Bengal. Here, the guava fruits were exposed to four doses γ-radiation i.e. 0, 100, 200 and 300 Gy using Cobalt-60 isotope with energy of 1.33MeV and dose rate of 4.94 kGy/h from 'Regional Agriculture Nuclear Research Centre', B.C.K.V, W.B. and subsequently stored in ambient storage condition. Irradiation of guava fruits with 200 Gy γ-radiation

increased the post harvest life (93.8%) without any negative impact in fruit quality parameters as evidenced by colour, aroma and taste as compared to the control (Non-irradiated).The same treatment also recorded least physiological loss in weight (PLW) % and unmarketable fruit % during the course of storage evaluation. Irradiation treatment also retarded the physical and biochemical changes associated with ripening such as firmness, titrable acidity, soluble solids content and vitamin C during storage. Most important finding is that, the crispiness of the fruit (when firmness reading upto 6-6.5 kg/cm^2) lost after more than 5 days in irradiated fruits whereas within 2.6 days in case of control. In conclusion, the optimal dose (200 Gy) for guava indicated the potential use of Co-60 gamma irradiation as a safe quarantine treatment besides farmer's friendly exploitable venture on commercial basis.

S4O31 A378

Post-harvest management of fruits and vegetables in trans-Himalaya region of Ladakh

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The trans-Himalayan zone is one of the highest and driest inhabited places on the earth. Climatic conditions of these regions are very harsh such as prevalence of extreme sub-zero cold temperature during winter month and low precipitation (9cm-30cm) in the form of snow, low relative humidity (20-45%).The sub-zero temperature prevalent in these region during the winter month (Oct-April) restrict the crop cultivation to a single season, i.e., only during the summer season (April-Oct) therefore to meet the vegetables requirement of the local people and the large numbers of troops deployed in Ladakh, post-harvest management of fruits and vegetables produced during the summer season is a must for their consumption during the winter month. The region remain cut-off from rest of the country during the winter month, i.e., from Nov-May due to heavy snowfall every year. Getting vegetables from outside the regions is beyond the scope of local people because of high transportation charge, i.e., only through airways. Every household in Ladakh own a storage facility with different tags and variation for storing vegetables mostly roots vegetables like potato, carrots, radishes, onion, turnip and cabbages for consumption during winter month in Ladakh region.This method of traditional way of storage can be helpful to meet nutrition requirement of the locals of this region,and, to minimize post-harvest losses.

S4O32 A268

Potentiality of solar drying in development of osmotically dehydrated spiced aonla (*Phyllanthus emblica* L.) segments

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Solar-drying technology offers an alternative which can be easily adaptable in rural areas for processing of vegetables and fruits in clean, hygienic and sanitary conditions with very less or zero energy costs. So here purpose was development of a snack based osmotically dehydrated aonla segments infused with varied combination of spices with better organoleptic and sensory qualities through solar drying. The objective of this work was to standardize the processing procedure, evaluate the physico-chemical, sensory, packaging and storage qualities of product. One set of blanched segments were subjected to osmotic treatment in 60^0 Brix sugar syrup with three varied spice levels for 24 hrs and another set of blanched-frozen segments in 60^0 Brix with three varied spice levels for 4 hrs with a slice to sugar syrup ratio of 1:2 (w/v) followed by draining the segments, drying in solar drier and packing in air-tight punnet boxes. The blanched frozen samples showed maximum solid gain and yield.Ascorbic acid content and total antioxidant capacity reduced during storage.Higher rehydration ratio was found in solar dried samples as compared to cabinet dried samples. Frozen samples showen superiority because of improvement in its microstructure which enhanced its texture and also the use of spice level-1 which contain 10ml/lit of ginger extract + black pepper 1%+ cumin 5% + salt 2% which given a mild flavour of these spices along with aonla flavour. Incorporation of spices in product formulation helped in development of diversified products by imparting characteristic flavor besides its antimicrobial action and ability to retain the bioactive constituents. Economic growth and energy requirement for anticipated growth can be achieved by adopting solar techniques for a sustainable development.

S4O33 A189

Physiological quality attributes of potato (*Solanum tuberosum* L.) cultivars under different packaging systems during ambient storage

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In developing country like India, the use of effective packaging materials for perishable produce like potatoes can have tremendous advantages over expensive technologies like controlled atmosphere storage facilities or irradiation treatments as a means to prolong postharvest storage life. Besides improving food security, improved packing strategies also extend the shelf life of produce and create

new options for long distance shipping. The present investigation was carried out in the post-harvest laboratory of the Department of Horticulture, CCSHAU, Hisar during spring-summer season of 2015-16 and 2016-17 with the objective to study the effect of various packaging materials on the storage behavior of potato cultivars. The suitability of different packaging materials *i.e.*, P_1**:** gunny or hessian cloth bags, P_2**:** nylon netted or mesh bags, P_3**:** cotton bags, P_4: linear low density polyethylene and P_5**:** plastic crates were used for the packaging of tubers of the premium potato (Solanum tuberosum L.) varieties *i.e.*, V_1: Kufri Bahar, V_2: Kufri Sadabahar, V_3: Kufri Surya, V_4: Kufri Pushkar. The experiment was conducted by keeping 5 kg of healthy and clean tubers in CRD (factorial) with four replications. After harvesting, potato tubers were sorted, graded, cured, and subsequently stored in different packaging materials at ambient temperature. Changes in quality attributes of potato tubers under different packaging materials were studied on the basis of their various physiological parameters like Physiological loss in weight (%), decay loss on both number and weight basis (%), sprouting loss on both weight and number basis (%), total loss (%) and specific gravity. Overall results revealed that packaging materials had a significant ($p \leq 0.05$) effect on physiological quality attributes. Generally, weight loss (%), decay loss (%), total loss and specific gravity increased as the storage period increased.

S4O34 A83

Fruit yield components and bio-active compounds of bitter gourd genotypes (*Momordica charantia* L.)

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Dietary intervention through the consumption of specialty foods may alleviate the nutrition related disorders. In the present investigation, 14 inbred lines of bitter gourd (*Momordica charantia* L) were evaluated consecutively for different fruit yield components, nutrient and anti-oxidant potential. The inbred lines demonstrated wide diversity for different morphological characters particularly fruit colour, shape and exocarp character. Fruit length across the inbred lines ranged between 5.63 cm in and 23.62 cm and that of fruit girth ranged between 5.18 cm and 18.16 cm. Fruit weight was highest in Selection-1 (121.23g) and lowest in Murhu (13.36g). Fruit yield/plant was the highest in Selection-1 (1272.30 g) and lowest in Murhu (262.43g). β carotene content of the immature fruits was, in general, much low which ranged between 0.12 mg/ 100 g fresh in the white fruited inbred line BG 1346501 and 1.31 mg/ 100 g fresh in the very dark green fruited inbred line Meghna-2. Total phenol contents ranged between 3.28mg/ 100 g fresh in the dark green fruited inbred line Itki and 6.87mg/ 100 g fresh in the white fruited inbred line BG 1346501.Ascorbic acid content ranged between 42.19mg/ 100 g fresh in the creamy-white fruited inbred line Kerala White and 59.04mg/ 100 g fresh in the very dark green fruited inbred line Meghna-2.High chlorophyll content of the fruit was significantly and positively correlated with β Carotene and ascorbic acid contents of the fruits and low chlorophyll content of the fruit was significantly and positively correlated with total phenol content of the fruits but negatively correlated with ascorbic acid contents of the fruits. Average ascorbic acid, β carotene and total phenol contents of three inbred lines containing low chlorophyll (1.89 mg/ 100 g fresh fruit) was 42.90 mg, 0.18 mg and 6.41 mg per 100 g fresh weight as against 48.52 mg, 0.84 mg and 4.06 mg per 100 g fresh weight in 11 medium and high chlorophyll containing inbred lines (4.28 mg/ 100 g fresh fruit). This investigation amply suggested scope for varietal improvement for special nutritional and medicinal qualities in bitter gourd.

S4O35 IS3

Effect of different media for dehydration of some ornamental flowers

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Elevated rate of respiration and ethylene evolution along with highly perishable and delicate nature of fresh blooms enacted as stumbling blocks to uphold the freshness and charm year-round. In contrast, crave of them can be summoned by perfectly dried, preserved and processed flowers include novelty, longevity, aesthetics, flexibility and year-round availability. So in light of above information, current investigation was undertaken employing three annual flowering species namely *Chrysanthemum morifolium* L., *Coreopsis tinctoria* Nutt. and *Gaillardia pulchella* Foug. cv. 'Red plume' to explore the aptness of 6 pure drying media *viz.* silica gel, white sand, cornmeal, saw dust, rice and wheat bran and 4 combination media of silica gel with cornmeal and sand@1:1 and boric acid with sand and saw dust@1:1 using embedded drying technique under both microwaveoven and room temperature condition for varied duration. Initially, the impact of diverse desiccants and periods on aforesaid samples were evaluated. As a consequence, 3,7,7,7,6,6,6,5,7,7days and 1,1.30,2,2.30,2,1.30,2,2,1.30,2.30min for chrysanthemum, 1,2,2,1,2,2,1,1,2,1days and 0.45,1.15,1.30,1.30,1.30,1.30,1,1,1,1.15min for *Coreopsis* sp. and 2,5,5,4,4,4,2,2,4,4days and 1.15,1.45,2.30,2.15,2.15,2.15,2,2.15,1.30,2min for *Gaillardia* sp. under ambient and microwave state duo were found optimum for aforementioned embedded materials. At maximum duration the elevated rate of moisture loss along with distorted characteristics like petal detachments, crispy petals etc. were apparent irrespective of materials and conditions. For chrysanthemum and *Coreopsis* sp., utmost moisture loss of 71.75 and 70.89% by rice bran and cornmeal and 69.37% by wheat bran and silica gel under microwave drying were perceived while surprisingly 83.61 and 83.52% loss noted by sawdust and cornmeal under ambient condition in *Gaillardia* sp. Improved anthocyanin and sugar content were obtained by sawdust, sand:boric acid and cornmeal in chrysanthemum, *Coreopsis* sp. and *Gaillardia* sp. respectively under microwave condition as compare to control. Conclusively, pure drying media with microwave drying found superior regarding post-drying parameters and longevity under polyethylene covered condition also for all species.

S4O36 A244

Effectiveness of postharvest treatments and modified atmosphere packagings on fresh-cut lettuce

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The present investigation carried out in two different parts in laboratory of Postharvest Technology, Horticulture section, College of Agriculture, Kolhapur. In the first part effectiveness of eight different post-harvest treatments was studied on the shelf life stability of fresh-cut lettuce while in second part pretreated fresh-cut lettuce was packed in polypropylene bags with modified atmospheres. In minimal processing, pretreated fresh-cut lettuce leaves with post-harvest treatments recorded changes in physico-chemical parameters, microbial count and sensorial attributes over the initial values. Pretreatment of fresh-cut lettuce with 15 gL^{-1} calcium lactate at 50^0C followed by ozonated water @ 1.2 mgL^{-1} for 1 minute (T_5) recorded minimum changes in physico-chemical parameters and headspace gas concentrations of packaged fresh-cut lettuceand registered highest overall acceptability among the postharvest treatments studied. The maximum percent browning and decay was observed in control treatment followed by calcium chloride (1%). The minimum total aerobic count was observed in fresh-cut lettuce leaves treated with sodium hypochlorite @ 150mgL^{-1} free chlorine for 15 minute (T_3) followed by UV-C radiation treatment (T_8). Significantly minimum total yeast and mold count was observed in UV-C radiations (1.505 log cfu g^{-1}).Pretreated fresh-cut lettuce packaged in perforated bags (M_5) recorded shelf life up to 6 days only. Decrease in percent moisture, ascorbic acid, polyphenol, headspace oxygen and sensory parameters while increase in physiological loss in weight, headspace carbon dioxide, ethylene, ethanol, acetaldehyde concentrations and microbial count was recorded in all MAP conditions. The MAP treatment, M_4 (10%CO_2 plus 3% O_2) recorded minimum changes in physico-chemical parameters, headspace gas concentrations with minimum accumulation of volatiles, and restricted microbial growth and controlled enzymatic browning, maintained quality and enhanced acceptability of pretreated fresh-cut lettuce up to 15 days under refrigerated storage.

S4O37 A92

Physical and sensory evaluation of cookies from aerial yam (*Dioscorea bulbifera* L.) flour

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A study was carried out at Department of Horticulture, Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2016-17.Cookies were produced from aerial yam and wheat flour blends. Aerial yam was processed into flour and used to substitute wheat flour at different proportions (20% aerial yam flour : 80% wheat flour , 40% aerial yam flour : 60% wheat flour, 60% aerial yam flour : 40% wheat flour, 80% aerial yam flour : 20% wheat flour, 100% aerial yam flour) and 100% wheat flour as control. The experiment was laid out in Randomized Block Design with four replication, the cookies were analyzed for physical and sensory attributes. The physical properties show that there were significance differences in weight, diameter, thickness and spread ratio ranged from 11.33-12.19, 3.90-4.23, 1.10-1.33 and 2.95-3.86 respectively. The sensory attributes (appearance, taste, texture, flavor and crispiness) were evaluated for acceptability of yam cookies with the help of score card by panel of judges. From the sensory evaluation, the treatment with 60% aerial yam flour + 40% wheat flour had highest overall acceptability. It was also found to be the most acceptable with respect to organoleptic characters especially taste, texture and flavour developed during baking as compared to other treatments

S4O38 A549

Influence of physical and chemical pre-treatments on biochemical and antioxidant properties of Tree Bean- An underutilized legume in north eastern hill region of India

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Tree Bean (*Parkia roxburghii* G. Don) is one of the highly nutritious leguminous vegetables grown abundantly in north eastern region of India. Nutritional loss has been reported due to improper storage of tree bean pods during the harvesting season. In the present investigation, we have studied the effect of physical (gamma irradiation) and chemical pre-treatments (NaOCl and H_2O_2) on biochemical and anti-oxidant properties of tree Bean. Moisture content, total soluble sugar, total phenolics, ascorbate content, flavonoids, reduced glutathione, ferric reducing antioxidant potential (FRAP) and 2,2-diphenyl-

1-picrylhydrazyl (DPPH) activities in tree bean pods were varied significantly under different treatments. Total flavonoids decreased under gamma irradiation however, increased in pre-chemical treatments which were varied in the range of 0.33-0.39 mg/g at four weeks of storage. Reduced glutathione, FRAP and Reducing Power appeared to be decreased under pre-treatments however, DPPH and ABTS radical scavenging activities increased under chemical pre-treatment compared with the physical treatments. DPPH in tree bean seeds was higher (87.56%) at 0.25kGy whereas, in pulp (97.26%), the same was higher at 1.0 kGy. Refrigerated tree bean seed and pulp retained maximum ABTS activities (96.96% and 94.86%) after four weeks of storage. Chemical pre-treatments with H_2O_2 (20-100 ppm) was effective under short-term storage up to four weeks. Biochemical and antioxidant properties in extruded tree bean products were observed to be higher as compared to the pre-treated pods under long term storage.

S4O39 A86

Shelf life studies in *Raphanus sativus* L. root vegetable in the cold arid region, Ladakh

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The root vegetables are important vegetables among the vegetable growing in Ladakh. Inaccessibility of vegetables during the winter due to extreme environment condition where ambient temperature falls to minus, the roots vegetables having long shelf life plays an important role among the people of Ladakh. Vegetables such as radish having the shelf life of five to six months. The study was conducted in the year 2014-2015 winter (October to June), at DIHAR, DRDO using randomised complete block design to check the shelf life of two local cultivars and one variety of IARI. The methods used for the study is modifications of existing methods that are used in Ladakh and elsewhere to suit local climatic conditions. Pits of 100X80 cm were dug in open area outside and freshly harvested roots were stored. The samples were analyzed for moisture, fresh weight, crude fibre and electrolyte leakage before storage. Data were collected after six months on percent weight loss, moisture loss, spoilage and other physiological changes in case of the two cultivars and in case of Pusa Himani the data was collected after every ten days. The samples were again analyzed for moisture, fresh weight, crude fibre and electrolyte leakage. We found that the check variety Pusa Himani has short shelf life of about one month where as the two local cultivars shelf life is about seven to eight months. Minimum water loss was in the root of Gya Labuk and maximum water loss was in Pusa Himani at third withdrawal. There was an increase in TSS with storage time and electrolyte leakage. Colour changes with storage are noted and the roots loose light colour and turn yellow with storage.

Session –V Stress Management

(Crop Modelling and Forecasting, Host-plant Resistance, Diagnostics and Epidemiology, Novel Approaches to Stress Management)

Oral Papers

S5O1 A568

An innovative organic formulation for management of mango stem borer *Batocera rufomaculata* De Geer (Coleoptera: Cerambycidae)

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Mango stem borer is a serious pest infesting mango trees in India and rest of the countries wherever mango is grown. The estimated percent loss due to borer ranges from 3 to 30% in Karnataka. Presently the management practice to contain the borer is by using insecticide/pesticide which harms the flora and fauna of the environment. The present management practices of borer are not acceptable for certified organic farms. Hence, there was need for developing protocol for managing the stem borer through organic means. At ICAR-NBAIR, an organic protocol was developed to contain the mango stem borer through external application. The formulation consisted of inert materials of clay origin mixed with herbal oils in the ratio of 1:0.375 served as repellent formulation. The infested trees were cleaned for the rotten bark, debris and faeces. The organic repellent formulation is diluted using water to melted ice cream consistency and brushed on the tree from the base up to a height of approximately one meter. The formulation was applied on to the healthy trees also to repel the borer infestation. The study was conducted in mango *cv* Alphonso aged 20-30 years, by selecting 25 each of healthy, infested and control (untreated) trees in Shimoga, Ramanagaram, Chikkaballapur and Kolar districts. Observations were taken on borer re-infestation and rainfastness at monthly intervals from all the experimental sites. The data suggested that the re-infestation of borer was observed after six months of application of organic repellent formulation. The formulation was rainfast withstanding even 2000mm of rainfall in Shimoga district suggesting that the formulation can be recommended for heavy rainfall zones of the country. The re-infestation of borer after six months till 12 months was hardly 2 percent. The borer damage in control was 16, 26, 18 and 16 percent in Chikkaballapur, Ramanagar and Shimoga districts respectively. After application of herbal repellent formulation the percent infestation decreased to less than one percent in all the experimental sites till six months after application.

S5O2 A280

Bio-efficacy of newer insecticides molecules against Tortricid complex of mango fruit borers

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Mango (*Mangifera indica* L.) is one of the most important and popular of tropical fruit crop. Several insect pests cause damage to mango crop, among them fruit borers cause considerable yield loss, as they damage the fruit directly. Mango fruit borer complex i.e *Archips sp.*, *Gatesclarkeana* sp. and *Dudua aprobola* (Tortricidae: Lepidoptera) were found infesting mango fruits during 'marble stage' of fruit development (April-May) in Lucknow region. The larvae of these fruit borers feed on fruits by weaving web connecting adjacent fruits. The young larvae of these borers scrap the epidermal tissue and the mature ones bore into the fruit and feed on the pulp. The affected fruits exude resin resulting in appearance of black or brown rough sticky patches on infested area. The larval entry portion starts decaying due to secondary infection, which subsequently spread to the pulp rendering them unfit for consumption. The peak incidence of these fruit borers was observed during the 21st Standard meteorological week with 16.5 percent infestation. In order to manage these fruit borers, bio-efficacy of newer insecticide molecules was tested in experimental farm of ICAR- Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow (India). The significant difference of the fruit borer infestation was found among the treatments after seven days of spray with insecticides ($F_{9, 40} = 4.93$; $p < 0.00$). Among the insecticides tested emamectin benzoate, indoxacarb and quinalphos reduced the fruit borer incidence significantly and are on par each other. Dinotefuran, bifernthrin and chlorantriprole also reduced the fruit borer incidence significantly. Indoxacarb, emamectin benzoate and flubendiamide reduced the fruit borers infestation upto 80, 76.7 and 73.6 per cent respectively over the control. Timely spray of insecticide at marble stage of fruit development helps in managing fruit borer effectively.

S5O3 A169

Management of sucking insect pests in grape

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Grape is a non-climatric fruit that grows on the perennial and deciduous woody climbing vine. It is fairly good source of minerals and vitamins. Grapes can be eaten as fresh or used for making jam, juice, jelly, vinegar, wine, grape seed extracts and grape seed oil. It is extensively grown in France, Italy, America, Africa, Australia, Algeria and India. Karnataka is the second largest grape growing state in India. North Interior Karnataka has major grape growing area comprising six districts along with Vijayapura. In 2014-15, Vijayapura contributed an area of 8906 ha, production of 1,06,536 tons, with average productivity 20 t/ha. Large acreage of grape cultivation is quite evident in Basavana, Bagewadi, Vijayapura, Indi, Muddebihal and Sindgi taluks of Vijayapura. Problems of viticulture in North Interior Karnataka are soil and water salinity, acute water shortage, insect pests and diseases. Among insects,

sucking pests v*iz*., Thrips (*Scirtothrips dorsalis* (Hood), *Rhipiphorothirps cruentatus (*Hood), *Thrips palmi* and mealy bugs *Maconellicoccus hirsutus* (Green) are important. Mealy bugs suck sap from the vine, including canes, leaves and fruit bunches and reduce crop vigour. It also excretes honeydew which promotes sooty mold, making the fruits not fit for consumption and raisin making. Thrips damage foliage, blossoms as well as berries. In response to the seriousness of these sucking pests, studies were conducted on the management during 2015-16. Different doses of Clothianidin 50 WDG (200, 250, 300 and 500 g.a.i/ha) were applied through soil drenching at the rate of one liter of insecticide solution /vine in active root zone. Buprofenzin 25SC (250 g.a.i/ha) and Methomyl 40 SP (500 g.a.i/ha) constituted other treatments along with untreated control. Clothianidin 50 WDG @ 300 and 500 g.a.i/ha were found significantly superior in managing both thrips and mealy bugs resulting in 101.00 and 102.58 q/ha of marketable berry yield respectively.

S5O4 A168

First report of *Artocarpus heterophyllus* and *Artocarpus altilis* as hosts of *Epepeotes uncinatus* Gahan, 1888 (Coleoptera: Cerambycidae) from Kerala, India

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The jack fruit belonging to the genus *Artocarpus* comprises of about 50 species of tropical edible fruit trees and among them *A. heterophyllus* and *A.altilis* are most valued for their edible fruits and much valued timber. Though several insects were observed infecting jackfruit tree, their influence on the yield and growth potential was not seriously considered as a big problem due to lack of information on their biology, host range, damage potential etc. Cerambycids or long horned beetles are known to be pests of forest timber plants and other trees. They are hardy beetles with ability to survive in diverse ecosystems, which has led to renewed interest on them. Survey and collection of pests of jackfruit under, ICAR-AICRP on Fruits were carried out in the jackfruit orchards and homestead gardens across Kerala State, South India from 2014 to 2016, with the aim of recording bio-ecology, host range, damage potential of cerambycid beetles as pests, which are known to be more destructive both in grub and adult stages. In the surveys, curiously beautiful large cerambycid beetles were observed feeding heavily solitarily or in groups of 2-3, on the jack leaves by severing and feeding on the midribs, veins and extensively feeding on lamina. They were identified as *Epepeotes uncinatus* Gahan, 1888. They were 1.5-3.5 cm long with characteristic greyish elytra with irregular black spots. Diagnostic features of the beetles included alternating broad white lines and slightly narrower black lines on thorax and head. The very long blackish antennae were 11 segmented with white patches on the basal segments and measured 3.5 to 7 cm and were more than 2 times the body length. There was a lateral spine like projection on the pronotum. The abdomen had single row of white spots on each side. Males are smaller in size compared to females. The present study revealed that *E. uncinatus*has added jackfruit trees, *Artocarpus heterophyllus* and *Artocarpus altilis* as its hosts, which are new host records. This is the first report of *E. uncinatus* as a pest of economic importance in jackfruit (*Artocarpus heterophyllus* Lamk., Family: Moraceae), especially as a defoliator in adult stage and wood borer in grub stage.

S5O5 A424

Host Plant Resistance Study in Indian Cherry (*Cordia myxa* L.) against *Dictyla cheriani* Drake (Hemiptera: Tingidae) in Arid Region of Rajasthan

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Twenty two germplasm accessions of *Cordia myxa* were collected from Rajasthan and established at the field gene bank for the study with regards to conservation, evaluation and resistance. The study was conducted to identify resistant accessions of Indian cherry and its association with morphomatric and biochemical traits. Based on Kaiser Normalization method, the germplasm accessions of *Cordia myxa* categorised as AHCM-22-1, AHCM-25 and AHCM-34 were found to be resistant; AHCM-14, AHCM-30, AHCM-31, AHCM-03 and AHCM-11 were found moderately resistant; whereas AHCM-16, AHCM-09, AHCM-29 and AHCM-04 were found to be moderately susceptible; AHCM-33, AHCM-08 AHCM-07 and AHCM-06 susceptible and AHCM-01, AHCM-26, AHCM-24and AHCM-32 highly susceptible germplasm accessions. The per cent leaf infestation was the highest in AHCM-32 (68.51 %) and the lowest in AHCM-22-1 (12.26 %) followed by AHMM/BR-8 (14.11 %). The leaf infestations ranged from 12.26 to 68.51 % and were significantly lower in resistant germplasm accession and higher in susceptible germplasm accession. The significant positive correlation (r = 0.965) was observed between per cent leaf infestation and tingid bug population per leaf. Free amino acid had positive correlation with percent leaf infestation (r=0.955) and was found the lowest in the resistant accession and the highest in the susceptible accession, whereas phenols (r= -0.865), tannin (r= -0.942), total alkaloids (r= -0.976) and flavonoid (r= -0.982) contents had significant negative correlation with percent leaf infestation and the highest in resistance and the lowest in susceptible accession. The percent leaf infestation had significant negative correlation with length of leaf (r= -0.868) and width of leaf (r= -0.835). Leaf size, leaf roughness and leaf hairyness were found large, high rough and high hairy, respectively in resistant accession of Indian cherry. The one principal component (PCs) was extracted explaining cumulative variation of 90.07% in tingid bug infestation. The flavonoid, total alkaloid, tannins, phenols content, leaf length, width, roughness and hairiness were the novel antibiosis and antixenotic characters found in Indian cherry which were resistant to *D. cheriani*.

S5O6 A646

Foraging activity and nesting behavior of *Braunsapis picitarsus* (Apidae: Hymenoptera), a key pollinator of cashew

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Cashew is an insect pollinated andro-monoecious tree crop having sticky pollen. In nature, cashew flowers are visited by multiple insect species many times, among which bees are considered as important pollinators. During the present investigation, a wild bee, *Braunsapis picitarsus* (Apidae: Hymenoptera) was noticed as one of the common pollinators of cashew in Puttur region, located in South - West Karnataka. Among the 13 bee species visited cashew flowers, *B. picitarsus* was the most abundant comprising 20 % of total species. Foraging activity of *B. picitarsus* started on cashew flowers between 9.00 and 10.00 am depending on the sunshine. Peak foraging activity was noticed between 11.00 am and 1.00 pm, while, the activity was nil during evening hours. Though, *Braunsapis* bees visited cashew flowers both for pollen and nectar, primary reward was pollen. The bees preferred freshly opened flowers. Around four to seven flowers were visited by a bee during a trip. Most of the times, the bees directly landed on the anthers of long stamen of male flowers and collected pollen, then moved below and collected nectar. Sometimes, bees collected nectar first and moved up on long stamen to collect pollen also. Bees visited the male flowers very commonly. Bees after collecting nectar from hermaphrodite flowers, they also moved up to the tip of stigma thus pollinating the flowers. Further, while moving among the flowers of inflorescence, bees touched the stigma of hermaphrodite flowers in flight during most of the times thus ensuring deposition of pollen grains on stigma. Foraging speed varied between 8-16 seconds / flower. Pollen load / bee was recorded between 197-924 pollen grains. The hermaphrodite flowers caged even after single bee visit of *B. picitarsus* could set fruit up to 35 %, indicating this species is one of the key pollinators of cashew. Interestingly, nesting sites of *B. picitarsus* were located in dried tiny sticks of cashew trees itself and the life stages were observed by periodical collection of nests. The other flora attracted *B. picitarsus* include few common weed species in cashew plantations. Flowers of *Antigonon leptopus* were found to be highly attractive to *B. picitarsus* which can be planted near/ around cashew plantations for bee conservation besides artificial nests.

S5O7 A55

Integrated disease management of yellow sigatoka leaf spot disease of Banana

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A field experiment was conducted during 2007-08, 2008-09 and 2010-11 at the farm of Banana Research, Nanded to study the effectiveness of different treatments against yellow sigatoka leaf spot disease of banana. The experiment was laid out in randomised block design in three replicates with eight treatments. The treatments used were To- suckers as a source of planting material, T_1 - soaking suckers in 0.1 percent carbendazim solution for 30 minutes. T_2 - tissue culture sapling as a planting material T_3 - drenching tissue culture sapling with 0.1 percent carbendazim solution T_4 - Phytosanitation (cleaning the plot), T_5 - spraying of propiconazole 25 EC @ 0.05 percent at 15 days interval, T_6 - Integrated disease management treatments (T_3 + T_4 + T_5) and T_7 – integrated disease managements treatments (T_2 + T_4 + T_5). Considering the effectiveness of different treatments, integrated management treatment T_7 – i.e. combine effect of banana garden planted with tissue culture saplings, phytosanitation and spraying of propiconzole @ 0.05 percent at 15 days interval (5.78%) and treatment T_6 i.e. combine effect of drenching tissue culture sapling with 0.1 percent carbendazim solution, phytosanitation and spraying of propiconazole 25 EC @ 0.05 percent at 15 days interval (6.24%) recorded significantly minimum percent disease index of sigatoka and were found at par with each other as compared with rest of the treatments under study. significantly maximum yield of banana was obtained from treatment T_7 i.e. cambine effect of treatment T_2 - T_4 and T_5 (83.9 mt/ha) and treatment T_6 i.e. combine effect of treatment T_3, T_4 and T_5 (81.5 mt/ha) as compared with rest of the treatment under study.From pooled result it can be concluded that, for effective management of sigatoka leaf spot and yield of banana, garden should be planted with tissue culture sapling, cleaning of the garden and spraying the garden with propiconazole 25 EC @ 0.05 percent (5 ml/ 10 lit of water) at 15 days interval after 30 days of planting the garden.

S5O8 A647

Epidemiology and management of rust in grape var. Bangalore Blue

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'Bangalore Blue', a popular and tolerant grape var. to downy mildew and anthracnose diseases is mainly grown in Bangalore, Kolar and Chikkaballapur districts of Karnataka state for juice purposes. Some 20,000 tonnes of Bangalore Blue are crushed annually to make juice. Besides others, 'rust' caused by *Phakospora euvitis* Y. Ono hampers the successful and remunerative cultivation of this variety if not managed properly. The infection results in severe defoliation and vines had only short shoots and nodes resulting in great loss in yield. The influence of climatic variables on the development of rust disease in this variety was assessed by regularly calculating the percent disease severity index (PDI) and recording data on corresponding meteorological factors. Epidemic was analyzed (49th SMW, 2016 to 9th SMW,

2017) in terms of Apparent Infection rate (r), Basic infection rate (R), Area under Disease Progress Curve (AUDPC) and Relative Area under Disease Progress Curve (RAUDPC). There was a constant enhancement in 'r' that was increased from 1.3143 in 52nd SMW (2016) to 28.4773 unit/day during 9th SMW (2017). Similarly, AUDPC that was 18.66 units/ day during 49th SMW (2016) ranged to 597.35 unit/ day during 9th SMW (2017). 'R' and RAUDPC recorded fluctuations. As 'R' decreased from 8.9819 unit/day during 2nd SMW (2017) to 0.4440 unit/day during 8th SMW (2017) and further increased to 0.9052 unit /day in the 9th SMW (2017); Similar fluctuations were recorded in RAUDPC that was 0.96045 unit/day in 2nd SMW and during 9th SMW it was 0.9052 unit/day. The relationship between severity of rust disease and weather factors was established through correlation analysis indicated that the severity of the rust disease was positively correlated with maximum temperature (r = 0.5157) & relative humidity during morning 7.30 h (r = 0.1882); negatively correlated with minimum temp, relative humidity (14.30h), rainfall & No of rainy days. Among different fungicides evaluated four applications of Azoxystrobin (0.1%) at fifteen days interval beginning at the onset of disease were most effective in the managing the disease where disease severity (PDI) was reduced to 8.67 compared with control (70.67) with respective yield (kg/vine) of 17.33 & 12.00, respectively. Respective residues (mg/kg) in grape berries at harvest were much below the European Union prescribed limits of MRL values. The influence of weather factors on the progression of rust disease to develop the disease prediction model and its management strategy has been discussed in the paper.

S5O9 A592

Status and diversity of *Phytophthora* and *Candidatus liberobacter* causing decline in Coorg Mandarin

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Coorg mandarin is one of the famous ecotype of mandarin grown in the districts of Kodagu, Hassan and Chikmagalur as a component of the multi-tier cropping system with coffee and pepper plantation. The cultivation of Coorg mandarin is hampered due to *Phytophthora* and greening diseases, which took heavy toll on the crop. A systematic roving survey was conducted in different places of Kodagu region to know the incidence and severity of *Phytophthora* and greening diseases. The Percent Disease Incidence for *Phytophthora* and Citrus greening ranged from 30-40 and 50-60 percent respectively. Hundred and nine soil samples were collected from the *Phytophthora* infected root zone of Coorg mandarin, the pathogen was isolated by using specific media. The result revealed that 58 isolates belong to *P. palmivora* (slow-growth), which were isolated from 60.89 % of soil samples and 32 isolates belong to *P. nicotianae* (fast-growth), isolated from 41.55% of soil samples respectively. Mean while total nucleic acid isolated from *Phytophthora* (58 number) and greening (178 leaf samples) isolates were amplified by PCR using ITS and 16s RNA gene region primers. The amplified PCR product of *Phytophthora* (0.5kb) and greening (1.2kb) were cloned and sequenced. The analysis showed that all *P. palmivora* and *P. nicotianae* isolates from Coorg mandarin shared nucleotide identity ranged from 90.5

to 96.5% and 91.6 to 100 % with *P. palmivora and P. nicotianae* isolates infecting different citrus species respectively. Further the sequence analysis of greening bacteria shared nucleotide identity ranged from 93.6 to 97% with Ca. L. *asiaticus* isolates infecting different citrus species in different part of the world.

S5O10 A497

Molecular Detection of Major viruses of Pears in North Western Himalayan Region

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Pear (*Pyrus communis* L.) is one of the important fruit crops of temperate regions of India. Productivity of pear in India is relatively low due to several biotic and abiotic factors. There are more than 40 virus and virus-like diseases reported in pear. Among these, Apple chlorotic leaf spot virus (ACLSV), Apple mosaic virus (ApMV) and Apple stem grooving virus (ASGV) are economically important viruses. Few suspected pear plants showing mosaic, curling, puckering etc were examined for the presence of virus by DAS-ELISA and found infected with ACLSV, ApMV & ASGV. To confirm the same, Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) was standardized by designing virus specific primers targeting respective coat protein gene. NADH dehydrogenase subunit 5 (NAD5) genes in mitochondrial mRNA of the apple was used as an internal control which reduces the risk of false negative results. A survey was carried out to know the status of ACLSV, ApMV and ASGV infecting pear in North Western Himalayan region of India. These samples were screened by optimized RT-PCR assay and found that, out of fifty five samples, eight were found infected with ACLSV, one sample with ApMV and three with ASGV. This clearly indicates the presence of ACLSV, ApMV and ASGV pear and hence need attention towards generation of virus free planting material and to develop suitable management practices.

S5O11 A325

RNAi induced gene silencing: a novel approach for plant parasitic nematode management

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Nematodes are the most diverse and abundant group of metazoans living in various habitats. Damage caused by plant parasitic nematodes in agricultural and horticultural crops is rising at an unusually high pace due to intensive cultivation and the changing trends in cropping systems. Globally, plant parasitic nematodes cause a monetary loss of over 157 billion USD, while, in India these cause a loss of over 2000 *crore* rupees annually. Protected cultivation - a growing trend - is the most affected by

nematode parasitism. Current nematode control strategies include nematicides, crop-rotation and use of resistant cultivars, but each of these has serious limitations. RNA interference (RNAi) represents a major breakthrough in application of functional genomics to nematode control. It involves suppression of gene-expression with sequence-specific, homologous RNA molecules. RNAi induced suppression of genes essential for nematode development, reproduction or parasitism highlights the considerable potential of the strategy for control of these damaging pests. It offers an environmentally safe way of controlling plant parasitic nematodes. To manage these pests using RNAi technology, the RNAi mechanism is performed partially *in planta* and partially in the nematode. siRNAs are generated by Dicer in plants to express dsRNAs of the nematode gene/s. When nematodes feed on a plant, plant-derived siRNAs or dsRNAs are ingested by the nematodes through its stylet. RISC then binds siRNAs to induce degradation of the specific nematode gene/s. siRNAs are then amplified in the nematode with the help of RNA-dependent RNA polymerase. Genes targeted by RNAi are expressed in a range of tissues and cell-types. The ingested dsRNA enhances plant resistance against the nematode by silencing its genes in the intestine, female reproductive system, sperm and both sub-ventral and dorsal oesophageal glands. Specificity of RNAi mediated resistance is based on RNA hybridization, which should make the resistance highly durable.

S5O12 A160

Case study on incidence of inflorescence blight and fruit rot (*Choanephora* sp.) on dolichos bean and yard long bean

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Inflorescence blight and fruit rot caused by *Choanephora* sp. was recorded in two major vegetable crops *viz.*Yard long bean and dolichos bean at a very high rate of spread. Usually, the disease occurs in mild proportions during rainy season in Kerala (June to September) affecting vegetable crops like cowpea and bhendi. However, during the current year (2016) the disease was noticed at a very high severity of more than 90 per cent on two crops grown at two different locations in Thrissur district of Kerala during October to January. None of the commonly used fungicides could control the disease. The pathogen was found to be luxuriously growing on the inflorescences of dolichos bean and the fruits of yard long bean. The first incidence of the disease was recorded during the last week of October, 2016. The disease spread was almost cent percent on susceptible genotypes of dolichos bean and more than 90 per cent in variety 'Vaijayanthi' of yard long bean. A study was conducted exploring the predisposing factors leading to the occurrence of the disease in epidemic proportions. Meteorological factors affecting the disease were studied and it was found that there is positive correlation of the disease severity with increasing atmospheric temperature. There was a drastic reduction in the rainfall during the current year; however, both the crops were raised under irrigated condition resulting in high humidity in the field. Atmospheric temperature more than 30^{o}C along with high humidity during the preceding week are found to be the major predisposing factors resulting in the epidemic in both the crops.

S5O13 A195

Bacterial wilt resistant and susceptible parental polymorphism screening using SSR markers in Brinjal (*Solanum melongena* L.)

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Brinjal (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. It is an important vegetable grown in India. Bacterial wilt of brinjal has been a major production constraint in the tropics and sub tropics. Lack of understanding about host, pathogen and environment might be one of the reasons for limited success in controlling this disease. Since breeding for resistance remains the best control strategy. In this study, six different genotypes of brinjal viz., CARI-1, IIHR-108, IIHR-107, Rampur Local, IIHR-500A and IIHR-575 were screened against bacterial wilt and polymorphism estimated by SSR markers. Among 245 SSRs used, all showed good amplification but only 37 primers were polymorphic and microsatellite allele sizes were determined at these 74 loci. These 37 primers exhibited a distinct variation in allele size. Marker loci, number of alleles per locus, heterozygosity for single locus SSRs and PIC were determined. The average polymorphic information content was 0.315 and it ranged from 0.239 to 0.375. In case of primer emh21J12 the resistant genotypes showed unique band at 170 bp and susceptible ones at 160 bp. So, the primer emh21J12 discriminated between resistant and susceptible genotypes. The dendrogram classified these genotypes into three main clusters. Cluster I consists of IIHR-575, IIHR-108 and IIHR-500, where IIHR-500 was solitary. The cluster II consists Rampur local and IIHR-7 whereas, cluster III was solitary comprise of CARI-1. In this study, co-dominant markers such as SSR proved to be highly effective tools in discriminating between these genotypes. Further, the barcode profile derived from the allelic variation of the microsatellite loci, clearly differentiated the brinjal genotypes in the present study. This barcode representation can be used as a fingerprint profile for each genotype as it clearly shows a unique pattern. The molecular barcode profile of six brinjal genotypes which may act as a reference system for accurate identification.

S5O14 A471

Residues of commonly used pesticides in exotic vegetables analyzed by LC-MS/MS for evaluation of waiting period

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Exotic vegetables viz., zucchini, broccoli, red cabbage, etc market is growing at the rate of 15 to 20% per annum and it is likely to increase further . Many pesticides are used to control pests in these crops but there is almost no information on persistence of pesticides in these crops under Indian climatic conditions. In this study, persistence behaviour of the pesticides imidacloprid, carbendazim, fipronil, fenazaquin, chlorantranilipreole and myclobutanilon on zucchini, broccoli and red cabbage were studied

following their foliar application twice at 15-day interval at the fruit setting stage in zucchini and head formation stage in broccoli and red cabbage grown under polyhouse. Samples of these exotic vegetables were drawn periodically at 0 (2h), 1, 3, 5, 7, 10, 15, 20, 25 and 30 days after second application of the pesticides. The quick, easy, cheap, effective, rugged, and safe (QuEChERS) method in conjunction with liquid-chromatography mass spectrometry (LC-MS/MS) was used for analysis of pesticides. Based on the persistence data thus obtained and the EU MRLs, waiting periods were recommended for safe harvest of these exotic vegetables. Waiting period values provide a means to ensure that the vegetables contain pesticide residues below permissible levels. The waiting periods for the pesticides in zucchini (green and yellow varieties) were: carbendazim (green: 14.1 days, yellow: 15.7 days), chlorantranilipreole (green: 9.2 days, yellow: 10.7 days), fipronil (green: 22.7 days, yellow: 25.1 days), fenazaquin (green: 26.5 days, yellow: 16.7 days), imidacloprid (green: 17.4 days, yellow: 23.5 days) and myclobutanil (green: 9.9 days, yellow: 12.3 days). In the case of broccoli, the waiting periods were 18.6, 9.5, 35.0, 25.1, 7.6 and 20.1 days for carbendazim, chlorantraniliproele, fipronil, fenazaquin, imidacloprid and myclobutanil. In red cabbage, the waiting periods recommended were 7.7, 11.7, 5.5, 9.8 and 2.5 days, respectively, for the pesticides listed above. All the pesticides degraded with time in/on the exotic vegetables, with the degradation following the first-order kinetics.

S5O15 A491

In vitro expression and purification of coat protein gene of *Leek yellow stripe virus* (LYSV) from garlic in India and its application in ELISA based diagnostics

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Leek yellow stripe virus (LYSV), a member of the genus *Potyvirus* (family *Potyviridae*) infects garlic (*Allium sativum*) worldwide including India. Morphologically, it is a flexuous filamentous particle of 815-820 X 11-13 nm dimensions containing ssRNA of approx 10.2 kb and transmitted by aphids in non persistent manner. On the basis of serology, immunosorbent electron microscopy (ISEM), reverse transcriptase polymerase chain reaction (RT-PCR) and sequencing, we report for the first time, the association of LYSV in garlic plants in India. Coat protein (CP) gene of *Leek yellow stripe virus* (LYSV) was over-expressed in *Escherichia coli* strain BL21 expression system and obtained ~35 kDa fusion protein bearing Histidine tag (6His) at its both N and C terminals. The protein was purified from insoluble fraction and reacted positively in western blotting with commercial anti-LYSV polyclonal antiserum (Bioreba, Switzerland) and hence, used as immunogen for the production of polyclonal antisera in New Zealand white rabbit. Polyclonal antisera specific to LYSV (titre 1:2000) detected the virus by direct antigen coated enzyme linked immunosorbent assay (DAC-ELISA) using commercial alkaline phosphatase (ALP) conjugated globulin fraction (Bioreba, Switzerland) in LYSV positive garlic sample. Further, the specific reactivity of the antisera was confirmed through western blotting and immunosorbent electron microscopy (ISEM). The primary antisera along with universal anti rabbit IgG (commercial) were successfully used for detection of LYSV infected samples up to 1:64,000 dilutions, in DAC-ELISA. The immunoreagents developed will be useful for the virus indexing in garlic tissue culture programme and quarantine certification programme as well.

S5O16 A639

Management of black spot caused by *Diplocarpon rosae* in open cultivated rose using strobilurin and triazole fungicides

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Rose is an important ornamental crop with huge demand from domestic and export markets. The black spot disease of rose caused by the fungal pathogen *Diplocarpon rosae* is a serious production constraint. This disease is serious in open cultivated roses. Black spot incidence starts after onset of monsoon and reaches maximum during Aug – September. There are no chemicals having label claims for the management of black spot of rose in our country. Hence, evaluation of fungicides have been made with chemicals belonging to different group of fungicides. Among the chemicals tested, Trifloxystrobin, Tebuconazole and Kresoxim- Methyl were very effective against this disease followed by Propiconazole as observed in three consecutive years. The combination product of Tebuconazole and Trifloxystrobin reduced the disease severity to 6-8%, while in control plots the disease severity was 60-80%.The disease incidence had positive correlation with area under disease progress curve (AUDPC). Black spot disease causes the severe defoliation that results in the poor photosynthesis and reduced flower production. The strobilurin fungicides besides reducing disease incidence, they favoured plant growth promotion and there was no defoliation in plots treated with them. The traditionally used chemicals carbendazim and mancozeb were not effective against this disease. Based on the flower yield and disease reduction Kresoximmethyl and Trifloxystrobin + Tebuconazole were found suitable fungicides for the management of rose black spot.

S5O17 A377

Screening salt tolerance of mango (*Mangifera indica* L.) rootstocks

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Mango (*Mangifera indica* L.) is considered to be sensitive to soil salinity and tolerant rootstocks are being commercially used for mango cultivation in salt affected soil. Identification of such rootstock from available genepool population requires thorough understanding of plant responses under stress with associated different levels of injury symptom with salt stress. Keeping this in view, polyembryonic genotypes *viz., Bappakai, Kurukkan, Nekkare, 13-1* and *Olour* with varying salinity tolerance were evaluated under salt stress conditions having 1, 2, 4 and 6 dSm^{-1} EC level created with standard stock solution of NaCl @200 meq/l using the calibration curves (EC dSm^{-1}=0.539x+0.27, where x=ml of stock solution/100g soil). Symptoms of salt injury in seedlings appeared within one month at 2 EC and all plants died except Nekkare, 13-1 and Kurukkan at 4 dSm^{-1}. Rootstock 13-1, exhibited higher cuticular wax (608.50 µg/cm^2) content in control conditions (normal soil) whereas, Kurukkan (590 µg/cm^2) and Nekkare (690.50 µg/cm^2) exhibited higher level of leaf wax when plants were grown under different salt stress conditions. Rootstock, 13-1 recorded higher leaf gas exchange parameters (Pn,5.9 µmol m^{-2} s^{-1}) and chlorophyll fluorescence attributes (Fv/Fm,0.789) with lower membrane injury index (MI). The

performance of Dashehari and Chausa plants grafted (scion) on 13-1 and Nekkare rootstock were also evaluated under salt stress conditions. The differential response of rootstock/scion interaction was noticed. The growth of salt sensitive Dashehari scion was not encouraging on 13-1 rootstock under salinity conditions. The physiological traits especially level of wax accumulation and chlorophyll fluorescence could be utilized as quick diagnostic tool for screening the tolerant mango genotype as rootstock.

S5O18 IS39

Calcined Kaolin (Surround WP) Effect on Heat Stress and Bananas (Musa sp.) Productivity in Costa Rica

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The effect of calcined kaolin applications (Surround WP, NovaSource, USA) to mitigate plant heat stress was assessed to measure productivity in bananas (*Musa* sp.). The trial was performed during two generations in the Centro Experimental de la Corporación Bananera Nacional (CORBANA) in Guápiles, Limón, Costa Rica. Banana variety used was Grand Naine. A randomized complete block statistical design was established with the following treatments: T1) Control without Surround WP; T2) Surround WP 5% every 15 days; T3) Surround WP 5% every 8 days; T4) Surround WP 3% every 8 days. Applications were made according the CORBANA program. Number of hands, intervals between days to flowering, and bunch weight were evaluated. Differences between means were measured by Fisher LSD test (P <0, 05). Production variables results were not statistically different between treatments (P <0, 05) in the evaluation of the two generations. However, Surround WP treatments showed a clear trend for greater number of hands, higher length of the central finger of the second hand and better fruit weight as compared to control treatment, mainly those applied to 5% and 3% every 8 days, the plants with Surround WP obtained 0,1 to 0,4 hands more than the control treatment. Fruit weights were 1,1 to 1,8 kg and 1,3 to 1,8 kgs more in Surround WP treatment as compared to the control for R0 and R1 generations, respectively. Intervals between days to flowering were 2 to 8 days and 8 to 14 days less in the treatments applied with Surround WP as compared to the control for R0 and R1 generations, respectively, improving crop growth return rate. This means higher productivity per area in treatments with Surround WP. Surround WP substantially helped minimizing heat stress effects and increased banana productivity.

S5O19 A259

Responses of Papaya Seedlings (*Carica papaya* L.) to Water Deficit Stress: Changes in Root Anatomy, OsmolyteAccumulation and Antioxidant Status

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Water deficit stress in crop production systems is more deleterious than the other abiotic stresses under changing climatic scenarios. Understanding of physio-biochemical response of plants under low water stress is of potential in identifying markers for stress tolerance in selection and breeding, and in delineating mechanism of crop tolerance to stress. The present study was conducted to appraise the effects of water deficit stress on root anatomical features,osmolyte accumulation and antioxidant activity in papaya seedlings (*Carica papaya* L.) cvs. Arka Surya, ArkaPrabhat, CO-4 and Red Lady differing in tolerance. Water deficit stress was imposed by withholding irrigation for 10 days. Compared with well-watered conditions, the water deficit stress caused distinct contraction in vascular system characterized by reductions in vascular bundles and cortex diameters with decline in xylem vessels number in the stressed plants, and cv. CO-4 maintained relatively higher cortex diameter and cv. ArkaPrabhat higher vascular bundle cross sectional area and xylem vessel number as compared to unstressed plants. The stress conditions also led to development of oxidative stress as evident from excessive production of reactive oxygen species (ROS) which led to reduced growth in all papaya cultivars; nevertheless, the negative effects of water deficit stress were more prominent in cvsRed Lady and Arka Surya. Water deficit stress induced significant accumulation of osmolytes like glycine betaine, sucrose, glucose and amino acids besides upregulation of enzymatic defense systems in cvsArkaPrabhat and CO-4. The results indicated that the ability of papaya plants to tolerate water deficit stress is the consequence of maintenance of better cortex diameter and xylem vessel number in roots and are reflections of high osmolyte pools and antioxidant status.

S5O20 A479

Physiological response of different Citrus rootstocks to drought stress

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Drought and moisture stress are the most important factors for citrus decline in central India. The adverse effect can be minimised by using drought tolerant rootstock for citrus. Hence efforts were made to screen commercially important and promising citrus rootstock viz., Rough lemon (*Citrus jambhiri*, Lush), Rangpur lime (*C.limonia*), Alemow (*Citrus macrophylla*), NRCC rootstock -2 (Rough lemon x *Troyer citrange*), NRCC rootstock -3, NRCC rootstock -6 (Rough lemon x *Troyer citrange*), CRH-12

(Chethalli), Shekhawasa and C.*volkamarina* against drought stress in the screen house. Six well grown seedlings were transplanted in each tray containing 18.5 kg potting mixture. Considering control treatment equivalent to field capacity other treatments were customised by applying 60%, 40% and 20% irrigation of calculated field capacity.C. *Volkamarina* showed the symptoms of drought susceptibility at the earliest and was evidenced from maximum decrease in relative leaf water content (38.6%) in 20% drought treatment as compared to control. Rough lemon rootstock was also equally susceptible to water stress and recorded maximum decrease in membrane stability index (30.1%) and chlorophyll content (13.1%) compared to control. Proline content in the leaves increased with the increase in drought period. In 20% drought treatment, per cent increase in leaf proline content varied from 39.9 – 72.6 % amongst various rootstocks and was maximum in C. *Volkamarina* followed by rough lemon and NRCC-2 rootstocks.The drought treatments also negatively affected the growth parameters as indicated by number of leaves, leaf and stem dry weight of volkamarina rootstock followed by rough lemon rootstock. Amongst NRCC rootstocks, NRCC -3 was more susceptible as compared to NRCC-6 and NRCC -2. Alemow, CRH-12 and Shekhawasa as showed less susceptibility to all the drought levels.

S5O20a A98

Photosynthetic efficiency and light saturation points in *Citrus* spp.

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Citrus is one of the important fruit crops in India. It is 3rd most important fruit crops after Banana and Mango. NEH region of India is considered as the natural source of many Citrus spp. and large variability found in Citrus. However, very little information is available regarding the photosynthetic efficiency of different Citrus spp. grown in different agro-climatic region of the country. Therefore, the present study were undertaken to know the photosynthetic efficiency of different cultivars of Citrus spp. grown in main Citrus belt in Central India. Various physiological parameters such as chlorophyll content, relative water content (RWC), cell membrane stability index (CMSI) and drought injury index (DII) along with light saturation points (LSP) were determined in selected commercial Citrus spp. *viz*., NRCC galgal-1, Flame grapefruit, NRCC grapefruit -6, Seedless N-4, Pummelo-5 and NRCC Acid lime-8. Among the selected *Citrus* spp., the total chlorophyll content was higher in NRCC Grapefruit (8.44 µg ml^{-1}) followed by NRCC Acid lime-8 (8.10 µg ml^{-1}) and Flame grapefruit (7.65 µg ml^{-1}). The CMSI was recorded higher in NRCC Acid lime-8 (93.56 %) followed by Seedless N-4 (91.71 %) and NRCC Grapefruit (90.00 %). Moreover, DII was observed higher in Galgal (58.16 %) followed by Pummelo-5 (39.47 %) and Flame grapefruit (37.51 %), whereas RWC was showed higher in NRCC Acid lime-8 (83.76 %) followed by Seedless N-4 (82.80 %) and NRCC Grapefruit (80.83 %). The LSP of different selected Citrus spp. are as mentioned: Galgal- at 800 PAR (Photosynthetically Active Radiation), Flame grapefruit- at 1000 PAR, Seedless N-4- at 1200 PAR, Pummelo-5 – at 1000 PAR, NRCC Grapefruit- at 1200 PAR and NRCC Acid lime-8 – at 1200 PAR. Among the selected *Citrus* spp., NRCC Acid lime-8 was found higher LSP and drought tolerant characteristics.

S5O21 A624

Low chill cultivars of temperate fruits in sub-tropics –A viable option to raise farm income under infrequent frost conditions

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Himachal Pradesh has been divided into four agro-climatic zones. Out of these, the subtropical area falls within 300 to 925 MSL, which accounts for about 52% of the total cultivable area. With the global warming, change has occurred not only in the temperature but also in precipitation, hail storms, high velocity wind and infrequent occurrence of frosts etc. The intensity and frequency of windstorms and hailstorms have also increased resulting in reduced fruit set and deterioration in quality. Due to the impact of climate change, the fruit crops grown in subtropical areas are becoming unsuitable.The genetic potential of area specific cultivars of fruit crops can be harnessed fully by growing under specific agro-climatic situations. On the contrary, the traditional cultivars/fruit still hold major share despite becoming uneconomic under emerging climatic scenario. Moreover, rising cost of cultivation has adversely impacted the profitability; consequently, farming no longer remains an attractive option. The micro level planning is needed to raise the farm income by identifying and promoting suitable low chill cultivars of temperate fruit crops. These fruit crops are not new to this area but need to be commercialized on large scale as cluster. The produce of such crops come 30-45 days earlier than the produce from conventional growing areas, which fetch premium price and extend its availability in the market. Resultantly, it will help reduce import of apple in the Indian market and reduce the burden on foreign exchange. In temperate fruits, there is an array of low chill varieties which suit to warm temperate and winter frost areas viz: peaches, plum, pecan nut, apple and pear. Recently, there are reports of planting and fruiting of low chill apple varieties from different parts/states of India even under tropical regions of country. A growers selection of apple 'Hrmn 99', evaluated and characterized in USA/Germany has shown preliminary promise for cultivation in relatively warm climates of Himachal Pradesh, Uttrakhand, Punjab, Rajasthan, Haryana,UP,Karnataka, Gujrat, MP and N-E region. Hence there is need to identify, evaluate and commercialize suitable low chill varieties along with development of hi-tech area specific technology. This paper shall focus on the various efforts, preliminary adaptation and scope of low chill temperate fruits in the subtropics of India under frost prone conditions.

S5O22 A500

Climate change effects and quality Makhana (*Euryale ferox* Salisb.) production under wetland ecosystem of North Bihar

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A field trial was conducted to study the climate change effects on quality makhana production at ICAR-RCER, Research Centre on Makhana during 2016-2017. The objectives of the study were developing new makhana production strategies to secure sustainable production under climate change or various weather conditions. High temperature and reduced humidity resulted in production of rather smaller nuts and leaves. The results revealed that makhana is a photo insensitive crop and its growth and development are markedly changed with the change of climates. Fruit number, seed numbers/fruits and yield were gradually increased from January to till September. Winter climate restricted commercial production of makhana for October transplanted crop. However, November and December planted makhana produced yield similar to January crop after recovering unfavorable weather of winter. The maximum numbers of fruit (15.33) and yield (62.0Q/ha) were observed in September planted crop. The gestation period of this crop was minimum (105 days) in January planted crop as compared to October (152 days). Winter makhana, which was planted in July showed highest nut quality in terms of protein (11.35 %) content. Plant grown in extreme winter showed decreased in protein content due to very low temperature. There were no serious diseases and pest incidence in 1.5 years crop cultivation. Makhana aphid was problem at nursery stage for winter crop without economic loss. During this study, the maximum temperature was 43^0C in May (2016) and the minimum temperature was 5^0C in January (2017). Hence, high and low temperature resulted in reduction in growth parameters (nut and leaf), while moderate temperature increased protein production and yield.

S5O23 A627

Climate Change: Impact and management strategies for fruit crop production in India

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Global warming and climate change is the greatest concern of mankind in 21st century. Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and that persist for a longer period typically decades or longer. The established commercial varieties of fruits, vegetables and flowers will perform poorly in an unpredictable manner due to aberration of climate. Melting of ice cap in the Himalayan regions will reduce chilling effect required for the flowering of many of the horticultural crops. Commercial

production of fruit plants particularly grown under open field conditions will be severely affected. Climate change is affecting the production of horticultural crops in India significantly. Apple belt in Himachal and other states is shifting towards higher altitude and the cultivation in lower elevations becoming unproductive. Due to high temperature physiological disorder of fruit crops will be more pronounced eg. Spongy tissue of mango, fruit cracking of litchi etc. Air pollution also significantly decreases the yield of several fruit crops and increases the intensity of certain physiological disorder like black tip of mango. Hence there is a need to protect these valuable crops for sustainability against the climate change scenario. The most effective way is to adopt conservation horticulture especially fruit crops, using renewable energy, forest and water conservation, reforestation etc. To sustain the productivity, modification of present horticultural practices and greater use of greenhouse technology are some of the solutions to minimize the effect of climate change. Development of new cultivars of fruit crops tolerant to high temperature, resistant to pests and diseases and producing good yield under stress conditions, as well as adoption of hi–tech horticulture and judicious management of natural resources should be the main strategies to meet this challenge.

S5O24 A686

Root proteomic responses to NaCl stress by a salt-sensitive banana genotype

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Soil salinity by NaCl is the growing abiotic stress around the world affecting the growth and productivity of banana crop. Proteomic responses of a salt-sensitive banana genotype was profiled using two-dimensional electrophoresis for number of differentially expressed proteins (DEPs) in root as being the critical primary organ vulnerable to salt stress. *Musa* AAA (Cavendish subgroup) 'Grand Nain' tissue culture plants were exposed to 1 (control) and 100 mM NaCl concentrations for 15 days and changes in the protein species between roots was characterised. From more than 900 reproducibly detected protein spots between control and treatment plants, 80 DEPs were observed of which the biological identity of 43 DEPs (28 up-regulated and 15 down-regulated) with at least two-fold difference in abundance were identified by in-gel digestion and peptide mass fingerprinting using MALDI-TOF mass spectrometer and database searching. The proteins were classified into 11 categories related to the metabolic changes occurring during NaCl stress and these proteins were involved in cell cycle and development (5 proteins), stress response (6), transcription (3), detoxification (2), signal transduction (7), carbohydrate metabolism (4), secondary metabolism (3), lipid metabolism (2), amino acid metabolism (5), transport function (4) and phytohormone metabolism (2). Many of these proteins have been reported to be differentially expressed under elevated NaCl concentration. All the proteins involved in cell development events were highly down-regulated in abundance implying plant growth process retardation. The result on proteins of signal transduction reveals that salt overly sensitive proteins were overexpressed and mediate the cellular signalling of the plant under salt (NaCl) stress.

S5O25 A688

Alleviation of salt stresses in micro-propagated grape rootstock plantlets with arbuscular mycorrhizal fungi

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The purpose of this study was to investigate the mechanisms underlying alleviation of salt stress by mycorrhization. Grape rootstock Male hybrid irrigated with tap water containing five salinity levels (0, 20, 40, 60 and 80 mM) and grown in pot soils with the arbuscular mycorrhizal fungi (AMF) were compared to non-mycorrhizal plants. The salinity significantly decreased plant growth, water absorption, total chlorophylls, chlorophyll stability index (CSI), K, P and S; while membrane damage, proline, Na, Cl and Na/K ratio increased. However, AMF-mediated growth stimulation was higher than non-mycorrhizal plants under salinity. Mycorrhization alleviated salt-induced reduction by uptake of significantly more P (50%) and S (7%), by synthesis of more total chlorophyll (13%) and by maintaining more water content in the shoots at higher salinity. The non-significant changes in accumulation of Na, Cl and K could be attributed to dilution effect because of simultaneous significant strong increase in the shoot (41%) and root (67%) dry matter of mycorrhizal plants. In conclusion, AMF may protect plants against salinity by alleviating the salt-induced osmotic stress by synthesising more chlorophyll and enhanced water absorption and improving the growth of the plant by accumulating more P and S.

S5O26 A221

Variation in incidence of downy mildew disease on Sharad Seedless grapes as influenced by different sources of potassium and their method of application

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Nutrition alters the compatibility relationship of the host-parasite environment within the plant. However, K is especially critical in the production and transport of fungus inhibiting phenolic compounds. Adequate potassium increases phenol concentrations, which play a critical role in disease resistance. This experiment was conducted to ascertain the influence of the combined application of different sources and methods of potassium application on downy mildew disease incidence in cv. Sharad seedless at IIHR, Bangalore. The plants were applied with three different sources of potassium fertilizers (SOP, KNO_3 and 19 all) and two methods of application (soil application and fertigation) Among the treatments, before downy mildew infection, highest total phenols in leaves were recorded in

treatment with 40% 19 all through fertigation + 60% SOP through soil. This treatment also showed the lowest number of disease infected plants. After downy mildew infection, highest total phenols in leaf were recorded in treatment with 40% KNO_3through fertigation + 60% SOP through soil. Different enzymes responsible for reduction in the incidence of diseases and different phenolic compounds which are responsible for increase or decrease of diseases incidence have been discussed.

S5O27 A235

Parasitization potential of *Trichogramma* Species and feeding potential of *Chrysoperlazastrowisillemi*on pests of pomegranate and theirbiosafety

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Laboratory experiments to determine the parasitization potential of *Trichogramma sp* on the eggs of *A.janata*and feeding potential of *Chrysoperlazastrowisillemi*(Esben-Petersen) on aphid *Aphis punicae* were carried out in the Department of Agricultural Entomology, TNAU Among all *Trichogramma* species tested, *T.chilonis* and *T.achaea*showed 100 ± 0.00 per cent parasitization on castor semilooper eggs followed by *T.pretiosum* and *T.japonicum* with 90 ± 3.16 per cent parasitization. The third instar grub of *C. zastrowisillemi,* with the developmental period of 3.4 days had consumed a maximum of 106.3 nymphs of aphid. Second and first instar grubs of *Chrysoperla* consumed a maximum of 68.1 and 30.7 nymphs during their development period of 3.2 and 2.7 days respectively. An individual *C. zastrowisillemi* grub consumed a total of 205.1 aphids during its total larval period of 9.3 days. Laboratory experiment was also conducted to assess the bio safety of most efficacious insecticides and botanicals against egg parasitoid *Trichogramma chilonis*Ishii and predatory green lacewing *Chrysoperlazastrowiisillemi* Esben-Petersen. The experiment included seven treatments with three replications. The treatments included were imidacloprid 17.8 SL (0.00712%) (Confidor®), thiamethoxam 25% WG (0.005%) (Actara®), chlorantraniliprole 18.5 SC (0.0037%) (Coragen®), fipronil 5% SC (0.01%) (Regent®), spinosad 45% SC (0.0125%) (Tracer®), azadiractin1% EC (0.02%) and untreated check. Chlorantraniliprole 18.5 SC (0.0037%), thiamethoxam 25 WG (0.005%), spinosad 45% SC (0.0125%) and azadirachtin 10000 ppm (0.02%) showed maximum emergence of *Trichogramma chilonis* indicating their biosafety. Likewise, the parasitization rate by *T. chilonis*was also not affected by the treatments. Regarding these toxicity of treatments against green lacewing predator, maximum grub mortality of *Chrysoperlazastrowisillemi*(80.0 per cent) was noted in thiamethoxam 25 WG (0.005%) whereas, chlorantraniliprole 18.5 SC (0.0037%) and spinosad 45% SC (0.0125%) showed a grub mortality of 50.0 and 40.0 per cent respectively at 24 HAT and found on par with each other. These results stress the need for temporal separation of *Chrysoperlazastrowisillemi* on integration with the insecticides.

S5O28 A99

Phenology of Nagpur mandarin in changing climate: A paradigm shift

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In the last two decades, there has been a growing concern about the effects of climate change due to global warming which has impacted the phenological processes in citrus cultivation. With the changing climate scenario it has become essential to revisit the phenological processes occurring in the Nagpur mandarin keeping in view the long term sustained productivity. Eight orchards were earmarked for *Ambia* cropping (ICAR-CCRI, Kalmeshwar, Ladgaon, Khumari, Budhla, Hetikundi, Jarud and Paratwada) and six orchards for *Mrig* cropping (Mandvi, Khumari, Ladgaon, Ajangaon, Hetikundi and Khairi) in Vidarbha region of Maharashtra.In *Ambia* crop the duration of stress varied from 30-41 days in different orchards. Full bloom appeared from third week of February to first week of March in striking contrast to usual period of flowering in January-February observed commonly about 15-20 years ago. The maximum and minimum day temperatures during the corresponding flowering period varied from 27.25 to 31.94^{0}C and 16.03 to 17.94^{0}C respectively, RH 30.57 to 81.57 %. Days taken for harvesting varied from 252-306 days. The yields varied from 16.76 to 24.85 tonnes/ha. The fruit drop per cent was observed maximum with 14.85 % to 33.58 % in the month of March when the fruit-lets were of 1-3 mm in size when the maximum temperatures were more than the threshold of 37^{0}C. The TSS and titratable acidity was 9.20 % to 10.66 % and 0.67 to 0.73 % respectively. In *Mrig* crop the duration of stress varying from 37 to 47 days. The full bloom appeared from first to last week of July in different orchards. The maximum and minimum day temperatures during the corresponding flowering period varied from 32.23 to 35.57^{0}C and 24.06 to 24.86^{0}C respectively. The RH varied from 45.86 to 81.29 %. Days taken for harvesting varied from 275-301 days in different orchards. The yield was 17.70 to 37.53 tonnes/ha. The fruit drop % varied 7.27 % to 23.09% in the month of July when the fruit-lets were of 1-4 mm in size. The TSS and titratable acidity was 10.83 % to 12.03% and 0.58 to 0.70 per cent respectively.

S5O29 A84

Ecofriendly management of various diseases of vegetable pea through SAR chemicals in Kashmir, India

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Pea is an important cool season vegetable and pulse crop of temperate and subtropical regions, grown worldwide as a source of proteins. It plays a significant role in the eco-buildup of agriculture as it enriches the soil by fixing the atmospheric nitrogen. Among the various biotic factors that affect the productivity of the crop, Ascochyta blight, root rot, Alternaria blight and Septoria blight are highly destructive diseases and have recorded the status of major diseases of pea throughout the Kashmir valley.

The frequent epiphytotics of the diseases in valley witnessed during past few years have necessitated to employ innovative management of the diseases. Experiment was therefore conducted in pea variety Rachna at SKUAST-K farm in a randomized block design. Six treatments including check namely gibberelic acid (1000 ppm), ethylene (1000 ppm), salicylic acid (1000 ppm), indole acetic acid (1000 ppm) and carbendazim 50 WP (1000 ppm) were used for seed treatment and one spray of all the growth regulators was carried out on the foliage stage of the crop. The data revealed that highest occurrence of wilt disease (8.20) was recorded in carbendazim treatment. Among the foliar diseases; Alternaria blight was highest in check plot with seed treatment by salicylic acid (5.0). Minimum incidence of Ascochyta blight(4.12), anthracnose (2.45) and septoria blight(2.38) were recorded in ethylene (1000 ppm). In foliar application+ seed treatment of growth regulators, Ascochyta blight was significantly impeded by all the chemicals and minimum disease severity was compounded in ethylene(2.75) followed by salicylic acid (3.10) and IAA(3.12) which gave significant control of the disease.

S5O30 A187

Screening the different varieties of brinjal (*Solanum melongena* L.) against Egyptian Broomrape (*Orobanche aegyptiaca* Pers.)

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Orobanche aegyptiaca Pers. (Egyptian broomrape) is an angiospermic root parasite, responsible for significant yield losses in several economic crops. It is a serious threat to various crops in Asia, Africa and Europe. Several methods have been tried for the management of broomrape such as cultural, chemical and biological methods. However, there is no promising method to control the parasite. Use of resistant host plant varieties against *O. aegyptiaca* is one of the most effective and sustainable management strategies. Therefore, this study was undertaken to screen twenty five brinjal (*Solanum melongena* L.) varieties in the green house condition against broomrape infection (*O. aegyptiaca*). The employed experimental design was completely randomized with three replicates. Plant resistance and susceptibility to a parasitic weed was estimated by measuring different parameters such as percent reduction in dry weight of host against control, number of *Orobanche* shoots emerged per host plant and total dry weight of (emerged shoot and tubercles) *Orobanche* increased. On the basis of these parameters, the varieties are grouped into four categories: highly resistant, moderately resistant, susceptible and highly susceptible. The results revealed that out of twenty-five brinjal varieties, fifteen (Prabha kiran, Nav Kiran, Sukhda, PK123, Govinda, Nagina, JK Kajal, Surya Kiran, 51-C, Green round, VNR-60, Neel Kamal, Brinjjal-1 Hybrid, Mahy Green, and F1 Hybrid No.38) were highly susceptible, Six (Green long, Shamli, Brinjal-Ad and Hybrid Green, Prasad and Ujjwal) were susceptible, two (Mahy 80 and Prapti) were moderately resistant, two (Mahy Ruby and Mahy 112) showed resistance against *O. aegyptiaca.*

S5O31 A167

Effect of trichomes in cowpea pods on infestation by spotted pod borer, *Maruca vitrata* (Fab.) (Lepidoptera: Crambidae)

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Forty eight cowpea accessions were evaluated for resistance to the spotted pod borer, *Maruca vitrata* in the Department of Agricultural Entomology, College of Horticulture, Kerala Agricultural University, Thrissur from September 2014 to June 2015. Significant variation was observed in terms of damage to cowpea pods due to spotted pod borer. The pod damage ranged from zero to 47.95 per cent. Eleven accessions, viz., EC 100092, Palakkadan thandan payar, IC 26048, IC39945, IC 2815, KBC – 2, EC 98668, IC 39947, IC 20645, IC 52110 and IC 52118 recorded zero damage to pods. The highest extent of pod damage (47.95%) was recorded in case of cv.Bhagyalakshmy. The trichome density and length of the pods were analysed. Positive and significant correlation was observed between per cent damage and trichome density (0.43) at 0.01 level. However trichome length did not show any significant variation among the different accessions and it did not show any significant correlation with per cent damage. Trichomes are important components of plant defense against insect attack and contribute to antixenosis in cowpea.

S5O32 A293

Raising sorghum as a border crop to enhance the population of *Aprostocetus diplosidis* Crawford for natural biological suppression of bitter gourd gall midge, *Lasioptera falcata* Felt and *L. bryoniae* Schiner

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Recently, *Lasioptera* spp. (Cecidomyiidae: Diptera) occurred in severe form in bitter gourd producing galls in tender shoots, leaf petiole and stem during 2015-2016 in Coimbatore and Tiruppur districts of Tamil Nadu. The mosquito-like fly lays its egg endophytically in tender shoots, resulting in formation of galls on the stem and petiole of the leaf, thereby retarding growth which results in reduced yield. Three parasitoids associated with gall midge were collected from the life stages of midge and identified as *Aprostocetus diplosidis* Crawford, *Bracon* sp., unidentified and belonging to Platygastrinae. Among these, *A. diplosidis* is known to be a predominant parasitoid contributing to natural parasitization of the midge up to 31.9%. *A. diplosidis* is a potential parasitoid with a wide host-range and parasitizes several gall midge species, including the sorghum ear-head midge, *Contarinia sorghicola*. Hence, an attempt was made to use sorghum as a refuge crop to enhance the population of the parasitoid, *A. diplosidis*, on the alternate host, *C. sorghicola*, by synchronizing the ear-head stage of sorghum with bitter gourd crop cultivation period. A field experiment was initiated with staggered sowing of sorghum to synchronize

the milky stage ear-head of sorghum with bitter gourd cropping period, along with a Control bitter-gourd crop (without sorghum as the border crop. Observations were made for eight weeks in the bitter-gourd field with and without the border crop of sorghum. Maggots in stem galls of bitter gourd were observed by destructive sampling for recording parasitization by *A. diplosidis.* Data gathered on natural parasitization of maggots of *Lasioptera* spp. by *A. diplosidis* indicated that sorghum crop with synchronized milky stage ear-heads in the bitter-gourd field recorded highest parasitization of *A. diplosidis* (up to 48.4%) against 28.1% in the Control bitter-gourd field. Enhanced parasitization by *A. diplosidis* of up to 20.3% was recorded when staggered sorghum was raised along with a bitter-gourd crop.

S5O33 A751

Gametophytic selection for *Fusarium* wilt resistance in carnation (*Dianthus caryophyllus* L.)

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An investigation was conducted on "Gametophytic selection for *Fusarium* wilt resistance in carnation (*Dianthus caryophyllus* L.)" at the Division of Floriculture and Medicinal Crops, Indian Institute of Horticultural Sciences, Hessaraghatta, Bangalore. Pollen of eight carnation genotypes was studied for their resistance against *Fusarium* wilt using mycotoxin; Fusaric acid in pollen germination media. The genotypes *viz*., IIHRCG- 201, IIHRCG- 202, IIHRCG- 205, IIHRCG- 206, IIHRCG- 207, IIHRCG- 208, IIHRCG- 209 and IIHRCG- 210 were assessed for their pollen germination and pollen tube growth in presence of fusaric acid at different concentrations (0, 0.5, 1, 2, 5, 10, 25 and 50 %). Among the genotypes assessed, IIHRCG-202 recorded the highest germination per cent (33.15 %), whereas the lowest was observed in IIHRCG-209 (18.81 %). The pollen tube growth was recorded to highest the same genotype IIHRCG-202 (152.81 µm), whereas the least tube growth was recorded in IIHRCG-201 (82.81 µm) respectively. The ability of the genotypes to resist the stress induced by fusaric acid was evaluated on the parameters; relative pollen germination and pollen tube growth over the control. the genotype IIHR-CG-202 recorded the lowest relative change in pollen germination per cent (68.44 %), which was on par with that of the genotypes IIHR-CG-207 (67.89 %) and IIHR-CG-208 (65.19 %) indicating significant level of resistance against *Fusarium* wilt. On the other hand the highest relative change in pollen germination per cent was recorded in the genotype IIHR-CG-209 (50.18 %). Similarly, the genotype IIHR-CG-202, recorded the lowest relative change in pollen tube growth (70.94 %), which was on par with the genotype IIHR-CG-208 (68.83 %). Whereas, among the different

concentrations of fusaric acid, taking into consideration the pollen tube growth at zero per cent fusaric acid concentration, the highest change was recorded at 50 per cent fusaric acid concentration (45.10 %), which was on par at 25 per cent fusaric acid (47.53 %). The information generated on source of resistance trough gametophytic selection from this study will be useful for developing resistant sporophyte for commercial cultivation.

S5O34 IS25

Microclimate Modification by Tamarindus indica Native to Oman

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This was part of a larger study that was conducted to quantify the amount, if any, that mature specimens of native Omani plants could modify their surrounding microclimates. Several specimens of *Tamarindus indica*, a tree species native to Oman, were monitored for the effects they could have on their microclimates in the wild as well as in developed landscapes. Monitored variables included Lux, photosynthetic active radiation, ambient temperatures, relative humidity and average wind speed, as well as vegetative data such as height, drip line, height off the ground where the canopies began, and leaf area index. Monitored specimens had similar effects on their microclimates in the wild as compared to those in the developed landscape. The specimens found in the wild, in southern Oman, were quite similar in size and stature to those studied in the developed landscape in Muscat, Oman. Results showed that on average mature specimens could reduce temperatures by 6.5%, increase relative humidity by 5.8%, a decrease light in lux by 71.9%, a reduction in PAR of 93.8%, and a decrease in average wind speed of 48.8%. These effects partially carried through to below canopy areas due to their shading through insolation abatement. This shows that mature specimens of this species could greatly impact microclimates in developed landscapes.

S5O35 IS6

Protective Role of Nitric Oxide during Bean Seed Germination under Salt Stress

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Laboratory experiments were carried out to investigate the ameliorative role of nitric oxide (NO) on bean seed germination under salinity conditions. Bean seeds were treated in 4 different NO concentrations i.e. 0.00, 0.1, 1.0 and 10 mM then allowed to germinate under salinity conditions induced by NaCl at concentrations of 0.00, 25, 50, 75 and 100 mM. The obtained results showed that salinity reduced bean germination behavior in terms of germination percentage, germination uniformity as well time required to 50% germination. Seed treatments with NO at all used concentrations had relieving effect of salinity and 1.0 mM was the most effective treatment. The present results indicated that, nitric oxide stimulated various growth aspects of bean seedlings perhaps through interference with the enzymatic activities responsible for biosynthesis and/or catabolism of growth promoting and inhibiting substances. Thus, it might be concluded that, NO could eliminate the adverse effects of salt stress in common bean.

Session VI: Applications of ICT in Horticulture

Oral Papers

S6O1 A428

ICT – A way forward for disseminating oil palm technology

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Oil palm crop has a potential for cultivation under 19.33 lakh hectares in India, but is cultivated in only 3.00 lakh hectares. ICAR-Indian Institute of Oil Palm Research is using Information Communication Technology (ICT) channels to disseminate oil palm technology more effectively by overcoming literacy barriers and addressing field problems instantly. Mobile Message Services are used to disseminate oil palm related technologies through SMS and voice calls. Advisories on practices recommended for oil palm cultivation are published in English and in vernacular languages for use by the stakeholders. During 2012-2017, 1139 text- and 1661 voice-calls were disseminated to 20.30 lakh and 40.42 lakh mobiles, respectively, to stakeholders in 13 States. About 858 farmers' queries on oil palm cultivation were answered. Feedback revealed that mobile messaging services are useful for adoption of practices, and stakeholders would like to receive SMS/Voice messages at weekly intervals. Video conference system established during 2014-2015 at our institute has enabled one-to-one interaction with and between stakeholders at different locations. Six sessions were conducted for stakeholders on oil palm cultivation through presentations and discussions. These sessions have been recorded and can be shared with stakeholders requiring the same information. Having observed usage and applications of mobile telephony, four mobile application (apps), viz., (i) Oil Palm Cultivation Practices, (ii) Oil Palm Nutrient Management, (iii) Oil Palm Pest Management and (iv) Oil Palm Disease Management were developed during 2015-2017 in English, Hindi and Telugu languages to provide instant support to the farmers to help them manage their crop/s. We witnessed 438 downloads of these apps. Such interventions of ICT help farmers and stakeholders to work for oil palm development more effectively and efficiently, thus helping develop oil palm cultivation and improve socio-economic status of the farmer. By achieving good yields through adoption of recommended practices, this can ultimately pave the way for self-sufficiency in vegetable oil production in the country.

S6O2 A711

Stability analysis in horticultural crop research: A re-look

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Crop improvement research, which begins with a search of potential germplasm material having exploitable wide variability for traits, culminates with the release of new cultivars of superior characters based on stability analysis. Normally, in such systematic study, stability models are constructed individually for each of the characters and stability measures are worked out to compare and test the performance of various genotypes/test material over periods/locations. However, it is often seen that a group of genotypes happens to be stable or ideal over years/environment for a particular trait, may not perform better than the existing promising variety (check) for other desirable traits of secondary nature, probably due to the presence of non-linear GXE interaction. Moreover, a varietal release program which recommends a variety locally or across environments may prefer to have an one, which perform the best not only for the trait under study but also equally good (meets the benchmark values) for all other traits,

which will be a real success when implemented in a farmer's field. In this direction, an attempt has been made to introduce a combined index based stability approach. Results are discussed in comparison with the existing approach by fortifying the efficacy of the modified approach from user's point of view.

S6O3 A397

An Online Information System for the Germplasm collection of IIHR

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Germplasm collection is an integral part of plant breeding programmes. At IIHR, germplasm collection and documentation has been carried out for a number of years. Digitization of the passport data of the germplasm is a very important aspect to enable quick retrieval of information which is very essential for planning and decision making. A web portal for showcasing the germplasm of the institute has been developed at IIHR. It has been developed for storing the passport and characterization data of the germplasm collection of the institute. It has been developed in WAMP server architecture which is based on Windows operating system; Apache web server, MySQL database and PHP scripting language. The backend database has been developed in MySQL while the web pages have been created in HTML and PHP pages. The format of the passport database is based on the 'Guidelines for Registration of Plant Germplasm 2014'. The database has been populated with the passport information of the germplasm collection of mandate fruit, vegetable, ornamental and medicinal crops of IIHR. An interactive/ dynamic user-friendly, web-based interface has been developed for retrieving selective information from the same. A user can obtain information from the database based on various criteria viz. collector number/ national identity, crop/ common/scientific name and source/ location. The information systemenables the quick retrieval of information in based on user criteria. It has been hosted on the intranet of IIHR and has been made available to all the scientists.

S6O4 A2

Unique DSS for cashew germplasm management: Harnessing latest IT tools

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I

n most crops, germplasm utilisation is rather inadequate due to non availability of proper characterisation and evaluation data on accessions. Even when they are available, it is a herculean task to select germplasm accessions having suitable combinations of characters for *per se* utilisation or in breeding programs owing to enormity of quantitative and qualitative data. However, advances in information technology have opened up new possibilities of managing this information and it is imperative to develop robust data management and retrieval systems for better utilisation of germplasm resources. ICAR-Directorate of Cashew Research houses the largest repository of cashew germplasm accessions in the country, in its National Cashew Field Gene Bank and the data on accessions has been collated since

1986. To manage and utilise this information, a powerful Decision Support System (DSS) was developed (www.mindstack.in/dcr/). The database was developed in MySQL and for user interface (front end), HTML5, CSS3, Twitter Bootstrap, jQuery, Masonry-jQuery, Select2-jQuery, amCharts, FlexSlider-jQuery were deployed. The back end utilises a PHP5 framework-Laravel. The DSS is open ended to facilitate inclusion of additional accessions, data and images. Further, it is accessible across different devices and platforms. Currently the DSS hosts data on 478 accessions with 68 characters in addition to passport data. The uniqueness of DSS is its ability to select one or many combinations of characters and their sub-categories for retrieval of accessions. Further, the frequency distribution pattern and real time pie diagram indicating proportion of accessions for a chosen character are crucial in deciding the worthiness of germplasm accessions during survey and collection and, their subsequent inclusion in gene bank. The easy to use interface and simple search facility akin to Google Instant in the DSS will be immensely useful to researchers, students, other stakeholders and this module can be emulated in other crops.

S6O5 A637

Integrating technological solutions to identify potential locations for rain water harvesting interventions in ICAR-IIHR farm at Hesaraghatta, Bengaluru

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Water constitutes the prime requirement for existence and sustenance of all life forms. However, the quantum of rainfall and surface water availability has remained constant leading to over-exploitation of ground water, declining water table levels and deterioration of water quality. Management of water resource includes prudent utilization of available water, protecting and preserving the environment & eco-system and also providing for natural and artificial recharge to ensure aquifer transmissivity and storability apart from preventing contamination and pollution. ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru is totally dependent on rains and bore well water for irrigation of experimental plots and laboratory needs. There is water shortage because of reduced output from borewells, change in rainfall pattern, and, the dried up Ivarakandapura lake. This criticality has to be balanced with increasing water demand due to enhancement of cultivated land, more experimental activities, construction of new buildings and additional environment controlled polyhouses/greenhouses. Devising practical solutions for management of scarce water resource is a big challenge. In this paper, an attempt is made to present the existing natural resources and the potential for better planning and management of water resources within a part of the farm area in ICAR-IIHR using advanced technological tools and computer applications to frame a methodology for identifying points where rain water harvesting will be effective.

S6O6 A657

Rainfall Trend Analysis of a Mini Watershed: A Case Study

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India is a tropical country, depends on south west Monsoon. Southwest monsoon sets on 1st of June and ends on 30th September. The case study considered in this case is very close to the coast where the monsoon sets in. The present study is aimed to carry out the probable trend of rainfall and to evaluate its implications on the tanks in Hunsur taluk of Mysore district, Karnataka, India. These tanks were the sources of water for the livelihood of the farmers in the command areas. The lakes considered in the case study are totally dried up in recent times. To study the reason behind drying of these lakes in the region, trend analysis is carried out for 40 years of data (1975-2014). The trend analysis is carried for the monthly average values, Seasonal and annual average values using Mann-Kendall test and Sen's slope estimation. The analysis shows no trend for the months of January, February, March, June and December. There is an increasing trend for the months August and October. However, there is a decreasing trend for the months of April, May, July and September. The decadal variation also indicates that there is a very significant decrease of rainfall for the months of June and July in the recent decade (2005- 2014) and hence a negative trend in the South-West monsoon season. The statistical investigation of 40-year data reveals that there is a decreasing trend in the rainfall for almost all the months and seasons which have led to the degradation of lakes in the taluk and catchment.

S6O7 A365

Application of remote sensing in fruit production

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Remote Sensing (RS) is the acquisition of information about an object or phenomenon without making physical contact with the object. There are two types of remote sensing namely active type and passive type. Active type having active sensor like LIDAR, RADAR, Scatteromater, Sounder, and Ranging instruments have own source of light or illumination. Passive type has passive sensors like Accelerometer and Hyperspectral radiometer which is detected in presence of reflected sunlight. They can be used for a number of application like crop inventory, crop condition, crop production forecasts, crop classification, area estimation, yield prediction, fruit quality measurement, canopy management for detection of the growth and health of fruit crops and abiotic stresses like drought and flood damage assessment, irrigation scheduling and management of variable rate of fertilization. The multispectral and thermal imaging for Huanglongbing disease (citrus greening) detection in citrus by using a mobile ground-based sensor platform indicated that, the HLB-infected trees reflected higher in the visible

regions of spectra than in non-invisible regions compared to healthy trees. Hyperspectral imaging to assess the foliar anthracnose disease of strawberry at three different stages of infection *i.e.*, healthy, incubation (infected but not yet symptomatic) and symptomatic. The result revealed that, not only healthy and symptomatic stages be recognized, but also the incubation stage identified through hyperspectral imaging analysis. RS provides authentic source of information for identifying, classifying, mapping, monitoring, and planning of natural resources, disasters mitigation and management as a whole. In addition, the technology will also provide information on site specific management and spectral, spatial and temporal- based fruit production to achieve the précised estimation of crop yield.

S6O8 A452

Intervention of precision farming in Cashew

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Advancing knowledge in tree architecture, growth physiology, possibility of using promising cultivars, water management etc. has enabled farmers to adopt closer planting and maintaining reachable canopy by tailoring soil and crop management applications to fit in varying conditions in the field popularly known as Precision farming**.** Precision farming is a modern method of cultivation involving planting of trees densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operations. This system produces precocious cropping, high and regular yields of good quality fruits and low labour requirement to meet ever rising production costs. Cashew (*Anacardium occidentale* L.), a member of *Anacardiaceae* family is cultivated in tropical regions on either side of the equator for its delightful nutritious kernel and apple. Precision farming has been negotiated in cultivation practices and the best soils for cashew are deep and well-drained sandy loams without a hard pan. The technique of softwood grafting was found to be suitable for commercial multiplication of cashew in a short time. Mulching the cashew tree basins helps to conserve the soil moisture and to prevent soil erosion. With organic matter, it inhibits weed growth and reduces surface evaporation during summer and also regulates the soil temperature. High density planting in cashew accommodates maximum possible number of the plants per unit area without impairing soil fertility. The use of fertigation is gaining popularity because of its efficiencies in nutrient management, time, labour and control over crop performance. Adopting this type of technology allows growers to evolve their standard practices and benefit from the improved crop outcomes.

S6O9 A157

Contribution of information and communication technologies for horticulture farmers in India

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Horticulture has emerged as the main engine of Indian agriculture. It contributes 30.4 per cent to GDP of agriculture from nearly 13 per cent of the total cropped area. Horticulture continues to surpass the food grain production for the last three years, with an annual production of 283.5 million MT in comparison to food grain production of 257.1 million MT in 2014-15. Horticulture crops play a unique role in India's economy by improving the income of the rural people. Cultivation of these crops is labour intensive and as such, they generate lot of employment opportunities for the rural population. Information and Communications Technology (ICT) is important for horticulture development. Lack of access to adequate extension services is a major problem to horticulture productivity. The potential of ICTs is significant in bridging the gap between farmer's needs of information and that available with research institutes/scientists. Desired information could be delivered by using ICTs-enabled services. It leads to improved agricultural advisory services in a cost effective manner. The advancements in ICTs can be utilized for providing accurate, timely and relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture. ICT is also empowering rural communities through providing useful information related with foods and their availability in nearby markets. The findings indicated that utilization of ICT by horticulture farmers is still low. It revealed that majority of the farmers still rely on traditional ICTs to get agricultural information. The existing opportunities should be exploited to implement ICT based extension to horticulture farmers. The County government should provide incentive to promote access to and use of ICT, integrate ICT at all levels of education. There is need for provision of incentives to promote access to and use of ICT. Since mobile phone is one of the most effective tools used, the county government should provide horticultural information through the mobile phone and address barriers to the use of ICT.

S6O10 A663

Temperatures zoning and its trend analysis for horticulture crops in north-west India using GIS in context to climate change

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The study was conducted at department of Agricultural meteorology CCS HAU, Hisar to quantify trend in temperatures, its variability and spatial distribution for the period of > 30 years in north-west India more than 30 years' data on maximum and minimum temperatures of twenty-two different agrometeorological stations of Jammu & Kashmir, Himachal Pradesh, Utrakhand, Punjab, Haryana, Chandigarh, Delhi, Uttar Pradesh and Rajasthan were used in this study. The temperature data was

analyzed for computation of as annual normal temperature and the coordinates were converted into decimal system for each meteorological station for spatial analysis. Temperature trends for different meteorological stations in hills, plains of north-west India were evaluated using trend analysis. The map of north-west India was digitized and different temperature zones for maximum, minimum and mean temperature were delineated using GIS. Out of 22 stations, half of the stations showed a significant positive trend and another half negative trend in maximum temperature. A significant positive trend in minimum temperature of twenty stations and negative at Srinagar and Ranichauri was observed. Mean temperature showed significant positive trend at seventeen but negative at five stations. Highly significant positive trend (0.1 to 3.0°C/100 years) in annual maximum temperature, (1.5 to 1.6°C/100 years) in annual minimum temperature and (1.1 to 2.5°C/100 years) in mean temperature was observed in north-west India. North-west India was divided into different six zones of maximum temperature and seven zones of minimum temperature. Spatial variation in mean annual temperature was from 13.1 to 25.6°C and on its basis the study area was divided into five zones by taking a class interval of 2.5°C. The study can be further refined by including the historical temperatures data of more meteorological stations located in the study area for better results.

S6O11 A14

Remote sensing and geographical information system in horticulture: Opportunities and challenges

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Horticulture crops play significant role in the food and nutritional security of the country. During the past few years, horticulture development has emerged as one of the major thrust area in agriculture sector. Accurate and timely information is necessary to evolve strategies for sustainable management of natural resources. Remote sensing (RS) and geographic information system (GIS) technologies are of great use in planning for efficient use of natural resources at national, state and district level. Application of these technologies in natural resource management are increasing rapidly due to great strides made in space borne remote sensing satellites in terms of spatial, temporal, spectral and radiometric resolute. Reliable and timely estimates of crop production provide information in market planning and export. Satellite remote sensing approaches offer an affordable, robust method for the derivation of field-scale crop water requirement. High-spatial remote sensing thermal imagery has potential as an indicator of some fruit quality parameters for crop field segmentation and irrigation management purposes. The application of a spatially distributed simple water balance method, lead to the estimation of temporal and spatial variation of crop water requirements. This study contributes to fill a gap in the knowledge on use of water resources in agricultural, which is essential for the implementation of a sustainable and sound water policy. Imaging technology has the potential in multiple areas of fruit production viz., crop load assessment, yield estimation, insect- pest incidence or disease infection, estimation of fertilizer, pesticide and herbicide application rates, monitoring and development of automated pruning and harvesting strategies.

Session –VII
Participatory Technology Development and Adoption
(Technology Assessment, Refinement and Dissemination**,** Technology commercialization, Public-Private Partnership, Socio-Economic and Gender issues)

Oral Papers

S7O1 IS66

Role Of Tropical And Subtripical Fruits For Crop Diversification, Biodiversity, Environmental Protection In Changing Climates, Nutritional Food Security And Poverty Reduction In Bangladesh

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Bangladesh economy is predominantly dependent on agriculture. So, the importance of horticulture in the national economy has been well justified. The Horticultural crops, particularly fruits, vegetables and spices are playing a vital role in crop diversification, human nutrition, economy, environment, with an ultimate goal of balanced diet, fight malnutrition, food self-sufficiency, biodiversity, environmental protection and poverty alleviation. In Bangladesh around 40 million peoples are suffering from micronutrient deficiency-the hidden hunger. Moreover, almost 70% peoples are below the poverty level. Our Government has paid much emphasis on rice but not on fruits, vegetable, spices and flowers production as our diet is rice based. Although there has been considerable success in variety development and technology generation in fruits and vegetables but their application are not adequate. Improved varieties of fruit like mango, guava, jackfruit, litchi, pineapple and banana are available in Bangladesh. The paper deals with mainly achievements, constraints and opportunities of horticultural crops (fruits) in Bangladesh for plantations and climate change. They are also contributing in nutrition and poverty alleviation of our land scarce, malnutrition affected and poor peoples. Bangladesh Agricultural University also established the largest fruit repository including a number of underutilized, tropical, subtropical, indigenous and temperate fruits here in Mymensingh. Contribution of the horticultural crops in the climate change, nutrition of poor people and to alleviate poverty in coastal (saline), hunger prone (monga) and flood affected areas also addressed. Plantation of underutilized fruit ber (Jujube) cv. BAU Kul 1 tremendously contributes in the poverty reduction and natural soil reclamation from saline to non-saline condition. Finally, the paper focuses on the future policy of the managements of horticultural crops in Bangladesh for economy, nutrition, food security, poverty alleviation and sustainable development.

S7O2 A591

Pomegranate orcharding enterprise for sustainable livelihood in Himachal Pradesh under changing climate: opportunities, constraints and prospective

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Global warming has severely affected the apple cultivation in Kullu district of Himachal Pradesh, prompting fruits growers to start pomegranate cultivation, which is considered suitable under changing climate. In Himachal, wild pomegranate '*Daru'* (*Punica granatum* L) is well adapted, occurs frequently in wild or semi-wild up to 4500 feet above MSL. Systematic studies were conducted on screening of

cultivars viz., Achikdana, Anar Shirin Mohammad Ali, Chawla, Ganesh, G-137, Jalore Seedless, Jodhpur Red, Kandhari Hansi, Kandhari Kabuli, Nabha, P-75-K-3, P-75-K-5, P-23, P26, Bhagwa in the mid-hill zone of state. The average highest yield (kg/tree) was recorded with Chawla (23.2) followed by Nabha (21.9) and Kandhari Kabuli (20.6), while the lowest was in Jodhpur Red (13.2). The highest fruit weight was recorded with P-75-K-5 (508 g) and the lowest with Bhagwa (176 g). The highest TSS was recorded in Kandhari Kabuli and the lowest in Bhagwa. Observations on fruit characters revealed that Kandhari Kabuli, having pinkish red fruits with blood red coloured grains and sweet taste with acidic blend; and Bhagwa, with attractive, saffron coloured fruits, smooth and glossy peel, attractive cherry-red coloured arils, soft seeded bold; are excellent varieties for cultivation in mid-hill zone of Himachal Pradesh. Studies were conducted at Experimental Farm of Regional Horticultural Research and Training Station, Bajaura during 2013-2015 to improve the quality of fruit with application of pre-harvest foliar sprays of nutrients. Pre-harvest application of Potassium (Potassium sulphate having 50 percent K) @ 0.5 percent at 30, 20 and 10 days before harvest during the 2nd year was found most effective to i) delay the harvesting time by 15 days to avoid glut in the marketing for getting good prices of produce; ii) to improve the elasticity of fruit, colouration of rind and aril with 16 per cent TSS in Kandhari Kabuli. Growing pomegranate as substitute crop of apple and stone fruits in lower Kullu valley fetches good remunerative prices, and shows a way forward to mitigate and harvest the unfavourable effects of climatic shift in farmer's favour by adopting new alternate crops.

S7O3 A709

Post harvest loss and marketing of fruits – economic analysis of pink flesh guava in local and distant markets in India

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Guava produced in Bengaluru in Karnataka is also transported to distant markets like Cochin in Kerala and Chennai in Tamil Nadu. An assessment of post harvest loss (PHL) was done in these markets. The main marketing channel followed was:

Producer → PHC → Distant Market WS → Retailer → Consumer

Marketing practices followed in marketing of pink flesh guava and losses occurring at the wholesale (transit) and retailers' level (storage) in the distant market - Kerala were studied from wholesalers and retailers. The PHL at the wholesalers' level was observed to be 3.6 per cent mainly due to pressed and crushed fruits during transit. The retail level loss was 4.59 per cent which was mainly due to storage for more than two days resulting in decaying, rotting, yellowing etc. Average price received by the wholesaler was Rs.29.17/kg with a margin of Rs.5.46/kg (23%). The retailers received a price of Rs.46.54/kg with a margin of Rs.16.35/kg (54%). Marketing practices followed in marketing of pink flesh guava and losses occurring at the wholesale (transit) and retailers' level (storage) in the distant market – Chennai (Tamil Nadu) were studied with wholesalers in Coimbeedu market and retailers in different parts of Chennai. The PHL at the wholesalers' level was observed to be 4.62 per cent mainly due to pressed and crushed fruits during transit. The retail level loss was 6.09 per cent which was due to pressing of fruits during handling. The wholesaler received a margin of 21.45 percent in trading of guava fruits. The retailers received a margin of 84 per cent. The Karnataka farmers can take advantage of the higher prices prevalent in the distant markets and increase their income. Pathological investigation indicated that losses occurred at different stages of handling due to Style end rot, Anthracnose, Canker and Thrips attack etc., which needs to be addressed. The storage losses of pink flesh guava were

estimated as 5.89 % after 4 days of storage at room temperature (24-32°C) that constituted mainly the physiological loss in weight (PLW). Spoilage started after 5 days of storage (10.5 %) and reached to 28.31 % by 6 days of storage. After 4 days of storage, guava fruits lose weight to the extent of 6 per cent and the spoilage starts after 5 days. Hence, care should be taken to dispose of the fruits within five days of harvest.

S7O4 IS10

Developing and scaling of small-scale technologies for vegetable producers ' lessons learned from a research project in Tanzania

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To meet the future challenge of feeding a growing world population estimated to be 9.15 billion people by 2050, many governments and donor organizations demand a fast development and scaling of agricultural technologies for improving productivity of particularly smallholder farmers in Sub-Saharan Africa. This requires to overcome gaps between national and international research organizations that have developed new technologies on the one hand, and development organizations on the other hand that are able to scale those technologies out to farmers as soon as they have been tested. This study presents the results of an impact analysis conducted in nine pilot villages after the first three years of an on-going United States Agency for International Development (USAID) funded program called 'The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING)'. The program combines a unique research component employing participatory research methods to test new technologies on-farm with a scaling methodology that led to technology scaling activities in more than fifty pilot villages in Tanzania. The study results reflect the adoption rates of different technologies by all beneficiaries, compares the changes in yield, production costs and gross margins for different vegetable crops, as well as contrasts the changes in vegetable consumption between project beneficiaries and non-beneficiaries. We finally proffer recommendations on the analytical assistance to future scaling projects and provide practical hints to improve the collaboration between research activities and technology scaling approaches.

S7O5 A654

Introducing potato in dryland system of Western Rajasthan of India to make farmers self-reliant

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Rajasthan has nearly 10,000 ha area under potato and productivity is 11.2 t/ha, compared to national productivity of 23 t/ha. The major limiting factors to cultivate potato in dry sand dunes are lack of awareness of improved potato production technologies, non-availability of quality seed and lack of initiative by public or private sectors on potato production in arid region. CIP in partnership of public and private sectors introduced potato in arid region to improve food and nutrition security and generate more income of farmers by producing table, seed and processing potatoes during short day winter. A baseline study of 110 households revealed that moderate temperatures, sandy loam soils free from soil borne diseases, clear sunny days for maximum tuber bulking in short time and excellent tuber quality are congenial for potato cultivation. The joint efforts of International Potato Center (CIP) and Central Potato Research Institute have successfully identified and introduced an elite drought and heat tolerant clone CIP 397006.18 for multilocation testing for variety release. 342 stakeholders including farmers, consumers, researchers, traders, extension workers of public and private sectors were trained on best production and post-harvest practices in dryland system. Sixteen farmer in Jodhpur and fourteen in Jaisalmer districts planted and harvested first time potato successfully on sandy soils in 2015-2016. The maximum tuber yield in Jodhpur and Jaisalmer districts were recoded 34.21 and 30.59 ton/ ha, respectively compared to 23 ton/ha of national average production. The introduction of locally adapted technologies and 80 days potato varieties has the potential to bring about 20,000 ha under potato and is expected to increase potato productivity by 50% in the state of Rajasthan by 2021. Adjoining State Gujarat to Rajasthan with similar agro-climatic situation has the highest potato productivity in country and cultivation of potato has changed their socio-economic profile completely.

S7O6 A655

A study on sustainable quality potato seed production in Karnataka and Maharashtra, India

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The states of Karnataka and Maharashtra produce over 700,000 tons of potato from about 55,000 ha annually with mean yields of approximately 13 tons/ha which is well below the national average of 23 tons/ha due to non-availability of quality planting material. For making small and marginal farmers self-sustainable in quality seed production, areas with low virus vector population were identified based on weekly aphid build up trend during *kharif* (monsoon) and *rabi* (winter) seasons in Chickmagalur and Chikkaballapur districts of Karnataka and Pune and Satara districts of Maharashtra respectively during 2013 to 2016 by three different methods: i) 100 leaves count, ii) yellow sticky trap and iii) yellow water pan trap. The yellow traps (sticky and water pan) attracted higher population of winged aphids due to availability of alternate host plants in the vicinity. *Myzus persicae* was recorded predominant in Karnataka and *Aphis gossypii* was principal vector in Maharashtra. The outcome of weekly aphid incidence concluded that Tarikere taluk in Chickmagalur district of Karnataka and Koregaon taluk of Maharashtra during *kharif* season and Chikkaballapur in Karnataka and Junnar in Pune, Maharashtra in *rabi* season were found suitable for healthy seed production. Low cost insect proof temporary net houses using PVC/ bamboo/granite poles was found economically viable technology for multiplying quality seed potato under protected condition where aphid build up is above thresh-hold level. Four net houses in Karnataka and one in Maharashtra gave satisfactory results for multiplying basic seed. The crop raised by farmers from seed multiplied in net houses was much superior and gave higher yield than to crop grown from seed imported from Punjab. The production of minitubers by aeroponic and further two multiplication in temporary net houses will make farmers to get locally produced quality seed at lower price than imported seed from other States. The farmers will generate more income by enhanced potato productivity.

S707 A159

Technology commercialization and incubation in horticulture: Status, progress and future strategy

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Innovative technical knowledge packaged as improved technology is the most critical input for crop productivity enhancement. Protecting such technical innovative knowledge through Intellectual Property protection and commercialization through licensing are main components of development agenda recognized world over. With ICAR adopting its Intellectual property policy by October 2, 2006, the Indian agriculture sector has moved towards the era of technology commercialization through licensing including new forms of engaging with the private sector through new models of Public Private Partnership. This paper details the technology commercialization efforts put forth under the horticulture sector. The ICAR-Indian Institute of Horticulture Research (IIHR) has emerged transferred over 100 technologies and earned an up-front technology transfer fee of over Rs 8 crores in the last eight years since the inception of technology transfer policies. Through the World Bank funded NAIP and subsequent NAIF, technology commercialization has also imbibed technology incubation and handholding support for encouraging budding Horti-preneurers. IIHR has successfully assisted establish and support five business entrepreneurs scale up their horticultural technology based businesses.This paper highlights the unique experiences under horticulture sector in the form of enhanced public to public and public to private sector partnerships, increased awareness regarding IP protection as revealed by the number of patents filed and increased awareness towards technology incubation and scaling up. Critical examination of the case brings forth the need for appropriate policy support for taking forward the technology commercialization towards setting up fully functional 'horti-business incubation centre' under the national grid of incubation facilities. The paper elaborates on a success model of setting up an Horti-based incubation facility and the critical factors for an appropriate supporting policy that ICAR needs to adopt for ensuring the successful implementation of technology commercialization and incubation ahead.

S7O8 A308

Mango cultivation in Karnataka: An Economic Analysis

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Karnataka stands fifth in India in production of mango. High Density Planting (HDP) as a technique in mango cultivation is gaining importance in the farming community. However, this needs a detailed economic investigation for advantage, if any. Mango cultivation is highly skewed towards Dharwad district in Northern Karnataka. Hence, an attempt was made to assess growth rate, cost-structure and economic feasibility of HDP versus the traditional method. Representative sampling procedure was adopted in selection of *taluks* (2) and villages (6) based on the area of concentration. Farmers were chosen randomly from the villages selected and the sample size was 60. The area under mango in Dharwad district showed 15.34% compound annual growth rate (CAGR) at the all-India level, and Karnataka showed a CAGR of 2.52%. These were significant at 1% level of probability. Total cost of

establishment was estimated at Rs. 1,84,823 and Rs. 2,98,676 per acre in traditional and High-density planting, respectively. Material costs constituted 33.73% and 28.37%, while maintenance-costs were 66.27% and 71.63% in traditional and high-density planting orchards, respectively. Similarly, maintenance cost during the bearing period (5^{th} year onwards) per acre per year was Rs. 21,783 in traditional orchards and 48,132 in HDP orchards. Average quantity of fruit produced per acre in HDP and traditional orchards was 7.48 and 3.50 tons, respectively. Payback period was lower in high-density planting (5.54 years) compared to the traditional (5.90 years). Net Present Value at 12% discount rate for the entire life of the mango (30 years) under both the systems was positive and was Rs. 4,39,117 and Rs. 1,16,032 in high-density planting and traditional orchards, respectively. Benefit:Cost Ratio was 2.00 in HDP orchards and 1.49 in traditional orchards. However, the ratio was greater than unity in both types of orchards, indicating remunerative returns per rupee invested in mango cultivation. Internal Rate of Returns (IRR) worked out to 26.00% in HDP, and 18% in traditional orchards, indicating attractive returns generation (as IRR under both the systems was above the current bank rate. Thus, our present study justifies extension and encouragement of HDP in mango cultivation.

S7O9 A708

Efficiency of Production and Export Competitiveness of Tomato, India

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Tomato production in India has increased more than four-fold from 4.24 million MT in 1991-92 and to 19.7 million MT in 2016-17 at a compound growth rate of 8.11 per cent per annum, mostly due to growth in acreage (6.1 %). Relatively higher growth in tomato production compared to other crops within the sector leads to diversifying tomato markets particularly to export market. The present paper examines the feasibility and efficiency of production and export competitiveness. Based on the data collected from 120 farmers in Karnataka it is revealed that production of summer tomato is highly profitable with a BC ratio of 2.86, which could be further raised to 3.11 if optimum time of planting is followed. However, probability of getting average net returns of Rs 3.72 lakhs/ha as realised during 2015 was only 0.22, implying high risk involved in production. Average technical and allocative efficiencies were estimated using Data Envelopment Analysis and the TE score of 0.79, suggesting scope to reduce the costs to the extent of 21 percent and still can sustain the same level of yield. The average AE score was 0.86 suggesting high degree of success of farms in achieving the best combination of different inputs in producing a specific level of output considering the relative prices of these inputs. For measuring comparative advantage, and degree of government interventions Policy Analysis Matrix was employed. Nominal protection coefficient on tradable output and nominal protection coefficient on tradable input were 0.55 and 0.71 respectively, while effective protection coefficient and protection co-efficient were 0.55 and 0.44 respectively, suggesting policy distortions in tomato production, mostly due to the subsidies on chemical fertilizers and import tariff on pesticides. At present development, there is a comparative advantage of exports of tomato especially to the neighbouring countries like UAE, Pakistan and Bangladesh.

S7O10 A158

Satisfaction level of potato contract farmers compared to non contract farmers in Banaskantha district of North Gujarat

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Contract farming in potato has gained importance in the past decade. Chips and french fries companies are now engaging closely with farmers to contract out potato production as per the required specifications to assure their raw material needs. At the same time, it also offers an assurance to the farmers of getting certain pre-fixed price and also the farmer doesn't have to bother about the market. Further, the APMC act has been amended by most states in line with the Model APMC Act with better and enabling provisions for contract farming both for the sponsor as well as the farmer. Banaskantha is the largest potato growing district of Gujarat both in terms of production and productivity. A number of potato processing companies have started contract farming operations in Banaskantha, Mc Cain, a Canadian MNC leading the way. This paper highlights the satisfaction level of potato contract farmers vis-à-vis non contract farmers in Banaskantha District of North Gujarat. The study was carried out on a sample of 100 potato growing farmers (50 contract and 50 non contract farmers). The selected contract farmers were associated with Mc Cain. The satisfaction level of contract farmers was compared with their non contract counter-parts on major parameters like productivity, price, payment time, assurance of returns, profitability and minor parameters like provision of agro advisory services including production technology, agricultural inputs, credit facilities provided etc. It was found that satisfaction level was higher among the contract farmers. All the contract farmers had assured returns. Productivity was found to be higher among contract farmers. In most years contract farmers got better prices. Payment was timely and in most cases immediate to the contract farmers compared to delayed payments in case of non contract farmers. Most of the contract farmers indicated that contract farming was more profitable compared to traditional (non-contract) potato farming owing to risk reduction of farmers by reducing uncertainty in returns they fetch from their produce.

S7O11 A197

Effect of Front Line Demonstrations on Yield Enhancement of Kachri *(Cucumis cellosus)*: A Case in Arid Zone of Rajasthan

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Kachri (Cucumis callosus) is drought hardy cucurbitaceous vegetable found growing abundantly during rainy season in the arid and semi-arid region of north-western India particularly in Rajasthan. However, the average district yield is 86.56 quintal\hectare, which is substantially lower than the national average (130 quintals\hectare). Krishi Vigyan Kendra, CAZRI, Pali- Marwar has conducted 45 Front Line Demonstrations under real farming situations between 2008-09 and 2012-13 at five different villages, namely Bhagwanpura, Dayalpura, Hingolla Kallan, Sodawas and Bittura Kallan located in

different blocks, namely Sumerpur, Jaitaran, Sojat and Raipur, respectively under KVK, CAZRI operational area. The area under each demonstration was 0.50 hectare. Through survey, farmers meeting and field diagnostic visit during the cropping period, low yield of kachari was conceived due to imbalanced use of nitrogenous fertilizer and indiscriminate practices to manage the powdery mildew disease and fruit borer. The economics and cost benefit ratio of both control and demonstrated plot was worked out. An average of Rs.73,128 was recorded as net profit under recommended practices while it was Rs. 41,788 under farmers practice. Cost benefit ratio was 3.7-4.9 under demonstration, while it was 0.8-1.5 under control plots. By conducting FLDs of proven technologies, yield potential and net income from kachri production can be enhanced to a great extent with increase in the income level of the farming community.

S7O12 IS29

Smallholder farmers' adoption of vegetable production technologies in Babati District, Tanzania

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Agricultural technologies has helped to increase crop yields and incomes, particularly during the green revolution era in Asia and some parts of Sub-Sahara Africa. However, adoption of yield enhancing technologies in the vegetable subsector is still low particularly within smallholder farms. The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program has tested and promoted the adoption of external low-input strategies such as (1) using good elite seeds and healthy vegetable seedlings (2) inorganic fertilizers (3) good agronomic practices - GAP (e.g., mulching, timely weeding, timely planting, organic manure, intercropping, crop rotation) (4) integrated pest management-IPM (chemical control and biological-using trap crops). Using 310 farm households sampled from five villages, we use both qualitative and quantitative methods to describe the dynamics of farmers' adoption of vegetable technologies and analyze factors influencing the choice of flagship technologies in Babati District in Manyara region, Tanzania. Findings show that farmers adopt the technologies that are convenient to them and the decision to use them is influenced by various socio-economic factors. We subsequently proffer policy-related recommendations that current and future scaling programs may consider to increase the adoption and sustainable use of vegetable production technologies among smallholder farmers to address food and nutrition insecurity challenges in developing countries.

S7O13 A569

Impact of technology dissemination on livelihood promotion through floriculture

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Technology dissemination refers to the spread of new ideas and proper technology from originating source to ultimate users i.e. farmers. Available agricultural technology is of no use till it reaches its ultimate users. Research, technology dissemination and the users, these three units are necessary for creation, dispersion and use of innovative knowledge. Commercial floriculture is a recent development in Madhya Pradesh which is gaining momentum spire the last few years. In quest for socio economic development of small and marginal farmers, floriculture has emerged as prominent and an attractive sector of agriculture in Indore district of Madhya Pradesh. The scope of floriculture in Madhya Pradesh has increased tremendously, which is evident from the increase in area from 1387 ha in 1999-2000 to 15610 ha in 2011-2012 and production from 833 tons to 150670 tons during the same period. Major flower crops being grown in this area are Marigold, Gaillardia, Chrysanthemum, Annual chrysanthemum, Tuberose, Desi rose and Gladiolus under open field condition. It was possible to find out the reason behind low productivity and quality of flower through regular survey, farmers meetings and field diagnostic visits. The major cause of low productivity and quality of flower yield was due to indiscriminate and irregular use of inorganic fertilizers, no use of micronutrient and biofertilizers in chrysanthemum, no pinching in marigold, cutting of gladiolus spike at ground level, unavailability of quality seed material, no use of proper plant protection measure etc. To combat these causes, Krishi Vigyan Kendra, Kasturbagram was successfully attempted and established the Linkages between scientist-extension functionaries and farmers to disseminate the proper technologies and ideas to enhance the area, production and productivity, consequently enhance the income and livelihood of flower growing community.

Poster Papers

Session –I

Global Scenario

(Production and Consumption, Trade, Marketing and Policy Issues, Nutrition and Health)

S1P1 A 512

Neuroprotective medicinal plants

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Neurological disorders are estimated to affect as many as one billion people worldwide. Increased life expectancy has resulted in a demographical transition from predominantly youthful population to older ones, causing increase in neurological disorders such as Alzheimer's and Parkinson's disease. A number of synthetic drugs are used against these neural disorders, but most of them have ill effects on health. Hence, the use of herbal drugs is resorted to, which are safe and cost effective. Herbal drugs are plant-derived compounds that act in the same or opposite way, as the neurotransmitters do in the body system. Herbals drugs offer an unexplored potential in terms of their efficacy, functionality and are more preferred due to fewer side effects. *Ginkgo biloba* is an ancient tree cultivated and held sacred by the Chinese for its health promoting properties. A study reported about the effect of *Ginkgo biloba* extract (GBE) on the memory of mice showed that the co-administration of TMT (Trimethyltin) with GBE significantly improved the decrease in memory loss. *Bacopa monnieri* has been used for centuries in Ayurvedic medicine, either alone or in combination with other herbs as a memory and learning enhancer, sedative, and anti-epileptic. *Mucuna pruriens,* a popular Indian medicinal plant has been used for long in traditional medicine for diseases including Parkinsonism. *Centella asiatica*used as a brain tonic in Ayurvedic medicine, has central nervous system effects such as rejuvenation and memory enhancing property. Some other neuroprotective medicinal plants are *Panax ginseng, Withania somnifera, Papaver somniferum* and *Hypericum perforatum.*

Neuroprotective medicinal plants show a wide range of biochemical and phenological action such as anti-oxidant activity, free radical scavenging activity and neurotransmitter effect.

S1P2 A583

Homestead utility of microgreens to manage nutritional deficiencies

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The spectrum of life in terms of income, life style and spending is changing rapidly with economic development in India. However, diet related diseases such as obesity, diabetes, cardiovascular disease, hypertension, stroke and cancer are escalating both in developed and

developing countries, in part due to imbalanced food consumption patterns. In developing countries like India, 13.5% people are chronically undernourished with Western-Asia and Sub-Saharan Africa, the most severely affected regions. Global Hunger Index of 35.0 to 49.39 reflects the multidimensional nature of hunger in India with four indicators like undernourishment, child wasting, stunting and mortality.Microgreens represents a new group of edibles highly concentrated with various bio-active compounds like vitamins, minerals, antioxidants etc., compared to their mature counterparts. Microgreens are very very specific type of seedlings of edible vegetables, herbs or other plants, ranging in size from 5 to 10 cm, which provide vivid colours for plate presentation and garnishing with characteristic hidden tangy flavours. Thus, microgreens present a way forward to manage nutritional deficiencies being observed in one and other sections of population particularly in children of our country. Microgreens not only have potential to bring healthy change in nutritional status of rural, urban and peri-urban population but could be good source of earnings for youth particularly in urban and peri-urban areas of the country. The higher level of antioxidants, minerals etc., in microgreens may be helpful to deal with oxidative stress. There are more than 25 microgreens commercially grown all over the world, which can easily be raised indoor or outdoor by using available resources. Inclusion of such edibles in Mid-day meal programme could be instrumental in improving the nutritional status of school age children nationwide.

S1P3 A606

Fruits and vegetables as functional foods for human health

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Fruits and vegetables are our traditional food. These are well known for their enriched amount of vitamins, minerals and fiber along with supplying bioactive components to the human diet. Health benefiting property of fruits and vegetables neautraceuticaly, besides fulfilling energy requirements tags them as functional foods. These foods are directly and indirectly involved in proper growth and disease resistance of human body. For instance, considering the major vitamins, fruit and vegetables like pumpkin, carrot, mango, papaya, beet root, sweet potato, green leafy vegetables are rich in vitamin A which combat diseases like blindness, kidney stones etc. Similarly, beans, papaya, banana, green leafy vegetable are rich in vitamin B, lowering the risk of beriberi, skin disease etc. In case vitamin C deficiency disorders, Barbados cherry, aonla, chilli, tomato serves the purpose for our body by combating diseases like scurvy etc. vegetables like green onion, brussels sprout, broccoli, cabbage are rich in vitamin K, and minimizes hemorrhagic tendencies. Accounting minerals fruit and vegetables like date, fig, fenugreek, mint, karonda, beans are rich in iron lowers the risk of anaemia. Cabbage, cauliflower, Chinese cabbage, drumstick rich in calcium which is very helpful to prevent bones related disease. Fiber rich fruits like fig, date, guava, okra, gaur, are responsible

for resistance of our body towards gut diseases controlling digestion and bowl moments of body also reduces risk of colon cancer etc. Apart from these fruits and vegetables are very good source of bioactive compounds like anthocyanin, carotene, lutein, lycopene, betalains, phenols, antioxidants, flavonoids which uplifts body resistance mechanism and prevents disease like cancer, cardiac and neurological disorders. Horticultural crops have a wonderful combination of these various bioactive compounds within them, their adequate consumption results in proper growth and maintenance of human health. Horticultural crops act as functional food and serve the purpose of nutritional security to the growing population.

S1P4 A59

Emerging trends of citrus cultivation in North-Western region of India

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In North-West sub-tropical region of India, citrus occupies major area among fruit crops. With the inception of national horticulture mission (NHM) and other initiative to diversify existing cropping systems in 2005-06, the area under all fruit crops increased significantly with maximum increase under citrus fruits particularly K*innow* mandarin. The total fruit crop area in this region is 2,10,000 hectare and among this area citrus occupies 96,000 hectare which accounts for approximately 46 percent of total fruit crop area. In 2005-06, citrus was cultivated on 49,000 hectare and in one decade the area under this fruit crop is doubled. In Punjab, the major kinnow producing state, the area under citrus has been increased from 26046 hectare to 51883 hectare, while, in Haryana, there was about 3.75 times increase in area under citrus as it was only 5401 hectare in 2005-06 and it is 19652 in 2015-16. Similarly, in Jammu region of Jammu and Kashmir, there was also marginal increase from 10867 to 14369 in last decade. Among citrus, *kinnow* mandarin occupies more than 90% area of total citrus fruits. The citrus is expanding in South-Western region of Punjab comprising Fazilka, Mukatsar, Bathinda, Faridkot district and Hoshiarpur district in Northern Punjab. In Haryana, The distrcts of Sirsa, Fatehabad, Bhiwani, Hissar and Narnoul recorded significant increase citrus cultivation area. The North-Western districts of Sri Ganganagar and Hanumangarh are also emerging as high quality kinnow producing belt of Rajasthan state. In Jammu, region the districts of Rajouri, Kathua, Jammu, Reasi, Udhampur and Samba recorded increment in citrus during last decade. Under diversification in existing cropping pattern, the fruit cultivation may be the best option and among fruit crops, the cultivation of citrus may be the best option owing to its economic viability in comparison to traditional cropping system and other fruit crops.

S1P5 A87

Colored sweet bell peppers (*Capsicum annuum* L.) as an important dietary source of β-carotene and ascorbic acid

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Vitamin and mineral deficiencies are prevalent in human populations throughout the world. Fruits and vegetables are an important dietary source of many of the vitamins and minerals required by humans. Plant carotenoids, such as β-carotene are precursors of Vitamin A biosynthesis and provide a major source of Vitamin A to human diets. Vitamin A deficiency affects hundreds of millions of pre-school age children in low income countries. Fruits of coloured sweet pepper (*Capsicum annuum* L.) can be a major dietary source of precursors to Vitamin A biosynthesis, such as β-carotene. In this investigation, 11 diverse open-pollinated and red fruited (Tara, 7/4, Santa, Aditi, 8/4 and Baby Bell), orange fruited (C/4-orange) , yellow (Ayesha, Arya and C/4-yellow) and green fruited (Green Wonder) genotypes of sweet pepper were evaluated consecutively for different fruit yield components and β-carotene and ascorbic acid contents of marketable maturity stage. The highest total soluble solids content (9.76 °Brix) was obtained in the genotype, 8/4, a red fruited genotype followed by 8.61°Brix in Tara, a red fruited genotype, while the lowest total soluble solids content (6.53 °Brix) was recorded in the genotype Baby Bell, a red fruited genotype. Significant differences were found among the genotypes for ascorbic acid content of the mature fruits. The highest ascorbic acid content (99.04 mg / 100 g fresh pulp) was obtained in the genotype, Green Wonder, a green fruited genotype followed by 91.23 mg/100 g fresh pulp in Tara, a red fruited genotype, while the lowest ascorbic acid content (50.09 mg/100 g fresh pulp) was recorded in the genotype Ayesha, a yellow fruited genotype. β-Carotene content was lowest in fresh fruit that were yellow or orange at harvest and was highest in red-fruited genotypes. The highest β-carotene content (0.56.77 mg / 100 g fresh pulp) was obtained in the genotype, Tara, a red fruited genotype followed by 0.52.75 mg/100 g fresh pulp in Aditi, a red fruited genotype, while the lowest of 0.19.06 mg/100 g fresh pulp) was recorded in the genotype C/4- Yellow, a yellow fruited genotype

S1P6 A198

Microgreens : An emerging option for nutritional security

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Microgreens (red amaranth, broccoli, cress, kale, dil, raddish, pea, sorrel etc.) are a new class of edible vegetables; very specific type which include seedlings of edible vegetables, herbs or other plants, ranging in size from 5 to 10 cm. They are older than "Sprouts" and

younger than “Babygreens”. Microgreens have higher levels of phytonutrients like vitamins C, B_9 and K_1 and the carotenoids compared to mature leaves. So, microgreens can be referred as ‘functional foods’ which have health promoting or disease preventing properties. As the spectrum of life in terms of income, life style and spending is changing rapidly with economic development leading to major challenges concerned with several nutritional deficiency related diseases. In developing countries like India, 13.5% people are chronically undernourished. Diet-related diseases such as obesity, diabetes, cardiovascular disease, hypertension, stroke, and cancer are escalating both in developed and developing countries, in part due to imbalanced food consumption patterns. In present situation, the availability of fresh and pesticide residue free vegetables for consumption are becoming scarce. Hence, the microgreens will be a better option for nutritional security because it can be easily grown in urban or peri urban areas where land is often a limiting factor. It has very short growth cycle, can be grown with or without soil and external inputs like fertilizers and pesticides are completely avoided.

Session –II
Genetic Improvement
(Plant genetic resource management, Conventional breeding, Biotechnology)

S2P1 A23

Geneticvariability and correlation studies in sponge gourd (*Luffa cylindrica* Roem)

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The performance, genetic variability, heritability, genetic advance, correlation and path analysis for yield and yield contributing characters viz., vine length (cm), number of primary branches, number of fruiting nodes on main stem, days to anthesis of first male flower, days to anthesis of first female flower, days to 50% flowering, span of flowering, sex ratio, node number at which first female flower appeared, days to maturity, average fruit length (cm), average fruit diameter (cm), number of fruits per vine, average fruit weight (g), number of seeds per fruit and 100 seed weight (seed index) of 45 sponge gourd genotypes were studied. Significant variations were observed for all the characters in all the genotypes used in the experiment. Highest genotypic and phenotypic variations were observed for number of fruiting nodes followed by number of primary branches, number of fruits per vine, yield per vine and sex ratio. Number of fruiting nodes on main stem, yield per vine, number of primary branches, number of fruits per plant and node at which first female flower appeared showed high heritability with high genetic advance. Total yield per vine was positively and significantly correlated with number of fruits per plant, number of fruiting nodes on main stem, number of seeds per fruit, number of primary branches, fruit weight, fruit length and seed index. Path coefficient analysis revealed that number of fruits per plant, fruit weight, sex ratio, fruiting nodes on main stem, seed index, days to first female flower appearance, number of seed per fruit and span of flowering showed positive direct effect on yield per vine, hence, selection for these traits for improving yield per vine in sponge gourd is suggested.

S2 P2 A42

A new promising lemon type seedless citron mutant identified

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Citrus, comprised of many cultivated and wild species is indigenous to India. Citron (*Citrus medica*), is an important species originated in India and presumed to be progenitor of acid lime (*C. aurantifolia*), Assam lemon (*C. limon*), Ada jamir (*C. assamensis*), etc. It is generally seeded oblong fruit having 12-20 seeds/fruit. At ICAR-CCRI a seedless citron renamed as 'CCRI Seedless Citron' has been identified. It is a bud sport developed through natural mutation identified in promising NRCC Citron-2 accession, which is seeded (12-16

seeds/fruit) lemon type citron. At maturity it attains a very attractive uniform yellow colour. The average fruit weight is 130-150 g with 85-95 mm fruit length, 50-55 mm fruit diameter and 1.5 to 2.5 mm axial diameter. Rind thickness of fruit ranges from 4.5 to 6 mm and 11-12 segments/fruit are observed. It contains 32-35 % juice having 4-5% acidity and 7-8°Brix TSS. Fruit quality was excellent with very strong aroma liked by consumers. It is early type, fruits mature in 120-130 days in comparison to acid lime which mature in 160-170 days. No new insect pest and diseases were observed on this variety. This is also having higher flavonoids content, particularly flavonones. The total phenol content was 8.2-8.4 mg/100ml. The TEAC (Trolox equivalent antioxidant capacity) was also high in this new mutant. It has high antioxidant potential with FRAP values ranged from 2.2-2.5 mmol Trolox L^{-1}.

S2 P3 A50

Multivariate analysis of fruit quality traits of brinjal (*Solanum melongena* L.)

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Highly significant differences among the genotypes were observed for total sugars, vitamin-C, anthocyanin in the peel, total phenols and DPPH free radical scavenging capacity for the two factors *viz.*, genotypes (G) and season (S) and their interaction (G x S). Paired t-test also confirmed the seasonal differences for all the fruit quality traits. First four Principal components (PCs), cumulatively contributing 74.4% variation, were selected. The first PC contributed 27.9% variation and was highly loaded with total phenols, vitamin-C and DPPH free radical scavenging capacity. TSS and total sugars; total phenols and DPPH free radical scavenging capacity; and moisture content and vitamin-C were significantly positively correlated pairs. Vitamin-C had a significant negative association with total phenols and DPPH free radical scavenging capacity. Anthocyanin in the peel and DPPH free radical scavenging capacity were also negatively correlated. It was quite difficult to differentiate the local cultivars and breeding lines/varieties based on these characters. No outlier was found and the genotypes *Kalo Makra*, BCB-123 and KS-8103 had the maximum distance from the centroid indicating their diverse nature.

S2 P4 A51

Storage of cassava (*Manihot esculenta* Crantz.) pollen under low temperature conditions

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Improvement of cassava through breeding is difficult because of monoecious, protogynous, non-synchronous, poor and irregular flowering. This makes necessary to store the pollen from male parents for later pollination. The objective of the storing cassava pollen is to maintain their germination, vigour and genetic integrity by providing the optimal conditions to preserve the genetic material for the future use. The international transfer of germplasm in the form of stored pollen is not generally restricted, which facilitates the easy exchange of genetic material between the nations. Hence, the study on storage of cassava pollen was undertaken. Pollen was collected from male flowers between 9.00 AM and 11.00 AM from cassava variety *Sree Padmanabha* (SP) and *Vellayani Hraswa* (VH) and was cryopreserved. Pollen viability was tested by acetocarmine staining, *in vitro* germination and field crossing with the desirable female parent after 45 days. The results showed that 45 days of storage in liquid nitrogen, the pollen staining was 59.1% and 63.9 % while pollen germination was 49.5% and 51.0 % in SP and VH respectively in the laboratory assessment. Hand pollination was carried out in the field using cryopreserved pollen and the normal fruit set was observed. These findings will form the base information in helping the breeders to plan hybridization programme in cassava and easy conservation and exchange of the elite germplasm.

S2 P5 A98

Photosynthetic efficiency and light saturation points in *Citrus* spp.

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Citrus is one of the important fruit crops in India. It is 3rd most important fruit crops after Banana and Mango. NEH region of India is considered as the natural source of many Citrus spp. and large variability found in Citrus. However, very little information is available regarding the photosynthetic efficiency of different Citrus spp. grown in different agro-climatic

region of the country. Therefore, the present study were undertaken to know the photosynthetic efficiency of different cultivars of Citrus spp. grown in main Citrus belt in Central India. Various physiological parameters such as chlorophyll content, relative water content (RWC), cell membrane stability index (CMSI) and drought injury index (DII) along with light saturation points (LSP) were determined in selected commercial Citrus spp. *viz*., NRCC galgal-1, Flame grapefruit, NRCC grapefruit -6, Seedless N-4, Pummelo-5 and NRCC Acid lime-8. Among the selected *Citrus* spp., the total chlorophyll content was higher in NRCC Grapefruit (8.44 µg ml^{-1}) followed by NRCC Acid lime-8 (8.10 µg ml^{-1}) and Flame grapefruit (7.65 µg ml^{-1}). The CMSI was recorded higher in NRCC Acid lime-8 (93.56 %) followed by Seedless N-4 (91.71 %) and NRCC Grapefruit (90.00 %). Moreover, DII was observed higher in Galgal (58.16 %) followed by Pummelo-5 (39.47 %) and Flame grapefruit (37.51 %), whereas RWC was showed higher in NRCC Acid lime-8 (83.76 %) followed by Seedless N-4 (82.80 %) and NRCC Grapefruit (80.83 %). The LSP of different selected Citrus spp. are as mentioned: Galgal- at 800 PAR (Photosynthetically Active Radiation), Flame grapefruit- at 1000 PAR, Seedless N-4- at 1200 PAR, Pummelo-5 – at 1000 PAR, NRCC Grapefruit- at 1200 PAR and NRCC Acid lime-8 – at 1200 PAR. Among the selected *Citrus* spp., NRCC Acid lime-8 was found higher LSP and drought tolerant characteristics.

S2 P6 A180

Heliconia – A speciality flower crop for landscape use

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Evaluation of Heliconia varieties was done at Department of Floriculture and Landscaping, College of Horticulture,Vellanikkara, KAU in order to select suitable varieties for potential landscape uses and commercial purposes. Fifteen varieties viz;*Heliconiastricta*–Bucky, *Heliconiabihai* – Emerald Forest,*Heliconiabihai*Kamehameha**,***Heliconiabihai* – Island Yellow,*Heliconiapsittacorum*–Halloween,*Heliconiapsittacorum* -Sassy pink,*Heliconiabihai X HeliconiaCaribaea* **–** Hot Rio Nights**,***Heliconiabihai*x, *Heliconia*caribaea- Yamakawa-Chocolate,*Heliconiarostrata, Heliconiachartacea* - Sexy Pink, *Heliconialongissima* -Red wings,*Heliconiaorthotrica* - Oriole Orange,*Heliconiaorthotrica* -Orange Marmalade,*Heliconiaorthotricha* - Macas pink and *Heliconia imbricata x latispatha*-José Abalo were evaluated. Variety Red wings was superior in terms of vegetative characters like plant height and plant spraed where as maximum number of suckers were observed in variety Oriole Orange. Among the varieties evaluated,Halloween, Red wings, Hot Rio nights, Kamehameha and Emerald Forest were identified as tall varieties and can be used for screening purpose. Oriole Orange, Orange Marmalade, Bucky were varieties of medium height and can be recommended as pot plants and corner planting. July –November was observed to be the main flowering season in all the varieties and free flowering was observed in varieties Orange Marmalade, Bucky, Red Wings and Island Yellow.Nature of inflorescence was erect in all the varieties evaluated except in varieties*Heliconiarostrata,Heliconiachartacea* - Sexy Pink

and*Heliconialongissima* -Red wings in which pendent type inflorescence was noticed.Vase life was highest in varieties Emerald Forest, Jose Abalo, Kamehameha, Halloween, Island Yellow and Oriole Orange.Emerald Forest, Kamehameha, Halloween and Island Yellow can be recommended as cutflowers for export purpose where as Bucky, Oriole Orange,Orange Marmalade, Sassy Pink,Hot Rio Nights and Yamakawa Chocolate can be recommended as cut flowers for local market. All these varieties were also identified as excellent for flower arrangements and bouquet making.

S2 P7 A262

Establishment of hairy root cultures of *Coleus forskohlii* for the production of forskolin

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Hairy root cultures of *Coleus forskohlii* were established from leaf explants of *in vitro* grown *C. forskohlii* plants upon infection by *Agrobacterium rhizogenes.* The effect of Agrobacterium strain, inoculation conc, time of co-cultivation, presence of antibiotic, growth regulators, strength of the medium, incubating conditions, state of the medium were determined for the production of forskolin. The optimization of *A. rhizogenes* inoculation, medium parameters etc are prerequisites for selection of high-producing organ clones with enhanced biomass and increased accumulation of secondarycompounds.

S2 P8 A281

Analysis of core collection of red onion germplasm at ICAR-DOGR

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Diverse genetic materials are required to meet the ever changing demands of plant improvement. Diversity in onion species occurs in the form of land races, traditional varieties, wild edible forms and related non-edible wild and weedy species. ICAR-Directorate of Onion and Garlic Research has been identified as a National Active Germplasm Site (NAGS) for onion and garlic germplasm collection and conservation in the country. Extensive germplasm surveys have been done in Maharashtra, Karnataka, Gujarat, Madhya Pradesh, Andhra Pradesh, Orissa, Rajasthan, Tamil Nadu, Chhattisgarh, Bihar, West Bengal, Sikkim, Arunachal Pradesh, Assam, Leh and Ladakh in collaboration with ICAR-NBPGR. A genepool of dark red, light red, white and yellow onion types has been collected. A total of 1229 germplasm accessions are being maintained at ICAR-DOGR consisting of 225 (dark red), 372 (light red), 309 (white), 35 (yellow), 8 (rose type), 59 (multiplier type), 139 (lines of 28 *Allium* species) and 82

(exotic).Among these germplasm**,** red onion accessions evaluated for three or more years in each of three seasons were grouped to form core sets. A total of 131 *kharif* onion accessions, 150 *late kharif* onion accessions and 237 *rabi* onion accessions used for core analysis. As year x accession interaction was non-significant, data averaged over years were used in analysis. Heuristic approach of 'Powercore' was used for formulating core set. MD% of all three sets ranged between 7 to 11%, which showed that there was no major difference in mean value of core set and entire set. VD% indicated that variance of core set was different from entire collection. CR was nearly 100% indicating that core had captured all the variability of basic collection. VR% showed that coefficient of variance of core sets was higher than entire collection. This season-wise core sets can serve as variable material for screening/evaluation of germplasm for various characters.

S2 P9 A298

Characterisation of Asiatic lily genotypes for flowering and quality parameters under protected condition

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The present investigations were carried out in the experimental block of the department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere, Chikmagalur, Karnataka during 2014-15, to characterize the Asiatic lily genotypes for flowering and quality of cut flowers under naturally ventilated polyhouse. The days taken for flower bud emergence were significantly differed among all the genotypes of Asiatic lily. The genotype Telisker was the earliest to show colour by taking (35.00 days) whereas, Ercolania (48.67 days) was late for expressing colour in its flower. The genotype Pirandeu was the earliest to show colour by taking minimum number of days followed by Telisker. The genotype Merluza (19.51 cm) followed by Courier (19.34 cm) produced significantly bigger sized flowers than any other genotypes. The genotypes viz., Pirandeu, CEB Dazzle, Dazzle, Courier, Pavia and Tresor recorded maximum number of spikes per square meter(24.00) while, the genotype Batistero recorded the minimum number (16.67). The genotype Pirandeu extended its vase life maximum up to (12.37 days) and found significantly superior over other genotypes and it was found to be on par with Pavia (12.17 days) whereas, the minimum number of days was recorded in Navona (7.73 days).

S2 P10 A315

In vitro conservation of RET medicinal plants: challenges and prospects

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Tissue culture techniques allow propagation of plant material with high multiplication rates in an aseptic environment. Virus-free plants can be obtained through meristem culture in combination with thermotherapy to ensure production of disease-free stocks and simplify quarantine procedures for international exchange of plant germplasm. This miniaturization of plants allows reduced space-requirements and considerable saving in labour-costs for maintenance of germplasm accessions. When one method of conservation is subject to unavoidable hazards, as with FGBs, an alternative method should be used as a back-up conservation method. The role of *in vitro* conservation techniques in the overall conservation strategies should complement other conservation strategies within the overall program of a given crop, accession cluster, species or population. Methods should be carefully chosen taking into account feasibility, practicality, economy and security of the material to be conserved. *In vitro* collections of species can be maintained at the same site or a separate site, but should have clear linkages with field gene banks. For rare, endangered and threatened (RET) species on the decline, *in situ* conservation may not offer adequate support. Biotechnological interventions supports *ex situ* conservation, besides complementing the conventional methodsalready in use, have a potential to broaden genetic base of species of high priority. Protocols for conserving plant diversity for 22 RET species of medicinal plants have been optimized. Some important ones,viz.,*Aegle marmelos, Embelia tjeriam-cottam, Holostemma adakodien Kaempferia galanga* and *Rauvolfia serpentina* are established *ex situ.* Attempts have been made to micropropagate these very important endangered plant species distributed over South India. These micropropagated plants were successfully field-planted after hardening under glasshouse, with varying survival rates recorded in different species. Slow-growth was tested under Reduced Culture Condition (RCC) involving light and temperature. Vitroplants could be conserved for 6-12 months at 10^0C and for six months under SCC(Standard Culture Condition) before the first sub-culture, depending upon the species. Protocols developed for large-scale propagation and *in vitro* conservation will be discussed.

S2 P11 A332

Identification of male sterility, its inheritance and fertility restoration in ridge gourd [*Luffa acutangula* (Roxb.) L.]

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Ridge gourd [*Luffa acutangula* (Roxb.) L.], also known as 'angular loofah' or 'fluted loofah', is an important vegetable in the tropical and subtropical countries, especially in Asia (in India) and Africa. It is a cucurbitaceous vine crop grown for immature fruits rich in dietary fibre and minerals. Ridge gourd is characterized by diverse sex-forms, viz., monoecious, androecious, gynoecious, gynomonoecious, andromonoecious and hermaphrodite types, with the predominant form being monoecious. Female flowers are solitary, whereas the male flowers are produced in racemes. Male sterility is of practical importance in breeding vegetables, as, it facilitates F1 hybrid seed production without the need for hand-pollination. Male-sterility in ridge gourd was first reported from India by Deshpande *et al*., (1979) and then, by Pradeepkumar *et al*. (2007). At ICAR-IIHR too, male-sterile plants were observed in two germplasm lines, viz., IIHR-12ms and IIHR-28ms, characterized by the presence of rudimentary male flowers that do not open, and fall off at 12-16 days after emergence. These *ms* plants were crossed with monoecious lines to study inheritance of the male sterility and to restore fertility in ridge gourd. Results of our study indicate that male sterility in ridge gourd is of the CGMS type, and, a single, dominant fertility-restorer gene restores fertility in the presence of the sterile cytoplasm.

S2 P12 A342

Assessment of bolting status in garlic using molecular marker

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Garlic (*Allium sativum*) cultivars are mainly sterile and propagated only vegetatively. Recently, many fertile garlic genotype in have been found in Central Asia and studied for flower morphology, restoration of flowering and fertility by manipulation of the environment, and flower-development in the bolting garlic. The present work aims to identify bolting in garlic clones using a molecular technique and to screen the available germplasm lines. Among various attributes in garlic, the bolting habit has been a primary characteristic used for classifying garlic clones. Mitochondrial-DNA based bolt markers were used for screening 32

accessions of diverse geographic origin. Amplification of bolt marker (length ∝1.4kb)was observed in all theaccessions, meaning that all the 32 accessions have aninherent ability for bolting, and need intense winter to be imposed on them. Our results were confirmed by amplifying a second, reliable mitochondrial-DNA based marker (length ∝ 3.7kb); but, due to non-synchronizationseen in the banding pattern, the entire population could be classified into four groups as per clones showing amplification of both markers, or absence of both markers, or presence of one of these. Sixteen accessions showed amplification of both the markers as these may have a chimeric gene arrangement (Ipek *et al*, 2007). Owing to the significant association of *bltm* with bolting, the present marker can be used for discriminating, molecularly,the completely-bolting clones reliably from the non-bolting or the incompletely-bolting ones. The bolter clones identified can be grown in hilly regions, as, the winter induces top-set or flowers in few clones of garlic. This is the first step in identifying short-day bolted garlic in India to stimulate their inherent flowering capacity.

S2 P13 A355

Performance study of onion (*Allium cepa*L.) varieties for quantitative traits in northern dry zone of Karnataka

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An investigation was conducted to ascertain the production potentials of different genotypes of onion*(Allium cepa*L.) were carried out in Main Horticultural Research and Extension Centre, University of Horticultural Sciences, Bagalkot during 2016. Experiment was conducted with nine different varieties of onion. Among them, growth parameters like, more numberof leaves were observed in ArkaBindu (12.62), highest plant height is seen in ArkaBheema (59.12cm) and the highest leaf length reported in Arka Kalyan (50.37). Number of rings- the highest is seen in Arka Pragati (10.50) and lowest in Arka Kalyan (7.70). TSS was found highest in ArkaKeetiman (14.70 ° B). Among yield parameters, bulb weight was the highest in Arka Pragati (212.62 g), total weight was reported highest in Arka Pragati (12.75 kg). Thus, onion is an important crop with many medicinal values, it has good yield and quality attributes. Thus identification of promising varieties as a commercial crop for the area with high yield and quality fruits would help the farmers in its adoption and improving their economic status.

S2 P14 A415

Characterization of *bael* accessions for morphological and fruitcharacters

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Bael (*Aegle marmelos* Corr.) is one of the important, underutilized fruits of Indo-Malaysian origin. It is known in India from the prehistoric times and finds mentioned in our ancient system of medicine. The importance of *bael* fruits lies in its curative, pesticidal and nutritive properties. A wide range of diversity in*bael*is found all over the Indian subcontinent. Some superior genotypes known to the locals are on the verge of extinction, and there is an urgent need to conserve these for use in posterity. Therefore, several collections of *bael* were made from areas with high variability from Maharashtra, Andhra Pradesh, Karnataka and Northern India to identify superior genotypes for various useful traits. These accessions were planted for characterization and conservation. Of these, 73 accessions were characterized for different traits. A large variability was seen in these accessions with respect to plant size, plant stature, leaf and flower / fruit characters. Plants collected from Andhra Pradesh and Karnataka exhibited the upright growth-pattern, while the other accessions were of the spreading type and short in stature. Leaves of all the accessions were trifoliate but leaf length varied from 2.52cm to 10.47cm. Collections from Maharashtra and Northern India had larger leaves while those from Karnataka and Andhra Pradesh had smaller leaves. Fruit weight range from 20g to 726g, and fruit shape varied from round to flattish-round to oblong. Fruit yield ranged from 1.0kg to 30.0kg per tree. Fruit colour was ash-green to light-yellow, while pulp colour varied from yellowish-white to pale yellow. Small-fruited accessions showed no fruit-cracking, while, 20 to 40 percent fruit-cracking was noticed in the large-fruited accessions. Promising accessions may be further evaluated and lines with specific traits such as cracking-tolerance may be used in breeding programmes in the future.

S2 P15 A416

Identification of thornless lines of Governor's plum (*Flacourtia indica*) from a segregating population

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Governor's plum (*Flacourtia indica*) is an indigenous, underutilized fruit of the tropical region. Plants of several species of the genus *Flacourtia*are found growing wild in the Western Ghats and other regions of peninsular India. It is a bushy shrub / small tree with a spiny trunk, and

branches that may grow up to 2.5m in height. Fruits are bright dark-red, 1-2 cm in diameter, sweet, edible and can be eaten raw or stewed. They have a high potential for processing into jams and jellies. Ripe fruits are often dried and stored as food. Presence of thorns is one of the major hurdles in commercializing this crop. Thus, seeds of thorny plants of Governor's plum were collected, sown and seedlings were planted to observe segregation of the thorniness trait in the next generation. No significant difference was seen in growth or leaf characters of the plants. In all, 38.88% of the plants were thornless, while, the rest were thorny. Further, just 12.5% of the female plants were thorny, while 100% of the male plants were thorny. Characterization of these individuals revealed that one plant (0106BDN) was superior to the rest with respect to yield and fruit quality. It was a thornless female plant, with an average yield of 15kg per year at seven years of age. Fruits were dark red in colour, 1.7g in weight, with total soluble solids (TSS) of 14.0^{o}Brix. This plant has been identified and multiplied for further evaluation.

S2 P16 A434

Ultra-dry seed storage as a cost-effective technique for germplasm conservation in horticultural crops

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The concept of ultra-dry seed storage eliminates any requirement for refrigerated storage, as, seeds in storage here contain very low water (moisture)level (2-5%).However, before committing valuable germplasm to storage at such low seed-moisture level, potential benefits/ risks of ultra-drying on seed-longevity should be evaluated (as, some reports indicate that drying seeds to a very low water content damages them. In our study,seedsfrom 21 important horticultural crops were dried to three moisturelevels, viz., (i) Recommended, (ii)Low (lower than recommended), and (iii) Ultra-low, using zeolite beads. These were then packed in sealed polythene-lined aluminium pouches and placed under(i) Ambient or (ii) Controlled temperature (15^{0}C). Seed quality parameters were recorded at 6-month intervals. Irrespective of the moisture content, seed quality was unaffected for 18-24 months, under controlled or ambient temperatures, in the following crops: tomato, eggplant, ridge gourd, onion, coriander, watermelon, pumpkin, bottle gourd, bitter gourd, okra and pea. Seeds with low moisture levels maintained the original seed quality in all the crops tested at 18-24 months of storage. Ultra-low moisture had a positive effect in chilli, bitter gourd, *Amaranthus* and China aster, compared to that under the recommended moisture levels at 18-24 months of storage under controlled or ambient temperatures. But, in Frenchbean, cowpea, dolichos and papaya, ultra-low moisture caused significantly reduced germination. In okra and *kalmegh*, it induced hard-seededness. Seeds with recommended moisture levels were as good as those with low moisture in all the crops excepting amaranth, chilli, bitter gourd and China aster up to 18-

24 months of storage under ambient temperature. In amaranth, chilli, bitter gourd and China aster, seeds with recommended moisture level showed a decline in germination and vigour, compared to seeds with low and ultra-low moisture under ambient temperature at 18-24 months of storage. However, seeds at 15^0C storage showed no decline in viability or vigour. Studies on biochemical and molecular changes in ultra-driedseeds of chilli, onion, tomato, brinjal, Frenchbean and papaya using isozymes and DNA markers revealed no variation from those stored at normal moisture level, except forFrench bean where ultra-dried seeds showed variation in enzyme and DNA profiles compared to seeds with low- or normal- moisture, due to loss of viability.

S2 P17 A444

Micropropagation of triploid seedless watermelon: Feasibility assessment

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Presence of crunchy seeds dispersed in the flesh of watermelon fruits comes in the way of its consumption as a table-fruit, and in juice making. Seedless watermelon is preferred on account of the above limitations and commands higher consumer acceptance and a premium price. Seedlessness in watermelon is conferred by triploidy (3n). Triploid watermelon is produced by crossing a tetraploid female line with a diploid pollen parent. Low seed-yield, high seed-cost, poor germination, reduced seed-viability, weak seedlings and a low field-establishment constitute the major limitations in growing seedless watermelon, in addition to a need for raising a fresh lot of triploid seeds every time. Micropropagation technology can facilitate rapid, clonal multiplication of seedless varieties from a limited starting-material. This also side-steps the need for production of fresh seeds - season after season - by manual crossing. A protocol was optimized by us for sustained micropropagation in triploid watermelon cv. 'Arka Madhura'. This involved media optimization for *in vitro* multiplication, induction of rooting, and addressing issues of hyperhydricity and leaf senescence. Acclimatization protocol was worked out, with 80-90% success. The protocol offers multiplication potential of nearly one million plantlets per year. Watermelon is an annual crop and, hence, there is a limit on keeping micropropagated plants for long periods, compounded by its creeper habit with intertwining tendrils. With the threat posed by viral pathogens under field-conditions, the high-value triploid watermelon is recommended for protected cultivation under polyhouse during mild weather conditions on vertical training. It warrants controlled pollination for successful crop production/ fruit-set. The paper examines feasibility and scope for commercial-scale micropropagation and cultivation of triploid watermelon.

S2 P18 A482

Evaluation of zucchini varieties under high-altitude, high-rainfall areas of Coorg region in Karnataka

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Zucchini (*Cucurbitapepo*) or Summer squash is a member of the Cucurbitaceae family comes in many different varieties with a distinct shape, color, size and flavor. The delicate flavor, soft shell and creamy white flesh of summer squash is a perfect addition to any summer meal. It is a powerful antioxidant and an anti-inflammatory agent with lot of vitamin C. An experiment was conducted at Central Horticultural Experiment Station (CHES) farm Chettalli at Coorg (Kodagu) district, Karnataka, India to assess the scope of Zucchini cultivation and varietal performance in high altitude high rainfall areas. The experimental station is situated at 1050 m above mean sea level with annual rainfall of 150 cm; mean temperature ranges between 15^0C and 32^0C; deep, dark-brown, well drained sandy loam to sandy clay loam soil. The present investigation was carried out during winter season (November – February) under open field condition. The experiment was laid out in Randomized Block Design (RBD) with eight varieties viz., Sanorita, KSP-2, Yellow Zucchini, Yellow, Sunny House, Champion, Dark Green and Green Zucchini and each with four replications. Seedlings were transplanted in mulched raised bed with drip irrigation and recommended cultural practiced were uniformly followed in all the varieties. The growth, yield and yield contributing characters were observed. There was significant difference observed in growth, yield and yield contributing characters of Zucchini varieties. The results revealed that among the eight varietiesevaluated, Zucchini var. Dark Green recorded the highest number of fruits (4.127kg per plant) and fruit yield (114.6t/ha) which was significantly different when compared to other varieties. There were no major pests and disease problem noticed in all Zucchini varieties during the growing season. However, lower incidence of leaf miner insect pest, powdery mildew disease and calcium deficiency at later stage were recorded. The leaf miner insect pest and powdery mildew disease were controlled by foliar application of Azadirachtin (3000ppm) and Hexaconzole (0.1 %), respectively.

S2 P19 A485

Collection, conservation and evaluation of wild and local Banana (*Musa* sp.) genotypes in Tripura and other North-eastern region

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Banana (*Musa* sp.) is the most important fruit in Tripura and other North- Eastern states and is cultivated in Tripura about 13,274.0 ha area with an annual production of 1,30,085.20

MT with a productivity of 8.9 MT (9.8 t) ha^{-1}. The genetic variation among the local genotypes offers a huge scope for selection of superior genotypes and other improvement programmes. At present most of the banana genotypes are found growing naturally in hill slopes and are being maintained in home gardens by farmers to a small extent**.** Due to Tripura and other north-eastern states favourableagro-climatic conditions, fertile and acidic soil with good depth and abundant rainfall favour the growth of various types of bananas making it a reservoir of many local genotypes.. The available germplasm were evaluated at College of Agriculture, Tripura, India during 2009-2016 for plant characters like height, pseudo-stem girth, number of leaf at flowering and harvest, leaf length and breadth, life cycle, and yield. Fruit bunch and finger characters like bunch weight, fruit length, number of hands/bunch, number of fingers/bunch, number of hands/ bunch, number of finger/ hand, fruit weight, fruit length, fruit diameter, fruit pulp weight, peel weight, TSS and other related characters were also recorded. Some of the local genotypes are Shabri Kela (AAB), Samai Kela or Gopi Kela or Bangla Kela (ABB), Champa Kela (AAB), Attia kela (BB), Katch kela (ABB), Kanai Bashi (AA), Red Banana (AAA), Mizo-Cavindish (AAA), Ram Kela(BB),*Musa Bulbisiana* (BB), *Musa acuminata*(AA),*Ensete* Banana,ornamental banana (*Musa ornate)* etc. Among all local genotype, Shabri (AAB), Samai (ABB), Mizo-Cavindish (AAA) and Champa (AAB) showed better performance with taste, flavor, texture, aroma, and overall acceptance and quality of fruit for fresh consumption with medium and tall stature plants have been recorded.

S2 P20 A489

Evaluation of jamun (*Syzygium cuminii* Skeels) collection for yield and fruit characters

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A study was conducted to evaluate the seventeen jamun (*Syzygiumcuminii*Skeels) collections maintained in Kerala Agricultural University during the year 2014-15. The trees are of seedling origin, they showed wide variation in their yield and fruit characters*viz.*, fruiting season, days to flowering to maturity, days to fruit set to maturity, fruit clustering habit, fruit weight, fruit volume, number of fruits per cluster, specific gravity, overall length and width of fruits, fruit shape, firmness/softness, colour, pulp, seed, pulp/seed ratio, juice content and yield. Based on cluster analysis on quantitative and qualitative data, KJ- 45 has recorded higher yield (54 kg $plant^{-1}$), 12 fruits per cluster, fruit volume (11.4 cc), fruit length (3.10 cm), fruit width (1.24 cm), single fruit weight of 12.28 g, pulp (90.39 %), seed (9.6 %) and pulp: seed (9.41). Hence, KJ- 45 is considered as superior collection followed by KJ-48, 47 and 7.

S2 P21 A523

Evaluation of tuberose (*Polianthes tuberosa* L.) genotypes under coastal ecosystem of Tamil Nadu

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Tuberose (*Polianthes tuberosa* L.) is an ornamental bulbous plant belonging to the family Amaryllidaceae. It is essential to develop varieties suited to specific climatic conditions that can be further utilized for genetic improvement of tuberose. Attempts made so far to exploit the available variability have culminated in the release of a few improved region specific selections as varieties from different parts of India and varieties suited to coastal eco-system are yet to be identified. Nevertheless, there still exists an ample scope to exploit the available variability to identify genotypes to suit coastal eco-system that will pave the way for future breeding programmes. Hence, an experiment were laid out to study the performance of 21 genotypes of *Polianthes tuberosa* L. collected from varied geographical locations with randomized block design replicated thrice to assess the genetic variability for sixteen economic characters. Results showed that the genotype PT-15 recorded relatively superior mean performance with respect to all characters. High PCV and GCV were observed for number of leaves per plant, plant height and rachis length. Low variability in terms of PCV and GCV observed for length of the flower and time taken for flowering. High heritability values of more than 60 per cent were observed for bulb volume followed by yield of flowers per plant, rachis length and duration of flowering. The genotypes *viz.*, PT-15 (Kuzhumani, Thiruchirappalli District), PT-3(Ravanthavadi, Dharmapuri District) and PT-10(Perumalpatti, Dindugul District) were identified as superior genotypes which are suitable for the coastal region based on *per se* values and can be utilized for future breeding programmes.

S2 P22 A526

Screening of different cultivars of tuberose (*Polianthes tuberose* L.) under humid agroclimatic conditions of Goa

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Tuberose (*Polianthes tuberose* L.) is one of the most important tropical bulbous ornamental plants cultivated for production of long lasting flower spikes. Adaptation and acclimatization of different cultivars under humid agro climatic conditions of Goa are to be

confirmed for their better performance. This not only help the farmers to grow released and new introduced and improved cultivars but also helps in making them understand their superiority over local cultivars. The present investigation was conducted to evaluate the performance of different tuberose cultivars viz., Mexican Single, Pearl Double, Suvasini, Bangalore local Double, Calcutta Double and Pune local under agro- climatic conditions of Goa during the year 2014-2017. All cultivars differed in their growth and flowering behaviour. Maximum plant height (52.21 cm) and maximum no. of leaves per plant (59.63) were recorded in Suvasini cultivar. Leaf length was significantly higher (52.93 cm) in Pearl double whereas leaf width (2.04 cm) was maximum in Calcutta Double.Days to appearance of initial spike were earlier in Suvasiniwhile it was late in Bangalore local Double.Minimum days taken for opening of basal floret (84.88 days) were recorded in Suvasini. Maximum no. of florets/spike (47.0) was observed in Pune local whereas length of spike (75.59 cm) was maximum in Mexican Single. Spike girth(0.68 cm),Spike fresh weight (69.06 cm), floret stalk length (3.6 cm), diameter of floret (5.24 cm), weight of individual floret (3.49g) and vase life (7.93 days) was significantly maximum in cv. Suvasini followed by cv. Pearl Double. On the basis of observations recorded for growth and floral parameters cv. Suvasini and Pearl Double could be recommended for commercial cultivation under Goa agroclimatic conditions.

S2 P24 A565

Season wise identification of core collection in white onion germplasm using agro-morphological characterization

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Onion (*Allium cepa* L.) is one of the most valuable vegetables in the world. However, despite its global culinary and economic significance, the knowledge about onion genetic diversity and resources is limited. The potentially devastating impacts of climate change on crop production and food security are now widely acknowledged. An important component of efforts to mitigate these impacts is the production of new varieties of crops which will be able to thrive in more extreme and changeable environmental conditions. There is therefore an urgent need to find new sources of genetic diversity for crop improvement. Further for thorough study of available vast germplasm collection will become tedious and costlier. Formulation of core set using whole genetic diversity and then critical analysis of that set of germplasm against variable traits and phenomenon is easier. ICAR-DOGR holds about 350 white onion germplasm being National Active Germplasm Site (NAGS) under NBPGR, New Delhi. White onion has more demand in processing industries as after dehydration it retains the white colour of the product. In the present study, initially basic white onion germplasm collection was differentiated into three seasons such as *Kharif* (230), *Late Kharif* (194) and *Rabi* (213) and evaluated for more than three years. Data has been recorded on 20, 19 and 24 morphological traits during kharif, late kharif and rabi, respectively and average values were used for

formulating core set, as year x accessions interaction found non-significant. Heuristic approach of "Powercore" has been used for formulating core set and core set includes 27 accessions, 34 accessions and 33 accessions from *Kharif*, *Late Kharif* and*Rabi* respectively. MD % of all three sets ranges between 9 to 15 % which estimate that there was no major difference in respective mean values of core set and entire set. VD value indicate**s** that variance for both collections not same (58.83, 46.43 and 45.12). Further CR% is near to 100% indicating that all the core set has captured all the accessions from all classes of basic collection and VR% of all the sets depicting that coefficient of variance of core sets is higher than entire collection. This core set as per season can serve as efficient initiation material for screening of germplasm against various purposes.

S2 P25 A572

Genetic Improvement of Annonaceous fruits

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The Annonaceae or custard apple family comprises about 120 genera and more than 2000 species. The genus, Annona has 120 species, six of them having pomological significance. Annonaceous fruits exhibit morphological affinity to one another but each one is unique and distinct for fruit shape, size, skin surface, pulp colour, texture, flavour and taste. Among the edible annonas, cherimoya (*A.cherimola*), sugarapple (*A. squamosa*) and hybrid between two, atemoya are most popular. The other less important edible Annona species are *A.reticulata*, *A.diversifolia* (Ilama) and *A.muricata* (Soursop). Large number of varieties / cultivars have been developed in annonaceous fruits through selection from seedling populations in different countries which are popular among the growers. There is greater scope to exploit interspecific variation than intraspecies variation. Some species like *Annona squamosa*exhibit narrow genetic variation. In India, an Annona hybrid, Arka Sahan has been developed for its big sized fruits having average fruit weight of 450g, less seeded (8 seeds /100g pulp), high pulp recovery (68.0-70.0%) and more shelf life (5days). Assisted pollination has been recommended for higher yield in Arka Sahan. There are no serious barriers in inter-specific hybridization between *A.squamosa*, *A.cherimola*, *A.diversifolia* and *A.reticulata*andgenetransfer across species boundaries is possible. Gene exchange among them should result in interesting novel recombinants, at times most esteemed ones like the popular atemoya. The present programme on genetic improvement in annonaceous fruits will be discussed in this paper

S2 P26 A586

Methylomics: DNA methylation modification – a novel approach to breeding crops

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DNA methylation provides a heritable mark that guides formation of transcriptionally silent heterochromatin. Methylated alleles are of potential value for applications in breeding. These are meiotically and mitotically heritable changes in gene expression that cannot be accounted-for by changes in DNA sequence. DNA methylation is essentially addition of a methyl (CH_3) group to cytosine or guanine nucleotides. In plants, cytosine can be methylated at CpG, CpHpG, and CpHpH sites, where, H represents any nucleotide but guanine. Differences in DNA methylation can be determined using methylation-sensitive amplified fragment length polymorphisms or MSAPs (Methylation-sensitive amplification polymorphisms) using restriction enzyme isoschizomers that are differentially sensitive to methylation, producing polymorphisms related to methylation differences (as opposed to sequence differences). We used papaya (*Carica papaya* L.) cv. Surya zygotic embryos for inducing variation through methylation modifying agents. Both hypo- and hyper- methylation modifiers were used. Methylation pattern in papaya plants regenerated from zygotic embryos was studied using MS-RAPD-PCR protocol where DNA-methylation-locus-specific restriction enzyme isoschizomers, *Hpa*II and *Msp*I were used. A total of 87 RAPD primerswere used for analyzing banding pattern in the samples using PCR to resolve methylation status in the plants. The technique of MS-RAPD-PCR resolved global DNA methylation pattern in test samples and is an efficient, cost-effective and sensitive method for the purpose.

S2 P28 A640

Variability and genetic divergence in vegetable Cowpea germplasm of Goa

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Vegetable cowpea or Yard long bean [*Vigna unguiculata* var. *sesquipedalis* L.(Walp)] is a warm season leguminous crop grown especially for vegetable purpose along the west coast of India. In Goa, pole type varieties are preferred over bushy types as they offer multiple harvests with comparatively longer pods. There is wide variability found for different morphological and other traits in the local types cultivated in the state of Goa. Exploration of genetic variability in the available germplasm is a prerequisite for initiation of any successful breeding programme. Twenty nine genotypes of vegetable cowpea including three improved varieties collected from different parts of Goa state were evaluated for twelve quantitative characters including yield. High variability was observed for pod yield/plant, number of pods/plant and pod length. The high variability for pod yield per plant is apparent as the pod yield ranged from 315.25 to 2070.45 g /plant with an average of 827.48 g per plant. Pod yield depends on number of pods per plant, pod length and pod weight. Number of pods per plant ranged from 36.65 to 147.80. Pod weight depends on pod length, number of seeds per pod and hundred seeds weight. Wide variation was observed for all these characters in the present study. The GCV value was maximum for pod yield per plant (g) followed by pod weight (g) and number of pods per plant. Low values of GCV were observed for days to first flowering, days to first harvest and number of seeds per pod. In the present study, the twenty nine genotypes could be grouped into fourteen clusters based on genetic distance. High coefficient of variation was observed for pod yield per plant, pod weight, number of pods per plant and pod length indicating their significant contribution in determining the inter cluster distances.

S2 P29 A649

Heterosis for yield attributing traits in brinjal (*Solanum melongena* L.)

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Brinjal (*Solanum melongena* L.), also known as eggplant, is commercially important solanaceous vegetable crop of Indian subcontinent. Rich variability exists for both cultivated type and its wild species in the country. It is popular among people of all social strata and hence, it is rightly called as vegetable of masses. To obtain high yield per unit area, exploitation of hybrid vigour is one of the good way and particularly in crop like brinjal. This study was conducted with 21 F1 hybrids and two standard checks at Horticultural Research Station, Pandirimamidi under High altitude and tribal zone of Andhra Pradesh to know the nature and magnitude of heterosis estimated as per cent increase or decrease of F_1 value over standard checks (standard heterosis). total Seventeen and four crosses noticed significant positive

heterosis over the checks Ravaiyya and US 172, respectively for yield per plant and twenty one and three crosses registered significant positive standard heterosis over Kanaka Durga and US 172, respectively for number of fruits per plant.

S2 P30 A652

Evaluation of Avocado suitable for cultivation in Kodagu Region of South India

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Avocado (*Persia americana*) is a pear shaped fruit known for its miraculous health and beauty benefits all over the world. It is also known as butter fruit or alligator pear. Native to Mexico, Guam and Central America, this green fleshy fruit has been in cultivation since time immemorial. Avocados are considered the healthiest fruit among all the fruits. It contains more fat, but at the same time, it is also packed with many nutrients. This fruit is naturally loaded with myriad essential nutrients and thus is traditionally used for treating several health and skincare problems besides being consumed as a food. Avocados are among the healthiest natural ingredients on the planet and are also considered a complete diet for babies. Avocado is grown in the Coorg region since long. Probably it was introduced from Bangalore by planters due to their personal interest and curiosity. Some of the avocado materials were planting at the station during 1947 to 1972.But most of these plants were planted as sample trees for domestic use and probably not for research purpose. Some of these trees are still exist in campus. The systematic research study at the station was started in 2000. In Kodagu, avocado is grown as one of the mixed crops in coffee-based cropping system under shade. Almost each house or estate in Coorg is maintaining few plants of avocado. More than 100 collections of avocado have been collected from Karnataka, Kerala and Tamil Nadu and maintained at the station. These accessions are under evaluation for various horticultural traits. The data revealed that there were significant differences in plant height, plant girth, and tree spread among different collections. The plant height ranged from 2.65 m in CHESPA-II-4 to 8.41 m in CHESPA-XIV-2. Plant girth ranged from 32.0 cm to 117.2 cm and it was the highest in CHESPA-1. Maximum plant spread (E-W) (7.50 m) was observed in CHESA-1, followed by 7.35 m in CHESPA-XIV-2. Minimum plant spread (E-W) (1.91m) was observed in CHESPA-II-4. Maximum plant spread (N-S)(6.70m) was observed in the CHES PA-XIV-2 and minimum plant spread (0.92m) was observed in CHES PA-XVII-2. Over all, higher tree spread and tree volume was recorded in PA-XIV-2 which was 24.62 m^2 and 176.01m^3, respectively. The highest marketable fruit yield was noticed in PA IV-4 (213 kg per tree) followed by 161 kg per tree (PA I-4). However, the avocado accession, PA XIV recorded the maximum number of fruits per plant (423fruits).

S2 P31 A653

Evaluation of Dragon fruit in Kodagu Region of Karnataka

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Dragon fruit (*Hylo*cereusundatus) belongs to family cactaceae and native to Mexico. Pitahayaor Dragon fruit is producing attractive edible, mildly sweet and delicious fruit with black seeds.It is rich in phyto nutrients and several vitamins reported to strengthened immune system and treat several heart problems. The plants of dragon fruit resembles with others cactus with angular fleshy, thorny stem. The plants are perennial and may survive for more than 20 years. Dragon fruit is fast growing climber with triangular stem. The stem is fleshy vine type with many branch segments. These segments have three way wings and three spines. The areal roots for help plants to climb over rocks, trees etc. The plants may be six or more than six meter in height depending on the growing conditions. An experiment was conducted at CHES, Chettalli orchard, to study the performance of dragon fruit accessions. The Chettalli station is located in the Western Ghats of South India, in Kodagu district of Karnataka, India. The experimental station is situated at 1050 m above mean sea level with annual rainfall of 150 cm; mean temperature ranges between 15^0C and 32^0C; deep, dark brown, well drained sandy loam to sandy clay loam soil. These dragon fruit accessions are being conserved, which was collected from various places of Karnataka and Andaman and Nicobar Islands of India. Among the 14 lines characterized and the results revealed that the fruit weight ranged from 188 g - 630 g, and the highest fruit weight was recorded in DF-I/2 (630 g). The highest fruit length and breadth (11.5 and 8.60 cm) was also noticed in same accession. The rind weight ranged from 87-149 g/fruit. Dragon fruit is having black, crunchy, nutty taste numerous seeds. Number of seeds per fruit ranged from 754-7289 and seed weight per fruit ranged from 1.36-8.03 g. It was observed from the dragon fruit germplasm that two types of pulp (white and pink) and the rind colour (yellow and pink) were noticed.TSS content ranged from 9- 15.2^0 brix. Further these lines may be evaluated for its yield and quality potential at different locations of Coorg and promising lines may be identified for further commercialization to suit Kodagu region of Karnataka.

S2 P32 A656

Transcriptome-based discovery of genes and pathways related to resistance against Stem Gall (*Protomyces macrosporus* Unger) in coriander

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Globally, Coriander(*Coriandrum sativum*) is grown for seeds and leaves purpose. Stem Gall, caused mainly by *Protomyces macrosporus* Unger, brings serious damage to coriander production globally. The knowledge of mechanism underlying its resistance to stem gall is still not known.Using high-throughput transcriptome sequencing and differential gene expression (DEG) analyses for coriander resistance (ACr-1) and susceptible (CS-6) varieties for stem gall was carried out to decipher resistance gene candidates and its associated pathways. *Denovo* transcriptome assembly was carried out and a total of 133,200,898 clean reads were assembled into 59,413 unigenes, out of which 33,573 could match to public databases.Among gene ontology categories, the maximum number of transcripts was associated withcell part, organelle part, macromolecular complex, catalytic, binding, transporter, structural molecule, transcription regulator, a metabolic process, biological regulation, pigmentation, response to stimulus were the terms that dominatedthese play an important role in disease tolerance mechanisms. Totally, 13123 genes were expressed in both the samples and out of which 431 significantly up-regulated and found genes involved in signal transduction are E1A/CREB-binding protein, phosphatidylinositol phospholipase C, two-component response regulator ARR-A family, mitogen-activated protein kinase 3, ethylene-responsive transcription factor 1 etc. and down regulated transcripts are phospholipase D1/2, auxin-responsive protein,serine/threonine-protein phosphatase 2A regulatory subunit B, ethylene-responsive transcription factor, protein phosphatase 1A etc. found significant with a cut of p-value 0.05. Pathways analysis transcripts were categorized in 24 functional pathways and a majority of were found in signal transduction pathway transport, and catabolism pathway, Translation and carbohydrate metabolism etc. Secondary metabolite pathway transcripts expressed differentially and belonged major to Phenylpropanoid biosynthesis pathway which is known to involve in disease response in plants. Our study transcriptome data provided comprehensive insight into gene expression profiles among genotypes and facilitated the molecular mechanism study of stem gall resistance in coriander.

S2 P33 A667

Using SSR markers and stomatal density for identification of clonal trees in polyembryonic mango variety Moreh

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Mango (*Mangifera indica* L.), a commercially important and leading fruit crop of India, exhibits both mono- and polyembryony. Most commercial varieties are monoembryonic.Polyembryonic varieties are not commercially cultivated for table-purpose, but produce true-to-type seedlings for use as rootstocks. Unambiguousidentification of a variety is essential to germplasm conservation and breeding programmes. Distinguishing nucellars from zygotic seedlings in germinating stones of polyembryonic varieties is critical for the nurseryman and the breeder. A study combining stomatal density and SSR markers was made for identifying maternal and sexual embryos in the polyembryonic variety, Moreh, at ICAR-IIHR during 2014-2015. This variety produces upto six seedlings per stone. Stage of leaf development and the specific sector of the leaf to be used for stomatal count was optimized at first. Petiolar-end, median-sector and leaf-tip end of fully expanded leave were optimized for analysis. Stomatal counts recorded in three mature trees of 'Moreh' were analyzed by a scatter-diagram. Significant differences were observed in distribution of the stomata, withthe petiolar-end registering the highest stomatal count.Stomatal count in the leaf-tip and mid-sector were similar as per R^2 values**.** To corroborate stomatal data, SSR markers were used for generating DNA profiles in'Moreh'. Ten polymorphic, genomic SSRs were testedin genotyping studies. Results obtainedinthe data on stomatal density matched SSR allelic data indicating, that, a combination of both these test strategies can help establish identity of a varietyunambiguously. Our study provides information for correct identification of a genotype, and is helpful in differentiating mother trees and, in turn, todistinguish nucellars from zygotic seedlings.

S2 P34 A670

Ethno-botanical and phyto-chemical analysis of jamun (*Syzigium cumini*): a case study in tribal belt of Karnataka, India

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The ethno-botanical exploration and phyto-chemical screening of Jamun belonging to the family *Myrtaceae* were done in Biligiri Ranga Hills, Chamarajanagar, a tribal belt of Karnataka, India during 2016-17. It is a hill range situated in south-eastern Karnataka, which is a protected reserve at the confluence of the Western Ghats and the Eastern Ghats, is home to eco-systems unique to both the mountain ranges. The indigenous knowledge of Jamun by local traditional healers and native Soliga tribes used for the treatment of health related disorders were collected through questionnaire and personal interviews. Informants within the age group of 25 to 80 were interviewed, among them one was a Vaidya.The investigation revealed that, the traditional healers and the inhabitants use Jamun to treat not only diabetics but stomach related complications and viral infections. Besides seeds, fruits, bark and leaves of Jamum were also used in folk medicine and socio-religious functions. At the study site, trees were > 25 m height with trunk girth up to 3.78 m and higher canopy volume. Fruits are small with TSS (13.31%) and pulp to seed ratio of 1.29. The phyto-chemical profiling revealed that Jamun species have secondary metabolites that are useful in human therapeutic and health care. Jamun pulp and seed were high in antioxidants and the seeds possess alkaloids and flavonoids in different quantities. The phyto-chemical content present in the samples corresponds with their ethno-medical significance. Present investigation indicates that BR Hills is blessed with splendid diversity of Jamun and related species. The documentation of community based indigenous traditional knowledge is essential to preserve the knowledge base to conserve the plant resources endemic to this area for sustainable use.

S2 P35 A679

Embryogenic cell suspension (ECS) - a potential explant for the development of non-chimeral mutants with Fusarium wilts resistance in banana cv.Rasthali (AAB, Silk)

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Banana (*Musa spp.*) is an important food fruit crop of international significance. In recent past, banana cultivation is highly threatened by Fusarium wilt,a lethal fungal disease caused by the

soil-borne fungus *Fusarium oxysporum* f. sp. *cubense* (*Foc*). Till date, chemical management remains as one of the important control measures whose efficiency is often limited by the newly emerging virulent strains of the pathogen besides affecting soil health. Under such circumstances, development of resistant varieties offers a permanent solution. In the present investigation, induced mutation was attempted under *in-vitro*conditions using embryogenic cell suspension (ECS) as explants. This was combined with toxin based selection to develop fusarium wilt resistant lines of cv.Rasthali. ECS enables easy handling of large populations under controlled conditions and avoids the problem of chimerism due to their single cell origin. ECS ofcv. Rasthali was treated with various concentrations of Ethyl methane sulfonate (EMS) for different time periods. Lethal dose (LD_{50}) was determined based on fresh weight gain (FWG), settled cell volume (SCV) and regeneration efficiency. The regenerated plants were screened *in-vitro* for wilt resistance using toxins like fusaric acid and culture filtrate. Pot screening of those putative mutants led to the identification of 16 mutant lines which are being multiplied for further sick plot and hot spot area evaluation.

S2 P36 A680

Development of direct regeneration protocol for mass multiplication of banana cv. Udhayam using immature floral hands as explants

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An experiment was conducted to develop a direct regeneration protocol for banana cv.Udhayam using immature floral hands as explants for mass multiplication purpose. The floral hands in position ranging from 8-25th whorl were cultured in MS medium supplemented with various combinations and concentrations of BAP, IAA, TDZ, and Kinetin. But early greening of floral hands (19 days) and meristematic clump formation (9 days) was observed in MS medium with TDZ alone. Similarly, MS medium fortified with BAP and IAA was found optimum for the conversion of floral meristem into shoots. Maximum of 25 shoots were obtained from a single meristematic clump. The single shoots obtained were successfully rooted in MS medium with activated charcoal and IBA. Results further indicated that the response of floral hands to direct regeneration varied not only with the growth regulators but also with the whorl number (16-22nd position). The tissue culture plants derived using the above protocols were true to type which was confirmed genotypically using ISSR markers. Results suggested that immature floral hands could be used as potential explants for mass multiplication purpose owing to their total freeness from contamination and higher multiplication rate which is 1.5 times higher than shoot tip explants which is traditionally used in banana tissue culture.

S2 P37 A681

Studies on the effect of steaming and age of suckers on *ex situ* macropropagation of banana (*Musa* spp.) varieties

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Banana is a major food fruit crop providing food and nutritional security to millions across the globe. Sucker is the primary and major source of propagating material in banana. In India, the requirement of banana seedlings is about 2500 millions but only 150-250 millions are produced through tissue culture catering to only 5 -10% of the total requirement; the remaining 90% is catered through suckers. Due to large capital investment required for the establishment of tissue culture facility, the production cost of tissue cultured banana is on the higher side making it less accessible to the small and marginal farmers. Under such circumstances, macropropagation is a simple cost effective technology ensuring the production of disease free and true to type quality planting material in banana. In the present investigation, macropropagation was attempted *ex-situ* in both bed and pot methods using suckers of three different varieties *viz.*,Rasthali (AAB), Neypoovan (AB) and Udhayam (ABB) of different ages (*viz.*,3,5 and 7 months old). Suckers were steamed at 100°C for five minutes and used as explants while saw dust as substrate. Decortication was restricted to three times for maximum shoot multiplication. The shoots developed from mother corm were separated along with minimum roots and dipped in IBA for better rooting. The plants were hardened successfully and they will be evaluated further for field performance.

S2 P38 A682

Development of bioreactor prototype for embryogenic cell suspension culture of banana (*Musa sp*. cv. Rasthali)

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Production of plantlets using bioreactor is a cost effective technology gaining momentum in various crops.In the present study, we designed and fabricated five different bioreactor prototypes such as (i) Bubble column bioreactor type I, (ii) Bubble column bioreactor type II, (iii) Bubble column bioreactor type III, (iv) Balloon type bioreactor type I and (v) Balloon type bioreactor type II for embryogenic cell suspension (ECS) of banana and the growth of ECS is

reported. M2 medium supplemented with 0.25 mg l^{-1} Zeatin, 1.1 mg l^{-1} 2,4-Dichlorophenoxyacetic acid (2, 4-D) and 30 g l^{-1} sucrose was used with an initial inoculum density of 2.0 ml of settled cell volume (SCV). The air flow rate was adjusted to 100-400 ml min^{-1} during culture period to achieve a homogenous mixing stage. Among the five different bioreactor prototypes, the balloon type bioreactortype Iwas found optimum for multiplication of banana ECS. The SCV in balloon type bioreactor increased from 2.0 ml to 26.0 ml l^{-1} within 14 days. This study revealed that the banana embryogenic suspension cells could be multiplied in duration of 14 days using balloon type bioreactor type I.

S2 P39 A683

A complete proteomic analysis of somatic embryogenesis in *Musa* spp. cv. Rasthali (AAB, Silk) : From initial explant to germination.

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Somatic embryogenesis (SE) is a highly reliable technique resulting in the formation of plantlets from somatic embryos. SE is mainly applicable to mass propagation and development of improved genetic traits of plants through genetic transformation and mutation breeding methods. In banana, SE is genome dependent and it varies with cultivars. Therefore, understanding the molecular and biochemical mechanism at various stages of SE will elucidate the underlying process which results in the development of SE in all commercial cultivars. In this study, efforts were made to identify the genes responsible for EC induction, development of somatic embryos and germination of somatic embryo through proteomic approach. Two dimensional gel electrophoresis (2DE) was used for the proteomic analysis of whole SE in cv. Rasthali. Around 70 spots were differentially expressed among different developmental stages of SE in which 16 spots were uniquely expressed in embryogenic calli (EC) alone. Similarly, 17 spots were highly abundant in EC than nonembryogenic calli and initial explant and these were subjected to MALDI-TOF MS/MS analysis which revealed that calcium mediated signaling protein and stress related proteins played a vital role in EC induction. Proteome analysis of somatic embryo developmental stages (0, 30, 45 and 60 days) showed that trehalose-phosphate phosphatase is ideally expressed in 30 days premature embryos and 4 spots which includes clathrin assembly protein, Ribulose bisphosphate carboxylase, cinnamoyl-CoA reductase and centroradialis were uniquely expressed in matured somatic embryo (60 days) which may act as a genetic marker for respective stages. In later developmental stages, around 4 spots were uniquely expressed in germinating somatic embryo (GSE) than non germinating somatic embryos (NGSE) which clearly elucidated that cold response proteins and calcium dependent protein plays a significant role in germination. The molecular basis behind SE may facilitate to develop SE in recalcitrant cultivars.

S2 P40 A684

Improvement of Saba (ABB- Bluggoe), a cooking type for wilt resistance

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Banana is the world's largest fruit crop with an annual production of 125 million tonnes (FAO, 2010). It is the staple food for nearly 400 million people worldwide. Around 43% of bananas belong to dessert and the remaining 57% to cooking types (Uma et al., 2005). Cooking bananas like Vayalvazhai, Monthan, Addukku Monthan etc. belonging to ABB genome of Monthan subgroup, are commonly cultivated for culinary in southern parts of India as they are rich in starch. Therefore, Saba an exotic collection from Philippines was introduced and evaluated under varied agro-climatic conditions to assess their suitability to Indian conditions. This was found to be a high yielder (35kgs), drought tolerant and more suitable for marginal cultivation. This was also recommended for release under Central Variety Release Committee in 2016. However this variety is highly susceptible to *Foc* similar to all other cooking bananas. Hence, efforts were taken to incorporate wilt resistance in Saba through conventional breeding. Several crosses were made using Saba as female and wilt resistant germplasm *viz*., Pisang Lilin (AA), Pisang Jajee (AA), and cv. Rose (AA) as male parents. Among the various cross combinations, Saba x Pisang Lilin produced the maximum seeds with 5 - 250 seeds per bunch. Approximately 3500 seeds were obtained in different phases from 430 crossed bunches and the well-developed zygotic embryos were germinated under *in vitro* conditions. A total of 25 hybrid progenies of the cross Saba x Pisang Lilin were evaluated under field conditions for growth and yield parameters. The bunch yield of these progenies ranged from 10 to 38.5 kg (Progeny No. 690), and they were rich in starch. Progeny No.690 recorded 10-15 % higher yield than Saba. The fruits are shorter, stout, bold and green. The pulp is starchy, firm with less TSS (20 ^{0}Brix). It is more suitable for preparing *bajji*. The evaluation of their degree of resistance to *Foc* race 1 is in progress under pot culture conditions.

S2 P41 A685

Growth characteristics of embryogenic cell suspension of banana (*Musa* spp.)

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Embryogenic cell suspension has been adoptedas a high throughput method to mass produce quality planting materials and has the advantages of scaling-up propagation using bioreactors. Reports on basic informations for scaling up of embryogenic cell suspension (ECS) of banana

are meager.In the present study, an attempt has been made to scale up the ECS of banana with necessary growth information. ECS of banana (*Musa* spp.) cvs. Rasthali (AAB), Nendran (AAB), Grand Naine (AAA), Red Banana (AAA), Neypoovan (AB) and Monthan (ABB) were established from immature male flower buds. M2 medium supplemented with0.25 mg l^{-1} Zeatin, 1.1 mg l^{-1} 2,4-Dichlorophenoxyacetic acid (2, 4-D) and 30 g l^{-1} sucrose was used with an initial inoculum density of 0.5 ml of settled cell volume (SCV) in 40 ml^{-1} of media in a 150 ml conical flask. The hydrogen ion concentration (pH), electrical conductivity (EC), sucrose level in ECS growing media and SCV were monitored periodically for 12 days. The growth of banana ECS is cultivar dependant. The media pH, EC and sucrose level varied during the culture period from 5.8 – 4.2, 3.3- 2.3 (mS cm^{-1}) and 30-20.2 g^{-1} respectively.About 2-4 fold increase of SCV was observed in the growth of ECS. The influence of initial sucrose concentration, culture volume, inoculum density and shaking speed were studied for proliferation of ECS.This protocol may positively help in scaling up of ECS production from conical flask to bioreactor resulting in the mass production of quality planting material in a short time span.

S2 P42 A687

Variability for L-DOPA content in thegermplasmof*Mucuna pruriens* an anti Parkinson's drug plant

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Mucuna pruriens (L.) DC. is an important underutilized medicinal plant, it belonging to the family Fabaceae and it is a multipurpose medicinal plant and its all the plant parts are useful. The seeds of velvet bean are used in Ayurvedic System of Medicine to relief the symptoms of Parkinson's disease is due to the presence L-DOPA (L-3, 4 Dihydroxy phenylalanine) in its seed. Its seed are rich source of protein which is used for feed or food to the livestock. It has a good agronomical potential as an inter crop in many horticultural plantations as cover crop or weed smothering and also as green manure crop to enrich the soil with nutrients. Mucuna germplasm collected from the different parts of India and were maintained at IIHR, Bengaluru. The 58 germplasm consists of both itchy and non itchy types having varied in seed coat colour viz., white, black, brown and white colour with mottle were screened for L-DOPA. The L-DOPA was extracted from the seed and was estimated by using analytical instrument Ultra High Performance Liquid Chromatography. The significant variability was observed for L-DOPA greatly among the germplasm. It ranges from 2.94%in IC 332432 to 6.91% in IIHR MP 62-1. The low content of L-DOPA lines was identified IC 332432(2.94%) and IIHR MP-95

(2.98%) was highly beneficial to consume as food. The lines having high L-DOPA is highly beneficial to the industries to preparation of drugs for the treatment of Parkinson's disease. The high L-DOPA lines IIHR MP 62-1 (6.91%), IIHR MP 21 (6.77%), IIHR MP 63-1 (6.76%), and IIHR MP 102 (6.57%) were itchy types are important for drug industry for extraction of L-DOPA and its cultivation is very difficult due to presence of itchy trichomes on the pods had hampering its cultivation. Hencethese high L-dopa lines can be utilised in breeding programme of Mucuna to develop high yield cultivars coupled with high L-DOPA content.

S2 P43 A693

Could the ploidy level of banana be determined based on stomatal traits?

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Inexpensive and accurate method for verification/determination of ploidy levels of progenies is required due to the production of different euploids and aneuploids in banana breeding. Although, protocols for root-tip chromosome counting or flow cytometry analysis are in vogue in banana, these techniques may be expensive for breeders working with large segregating populations. Therefore, the aim of this study was to assess the overall degree of polymorphism and similarities among stomatal traits and also to examine the reliability of these stomatal traits in 239 banana germplasm for determination of their ploidy levels. Results showed considerable variations/diversity among banana genotypes and all the stomatal traits viz. stomatal density (SD), stomatal length (SL), stomatal width (SD) and stomatal size (SS) were significantly different within the same ploidy level of intra and/or intergenomic hybrids of A and B genome. With increase in ploidy levels, SD significantly decreased from 85.0 (AA) to 25.4 (ABBB) number/mm^2 while SS were increased significantly from 705.8 (AB) to 1355.7 (ABBB)μm^2 genome. However, the SD ranges overlap among ploidies, more specifically diploids having BB genomes with triploids. A comparison of SS and SD shows that the higher the ploidy, the larger and less numerous were the stomata, the relationship being approximately linear as revealed by scatter plot analysis. However BB diploids, are not likely to be so sharply distinguished from triploids because of its overlapping as revealed by cluster analysis, box plot and descriptive distribution analysis. In general SS is clearly the most reliable index of ploidy than SD as the later was more variable and overlapping with even tetraploids. In conclusion, stomatal characters offer a leadfor assessing ploidy in banana though chromosome counts/flow cytometry cannot be entirely eliminated in banana germplasm.

S2 P44 A694

Biofortification of banana for carotenoid through conventional breeding approach

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Controlling of vitamin A deficiency (VAD) situation in India appears to be a demanding task as a significant increase in the magnitude of VAD was observedamong Indian women from 2001(5.9%) to 2011 (30.3%). Among the different approaches to combat VAD includes dietary intervention such as supplementation, food fortification and consumption of pro-vitamin A rich foods, bio-fortification of poor man's food with pro vitamin A is the best way. Banana is known as poor man' fruit mong the fruit crops, bananas are widely consumed, primarily because of their low cost and their potential as functional and nutraceutical food, moreover, Bananas are an ideal food for young children and families for many regions of the world, because of their sweetness, texture, portion size, familiarity, availability, convenience, versatility, and cost. Among banana diversity of India, Nendran, a plantain type, popular in Kerala and other parts of Southern India, was found to be rich source of carotenoid.As the soft pulp characters of ripened fruits is the highly acceptable character of desert type banana, this plantain type bananas is not preferable one in other parts of India. Thus to improve the quality of fruits without reduction in carotenoid content efforts were taken to improve the Nendran cultivars through conventional breeding approach. Nendran female buds were crossed with cv. Rose, Calcutta 4 and Pisang Lilin. Through embryo culture, 47 Nendran based progenies were obtained from 528 crossed seeds. Of which, two hybrids, each from Nendran x cv. Rose and Nendran x Pisang Lilin cross combinations, recorded 18% higher yield with two times high carotenoid content than the Nendran Evaluation of these hybrids in large scale is in progress to confirm their yield potential and stableness of carotenoid content.

S2 P45 A695

Gene action studies in Brinjal

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The investigation was undertaken at the, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The six genotypes (AKLB -9, AKLB -27, AKLB - 30, Selection 167, GADB – 1, Local C-2) were crossed in full diallel fashion including reciprocals. All parents, resultant crosses and reciprocals with standard check *Phule Arjun* (F_1) were evaluated in summer 2015. The study revealed that most of the promising crosses

arose from parental combinations with low x low or medium x low general combiner in most of important traits like yield and contributing characters. Additive gene action was found to be predominant for the characters plant height and number of fruits per inflorescence in *kharif,* summer and pooled data respectively, whereas days to 50 % flowering in *kharif* season only. The non-additive gene action was predominant for the characters plant spread, days required for first flower, days to 50 % flowering (summer and pooled mean), and number of flower per cluster, days, number of fruits per plant, fruit length, fruit diameter, fruit yield per plant and fruit yield per hectare in *kharif,* summer and pooled analysis respectively. Analysis of genetic components of variation revealed the importance of non-additive systems operating in inheritance of yield and its important components.

S2 P46 A704

Studies on future fruits of Himalaya

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Himalayas are considered one of the major hot spot of plant diversity in India. Wild fruit plants are playing crucial role in livelihood and nutritional security of the local population in hilly regions. These wild resources have tremendous potential to mitigate the challenges of climate change, biotic and abiotic stress, irrigation water crises and utilization of poor degraded lands. Various parts of these plants are used in traditional system of medicines. Keeping above in mind, Defence Research & Development Organisation (DRDO) has done extensive survey and studies on underutilized fruit crops of Himalayan regions of India, with the aim to identify the potential genotypes, evaluation and conservation of valuable genetic diversity, scientific propagation, cultivation and utilization of these resources to develop future fruits of Himalayas. Based on the studies, DRDO has identified *Hippophae* spp (Seabuckthorn), *Cratagus crenulata* (Hawthorn), *Pyrus pashia* (Mehal), *Myrica esculenta* (Kaphal), *Rubus ellepticus* (Hisalu), *Berberis aristata* (Kilmora), *Rhododendron arboreum* (Buransh), *Punica granatum* (Darim), *Ficus palmata* (Bedu), etc as potential crops for future having nutritive and nutraceutical properties. Based on initial studies of these crops, techniques were standardized for their scientific propagation to conserve the diversity and boost the availability of quality planting material for commercial cultivation. Field gene banks have been established in different zones of Himalayan regions to conserve the valuable diversity and support the future breeding programme. Efforts have also been made to develop the methods for their commercial cultivation. In order to minimize the wastage of perishable fruits growing in remote hilly regions, value addition technologies have been developed. Initiatives have also been undertaken to patent and commercialize the processing methods where raw materials is plenty available. Developed technologies have been transferred to private vendors which have created awareness in local population about their economic values besides generating employment.

The need of the hour is to provide policy support like setting up modern nurseries and boost the plantation by adding these crops in government schemes. Also support is requires in establishing the primary centers in remote hilly regions to tap the resources and generate entrepreneurship among the local youth.

S2 P47 A710

Screening for black spot (*Diplocarpon rosae*) resistance in *Rosa* spp. and identification of resistant source for rose breeding.

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Rose (*Rosa hybrida* L.) is one of the most economically important and popular flower plant in national and international scenario. Besides being valued as ornamental plant, roses are commercially valuable as cut flowers, loose flowers and utilized in production of aromatic and neutraceutical products. However, cultivation of rose in open field is challenged by black spot disease (*Diplocarpon rosae*) demanding frequent spraying of plant protection chemicals that have negative impact on environment and soil. Genetic improvement for disease resistance is major objective in global scenario of rose breeding. Identification of resistant source and efficient screening of resulting progenies are major part in resistance breeding program. In an experiment conducted at Indian Institute of Horticultural Research, Bangalore, rose genotypes were evaluated in field against black spot disease.Fifty four genotypes comprising of two rose species, 13 progenies and 39 varieties were screened during the peak period of infestation. Scores were given based on the disease symptoms developed on a 0-5 scale. For each genotype, two replications were considered with five observations in each. Observations were recorded four times and scores were converted to percentage of disease inex (PDI). Based on screening done 'Knock out' was immune (0 PDI), 'Carefree Beauty, 'Nishkant', 'Crypton Duty' were moderately resistant (6-10 PDI) and IIHR 3.7.12 was found moderately susceptible (11-25 PDI). Five genotypes namely Yellow Baby, Rubycon, and IIHR-204 were found highly susceptible (51-75 PDI). Majority of the genotypes were classified as susceptible based on disease scoring (26-50 PDI). Anatomical structure of leaf, stomata as well as hairs on leaves was assessed to assign the characters contributing for resistance.

S2 P48 A712

Effect of pollen storage conditions and pollen storage period on fruitset and seed yield in hybrid seed production of watermelon under open field conditions

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In watermelon, the pollen of the flowers remain viable for only a short time under open field conditions which is a major problem in hybrid seed production affecting both fruit set and seed set. Pollination *via* stored pollen has practical applications especially when pollen viability is less, in addition to problems of synchronization of flowering between parents and unanticipated rains during crossing. In order to maintain pollen viability during storage, a field experiment was carried out on pollen handling at Indian Institute of Horticultural Research , ICAR –IIHR ,Bangalore during 2012-2013 to study the effect of pollen storage conditions and pollen storage period on fruit set and seed yield attributes in hybrid seed production of watermelon under open field conditions. The variety used in the study was Arka Manik. The treatments consisted of five storage conditions namely,T1-Pollen storage at deep freezer conditions (-20^{0}C),T2- Pollen storage at refrigerated freezer conditions 4^{0}C,T3- Pollen storage at refrigerated conditions 10^{0}C,T4- Pollen storage at ambient room temperature and T5- Fresh pollen (control).Pollen from male flowers was stored for seven storage periods namely, 1, 2, 3, 4, 6, 7 and 10 days and compared with fresh pollen (control) on hand pollination of fresh female flowers of Arka Manik on the day of anthesis .A Factorial randomized block design was adopted with three replications. The results indicated that T2- Pollen storage at refrigerated conditions 4^{0}C recorded highest fruitset on artificial crossing at 5 days of pollen (38.35%) , highest seed weight per fruit (41.95 g) at 4 days of pollen storage, higher seed number per fruit (210) at 4 days of pollen storage and 100 seed weight (21.14g) at 3 days of pollen storage as compared to fresh pollen which recorded values of 36.57% , 41.95g, 108 seeds and 20.19g respectively .There were no seeded fruits in all the treatments at 10 days of storage indicating that pollen viability is completely lost after 10 days of pollen storage. The seed quality in terms of hundred seed weight was also highest in T2- Pollen storage at refrigerated conditions 4^{0}C,at 3 days of pollen storage (21.14g) as compared to fresh pollen of 20.19 g. Therefore, storage of pollen in refrigerated conditions at 4^{0}C for 3 days is recommended for extending pollen viability in terms of higher fruitset and seed set without any deterioration in seed quality in F1 hybrid seed production of watermelon.

S2 P49 A716

Potential and Promising Edible Future Fruit Crops for Western Ghats

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South India is bestowed with wide agro-climatic variations from sub-tropical to tropical conditions which provide scope for growing a large number of new generation fruit crops like rambutan, mangosteen, durian, avocado, dragon fruit, pulasan, longan, passion fruit, chempedak, rose apple and malayan apple etc., having national importance in view of their potential markets. Many of them are rich in antioxidants and neutraceutical properties. Commercial production and processing for value addition of these crops would also enhance the income of small and marginal farmers.Currently, all the exotic fruits grown are for intrastate and interstate trade. Many of these fruits introduced to a great extent are of seedling origin. Even though they got adapted gradually to the tropical humid western peninsular India, Rambutan and pulasan remained locally cultivated fruit in some parts of Kerala and adjoining areas of Tamil Nadu for quite some time. Systematic work on the future fruit crops started a decade ago at IIHR- Central Horticultural Experiment Station, Chettalli, Kodagu, Karnataka. Acreage under rambutan reportedly has increased appreciably to about 500 acres in Kerala, Karnataka and Tamil Nadu. Few commercial plantations of Rambutan in these regions have more than 1000 trees and production potential of this crop may soon witness a quantum jump as considerable planted area is approaching bearing stage. Currently, there is an ever growing demand for mangosteen fruits in the metros. Avocado is the most nutritive among fruits and regarded as the most important contribution of the modern world to human diet. The pulp is rich in fat and widely used in the preparation of cosmetic industries. It is grown very limited scale and back yard cultivation in Karnataka, Tamil Nadu, Kerala, Maharashtra and Sikkim. On the other hand, another new generation fruits crops member, Dragon fruit is also a possessing potentialities to become a promising fruit crop in India.Its cultivation has started in some parts of Karnataka, Kerala, Andaman, West Bengal and Andhra Pradesh. Undertaking awareness programme among the growers, consumers and entrepreneurs regarding the potential of these fruits in the local and export markets, development of trait-specific superior types, crop husbandry practices including pests and diseases management, post-harvest management and value addition protocols are the critical needs for promoting this crop for fruit crops diversification and sustainable livelihoods of the growers. Among the different future fruit crops, as of now rambutan, avocado, mangosteen and dragon fruit holds high potential for diversification of commercial fruit culture in the tropical humid regions of the western Ghats

ecosystem apart from parts of the North East regions and Andaman and Nicobar islands of India. This paper outlines the scope, perspectives, needs of research and potential markets forfuture fruit crops in the humid tropical regions of South India.

S2 P50 A720

Pollen Cryopreservation in *Vasconcellea Species*: An Approach for Introgressing Papaya Ring Spot Virus Resistant Genes into *Carica papaya* (L.)

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Papaya is an important fruit crop, originated from tropical America, known for its nutritive value, relative easiness of agronomic practices and year round production. The spread, distribution and cultivation of papaya are hindered by a devastating disease Papaya Ring Spot Virus (PRSV-P). Efforts were made to control PRSV by cross protection, transgenic approach, cultural practices, quarantine regulations restricting plant movement and use of insecticides against insect vector. But the ideal and sustainable method of controlling PRSV is through introgression of resistant genes into the susceptible cultivated ones. These resistant genes are exhibited in the *Vasconcellea* gene pool, earlier both genera were grouped in *Carica* genus. An attempt was made to cryopreserve the *Vasconcellea* pollen to overcome the asynchrony in flowering to enable pollen exchange for assisting shuttle breeding. Since four species viz., *V. cauliflora*, *V. parviflora*, *V. goudotiana* and *V. cundinamarcensis* were available in Indian Institute of Horticultural Research, Bengaluru, pollen of these species were collected during 8 am to 9 am before flower opening, tested for fresh pollen viability *in vitro* using 6% sucrose by Hanging Drop method and stored in Liquid Nitrogen without any delay. The pollen viability was analysed at 1, 2, 4 and 6 months interval. Higher fresh pollen germination was recorded in *V. cauliflora* (95%) followed by *V. goudotiana* (90%), *V. parviflora* (83%) and lowest in *V. cundinamarcensis* (54%). After 1, 2 and 4 months of cryostorage, the pollen germination was on par with the fresh pollen germination percentage. At six months of cryostorage, the pollen germination percentage remained intact and noted 81%, 92% and 90% and 53% in *V. parviflora*, *V. cauliflora*, *V. goudotiana* and *V. cundinamarcensis* respectively. Since the pollen grains from *Vasconcellea* species are low in moisture content and smaller in size, the damage by exposure to ultra low temperature was minimum. Hence, cryopreservation of *Vasconcellea* pollen can be a viable approach for crop improvement programs to introgress PRSV resistance into papaya cultivars.

S2 P52 A722

Effect of fertigaton using different rates and sources of fertilizers on growth and yield in Cabbage (*Brassica oleracea* var. capitata)

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A field experiment was conducted to study the effect of fertigation on the performance of Cabbage variety, Unnati, at ICAR-Indian Institute of Horticultural Research, Bengaluru, during *rabi* of 2013 and 2014. The experiment was laid out in Randomized Block Design withthree replications and consisted of a total of10 treatments, which included different doses, sources of fertilizers and its frequency of application. The pooled analysis of two years data revealed that the application of recommended dose of fertilizer (150:100:125 kg NPK ha^{-1}) through fertigation using water soluble fertilizers on weekly interval resulted in higher values for leaves per plant (25.67) and leaf weight per plant (599.00 gm) at 50 days after transplanting, which remained on par with the same dose and source applied at bi-weekly interval. Similarly, these two treatments recorded higher values for head weight (454.0 and 423.6 g), stem weight (102.3 and 94.0 g) and root weight (66.67 and 45.67 g) at harvest. All the fertigation treatments recorded higher yields over the conventional soil application of fertilizers to the tune of 9.0 - 57.34 per cent. Among the fertigation treatments, application of 100 per cent recommended dose using water soluble fertilizers at weekly interval resulted in significantly higher yield (59.32 t ha^{-1}) than all the other treatments tested except the treatment where the bi-weekly application of same dose of fertilizer through the same sources (56.55 t ha^{-1}) was done.

S2 P53 A723

Freeze storage of pollen: Exploring the feasibility for pollen conservation and crop improvement in Passion flowers (*Passiflora* spp.)

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Yellow passion fruit (*Passiflora edulis* f. *flavicarpa* Deg.) is a potential fruit crop in the developing countries owing to its delicious taste and nutritive values. Being self-incompatible, the fruit production is impaired however weak compatibility barriers with related species can be instrumental for improvement. Sweet passion fruit (*P. alata* Curtis) and Maypop (*P.*

incarnata) are two related *Passiflora* species with edible fruits and medicinal properties which can be utilized for improvement programs. An attempt to find out optimum stage of pollen collection for viability assessment and amenability of *Passiflora* pollen for low temperature storage were made at ICAR-IIHR, Bengaluru. Maximum *in vitro* germination was obtained for pollen collected on the day of anthesis while those collected at pre-anthesis did not germinate *in vitro*. Pollen from the three *Passiflora* spp. germinated in modified Brewbaker and Kwack's media (200ppmH_3BO_3+500ppm$CaNO_3.4H_2O$+100ppmKNO_3) supplemented with sucrose (15-20%) and PEG (30%) using hanging drop technique. Higher fresh pollen germination was observed in *P. edulis* (62.60%) followed by *P. alata* (51.91%) and least in *P. incarnata* (20.80%). Pollen of all three species lost viability under low temperature storage at 4 and -20°C while cryopreserved pollen remained viable for six months with reduction in germinability. Heavy and sticky nature of *Passiflora* pollen have attributed to the loss in viability and germinability during storage. High moisture content of pollen, coupled with the lipophilic substance pollenkitt (associated with exine and prevents dehydration) may have contributed to pollen damage during cryopreservation. The study reveals the pretreatment requirement of *Passiflora* pollen prior to cryopreservation and the results of the study can be beneficial while developing both genetic breeding and conservation strategies in Passion flowers.

S2 P54 A727

Evaluating bael [*Aegle marmelos* (L.) Correa] cultivars for yield and quality under Lucknow conditions

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Bael,botanically known as *Aegle marmelos* (L.) Correa has become a potential fruit crop in most parts of our tropical and sub-tropical India. Its popularity as a fruit of waste lands especially in arid and semi-arid tracts is far more than *aonla, jamun*, custard apple and many other, known under-utilized fruit crops principally because of its medicinal and high market value, ever increasing demand for *sharbat* (juice) and candy making; and, above all the long shelf life of fruits provided the fruits are harvested along with stalk without any internal or external damage while harvesting. *Bael* fruits can easily be stored without much effort under ambient conditions for a month and transported to distant parts of the country. In the recent past, during last few decades, a number of improved *bael* cultivars have been developed which show distinct variability in productivity and quality parameters. Keeping this in view, an experiment was conducted during 2006-2016 at ICAR-CISH Lucknow in randomized block design to evaluate the performance of nine bael cultivars, viz.NB-5, NB-9, NB-16, NB-17, CISH B-1, CISH B-2, Pant Aparna, Pant Sujata, Pant Shivani. The findings indicated that NB-9, NB-16, CISH B-1, CISH B-2 and Pant Aparna started fruiting from third year while NB-5, NB-17 and Pant Shivani from fourth year and Pant Sujata from fifth year after planting. Growth

parameters revealed tree height ranging from 5.12 m to 6.72 m with maximum in NB-17; tree girth from 77 to 92.75cm, plant spread in east west direction from 5.25 to 6.96 m, while in north-south direction in between 4.88 and 7.05 m after ten years. The pooled means for fruit yield revealed maximum average yield in CISH B-1 (48.07 kg/tree) followed by NB-9 (45.4 kg/tree). The differences in fruit yield of bael cultivars viz. NB-9, NB-16, NB-17 and CISH B-2 were not significant. Total soluble solids ranged in between 34 ^{0}B and 44.3^{0}B while total sugar ranged in between 11 and 14.99%. Total phenol content ranged in between 1.93 and 2.68% in different cultivars. Large fruited types included cultivars like NB-17, CISH B-2 and Pant Shivani with fruit weight ranging from 1.95 kg to 2.12 kg/fruit. The cultivars, viz. NB-5, NB-9, CISH B-1, Pant Aparna and Pant Sujata fell in the medium fruit-size group, with the average fruit weight from 0.8 kg to 1.2 kg/fruit. NB-16 produced the smallest size fruits (0.598 kg/fruit). As regards seed contents, it ranged from 58.5 to 147 seeds/fruit. CISH B-2 had the minimum seeds, i.e., 60 per fruit among large fruited types while CISH B-1 had the minimum seeds (58.5/fruit) among cultivars with medium size fruits. On the basis of overall performance, CISH B-1 and CISH B-2 both proved to be superior *bael* cultivars under Lucknow conditions.

S2 P55 A202

Response of different cucurbit rootstocks on growth and yield of grafted polyhouse cucumber during winter season in western Rajasthan

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Cucumber is among the most preferred cropsby polyhouse growers in western Rajasthan.Its off-season (in winter) cultivation is more profitable due to higher prevailing market price, though growers have to compromise with yield,especially when night temperature during winter months (in non-heated polyhouse) falls belowthe required optimum lowest (ie., 16-18^{0}C) for its growth and production. Grafting has shown to enhance performance of commercial cultivars under constraint environments when these are grafted ontoselected rootstocks. In present study, the performance of commercial cucumber (Infinity), either non-grafted or grafted onto bottle gourd (Sharda F1), muskmelon (Kesar F1), fig-leaf gourd, pumpkin (BSS-750 F1) and winter squash (ArkaSuryamukhi) as rootstocks,were evaluated for their growth and yield parameters during winter season (November to March) of 2015-16in polyhouse at ICAR-CAZRI, Jodhpur. Among the tested rootstock-scion graft combination, fig-leaf gourd rootstock-grafted cucumberresulted highest plants biomass production, per plant fruit weight and fruit number,and finally the fruit yield. Comparative to non-grafted control, fruit yield increased to a tune of 30 percent and 10 percent in plants grafted onto fig-leaf gourd followed by bottle gourd rootstock, respectively. Fruit parameters such as fruit girth and pericarp thickness were also higher in fig-leaf gourd rootstock grafted cucumber plants.The improved yield of grafted cucumber was partly ascribed to increased root biomass and more root-to-shoot nutrient transfer. From this study, it is concluded that grafting cucumber

onto fig-leaf gourd can enhance fruit production under sub-optimal temperature condition of winter (off) season cucumber in naturally ventilated polyhouse.

S2 P56 A703

Survey, collection and conservation of water chestnut (*Trapa natans* var.*bispinosa* Roxb.) :An underutilized fruit for water logged area

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Few plants incite as much contradictory perspective as the water chestnut (*Trapa natans* var. *bispinosa* Roxb.) the world over. This floating-leaved aquatic plant is an important agricultural product in India and China, is conserved as a disappearing species in Europe and despised as a noxious weed in the United States. Water chestnut (*Trapa natans* var.*bispinosa* Roxb.) is an underutilized plant species which is valued for its nutritional, medicinal, phytoremedial and ecological properties in the ethnic societies. Since, it is a potential crop for water logged areas and appears to possess immense nutraceutical properties it could possibly be exploited for commercial cultivation. With the above view preliminary surveys were conducted by the department of Applied Plant Science, Babasheb Bhimrao Ambedkar University, Vidya Vihar, Lucknow in the water chestnut growing areas in five blocks in the district Lucknow in central Uttar Pradesh. Promising germplasm variability has been recorded for fruit colour (green to red), kernel colour (white to yellow white), physical parameters of leaves viz., leaf length (2.87 to 6.60 cm) and leaf width (4.10 to 7.86 cm). Physical parameters of fruit were found to vary for their length (3.03 to 6.38 cm), breadth (3.03 to 4.87 cm), cheek diameter of fruit (2.66 to 4.86 cm), kernel length (2.64 to 3.84 cm), kernel breadth (2.81 to 4.30 cm), kernel: peel ratio (1.23 to 3.97), kernel volume (3.93 to 11.57 cm), kernel specific gravity (0.93 to 1.91), weight of kernel (5.99 to 46.13g), kernel diameter (2.83 to 4.13 cm), peel weight (3.99 to 13.40 g), peel thickness (0.11 to 0.39 cm), peel ratio (0.91 to 4.48) and fruit volume (8.33 to 25.73 ml) etc. as also biochemical parameters *viz.*, TSS (4.60 to 10.53 ºBrix), acidity (0.06% to 00.10 %), specific gravity (1.01 to 1.76) and ascorbic acid (5.08 to 9.70 mg/100gm) etc. On the basis of variability studies 20 promising morphotypes have been collected from the local farmers from the five blocks of District Lucknow and conserved at the experimental farm of the University for further evaluation.

S2 P57 IS8

Evolutionary shift towards bisexuality in polygamodioecious trees of nutmeg (*Myristica fragrans* Houtt.)

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Myristica fragrans Houtt, commonly called nutmeg tree is a tropical evergreen species belonging to the most archaic existing order Magnoliales. The tree is known for two major spices it produces- Mace and nutmeg. The major problem faced in nutmeg plantation is its characteristic polygamo-dioecy. Three sexual phenotypes are observed in nature, Unisexual male trees producing only male flowers, Unisexual female trees which produce only female flowers and Bisexual trees which produce both male and female flowers in varying ratios. To understand the basis of dioecy in nutmeg, a survey in various nutmeg plantations and solitary trees across various parts of Kerala was conducted. Field data showed a consistent shift to bisexuality. Solitary trees observed were all confirmed to be Bisexual trees. To further studies, DNA was isolated for 6 random trees bearing fruit and 6 trees which never bore any fruit as per the observations in the plantations and 2 bisexual trees. The DNA was amplified and tested using 70 ISSR primers and 25 RAPD primers. No consistent polymorphism was observed among the sexual phenotypes, leading to the conclusion that there might not be any genotypic differences leading to the differences in sexual phenotypes. It was inferred that evolutionary shift to bisexuality might also be brought about by epigenetic differences and differential gene expressions which is detailed in the present paper.

S2 P58 IS9

A novel pomegranate (Punica granatum L) variant with the high anthocyanin content

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Pomegranate (P*unica granatum* L*)* is an important tropical fruit crops consumed all over Asia andit contains many antioxidants including anthocyanins. In the present investigation, a novel somaclonal variant has been identified from an orchard having tissue cultured pomegranate plants of cv. Bhagwa at Korlakunte village, Challakere (Taluk), Karnataka. The identified

variant had shown clearly visible differences compared to remaining plants of cv. Bhagwa in terms of leaf and fruit characteristics when it was characterized as per DUS guidelines for pomegranate. The leaf blade shape was lancolate as against elliptical lanceolate in cv. Bhagwa; leaf apex shape was obtuse in case of the variant compared to round shape in Bhagwa;. Further, the variant has exhibited prominent leaf veination compared to cv. Bhagwa. When the fruit characters were considered, the fruit shape was oval (ovate in cv. Bhagwa) with a long crown length of 26.30 mm (15.54 mm in cv. Bhagwa) and has a clearly visible neck. Further, the variant had nipple which was absent in Bhagwa. When this variant was subjected to fruit quality analysis for acidity, sugar content, ascorbic acid and anthocyanin content along with other pomegranate genotypes, significant differences were observed for anthocyanin content ($p > 0.05$). The identified variant has recorded 310.49 mg of anthocyanins per 100 ml of fresh juice which is twice as that of cv. Bhagwa (140.79 mg/100 ml of fresh juice) [AOAC official method 2005.02 at FSAQCL, CSIR-CFTRI, Mysuru]. However, non-significant differences were observed for other quality parameters like acidity, ascorbic acid and sugar content. Further, the identified variant has shown better shelf-life compared to Bhagwa.

S2 P59 IS17

Evaluating Peach cultivars Bred by Nikita Botanical Gardens according to their resistance towards leaf curl and powdery mildew

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The leaf curl (agent – the fungus *Taphrina deformans* Tul.) counts among the most harmful peach diseases, leading to abrupt falling yields and even to complete dying of trees. Another common peach disease is the powdery mildew, caused by the fungus *Sphaerotheca pannosa* Lev. var. *persicae* Woronich. This morbus affects leaves, shoots, and fruits, which are being covered with white felty flecks. Developing cultivars with enhanced resistance to leaf curl and powdery mildew facilitates the reduction of expenses for pesticides, the improvement of ecological conditions in agrocenoses, the enhancement of viability and commercial properties. During 2012-2016 the research included 37 peach cultivars bred by Nikita Botanical Gardens. According to research data, an enhanced and sustainable resistance to leaf curl, compared with the reference (Sovyetskiy), was shown by 9 peach cultivars: Krymskiy Shedevr, Lakomiy, Nikitskiy Podarok, Temisovskiy, Druzhestvenniy, Naryadniy Nikitskiy, Progress, Pushistiy Ranniy, Champion Ranniy. Krymskiy Shedevr demonstrated the lowest vulnerability to this disease. The cultivar Gagarinets has been selected owing to its enhanced resistance to powdery mildew.

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S2 P60 IS18

Assessment of chilli varieties in Salem district for higher productivity

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Chilli is grown in Kolathur block of Salem district in an area of nearly 879 ha. Based on farmers request and field survey conducted by KVK Scientists during 2013-14, an onfarm trial was conducted at 5 locations in pannavadi village of kolathur block. In this trial three varieties (Lalima, LCA 625 and Kovilpatti 2) were assessed for yield, pest disease tolerance and quality parameters.Lalima was the farmers grown local check, Kovilpatti2 (K 2) was used as reference variety and LCA 625 was the variety released by LAM Research Station, Guntur, Andrapradesh Horticultural University(APHU).LCA 625 gives an average yield of 6.2-6.8 t / ha, fruit length of 9-11 cm, good pungency and good colour retention during storage. Hence this variety was chosen for the performance in kolathur block. Seeds of LCA 625 were purchased from the LAM station, Guntur and distributed to farmers. Farmers were given training on protray nursery raising, improved package of practices and value addition in chilli.In addition to this planofix and arka vegetable booster were also given for foliar spraying to increase the fruit set and quality. Observations on parameters like germination per cent, crop duration, day of first flowering, green chilli and red chilli yield, no.of fruits, fruit length, pungency, total yield, net income and BCR were studied and the pooled data of the above parameters at 5 locations are presented.The results indicated that the maximum fruit set was observed in LCA 625 than the other two varieties, fruit length was observed to be higher (9.78 cm) in Lalima than LCA 625 (8.44 cm), The crop duration was found to be 207days for LCA 625 and 210 days for the other two varieties with high yield of 12.6 t/ha of green chilli in LCA625 and 12.46t/ha in Lalima, whereas the reference variety yielded only 3.42 t/ha of green chilli.Further dry chilli yield of 4.82 t/ha in LCA625, 4.32 t/ha in Lalima and 1.8t/ha in Kovilpatti 2. With the net return of Rs. 79,120 and BCR of 3.04 LCA 625 performed well compared to net return of Rs 71,740 and BCR of 2.9 in Lalima and Rs. 32,120 and 1.94 in K 2. With the assessment made in 5 locations it was observed that though in most of the parameters LCA 625 excelled other two varieties, the colour of dry chilli during storage was orange compared to Lalima with bright attractive red colour. Hence in the market Lalima fetched more price than the other two varieties. However the pungency was more and the shrinkage of skin was less in LCA 625 compared to other varieties and also there was less pest disease incidence in LCA. Hence it is suggested for the Researchers that LCA 625 may be refined for marketable colour.

S2 P61 IS19

Assessment of Chrysanthemum varieties suitable in Salem district for yield and productivity

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Chrysanthemum (Samanthi) is being cultivated in an area of 850 ha in Salem district covering omalur and kadayampatti blocks and some scattered patches all over the district. Scientist team from KVK, sandhiyur visited the Pannapatti village cluster where more than 90% of the area are under Chrysanthemum cultivation and conducted base line survey about village and the farmers behaviour. PRA was conducted with help of Multi disciplinary team and group of local farmers and found the local felt and unfelt needs in chrysanthemum cultivation. Then an on farm trial (OFT) was proposed during 2012-13 for assessing the suitable high yieiding varieties under farmer's cultivation in which the TNAU released variety CO1 performed well and recorded highest yield(11.2 t/ha) than the local variety (5.8 t/ha). The major attribute for increase in yield is big flower size (4.0-4.5 cm dia) in CO 1 than the local varieties (2.8-3.4 cm). Besides, CO1 gave ratoon crop that led to dramatic reduction in cost of cultivation. Moreover CO1 being early flowering (25 -30 days) than the existing varieties led a better market price in lean season too. By seeing all the merits it was recommended to the farmers to cultivate this crop along with other existing varieties to have the marketable produce throughout the years. Hence during 2013-14 through KVK this variety CO 1 was popularized through FLDamong the people of pannapatty.CO1 variety with big flower size and increase in yield than the local varieties fetched higher price in market. Due to its early flowering habit it fetched more returns during the peak season when the other varieties are in vegetative stage. The average yield was 104 quintals/ha as against 76 quintals/ha in local varieties with 36.84 % yield increase. The farmer obtained a net return of Rs. 302500/ha with BCR of 2.1in a period of eight months. The rate /Kg varies from Rs.10 /Kg to Rs 140/Kg. Further, it fetched an addition yield (4.3t/ha) during ratoon crop and an income of Rs. 80000/ha. Before the intervention of KVK, the farmers used to grow only the local varieties and their economic gains were less. They had low level of knowledge about the scientific method of cultivation and IPM measures. But after the intervention, they were well trained in problem diagnosis, ecofriendly management practices and groupmarketing activities.

S2 P62 IS22

Self-fertility of the apricot cultivars and forms introduced on south coast of the Crimea

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The research involved 23 introduced cultivars and forms of *Armeniaca vulgaris* Lam. from the collection of Nikita botanical gardens (NBG). All genotypes were classified into groups according to their geographical origin. The study was being conducted in 2006-2016. The site is located on the southern coast of Crimea at 200 m above sea level. The control variant was one of the best cultivars by economically valuable characters – Krymsky Amur – zoned in the Crimea.The study purpose was to determine degree of self-fertility of some apricot cultivars taken from different geographical groups and selection forms under conditions of South Coast of the Crimea.As a study result it was found out that among investigated European genotypes about 70% are self fertile or partly self fertile. Majority of Central Asian, American and Chinese cultivars is non-self-pollinate. Apricot pollen ability to sprout in the artificial nutrient medium with 15% and 20% sucrose solution was estimated to understand its quality. Optimal concentration of sucrose solution was determined for groups of cultivars involved in the experiment. In conclusion, cultivars, characterized by the highest pollen vital capacity were marked out.Four apricot cultivars and forms (Roxana, 7(2)-2-50, 47-L/11, H-II 5/33) were chosen for further breeding and production as they tended to be self-fertile during the whole study and formed the highest level of potential yield.

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S2 P63 IS37

Oligomeric protein complexes contained in fruits of the Crimean walnut varieties

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Protein composition was studied in order to determine the fractional structure of fruits kernels of 7 walnut varieties (Alminsky, Arkad, Burlyuk, Dolinny, Podarok Valentiny, Karlik 3, Karlik 5) of Nikita Botanical Gardens selection grown in soil and climatic conditions of the foothill Crimea. In the conducted studies the presence of oligomeric protein complexes were revealed in each of the analyzed fractions by means of gel electrophoresis and 2-mercaptoethanol treatment. The change in the molecular weight profile can be explained by breaking thio-diester bonds, which participate in oligomeric protein complexes formation. The obtained results are similar for all studied walnut varieties, which indicates the possible functionality of these proteins only in the form of complexes in their native state. According to B. Sarath et al. 2011; T. William Hutchens et al. 1991, proteins built from several subunits can serve as complexing agents for selenium (Se) and copper (Cu). Further investigation of the amino acid sequence of these proteins will make it possible to clarify their functions.

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S2 P64 IS44

Methods and results of a rose breeding from different garden groups in the South of Russia

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The creation of a garden roses' collection in the South of Russia was begun in 1812 in the Nikita Botanical Gardens, which is situated in the Southern Coast of the Crimea. The breeding research was also started by Nickolas Gartvis there in 1824. Over 100 cultivars of roses were created by him during 36 years. In the mid of 20th century introduction and breeding research was continued by Nickolay Kostetsky, Vera Klimenko, Konstantin Zykov and Zinaida Klimenko. It is being done for the time being.The main objective of a garden roses' breeding in the Nikita Botanical Gardens was and is creation of the new cultivars, which have high ornamental qualities, fragrance, decease resistance, long-term and reiterated flowering, fit for xeromorphic climatic conditions of Mediterranean type in the Crimea and the same ones in the South of Russia.As the result of a long-term study of more than 6,000 roses' species and cultivars from the Nikita Botanical Gardens collection and Crimean flora some valuable characteristics' donors have been discovered, which were used in the selection while creating the domestic cultivars.The main methods of garden roses' breeding in the Nikita Botanical Gardens are different kinds of hybridization, a clone breeding and an experimental mutagenesis-chemical and radiation ones.As the result of the use of a complex roses' breeding system, which has been worked out in the Nikita Botanical Gardens, more than 100 perspective cultivars and breeding forms from 10 garden groups have been obtained (Hybrid Tea, Grandiflora, Floribunda, Polyantha, Kordesii, Rambler, Large-flowered Climber, Shrub, Miniature, Modern Shrub) for the conditions of the South of Russia. Fifty of them, which have

high potential abilities, are fit for cultivation not only in the South of Russia but as well in many other regions – in Urals, Siberia and Far East. Three garden roses' cultivars from the collection of the Nikita Botanical Gardens (Klimentina, Korallovy Siurpriz, Pestraya Fantasia) were awarded the prizes of the International Rose Contests in Italy and Germany.

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S2 P65 IS46

Ethnobotanical awareness and interest in biodiversity for environmental sustainability: A case study incorporating *Morus bomcycis* among other ethnobotanicals in suburban Japan

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According to the UN Sustainable Development Goal 15, biodiversity is an essential element of environmental sustainability, and is part of the 2030 agenda. However, with husbandry of biodiverse systems increasingly lacking, recent increases in human migration to urban and periurban areas, and with most practical needs provided for by modern industrial technology, a decrease of contact with nature has resulted in less reason to retain traditional knowledge associated with nature. Our study seeks to find the relationships between people's current understanding of ethnobotanicals and edible plants and how they perceive biodiversity in their neighborhoods. This study aims to find and understand this connection in modern-day suburb near Tokyo, Japan. To find the current perspectives, we received 128/662 responses to a questionnaire given to all residents of a housing complex in suburban Matsudo City, near Tokyo, Japan, regarding biodiversity, ethnobotanicals and commonly found edible plant knowledge. For specific ethnobotanical knowledge, we studied *Morus bomcycis*. Our findings show that low ethnobotanical knowledge is directly correlated with a lack of interest in biodiversity. We also found that most people do not know the usages of native plants, with a slight increase with age or place of birth. Our conclusions suggest that in order to foster biodiversity based upon native plant life, these plants should be thoughtfully placed in the nearby environment, and some sort of education is prescribed for understanding the human-plant connections available. With an increase in an understanding of ethnobotany, people can begin to connect more deeply with their natural surroundings.

S2 P66 IS51

Gynogenic Response of Muskmelon Genotypes Varied with Temperature Treatments and MS Medium Supplementations

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Development of novel inbred lines in short-span through haploidy is prerequisite for hybrid development in muskmelon. Among the several techniques utilized for haploid generation, Gynogenesis, megaspore culture technique, can generate haploid plants from ovules, the female gametes. It is beneficial as requires less time besides ensuring higher potential for generation of a haploid plant in comparison to parthenogenesis induced through irradiated pollen method. This study compares the gynogenic response of two genotypes of *Cucumis melo* cv. *reticulatus*, MS-5 and MM Sel. 103 on three modified MS media, TDZ (@ 0.02 and 0.04 mg/L), and Coconut water+Proline+2,4-D+Kinetin. Ovaries of both the genotypes were subjected to two temperature treatment steps i.e. heat treatment at 35°C for 2 days and cold treatment at 4°C for 4 and 8 days. Both genotypes varied in their response to temperature and MS medium supplementations. Genotype MM Sel. 103 exhibited highest callusing rate on Coconut water+Proline+2,4-D+Kinetin supplementation without any temperature treatment. However, heat treated explants showed best results on media supplemented with TDZ @ 0.04 mg/L. While, MS-5 genotype, showed better callusing rate on TDZ supplemented MS media (@ 0.02 mg/L) on heat and cold treatment (for 4 days). The generated calli differentiated and mimicked different stages of embryos as observed under stereomicroscope. Embryo count done post 15 days of culturing exhibited higher number of embryo and ovule like structures in MM Sel. 103 genotype as compared with MS-5. However, the size of ovules or embryos was same in both the genotypes.This work accentuates the need for optimization of genotype specific modulations in culturing media and pre-treatment protocols for successful generation of haploid through gynogenesis in muskmelon

S2 P67 IS52

Genetic association among Indian melon accessions, including agrestis and momordica landraces

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Genetic diversity analysis of 70 melon accessions collected from various agro-ecological regions of the world *viz*., India, Afghanistan, USA and Israel was performed using 30 SSR markers. The four markers, CMAG59, CMTCN38, CMMS3-1 and EMS178 revealed up to 4 alleles. Seven SSR markers revealed specific/unique alleles and identified twenty-three genotypes. Across the genotypes, maximum number of alleles (58) were detected in IC-274034 and the percentage of polymorphic marker was maximum (86.9) in PAUS-19. In present study, average observed heterozygosity (53%) with in this melon germplasm collection was higher as compared to the average expected heterozygosity (48%). The dendrogram illustrating genetic relationship, classified genotypes into three major clusters, Cluster I, Cluster II, and Cluster III. The similarity coefficient estimated by dice similarity coefficient ranged from 0.34 to 0.91. Clustering pattern was independent of horticultural groups and geographic origin. High PIC values, number of alleles and observed heterozygosity frequency, explained relatively high genetic diversity present among melon accessions.

S2 P68 IS56

Fractional and amino acid composition of proteins of the Crimean varieties of walnuts

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The comparison results of the fractional and amino acid composition of proteins in the kernels of fruits of 7 walnut varieties of Nikitsky Botanical Garden selection are presented. The walnut varieties were cultivated in soil and climatic conditions of the foothill and plain-steppe agro-climatic zones of the Crimea. In the study 4 protein fractions were isolated from the analyzed plant material, namely, albumins, prolamines, globulins, and glutelins. Isofocusing data for soluble protein fractions are obtained. The coefficient of amino acids score differences, the rationality coefficient of the amino acid composition, the protein efficiency ratio, and the essential amino acid index are calculated for each pomological variety.

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S2 P69 IS57

Sources of winter hardiness of the Nikitsky Botanical Garden peach collection in the Steppe Crimea

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Extreme negative air temperatures are limiting factors for the spread of peach culture in southern Russia. The study of the gene pool of the peach Nikitsky Botanical Garden in the steppe Crimea on the basis of "winter hardiness" has been carried out by field and laboratory methods. The result was the distribution of cultivars and forms into four groups of winter hardiness. The first group includes non-hardy and slightly winter-hardy cultivars, in the second - medium winter hardy, in the third – winter-hardy and the fourth - highly winter-hardy. The donor of "peach generative buds frost resistance" - "Start" was allocated, and 74 cultivars as a source of peach winter hardiness were identified. They include: peaches ‘Demerdzhinskiy’, ‘G.Lebedev’, ‘Candidatskiy’, ‘Crymskiy Feyerverk’, ‘Comanche’, ‘Melitopolskiy Yasnyiy’, ‘Nikitskiy Podarok’, ‘Osvezhayushciy’, ‘Ranniy-84’, ‘Sochnyiy’, ‘Suncrest’, ‘Hui-Huni-Tao’, ‘C16/87’, ‘C4/21’, ‘10487’, nectarine ‘Crimchanin’, ornamental peach ‘Vesenniy Ogone’ and etc. There was 51 percent share of domestic cultivars or the Nikita Botanical Garden selection among the winter hardy cultivars. Also, there were identified peach cultivars with a set of economically significant signs. They were recommended for commercial use or for breeding as sources of winter hardiness, high yield and good fruit quality, namely: 'Alma-Atinskiy', 'Bianca de Verona', ‘Vostok 3’, ‘Doneckiy Zheltyiy’, ‘Zolotaya Moskva’, ‘Crimskaya Osene’, ‘Kudesnik’, ‘Posol Mira’, ‘Shans’, ‘Yubileynyiy Ranniy’, ‘C4/38’, ‘C7/186’, ‘C4/57’ ‘C1/227’. The paper presents a brief description of these cultivars.

S2 P70 IS58

Morphological characteristics of ornamental peach cultivars in connection with breeding

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The ornamental peaches collection in the Nikita Botanical Gardens is a large one of this plants group in the world. The number of cultivars in the collection varies from 85 to 100 or more in different years, depending on the prospects of existing samples for some parameters. The gene pool of this collection is based on the form diversity *Prunus persica* and obtained hybrids with *P. davidiana*, *P. mira*, *P. kansuensis*, *P. dulcis*. The best ornamental accessions with the main morphotypes on the signs of flower, leaf and crown, with a complex of adaptive parameters, including winter-hardiness and resistant to fungal diseases are represented in it. Morphological characteristics and their gradations for *P. persica*, established by UPOV, reflect the range of the fruit peach cultivars variability in a greater degree. Ornamental varieties have their original features, especially concerning the quantitative and qualitative characteristics of the flower. The use of wild peach and almond species in breeding for ornamentality significantly have been widened the range of variation of morphological features and determined the appearance of their new gradations. Analysis of the collection composition according to the main ornamental and morphological features showed that its form diversity is represented by 4 gradations of the tree vigor, 4 – of crown type, 7 – of the corolla color, 5 – of the degree of double flower, 8 – of the shaped flower, 3 – of the leaves color, 7 – of the flowering time and others. In connection with this, we have adapted a table with morphological characteristics for describing ornamental peach cultivars to evaluate their distinctness considering the nature of the signs variability. The table contains 62 signs, represented by 245 gradations, with 33 signs characterizing the structure of the flower.

S2 P71 IS48

Inheritance and Correlation of phenol and flavonoid genetic patterns for genome sequencing project in onion (*Allium cepa* L.)

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Onion (*Allium cepa*) is one of the economically important vegetable crops, which is important for the dietary and culinary purposes, and contains secondary metabolites pharmaceutically important, so called 'quercertin'. In addition, onions are well known health functional ingredients. Among them, phenol and flavonoid components were analyzed by genetic analysis. This study was conducted to analyze the relationship between phenol and flavonoid genetic patterns and other traits in an onion genome sequencing project. We have two cultivars in cultivated in Korea in order to sequencing and gene inheritance, "Umgi-nara" and "Sinsunhwang". "Umgi-nara" is a red onion, which is a homozygous cultivar and a winter type, medium-late and good storage with high uniformity. Another cultivar "Sinsunhwang" is a yellow onion, which is a homozygous cultivar, other characters is similar as "Umgi-nara". In this research, F_1 and F_2 generations of red and yellowish brown onions were obtained in the middle of material building for the genetic analysis. The analysis of F_2 traits for each plant was conducted after transplanting on field. In the F_1 generation, the red color showed dominance over brown one. And, in the F_2 some onion seedling showed red color on their stems. The correlation coefficient of phenolic compounds was as high as 0.857. The amount of phenolic compounds ranged from 500.0 mg up to 880 mg. This was different according to onion color and red color showed high tendency. This indicates that the thumb red is red, and the red line as a whole is high. The content of flavonoid was different from that of phenol. The content of flavonoids according to the color of onion is known to vary in the order of red> yellow> white. However, this genetic pattern did not match in this study.

S2 P72 A728

PDKV Trupti: New Acid lime Variety for Pickle

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A pickle type acid lime variety "PDKV Trupti" developed at AICRP (Fruits') Dr. PDKV, Akola evolved from limb sport selection. The fruits of " PDKV Trupti are round to oblong, yellow at maturity ,large size weighing about 59 to 60 g , with average 53.50g wt of *ambia bahar* fruits, having fruit segments : 9-10 no, warty and thick peel (0.28cm) with strong very strongadherence and thick rind, peel percentage (22.25%), rag 28.73% fruit pulp : light greenish yellow, texture coarse, comparatively moderate juicy (49.75%) , flavor good, sour and highly acidic (8.55%) , seed : 9-10 and highly poly embryonic and having yield potential : 25 to 27 tones/ha. PDKV Trupti had obtained maximum score for quality attributes for pickle and

pickle quality (93) as well as overall consumer acceptance (8.37) which was ranked first and came under the category of liked very much on Hedonic Scale by the referee and consumers. This was largely because PDKV Trupti 3 fruits were thick peeled, having highest peel percentage, moderate juicy, maximum rag % compare to the ruling varieties PDKV lime, PDKV Bahar, Saisarbati, Pramalini, Vikram and PDKV Chakradhar used as check which were mostly thin peeled.

S2 P73 A5

Evaluation of different rootstocks and method of propagation forgraft compatibility and growth of pomegranate (*Punica granatum* L.)

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The present investigation was undertaken to assess the graft compatibility of various rootstocks with the new pomegranate cultivar, Phule Bhagwa Super by adapting various propagation methods during 2012 to 2015. Two propagation methods *viz*., wedge grafting and patch budding and eleven rootstocks *viz.*, Ganesh, Bedana Suri, Alandi, Kandhari, Jallore Seedless, Jodhpur Red, Patna-5, Muscat, Yercaud, Bedana Sedana and Daru with total 22 treatments combinations and 50 grafts in each treatment and replication were taken as sample size. Fifteen cm long leafless scions of 6-9 months old from cv. Phule Bhagwa Super were used for grafting/budding on one year old seedlings of different rootstocks. Bedana Suri and Alandi rootstocks took significantly minimum time (17.77 days) for bud sprout and significantly highest bud sprouting (80.0 %) 30 days after grafting/budding was recorded by Bedana Suri as compared to other rootstocks. Maximum survival (76.67 %) of grafts/buds after 90 days of grafting/budding and highest shoot growth rate was also recorded in the same rootstock. Bedana Suri rootstock also recorded the longest shoot length, highest number of shoots & internodes and maximum girth at graft/bud union. Uniform stock/scion girth ratio (1.0) and graft compatibility was recorded in rootstocks, Ganesh, Bedana Suri and Kandhari with wedge grafting. Bedana Suri rootstock produced longer shoot and root and highest fresh shoot and root weight while, highest shoot/root weight ratio was recorded in Kandhari. It is concluded that better graft compatibility of cv. Phule Bhagwa Super was found with Bedana Suri, Ganesh, Kandhari, Jallore Seedless and Alandi rootstocks, either by wedge grafting or patch budding method to obtained higher success and better stionic growth.

S2 P74 A181

Performance of Anthurium (*Anthurium andreanum* Lind.) cultivars under NVPH

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An investigation was carried out at experimental plot, College of Horticulture, Mudigereto evaluate the performance of seven *Anthurium* cultivars under NVPH. Cv. Tropical gave highest plant height (73.12 cm) which was on par with Fire (64.22 cm). Number of leaves were highest in Midori (13.44) followed by Tropical (12.56) and Fire (12.33). No significant difference was observed for leaf area and LAI . Flowering was earliest in Fantasia (30.63) days. Cv. Tropical showed longest peduncle length (15.53 cm) followed by Midori (14.07 cm). Spadix angle to spathe was highest in Fantasia (35.10) and Midori (34.40). Cv. Tropical produced highest number of flowers (13.41) per year. Vase life was longest in Midori (35 days) followed by Tropical (32.22 days). Highest B:C ratio was noticed in Tropical (3.5) followed by Midori (3.34) and least in Fantasia (1.99).

S2 P75 A284

Physiological and biochemical effects of chemical mutagenesis on *in vitro*-raised plants of *Gerbera* (*Gerbera jamesonii* Bolus)

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Gerbera (*Gerbera jamesonii B*olus) is an attractive ornamental flower of high economic importance. The present investigation was aimed to the physiological effects of chemical mutagenesis on *in vitro*-raised plants of *Gerbera jamesonii* Bolus. *In vitro* shoots of gerbera were established from flower bud and stalks explants in 5.0 mg BAP and 1.0 IAA on MS Medium, were exposed to induce mutations through chemical mutagenesis, different concentrations of ethyl methane sulphonate [EMS; 0.1, 0.5, 1.0, 1.5 and 2.0 % (v/v)] were administered for 10 min or for 15 min. The activities of superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR), catalase (CAT), and polyphenol oxidase (PPO) were tested and increased significantly compared to untreated control shoots. Significant changes were observed as compared to untreated shoots in total phenol and total protein but chlorophylls were decreases. Increases in the activities of the enzymes, and in the concentrations of phenolic compounds and proteins, indicated the importance of these biomolecules in protecting gerbera plants grown under abiotic stress conditions.

S2 P76 A742

Conservation of Fruit Crop Diversity Utilizing Public Green Spaces

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Fruit crops diversity plays pivotal role in nutritional security, poverty alleviation, economic upliftment in addition to maintaining sustainable horticultural production and clean environment. Judicious utilization of land and natural resources is urgently needed to feed burgeoning population with nutritionally rich diet along with essential developmental activities. Land is a shrinking resource for agri-horticulture sector and in view of increasing population pressure and rapid urbanization process, there is meagre scope for horizontal expansion for fruit crop conservation. Contrary, the huge diversity exists in fruit crops which mainly come from seedling population raised by ancestors through the ages. These resultant progenies are very useful to mankind as they vary in flowering time, bearing behaviour, maturity, fruit quality traits and post harvest life. Conservation of available fruit crop diversity of the tree fruit crops in research institutions only is a herculean task as they require lot of space and recurring cost for management. Simultaneously, the existing diversity of fruit crops is getting eroded every year from community places in villages, backyards and kitchen gardens by natural calamities, anthropogenic activities and heavy biotic pressure. Currently, there are ample green spaces available at public places are being unutilized and lying waste viz., parks, court premises, hospitals, educational institutions, cantonment areas, national high ways and railway premises. In view of the above facts, these vacant green spaces can be utilized by planting important tree fruits crops for conservation of genetic diversity which may provide a future long term platform for revenue receipts, employment opportunity, nutritional security, ecological balance. Hence, sincere efforts are immediately needed to conserve the valuable

diversity of fruit crops by utilizing public green spaces which will finally result in long term conservation of fruit crop genetic resources.

S2 P77 A748

Potential of new F_1 hybrids of China aster (*Callistephus chinensis* (L.) Nees.)

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China aster is a flowering annual belongs to the family Asteraceae and is native of China. It is commercially grown for cut flower and loose flower by marginal and small farmers. Hybridization was carried out using five ICAR-IIHR varieties *viz.*, Arka Aadya, Arka Archana, Arka Kamini, Arka Poornima and Arka Violet Cushion as female parents and 23 stabilized lines as male parents. A total of 51 F_1 hybrids were developed and evaluated with their parents for flower quality and yield attributing traits at the Division of Floriculture and Medicinal Crops, ICAR-IIHR, Bengaluru during 2016-17. The F_1 hybrids and their parents showed significant differences for morphological traits. Among the F_1 hybrids and their parents evaluated, maximum plant height was recorded in hybrid 15-47 (81.60 cm) and 15-49 (81.60 cm), while, maximum plants spread was recorded in 15-7 (75.00 cm). The number of leaves/plant was ranged from 9.6 (IIHRJ3) to 25.2 (15-44), however, maximum number of branches/plant was recorded in SAT-6 (27.2), while it was minimum in MIS-1(BR) (10.00). The minimum number of days taken for first flower opening was recorded in 15-38 (51.40 days), while delayed flowering was recorded in KS-6 (86.20 days). Maximum stalk length was recorded in I69-2 (57.40 cm) followed by 15-1 (56.40 days). Maximum number of flowers/branch (8.6) and flowers/plant (108.60) was recorded in 15-29 and 15-5, respectively. Maximum one-hundred flower weight was recorded in 15-55 (445.4 g) followed by Arka Poornima (441.80 g), whereas, minimum recorded in 15-5 (74.60 g). Highest weight of loose flowers/plant was recorded in 15-16 (317.8 g) followed by 15-20 (311.60 g). The number of ray florets/flower head was ranged from 174 (CC5-1-23) to Arka Shashank (30.40). The flower diameter was recorded highest in IIHRE10 (7.16 cm), followed by 15-48 (6.68 cm) and 15-55 (6.62 cm). On the basis of evaluation, F_1 hybrids 15-35, 15-38 and 15-53 for attractive flower colour, flower form and hybrids 15-16, 15-20, 15-7 and 15-24 for loose flower yield were found promising.

S2 P78 A753

A new chemotype of palmarosa, *Cymbopogon martini* (Roxb.) W. Watson identified from Aravalli range near Udaipur, Rajasthan

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Palmarosa (*Cymbopogon martini* var. Motia), an essential oil bearing grass of Indian origin, is highly valued by the cosmetics and perfumery industries for its sweet-smelling essential oil obtained from its inflorescences and leaves. During an exploration to Aravalli range of Udaipur, palmarosa grass covering the entire hills were noticed, which upon close observation revealed entirely different aroma compared to cultivated palmarosa. Hence, it was thought to investigate and compare its morphological characters along with yield and quality parameters with released variety of palmarosa PRC-1. The seeds of the Udaipur chemotype were collected and seedlings were transplanted at ICAR - Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat along with seedlings of palmarosa var. PRC-1. The two years observation revealed that though the Udaipur chemotype is short and bushy it recorded significantly highest dry biomass weight, essential oil content and essential oil yield compared to cultivated palmarosa. Further, morphological characterization carried out based on collar, auricle and ligule of the leaf and involucral bract of the inflorescence revealed no significance variation between these two accessions. However, GC/MS analysis of the essential oils of these accessions showed entirely different spectra of chemical compounds. The cultivated palmarosa essential oil contains 70-90% geraniol and 7-8% geraniol acetate, whereas, it's Udaipur chemotype contains limonene epoxide (22.1%), trans carvyl formate (17.31%), carvyl acetate (17.21%), limonene (12.95%), dihydro linalool acetate (9.3%), delta cadinol (5.31%) as the major components. As the newly identified chemotype is wildly distributed in Aravali hills of Udaipur, it can be commercially utilized by mere distillation of its essential oil, once its industrial utility is established. Considering the Udaipur chemotype's wild adaptability, sturdy growth, high herbage and essential oil yield, it can also be utilized in palmarosa breeding programme.

S2 P78 A754

Genetic variability and trait-specific characterization of walnut genetic resources for future improvement programme

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Persian walnut (*Juglans regia* L.) occupy the prime place among the temperate nut crops cultivated in Himalayan region because of its high nutritional value, wide range of adaptability to edaphic and climatic variations and it also has potential to combat climatic vagaries. Traditionally, walnut growing in the Himalayan region of the country is of seedling origin and hence it exhibits ample amount of genetic diversity. ICAR-Central Institute of Temperate Horticulture, Srinagar has about 350Persian walnut accessions collected from North Western Himalayas and few of exotic origin. This large scale diversity offers a great advantage to the breeders. However, the extent of variation in the germplasm collections and their accessibility to biologist and breeder are essential factor affecting their utilization in crop improvement programme. Hence, the study was initiated in walnut germplasm to characterize genetic variability and to identify trait specific genotypes for potential parent selection and varietal improvement. In the first phase, a total of 136 walnut accessions were characterized during the year 2015 and 2016. Both qualitative and quantitative traits were studied such as tree growth habit, bearing habit, branching density, nut and kernel characters. Tree growth habit of walnut accessions were categorised as erect (04), semi-erect (63) and spreading (69) type. Walnut accessions exhibited all three type of bearing habits viz., terminal (122), intermediate (12) and lateral (2). Lateral bearing habit was exhibited by Serr (exotic) and CITH-W-121 (IC-0622836). Four types of branching density were recorded viz., sparse (09), intermediate (90), dense (36) and very dense (01). Nut characters exhibited wide variability among the accessions: nut weight (6.09-24.23g), nut thickness (26.87-41.64mm), nut length (29.70-53.36mm), nut diameter (26.17-43.97mm) and shell thickness (1.01-2.36mm). Kernel weight and recovery varied between 3.30-11.16g and 36.27-60.19% respectively. Accessions were also characterized for other promising traits viz., shell colour, shell integrity, nut shape, shell texture, shell seal and removal of kernel halves. This type of detailed and trait specific characterization will enhance the utilization of genetic resources in future walnut improvement programme to breed improved and high nut yielding varieties for doubling farmers' income.

S2 P79 A755

Breeding medicinal crops – Opportunities, challenges and achievements at ICAR-IIHR

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Demand for herbal raw materials is growing globally at the rate of 15 to 25% annually and this upsurge resulting in indiscriminate exploitation of wild resources. Bringing medicinal plants under cultivation eases pressure on natural resources, ensures correct identity, consistent quality and reliable supply of raw material. Breeding elite genotypes of medicinal crops is very essential to maintain high quality, profitable and sustainable production. Breeding of medicinal plants is still a virgin area of research and the existing unexploited natural variability presents a great opportunity to tap the genetic potential of medicinal plants through simple inexpensive breeding procedures. The challenges are many as they are a large divergent group of species with varied reproductive biologies with little or no information on the phenology, genetics, complex mechanisms behind synthesis of secondary metabolites and expensive analytical procedures. ICAR-IIHR is working on the development of elite lines with higher economic yield and active ingredient in commercially important such as Ashwagandha, Kalmegh, Mandukaparni and Velvet bean throughconventional breeding methods like selection, recombination and polyploidy breeding.In Ashwgandha (*Withania somnifera*),Arka Ashwagandha with higher root yield and withanolide content, inVelvet bean (*Mucuna pruriens*),Arka Dhanvantari and Arka Aswini with higher seed yield and L-dopa content and inMandukaparni (*Centella asiatica*)Arka Divya and Arka Prabhavi with higher leaf yield and higher asiaticoside content have been identified for commercial cultivation.Promising advance breeding lines are in pipeline in Velvet bean and Kalemgh.In addition to conventional breeding techniques a multi disciplinary approach involvinggenetic and metabolic engineering and omics technology will hasten genetic improvement in medicinal crops.

S2 P80 A756

Development of Indian gynoecious cucumber lines through marker assisted selection (MAS)

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Cucumber (*Cucumissativus* L.) has extremely narrow genetic base strongly reduced to 3-10% DNA polymorphism during its domestication. Indian cucumber cultivars are basically monoecious in nature and associated with crown fruit inhibition. Lateral shoots of these monoecious cultivars usually have stronger female tendencies while main stem produces mainly staminate flowers. Gynoecious based hybrids produced by crossing gynoecious and monoecious lines are very much productive. In the present study one stable gynoecious line (G421) was used as donor parent and Indian monoecious cucumber variety PusaUday as recipient parent. All the F_1 plants were gynoecious and predominantly gynoecious habit and these were backcrossed to PusaUday for developing $BC_1F_1$and selfed to produce F_2 plants. The F_2 plants were used to study of the inheritance gynoecious trait (*F*) and mapping was carried out. The F_2 progenies of PusaUday × G 421 cross showed 153 gynoecious plants and 56 monoecious plants at the ratio of 3:1 which confirmed the single dominant gene for gynoecism.The heterozygous BC_1F_1 plants were selected based on genotyping and then selfed and backcrossed with PusaUday again to obtain BC_1F_2 and BC_2F_1seeds. Based on phenotyping and genotyping, plant #29 from BC_1F_2 population was selected and selfed to develop BC_1F_3 population. The recurrent parent genome recovery was analyzed in BC_1F_3 generation using SSR markers covering all 7 chromosomes which allowed identifying the plants that were more similar to the recurrent parent. The development of gynoecious lines with inherent traits of Indian *desi* cucumber will be more preferred by Indian consumers. The successful application of molecular marker assisted breeding for incorporation of gynoecism in Indian cucumber genetic background will pave the way for utilization of markers for other traits including earliness and disease resistance in future breeding programmes.

S2 P81 ID4

Bioecological assessment of ornamental arboreal plants within initial stages of introduction on South Coast of the Crimea and Black Sea Coast of Caucasus

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The article covers introduction peculiarities of ornamental arboreal plants growing on South Coast of the Crimea (SCC) and the Black Sea Coast of Caucasus (BSCC). It was found proved that under conditions of SCC introduction priority goes to non-moisture - and soil fertility-required. Such characteristics were noticed for many Mediterranean species of ornamental arboreal plants, what promoted them for parks layout and landscaping in populated areas in this region. On the Black Sea Coast of Caucasus planting structure of ornamental arboreal plants species from North American floristic region prevail here, they are mainly characterized by rather high demand in soil moistening. Low level aeration in soil is one of negative factors,

that limits growth and development, quality and life time of introduced ornamental

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S2P82 A33

In vitro production of cormels in gladiolus through gamma rays

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The present experiment was conducted to standardize the protocol for *in vitro*mutagenesis of *Gladiolus grandiflorus* varieties 'Punjab Glance' and 'Sylvia'. The nodalbudswereirradiated withdifferentdosesofgamma rays (Co^{60}) 0, 5,8,10 and 12 Gy.Irradiatedexplantswerethenculturedaseptically onMSbasalmediumsupplementedwith5 mg/l (BAP)+2mg/l (IBA) and agar-agartoinduceshoot and rootproliferation. Explantstreatedathigherdoses(10 and 12Gy)showed deleteriouseffectsof ionizing radiation. Morphological abnormalitiesin terms of stuntedgrowthwereobservedat10 and 12Gy of gamma rays. Minimum time was taken to shoot (14.07) & root (15.06) formation and days to cormel formation (60.04 days) at 8 Gy. *Invitro*-raisedmutantcormels and non-irradiated(control)plants were transferredto plastic pots onemonthafter acclimatizationunder laboratory conditionsandexaminedfortheir morphologicaltraits. These mutated cormelswere multipliedonalarge-scale throughmicropropagationand evaluatedfor

theirstability.Thisstudydevelopedamutagenesisprotocolthatcouldbeusedtodevelopnovelcolourmutantsingladiolus.

S2P83 A68

Diversity of brinjal in eastern part of India

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Brinjal (*Solanum melongena* L.) is the most popular and widely cultivated vegetable crop in eastern part of India. West Bengal is the largest producer of brinjal in India with a productivity of 18.43 t/ha. Characterization of local genetic resources for identification of important traits for further utilization is important in the present day breeding programme. Cultivars of brinjal collected from different parts of eastern India have been characterized through different studies. Growth, floral and fruit characters have been expressed as separate genotypic features, so it is difficult to identify set characters for general characterization of brinjal. However, a wide range of days to 50% offlowering, fruit length, fruit girth, fruit weight, number of marketable fruitper plant, marketable fruit yieldper plant, infestation of FSB and incidence of bacterial wilt disease among the genotypes was observed. Fruit weight, plant height and days to 50% of flowering exhibited high heritability and genetic advance. Among the yield component traits, fruit weight and number of marketable fruits per plant showed highly positive direct effects on marketable fruit yield perplant. Total sugar and phenol content of fruits have a direct bearing towards tolerance/susceptible reaction of brinjal genotypes. The correlation study between different histological parameters and incidence of bacterial wilt disease in eggplant revealed that average large vessel area in the vascular bundle of both stems and roots of the genotypes showed negative correlation with incidence of bacterial wilt. Divergence analysis based on various yield component traits grouped brinjal genotypes into nine main clusters. Dendrogram based on hierarchal clustering grouped genotypes based on their yield component traits rather than their geographic origin. Based on averages and principal component analysis, six genotypes (BCB-30, Deshi Makra, Gujrat Brinjal Round, 09/BRBWRes-3, BCB-10, 10/BRRVar-2) appeared to be promising donors for use in further breeding programme.

S2P84 A69

Heterosis breeding could improve yield, fruit quality and dual disease tolerance in tomato

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The major problems faced by the growers of the Gangetic plains of West Bengal, a forerunner in vegetable production in India, are the huge incidence of ToLCV and bacterial wilt diseases particularly in early-autumn crop. Keeping in view, a study was undertaken following 4×4, line × tester analyses utilizing 4 lines identified as tolerant to bacterial wilt (Utkal Raja, Utkal Kumari, Utkal Deepti, Utkal Urbashi) and 4 testers tolerant to ToLCV (CLN 2777F, CLN 2777B, CLN 2777C, CLN 2498D) disease to estimate the combining ability, mode of gene action, extent of heterobeltiosis and dominance effects in the inheritance of fruit yield , quality and disease severity traits.Bacterial wilt disease incidence was recorded from hybrids and parents from 45 days after transplanting (DAT) up to 90 DAT following the method of Winstead and Kelman (1952) from sick field and grading of ToLCV was done according to Banerjee and Kalloo (1987) using 0-4 grading scale starting from 30 DAT up to 90 DAT.Based on gca effects, two parents CLN 2498D and Utkal Deepti were identified as the most promising combiners and could be utilized further in tomato resistant breeding programme. On the basis of *per se* performance, heterosis manifested in them and sca effects, two outstanding hybrids (CLN 2498D × Utkal Kumari , CLN 2498D × Utkal Deepti) could be identified for high yield , better quality traits and dual disease resistance. These two hybrids could be exploited at commercial level in the Gangetic plains of West Bengal after critical multilocational evaluations. Overwhelming response of non-additive genetic control of these studied traits suggested heterosis breeding could be used to improve the traits. The dominance effects clearly demonstrated partial- to over-dominance reactions for the inheritance of fruit yield and other economically important traits in tomato.

S2P85 A70

Genetic variability studies in Dolichos bean (*Dolichos lablab* L.)

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Dolichos bean (*Dolichos lablab* L.) is an important vegetable crop all over India due to its local acceptability by the people. The yield of Dolichos bean has remained low in tropical climate of India mainly due to the lack of genetic information and limited improvement work. Dolichos bean has a wide range of genetic variability *viz.*, plant habit, branching habit, stem pigmentation, pod color and pod characters etc. Twenty Dolichos bean genotypes were evaluated for its genetic variability using RBD design in APHC, kalavai, Vellore. Analysis of variance showed significant variation for all the characters among the genotypes which indicated that genetic variability was present among the different genotypes. High genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) estimates were observed for total biomass @ 50% flowering, number of racemes per plant, number of pods per plant, pod length (cm), pod width (cm), green pod yield per hectare (t/ha.), green pod yield

per plant (g) and carbohydrate. High heritability with high genetic advance was observed for leaf area index @ 50% flowering, total biomass @ 50% flowering, number of racemes per plant, number of flowers per raceme, number of pods per plant, pod length (cm), pod width (cm), pod weight (g), green pod yield per hectare (t/ha.), carbohydrate and green pod yield per plant (g). The broad sense heritability ranged from 45.84 % to 99.11 % and signified the observed variation to be genotypic in origin. High heritability coupled with genetic advance observed for these characters imply the potential for crop improvement through the selection.

S2P86 A75

Genetic variability and heritability for earliness and yield related characters in ridge gourd [*luffa acutangula* (L.) Roxb.]under southern dry zone of Karnataka.

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Ridge gourd is an important crop cultivated widely in the tropical countries including India for its green long fruits that are cooked as vegetable. Genetic variability and the transmittance of favourable genes to the progenies are two important factors in the success of any crop improvement programme. Therefore the present study was conducted with 25 genotypes of ridge gourd collected from different sources and their evaluation for growth parameters, fruit yield and yield contributing traits using Randomized Block Design at College of Horticulture, Mysuru, Karnataka during *Kharif*, 2015. The results indicated significant variability among the genotypes studied for all the traits observed except for seed test weight. Considerable variability was found for fruit yield per plant (0.297 kg -1.83 Kg), with IC-92638 and Arka Sujath being the highest yielders. Number of fruits per plant varied from 1.60 (Ghataprabha Local) to 8.0 (IC-92638). High values of Phenotypic co-efficient (PCV) and genotypic co-efficient (GCV) of variation were observed for fruit yield per plant, number of fruits per plant, vine length and for seed yield per plant. These traits also exhibited high heritability coupled with high values of genetic advance expressed over per cent of mean, suggesting the possibility of improvement in these traits through simple selections. However, the earliness traits viz., days to 50% female flowering, days to first harvest, and fruit size in terms of length and fruit diameter exhibited moderate values of GCV and PCV along with moderate levels of heritability and genetic advance.

S2P87 A79

Genetic diversity among cultivated and wild species of Tomato

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The present investigation was carried out todetermine the relationship and genetic diversity among 12 tomato genotypes including cultivated types and five wild relatives. Observations were taken on 30 qualitative and quantitative characters and the data were subjected to the principle component analysis (PCA) and hierarchical cluster analysis (HCA). The first seven principle components having eigenvalue more than one and cumulatively contributing93.7% to the total variability were selected. The PC1 added 45.1% variation with thesignificant loading of primary branch per plant, fruits per cluster, fruit weight, equatorial diameter, test weight and growth habit**.**These were the traits responsible for maximum variation among the cultivated and wild relatives of tomato. On score plot of PC1 and PC2, all the cultivated types were present on the right side of the graph whereas all the wild relatives were fallen on the left side of the graph indicating the clear difference between cultivated and wild relatives. HCA revealed that the tomato species had considerable diversity and were classified into five divergent clusters. Cultivated and wild relatives occupied different clusters and there was no grouping of cultivated and wild relatives in the same cluster. Among five clusters, cluster 4 had the highest number of genotypes (4) whereas cluster 3 and cluster 5 had theleast number of genotypes. Cluster 1 and 2 were having 3 genotypes.Scoreplot, as well as dendrogram, confirmed that *Solanum peruvianum* is the most distant species as it was located far from the other esculentumspecies complex.

S2P88 A81

Heterosis and combining ability studies in bell pepper (*Capsicum annuum*L.)

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A field experiment was conducted at Department of Vegetable Science, College of Horticulture Mudigere, to study the heterosis and combining ability for yield and quality traits in bell pepper (*Capsicum annuum* L.). Thirty F_1 hybrids were produced by crossing six parents

in complete diallel mating design with reciprocals. Variance due to parents, hybrids, F_1 and reciprocals were highly significant for all the characters. In case of interaction of F_1 vs. reciprocals except plant height at 30DAT, number of primary branches and number of locules per fruit and in case of interaction of parents vs. hybrids except number of secondary branches, yield per plant and number of locules per fruit all characters showed significant differences. The diallel analysis revealed that no single parent was superior for all the traits under consideration. Significant *per se* performance and economic heterosis in desirable direction was recorded in several crosses. Maximum standard heterosis for total yield per plant was observed in the cross Yolo Wonder x California Wonder (26.91 %) followed by California Wonder x Yolo Wonder (15.90 %). In most of the characters SCA variance was greater than GCA variance. Among the parents, Yolo Wonder was good general combiner followed by California Wonder and Arka Mohini. Among the hybrids California Wonder x Yolo Wonder, Arka Mohini x Soaln Bharpur and Arka Mohini x California Wonder crosses had significant SCA effect for yield per plant. California Wonder x Yolo Wonder and Arka Mohini x Yelavigi Collection were good cross combinations for ascorbic acid content whereas, Arka Mohini x Yolo Wonder was good cross combination for shelf life. The present study reveals that heterosis breeding is useful for improvement of bell pepper crop.

S2P89 A88

Applied mutagenesis in tomato for the isolation of mutants with enhanced fruit quality

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Spontaneous or induced mutants, with desirable changes in particular characters have been a key material for gene discovery, mapping, functional genomics and breeding in many crops including tomato. The present investigation was undertaken to study the frequency and spectrum of macro-mutations of gamma rays, ethyl methane sulphonate (EMS) and their combinations in "Patharkutchi," the highly adaptable and popular cultivar of West Bengal. The dry seeds were irradiated with 50, 100, 150, 200 and 250 Gy gamma rays. Pre-soaked seeds of this genotype (6 h, in water) were treated with 0.05, 0.10, 0.15, 0.20 and 0.25% ethyl methane sulphonate (EMS) for 8 h at 25 ± 2^{o}C. Gamma irradiated seeds of this genotype were also pre-soaked (6 h, in water) before treating with 0.15 % EMS solution for 8 h at 25 ± 2^{o}C as combination treatment. The EMS treated seeds were washed thoroughly in running water at least for an hour before sowing.

Combination of gamma radiation and EMS caused more damage followed by EMS treatment and gamma radiation, alone in M_1 generation. Gamma irradiation (50-150 Gy) was most efficient followed by 0.05- 0.10 % EMS and their combination treatment in inducing wide array of macro-mutation in tomato. One mutant "Dark green fruit" could be isolated from the

M_2 population of Patharkutchi treated by 150 Gy gamma radiation. Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll content in the leaf and immature fruit of this mutant was markedly high compared to the parental genotype. Average total chlorophyll content in the leaf and immature fruit of the mutant over M_3 and M_4 generation was 318.52 mg/100 g fresh and 21.93 mg/100 g fresh, respectively in sharp contrast to 198.25 mg/100 g and 12.21 mg/100 g fresh, respectively in the leaf and immature fruit of the parental line. This "Dark green fruit" mutant with higher average lycopene (7.49 mg/100 g fresh) and ascorbic acid (35.86 mg/100 g fresh) contents in the ripe fruits emerged as a promising genetic resource for further utilization in breeding tomato for enhancement of lycopene and ascorbic acid content in the fruits.

S2P90 A132

Breeding for Industrially Valued Chillies: Retrospect and Prospectus

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Chilli (*Capsicum annuum* L.) is one of the most important commercial spice, used as vegetable in the world, as green chillies, red ripe and whole dried pod in culinary mainly due to the chemical constituents namely capsaicinoids (pungency), capsanthin and capsrubin (colours) and oleoresin –is a colourless and odourless liquid. In the recent years, oleoresin is gaining prime importance and widely used in medicines, weapon, meat, liquor industries; whereas the utility of carotenoid pigments has been expanded in cosmetics, food, textile, pharmaceutical industries. Among chillies, the paprikas are rich source of capsanthin, the cultivar Byadagi chilli under paprika group having high capsanthin (199.03 ASTA Units), which is mainly preferred in the food industries as a natural dye in place of synthetic colour. The increased awareness of medicinal properties like natural carotenoids and capsaicinoids would be a great potentiality of chillies to versatile in horticultural world. In this view, there is a need to breed varieties/hybrids for industrially valued traits like oleoresin and carotenoid pigments by understanding the trait genetics of inheritance which isa prerequisite for genetic improvement of paprikas with aid of molecular markers. Therefore, the development of varieties/hybrids with high yield and industrially valued traits is a great challenge and thus the improvement of industrial value traits would have great impact on economic growth of the world.

S2P91A144

Effect of Pollen Parent on Fruit Development and Quality of Intervarietal Crosses of Guava

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Pollen parents have strong impact on physical and biochemical properties of fruits as reported in wax apple, papaya, mandarin orange, pistachio nut, loquat, citrus, grapes, etc. The genetic variations in the pollen grains can serve as the basis for selection of males to improve yields, fruit quality and alter fruit ripening time depending on the market demand.Two superior guava varieties Allahabad Safeda and Shweta were crossed with two different pollen parents viz. Arka Kiran and Baruipur Local to explore xenial and metaxenial effect.Pollen supplying genotypes could not significantly enhance the average weight of crossed fruits on both the seed parents with an exception of Shweta × Baruipur Local. Selection of Arka Kiran and Baruipur Local as pollen parents proved to be beneficial for reducing number of seeds per fruit although the seeds became bold when Arka Kiran was selected as pollen parent. Arka Kiran and Baruipur Local as pollen donors in Allahabad Safeda produced fruits with enhanced T.S.S. of 20.07% and 19.33% respectively. Allahabad Safeda when pollinated with pollens of Arka Kiran, an enhancement in quantity of (24.86 mg) ascorbic acid/100 g edible fruit pulp than female parent took place. The crossed fruits, those engross 'Shweta', as female parent always have prominent ridges but they became more prominent when the flowers of 'Shweta' were crossed with 'Baruipur Local'.

S2P92 A172

Induced mutation in flower head shape and flower colour in (*Chrysanthemum morifolium* R.) cv. 'Little Pink' through gamma radiation

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In the present study rooted cuttings of cv. Little Pink were subjected to gamma radiation (1 to 4.5 krad) with the objective of inducing flower colour and shape mutants. The experiment was conducted at Horticulture Research Farm, Departmentof Applied Plant Science, Babasaheb Bhimrao Ambedkar University, Lucknow and was laid out in randomized block design with nine treatments replicated three times. The quantitative and qualitative characters viz., survival percent, plant height, number of branches, number of leaves, number of abnormal leaves, number of flowers per plant, number of abnormal flowers per plant, number of suckers per plant and number of chimeric plants obtained were observed after irradiation.The results showed that the maximum plant survival (100%), maximum height of plant (47.66 cm), number of leaves (297.56), number of flowers, number of suckers (25), yield was recorded in control while minimum was recorded in higher radiation doses of 2.5 to 4 Krad which induced dwarf mutants. However, suckering was significantly reduced and cuttings for next generation could not be developed from these plants. Maximum number of branches per plant (25.66), diameter of flowers (5.95cm), number of ray florets (319.33), weight of flowers (5.66g) and chimeric plants was recorded in lower radiation doses of 1-2 Krad which induced earliness in the flower bud initiation, resulting in increased flowering duration, flower head shape, and flower colour. There was significant change in shape and size of ray florets of treated plants over control. Leaf and floral abnormalities were also observed in treated plants with gamma radiation.

S2P93 A184

Effect of orthotropic shoots of black pepper (*Piper nigrum* L.) to graft on *Piper hymenophyllum*

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Black pepper is commercially propagated vegetatively by using runners in India, while orthotropic shoots are used in Indonesia, Malaysia, Vietnam, Cambodia and Brazil. Orthotropic shoots are totally free from soil contamination; which gives earlier flowering and starts from second year of planting. In India, there are hardly any reports on the use of orthotropic shoots as planting material. Nowadays black pepper is seriously affected by foot rot disease (*Phytophthora palmivora*) causing severe crop loss and affected by nematode causing slow wilt disease. These two disease complex make pepper unproductive. As chemical control is not ecofriendly, the focus is now on using resistant rootstocks.*Piper hymenophyllum,* a wild species endemic to Lower Pulney hills of Tamil Nadu has been identified as a resistant rootstock of *Phytophthorapalmivora*and tolerant to nematode. With this background, an attempt has been made in this study to utilize the orthotropic shoots as scion materials and *Piper hymenophyllum* used as a rootstock material. The experiment was laid out in Factorial Completely Randomized Design with three replications. Three types of scions were used *viz.*, terminal, semi hardwood

and hardwood scions from orthotropic shoots in the three varieties of black pepper *viz.*, Panniyur-1, Kottanadan and Karimunda.In this study, grafting success,shoot and root traits was observed for orthotropic shoots when grafted on *Piper hymenophyllum*. In shoot traits,Panniyur-1 variety of orthotropic shoots of semi hardwood as a scion with *P.hymenophyllum*recorded the best performance. For root traits, Panniyur-1 with semi hardwood and hardwood scion with *Piper hymenophyllum*recordedthe best performances and grafting success. Panniyur-1 variety of orthotropic shoots as semi hardwood scionwith *Piperhymenophyllum*recordedthe best performance. Hence, result revealed that, the hardwood and semi hardwood scion could be selected as suitable types of scions on Panniyur-1 variety of black pepper.

S2P94 A190

Correlation and path coefficient analysis for vegetative and yield attributing characters in brinjal

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An experiment was conducted during Autumn-winter season of 2014-2016 for evaluation of 21 brinjal genotypes for 21 characters. It was found that genotypic correlations were higher than the phenotypic correlation indicating a strong inherent association among the variables at genotypic level. Considering these traits as selection criteria, direct selection may be done to avoid indirect effects of the other characters for developing high yielding varieties. Both at the genotypic and phenotypic levels, yield per plant had highly significant positive correlation with fruit weight, productive: non-productive flower ratio, number of primary branches per plant, fruit length, fruit peduncle length, number of fruits per plant, fruit diameter and plant circumference. The maximum positive direct effect was observed by fruit weight followed by plant circumference, number of fruits per plant. These traits also influenced other components towards yield per plant indirectly and may be considered for any future improvement programme for yield in brinjal.

S2P95 A194

Evaluation of French bean (*phaseolus vulgaris* l.) genotypes under Zone-9 of Karnataka

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An investigation on evaluation of French bean (*Phaseolus vulgaris* L.) genotypes under Zone-9 of Karnataka was carried out in randomized block design with three replications in the experimental block at Department of Vegetable Science, College of Horticulture, Mudigere, Karnataka during 2014. The genotypes*viz*., Mridula, ArkaKomal, Selection-9, ArkaSuvidha, ArkaAnoop, Arka Bold, Powel, Sunil, Jyothi, Nandi, ArkaSharath and Anuradhawere used.Among the twelve genotypes maximum per cent of germination was observed in Selection-9 (98.81 %) and Jyothi (98.60 %). ArkaAnoop performed better for most of the characters like plant height (45.33 cm), number of primary branches (9.00), number of cluster per plant (10.06), number of pods per plant (44.33), pod length (17.00 cm), pod yield per plant (82.00 g), pod yield per plot (5.90 kg / plot) and pod yield per hectare (18.26 t/ha). ArkaKomal and ArkaSuvidhawere the early flowering genotypes. Correlation studies revealed highly significant and positive association of pod yield per plant with most of the characters *viz*., number of pods per plant, number of primary branches per plant, plant height, number of secondary branches per plant, number of clusters per plant, pod length and pod circumference. Path analysis revealed that number of primary branches per plant at 45 days after sowing, number of pods per plant and pod circumference were the most influencing traits on pod yield per plant. Highest net profit and benefit to cost ratio was obtained from ArkaAnoop (3.63:1) followed by ArkaSuvidha (3.48:1) and these two genotypes performed better under Zone-9 of Karnataka.

S2P96 A201

Variability Analysis inChilli (*capsicum annum*l.)Genotypes

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The present investigation entitled "Variability Analysis in Chilli Genotypes"was conducted at Horticulture Complex, JNKVV, and Jabalpur (M.P.) during the year 2015-16. The experimental material consisting of eighteen genotypes of chilli were sown on plot size of 2.4 m × 4.0 m in a Randomized Complete Block Design with three replications to estimate the genetic variabilityand heritability and genetic advance for thirteen quantitative traits. Analysis of variance revealed highly significant difference among the genotypes for all the characters studied. The PCV was higher than the GCV for all the traits. High magnitude of PCV and GCV were observed fornumber of fruit plant^{-1} followed by average fruit weight, fruit yield plant^{-1}, while it was low fornumber of branches plant^{-1}.The heritability estimate were observed very high for plant height at 120, 90 and 150 DAT, fruit yield ha^{-1}. However, it was high for plant height at 60 DAT, average fruit weight, fruit yield plot^{-1}, days to first picking, fruiting span, fruit yield plant^{-1}, plant height at 30 DAT, number of fruit plant^{-1} and fruit length.High heritability coupled with high genetic advance as percentage of mean were observed for average fruit weight, number of fruit plant^{-1} suggested that the predominance of additive gene action indicating better scope for improvement of these traits by an effective selection programme.

S2P97 A203

Rootstock Breeding against *Fusarium*Wilt in Vegetable Crops: a Way Forward

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Fusarium wilt, being a soil borne disease, is difficult to eradicate and became a major production constraints in almost all Solanaceous as well as in Cucurbitaceous vegetable crops.Loss of 30-40% in chilli, 24.14-47.94% in tomato and more than 90% in melons have been reported due to the pathogen. Breeding varieties for *Fusarium* wilt resistanceis time and resource consuming due to involvement of several genes governing the resistance and transfer of some portion of undesired genome of the donor due to tight linkage.Sometimes the donor species is not at all crossable with the cultivated species or might produce sterile hybrids. To avoid such problems, rootstocks can be identified in the non-crossable wild germplasm or may

be bred by involving the crossable accessions of some donor speciesand the grafts with susceptible scion can easily be raised as commercial crop. To come out with a resistant rootstock, the available germplasm has to be screened in the hotspot areas of by artificial inoculation with spore suspension. RS-841 (*Cucurbita maxima* × *C. moschata*) has been identified for watermelon and cucumber. The lines, CM-17187, PI-296341, *Solanum torvum* and PI-126915 have been reported to confer durable resistance in muskmelon, watermelon, brinjal and tomato, respectively. Therefore, these lines are to be used in further to develop resistant rootstocks of these crops. Transgenic rootstocks can also be developed by over-expression of antifungal genes driven by a root-specific promoter like *LjNRT*2. Although, theoretically, the transgene protein will be accumulated only in the roots of the trans-stock, this area needs further study. Some authors reported undesired effects of the wild rootstocks on fruit quality; therefore, the fruit quality attributeshave to be tested in different stock-scion combinations before recommending the resultant for a commercial crop.

S2P98 A204

Morphological characterization of carrot (*daucus carota* l.).in Garo hils, Meghalaya, India

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Fifteen germplasm lines of carrot collected from different parts of Meghalaya, India were evaluated on the basis of 15 horticultural traitsin a randomized block design with three replications at Krishi Vigyan Kendra, ICAR NEH, Sangsangiri, Tura, Meghalaya, India during winter season from October to January (2014-15). There was sufficient variability among the genotypes of carrot for all the attributes under study viz., leaf length(cm), leaf width(cm), petiole length (cm), root length(cm), root diameter(cm), days to root harvest, root weight(g) and yield(t/ha). On the basis of the yield and root quality attributes, 5 genotypes of carrot viz., Shillong-2, Tura selection-2, Pusa Vrishti, Tura selection-7, Pusa Rudhira were identified as superior ones and which could be used in further breeding programmes in developing new varieties.

S2P99 A205

Genetic mechanism of sex expression in Vegetable Crops

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The flowering plants or angiosperms are the most diverse groups of plants. Different flowering habits (sex expression) are found in angiosperms. Hermaphroditism is the basic form in angiosperms. It is presumed that through the process of spontaneous mutations other sex forms originated in nature. The abortion of stamen and pistil in the perfect flower resulted in pistillate and staminate flowers, respectively and the appearance of these flowers on the same plant or on different plants decided the various flowering habits. The abortion is due to sex gene and their interaction with environmental factors. Flowering habits (sex expression) in vegetable crops are hereditary and controlled by some genetic factors on chromosome. It is also influenced by environmental factors.Cucurbits show a wide range of variation in sex forms. In cucurbits mainly eight types of flowering habits are found viz. trimonoecious, monoecious, androecious, andromonoecious, gynoecious, hermaphrodite and Dioecious. The sex expression in cucumber is controlled by three major genes, namely, F (also known as Acr), M and A. The F locus determines the degree of femaleness (FF>Ff>ff). M locus determines whether the flowers are unisexual (M-) or bisexual (mm). Trimonoecious sex form in cucumber is controlled by Tr gene, whereas in muskmelon it is controlled by the interaction of a and g genes. Sex expression in asparagus is controlled by a single factor, maleness being dominant; thus Mm for male and mm for female. Spinach is tetramorphic and sex expression ranges from maleness to complete femaleness. In *Dioscorea sinaata* femaleness is controlled by 2A+2X and male by 2A+X. it is concluded that a strong Y chromosome is involved in sex determination of Yams. Sex expression is important to understand the breeding behaviour of vegetable crops.

S2P100 A217

Evaluation of different genotypes for growth, yield and quality of Strawberry (*Fragaria X ananassa*Duch.*)* under naturally ventilated polyhouse in hill zone of Karnataka

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An experiment was conducted to evaluate different genotypes of strawberry (*Fragaria X ananassa*Duch.*)*for growth, yield and quality in low costpolyhouseof the Department of Fruit Science, College of Horticulture, Mudigere, during 2015-16. The experiment was laid out in

Randomized Complete Block Design with seven treatments replicated thrice. The maximum plant height (32.30 cm), number of leaves (30.40), plant spread North-South and East–West (48.47 cm and 53.93 cm respectively), leaf area (206.04 cm^2), leaf area index (6.95), total dry weight (29.04g), maximum total chlorophyll content (2.33mg/g of fresh weight) was observed maximum in genotype Sabrina, while the Cristal accounted maximum runners per plant (10.70). The genotype Elyana took minimum number of days for flowering (53.37) whereas, genotype Sabrinatook longest duration for flowering (69.80 days). The maximum number of flowers per plant (29.06), number of fruits per plant (22.36) and yield per plant (380.29g) was recorded in genotype Sabrina. The maximum fruit weight (20.01 g), diameter (3.28cm) and volume (24.37 cc) was recorded in genotype Fortuna. The fruit quality parameters liketotal soluble solids (11.53 °Brix) was maximum in Safari, the ascorbic acid content (73.30 mg/100g) was maximum in Sabrina, total sugars(7.50%)was maximum in genotype Fortuna,sugars to acid ratio(12.20)was maximum in Elyanaand minimum titratable acidity (0.50%)was recorded in Fortuna. The genotype Fortunaresulted in maximum benefit cost ratio (2.56). Among different genotypes evaluated, the Sabrina genotype performed better for maximum growth and yield.

S2P101 A247

Diversity analysis in thermo tolerant genotypes of tomato (*Solanum lycopersicum* L.) based on morphological, physiological and biochemical traits

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In tropical and subtropical regions, heat stress is a major limiting factor for the growth, reproduction and yield of many vegetable crops including tomato. The vegetative and reproductive processes in tomato are strongly modified by temperature alone or in conjugation with other environmental factors.Though tomato requires optimum day temperature between 25°C to 30°C and 20°C during the dark period, but 2-4°C increase over the optimal temperature adversely affects its flowering and fruit set and thus reduces crop yield. Keeping above fact in mind, twenty-onetomato genotypes were evaluatedto study geneticdiversity.Pollen germination per cent and fruit set per cent was recorded maximum in all the tolerant genotypes as compared to heat sensitive genotypes. Under heat stress condition,relative water content (RWC) and membrane stability index (MSI) were recorded maximum in Pusa Sadabahar (83% and 86% respectively). Highest proline content was recorded in wild genotypes like, Spm followed by Spr1 and TH-348-4-5-1. Yield per plant had positive and highly significant correlation with pollen germination per cent, average fruit weight, fruit set per cent, RWC, MSI and lycopene content, but negative correlation with days to 50per cent flowering (-0.63). High heritability coupled with high genetic advance as per cent over mean was recorded in yield per

plant, fruit pericarp thickness, fruit equatorial diameter, chlorophyll a, chlorophyll b and total chlorophyll content.Based onD^2 study,21 genotypes were categorized into 4 distinct clusters with heat tolerant and heat sensitive genotypes in different clusters.Principal component analysis showed that the first 2 componentscontributed 77.6% of total variation for morphological traits, while for biochemical traits first four components accounted 88.9% of the total variation.

S2P102 A248

Studies on combining ability in eggplant (*Solanummelongena*L.) for yield and its component

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Present investigation was carried out during autumn winter season 2013-14 and 2014-15 at the Vegetable Research Centre of GBPUA&T, Pantnagar with 43 genotypes including 10 lines, 3 testers and 30 F_1's of brinjal. The experiment was laid out in Randomized Block Design with three replications. The observations were recorded for 11 characters. Variances due to testers were greater than variances due to lines for most of the characters. The estimates of GCA effect indicated that PB71, BB85, PB66, SwarnSyamli and DBL02 were best general combiner for earliness (days to 50% flowering), whereas the best specific cross was BRLVAR6 × DBL02. For weight of marketable fruits per plant PB66, SMB115, LC7, BRLVAR6 were best general combiners and SMB115 × DBL02, PB66 × Pant Samrat and IBWL 2001-1 × Pant Rituraj were best specific combiners. Pant Rituraj was found best general combining effect for plant height, fruit diameter, weight of marketable fruits per plant, number of unmarketable fruits per plant, total yield per plant and total yield per hectare. Pant Samrat showed good GCA effects for number of primary branches per plant, number of marketable fruits per plant, weight of unmarketable fruits per plant and total number of fruits per plant. DBL02 was recorded best general combiner for earliness and fruit length. SMB115 and PB 66 were best general combiners for most of the yield characters. SMB115 × DBL02, PB66 × Pant Samrat and IBWL2001-1 × Pant Rituraj were showed highest SCA effect for most of the characters. Therefore, these cross combinations could be commercially exploited for higher yield.

S2P103 A252

Modern approaches towards breeding of *Lilium*

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Lilium is a popular genus among ornamental bulbous plants, belonging to the monocotyledonous family *Liliaceae*. Owing to its wide diversity of flower color, attractive flower shape, long multi-flowering stalk, and having long post-harvest shelf life, lilies are and have been in high demand as cut flower in international flower trade. In the present times, popularity of lilium as a cut flower has started building up in the Indian metropolitan markets, where the consumer likening for lilies is increasing day by day. In 1987, Shimizu reported that as compared with other ornamentals, lily systematic breeding history is short and the breeding history of lily traces back to more than 200 years. However, the real breakthroughs on lily breeding, as reported byMcRae in 1998, are only recent 50 years when assortments of Asiatic hybrids were bred. To date, more than 9,465 lily cultivars have been registered in the International Lily Register and Checklist. Although conventional methods have paved way for breeding lilies, but it involves time consuming tedious efforts and often desired traits are selected on plant phenotype which may mislead the breeder. Introduction and adoption of non-conventional modern breeding strategies has revolutionised the breeding systematics of lilium and much is to be done for crop improvement in *Lilium* in the future.

S2P104 A263

Performance of cucumber genotypes in Southern-agro climatic region of Andhra Pradesh

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Thirty-two cucumber genotypes were evaluated at College of Horticulture, Anantharajupeta during *Kharif*2017. The genotypes were acquired from NBPGR regional centers Thrissur and Rajasthan. The design of the experiment was RBD with three replications. The objective of the present studywas to assess the variability present among the genotypes. A wide range of variation was observed for the ten best traits. Among the growth parameters studied the number of primary branches were highest in genotype JB-595504 (8.73), while minimum were recorded in Local-2 (1.42). In genotype Local-2 first female flower appeared at lowest(3.42)node where as, inJB-595510at (11.7) node. Lowest Number of days for first female flower appearance were recorded in IC-550207 (38.68 days), while JS-541367 recorded the maximum number of days for first female flower appearance (60.63).The days taken for fruit maturity were lowest ingenotype IC-550207 (50.90), while the maximum number of days

for fruit maturitywere recorded in SKY-613484 (78.21). Among the fruit characters, fruit length (26.7 cm) and fruit weight (1.05 kg) were highest in IC-550207, while lowest fruit length (4.74 cm) and fruit weight (0.26 kg) were recorded in IC-567558-3 and Local-2 respectively.Fruit yield per plant was recorded highest in JB-595504 (6.5 kg), while lowest yield was recorded in SKY-613479 (1.67 kg). Number of fruits per plant were highest in Local-2(11.4), while lowest were recordedin SKY-613479 (3.47).TSS was recorded highestin genotype IC-567558-4 (4.38^0 B), while lowest in JS-541367(2.10^0 B). The genotypeJB-595504 recorded the highest acidity (0.77%), while lowest was recorded in IC-567558-5 (0.15%).

S2P105 A264

Conservation and exploitation of underutilized fruit crops: A review

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Plant biodiversity represents the primary source for food, feed, shelter, medicines and many other products and are important means that make life on earth possible and enjoyable. The number of plant species used by humans around the worldis only one third of the number of species. There is global concern on shrinking food base depending on a meager three crops-wheat, rice and maize. New Crops are to be encouraged to fit into the changing food habits, life styles and above all climate change. The best suited crops for upcoming climate changes are fruit crops. Underutilized fruit crops are commonly applied tothe species whose potential has not been fully realized.Mainly Aonla, jack, beal, karonda, Annonaare, Chironji, Kirani and Jamun semi-domesticated cultivars to particular, often quite local, environments. Many of these cultivars and species, along with a wealth of traditional knowledge about their cultivation and use, are being lost at an alarming rate.There is a growing realization that fruit cultivation must diversify. Underutilized fruit crops have an important role to play in advancing horticulture development beyond the Green Revolution model of improving and raising the yields of staple crops.Underutilizedfruit Crops are getting attention world around because of their benefits in health and nutritional security. Hence there is a need to exploit the underutilized fruit crops and to conserve the extinct species meagerly.

S2P106 A265

Assessment of distinctiveness, uniformity and stability ofChina aster [*Callistephus chinensis* (L.)Nees.]genotypes

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China aster is commercially grown as annual flower crop for cut flower and loose flower. It is used for flower decoration, preparation of bouquets and garlands. It belongs to the family Asteraceae and is native of China. Morphological characterization of China aster

genotypes were carried out in the division of Floriculture and Medicinal Crops, ICAR-IIHR, Bengaluru during 2015-16 and 2016-17 by adopting DUS guidelines developed by Protection of Plant Varieties and Farmers Rights Authority, New Delhi. A total of 42 genotypes were characterized for 21 traits including qualitative and quantitative traits belonging to ten vegetative and 11 floral traits. Among these 21 traits, two were monomorphic, four dimorphic and 15 were polymorphic indicating their potential for varietal characterization. Six traits were identified as grouping traits, *viz*. plant height, plant type, flower head diameter, ray florets in outer rows- shape, ray floret in the outer rows(colour of inner side), type of flower head. Further, the expression of characters in different genotypes remained same for the two consecutive years confirming the uniformity and stability of the genotypes for visual traits. This characterization clearly established distinctness among the different genotypes for various traits. Present study will be useful for breeders/farmers to identify and differentiate China aster genotypes and to pursue protection under PPV& FR Authority, New Delhi. The characterization of genotype will also results trait specific information which can be used in the development of superior genotypes in China aster.

S2P107 A269

Introgression of 'Ogura' cytoplasm into cabbage alters its nutritional quality and antioxidant activity

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Abstract: 'Ogura' based cytoplasmic male sterility (CMS) systemis widely used for hybrid seed production in *Brassica* vegetables. The adverse effects associated with the introgression of alien 'Ogura' cytoplasm from Japanese radish into *Brassica* vegetables in terms of alteration in agronomic performance and floral deformities are well known. However, the effect of introgression of 'Ogura' cytoplasm on different nutritional traits like plant pigments, vitamins and antioxidant compounds is still unknown. Therefore, present investigation was aimed to study the effect of 'Ogura' cytoplasm introgression on different nutritional traits in 17 lines of cabbage. The experimental results revealed that introgression of 'Ogura' cytoplasm in cabbage altered its different quality attributes significantly. In general, concentration of different nutritional compounds was increased 3-5 times in some lines, while a reduction of 4-5 folds was noticed in others. However, drastic elevation in the concentration of CUPRAC and FRAP was observed in the CMSline RRMA (29 times) and 5A (78 times), respectively. On the other hand, the amount of CUPRAC, anthocyanin and lycopene was reduced severely in the CMSlines 9A (27 times), 1A (44 times) and CH2A (16 times), respectively. The possible reason for alteration in different quality traits might be attributed to nucleo-cytoplasmic and mitochondrial gene interactions associated with the

introgression alien cytoplasm. Therefore, best performing CMS lines viz., RRMA, RJA, PMA, 208A and 5A with increased concentration of different nutritional compounds may be utilized in future breeding programs for quality F_1 hybrid development in cabbage.

S2P108 A304

Assessment of distinctiveness, uniformity and stability (DUS)inChina aster [*Callistephus chinensis* (L.)Nees.]genotypes

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Forty two China aster genotypes were characterized using morphological descriptors adopted from DUS guidelines of PPV&FR Authority of India, and examined for their distinctiveness, uniformity and stability. Of the 15 visually assessed DUS descriptors, two were found to be monomorphic, four characteristics were dimorphic and nine characteristics polymorphic; all of the six measurable traits showed polymorphism. No variability was observed in leaf dentation and leaf-midrib pigmentation. Plant height categorized the genotypes as short (11), medium (15) and tall (16). Most of the genotypes studied had an erect plant type, six genotypes were semi-erect, and just threegenotypes(Arka Aadya, Arka Archana and IIHRE10) were of spreading type. Thirty three genotypes grouped under large-flower-diameter, seven as small,and,'Arka Shashank' and'Milady Scarlet' as medium. Shape of the outer row of ray florets was pointed in 27 genotypes and blunt in 15 genotypes. As fortype of flower-head, the genotypes grouped as semi-double (38) and power-puff (4). Corolla-lobe inthe disc florets was white in 'Arka Poornima' and 'Arka Shashank', yellow in 39 genotypes and purple in 'Arka Violet Cushion' and IIHRCC5-1A. Genotypes IIHRCC39 and IIHRE10 were distinct in having long outer ray-florets.Further, expression of characters in different genotypes remained constant over two consecutive years, confirming uniformity and stability of the genotypes for visual traits, thus clearly establishing distinctness among genotypes for various traits.Ourresults are ofpotential use to the breeder/farmer for identifying/differentiating China aster genotypes to seeking protection under PPV&FR, New Delhi, besides their use in helping develop superior genotypes.

S2P109 A316

Comparative study in Gladiolus (*Gladiolus hybrida* L.) cv. Forta Rosa for growth and flowering underdifferent environmental conditions

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The present investigation was conducted at GBPUA&T, Pantnagar, Uttarakhand in 2014-2015 to studycomparative performance of gladiolus (*Gladiolus hybrid* L.) cv. Forta Rosa for growth & flowering under different environmental conditions. Threetreatments,*viz*, open field, shade-net and polyhouse were imposed in Randomized Block Design, with eight replications. The study revealed that temperature, humidity and CO_2 concentration under protected condition had a strong influence on plant characters with respect to economic yield. Plant height (55.66cm, 69.67cm and 110.02cm) at 30, 60 & 90 days after planting, respectively, number of leaves (8.55), spike length (115.98cm), rachis length (96.02cm), number of florets per spike (18.13), corm fresh-weight (81.88g) and corm diameter (7.88cm) were found to be superior in polyhouse-grown plants. However, parameters like days taken to spike-heading (89.88), days to opening of basal floret (95.38), days to full bloom (159.5), floret diameter (10.36cm), per plant number of corms (1.75), number of cormels (172.38) and cormel fresh-weight (16.49g) was maximum under shade-net. Findings of this investigation reveal that protected conditions are superior to open-field for growth and flowering in Gladiolus.

S2P110 A318

Evaluation of potato (*Solanum tuberosum* L.) genotypes under hill zone of Karnataka

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Field-performance of potato genotypes under hill zone of Karnataka was studied at Department of Vegetable Science, College of Horticulture, Mudigere, Karnataka, during the year 2015. The experiment was laid out inRandomized Block Design, with four replications. Nine genotypes (TT7006, TT7007, TT7010, TT7011, C-28, MCIP-9-1, MCIP-9-11, Kufri Surya and Kufri Jyoti) were procured from International Potato Centre for the study. Among

the genotypes evaluated, maximum tuber-sprout percentage was observed in Kufri Jyoti (100), followed by TT7011 (98.75) and TT7010 (96.66). Genotype TT7011 performed better for most characters like number of tubers per plant (4.43), number of tubers per plot (266.80), total tuber yield per plot (18.98kg), total tuber yield per hectare (26.36t), marketable yield per plant (169.6g), marketable yield per plot (10.21kg), marketable yield per hectare (14.18t), dry matter (19.88%) and total sugars (2.55%). Genotype TT7010 recorded maximum number of stems (4.58), total tuber yield per plant (360.19g), tuber diameter (6.13cm) and was found to be significantly superior over the other genotypes. Correlation studies revealed a highly significant and positive association of total tuber yield per plot with marketable yield per plot, number of tubers per plant, dry matter and number of stems. Path analysis showed that number of tubers per plant, marketable yield per plot, number of stems and tuber weight were the traits with greatest influence on total tuber yield per plot. Thus, these characters deserve a higher weightage in selection. Highest net profit and benefit-to-cost ratio was obtained in TT7011 (2.14:1), followed by TT7010 (2.10:1), and, these two genotypes performed better at Mudigere inthe hill zone of Karnataka.

S2P111 A319

Genetic divergence and character association in chilli (*Capsicumannuum* L.) germplasm

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An experiment was laid out to evaluate 40 chilli genotypes in Randomized Complete Block Design, with two replications, to study genetic variability, heritability, correlation, path analysis and genetic divergence in the experimental block of Vegetable Science, College of Horticulture, Mudigere,during 2013-2014. Analysis of variance revealed highly significant differences among genotypes for growth and yield parameters. High heritability, in association with high genetic advance over mean, was observed for number of fruits per plant, fruit diameter, fruit length, pedicel length, fruit weight, fruit yield per plant, fruit yield per plot and fruit yield/ha, indicating predominance of the additive gene component. Thus, there is ample scope for improving these characters through direct selection. Fruit yield per plant was positively and significantly associated with plant height at 60 DAT (Days After Transplanting)and 90 DAT, number of branches at 60 DAT and 90 DAT, number of fruits per plant and fruit weight.Path analysis revealed that the highest, positive, direct effects on fruit yield per plant were seen in days to first harvest (0.7624), number of fruits per plant (0.2331), fruit weight (0.1745) and fruit yield per hectare (0.6765). As per Mahalanobis D^2 analysis, these genotypes of chilli grouped under eight clusters. Among these, Clusters I (15) and II (13)contained the highest number of genotypes. Characters like fruit weight (40.38%), followed by fruit diameter (28.46%), number of fruits per plant (12.31%) and days to first harvest (10.77%) contributed the most to the overall genetic diversity. Genotypes DCC–69,

DCC–134, DCC–135, DCC–164 and DCC–167 were found promising for cultivation in the hill zone of Karnataka.

S2P112 A320

Inheritance of root epidermal, phloem and xylem colour in IPC-122 × IPC-126 cross of tropical carrot (*Daucus carota* L.)

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Carrot is a dietary source of nutrients which are abundant in different genotypes of carrot. Realizing their nutritional importance, there is an urgent need to develop multi-nutritional carrot varieties of multicolor. Therefore, genetic information of root epidermal, phloem and xylem colour could help understand their genetic pattern to work out suitable breeding strategies for the tropical carrot. The experimental study was made using two inbred lines, IPC-126 and IPC-122, having uniform epidermal, phloem and xylem colour (purple and red, respectively). These two inbred lines were hybridized, followed by self-pollination of F_1 to obtain F_2 generation. Roots in F_1 clearly expressed purple epidermal and xylem colour and red phloem colour. F_2 population from both IPC-122 and IPC-126 segregated as per Mendelian ratio of 3:1 where purple colour was dominant over red colour (denoted as '*P*' and '*r*' respectively) in root epidermal and xylem tissues. Phloem colour was found to be governed by a single dominant gene '*P*, that is, purple over red '*r*'.

S2P113 A336

Analysis of genetic diversity in pomegranate using SRAP (Sequence-related amplified polymorphism) markers

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Pomegranate (*Punicagranatum* L.) is one of the most important fruit crops of the arid and semi-arid regions. In India, it is commercially cultivated in Maharashtra, followed by Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, Gujarat, Rajasthan, Punjab and Haryana. Pomegranate genotypes show a wide range of variation in the size of fruit, sweetness,

time of ripening, juiciness, and proportion of seeds to flesh. Therefore, breeding for useful traits has gained importance in this crop. For this, it is required to determine genetic relationships and precise identification of the genotypes, and to conserve its genetic diversity. In the present study, Sequence-related amplified polymorphism (SRAP) marker system was used for assessing genetic diversity in 121 pomegranate genotypes, maintained in the field gene-bank at ICAR-IIHR, Hessaraghatta, Bangalore. Forty SRAP combinations were used, of which 10 primer combinations showedclear and reproducible polymorphism. Average polymorphic information content (PIC) value was 0.24. Number of alleles per locus ranged from 1.66 to 4.00, at an average of 2.03. Expected heterozygosity varied from 0.215 to 0.445, at an average of 0.306. Cluster analysis was performed from neighbour-joining-analysis, using DARWIN softwareVersion 6.0. Dissimilarity coefficient ranged from 0 to 1, suggestingvariability within the genotypesstudied. Of the 121 genotypes, 114 amplified and were grouped into three major clusters. No clear grouping based on origin was seen. These results confirm that SRAP markers can be used as an effective marker system for determining genetic diversity and population-genetics structure in pomegranate.

S2P114 A352

Role of Biotechnological Approaches in Fruit Crop Improvement- A Review

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The long juvenility and the problem of incompatibility and sterility are the biggest hinderance of fruit crops through conventional fruit breeding. To mitigate the stresses of biotic and abiotic nature, improvement is desired in already cultivated cultivar for one or few traits. In that regard, the biotechnological tools will prove quite useful to expedite the rate of fruit crop improvement. For production of quality planting material by tissue culture is commerciaized in banana and strawberry. Biotechnological tools such as Somaclonal variation and *in vitro* mutagenesis are the choicest method for varietal development in banana. GCTCV-119 and Novariaare the result of somaclonal variation and in vitro mutagenesis, respectively. Somatic hybridization has been explored for the rootstock and scion improvement of citrus. Somatic hybridization research of almost two decades in citrus is yielding fruit now. Embryo rescue has helped in accelerating the pace of stenospermocarpic grape improvement and 'Sweet Scarlet' and 'Thomcord' are two of the seedless table grapevines, which were released using this technique. Transgenic variety Rainbow and Sun Up carrying resistance to PRSV are being commercially cultivated in Hawaii of USA. With the introduction of concept of *cisgenics*, the genetically transformed fruits are likely to get public acceptance. Molecular marker aid great help in early diagnosis of sex of dioecious fruit plant like date palmand papaya. Presently marker linked to resistance for dagger nematode and pierce disease at university of California in the breeding programs are routinely used for grapevine rootstock improvement. Genome sequencing has unveiled the mystery about various genes, the phyllogenetic relationship and evolution history of sequenced fruit crop.

S2P115 A353

Cytoplasmic Male Sterility (CMS): Reliable approach for commercialization of hybrids in cauliflower

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Cauliflower (*Brassica oleracea* L.var. botrytis L.) is an economically important vegetable crop that manifests heterosis. To exploit such heterosis, Cytoplasmic male sterility (CMS) system is gaining popularity among public as well as private sector as a most reliable option. CMS is a maternally inherited trait encoded in the mitochondrial genome, and the male sterile phenotype arises as the result of interaction of a mitochondrial CMS gene and a nuclear fertility restoring (*Rf*) gene. The use of CMS lines to produce hybrid seed can overcome the danger of sibs and hybrids can achieve 100% purity at low cost. Moreover, in cauliflower, F_1 hybrid is harvested as a vegetative produce (curd stage) and fertility restoration is not needed, this makes CMS more acceptable and valuable hybridizing systemin this crop. Some problems like poor seed set, floral abnormalities etc., related to CMS were solved through interspecific hybridization and other biotechnological interventions. In this review, various aspects related to CMS including history, its effect on normal crop, problems, advantages, its practical implications and future prospects in cauliflower breeding, have been discussed.

S2P116 A366

Diversity analysis of KAU released cocoa (*Theobroma cacao* L.) varieties based on morphological parameters

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Cocoa Research Centre (CRC) at Kerala Agricultural University (KAU) is holding the largest cocoa germplasm in Asia comprising of 632 accessions,andhas done immense research in cocoa which resulted in release of 10 varieties during its first phase. These varieties will form the parental material for establishment of poly clonal gardens. Seeds collected from these

gardens will serves as the source for planting material all over cocoa growing tracts of India. As reported about self incompatibility, cross incompatibility is also a major constrain in cocoa research. Hence, understanding similarity or dissimilarity among the varieties before establishing clonal gardens is essential. Morphological analysis with respect to the selected quantitative and qualitative pod characteristics were taken into consideration for the analysis. Six qualitative and eight quantitative pod and bean characters of each varieties were recorded as per the standard descriptors. The genetic associations among the varieties were estimated through Jaccard's similarity coefficients using NTSYSpc version 2.1. Cluster analysis was done on the similarity matrix and dendrogram was constructed using Unweighted Pair - Group Method (UPGMA). Diversity analysis based on qualitative and quantitative traits grouped the ten cocoa varieties into five clusters at 68 per cent similarity level. Both qualitative and quantitative clustering grouped CCRP 1, CCRP 7, CCRP 8 and CCRP 10 in single cluster.Pod weight (608.84g), pod length (18.82cm), pod breadth (9.12cm), husk thickness (0.95cm), total wet bean weight (132.78g) and single dry bean weight (1.09g) were found to be highest in cluster IV. Whereas total number of beans per pod was maximum in cluster III with approximately 43 beans per pod and cluster V was found to have highest single wet bean weight (3.38g).Homology between qualitative and quantitative clustering pattern was also worked out and the result shown significant variation in distribution pattern of varieties under study.

Acceleration of breeding programmes in fruit crops

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The time to develop new cultivars and introduce them into cultivation is an issue of major importance in fruit breeding. This is because breeders have an urgent need to help provide solutions to feed a growing world population, while in parallel, time savings are linked to profitability. Fruit breeding processes may in general be broken down into the following five key elements: (1) germplasm variation; (2) crossing; (3) generation of new genetic combinations; (4) screening and selection (identification and subsequent fixation of desired allelic combinations); and (5) line/cultivar development. Each of these has implications in relation to the time taken to breed a new cultivar, we propose to implement in vitro nurseries, mutation breeding, induced recombination, GM breeding, rapid generation cycling, doubled haploids, marker assisted selection, manipulating cultural conditions and promoting flowering through biotechnology, these could substantially shorten generation time through rapid cycles of meiosis and mitosis. This could prove a useful tool for speeding up future fruit breeding programs with the aim of sustainable fruit production. However, other methods that create new genetic variation along with improvements in selection efficiency compensate to a large extent for this limitation. Progress in accelerating the fruit breeding process continues by exploiting new emerging ideas in science and technology.

S2P118 A379

Assessment of agro-morphological traits for genetic variability and relationships in okra germplasm

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The study was carried out using 30 okra genotypes to study genetic variability and relationship between various morphological traits. The experiment was laid out in RCBD with three replications during *kharif* season 2013. The results revealed that, plant height was maximum for HRB 140-2-2 (108.1 cm) whereas, highest value for stem diameter (2.6 cm) and fruit weight (10 g) was observed in HRB-124-1-1. The genotype HRB-140-2-2 recorded the highest number of nodes (18.1). The lowest value for days to 50% flowering was recorded in HRB-106-1-1 (41.0), which indicated earliness. HRB-146-1-1-2 (42.9) had maximum number of fruits per plant. Fruit yield plant^{-1} was found maximum inHRB-108-2-2 (398.9 g). Significant differences among genotypes were observed for all the characters under study. High heritability coupled with high genetic advance as per cent of mean was observed for number of branches plant^{-1}, number of nodes plant^{-1}, number of fruits plant^{-1} and fruit yield plant^{-1} indicated that these traits were under strong influence of additive gene action and hence simple selection based on phenotypic performance of these traits would be more effective. Studies on correlation revealed the higher magnitude of genotypic correlations than the corresponding phenotypic ones. Fruit yield plant^{-1} had significant positive association with plant height (0.309 and 0.293), number of branches plant^{-1} (0.250 and 0.244), number of nodes plant^{-1} (0.773 and 0.808), number of fruits plant^{-1} (0.872 and 0.889) and fruit weight (0.391 and 0.429) at phenotypic and genotypic level, respectively. Path analysis revealed high positive direct effect of number of fruits plant^{-1} (0.853), fruit weight (0.425), number of nodes plant^{-1} (0. 073), diameter of edible fruits (0.0183), days to 50% flowering (0.0045), and stem diameter (0.0038) on fruit yield plant^{-1}.

S2P119 A380

Estimates of genetic variability, character association and path analysis of yield and other horticultural traits in cabbage (*brassica oleracea* var. *Capitata* l.)

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The estimates of genetic variability, character association and path analysis for marketable head yield and horticultural traits were carried out in 41 cabbage genotypes during 2013-14. These genotypes were evaluated in randomized block design at the Vegetable Research Farm, CSKHPKV Palampur. The PCV and GCV values were high for marketable head yield plot^{-1} (32.47 and 30.17), net head weight (27.64 and 25.54) and gross head weight (20.44 and 18.71). High heritability was estimated for marketable head yield plot^{-1} (86%), net head weight (85%) and gross head weight (83%). Genetic advance as per cent mean varied from 4.18 to 57.78%. It was highest for marketable head yield plot^{-1} (57.78%) followed by net head weight (48.63%). Whereas, association of characters and the magnitude of their relationship with other characters at genotypic level revealed that marketable head yield had positive and significant correlation with net head weight (0.95), equatorial diameter (0.91), heading percentage (0.74), marketable heads per plot (0.74), gross head weight (0.69) and some other traits. Days to harvest (-0.29) showed negative correlation with marketable head yield. Marketable head yield was taken as dependent variable while computing the path co-efficient. Positive direct effect on marketable head yield was the highest for net head weight (0.88), followed by equatorial diameter (0.78), number of marketable heads plot^{-1} (0.77) *etc*. Low residual effect (0.12) revealed that all the traits under study accounted for 88.39% of variability towards marketable head yield. From this study, it was concluded that high heritability accompanied with a high genetic advance for marketable head yield, gross head weight and net head weight revealed the role of additive gene action and thus, a high genetic gain is expected from selection for these traits. Among all the traits, net head weight was proved to be the most effective selection index while carrying out genetic improvement in cabbage.

S2P120 A401

Impact of surface-sterilization time and plant bioregulators on *in vitro* regeneration of bulb-scale explants in hybrid *Lilium* cv. Sorbonne

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The present investigation was undertaken to evolve the most suitable duration of surface- sterilization with 0.01% $HgCl_2$ for controlling contamination in bulb-scale explants cultures of hybrid *Lilium* cv. Sorbonne using MS medium as the base, andsupplemented with hormones, BAP (1.0 mg/l), 2,4-D (0.5mg/l). Bulb-scale explants sterilized with 0.01% $HgCl_2$ for 6 min showed significantly low contamination from fungi (6.67%), bacteria (6.66%), and culture death (6.67%). This treatmentgave a high rate ofaseptic cultures(86.67%) and survival (80.00%). For callus-induction, the culture medium was supplemented with BAP (0.5 mg/l or 1.0 mg/l) and 2,4-D (0.5mg/l, 1.0 mg/l, 1.5 mg/l, 2.0 mg/l or 2.5 mg/l), alone or in combination, besides a Control. At 30 days after inoculation, MS medium fortified with2,4-D @1.5 mg/l significantly advanced the number of days required for callus induction (14.33 days), and showed maximum percent callus production (80.00%).This treatment also gave the best callus proliferation/spread (0.26cm × 0.16 cm). Upon subculture on the parent medium (supplemented with 2,4-D @1.5 mg/l), callus-spreadimproved (0.3cm × 0.26cm) and gave a compact, light-green callus mass. Thus, 6 min was found to be the best duration for surface-sterilization with 0.01% $HgCl_2$,while, MS medium supplemented with 2,4-D @1.5mg/l resulted in maximum callus-formation. *In vitro* propagation of this highly valued cut-flower is of great importance for mass supply of disease-free planting material.

S2P121 A402

Efficacy of molecular markers associated with sex-expression in papaya (*Carica papaya* L.)

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Papaya (*Carica papaya* L.) is an edible tropical fruit crop with several medicinal and nutritional benefits. Being a polygamous plant, it has three types of sex forms, *viz.*, male, female and hermaphrodite. There are several reasons for the need for a desirable sex-type in papaya plant to be identified prior to planting. Generally, in a plantation, the male plants outnumber female plants, rendering it unproductive. Unfortunately, growers cannot identify productive and unproductive plants at the nursery stage. An experiment was conducted during 2014-2015 to identify the efficacy of gene-based markers associated with sex expression in papaya. Seedlings of gynodioecious ('Red Lady', P-9-12, P-7-2 and P-9-5) and dioecious ('Pusa Nanha' and P-7-2 x SAM) genotypes were selected for the experiment. In all, 10 primers (ISSR and SCAR) were usedfor distinguishing the sex-form in seedlings, and in well-differentiated, adult plants. The following markers linked to sex-form in papaya were used for validation in a population of six papaya genotypes. A total of 10 sex-linked DNA markers (9 SCAR and 1 ISSR) were employed for validation of sex in 6 genotypes of papaya. Of these 10, just five (T12, W11, SCAR SDSP, C09/20 and GACA4) amplified for sex-expression. However, five SCAR markers (SCARp, SCARpm, T1, STS 807 and STS 831) did not amplify in all the sex-genotypes in the study. Of the two marker-systems tested, SCAR markers were more consistent. Markers 'T12, '' CFW+CRV' and 'W11' were the most informative, and predicted sex-form with 100% accuracy. These markers can be used by breeders and commercial papaya-growers for identifying the desired sex type at the seedling stage itself in papaya.

S2P122 A418

Line x Tester analysis in okra [*Abelmoschus esculentus* (L.)Moench.]

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Genetic studies in okra (*bhindi*) [*Abelmoschus esculentus* (L.) Moench.]through Line x Tester analysis were undertaken to evaluate breeding value of parental lines from combining-ability, and to understand the scope of heterosis breeding for developing commercial F_1 hybrids. Four lines were selected for high yield, *viz*., L_1 (SKY/DR/RS/107), L_2 (3), L_3 (IC 69257) and L_4 (307-10-1-II) and five testers identified for earliness and production traits, *viz*., T_1(608-8-1), T_2(770), T_3(IC 140880), T_4(137-10-1,2) and T_5(Tiruchi Local) were crossed to produce twenty F_1 hybrids. These hybrids, along with their parents, were evaluated for 17 growth and yield parameters to assess combining-ability, gene action and heterosis. Proportional contribution of the tester towards total hybrid variance was greater for most traits, including number of fruits plant^{-1} and yield plant^{-1},indicating a predominant role of additive gene action and the possibility of identifying superior genotypes through simple selection for yield enhancement in *bhindi*. Among the hybrids, L_2 x T_2 was the best, as, it out-performed the others, with high mean, heterotic vigour and significant *sca* for the two most-important traits, *viz*., number of fruits plant^{-1} and yield plant^{-1}. Presence of significant *gca* among parents with a non-significant *sca* in the resultant hybrid for fruit weight in L_4 x T_1 and L_4 x T_2, and number of fruits plant^{-1} and yield plant^{-1} in L_3 x T_2, indicate a possibility of exploiting these hybrids for recombination breeding.

S2P123 A442

RNAi technology and its application in vegetable crops

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RNA interference (RNAi) is a gene-silencing phenomenon involving sequence-specific gene regulation induced by double-stranded RNA (dsRNA), thereby, resulting in the inhibition

of translation or transcription. During the 1990s, post-transcriptional gene-silencing (PTGS) was reported fromseveral organisms including fungi, animals, ciliates, and plants. The phenomenon of gene silencing was discovered accidentally in petunia flowers, where expression of chalcone synthase (a pigment-producing gene), resulted in variegated flowers instead of the expected deep-purple color. As the expression of both the transgene and the homologous, endogenous gene was suppressed, the phenomenon was termed "co-suppression". A similar phenomenon reported in the fungus,*Neurospora crassa*, was named 'quelling'. In 1998, Andrew Fire, Craig C. Mello and colleagues, for the first time, showed potent and specific genetic-interference by double-stranded RNA (a mixture of both 'sense' and 'antisense' RNA) in the nematode,*Ceanorhabdites elegans*. The mechanism was called RNAi or RNA interference. RNAi regulates expression of protein-coding genes, and mediates resistance to both exogenous-parasitic and exogenous-pathogenic nucleic acids.RNAi can be used for achieving desirable traits in a crop by manipulating gene expression. RNAi mediated gene-silencing involves, mainly, identification of the target gene(s), followed by generating an RNAi construct with a hairpin cassette (gene cloned in the 'sense' and 'antisense' orientation, flanking a spacer or an intron), plant transformation and, finally, screening-for and evaluating the trait in question.

S2P124 A451

Unique morphotypesof betelvine (*Piperbetle* L.)

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Betelvine is a perennial, evergreen creeper grown in shady conditions with moderate temperate & high humidity. It is a heritage crop & cultivated throughout India. More than 100 known cultivars are being grown throughout the country. Being a dioecious crop, The cultivars are broadly classified as male(Kapoori) and female(Bangla) types.In the present study, 40 germplasm and twenty hybrids were characterized for eleven qualitative and six quantitative traits. Variability for many traits has been noted in the germplasm and hybrids. Some unique morphotypes recorded for different traits are as follows. Longest orthotropic stem intermodal length was recorded in CARI-2(10.26cm) and Ghanegette recorded shortest (3.28 cm). CARI-6 exhibited maximum plagiotropic leaf l/b ratio of 2.51. Female inflorescence length was shortest in Maghai (1.85cm) and longest in Halisahar Sanchi (4.44cm). Longest male inflorescence was recorded in Dobbaspet Ambadi (12.76cm) and IIHRBV 96-1(12.58 cm).Majority of the lines recorded acuminate leaf apex shape except Banavalli which had shown acute leaf apex shape. The clones Sirugamani 1 and Swarna Kapoori exhibited profuse flowering habit. Meetha pan has leaves which are non-pungent with sweet taste. Among hybrids, IIHRPBH 09-16 possessed light green leaves and hybrid IIHRPBH 06-4 has cordate

leaves with male inflorescence. Hybrids IIHRPB ON 2 and ON 1 have dwarf growth habit with very short intermodal length and small leaf size and are suitable for ornamnetal potted plants.

S2P125 A455

New dimensions inbreeding of horticultural crops

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Fruit crops have a juvenile phase, which can last from 2 to 8 years, during which they grow vegetatively without any fruit production. Thus, traditional fruit tree breeding takes very long time-20 to 40 years to develop new varieties. Transgenic plants offer a more direct and quicker-strategy, to provide genetic solutions. The majority of existing commercial genetically (GM) crops have been designed to expresstransgenic proteins with a limited spectrum of biologicalactivity (e.g., insect resistance, herbicide tolerance). Therefore, to study the effect of transgenics,a field experiment is carried in farm of the college in 2016-17.Papayas suffer from a serious disease caused by (PRSV), a major limitation to papaya production worldwide. This virus induces plant stunting and drastically reduces the yield and quality of fruits. The first commercialized transgenic papayas genetically modified with coating protein were SunUp and Rainbow in Hawaii. One PRSV-resistant papaya currently under development in China was generated by cloning of the papaya PRSV replicase (rep) gene, and then introducing the rep gene into papaya. It has been shown to exhibit resistance to PRSV in field trials..

S2P126 A461

In vitro plant regeneration – a potential tool for mass multiplication in cocoa

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Cocoa (*Theobroma cacao* L.) is the only source of chocolate and it serves as a supporting crop to farmers in the present scenario of price fall with respect to other plantation crops. Cocoa is mainly propagated through seeds. However, high out crossing nature of the crop insist to develop seedlings only from specially designed polyclonal gardens. Otherwise the quality of planting material will be drastically affected. This forms the major constraint in large scale production of planting materials in cocoa. The polyclonal gardens are available only with

limited Government institutions and the seedlings produced from these cannot meet the rising demand. Moreover, the other propagation techniques, like grafting and budding are labour intensive and costly. Management of budded seedling is also very difficult. *In vitro* techniques for micro propagation can address the question of availability of bulk planting material. However, viable protocols are developed for cocoa micro propagation, the response of the media varied with genotypes. Hence it is very much essential to standardise the protocol that is genotype specific.

S2P127 A465

Variability for stomatal index in different accessions of betelvine (*Piper betle* L.)

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Betelvine (*Piper betel* L.) is a perennial dioecious creeper native of Malaysia and belongs to family Piperaceae. It is an important commercial crop grown in many states of country and more than 100 local varieties are being cultivated. Variations in stomatal characteristics may influence plant growth and productivity. Stomatal index (SI) is extensively used feature for inter and intraspecific diversity, taxonomical and pharmacognostic studies. In the current study intraspecfic variability for stomatal index was studied in sixty one germplasm lines of betelvine comprising 48 female clones and 13 male clones. The impressions of lower leaf epidermis were taken on harvestable leaves of well expanded matured leaf. Stomatal index (%) was calculated as number of stomata x100 /(number of stomata + number of epidermal cells) . SI varied significantly among the germplasm. Mean SI of germplasm is 17.09 varied from 11.81 to 21.91. The mean SI of female cultivars is 16.93 while the male cultivars is 17.66. The highest stomatal index was recorded in female cultivar IIHRBV 128 (20.53) and lowest was in IIHRBV 165 (12.14). The highest stomatal index among male cultivars was recorded in IIHRBV 8 (21.91) and the lowest was recorded in IIHR BV58 (11.81). The results revealed that stomatal index significantly varied in betelvine germplasm and in general male clones showed higher stomatal index compared to female clones. Stomatal index may be useful as marker in delineating intraspecfic variability in betelvine and identify potential high yielding genotypes for further genetic improvement.

S2P128 A470

Studies on cross compatibility of Papaya with *Vasconcellea species*

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Papaya (*Carica papaya* L.) is one of the most important fruit crops of tropical region of the world. One of the major impediments worldwide in papaya cultivation is the Papaya Ring Spot Virus (PRSV) disease. Resistance against PRSV was identified in *Vasconcellea* species *viz., V. cauliflora, V. cundinamarcensis, V. candicans, V. quercifolia and V. stipulata*. In order to develop intergeneric progenies with resistance to this disease, attempts were made to hybridize the *Carica papaya* L. varieties *viz*., Arka Prabhath, Arka Surya and Red Lady as a female parents with the wild spp. *V. cauliflora, V. cundinamarcensis* and *V. parviflora* as a male parents at ICAR-IIHR, Bengaluru, using the standardized nutrient media for pollination. Results revealed that the combination of Arka Surya X *Vasconcellea cauliflora* recorded highest fruit set (67.86%) followed by Arka Surya X *V. cundinamarcensis* (58.82%). Even though highest percentage of fruit set was recorded when Surya was used as female parent, the highest total (number) of 139 seeds were recovered in Arka Prabhath x *V. cauliflora* followed by Arka Prabhath x *V. cundinamarcensis* (98.00). This success gives an indication that Arka Prabhath as a female parent is a good combiner among the selected parents. The results pertaining to per cent germination of F_1 intergeneric hybrids, vegetative traits and PRSV screening and will be discussed in detail.

S2P129 A474

Use of *ycf-1b* gene as a DNA barcode for species identification in Rose

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Rose is one of the most important beautiful flowers to be cultivated by humankind, since time immemorial. Rose is number one cut flower in world trade both in quantity and value. Rose flower is not only famous as cut flower, but they are equally valuable as loose flower, essential oil and other processed products. The genus *Rosa* (Rosaceae) has about 200 species distributed in the Northern Hemisphere. Conventional taxonomy divides the genus into four subgenera, in which *Rosa* is major one comprising about 95% of all species. There is a vast wealth of species available having one or another special character. They need to be protected and utilized for rose breeding. But, the identification of a species is difficult due to multiple names given to a species..Hence, to supplement, molecular techniques; PCR-based approach is required. DNA barcoding in new molecular tool for species identification, where species is identified based on nucleotide diversity of short DNA segments. It has vast application in identification, monitoring, phylogenetic relationship of different species and their documentation. In the present study DNA from young leaves of selected species was isolated, and ycf-1b gene (~800bp) of plastid region was amplified. *ycf1b*, is among the most variable loci present in plastid genome to be used as barcodes as confirmed by the various research and hence, can serve as a barcode of land plants. The amplified product is then sequenced followed by multiple alignment of the sequences from different species was done to

see the variations among them. The present study using *ycf-1b* sequence information will help in removing ambiguities in species identification and help in systematic characterization of the rose species germplasm for further use.

S2P130 A503

Studies on the genetic variability among F_4 progenies of brinjal (*Solanum melongena* L.)

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An experiment was carried out at the Educational Research Farm, Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (M.S.) to evaluate fifty brinjal genotypes. Fifty F_4 progenies of brinjal were evaluated to study the extent of variability present in the experimental material. Analysis of variance indicated presence of large variability for different characters under study. Most of the growth, flowering, fruit and yield characters under study were found significantly varied. The magnitude of phenotypic variance was greater than genotypic variance in all the characters under study. The magnitude of the genotypic variance was greater than environmental variance for most of the characters except days to last harvest, days to first harvest and harvesting span. High heritability values were obtained for most of the characters studied except days to last harvest, days to first harvest, harvesting span. The highest estimates of genetic advance were recorded in fruit weight. Similarly, high values of genetic advance accompanied by higher heritability were observed for the character fruit weight. Genotypes 86 and 88-7 for earliness, 60 for maximum length of fruit, 57 for maximum girth and maximum weight of fruit, 62, 64, 72 and 88-2 for maximum harvesting span, 62 for maximum number of fruits and maximum number of fruit per plant, and 71 and 61 for yield were found promising, hence can be utilized for improvement for these traits in brinjal.

S2P131 A504

Evaluation of china aster [*Callistephuschinensis* (L.)Nees] F_1 hybrids for growth, flower quality and yield

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China aster [*Callistephus chinensis* (L.)Nees.]is commercially grown for cut flower, loose flower, bedding plant, flower decoration, preparation of bouquets and garlands.Hybridization was carried out in Line x Tester fashion which included five lines v*iz.*,Arka Kamini, Arka Poornima, Arka Aadya, Arka Archana and Arka Violet Cushion and three tester lines *viz.* ,Arka Shashank, Local Violet and Local Pink during 2015-16.A total of 15 F_1 hybrids produced through hybridization and 8 parents were evaluated for growth, flower quality and yield in RBD with two replications during 2016-17.The parents for hybridization were selected on the basis of flower quality, earliness and high yield. Results revealed that, among quality traits, both spreading and semi-erect plant types were found to be dominant over erect type. The crosses between semi-double and pompon parents led to partial powder-puff flower form (L5xT2 and L5xT3) or pompon (L1xT1, L3xT1 and L4xT1) flower form.The cross between semi-doubleand powderpuffflowers led to pompon form (L1xT1, L3xT1and L4xT1) as well semi-double form (L2xT2 and L2xT3).TheF_1 hybrids and parents showed significant variation for all the quantitative traits. Among hybrids, L3xT2 (ArkaAadya x Local Violet) was the best performer with highest number of leaves per plant (312.47), number of branches per plant (23.19), number (93.66) and weight of flowers per plant (293g) and flower yield per hectare (24.68 tonne). L2xT1(ArkaPoornima x ArkaShashank) recorded maximum plant height (73.16 cm) and longest duration of flowering(28.92 days).

S2P132 A507

*In silico*comparative analysis for identification of *Xanthomonas axonopodis* pv. *punicae*interacting resistance proteins in pomegranate

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Bacterial blight disease caused by *Xanthomonas axonopodis*pv. *punicae*(Xap) has adversely affected pomegranate production in India. These phytopathogenic bacteria secrete and inject effector proteins into plant cell through type I and type III secretion system (T3SS) and suppress genes involved in pathogen associated molecular pattern triggered immunity (PTI) and effector triggered immunity (ETI). However, plants possess resistance proteins (R) to counter specific effectors and initiate ETI and PTI. Information on host pathogen (Xap) interaction is scarce and this experiment was undertaken to identify the genes involved in such interaction. Bioinformatics tool, BLAST-P and Conserved Domain Database available at National Center for Biotechnology Information (NCBI) were employed for identification and classification of R-proteins from whole genome sequence of pomegranate cv. Bhagwa. A set of 97 R-proteins were identified, further 36 protein sequences were grouped into Nucleotide binding site (NBS), 24 were grouped under Resistance like proteins (RLP), 13 were grouped

under Resistance like kinases (RLK) and remaining 24 proteins were grouped under other *R*-proteins (Oth-R). Among *R*-proteins identified, eight showed homology with *Xanthomonas* resistance genes from rice (*Xa1, Xa5, Xa13, Xa21, Xa3/26 and Xa25*), tomato (*Bs4*) and pepper (*Bs2*). Recessive resistance genes *Xa5* and *Xa25* showed significant homology with 85% and 66% identity respectively. Dominant resistance gene *Xa21* showed 40% identity having lowest E-value. *Bs2* and *Bs4* showed low homology with 31% and 37% identity respectively. Present study has helped in identifying major putative genes involved in PTI and ETI from pomegranate genome. This study helps in validation (Up regulation or Down regulation) of identified *R*-genes within the host and study on effectors from pathogen is needed to understand possible mechanism for disease susceptibility in pomegranate.

S2P133 A514

Novel medicinal plants, an untapped treasure.

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A vast majority of the world population today are unable to afford the modern synthetic medicines and chiefly depend on herbal medicines for health care. The widely used medicinal plants are a few which are being cultivated for the extensive use and export market. Much of the propagation and cultivation trials were concentrated in a few crops like *Rauwolfia, Catharanthus, Solanum, Dioscorea, Opium* and*Senna*. The global interest in herbal medicines has grown rapidly in recent years leading to remarkable increase in the demand for medicinal plants. Medicinal plants growing naturally in the wild still remain as the main source of herbal medicines.There are many medicinal plants, which can be exploited but are not cultivated widely so far due to a variety of agronomic, genetic, economic and cultural reasons. Lack of scientific knowledge, unstable market price, and unavailability of good quality raw materials free from adulteration and paucity of the resources might have prevented large-scale exploitation of these medicinal plants. There is great scope for domestication and exploitation of these plants as potential herbal drugs in future.Thus, these novel plants would open new vistas in the herbal drug industry. The anti-diabetic property of *Nerviliaaragoana* (Gaud.), a medicinal orchid that is widely distributed in the forests of Western Ghats has been reported. Similarly*Ensetesuperbum,* a species of banana has been found to possess anti-inflammatory property. Some lesser-known medicinal plants like *Salaciareticulata, Symplocoscochinchinensis, Curcumacaesia, Alpiniagalanga, Solanumtrilobatum*, *Physalisminima* were found to possess many therapeutic uses.There is an urgent need of domestication and development of agro-techniques for commercial cultivation of these plants. There should be systematic research to locate prospective molecules possessing different therapeutic properties from these plants.

S2P134 A536

Manifestation of heterosis in artificially bred Trinitario cocoa hybrids

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Cultivated cocoa (*Theobroama cacao* L.) is mainly classified into Criollo, Forastero and Trinitario based on their reproductive and agronomical behavior. Criollo consist of a small inbreeding group with superior quality and classified as "fine cocoa' which are poor yielders and susceptible to diseases. Forestero is the hardiest cocoa but quality wise inferior to criollo. Trinitario is a natural hybrid between Criollo and Forestero and show series of individuals expressing varying range of characters of their parents. Incorporation of high quality criollo character to the genetic base of Forestero led to evolving man made trinitario at Cocoa Research Centre resulting in field establishment of 240 hybrids. After a preliminary yield trial , hybrids were selected for further evaluation. Cocoa exhibited heterosis in yield andyield contributing characters like pod length, pod breadth, pod weight, total wet bean weight/ pod, number of beans/ pod, single bean dry weight, length, breadth and width. Relative heterosis (RH), heterobeltiosis (HB) and standard heterosis(SH) were estimated for the selected hybrids using standard procedures. CCRP, a superior hybrid form CRC, KAU, served as the standard check.. High positive and significant RH for pod weight was exhibited in Hyb.21 (64.62%) and wet bean weight/pod in Hyb.16 (47.04%). The highest positive and significant value for HB for pod weight was observed in Hyb.10 (38.51 %) and total wet bean weight per pod in Hyb.30 (39.53%). The highest positive and significant standard heterosis (SH) for pod weight was observed in Hyb.10 (38.51%) and wet bean weight per pod (48.58%) in Hyb.21 andhighest single seed dry weight in Hyb.11 (56.91%).

S2P135 A571

Genotypic response to gynogenesis for haploid induction in short day onion

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The development of hybrids in onion is a decelerated process due to non-availability of homozygous lines. The cross-pollinated nature, biennial cycle and severe inbreeding depression are the major limitations in this regard. The genotypic response in development of doubled haploids is considered prominent in onion. Therefore, experiment was planned to study the genotypic response to gynogenesis in short day onion, wherein thirty genotypes including released varieties, advance populations and B- lines were used. The unopened flower buds were cultured on BDS medium fortified with BAP and 2, 4-D. The observations were recorded on opening of immature flower buds (%), days to opening of buds, sprouting (%) and days to sprouting. PBR-42B-1 took maximum (13.67) and G-SCY-102 minimum(4.33) number of days for opening of the buds.The flower bud opening was maximum in CT-1201(100%) and minimum in PN1322 (30%). D97Brecorded highest sprouting percentage (1%), whereas response was absent in 21 genotypes. Days taken for sprouting of putative haploids was maximum (131.33) in D97B and minimum in D30B (94.00).The haploidy status was confirmedby the chromosome counting.

S2P136 A623

Male sterile lines and their contribution for development of hybrids in African marigold (*Tageteserecta*L.)

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Identification of a male sterile system is prerequisite in breeding programs aiming at development of hybrids. Importance of male sterile system in marigold (*Tageteserecta L*) breeding program is unique, as male sterile flowers are known to have enhanced shelf life which is essential in floriculture industry. Identification of efficient male sterile line that can produce sterile hybrids is of significant importance besides its utility in commercial viability of hybrid seed production. ICAR-Indian Institute of Horticulture, Bengaluru has developed

different male sterile systems in marigold that can be efficiently utilized in hybrid breeding program. In this study, we have screened seven of these male sterile lines for their efficiency in hybrid development. Hybrids were evaluated for different vegetative (plant height, plant spread, number of primary and secondary branches) and flower characters (flower number per plant, petal meal per flower, flower size, fresh weight per flower, shelf life and number of harvests).Flower weight per plant had significant and positive association with plant height, number of primary and secondary branches, plant spread, flower number per plant, flower size, fresh weight per flower, shelf life and number of harvests. Since, the association is in desirable direction, selection for these traits will ultimately improve the yield.Among seven male sterile lines used as seed parents in the study, three were petaloid sterile lines and four were apetaloid sterile lines. Three fertile pure lines, were used as pollen parents and were evaluated in different cross combination with all the seven sterile lines. Among petaloid male sterile lines,L1 is good general combiner for flower parameters and L3 for both vegetative and flower parameters. Among apetaloid male sterile lines, L4 is the best general combiner for improvement of plant height and flower characters. Among the pollen parents, T3 is best general combiner for vegetative and flower characters.

S2P137 A632

Identification of stable resistant source in chilli (*Capsicum annuum* L.) Againstroot rot caused by *Phytophthora capsici*

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Chilli (*Capsicum annuum* L.; 2n=24) is an important vegetable cum spice crop grown worldwide and belongs to the familySolanaceae. Chilli fruits are rich source of several vitamins (A, C and E) and minerals like molybdenum, manganese, potassium and copper. Chilli cultivation is severely affected by various biotic and abiotic stresses. Among them, root rot caused by *Phytophthora capsici* is a major disease limiting chilliproduction worldwide. *Phytophthora capsici* attacks the roots at all developmental stages, causing sudden wilt and collapse of the crop in patches. *Phytophthora* infection is enhanced by warm temperatures and frequent rainfall conditions. The objective of the present study was to identify the stable source of genetic resistance against the virulent isolates of*P. capsici* causing root rot in chilli. In order to achieve the objective, chilligenotypes were screened against two virulent isolates of *P. capsiciviz*., Belagavi PC1 and IIHR PC1, and were used to screen five genotypes known for resistance to *Phytophthoracapsici* elsewhere along with a highly susceptible check variety, ArkaMohini. Among the six lines evaluated, IHR 3575, IHR 3574 and IHR 4504-2 were found highly resistant against both the isolates tested. However, IHR 4504-1 was found highly resistant against IIHR PC1 and resistant against Belagavi PC1 isolate; whereas IHR 4567 was

found resistant against Belagavi PC1 isolate and moderately resistant against IIHR PC1 isolate. The identified resistant genotypes in the study will be the potential sources of resistance in the future chilli breeding program against virulent isolates of root rot caused by *Phytophthora capsici.*

S2P138 A633

Identification of stable source of resistance to Chilli Leaf Curl Virus in chilli (*Capsicum annuum* L.*)* through challenge inoculation with whitefly (*Bemisia tabacci*)

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Chilli leaf curl virus(ChiLCV) is one of the most predominant begomoviruses affecting chilli crop productivity throughout the tropics and subtropics of the world, and is transmitted by whitefly (*Bemisia tabaci)*. In the recent past, epidemics of ChiLCVin chilli crop, in association with the upsurge of whitefly is reported in all the major chilli growing areas of the countrycausing up to 100% yield loss. Presently no commercial variety having resistance to ChiLCV is available in the market. In this background, the present work has been initiated with an objective to identify the stable genetic source having resistance across the*Capsicum* sp. In order to achieve this, initially a reliable vector mediated screening methodology has been standardized under screen house conditions. Among the two hundred lines challenge inoculated in the screen house, three lines *viz*., IHR 4613, IHR 4577 and IHR 4031 showed no visual symptoms even four months after challenge inoculation (20-25 virulent whiteflies/ plant) and were further confirmed by PCR. These three promising lines having resistance to ChiLCV will be of great use in the future resistance breeding programme.

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S2P139 A636

Genome editing: A new perspective in breeding horticultural crops

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Conventional breeding technologies, such as natural cross-hybridization, mutation induction through physical or chemical mutagenesis, and modern transgenic tools are often used to enhance crop production. However, these breeding methods are sometimes laborious and complicated, especially when attempting to improve desired traits without inducing pleiotropic

effects. Therefore to lessen these complexities crops of the near future will be genome edited by a technology called "Genome editing with engineered nucleases" or GEEN, a technology that can add, remove or repair existing genes that might be not desirable such as genes that make crops susceptible to diseases, insects, drought, heat, cold or other biotic and abiotic stress factors. The GEEN technology has been developed to repair the mutated sequences of human, animals and plant genomes. The double stranded DNA repair system either uses a set of enzymes to directly join the DNA ends of the double stranded DNA breaks or uses homologous sequences as templates for regeneration of missing DNA sequences at the break point of a genome. Therefore using the DSBs technology, one can repair mutated genes or add genes in a genome while using the host's natural gene regulatory systems. Hence, it is only a matter of time to use genome editing technology by solving the major crop biotic and abiotic stress problems by adding, removing or repairing of their specific genes.

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S2P140 A638

Exploitation of heterosis for biochemical components in African marigold (*Tageteserecta*L.)

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Marigold (*Tagetuserecta*L.) is a popular flower crop and over the years the area under marigold is expanding because of its utility as feed in poultry and also for its importance in pharmaceutical industry. Besides the total carotenoid, zea-xanthin and lutein are the major biochemical components that are of particular interest to the industry. Development of hybrids rich in these biochemical components is a challenge to the seed industry. Male sterile lines are invariably sought after for hybrid development because of its commercial viability. Seven male sterile lines developed under marigold breeding program were evaluated for their effective contribution in exploiting heterosisfor biochemical components. Among seven male sterile lines used as seed parents in the study, three were petaloid sterile lines and four were apetaloid sterile lines. All the seven sterile lines were tested for their combining ability with selected tester pollen parents and potential in hybrid seed production. General combining ability (GCA) to specific combining ability (SCA) ratio was less than unity for carotenoid, zea-xanthin and lutein indicating non-additive gene action governing all the biochemical components evaluated. Line versus tester mean squares for combining ability was significant for carotenoid, zea-xanthin and lutein indicating importance of identifying right combination of sterile and pollen parents for hybrid development. Hybrids derived from petaloid sterile line contained maximum carotenoid per 100gm of petal meal (1571.18mg) as well as carotenoid yield per plant (888.20 mg). In general, biochemical components per 100gm of petal meal were higher in apetaloid sterile lines but yield of biochemical components per plant was higher in petaloid male sterile lines. Total carotenoid, zeaxanthin and lutein per plant were maximum

in hybrid combinations resulting from petaloid sterile lines indicating the importance of petaloid sterile lines in production of hybrids.

S2P141 A666

In vitro screening of banana cultivars for antilithiatic potential

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Banana cultivars of different genome and ploidy (Poovan (AAB), Red banana (AAA), Neypoovan (AB), Karpooravalli (ABB), Sannachenkadali (AA) and Bhimkol (Wild-BB)) were evaluated for their antilithiatic potential (dissolution of kidney stones) under *in vitro* conditions. The aim of the present investigation was to scientifically validate the traditional use of banana corm as antilithiatic agent. Solvents of varying polarity were used to extract the secondary metabolites present in the banana corm. Formation of kidney stone involves three important stages namely nucleation, growth and aggregation, which were examined under *in vitro* conditions, using the solvents extracts of different polarity from all the cultivars. The results revealed that all the banana corms extracts were found to show antilithiatic property in all the stages of stone formation. Among the cultivars, the methanolic extract of Red banana corm had the maximum potential to inhibit the calcium oxalate stone formation at all the three stages of stone formation.

S2P142 A675

Survey and identification of groundnut bud necrosis virus Isolates infecting tomato in karnataka

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Tomato is an important vegetable crop grown in Karnataka, past five years Tospovirus incidence has increased causing yield loss upto 15 to 60%. Groundnut bud necrosis virus (GBNV) is a quasi-isometric virus belonging to genus Tospovirus, the family Bunyaviridae and is vectored by *Thrips palmi* transmitted in a propagative manner. Survey conducted in tomato fields and plants showing symptoms of chlorotic/necrotic ring spots, apical bud necrosis and petiole necrosis were collected from farmer's fields in the major tomato growing areas like Bangalore rural, Mandya, Shivamogga and Hassan district of Karnataka during 2016-17. The symptomatic samples were mechanically inoculated to cowpea Cv.C-152, tomato and chilli for virus maintenance and virus identification. Leaf dip preparation of infected samples observed under electron microscope revealed the presence of quasi isometric particles of 80-85nm in size and in ELISA testing reacted strongly to polyclonal antibodies of GBNV but not to CMV.

For molecular identification, total nucleic acid isolated was reverse transcribed and the cDNA was used for PCR amplification using N gene specific primers. The PCR has resulted amplification of 0.7kb DNA fragments only form virus infected samples but not from healthy control. Cloning, sequencing and sequence analysis of PCR DNA fragments in NCBI blast search resulted 96 to 97% nucleotide identity with N gene sequences of GBNV. Based on Electron microscopy, ELISA testing and Sequencing the causal virus was identified as Groundnut bud necrosis virus.

S2P143 A718

Studies on phenology of guava and wild species for crop improvement

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Guava (*Psidium guajava*L.2n = 22) is one of the most important commercial fruit crops of the sub-tropical and tropical regions of the world. Even though an exotic crop of India, due to its hardiest nature, it has very well adapted to a wide variety of soil and climatic conditions of India and it gives assured yield with minimum care. Improvement of fruit and yield traits coupled with resistance to wilt and nematode complex are the major breeding objectives of the crop improvement programmes in many parts of the world.The growing cycle depends on plant genotypes as well as on climatic conditions. To make use of different genotypes for effective crop improvement programme, it is crucial to know their phenological stages. As these studies help to bring out precise information about the flowering behavior, duration of flowering, anthesis and pollen dehiscence, time taken for fruit set, duration of fruiting and harvest which helps to plan and an effective hybridization programme involving the wild species and cultivated varieties. Work on phenological studies carried out at ICAR-IIHR, Bengaluru involving the wild species *viz.*, *P. guineense*, *P. chinensis*, *P.cattleianum* and *Psidiumguajava* cv. Arka Kiran has shown considerable variation for the traits studied. The results revealed that the days taken from flower bud initiation (from when the flower bud becomes visible) to full bloom ranged from 19 (*P. cattleianum*) to 23 days (*P. guineense*), time of flowering was in synchronization with Arka Kiran(February-April and August-September) in *P. guineense* and*P. chinensis.* The duration of flowering (30 days), per cent pollen germination(40.23), duration of fruit set to harvest (100 days) and duration of fruiting (65 days) was found to be low in the wild species *P. cattleianum*.The results obtained with respect to other species and *Psidiumguajava* cv. Arka Kiran are discussed in detail, which would help to plan an efficient hybridization programme.

S2P144 IS36

Stenting in grapes (vitisvinifera L.) an alternative method of vegetative propagation

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During the process of mutation breeding in grapes through cuttings by gamma rays, the lesser rate of survival of cuttings was observed. An inhibition of rooting of cuttings by gamma rays is one of the reasons for the lesser survival rate of cuttings. Thus, in order to combat this problem of lesser survivability an alternative method of vegetative propagation called 'Stenting' (cutting and grafting is performed at same time) was tried as an initial step for mutation breeding. The rootstock and scion were taken from cv. Paneer. Cuttings with one leaf and a bud as scion is grafted onto a non-rooted cuttings which act as a rootstock. The trail of experiments were set up to evaluate the success of stenting in grapes with indole-3-butyric acid (IBA) as rooting hormone with concentration of 0 and 1500 mg/l for 30 minutes under completely randomized design (CRD) in six replicates. The results indicated that stenting with IBA treatment influenced bud-take and root formation. Development of graft union and initiation of roots on rootstocks were observed simultaneously in 20 days of time. The highest bud-take percentage was obtained in 1500 mg/l IBA. Stenting method of propagation can be alternative method of vegetative propagation combining cutting and grafting with different combination of rootstocks and scion depending on the priority.

S2P145 A27

Stability of fenugreek (*Trigonellafoenum-graecum)* genotypes for seed quality characters

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The relative ranking and values of different genotypes varies with environment. One of the major objectives in any plant breeding programme has been to develop stable varieties which minimize the effects of environment on performance. Present work on stability of fenugreek genotypes was carried out during rabi 2012-13, to study the genotypic and environmental interaction, comprising of sixteen genotypes. The experiment was laid out in

randomized block design with three replications of each treatment, with 30cm X 10cm plant spacing having plot size of 2.4 m X 3.0 m and consisting of five environments (date of sowing). The observations recorded were, field emergence index, seed germination, test weight, seed vigour index I and II and seed yield. The statistical analysis was done using mean data of ten plants taken from each plot. The experimental data obtained from the replications for all the characters investigated were analyzed through Eberhart and Russell model. The stability analysis for seed yield revealed that nine out of sixteen genotypes had stable and predictable performance on account of non-significant deviation from regression. Genotypes namely, FGK-30 (15.36 q/ha), HM-219 (15.03 q/ha), HM-348 (15.43 q/ha), and PEB (15.03 q/ha), non significant regression co-efficient and deviation from regression were found stable and suitable for wider adaptability. For seed germination HM 444 was found to be stable for wider adaptability with high mean (97.28); non significant bi near unity (1.07) and s2di near zero (-0.98). It was asserted that HM-348 has shown promising and consistent performance in wider environments for seed yield per hectare whereas HM-346 in poor environment for seed yield per hectare; HM 355 has wider adaptability for seed germination.

S2P146 A32

Studies on response of African marigold to plant growth regulators for seed production

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A field experiment was conducted at College of Agriculture, Nagpur, India during summer season of the year 2012-2013to study the response of African marigold to two plant growth regulators viz. $GA_3$and NAA at four different concentrations of 100, 200, 300 and 400 ppm as foliar spray for higher and better quality seedproduction. The result indicated that, significantly maximum vegetative growth with respect to height of plant at 60 DAT, seed yield $plot^{-1}$, seed yield ha^{-1}, weightof seeds $flower^{-1}$ and longevity of intact flower were recorded with GA_3 300 ppm treatment and it was statistically at parwith all other levels of GA_3 and NAA 100 ppm. NAA 400 ppm treatment recorded significantly maximumbranches $plant^{-1}$. Significantly early first flower bud initiation and 50 per cent flowering were observed with GA_3 300 ppm treatment.

S2P147 A61

Genetic fidelity studies of tissue culture raised plants of banana (M*usa* spp.) cultivar G-9

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The present investigation was undertaken to develop *in vitro* protocol to assess the genetic fidelity of *in vitro* raised plants in banana cultivar Grand Naine. CetylTrimethyl Ammonium Bromide (CTAB) extraction method was used for genomic DNA isolation from young leaves taken from *in vitro* raised plants as well as mother plant of banana cultivar Grand Naine.*In vitro* raised plants were examined for genetic stability using fifty RAPD primers. Out of fifty primers screened, twenty eight primers produced amplification while twenty two primers did not show any amplification. The results showed that all RAPD profile for *in vitro* raised plants were monomorphic and similar to their mother plant, which showed that all the plants raised through micropropagation were true to type or identical to the mother plant.

S2P148 A62

Conservation and exploitation of underutilized fruit crops: A review

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Plant biodiversity represents the primary source for food, feed, shelter, medicines and many other products and are important means that make life on earth possible and enjoyable. The number of plant species used by humans around the worldis only one third of the number of species. There is global concern on shrinking food base depending on a meager three crops-wheat, rice and maize. New Crops are to be encouraged to fit into the changing food habits, life styles and above all climate change. The best suited crops for upcoming climate changes are fruit crops. Underutilized fruit crops are commonly applied tothe species whose potential has not been fully realized.Mainly Aonla, jack, beal, karonda, Annonaare, Chironji, Kirani and Jamunsemi-domesticated cultivars to particular, often quite local, environments. Many of these cultivars and species, along with a wealth of traditional knowledge about their cultivation and use, are being lost at an alarming rate.There is a growing realization that fruit cultivation must diversify. Underutilized fruit crops have an important role to play in advancing horticulture development beyond the Green Revolution model of improving and

raising the yields of staple crops.Underutilizedfruit Crops are getting attention world around because of their benefits in health and nutritional security. Hence there is a need to exploit the underutilized fruit crops and to conserve the extinct species meagerly.

S2P149 A77

Appraisal of genetic variability and character association in okra genotypes for yield and contributing characters

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Okra (*Abelmoschusesculentus* L. Moench) commonly known as lady's finger and it belongs to the family Malvaceae. It is one of the most important vegetable crops cultivated in tropical, sub-tropical and warm temperate regions of the world.Genetic diversity in 20 okra genotypes for 22 morphological and agronomic traits (13 quantitative and 9 qualitative) was studied. The experiment was laid out in randomized block design with three replications during 2015-16. The phenotypic and genotypic variances, phenotypic (PCV) and genotypic coefficients of variation (GCV), heritability, genetic advance of the characters wereestimated. The genotypes demonstrated wide range of variability for all characters. In this study PCV was higher than its corresponding GCV thus revealing the role of environmental factors.Highheritability (h^2b) was recorded for all characters except days to first flowering which have moderate value. Genetic advance (GA) in per cent of mean was high for all the characters except for first flowering node, fruit length, fruit diameter which recorded moderate GA . Low genetic advance is registered for days to first flowering and days to 50% flowering. The higher value of genetic advance indicates that selection of genotypes on the basis of these characters is desirable. Fruit yield showed positiveand significant association with fruit diameter, number of fruits per plant, average fruit weight, number of seeds per pod,first flowering node.The genotypes, *viz.*KashiKranti, KashiSatdhari, VROB-159, Punjab-8 and KashiMohini were found promising for most of the yield contributing traits. These genotypes could be used further in hybrid breeding programme of okra.

S2P150 A89

Morphological characterization of brinjal (*Solanummelongena*L.)germplasm

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Brinjal (*Solanummelongena*L.) is an important solanaceous vegetable in many countriesof Asia and Africa. Assessment of genetic resources is the starting point of any crop improvementprogramme. 110 accessions of eggplant are maintained in All India Coordinated Research Project on Vegetable Crops, at Horticultural Research and Instruction Farm, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.). They have been evaluated for fifteen quantitative and twenty qualitative characters. A significant differences were observed in all characters. Most of genotypes showed intermediate growth habit, intermediate leaf lobing and acute leaf blade tip angle. Pigment production was a common feature; however its expression in different plant parts was not same. Propensity of pigment expression was highest in stem and petiole followed by the vein, calyx and lamina. Development of prickles in different plant parts was a predominant feature. Prickles appeared in stem, petiole, calyx including peduncle and leaf including veins. Most of genotypes were early to mid-early flowering and born in three patterns *i.e.* solitary, cyme and mixed (both solitary and cyme). Solitary flowers and basal flowers of cyme were fertile while additional flowers of cyme were sterile. Fruits developed from solitary and basal flower of cyme were bigger in size as compared to those from additional flowers in cyme. Out of 110lines, 91 genotypes were having purple flowers while 19 genotypes had white colour flowers. The fruit shape was observed to variable and oblong (19.09%), round (15%), medium long (18%) and long (47.27%). The genotypes fell into five fruit colour groups namely purple (38%), green (37%), white (12%), scarlet red (7%) and green with purpleand white strips (9%). The wide regional variations for plant, flower and fruit descriptors revealed enough scope for improvement of yieldcharacters by selection. The genetic differences among the genotypes are potentially relevant to breedingprogrammesand the variability created through hybridization of the contrasting forms could beexploited.

S2P152 A103

Syngameons study to improve breeding practices in fruit crops

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Interspecific hybridization which is an important mechanism that generates biological diversity is a matter of controversy. Whereas some authors focus on the potential of hybridization as a source of genetic variation, functional novelty and new species, others argue against any important role, becausereduced fitness would typically render hybrids an evolutionary dead end. By drawing on recent developments in the genetics and ecology of hybridization and on principles of ecological speciation theory, we develop a concept that reconciles these views and adds new possibilities for breeding fruit crops. Syngameons study in fruit crops totally change the scenario of hybridization and out come with possible interchange of genes or high incidence of interspecific inter compatibility within the species populations in different fruit crops by studying the hybrid species complex.

S2P153 A105

Study of various strawberry cultivars under field conditions in sub-tropicalregion of Punjab

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A field experiment was carried out in the Department of Horticulture, Khalsa College, Amritsar during the year 2013-14 and 2014-2015 to study the performance of strawberry cultivars in sub tropical conditions. The runners of five strawberry cultivars i.e.. Chandler, Tioga, Fern, Selva and Blackmore were planted at 30 x 40 cm apart on the raised beds on three times of planting i.e. mid of October, end of October and mid of November.The results of the study indicated that out of the five cultivars tried, cv. Chandler proved to be the most promisingwith respect to vegetative growth, yield and fruit quality followed by cv. Blackmore and Tioga. Fruit TSS, total sugars and ascorbic acid level of the fruits were also found higher in cv. Chandler with the least in cv. Selva. Out of the time of planting, middle of October proved to be the best in all the parameters. .

S2P154 A106

Studies on flowering and fruit characters of *jamun* genotypes (*Syzygium cuminii*Skeels.) in central and sub-mountainous zones of Punjab

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An experimental survey was conducted to know the variability of flowering and physical characters of jamun genotypes (*Syzygiumcuminii*Skeels) in Amritsar, Gurdaspur and Pathankot districts during 2015-2016. In the survey 25 seedlings of jamun were evaluated for their flowering, physical characteristics and biochemical composition. Significant difference was observed among the genotypes for the characters studied. Genotype GD-17 showed early initiation of flower (Late February), maximum duration of flowering (29 days). Genotypes GD-6 and GD-10 had maximum fruit length (3.58 cm) and fruit width (2.75 cm) respectively. Maximum seed weight was recorded in GD-32 (4.08 g). Two genotypes viz., GD-6 and GD-10 had good eating qualities and early maturation (mid June). Hence, all these characters could be considered as important traits for breeding programme.

S2P155 A107

Genetic variability in economical traits of F_2 segregating population in China aster (*Callistephuschinensis* [L.]Nees.)

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The present investigation was taken up to study the genetic variability, heritability and genetic advance for economical traits like plant height, number of branches per plant, number of flowers per plant, individual flower weight, flower yield per plant, flower diameter, duration of flowering and vase life of F_2 segregating population of two crosses *viz.*, AAC-1 × ArkaPoornima and ArkaKamini × P G Purple. Both the crosses differed in their mean performance for all the characters under study. The estimate of PCV was higher than the GCV with narrow differences between GCV and PCV for all economical traits, indicating little environmental influence on the expression of these characters. High (> 20%) PCV and GCV were observed for number of flowers per plant, individual flower weight and flower yield per plant in both the crosses. High heritability along with high genetic advances as per cent mean were recorded in both the crosses for plant height, number of branches, flower diameter,

number of flower per plant, individual flower weight and flower yield per plant indicating that characters are governed by the additive type of gene action and these characters are useful in phenotypic selection and breeding of china aster.

S2P156 A109

Genetic analysis for quantitative and qualitative traits in F_2 segregating population of two crosses of China aster [*Callistephuschinensis* (L.)Nees.]

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Two china aster crosses *Viz.*, AAC-1 × ArkaPoornima and ArkaKamini × P G Purple in F_2 segregating population were evaluated to determine the genetic variability, heritability, genetic advanceand genetic advance as percent of mean for 19 quantitative and qualitative parameters. Significant variation was recorded for the all the characters under study. The estimates of PCV were higher than GCV for all the characters in both the crosses studied. The F_2 population of both the crosses showed high to moderate PCV and GCV for all the growth parameters except stem girth which showed moderate to low PCV and GCV. However, low PCV and GCV were found for all the flowering parameters, moderate PCV and GCV were found for quality parameters except flower stalk length which showed high to moderate PCV and GCV and high PCV and GCV was observed for all the yield parameters. Heritability was moderate to high for all the growth, flowering, quality and yield parameters coupled with moderate to high genetic advance as per cent mean except for stem girth, days taken for flower bud initiation, days taken for first flowering and days taken for 50 per cent flowering which showed low to high heritability and moderate to low genetic advance as percent of mean.

S2P157 A110

Character association and path analysis for quantitative and qualitative traits in velvet bean (*Mucunapruriens L.*)

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Genotypic and phenotypic correlation, direct and indirect effects on seed yield and L-DOPA yield in velvet bean (*Mucunapruriens* L.) genotypes reveled that genotypic correlation was higher than the phenotypic correlation for most of the traits studied indicating that high heritable nature of the characters. Seed yield per plant showed highly significant and positive

correlation with number of trifoliate leaves per plant (0.906, 0.786), leaf area at harvest (0.822, 0.689), number of days to flower bud initiation (0.755, 0.651), days to 50 per cent flowering (0.758, 0.641), number of inflorescence per plant (0.760, 0.713), number of pods per bunch (0.973, 0.868) and pod yield per plant (0.998, 0.757) and L-DOPA yield per hectare (0.873, 0.869) both at genotypic and phenotypic levels respectively. L-DOPA yield per hectare (1.517)exhibited high direct positive effect on seed yield followed by days to 50 per cent flowering (1.141) and leaf area at harvest (0.531). Seed yield per plant (1.066) exhibited maximum positive direct effect on L-DOPA yield followed by number of trifoliate leaves per plant (0.818) and test weight of seeds (0.293).

S2P158 A111

Mean performance of velvet bean (*mucunapruriens* l.) genotypes for growth and yield parameters and L-Dopa content in rubber plantation under hill zone of Karnataka

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Mean performance of 11 velvet bean (*Mucunapruriens* L.) genotypes for growth, yield and quality attributes indicated significant differences among the genotypes for all characters studied*viz*vine length, number of trifoliate leaves, number of branches, stem girth, leaf area, chlorophyll content, days to flower bud initiation, days to 50 per cent flowering, days to pod maturity, number of flowers per inflorescence, number of bunches per plant, number of pods per bunch, pod length, pod width, pod yield, seed yield, test weight of seeds, L-Dopa content and its yield. The genotype ArkaDhanvantari had significantly highest pod yield (154.69 g /plant), seed yield (82.37 g) and L-Dopa content (3.74 %) and its yield (3.08 g/plant). The genotypes IIHR Selection -2 (140.98g), IC 471876 (137.31 g) and IIHR Selection -10 (137.11 g) had higher pod yield per plant and also the genotypes viz., IIHR Selection -2 (3.62 %), IIHR Selection -8 (3.23 %), ArkaAshwini (3.49), IC 369144 (3.32 %) and IC 385926 (3.44 %) had highest L-Dopa content.

S2P159 A134

Exploring the possibility of developing commercially exploitable hybrids of ripening inhibitor (*rin*) mutant

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Many ripening inhibiting mutants which lengthen the shelf life of the fruits have been investigated not only to understand fruit ripening but also to develop hybrids possessing increased keeping quality.The present investigation was outlined to characterize the ripening inhibitor (*rin*) mutant and its hybrids to explore the possibility of its commercial utilization.The genotype possessing the *rin* gene (BCT-111*rin*) was semi-determinate in growth habit with normal green leaf containing a total chlorophyll content of 164.27mg/100g fresh weight. Immature fruits with increased size of sepals were uniformly light green in colourcontaining a chlorophyll content of 10.16mg/100g fresh weightas against the average of 11.03mg/100g in three normal genotypes. Fruits of the *rin* genotype had the lowest of 1.61% total sugar content and 0.36% titratable acidity in the fruit pulp. The fruits did not ripe and remained bright yellow till the end and lycopene content in the fruits was very low of 0.38 mg/ 100g fresh weight as against the average of 3.56mg/100g fresh weight in three normal genotypes due to highly down-regulated ripening related ethylene biosynthesis.Appreciable ascorbic acid content in the fruits (25.66mg/ 100g fresh weight) suggested that ascorbic acid synthesis in the fruits and fruit ripening event were uncorrelated physiological processes.The hybrids between the genotypes with *rin/rin*geneand the genotypes possessing either *dg/dg* or *Aft/Aft* gene significantly enhanced all fruit morphological characters. The *dg*/*Dgrin/Rin*hybrid was the highest yielder(4.72kg fruit/plant). Average of 3.50mg lycopene content/100g fresh of the 4 *rin/Rin* hybrids (*Aft*/ *aft rin/Rin* , *dg*/*Dgrin/Rin* , og^c /Og^c*rin/Rin*and *hp-1/Hp-1 rin/Rin*) was slightly lesser than the average of the three normal tomato lines indicating negative effect of the "*rin*" gene even in heterozygous condition on the carotenoid biosynthesis although such depressive effect was too inconspicuous to their use in commercial hybrid breeding programme.

S2P160 A146

Conservation of biodiversity- A review

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*Biodiversity*is the variability among living organisms, which provides goods such as food, fiber, medicine, services such as air and water purification, climate regulation, control and nutrient cycling. Conservation is essential for maintaining the ecological functions, including stabilizing the water cycle, maintenance of soil fertility, pollination and cross-fertilization of plants, protection against soil erosion and stability of food production. It requires the participation of people, working with various conservation mechanisms. Mainly two types of conservation are there viz.,*in-situ* and *ex-situ*. *In-situ* conservation is the most appropriate way of conserving biodiversity.Some established natural habitats are: national parks and sanctuaries; biosphere and nature reserves; protected forests and preservation plots. Conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity. That's why protected areas form a central element of any national strategy to conserve biodiversity. *Ex-situ* conservation involves conservation of genetic resources, wild and cultivated species and draws on a diverse body of techniques and facilities. It includes: gene banks; *in-vitro* plant tissue and microbial culture collections;captive breeding of animals and artificial propagation of plants with possible reintroduction into the wild andcollecting living organisms for zoos, aquaria and botanic gardens for research and public awareness. Biodiversity policy and conservation activities are informed, enhanced and driven by research and technology. Intensive field surveys and germplasm collection of multipurpose native species are urgently needed for rehabilitation of degraded lands by the introduction of these species. This can also lead to the conservation of range plant gene pool. Thus, now a day's biodiversity conservation has become essential for sustainable development and socio-economic growth of the country.

S2P161 A188

Genetic studies in F_3 progenies of Bitter gourd (*Momordicacharantia*L.)

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Geneticvariability, genotypic and phenotypic coefficient of variation, heritability, genetic advance and correlation analysis were undertaken for twelve characters of bitter gourdobtained from the cross Phule Green Gold x Hirkani in F_3 generation. High genotypic and phenotypic coefficient of variation and high heritability estimates associated with high values of genetic advance as a percent mean were observed for number of primary branches per vine, number of fruits per vine, average yield per vine, average weight of fruit, yield tonnes per hectare which indicated additive gene action for these characters, which could be improved by simple selection method. Fruit yield per hectare showed significant and high positive correlation both at phenotypic and the genotypic level with length of vine at last harvest, number of primary branches per vine, number of fruits per vine, average weight of fruit, average length of fruit and average diameter of fruit and fruit yield per vine. It is suggested that characters viz., number of fruits per vine, average weight of fruit, average length of fruit and average diameter of fruit should be given priority for selecting high yielding genotypes.

S2P162 A200

Mean performance of Bottle Gourd [*LagenariaSiceraria*(MOL.)Standl.] genotypes for quantitative characters

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An experiment was conducted at Research cum Instructional Farm at Department of Vegetable Science, Indira GandhiKrishiVishwavidyalaya, Raipur (C.G.), India; during *Kharif* season 2015 to find out suitable bottle gourd genotypes forearliness and yield under Chhattisgarh plains. Seventy three bottle gourd genotypes were evaluated for different quantitativecharacters. Analysis of variance revealed that mean sum of squares due to genotypes was highly significant for all characters. Among 73 genotypes, the genotype IBG 60 was best for earliness (25.33 days) for days to 50% flowering and genotype IBG 45 was best for early male flowering *i.e.* 18.26 days and PusaSamrudhi was best for early female flowering *i.e.* 24.66 days and also exhibited early fruit setting (30.26 days). Genotype IBG 57 recorded early harvesting *i.e.* 41.73 days. Maximum number of fruitsper plant (15.8) was recorded in genotype IBG 59. Genotype IBG 61 showed maximum yield (432.9 q/ha). Studies revealed that the genotypes IBG 60, IBG 45, PusaSamrudhiwere found to be promising for earliness and genotypes IBG 57, IBG 59 and IBG 61were found to be promising for fruit yield.
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S2P163 A227

Evaluation of some newly introduced pomegranate (Punicagranatum) genotypes under mid-hills conditions of Himachal Pradesh

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Twenty pomegranate (*Punicagranatum* L.) genotypes namely Parfyanets, Saharnyi, Loulou, Nusai, Cloud, Green Globe, Podarok, Crab, Al-sirin-nar, Purple Heart, Kaim-anar, 20090265, Gulyalek, Haku-botan, AlkPustGhermezSaveh, Eve, Dewey, Ovadan, Sogdiana and Orange were evaluated under mid hills conditions of Himachal Pradesh. Largest and heaviest fruits were observed in Green Globe (296.3 g), whereas lightest fruits were in 20090265 (144.56 g). Aril percentage varied from 47.95% to 70.94% while as maximum aril/rind ratio was recorded in 20090265 (2.55) and minimum in Purple Heart (1.12). TSS content was maximum (15.87°B) in Purple Heart and minimum (9.93°B) in Ovadan. Titratable acidity varied from 2.26% to 0.66%. Wide variability in terms of total sugar content were also observed which ranges from 7.55% (Ovadan) to 14.13% (Purple Heart). Genotype Ovadan (30.60 mg/100 ml) have highest anthocyanins content whereas Hakubotan (3.23 mg/100 ml) have lowest anthocyanin content. Maximum phenols from the juice was obtained in Al-sirin-nar (981.24 mg/100 g), whereas it is minimum in AlkPustGhermezSaveh (308.03 mg/100 ml). Dewey, Green Globe, Podarok and Loulou are most suitable for use as a cultivar directly being big size of fruit, medium to soft seeded and high yield potential or in used for future breeding programme for further improvement in local cultivars.

S2P164 A228

Genetic analysis of exotic germplasms of pomegranate (*Punicagranatum* L.)

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Exotic pomegranategermplasm accessions from USDA-ARS, National Clonal Germplasm Repository, University of California, Davis, USA were evaluated to study genetic variation among yield and its components using a randomized block design. Twenty pomegranates (*Punicagranatum* L.) accessions were studied to determine the genetic parameters to understand the usefulness of genotypes in the breeding programme. Forty characteristics were measured in fruits, arils, leaves, andflowers,as well as juice characteristics including,total

solublesolids, titratable acidity, sugars, anthocyanin and phenols. Analysis of variance showed that there was a considerable genetic variation.It establishes that among all the parameters analyzed, a significant genetic difference was present for yield and yield attribution traits for exotic germplasm of pomegranate understudy. All plants were grouped into five clusters among them Green Globe, and Hakubotan was most distinct from others. The dissimilarity level ranged from 1 to 120, indicating that there were germplasm accessions that were either very near or very different from each other. However, significant inter-cluster variations revealed that hybridization program could be useful for the development of better plant type. The combination of fruit weight, fruits length, 100 arilweight, total soluble sugars, reducing sugar, TSS/acidity ratio, TSS %, juice %, and fruit yield/plant attributed 28.59 % of the total variation and were, consequently, the most useful for genetic characterization of this pomegranate germplasm accessions. The results of this study may help in developing strategies for pomegranate breeding program to have better varieties regarding quality and yield.

S2P165 A251

Evaluation of Fennel (*foeniculumvulgare*mill.) Varieties under Eastern Dry Zone of Karnataka

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India is known as ‘land of spices’ and is the largest producer, consumer and exporter of sedd spices and their products. Fennel (*Foeniculumvulgare*Mill.) is an important seed spice mainly grown in Gujarath and Rajasthan and to some extent in other states. A field experiment was conducted during November, 2015 to April 2016 at the Department of Plantation, Spices, Medicinal and Aromatic crops, College of Horticulture, UHS campus, GKVK, Bengaluru,Twelve fennel varieties were collected from various institutes and were evaluated using Randomized Complete Block Design with three replications. Results reveal that significant variation among the varieties for bothquantitativeand qualitative traits. Significantly maximum Plant height (177.46 cm), number of primary branches (11.46), number of umbels (30.5), number of umbellets per umbel (37.12), number of seeds per umbellet (34.33) and seed yield (31.3 q/ha) was recorded in RF-145. Followed by GF 12, RF 143, and RF 205 Early flowering (52.66 days) was noticed in RF- 205.

S2P166 A275

A diallel study of yield components and fruit quality in tomato (*Solanumlycopersicum*L.) under leaf curl disease severity condition

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Tomato leaf curl virus (ToLCV) causing leaf curl disease of tomato is a serious production constraint throughout the world.Ten parents (Nine resistant and one susceptible to ToLCV) and their 45 F_1 hybrids produced based on diallel design method II were evaluated for general and specific combining ability (GCA, SCA) for fruit yield and quality during 2014-15 autumn-winterunder leaf curl disease severity conditions.The ANOVA for combining ability revealed that the MS due to GCA and SCA effects were highly significant ($P \leq 0.01$) for all the characters studied. The ratio of σ^2SCA/ σ^2GCA was more than unity for all the studied traits except for lycopene content, which indicated the predominance of non-additive gene effects. Based on the GCA effects, parents CLN-3022-138-6-7-0, PVB-2, CLN-3024-104-48-1-0 andCLN-3022-154-11-11-0 were found best general combiner for yield and quality traits. A perusal of the results indicated that the phenotypic performance of the parents in general had positive correlation with GCA effects of the parents. However, the same was not true for titratable acidity, lycopene content and dry matter. The best hybrid combinations that reflected the high positive values of SCA were found to be those of the F_1 hybrids CLN-3022-138-6-7-0 × CLN-2123 C for total yield; CLN-3022-138-6-7-0 × CLN-3022-154-11-11-0 for fruit weight; CLN-3022-138-6-7-0 × CLN-3024-104-48-1-0 for number of locules; CLN-3022-138-6-2-0 × CLN-3024-104-48-1-0 for equatorial diameter; CLN-3008-17-10-0 × PVB-1 for polar diameter; CLN 2123 D × Punjab Chhuhara for pericarp thickness; CLN-3008-17-10-0 × CLN 2123 D for TSS; PVB-1 ×CLN-3022-154-11-11-0 for total titratable acidity; PVB-1 × Punjab Chhuhara for lycopene content and CLN-3024-104-48-1-0 × CLN 2123 C for dry matter. On the basis of phenotypic performance, SCA effects and resistance to ToLCV disease, hybrids CLN-3022-138-6-2-0 × CLN-3022-138-6-7-0, CLN-3022-138-6-2-0 × CLN-3022-154-11-11-0, CLN-3022-138-6-7-0 × CLN 2123 C, CLN-3022-138-6-7-0 × PVB-1 and CLN-3022-17-10-0 × PVB-1 were identified as promising. These hybrids are recommended for multilocation testing to assess their suitability for commercial cultivation under ToLCV prone areas and seasons.

Keywords: Tomato, ToLCV, Diallel, General combining ability (GCA), Specific combining ability (SCA)

S2P167A288

Varietal evaluation of gerbera (*gerbera jamesonii* hook.) in terms of certain vegetative and floral parameters - a study

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Gerbera (***Gerbera jamesonii*** Hook.), named in honor of German naturalist, **'Traugott Gerber'** is considered as nature**'**s one of the beautiful creations because of the excellent flowers with exquisite shape, size and vibrant colors. It finds utility in garden beds, borders, rock gardens, pot culture, and as cut flower. A study was carried out from October, 2013 to February, 2015 at the Horticulture Research Station, Mondouri, of Bidhan Chandra KrishiViswavidyalaya, in the warm and humid subtropical plains of West Bengal, to evaluate the growth and flowering of 11 cultivars of Gerbera under polyhouse (Stanza, Inferno, Preintense, Brilliance, Balance, Paradisi, Goliath, Walhalla, Rosalin, Jaffna, Daneallean).Among the varieties studied, there were highly significant variations observed for growth and quality parameters. Under the warm humid subtropical climate of West Bengal, the maximum no. of leaves (36.47) was produced by cultivar Balance, maximum growth in plant height (55.52 cm) was observed in cultivar Stanza while the maximum leaf length (33.81 cm) was recorded in cultivar Stanza. Among the cultivars, cultivar Inferno produced largest flowers with average diameter of 10.27 cm. In terms of flower disc diameter, the highest measure was observed in cultivar Jaffna at 2.41 cm. The shortest duration to reach harvest maturity (17.61) was observed in cultivar Daneallean. As per observation, cultivar Preintense showed the longest field life (23.84 days). Keeping the above parameters and the resultant observations in consideration, cultivar Stanza emerged as the most suitable Gerbera cultivar for commercial cultivation in the plains of West Bengal.

Keywords: Gerbera, Varietal Evaluation, polyhouse

S2P168 A330

Studies on tissue culture in gerbera (*Gerbera jamesonii*L.)

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The present investigation was carried out at Agri-Biotech Foundation in PJTSAU Campus, and College of Horticulture, Rajendranagar, Hyderabad, during the year 2015-2016. Here, an

attempt was made to determine the response of capitulum explants in gerbera (*Gerbera jamesonii*L.)for micropropagation through enhanced axillary-shoot multiplication, inan elite variety 'Savannah'.Response was determined on various media and MS medium supplemented with 3 mg/l BAP + 0.1 mg/l IAA was found to be the best for culture establishment and emergence of primordial (14.66 days). Early shoot-initiation was observed on MS medium supplemented with 3mg/l BAP + 0.5mg/l NAA (10.66 days).MS medium supplemented with 2 mg/l BAP + 0.5 mg/l NAA produced maximum number of shoots in the shortest time (26.00 days) while1mg/l BAP + 0.5 mg/l NAArecorded significantly high shoot-length (33.00mm). MS medium supplemented with 2mg/l IBA was the best medium for *in vitro* rooting, as, it induced highest rate of rooting (83.33%), early rooting (19.00 days) with maximum root length (54.66mm). In Vermiculite + Vermicompost (1:1 v/v) medium, survival rate was highest(80.00%) with maximum plant height (47.00mm).

S2P169 A349

Performance of bird's eye chilli(*Capsicum frutescens* L.) accessions for yield and its componentquantitative/ qualitative traits

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Bird's eye chilli (*Capsicum frutescens* L.), belonging to the family Solanaceae, is a crop native to South America and was introduced into India around the 16th Century AD. Used as a spice, it is also of great medicinal value owing to its high nutritional status. Despite its wide use, bird's eye chilli is yet to draw due attentions from the farming community. Although grown in the coastal parts of Kerala, Karnataka and Tamil Nadu, it is a neglected crop. Therefore, developmental programmes should be initiatedin this crop to improveproductivity and quality. As not much systematic research work has been done on any aspect in this crop compared to that in theother commercial species, *Capsicumannuum*, the present study was made.Thirty-six accessions of bird's eye chilli were collected from different locations in 2015-2016 and evaluated for qualitative and quantitative traits at the farm field of Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mudigere, Karnataka, India. Significant differences were recorded within the accessions for variouscharacters.Accession-26 recorded maximum plant height (94.23cm), number of primary branches per plant (8.05), maximum fruit-yield per plant (855.95g) and yield per hectare (20.71q/ha). Accession-17was the earliestto flower (52.14 days) and earliestto mature (24.25 days). Accession-20 recorded maximum fruit-length (3.42cm), fruit-width (1.49cm), fresh and dry weight of 100 fruits (231.51g & 98.71g, respectively) and seed test-weight (4.53g). Among the qualitative traits, maximum capsaicin content was recorded in Accession-15 (1.86%). Maximum ascorbic acid and oleoresin content was recorded in Accession-30 (159.05mg/100g and 11.36%, respectively); whereas, Accession-27 recorded maximum

capsanthin content (436.05 colour units).Accessions 26, 15, 30 and 27 were identified as the best performers.

S2P170 A360

In vitro propagation of Quince (*CydoniaOblonga)*

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Forced and unforced shoot tips were surface sterilized with different sterilant regimes and incubated under normal culture room conditions. Satisfactory culture asepsis (55.99%) and explant survival (56.66%) was achieved in forced explants by subjecting them to the treatment of 0.1 per cent Mercuric chloride for 10 minutes followed by 70 per cent ethyl alcohol for 10 seconds. Murashige and Skoog's full strength medium with 0.50 mg /l BAP and 0.01 mg/l IBA gave the best response in terms of establishment of cultures. Murashige and Skoog's full strength basal media supplemented with BAP and IBA at different concentrations were tried for culture proliferation of quince and it was found that BAP at 0.50 mg/l and IBA at 0.01 mg/l gave the highest per cent proliferated cultures (72.49 %), Shoot number/explants (5.75) and maximum shoot length(5.49cm). However, the lowest percentage of proliferated cultures (41.66%) were observed in WPM medium supplemented with BAP 0.50mg/l and IBA 0.01mg/l. Microcuttings (10-15mm) from the proliferated cultures were inoculated in two media supplemented with different IBA concentrations for rooting. MS medium fortified with IBA (1.25mg/l) resulted in maximum rooting(81.66%) , root number/shoot(5.00) and root length(6.15cm).

S2P171 A364

Per se performance of pumpkin genotypes during *rabi* season under Southern Zone of Tamil Nadu

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The present investigation was carried out during *rabi* 2015 with 32 pumpkin (*Cucurbitamoschata*Duch. ex. Poir) collected from different parts of Tamil Nadu to identify small fruited high quality genotypes. The genotypes CM-17, CM 10, CM 5 (3.40) recorded more number of primary branches, the highest vine length was recorded in CM18, CM10, CM17 (10.79, 10.73, 910 m) genotypes. The higher petiole length was recorded in CM21, CM18, CM15 (26.67, 24.63, 24.40cm). The higher leaf length was recorded in CM8, CM5, CM11, CM25(15.07, 14.87, 14.83cm). The leaf breadth was highest in CM15 (22.09), the

higher inter nodal length in CM17, (12.6cm) were recorded. The first male flower node was observed in CM30, CM23, CM4, CM8 the first female flower appeared early in CM12, CM10, CM26 (20.73, 21.6, 21.6node). The early female flowering was recorded in CM29, CM20 and CM16. The lowest sex ratio was recorded in CM11 (27.47). The days taken for fruit maturity less in CM29 and CM32 (78.6 and 93.2 days). The genotypes CM29, CM28 recorded higher number of fruits per plant (3.13 and 3.0). The genotypes CM29 (44.8cm) recorded less fruit diameter, the maximum fruit length CM32, CM3 (35.93 and 32.27cm), fruit weight (0.95 and 1.11kg). The highest yield per plant was recorded in CM23 & CM32 (9.48, 8.54 The highest TSS content (10.58^{o} brix) in CM14, acidity (0.76) in CM27, ascorbic acid (15. 13mg) and beta carotene content in CM29, and CM26 (1.06 and 0.97 mg). The CM29 and CM28 genotypes were identified as small fruited type among the genotypes studied.

S2P172 A383

Evaluation studies of an underutilized vegetable - Oriental pickling melon (*Cucumismelo* L. *conomon*) genotypes for quantitative and quality traits

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Oriental pickling melon (*Cucumismelo*L. Var. *Conomon)* belongs to the family Cucurbitaceae with chromosome number 2n=24. It is an ideal summer vegetable crop chiefly grown for fresh vegetable as well as pickling purpose. It has musky odour with smooth tender skin. A field experiment was carried out at University of Horticultural Sciences Bagalkot, Karnataka to study yield and quality parameters of oriental pickling melon. The results revealed that among the twenty-four genotypes, GR-2-1 recorded maximum vine length (204.00 cm) and maximum number of leaves were found in GR-3 (201.66). GR-2-1 genotype recorded maximum number of primary branches per plant (7.49). BCMCO-01 genotype was superior with respect to yield attributes like number of fruits per plant (13.50). Highest fruit weight noticed in Udupi Local (1.31 kg), while maximum fruit yield was noticed in Sirsi Local (18.41 ton/ha). With respect to quality parameters, Sirsi Local genotype was recorded high TSS content (5.85^{o} Brix). Maximum β - carotene content was found in Soubhagya (0.69 µg/100g). While, maximum ascorbic acid content was in Mysoe Local (14.42 mg/100g). Where in highest total sugars were noticed in Sirsi Local (4.96 %) and higher reducing sugar in GR-1-1 (2.65 %). Non-reducing sugars were maximum in Sirsi 2-13 (4.34 %). Though oriental pickling melon is an under exploited crop, it has good yield and quality attributes. Thus, identification of promising genotypes as a commercial crop for the area with high yield and quality fruits would help the farmers in its adoption and improving their economic status.

S2P173 A400

Characterisation of jackfruit accessions for identification of elite types

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Kerala, owing to its proximity to Western Ghats, is endowed with a rich diversity in jackfruit accessions. The crop ranks second after banana, in terms of acreage and production. The peak season of availability of the fruit in the State is from March to May. However, a major chunk of the production is wasted due to lack of post-harvest technological interventions. The present study aims at collection and evaluation of jackfruit accessions based on physic-morphological and biochemical attributes, in addition to the season of fruiting.Jack fruit accessions with off-season fruiting, beginning from January and extending up to July were identified in the present study. Accession AH-6produced fruits round the year.Wide variation was observed in physico-morphological characteristics like fruit shape, weight,rindcolour and percentage composition of the various constituents. Accession AH-26 recorded maximum fruit length whereas fruit girth was maximum in AH-8. Maximum fruit weight of 23.3 kg was observed in the accession AH-25 while the minimum (3.85 kg) was in AH-31. Fruit diameter varied significantly from 30.50 cm in AH-8 to 18.46 cm in AH-6. Wide variation was recorded in the number of bulbs from 48 in AH-7 to 618 in AH-26. Percentage of pulp was highest (43.04) in AH-9. Constitution of rind varied from 11.83 % in AH-1 to 66.21% in AH-21. Biochemical constituents also varied significantly among accessions. Titratable acidity varied from 0.120 to 1.120 %. Highest ascorbic acid content (12.5 mg/100g) was recorded in the accession AH-4. Pectin content varied from 0.25 % in AH-29 to 8.39 % in AH-23. Reducing, non-reducing and total sugars varied significantly among the accessions. Highest reducing sugar content (17.28 %) was recorded in AH-11 while non-reducing sugars were highest (18.52 %) in AH-20 and highest total sugars (34.75 %) were observed in AH-34. Significant variation in total carotenoids was also recorded wherein highest content (3131.8µg/100g) was seen in the accession AH-2 which was on par (3121.5µg/100g) with the check variety MuttamVarikkka. Accession AH-34 had the highest total soluble solids (32 º Brix).

S2P174 A493

Evaluation of wild apple accessions in Kashmir valley

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Thirty-three wild apple genotypes were collected during survey from different locations of Kashmir valley to assess the presence of variability for desired traits and amount of variation for different parameters. Analysis of variance for the various traits under study revealed significant differences at genotypic level among the selections. The phenotypic and genotypic variance phenotypic coefficient of variation and genotypic coefficient of variationwere found to be highest for fruit weight and number of seeds/fruit.The estimates of heritability in broad sense and genetic advance (as percent of mean) were high for fruit weight followed by acidity length of stalk number of seeds fruit length and fruit diameter, correlations among different traits like fruit diameter, fruit length and fruit weight revealed a positive relationship of these traits with fruit yield. Estimates of divergence revealed that significant divergence existed among the collection. Based on Mahalanobis D^2 value, the genotypes were grouped in 8 clusters with 17 genotypes in cluster I followed by 8 genotypes in cluster III, 3 genotypes in cluster II and rest were monogenic.Maximum intra cluster distance was observed in cluster III (139.24), whereas inter cluster distance was maximum between cluster II and V (5213.52). Significant differences were observed in cluster means with maximum range in fruit weight followed by TSS. Fruit and leaf traits such as leaf length and width, and fruit height, width, and weight, and skin flesh and juice color were predominant in the first two components for contribution to diversity.Appreciable diversity present in the material can be channelized for coherent breeding programs in future.

S2P175 A525

Effect of pre-crossing treatment on Rose hybridization

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Rose (*Rose sp*.)belongs to the family rosaceae and occupies the top most position among cut flowers in both national and international markets. In rosehybridization,seed setting

and seed germinationare the major problems that limit the introgression of desired characters. Most genotypes do not set seed and even those that set seed either fail to develop or take long time for maturation and their hybridization efficiency is limited by the number of seed set per hip. An attempt has been made to enhance seed setting andstrengthen hybridization program for integration of valuable gene pool into the desired genetic background. Two varieties viz., Tajmahal and Five Star, with nine pre crossing treatment combinations were used. Different concentration and combination of GA_3(0, 100, 250 ppm) and boric acid (0, 250, 500 ppm) were used for pre treatment of stigma during hybridization prior to crossing. Crossing success ranged from 16.66 to 70.0%. A wide range is observed among treatments and between varieties for hip weight (3.85 to 5.20g), number of seeds per hip (3.85 to 5.20), hip size (1.77 to 1.96cm) and seed weights/hip (0.19 to 0.44g). With different pre-crossing treatments, percentage of floaters ranged from 0.00 to 21.13 while percentage of sinkers ranged from 66.63 to 100. Pretreatment of stigma with GA_3 250ppm resulted in early maturity of hips in both varieties. GA_3 250 ppm could also enhance the success in crossing resulting inhip setting of69% in Tajmahal and 96% in Five Star. Combination of GA_3 (100ppm) with boric acid (500ppm) maximized the number of seeds per hip. Similarly, seed weight could be maximized using GA_3 (250ppm) with boric acid (250ppm) combination.

S2P176 A527

Varietal response in rose for micropropagation

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A protocol for rapid *in vitro* propagation of two newly developed cultivars of rose viz., ArkaSwadesh and IIHRR7-1 was standardized using nodal segments as explants. The nodal segments were surface sterilized with bavistin (0.25 %) and cetrimide (0.125 %) for 30 minutes, followed by treatment with 0.1 % mercuric chloride for 10 minutes. Explants were cultured on full strength Murashige and Skoog medium (MS) supplemented with different concentrations of benzyl aminopurine (BAP 1-5 mg/l) alone or in combination with napthalene acetic acid (NAA, 0.1 - 0.2 mg/l) and gibberellic acid (GA_3,0.5 mg/l). The best response for multiple shoot production (i.e more than 3 micro-shoots) was obtained in medium supplemented with 3 mg/l BAP and 0.5mg/l GA_3 in 3-4 months in both the cultivars. The same media gave better response in terms of shoot length, number of branches per shoot and number of leaves per shoot in both cultivars. However, ArkaSwadesh gave better response for *in vitro* shoot elongation of microshoots as compared to IIHRR 7-1 making it more responsive to micropropgation. The *in vitro* shootlets were rooted on half strength MS media supplemented with 0.5 mg/l IBA (Indole butyric acid).

S2P177 A539

Medicinal *Kaempferia* species: emerging drugs

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Medicinal *Kaempferia* species belong to the family Zingiberaceae. The genus contains approximately 50 species distributed from India to Southern China and Malaysia which are source of valuable bioactive compounds. Among them, *K. parviflora*, *K. rotunda* and *K. galanga* are mostly used for medicinal purpose. *K. parviflora*also known as Thai Ginseng is an important medicinal plant under this genus, indigenous to the north-eastern part of Thailand. Rhizomes of *K. parviflora* have been used as traditional medicine for rectifying male impotence, body pains and gastrointestinal disorders among local people of Thailand.Methoxyflavones are the major pharmacologically active constituents reported in this species. In India it is found growing wild in Manipur and Nagaland.*K. rotunda* is an important medicinal plant in the ancient system of traditional medicine in India and Indonesia used against abdominal pain, wounds, diarrhoea and colic disorder. The main bioactive constituent is cretopoxide useful in inhibition of tumors. *K. galanga*is a highly priced medicinal plant from this genus which forms a component of over 59 ayurvedic medicines and is extensively used in pharmaceutical industries, perfumery,cosmetics and as spice ingredients.There are only few studies available on the breeding systems and pollination mechanisms of these species. Taxonomic identification to the species level is difficult in this genus without floral parts. These species which have potential for commercial exploitation are at present collected from wild which may lead to their extinction.Extensive studies on the growth and development and pharmacological properties are required for further cultivation and utilization of these under exploited *Kaempferias* in medicine.

S2P178 A561

Performance studies of Oriental pickling melon (Cucumismelo L. Var. Conomon) genotypes for quantitative traits and qualitative traits

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Oriental pickling melon (*Cucumismelo*L. car.*Conomon)* belongs to the family Cucurbitaceae with chromosome number 2n=24. It is an ideal summer vegetable crop chiefly grown for fresh vegetable as well as pickling purpose. It has musky odour with smooth tender skin. A field experiment was carried out at University of Horticultural Sciences Bagalkot, Karnataka to study yield and quality parameters of oriental pickling melon. The results revealed that among the 24 genotypes, GR-2-1 recorded maximum vine length (204.00 cm), maximum number of primary branches per plant (7.49). andmaximum number of leaves was found in GR-3 (201.66). BCMCO-01 genotype was superior with respect to yield attributes like number of fruits per plant (13.50). Highest fruit weight was noticed in Udupi Local (1.31 kg), while maximum fruit yield was noticed in Sirsi Local (18.41 t/ha). With respect to quality parameters, Sirsi Local recorded high TSS content (5.85° Brix). Maximum β - carotene content was found in Soubhagya (0.69 µg/100g). Whereas highest total sugars were noticed in Sirsi Local (4.96 %) and higher reducing sugar in GR-1-1 (2.65 %). Non reducing sugars were maximum in Sirsi 2-13 (4.34 %). Though oriental pickling melon is an under exploited crop, it has good yield and quality attributes. Thus identification of promising genotypes as a commercial crop for the area with high yield and quality fruits would help the farmers in its adoption and improving their economic status.

S2P179 A648

Characterization of gamma ray induced mutants of fennel (*Foeniculumvulgare* Mill.) using morphological characters

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Induced mutation has been proved to be a pivotal approach in generating genetic variability for breeding improved varieties employing conventional and/or molecular means. Mutation induced by gamma rays has been successfully used in many crops to develop new varieties with novel traits. Genetic variability for different essential traits is low in fennel crop. In the present investigation gamma ray induced 99 mutants with its parent (Rajasthan Fennel-1) was evaluated for different essential traits. The mutants were evaluated for different traits for which, they were selected in M_2 generation. Mutants plants were evaluated to know the variability and stability of mutants for different characters based on morphological characters. The earliest (54 days) flower appearance was recorded in M-36 followed by M-39 (55 days) while among the different mutants, highest, number of primary branches (20) was found in M-4 followed by M-72 (18) and M-32 (18). Dwarfism was observed in some of the mutants and minimum plant height (60 cm) was observed in M-36 followed by M-40 and M-61 (67.5 cm), M-76 (72 cm), M-69 (75 cm) and M-74 (78 cm). Maximum number of secondary branches

(58) was recorded in M-72 followed by M-22 (55) and M-70, M-77, M-88 and M-17 were recorded 52 secondary branches. Maximum number of umbels (260) was observed in M-90 and maximum number of umbellate per umbel (42) was recorded in M-85. Highest number of seeds per umbel (980) was recorded in M-85 while, early crop maturity was observed in was taken by M-38 (155 days) followed by M-36 (161 days. Higher test weight (10 g) was found in M-70 and highest seed yield per plant was recorded in M-4 (307.1 g) followed by M-35 (270.99) and M-2 (261.75 g). Negative results in some of the morphological characters were also observed in mutants.

S2P180 A668

Correlation and path co-efficient studies for yield and yield attributing characters in chilli (*Capsicum annuum*L.)

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Seventy one genotypes (54 F_1 hybrids, 15 parents and two commercial checks) of chilli (*Capsicum annuum* L.) were evaluated at Horticultural Research Station, Lam, Guntur, Andhra Pradesh to carry out the correlation studies between twelve quantitative traits and to estimate the direct and indirect effects of yield attributing traits on yield per plant. The phenotypic and genotypic association of fruit yield per plant was significant and positive with plant height, plant spread, number of fruits per plantand days to fruit maturity indicating the importance of these traits in selection for yield. The path analysis revealed that the direct contribution of number of fruits per plant and average dry fruit weight was high and positive on yield per plant. Whereas, it was moderate, positive for days to fruit maturity and low, positive for fruit length indicated that its true relationship with yield and direct selection based on these traits may be helpful in evolving high yielding genotypes of chilli.

S2P181 A669

Combining ability studies for biochemical traits in chilli (*Capsicum annuum* L.)

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Fifty fourF_1hybrids were developed in chilli using Line x Tester mating design with nine lines and six testers at Horticultural Research Station, Lam farm, Guntur, Andhra Pradesh during *kharif*, 2013-14 and 2014-15 to estimate the combining ability effects for seven biochemical traits. The analysis of variance revealed significant differences among the parents, crosses and parents vs. hybrids for all the traits studied indicating that the existence of wide variability

among the material studied. All the characters exhibited low *gca* to *sca* ratio indicated predominance of non-additive gene action in inheritance of all traits studied and improvement can be made through heterosis breeding. Among the parents, the lines LCA 504, LCA 446, LCA 466, LCA 654 and LCA 355 and the testers G4, LCA 678, LCA 453 and LCA 705-2 were found to be good general combiners and among the 54 hybrids, the hybrids LCA 504 x LCA 678, LCA 615 x G4, LCA 655 x LCA 315, LCA 355 x LCA 678, LCA 504 x G4, LCA 504 x LCA 453 and LCA 607 x LCA 703-2 were found to be promising hybrids as they have exhibited significant *gca* and *sca* effects in desirable direction for most of the quality traits. The resulted promising hybrids may be further tested over locations or seasons and recommended for commercial release and identified good general combiners could be utilized in future chilli breeding programmes.

S2P182 A673

Assessment of genetic divergence through multivariate analysis in paprika (*Capsicum annuum*L.)

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Paprika *(Capsicum annuum* L. 2n = 24) is one of the important spice crops grown all over the world.Paprika, a form of chilli is mainly valued for its high colour, low or no pungency and oleoresin. In chilli, three major products *viz.*,oleoresins,powder and dried chilli (both in whole and powder form) are traded in the world market. India is the world's leading producer occupying an area of 0.83 million hectares with a production of 1.8 million tonnes and productivity of 2 MT/ha (NHB, 2016). Forty four genotypes of paprika (*Capsicum annuum*L.) were evaluated to understand the extent of genetic diversity through 13 yield and yield attributing traits and 7 quality traits at Horticultural Research Station, Lam, Guntur, Andhra Pradesh.The analysis of variance revealed significant differences among the genotypes for all the characters studied. Based on hierarchial cluster analysis, the 44 genotypes were grouped into 7 clusters. Among all the clusters, cluster I was the largest containing 13 genotypes followed by cluster II with 10 genotypes, cluster III and cluster V with 6 genotypes, cluster VII with 4 genotypes, cluster IV with 3 genotypes, cluster VI with 2 genotypes. The maximum inter-cluster distance was observed between cluster IV and cluster VII (1217.10) and the minimum inter-cluster distance was observed between cluster I and cluster II (424.49). The cluster VII exhibited highest intra cluster distance (475.42) and cluster VI had minimum intra-cluster Euclidean^2 distance value of 231.65. The maximum contribution towards genetic divergence was shown by total extractable colour (21.56%) followed by red carotenoids

(19.87%), yellow carotenoids (13.95%), ascorbic acid (7.29%), dry fruit yield per plant (7.29%), oleoresin content (6.98%) and capsaicin content (6.87%). The principal component analysis revealed that first eight principal components with eigen value more than one were observed to contribute 83.62 per cent towards the total variability. Among the eight principal components, PC1 contributed maximum towards variability (25.18%). Considering diversity pattern and horticultural performance, the genotypes Warangal chapata double patti, Warangal chapata single patti, LCA-511 and LCA-512 were identified as promising parents and could be utilized for efficient hybridization in paprika.

S2P183 A705

Effect of different plant growth regulators on yield of chilli cv.pusa jwala

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An experiment to study the effect of different plant growth regulators on growth, yield and quality of Chilli was carried out during 2015-16 at research farm, College of Agriculture, J.N.K.V.V., Tikamgarh (M.P.) The experiment was laid out in RBD with ten treatments and three replications. The plant growth regulators used were T_1 - NAA (20 ppm), T_2 - NAA (40 ppm), T_3 - NAA (60 ppm), T_4 - GA_3 (25 ppm), T_5 - GA_3 (50 ppm), T_6 - GA_3 (75 ppm), T_7 - Ascorbic acid (100 ppm), T_8 - Ascorbic acid (200 ppm), T_9 - Ascorbic acid (400 ppm) and T_{10} – Control. The first spray of all treatments imposed on 27th September, second spraying of treatments on 17th October. Observations on growth yield and quality parameter were recorded, the vegetative growth in respect of plant height, number of branches per plant and number of leaves per plant. Quality parameters included average weight of fruit, fruit length, fruit girth and ascorbic acid content in fruit. Results obtained in the present investigation revealed that, the highest plant height (56.39 cm), number of leaves (90.35 plant^{-1}), number of branches (26.97 plant^{-1}) at 30, 60 and 90 DAT. Maximum fruit length (10.91 cm) and fruit girth (2.01 cm) NAA @ 40 ppm followed by NAA @ 60 ppm. The highest yield of chilli can be harvested with the spray of NAA @ 40 ppm (7.05 t/ha) closely followed by NAA @ 60 ppm (6.72 t/ha) and GA_3 @ 50 ppm (6.46 t/ha) while the lowest was recorded with the Control. Highest Gross income (Rs 84,600 ha^{-1}), Net monitory returns of (Rs. 48,820 ha^{-1}) and B:C ratio of (2.36) were obtained with NAA @ 40 ppm. Least was recorded with Control.

S2P184 A706

Inheritance of parthenocarpy in cross of Indian monoecious and non-parthenocarpic Cucumber (*Cucumis sativus* L.) line

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The gynoecious and parthenocarpic inbred line, Pant Parthenocarpic Cucumber-2 (PPC-2) was crossed with Indian monoecious and non-parthenocarpic cultivar Pusa Uday to develop F_1, F_2, BC_1P_1 and BC_1P_2 to determine the inheritance of parthenocarpy. The crop was grown under insect proof net house of 40 mesh and pistillate buds were also covered using butter paper bags before anthesis to prevent from outcrossing. The observations were recorded separately for the development of early parthenocarpic fruits (*i.e.*1-7th nodes), late parthenocarpy (8th and above nodes) and non-parthenocarpic fruits. In F_1 generation, out of 40 plants screened 2 plants produced parthenocarpic fruits at lower nodes (1-7th nodes) and 37 plants produced parthenocarpic fruits at upper nodes (8th and above) whereas only 1 plant did not produced any fruits was considered as non-parthenocarpic fruit development. The segregation of F_2 population (PPC-2 × Pusa Uday) and test crosses for parthenocarpic fruit development suggests that parthenocarpy in gynoecious and parthenocarpic cucumber line PPC-2 is under the control of incomplete dominant gene. Therefore, the information generated on inheritance of parthenocarpy from this study would be of immense importance in the context of developing parthenocarpic cultivars/hybrids in cucumber suitable for protected cultivation.

S2P185 A76

Male sterility in onion: A functional tool in heterosis breeding

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Onion (*Allium cepa* L.) is a highly cross pollinated crop withprotandry nature of breeding system, out crossing results in terms of hybrid vigour, facilitates economical F_1-hybrid development. However, F_1 hybrid development is limited in India due to its small, numerous hermaphrodite flowers which make it difficultfor hand emasculation and pollination. Therefore, intervention of male sterility (*ms*) is an indispensable tool to exploit heterosis with the aid of molecular markers. The molecular markers linked to *ms* trait could distinguish male sterile population from male fertile population. In this study, marker assisted selection (MAS) of *ms* locus was carried out in AkraKirthiman, ArkaLalima, *ms*–10, *ms*–11, *ms*–22 and *ms*–16 with aid of *orf*725 marker, and male sterility was confirmed. Progenies resulted from *ms* line paired with fertile populations, correspondingly identified their counterpart as maintainer lines (B lines). Application of molecular marker linked to *ms*–lines could shorten the onion breeding cycle for F_1 hybrid development by exploitation of heterosis.

S2P186 A234

Combining ability and gene action studies for fruit yield and its components in tomato (*Solanumlycopersicum* L.)

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The present investigation was undertaken from *Rabi*, 2014 to *Rabi*, 2015 at Horticulture Research Farm, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.) to study type of gene action involved for total fruit yield and its components, to ascertain the magnitude of heterosis, to estimate the general combining ability and specific combining ability of parents and crosses, respectively. The experimental material comprised of six genotypes as diverse lines and four broad base testers. Combining ability studies by using Line x Tester analysis which consists of six lines and four testers *viz*., ITOM-11-1, ITOM-11-3, ITOM-11-6, ITOM-11-11, ITOM-11-12, ITOM-11-14 and Pusa Ruby, KashiAnupam, Pant T-3 and Cherry Tomato-1, respectively for total fruit yield and its components, revealed the involvement of both additive and non-additive gene action. By using best general combiner namely ITOM-11-1, ITOM-11-12 have been identified for earliness and short duration, ITOM-11-11, ITOM-11-12 for higher fruit yield whereas, KashiAnupam and Cherry Tomato-1 have been used as broad base tester for fruit yield and its component for tomato improvement programme. High *per se* performance, remarkable heterosis and significant sca effect was expressed in the following crosses *viz.*, ITOM-11-11/KashiAnupam ITOM-11-3/KashiAnupam ITOM-11-12/KashiAnupam ITOM-11-6/KashiAnupam and ITOM-11-1/KashiAnupam with higher yield in F_2 generation.

S2P187 A744

Morphophysiological characters of *Dendrobium*var. Yellow Splash as influenced by bioinoculants and various levels of benzyladenine

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Among the diversified species of orchids, *Dendrobium* is the most commonly grown species in India and Kerala. They are highly specific about their nutrient requirement which often becomes a problematic factor leading to the declination in the preference of this species among farmers. The use of bio-inoculants in crop production of ornamentals has opened up a new possibility of using them for improving the growth and yield of orchids also. Hence the objective of study was to evaluate the response of *Dendrobium*cv. Yellow Splash to different kinds of bio-inoculants *viz.*, AMF, Azospirillumand microbial consortium PGPR Mix – 1 developed byKAU, along with 50, 100 and 150 ppm of benzyladenine. The experiment consisted of ten different treatments involving bio-inoculants and benzyladenine which were super imposed on the existing package ofpractice recommendation of KAU, for orchids.From the results it could be observed that morphological characters like plant height and number of leaves weremaximum in the plants inoculated with AMF along with 100ppm benzyladenine. Treatment consisted of *Azospirillum* and 100ppm benzyladenine was superior in terms of other morphological parameters like leaf breadth, leaf area and plant spread. Maximum leaf length and highest number of shoots were observed in plants inoculated with Azospirillumand 150ppm benzyladenine. As far as rootparameters are concerned, highest root length was observed under the treatment AMF along with 100ppm benzyladenine while number of roots and root volume was highest in plants inoculated with *Azospirillum* and 150ppm benzyladenine. Regarding the physiological parameters, plants inoculated with AMF and 100 ppmbenzyladenine had highest chlorophyll content while highest stomatal frequency was observed under the treatment *Azospirillum* and 100ppm BA.From the study it could be concluded that inoculation of *Dendrobium* orchids with bio-inoculants like AMF and *Azospirillum* can significantly improve the morphological characters of the plants which in turn influence the production of quality spikes.

S2P188 A63

Study of compatibility mechanism in cocoa (*Theobroma cacao* L.) trees

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Cocoa (*Theobroma cacao* L.) is an important plantation crop grown as a mixed crop under coconut, areca nut and oil palm in India. Cocoa breeding programmes are mainly focused on increasing yield, quality and disease resistance. However, there are many problems that impacts cocoa production, among which self incompatibility is a major constraint. Therefore, in the present investigation compatibility mechanism was studied in ten cocoa trees belongs to ten different accessions. Based on the frequency of flower retention after manual protected pollination, trees were classified as self-incompatible or self-compatible. Trees with flower retention (FR) of 10% or less 15 days after pollination were classified as self-incompatible,

whereas trees with 30% or more flowers after the same span of time were considered as self-compatible. About 16 to 51 flowers were self pollinated in cocoa trees depending on the availability of flowers to determine their compatibility reaction, 16 flowers in cocoa tree belongs to accession VTLC-168 and 51 flowers in VTLC-155. Among the ten trees studied flower retention varied from 0% to 6.6%. Maximum flower retention percentage of 6.6 was observed in the tree of accession VTLC-156 and 0% flower retention was recorded in seven trees belongs to seven different cocoa accessions viz., VTLC-144, VTLC-146, VTLC-148, VTLC-149, VTLC-155, VTLC-168 and VTLC-191. Remaining two trees exhibited flower retention percentage of 2.9 (VTLC-151) and 6.4 (VTLC-153). Therefore, all the 10 trees belong to ten different accessions studied in the present investigation exhibited self incompatibility reaction.

Session –III
Production Management
(Cropping systems, Resource Conservation and Use Efficiency, Climate resilience, Mechanization and use of non - conventional energy resources)

S3P1 A57

Effect of dates of planting on growth and yield of banana Cv. Ardhapuri

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A field experiment was conducted at Banana Research Station, Nanded during 2007-08, 2008-09 and 2010-11 to investigate the effect dates of planting on growth and yield of banana Cv. Ardhapuri. The experiment was conducted in RandomizedBlock Design with three replications and twelve treatments. There were twelve dates of planting viz. T_1 – 15th June, T_2-15th July, T_3 – 15thAugust, T_4 – 15th September, T_5 – 15th October, T_6 – 15th November, T_7 – 15th December, T_8 – 15th January, T_9 – 15th February, T_{10} – 15th March, T_{11}-15th April, T_{12} – 15th May. The plants were planted at spacing 1.5 M x 1.5 M. The recommended package of practices of banana were adopted during investigation, Form three years pooled data the significantly maximum height of plant (177.4 cm), girth of stem (67.1 cm) Number of leave (16.0), Number of fingers (135.1), Banana yield (77.7 Mt/ha) and CB Ratio (1:4.69) were recorded by treatment T_1 (June planting) as compared to rest of the treatments.

S3P2A141

Plant Growth promoting Rhizobacteria (PGPR) for sustainable fruit production

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India is the mile stone in the horticulture map of the world with its second largest production of fruitsin world. Indian population is at present more than 1100 million and expected to be 1300 million by 2025. Such increase in population will magnify the demand for more fruit production from rapidly shrinking cultivated land area which will require huge amount of fertilizers and other inputs of production. In recent year, the concept of fruit production is undergoing a change, where different type of cultural practices are being used in sustainable fruit production like propagation, training, pruning, manuring, spraying of growth regulators etc.Plant growth promoting rhizobacteria (PGPR's) are defined as free-living soil, rhizosphere, rhizoplane and phylosphere bacteria that are beneficial to plant and soil health.

The use of PGPR's as biofertilizers is one of the most promising biotechnologies to improve primary production with low inputs in fertilizers as well as biocontrol, nutrient mobilization, phytohormone production and nitrogen fixation. Various studies have been conducted to ascertain that the application of plant growth promoting rhizobacteria improves the plant growth, yield, quality, leaf nutrient status and soil health by increasing nutrient absorption, producing plant hormones, solubilization of inorganic phosphates or mineralizing organic phosphate or other nutrients, fixing atmospheric nitrogen, and preventing deleterious effects. The plant growth promoting rhizobacteria is the key for sustainable production of different horticultural crops. It is essentially the technical and managerial component for maintaining a balance in the nutrient system between the plant and growing media.Use of PGPR's result in benefittingfruit growers as well as the environment. In this review, we have discussed about role of PGPR's in growth and sustainable quality fruit production.

S3P3A322

Response of Nagpur mandarin to fertigation vs. soil application of iron to black clay soil

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Availability of the micronutrient iron in alkaline soils is known to be one of the important soil-fertility requirementsfor quality citrus fruit production. Fertigation is one of the viable options for improving the use efficiency of the iron applied. With this background, a field experiment was conducted during 2011-2016 to compare the effect of different doses of iron (as iron sulphate) through soil application and fertigation on yield and fruit quality in bearing trees of 12-year-old Nagpur mandarin growing on smectile-rich black clay soil (*VerticUstochrept*). Treatments consisted of soil application of iron sulphate @ 100g/plant (T_1), 200g/plant (T_2) and 300g/plant (T_3); fertigation withiron sulphate @ 100g/plant (T_4), 200 g/plant (T_5) and 300g/plant (T_6), each replicated four times, tested underRandomized Complete Block Design. Mean effect of fertigation (20.5 to 21.2 tonnes/ha) on fruit yield was significantly higher than in soil application (10.9 to 12.0 tonnes/ha). However, highest fruit yield was observed in fertigation with $FeSO_4$ @ 200g/plant (76.5kg/tree), followed by 300g/plant (74.7kg/tree) and 100g/plant (74.0kg/tree). On the other hand, among treatments involving soil application of $FeSO_4$, at all the rates equivalent to fertigation rates, fruit yield was significantly lower. Distribution of average number of fruits per plant too followed the same magnitude of response,with the best at 200g $FeSO_4$, followed by 300g $FeSO_4$ and 100g $FeSO_4$ given through fertigation. In treatments of soil application, the best treatment was 300g $FeSO_4$,followed by 200g $FeSO_4$ and 100g $FeSO_4$. Various fruit quality parameters (average fruit weight 190.6g, TSS 10.05˚Brix, juice percent 46.3%) were highest with fertigation-applied $FeSO_4$ @ 200g/plant, followed $FeSO_4$ @ 300g/plant (average fruit weight, 189.5g, TSS, 10.0˚Brix and juice content 46.1%). The highest TSS to acidity ratio was observed with fertigation-applied $FeSO_4$ @ 200g/plant (12.4), followed by $FeSO_4$ @ 300g/plant (12.4),while, the lowest TSS to

acidity was observed with soil application of $FeSO_4$ @100g/plant treatment (9.95). Our studies, thus, showed that application of iron through fertigation is far superior to soil application, and 200g/plant through fertigation compared to 300 g/plant through soil application was optimum for best quality Nagpur mandarin production.

S3P4A323

Studies in crop stage specific customized fertigation products for Tomato

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Tomato is one of most important vegetable crops cultivated worldwide. In recent years, drip irrigation has been widely adopted by tomato farmers in India along with use of hybrid seeds and water-soluble fertilizers, which explains the reason behind manifold increase in tomato production. Fertigation is a unique strategy to improve use-efficiency of both water and nutrients. Selection of inputs, and, rate and time of application are critical for successful fertigation, since, it is important to estimate physiological demand and ensure compatibility. However, no crop-specific products exist in the market, and farmers use whatever generic products available at hand, leading to imbalance in nutrition and inability to realize potential yields. We are contemplating to develop a crop-growth-stage-specific fertigation product for tomato. For this, systematic survey was conducted in five major tomato-growing States that use micro-irrigation and where farmers followed established practices. A huge gap was observed between the ideal and current practices. Therefore, the present study envisaged to formulate and validate customized fertigation products for tomato under Indian the conditions. Experiments were scheduled in four major tomato-growing States. Crop-stage-wise nutrient requirement of tomato was studied, and five growth stages were identified. Two different nutrient grades were formulated, which seemed to fulfill major requirements of the tomato plant, together with supplementary application of urea, magnesium sulfate and calcium nitrate, in economic measures. The two grades were decided depending upon nutrient requirement of the plant at each stage and the recommended dose of nutrients for tomato under the Indian conditions. These were compared with the best practice in the State and individual farmer's practice. Results revealed significant improvement in yield and quality of tomato in all the four States using customized, stage-specific nutrient grades in comparison to the farmers' practice.

S3P5A333

Influence of colour shade-nets on cut-foliage production in *Philodendron* cv. Xanadu

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Photomorphogenic effect of red, green, white and black shade-nets permitting light intensities ranging from 240.5 to 370 µmol m^{-2} s^{-1}on cut-foliage production in *Philodendron* cv. Xanadu was recorded in a study conducted at ICAR-Indian Institute of Horticultural Research, Hessaraghatta, Bengaluru, during 2014-2016. Plants grown under white shade-net gave the highest amount (number) of cut-foliage / plant / month (14.53). Cultivation of plants under the black shade-net resulted in maximumlength of stalk (26.27cm), which was on par with thegreen net (25.86cm) and white net (24.91cm). Plants under the green shade-net had maximumaverage width of lamina (5.36cm), which was on par with white net (5.19cm). Vase-life did not vary significantly among cut-foliage grown under differently coloured shade-nets. Green shade-net, followed by the white shade-net was found to have greater developmental time intervals between just-expanded-tender-leaf-stage to fully-expanded-mature-leaf-stage, compared to the black and red shade-nets. Highest photosynthesis rate was observed in plants under the red shade-net, followed by the white and the green shade-nets, and, it was lowest under the black shade-net. Higher transpiration rate and stomatal conductance was observed under the red and green shade-nets. Infestation with aphids was observed during the last week of March, 2016 with the white shade-net recording maximum number of aphids (18.35 per leaf), followed by the red net (14.38 per leaf). Incidence of *Cercospora*Leaf Spot was recorded during January- February, with a PDI <5 across the shade-net colours. Weighted averages were assigned for various characters of commercial importance as per market standards. Cut-foliage from growing under the white shade-net gave the maximum weighted average (91.37) and can, therefore, be recommended for cultivation of *Philodendron*cv. Xanadu.

S3P6A357

Growth, biomass and yield of zucchinias influenced by nutrient scheduling under soilless cultivation

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An open and polyhouse experiments were conducted to study the effect of nutrient scheduling on growth, biomass and yield of zucchini hybrid Champion under soilless

culture. The study was carried out with four nutrient schedules and seven replications in a completely randomized design. Silpaulin grow bags of size 4x1x1feet were filled with 20 kgs of Arka Fermented Cocopeat (AFC) and two seeds were sown directly on to the substrate. One set of grow bags were placed in a temperature controlled polyhouse with fan and pad cooling system. Another set of grow bags were maintained in open conditions for comparison purposes. Fertilizers schedule that meets the plant requirements of N, P, K, secondary and micronutrients was made available through proprietary water-soluble mixtures. The results revealed that the nutrient scheduling of 168 ppm N-NO_3, 16 ppm P and 189 ppm K per plant recorded maximum fruit length (24.12cm), fruit girth (44.4mm), fruit weight (335.6g) and yield (5.71kg/plant and 71.39tonnes/ha) under open soilless culture. However, maximum plant height (61.25cm), number of leaves (43.33) and total plant dry biomass (146.8g/plant) of zucchini were recorded with application of 185 ppm N-NO_3, 19 ppm P and 224 ppm K per plant. The above mentioned nutrient schedule recorded highest growth and zucchini fruit yield in protected conditions also. Between open and polyhouse soilless cultivation of zucchini, highest plant height (80.6cm), number of leaves (47.4), number of fruits (22.3) and total plant dry biomass (144.7g/plant) were recorded with polyhouse conditions. However, stem diameter (35.2mm), maximum fruit length (23.2cm), fruit girth (42.9mm), fruit weight (315.4g) and yield (5.27kg/plant and 65.8t/ha) were recorded with open conditions. Zucchini plants raised on Arka Fermented Cocopeat registered higher plant height (54.7cm), stem diameter (35.2mm), number of leaves (39.3), total plant dry biomass (139.8g/plant), number of fruits (16.8), fruit length (23.2cm), fruit girth (42.9mm), fruit weight (315.4g) and yield (5.27kg/plant and 65.8t/ha) compared to soil (3.70 kg/plant and 46.3t/ha).

S3P7A390

Seasonal influence on volatile aroma constituents of two banana cultivars (Grand Naine and Nendran) under Kerala conditions

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Banana is a tropical fruit with a pleasant flavour, widely consumed throughout the world. Volatile aroma compounds are responsible for olfactory flavor of banana. However, the development of aroma flavors is affected by the temperatures during the fruit growth period.In order to get good quality fruits in terms of aroma it is essential to understand the optimum temperature for maximum aroma production. The approach used in this study is to alter the

dates of harvest so as to change the temperature during the fruit growth. The study was conducted on 2 banana cultivars viz., Grand Naine, and Nendran grown in Kerala state. Samples were collected at full maturity stage at quarterly intervals during period October 2013 to February 2015. Weather parameters were recorded from shooting to harvest period.Harvested fruits were immediately transported to the Indian Institute of Horticultural Research, Bengaluru and ripened at room temperature. The volatile compounds were identified using solid phase micro-extraction (SPME) and gas chromatography-mass spectrometry (GC-MS). More than 50 major volatile compounds were identified in both the cultivars irrespective of the seasons. The results revealed that with increased temperature volatile aroma compounds decreased in cvs. Grand Naine and Nendran. Total volatile compounds were higher in cv. Grand Naine compared to cv. Nendran. Cultivar Nendran recorded increased concentrations of esters, alcohols and decreased aldehydes, ketones and acids at high temperatures.Phenols and other constituents did not show much variation with respect to the temperature in both the cultivars. Among esters, Isoamyl butanoate and 3-Methylbutyl-3-methylbutyrate esters were the most abundant in boththe cultivars. Ketones, especially 4-Methyl-1-penten-3-one was higher in cv. Nendran whereas esters were lower compared to cv. Grand Naine. Total area of aroma constituents in cultivars Grand Naine and Nendran were high in October month followed by February with mean growth temperature of 30.5ºC and 32.6ºC respectively.In case of cv. Nendran, total area of esters and alcohols were maximum at high temperature (34.5ºC) but in cv. Grand Naine, esters and alcohols decreased with high temperature. Results indicated that fruits harvested at October month were better in terms of volatile aroma quantity in both the cultivars due to lower growth temperature. Seasonal variations were observed to affect two cultivars differentially in terms of percentage of groups of volatile compounds.

S3P8A448

Influence of yield parameters and cost economics due to application of various levels of water soluble fertilizers in brinjal hybrids

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Field investigation was carried outto study the influence of yield parameters and cost economics of brinjal hybrids due to application of various levels of water soluble fertilizer in the University Orchard, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar. Foliar feeding of water soluble fertilizer NPK (19:19:19) at 0.5 per cent and 1% along with 100 and 75 per cent recommended dose of NPK (200:150:100 kg ha^{-1}) with 5 and 7 sprays, each starting from 30 DAT at 10 days interval, formed twenty treatments in two hybrids. The experimental plots were laid out in Randomized Block Design and replicated thrice. The observations on various yield parameters were recorded and subjected to statistical analysis. The cost economics was worked out based on the prevailing

market price. The results obtained showed that among the two different concentrations of foliar applied nutrients, 7 sprays of 1% NPK (19:19:19) along with 100 per cent recommended dose of fertilizer (200:150:100 kg ha^{-1}) recorded the earlier days to 50% flowering, highest number flowers per plant, fruit girth, fruit weight, yield per plant, yield per plot and yield per hectare. The treatment which received 7 sprays of 1 per cent NPK (19:19:19) along with 100 per cent recommended dose of fertilizer (200:150:100 kg NPK ha^{-1}) was found to be the best with higher benefit cost ratio when compared to all other treatments.

S3P9A450

Softwood grafting: A novel technique for multiplying Coorg mandarin (*Citrus reticulata*Blanco.)

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Citrus is one of the most important fruit crops of the world grown in over 100 countries. Coorg mandarin is well-known for good quality fruits, and is grown mainly in Coorg (Kodagu), Hassan andChikmangalur districts of Karnataka, in Palani hills of Tamil Nadu, and in Wayanad district of Kerala. It is mainly grown as one of the component crops in coffee-based cropping systems in these regions. Several factors such as greening, phytophthora andtristeza diseases, and a lack of quality planting material, have led to a decline in the area under cultivation of Coorg mandarin. The present investigation was carried out at Central Horticultural Experimental Station, Chettalli,under polyhouse, to work out a protocol for softwood grafting in Coorg mandarin.**T**wo- to three-month old Coorg mandarin shoots were grafted ontoone-, two-, three-orfour-month old rootstock of 'Rangpur lime'. Early sprouting (11 days), taller plants (27.2cm), greater number of shoots per plant (4.05) and number of leaves (17.3) were observed in the four-month old rootstock than in the other treatments. 100% graft-success was seen in two-, three- and four-month old rootstock than inthe month-old rootstock (85%). Thus, age of the rootstock had a significant effect on plant growth and graft success rate. Application of softwood grafting to Coorg mandarin can help rapidly multiply quality planting-material. Also, this would help shorten the nursery-phase and reduce cost of production besides helping meet current demand for planting material.

S3P10A467

Effect of plant growth regulators and pinching on growth and flower yield of African marigold (*Tageteserecta* L.)

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Marigold is one of the commercially exploited flower crops that belong to the family Asteraceae. For higher economical yield and better quality of marigold flowers, crop regulation and flower forcing are important techniques done by pinching and application of PGRs.Hence, an experiment was carried out in factorial randomized block design replicated thrice with 14 treatments with two F_1 hybrids *viz.*, Gold Benz tall and Maxima yellow. The experiment was conducted with treatments GA_3 @ 50, 100 and 150ppm, NAA @ 50, 100 and 150ppm, MH @ 250, 500 and 750ppm, Alar @ 200, 400 and 600ppm and pinching with untreated control. These were applied as foliar spray to the respective plots as per treatment schedule in two doses at ten days after planting and twenty days after first spray and the pinching was done at twenty days after transplanting. The study revealed that among the varieties Gold Benz tall performed better for all the growth attributes but the number of laterals per plant Maxima yellow performed better. Application of GA_3 and NAA significantly enhanced flowering when compared to control, while pinching delayed flowering. The treatment of GA_3 @ 150ppm in both varieties recorded maximum number of flowers per plant and flower yield per plant as compared to control (Gold Benz tall, 30.13 and 406.21 g; Maxima yellow, 33.16 and 402.83 g). Based on the results of the present study, foliar spray of GA_3 @ 150 ppm was found to be superior to other growth regulators in increasing the yield of flowers. The varieties Gold Benz tall and Maxima yellow performed equally well for GA_3 @ 150 ppm application.

S3P11 A480

Feasibility of micro-sprinkler irrigation systems in pomegranate

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In India, pomegranate is most important fruit crop of arid and semi-arid regions. Pomegranate growing areas are characterized by shallow gravelly soils, undulating topography with meagre water resources and hence, micro-irrigation is becoming increasingly popular. Micro-sprinklers have been reported to be effective in commercial citrus cultivars in sub-humid regions. Hence, the study was conducted to evaluate feasibility of micro-sprinklers in pomegranate orchard. Various treatments i.e. application of irrigation water using four drippers

(4 l/h, 2 online, 2 on 1 m long micro-tube) placed on four sides of the plant, 2 micro-sprinklers as microjet 180^{o} placed symmetrically at 0.20 m from the trunk along the row, 2 micro-sprinklers as microjet 360^{o} placed symmetrically at 0.60 m from the trunk along the row, basin (Double ring) method of surface irrigation, water applied directly in basin through irrigation pipe were evaluated.The results revealed that cumulative irrigation required to applied during three years was lowest under drip (3485 L) followed by basin (4837 L) and very high under microjet 180^{o} (8219 L) and microjet 360^{o} (7532 L) irrigation systems. Microjet irrigations systems have very large wetting zone. Maximum uptake of leaf N (2.12%) and Mn (40.4 ppm) was recorded under drip while leaf K (0.98%), Cu (105.4 ppm) and Zn (35.9 ppm) was in basin system of irrigation. This has reflected in attaining vigorous growth of pomegranate plants. Maximum fruit yield was produced in basin (10.39 kg plant^{-1}) and drip (7.62 kg plant^{-1}). Quality of fruits was also better under these irrigation systems. Fruit yield based water use efficiency was highest in drip (0.526) than basin (0.499) system of irrigation. Disease incidence in the plants was less under drip and was quiet high in microsprinkler systems of irrigation. Experimental results clearly indicate that micro-sprinkler irrigation system is not beneficial in arid to semiarid tropical climate.

S3P12 A520

Effect of sprigging density and foliar nitrogen on the growth of Bermuda grass (*Cynodondactylon* L. Pers. x *Cynodontransvaalensis*)

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Turf grasses have been utilized by humans to enhance their environment for more than 10 centuries. Aesthetically, lawns enhance the quality of life, contribute to social harmony and community pride, increase property values and compliment other landscape plants. The beauty of any garden largely depends on the greenness of the lawn. The first and foremost criteria for a well establishment and a satisfactory lawn are selection of suitable grass species and methods of its establishment.The complexity and comprehensiveness of these environmental benefits that improve our quality oflife are just now being quantitatively documented through research.An experiment was carried out to study the effect of different spacing levels and foliar nitrogen on the growth and establishment of bermuda grass(*Cynodondactylon* L. Pers. x *Cynodontransvaalensis*)during 2013-2015. Bermuda grass sprigs were planted in different spacing levels and foliar spray of urea with twelve treatment combinations comprising of 10 x 10 cm with 1%, 1.5% and 2%; 15 x 15 cm with 1%, 1.5% and 2%; 20 x 20 cm with 1%, 1.5% and 2%; 25 x 25 cm with 1%, 1.5% and 2%, in factorial randomized block design with three replications. It was found that the earliest spread and ground cover were observed in planting sprigs at closer spacing of 10 x 10 cm in combination with foliar application of nitrogen in the form of urea at 2 % for two times at seven and fifteen days after planting.

S3P13 A521

Influence of growth regulating chemicals on growth and flowering in Jasmine (*Jasminumsambac*. Ait.)

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Jasmine is an important commercial flower crop occupying larger area among the traditional flower crops grown in Tamil Nadu. The crop has a main flowering season during March to October and an off-season from November to February. During the off-season, flowering is very poor or there is no flowering at all. In recent years, growth regulators are valuable in floriculture for manipulating growth and flowering of many crops and hence an attempt has been made to induce flowering during off season using growth regulators in Jasmine. The treatment comprises of both growth promoting substances *viz.*, NAA and GA_3 and growth retardants (Cycocel and Maleic Hydrazide). The experiment was laid out in randomized block design with three replications. The data on vegetative parameters *viz*., plant height, number of primary shoots, number of nodes, internodal length, number of leaves and flowering parameters *viz.*, days taken for flowering, duration of flowering, flower yield and hundred flower weight were recorded. Results revealed significant differences among the growth regulator treatments. Application of NAA @ 75 ppm recorded the highest plant height (130.6 cm and 178.5 cm), number of primary shoots (21.68 and 35.68), number of nodes (9.86 and 15.89 cm) and number of leaves (1250 and 2689.5) at 90 and 180 DAP respectively. Earliness in flowering (26.38 DAP) and maximum duration of flowering (171.00 days) was noticed with GA_3@ 150 ppm. From the above studies, it can be inferred that application of GA3 @ 150 ppm or NAA @ 75 ppm could be recommended for enhanced growth and higher flower yield in *Jasminumsambac.*

S3P14 A522

Effect of plant growth regulators and pinching on growth and flower yield of African marigold (*Tageteserecta* L.)

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Marigold is one of the commercially exploited flower crops belongs to the family Asteraceae. Presently, in our country commercial extraction of marigold carotenoids is becoming popular. Production of economical yield and better quality of marigold flowers, requires proper crop management techniques. Crop regulation and flower forcing by adopting pinching and application of PGRs are important techniques to make marigold production profitable. Hence, an experiment was carried with 14 treatments with two F_1 hybrids *viz.*, Gold Benz tall and Maxima yellowin Factorial Randamized Block Design replicated thrice. The treatments comprised of GA_3 @ 50, 100 and 150ppm, NAA @ 50, 100 and 150ppm,MH @ 250, 500 and 750ppm, Alar @ 200, 400 and 600ppm applied as foliar spray in two doses at ten days after planting and twenty days after first spray and the pinching was done at twenty days after transplanting. Growth parameters like plant height, number of laterals per plant, number of leaves per plant were significantly influenced by the application of growth regulators. The variety Gold Benz tall performed better for all growth attributes but number of laterals per plant were more in Maxima yellow variety. GA_3 @ 150ppm treatment registered maximum plant height (70.44cm), number of laterals per plant (16.13), number of leaves per plant (383.76) and leaf area (113.51cm^2). While pinching delayed flowering, GA_3 @ 150ppm treatment in both Gold Benz tall (30.13 and 406.21 g) and Maxima yellow (33.16 and 402.83 g) cultivars recorded maximum number of flowers per plant and flower yield per plant. Gold Benz tall with GA_3 @150ppm recorded the highest yield (406.21 g). It can be concluded that GA_3 @ 150 ppm was superior in increasing the flower yield in both varieties.

S3P15 A529

Studies on effect of weed management on seed quality of bitter gourd var. Preethi

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Weed management in seed production is important to reduce weed competition and disease risks. The effect of weed management practices on efficiency of weed control and quality of produced seeds is a matter of concern to the seed growers. An experiment was conducted to study the effect of weed management on seed quality of bitter gourd with nine treatments of weed management replicated thrice in RCBD. Highest seed yield (0.73t/ha) was recorded with the treatment of Pre-emergent application of Pendimethalin@0.75a.i/ha plus one hand weeding at 40 DAS followed by Mulching treatment using black polythene(0.65t/ha) which were on par. The lowest seed yield (0.18t/ha) was in weedy check treatment followed by hand weeding treatment at 20, 40, 60 DAS.Cent percent weed control efficiency was obtained with mulching using black polythene followed by pendimethalin +one hand weeding at 40DAS (97.97) which were on par.Various weed management treatments affected seed quality significantly.The treatment, mulching with black polythene was significantly superior with respect to percentage germination (82.52) and vigour index I (1924.15) and Vigour index II (27.24) which were on par with the treatments, weed free check and Pendimenthalin +one hand weeding at 40 DAS.Highest seedling length (26.10) and seedling fresh weight (2.45cm) were also recorded in the same treatment. However, seedling dry weight did not vary significantly in various weed control treatments.

S3P18A540

Nutritional Status of Mango Orchards in Chittoor District of Andhra Pradesh, India

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Nutritional status of soil is the basis for devising a suitable fertilization strategy and it has a very important impact on yield and quality of mango fruit. To determine the available nutrient status and to identify nutritional constraints, 78 soil samples from 21 mango orchards (5 to 70 years)in Chittoor district of Andhra Pradesh were utilized for the present study. The organic carbon content of the soils ranged from 0.09 to 0.74% with a mean value of 0.39%.

Organic carbon was low (<0.25%) in 77% orchards, medium in 23% orchards and none under high category. N was low in all but majority orchard had high available P and K. Available P was high in 92%, medium in 5% and low in 3% orchards while, available K was high in 80%, medium in 17% and low in 3% orchards. In 62.8% of the study area, the DTPA-Fe content is < 10.0 mg kg^{-1}, while, in 25.6% of mango orchards, it varied between 5 and 10 mg kg^{-1} and in 11.6% orchards, it was greater than 10 mg kg^{-1}, indicating that available Fe content was not sufficient to meet the crop demand. In 7.7% orchards, DTPA-Mn content was < 5 mg kg^{-1}, while in others it varied from 5 to 10 mg kg^{-1} (48.7%) and >10 mg kg^{-1}, (43.6%). None of the soil samples were found deficient in Zn with 20.5% samples having marginal and 79.5% samples having sufficient available zinc. Majority of samples (74.4%) showed high contents of Cu and 12.8% of orchards were marginal in DTPA-Cu. Of the 78 soil samples, 11.5% orchard fall in deficient, 37.2% in marginal and 51.3% orchard soils falling in sufficient categories. These results suggested that mango orchards in Chittoor district were severely deficient in N (100%) and Fe (63%) and to some extent in Cu (13%), B (11.5%) and Mn (8%).

S3P19 A556

Effect of foliar application of micronutrients and potassium humate on growth and flower yield of African marigold (*Tageteserecta* L.)

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A field experiment was conducted in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Tamil Nadu during 2014- 2015 to study the effect of foliar application of micronutrients and potassium humate on growth and flower yield of African marigold (*Tageteserecta* L.). The experiment was laid out in the randomized block design (RBD) with three replications. Various micronutrients*viz.*, $ZnSO_4$ @ 0.5%, $FeSO_4$ @ 0.5%, $MgSO_4$ @ 0.5 % and Potassium humate @ 1% were sprayed on 25 DAT and 50 DAT to formulate thirteen treatment combinations including one control. The marigold F_1 hybrid Maxima Yellow was used for this study. The following growth characters *viz.*, plant height, plant spread, numbers of branches were observed at 30, 60 and 90 days after transplanting. Flowering character *viz.*, days to flower bud initiation, duration of flowering, number of flowers $plant^{-1}$, flower diameter, single flower weight, flower yield $plant^{-1}$, flower yield $plot^{-1}$, flower yield kg ha^{-1} were recorded. Since xanthophyll and chlorophyll are an important component of marigold, theywere also estimated. Foliar application of all the treatments significantly influenced the growth, flowering and yield parameters of African marigold when compared with control. Among the thirteen treatments the highest plant height (64.32cm), plant spread (53.04cm), number of branches (22.49), number of leaves (202.15), leaf area (50.85cm), dry matter production (116.23 g $plant^{-1}$), number of flowers $plant^{-1}$ (43.83), flower diameter (11.0cm), single flower weight (11.45g) and flower yield per plant (468.44g) were observed in

treatment which received foliar application of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5%, $MgSO_4$ @ 0.5 % and Potassiumhumate @ 1% on 25 DAT and 50 DAT.

S3P20 A723

Effect of fertigaton using different rates and sources of fertilizers on growth and yield in Cabbage (*Brassica oleracea* var. capitata)

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A field experiment was conducted to study the effect of fertigation on the performance of Cabbage variety,Unnati, at ICAR-Indian Institute of Horticultural Research, Bengaluru, during *rabi* of 2013 and 2014. The experiment was laid out in Randomized Block Design withthree replications and consisted of a total of10 treatments, which included different doses, sources of fertilizers and its frequency of application. The pooled analysis of two years data revealed that the application of recommended dose of fertilizer (150:100:125 kg NPK ha^{-1}) through fertigation using water soluble fertilizers on weekly interval resulted in higher values for leaves per plant (25.67) and leaf weight per plant (599.00 gm) at 50 days after transplanting, which remained on par with the same dose and source applied at bi-weekly interval. Similarly, these two treatments recorded higher values for head weight (454.0 and 423.6 g), stem weight (102.3 and 94.0 g) and root weight (66.67 and 45.67 g) at harvest. All the fertigation treatments recorded higher yields over the conventional soil application of fertilizers to the tune of 9.0 - 57.34 per cent. Among the fertigation treatments, application of 100 per cent recommended dose using water soluble fertilizers at weekly interval resulted in significantly higher yield (59.32 t ha^{-1}) than all the other treatments tested except the treatment where the bi-weekly application of same dose of fertilizer through the same sources (56.55 t ha^{-1}) was done.

S3P21 A615

Effect of conventional and water-soluble fertilizers in fertigation on NPK content in Rhizosphere and on growth and yield of Papaya

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Effect of conventional and speciality fertilizers in fertigation on growth parameters, yield parameters, soil NPK status at different soil depths was studied in field experiments of papaya in variety Red Lady. There was significant favourable effect of speciality fertilizers on growth of papaya. Tree height and canopy width increased significantly whenrecommended dose of NPK was given through speciality fertilizers.Height of the tree ranged from 162.1 cm to 179.63 cm. The maximum height (179.63 cm) of the tree was recorded in the treatment where completely soluble water-soluble fertilizers were used to supply NPK. Similarly, the maximum

canopy width (279.0 cm) was observed in the same treatment. Number of fruits per tree increased from37.3 in control treatment where NPK were given through conventional fertilizers as basal application to 45.3 fruits in the plots where completely water-soluble fertilizers were used in drip fertigation to give 75 % of RDF of NPK. Papaya fruit yield ranged from 32.96 kg/tree to 55.1 kg/tree.Treatment T6 where 100% RDF of NPK given through speciality fertilizers gave highest yieldfollowed by T7 where 75 %RDF of NPK given through speciality fertilizers.Similarly,Papaya fruit length was maximum (21.85 cm) when NPK given through speciality fertilizers than the conventional fertilizers.Papaya fruit girth ranged from 32.52 cm to 35.33 cm. The maximum fruit girth was observed when NPK was given through speciality fertilizers. Average Individual fruit weight ranged from 0.88 kg to 1.22 kg. Speciality fertilizers significantly increased the fruit weight.Depth wise distribution of N, P, K showed that N, P, K contents were more in 20-40 cm depth than 0-20 cm depth when speciality fertilizers were applied. Similarly, available N, P, K contents were more in the treatments whereN, P, K was given through speciality fertilizers in drip fertigation than when N& K were given through conventional fertilizers and P applied as basal.

S3P22 A622

Seed priming studies in Cashew: Influence on softwood grafting

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Cashew, an important cash crop is mainly propagated through soft wood grafting. The vigour of the root stock has got a profound influence on the grafting success and production of healthy grafts. Seed priming has been reported as an effective technique to produce vigorous seedlings in many crops. Hence, a study was conducted at Regional Agricultural Research Station, Pilicode to know the influence of different seed priming agents on the growth and vigour of the rootstock seedlings and softwood grafting using the popular cashew variety of the region, Priyanka. The percentage of successful grafts were highest at 30 days after grafting (DAG) with non-primed rootstocks while height of grafts were highest with those grafted on to rootstocks primed with distilled water for 24 hours (29.01% increase). Number of leaves did not show any difference. At 45DAG the control treatment and those primed with KCl 1% were on par regarding grafting success while height of grafts were highest with those grafted on to rootstocks primed with distilled water for 24 hours. Number of leaves did not show any difference at this period also. At 60DAG grafting success was similar as 45 DAG. At 60 DAG, the plant height and number of leaves were highest with $KNO_3$3%primed root stocks. This treatment had 10.5% longer grafts with an increase of 80.85% in number of leaves present. As 5-6 month, old grafts are usually used for planting, it could be concluded from this experiment that priming with $KNO_3$3%helps in obtaining vigorous grafts in cashew.

S3P23 A644

Foliar fertilization for enhancing yield and fruit quality of apple under rain-fed conditions of mid-Himalayas

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Apple (*Malus domestica*) is the leading temperate fruit crop of North-Western Himalayan states of India. In Himachal Pradesh, apple was grown on an area of 1.11 Lac ha and producing 7.77 Lac MT crop during the year 2015-16 (hpagrisnet, 2017). The average productivity (7.02 MT/ha) is much lower than the potential yield of the crop due to several reasons. One of the major constraints is that most of the apple plantations are grown over hilly slopes subjected to huge loss of productive soil due to soil erosion. This reduces the soil fertility and subsequently the crop productivity. In addition modern fruit cultivation practices like high density plantation, obtaining higher yields from relatively young plants and obtaining high quality fruits requires more attention to plant nutrition (Bright, 2005).Nitrogen is a major element, required by all plants. Adequate nitrogen is essential for tree growth, leaf cover, blossom formation, fruit set and fruit size, all of which combine to determine crop yield (Bright, 2005). The application of micronutrient fertilizer in the cultivation zone may not meet the crop requirement for root growth and nutrient use.Therefore, a participatory experiment was conducted to assess the effect of foliar application of urea and Agromin on apple. Agromin is a commercial formulation of micronutrients containing mineral elements comprising of optimum proportion of zinc, copper, manganese, boron, molybdenum and magnesium. The experiment was conducted at three different sites at altitudes between 1800 to 2200 m above mean sea level. 13-15 years old, uniform trees of cultivar Royal Delicious were applied with treatments *viz.* Urea @ 0.5%, Agromin @ 0.25%, Urea @ 0.5% + Agromin @ 0.25%, Urea @ 1.0% and Urea @ 1.0% + Agromin @ 0.25%. Urea and Agromin sprays were done between tight to pink cluster stage of growth. These treatments were compared to control plants which were applied the recommended doses of Nitrogen.Results obtained from the experiment showed that vegetative growth was significantly influenced by the application of Urea and Agromin. Application of Urea @1.0% + Agromin 0.5% (T_5) resulted in highest plant height (29.17 cm), girth (1.10mm), shoot extension growth (45.25cm) and tree spread (14.23 cm) which was at par with treatment T_4. Maximum fruit length (6.71cm) , diameter (5.57cm), fruit weight (88.41g) and total yield per plant were recorded in the treatment T_5 (Urea @1.0% + Agromin 0.5%)which was closely followed by the treatments T_3(Urea @0.5% + Agromin @ 0.25%) and T_1 (Urea 0.5 %). The highest benefit: cost ratio (2.80) was obtained in the

treatment T_5 (Urea 1.0 % + Agromin 0.25 %). The lowest B:C ratio (2.45) was observed in Control due to the lowest number of large and medium grade fruits.

S3P24 A25

Early market supply of newly developed CCRI exotic and indigenous citrus scion cultivars via micro budding: An innovative early age propagation technique

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Commercial citrus nurseries use shield budding for nursery stock production and favourable season/ climate are prerequisites. Further bud grafts require long time (18-22 months) for field release which limits the rate of multiplication. A micro budding protocol is standardized and successfully employed on just 4 months old rootstock for faster economical multiplication of newly developed CCRI citrus exotic & indigenous scion cultivars and alsothe local scion cultivars (Nagpur mandarin) of Central India, in low cost screen house.Scions are sourced from STG derived disease free, tested mother stock of newly developed varieties viz., Cutter Valencia, USA-145 Pummelo, Flame grapefruit, Frost Owari mandarin (promising), and indigenous varietiesviz., NRCC Pummelo 5, NRCC Grapefruit 6 & N4 seedless mandarin. Normally in conventional budding the tree takes five years for commercial bearing while micro budded plants come to commercial bearing from three years after planting which means that grower starts recovering the returns in shorter time. The micro budding technique was successful in almost all exotic & indigenous varieties with maximum budding success (100%) in Cutter Valencia, Flame grapefruit, USA-145 Pummelo, NRCC Grape fruit and NRCC Pummelo 5 & N4 followed by local Sweet orange(93.33 %), Frost Owari (86.66%) and Nagpur mandarin(73.33%). Significant differences were recorded in days taken for sprouting, plant height, and scion girth, scion height and number of leaves. Number of leaves were maximum in N4 Seedless (14) followed by Cutter Valencia (12) & Sweet orange (11) and minimum in NRCC Pummelo5 (6) followed by Frost Owari (9). Micro budding technique could be effectively utilized to multiply the newly developed released CCRI exotic & indigenous scion cultivars for early orchard establishment.

S3P25 A175

Effect of mulching, nutrition growth, quality, yield and nutrient uptake in chrysanthemum (*Dendranthema grandiflora*Tzvelev.) cv. Marigold

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An investigation was carried out in Floriculture section, at Regional Horticultural Research and Extension Centre, GKVK campus, Bengaluru during 2015-16. The nutrient management experiment was laid out in Randomized Complete Block Design (RCBD) comprising of different levels of nutrients *viz.*,75, 100, 125 and 150 per cent RDF (120:150:100 kg NPK/ha) with mulching and 100% RDF without mulching as control. Results indicated that, application of 150 per cent RDF (180:225:150 kg NPK/ha) with mulching recorded maximum plant height (51.78 cm), leaf area (88.62 cm^2), number of branches (22.83) and number of suckers (11.17), early flower bud initiation and 50 per cent flowering (73.05 and 103.60 days, respectively), flower diameter (5.44 cm), numbers of sprays per plant (14.40), flower yield $plant^{-1}$ (658.35 g) and yield $hectare^{-1}$ (24.38 t). Available nitrogen (329.27 kg/ha), phosphorous (25.52 kg/ha) and potassium (171.35 kg/ha) at 120 DAP was highest in the treatment (T_4) 150 per cent RDF with mulching and lowest available soil NPK was registered in 100 per cent RDF without mulching.During 120 days after planting, maximum plant NPK content (1.33%) was recorded in the treatment with (T_4) 150 per cent RDF with mulching. Same treatment showed the maximum NPK uptake in plants (76.95 kg/ ha) at 120 DAP in Chrysanthemum cv. Marigold than the control plants. The economic analysis clearly indicated a higher cost benefit ratio (1:3.52) for 150 per cent RDF with mulching compared to rest of the treatments. From the above results, it can be concluded that, application of 150 per cent RDF with mulching NPK per ha which showed improvement in growth, flowering, quality, yield. It may be concluded that treatment (T_4) 150 per cent RDF with mulching may be practiced to achieve maximum yield and quality flowers in chrysanthemum cv. Marigold.

S3P26 A176

Production of quality planting material in chrysanthemum (*Dendranthema grandiflora*Tzvelev.) under polyhouse condition by manipulating day length

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Chrysanthemum is a short day and photosensitive plant requiring long days for vegetative growth and short day for flowering. Under long days, chrysanthemum tends to remain vegetative. Hence, regulation of light during short day condition may help to delay the flowering and to encourage the vegetative growth which inturn helps in quality planting material production. An investigation was carried out in Floriculture section, at Regional Horticultural Research and Extension Centre, GKVK campus, Bengaluru during 2015-16 under polyhouse. Providing extra hours light of four hours helps to achieve year-round production of planting material using six varieties of chrysanthemum. Among them, Arka Kirti produced the higher number of cuttings (692 and 581) followed by ArkaChandrama (692 and 581) at 60 and 120 days after plantingrespectively. Maximum rooted cuttings recorded in cv. Arka Kirti (765 and 535) followed by ArkaChandrica (623 and 516) at 60 and 120 days after plantingrespectively. The maximum rooting percentage was recorded in var. Arka Chandrika (89.93% and 89.47%)at 60 and 120 DAP. The longest rooted cutting was recorded in cv. Marigold (12.15 cm) which was on par with cv. Arka Chandrika (11.41cm) and lowest was recorded in cv. Arka Indira (9.58 cm). However, the longest internodal length of cuttings was recorded in cv. Arka Chandrika (2.69 cm) followed by cv. Arka Chandrakant (2.25 cm) and it was lowest in Arka Indira (1.76 cm). Similarly highest root length was recorded in cv. Arka Chandrika (8.50 cm) and it was lowest in cv.Arka Indira (96.01 cm). Highest root spread was recorded in cv. Marigold (4.64 cm) and lowest root spread was found in cv. Arka Kirti (93.13 cm). The present study concludes that, a four hour day extension by lighting is an effective strategy to create long days resulting in continuous vegetative growth and leads to year round production of quality planting material.

S3P27 A185

Effect of fertigation levels on yield and quality parameters of different varieties of anthurium (*Anthurium andreanum* Lind.) under shadehouse condition

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An experiment was carried out in Floriculture section, at Regional Horticultural Research and Extension centre, UHS campus, Bangalore during 2015-16. Experiment was laid out in Factorial Randomized complete block design comprising of four levels of fertigation (200:100:250 kg NPK/ha through soil application, 150:75:187.5 kg NPK/ha, 200:100:250 Kg NPK/ha and 250:100:250 kg NPK/ha through fertigation) and two varieties (cv. Tropical and cv. Xavia) of anthurium. Results revealed that, application of 200:100:250 kg NPK/ha at 15 days interval through fertigation resulted in increased plant height (109.88 cm), number of leaves per plant (10.41), leaf length (51.91 cm), leaf width (33.11 cm), leaf area (1459.69 cm^2), number of suckers (1.98), stalk length (68.20 cm), stalk diameter (7.60 mm), spathe length (18.33 cm), spathe width (12.61 cm), spadix angle (34.95^o), number of flowers per plant (8.75), per m^2 (61.25) and per hectare (4.90 lakh), first grade flowers (71.81%), cumulative water uptake (73.17 g), minimum cumulative transpiration loss (44.46 g), fresh weight (47.75 g) and vase life (27.0 days) was recorded in F_3 fertigation level. Among the varieties maximum plant height (104.42 cm), leaf width (31.24 cm), leaf area (1262.89 cm^2) number of suckers (1.18), stalk length (64.46 cm), stalk diameter (7.52 cm), spathe length (18.24 cm) and vase life (28.83 days) was recorded in cv. Xavia. Whereas, highest number of leaves per plant (10.01), leaf length (50.01 cm), spathe width (12.12 cm) and flower yield (7.63) was recorded in cv. Tropical. Winter season was found to be ideal with respect to high yield and quality of flower production.From the above results it can be concluded that, cv. Tropical, fertigation with 250:125:312.5 kg NPK per ha at fortnightly interval has been found to be optimum for realizing maximum yield, quality flowers and highest returns in anthurium under shade-house condition.

S3P28 A191

Evaluation of mulching and different irrigation practices on yield and water productivity of vegetables grown in acid soils of eastern plateau and hill region of India

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An effort was initiated at research farm of ICAR-RCER, Research Centre Ranchi (Jharkhand) during 2015-16 to investigate the efficacy of drip irrigation (DI), drip irrigation with bicolor polythene mulch (DIM) and furrow irrigation (FI) on cropping sequences concurrently throughout the year. The cropping sequences viz. cabbage- cauliflower- broccoli; moong bean- cow pea -french bean and tomato-vegetable soyabean-capsicum were cultivated as rabi, summer and kharif crop respectively.The irrigation treatments were replicated thrice in factorial randomized block design. The DIM & DI plots were not disturbed whereas, FI plots were ploughed and prepared after uprooting of the previous crops before sowing or transplanting. The initial soil status of experimental plots showed soil reaction of 4.65 pH, 0.30 EC ($mScm^{-1}$), with available nitrogen, phosphorus and potassium content of 147, 11.5 and 200.7 kg ha^{-1}, respectively. The DIM registered highest curd yields of 31.90, 26.6 and 10.27 t ha^{-1} for cabbage, cauliflower and broccoli, respectively while the lowest yields of 27.26, 12.61 and 5.21 t ha^{-1} were recorded under FI. The highest water productivity in cabbage, cauliflower and broccoli was 14.3, 11.9 and 4.59 kg m^{-3}, respectively in DIM while lowest water productivity in FI. The DIM also recorded the highest economic water productivity for cabbage (143 Rs m^{-3}), cauliflower (119 Rs m^{-3}) and broccoli (91.86 Rs m^{-3}) followed by DI. The lowest economic water productivity was recorded under furrow irrigated cabbage (27.6 Rs m^{-3}), cauliflower (16.55 Rs m^{-3}) and broccoli (10.55 Rs m^{-3}). The DIM recorded significantly higher yield of 0.68, 15.29 and 2.46 t ha^{-1} for moong bean seed, cowpea and French bean, respectively compared to other irrigation practice. Similarly, the highest water productivity of 0.39, 8.81 and 1.42 kg m^{-3} was recorded in moong bean, cow pea and French bean, respectively under DIM. The DIM also recorded the highest economic water productivity for moong bean (15.61 Rs m^{-3}), cowpea (176.10 Rs m^{-3}) and french bean (28.83 Rs m^{-3}) followed by DI (22.01 Rs m^{-3}). The lowest economic water productivity was recorded under furrow irrigated moong bean (0.96 Rs m^{-3}), cowpea (13.44 Rs m^{-3}) and french bean (1.46 Rs m^{-3}). Similarly, DIM also recorded significantly highest yield of 8.39, 7.31 and 3.57 t ha^{-1} in tomato, vegetable soyabean and capsicum, respectively, while the lowest yields of 2.10, 2.24 and 1.02 t ha^{-1} were recorded under FI. Thus the drip irrigation in conjunction with polyethylene bicolor silver black mulch technology was very effective for commercial cultivation of concurrent vegetable cropping sequences in eastern plateau and hill region of India.

S3P30 A584

Effect of protected environment on off-season seedling raising of papaya

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To evaluate the effect of different types of structure on off-season papaya seedling raising, two-year experiment was laid out during February 2015 & February 2016. Different types of structures like poly-cum-shade net house covered with 200-micron UVS plastic and 50% white shade net, naturally ventilated walk-in-type tunnel covered with 200-micron UVS plastic, black shade net house covered with the 50% black shade net were constructed at PET greenhouse complex, RE & RE Department, CAET, JAU, Junagadh, Gujarat. An open field was selected as control. Proportion of soil, sand and FYM was kept as 1:1:1 for preparation of the root media. Climatic parameters like temperature, RH and light intensity were recorded at 3 h interval (9:00, 12:00, 15:00 and 18:00). Morphological observations *viz.*, germination percentage, seedling height, collar diameter, number of leaves and tap root length were measured during the experiment period. Maximum weekly average temperature (33.3 ^{0}C) and minimum weekly average temperature (27.7 ^{0}C) was recorded in walk-in-type tunnel and black shade net house respectively. Maximum weekly average relative humidity (42.3 %) and minimum weekly average relative humidity (24.3 %) was recorded in walk-in-type tunnel and open field condition respectively. Maximum weekly average light intensity (43310 lux) and minimum weekly average light intensity (18250 lux) was recorded in walk-in-type tunnel and black shade net house respectively. Morphological observations of papaya seedlings *viz.*, seedling height (34.8 cm), collar diameter (5.5 mm), number of leaves per plant (13.6), tap root length (21.1 cm) and germination percentage (93.9 %) were observed highest in poly-cum-shade net house followed by walk-in-type tunnel. Quality parameters of papaya seedlings *viz.*, vigour index (3266) and sturdiness (83.5) were observed highest in poly-cum-shade net house and black shade net house respectively. Benefit cost ratio for papaya seedling raising in different types of the structures was more or less same *i.e.*, 4.13 to 4.84.

S3P31 A603

Mushrooms as a novel complimentary food to mitigate mineral malnutrition

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A healthy balanced diet is the first step towards nutritional security. Diversity in terms of eating different varieties of food is one way of ensuring a healthy diet. Diverse food can help in formulating combination diets which will compliment for different nutrients. Minerals are inorganic nutrients required in minute quantities for the efficient physicochemical functioning of life and play variable but essential roles in various activities of the body. Mushrooms are edible Macro fungi increasingly gaining importance as an alternative source of nutrition. However, mushrooms have not yet become a part of dietician's chart of healthy food. Although there are more than 2000 species of edible fungi, the nutritional data base of only 109 mushroom varieties are yet available. The present study was undertaken to profile the macro and micro elements of twenty different varieties of wild and cultivated culinary medicinal mushrooms of India. The mineral data showed a wide variation among different species. Potassium, phosphorus and zinc content of four commonly eaten mushrooms (Button, oyster, Milky and Shiitake) was higher to most of the commonly eaten Indian fruits and vegetables. Sodium content was low making mushrooms a healthy food. Among the trace elements; zinc content was higher to most of the fruits and higher or equivalent to most of the commonly eaten Indian vegetables. Iron content of the common oyster mushroom at 1.15mg/100g was equivalent to that of spinach (1.14mg/100g) but with better bioavailability. Mushrooms are also a good source of Selenium This study will not only help in building the nutritional database of Indian edible mushrooms but will also add to the global mushroom nutrient database; which can be an important scientific information for the nutritionists, food technologists and health managers to design complimentary designer foods for specific and general health needs of the human beings.

S3P32 A616

A method to protect the plumule and radicle of oil palm (*Elaeisguineensis* Jacq.) germinated seeds during transport.

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Oil palm(*Elaeisguineensis*Jacq.) is a domesticated monocious tree having more edible oil in their fruits. In India, introduced as rainfed crop, now grown as irrigatedcrop. Due to rapid area expansion, demand for planting material is noticeable in oil palm. Germinated seeds having a well developed neck and differentiated plumule and radicle are transported for planting in the nursery throughout the country, sometimes even abroad. Germinated seed being delicate, 10-20% damage in either plumule or radicle or both is experienced in transport, which make the seeds unusable. With the aim to protect the seeds from damage in transport, a paste consisting of sodium alginate was designed to give a coat near the neck portion, approximately 2mm thickness where plumule and radical differentiate. The paste had given complete protection along with shell and the plumule/radical did not break even if dropped from a height of 5 meters. The paste did not affect the growth of plumule and radicle of seeds up to 30 days kept inside the germination room and their establishment is statistically on par with normal seeds in different crosses of D x P. The performance of the treated seeds has been evaluated in the nursery with T1: Fresh (15 days old, coated with sodium alginate), T2: Fresh + GA 1000 (15 days old, coated with sodium alginate having GA_3 1000ppm), T3: Fresh +GA 500 (15 days old, coated with sodium alginate having GA_3 500ppm) and T4: Control (15 days old germinated, without coating) with 5 replications. The growth parameters like plant height, stem girth, number of leaves and root length of four month old seedlings of these treatments were found to benon significant and on par with control. This method is highly useful for long distance transportation of germinated oil palm seeds without any damage.

S3P33 A344

Effect of mulching on growth and yield in chilli (*Capsicum annum* L.) varieties in Northern dry-zone of Karnataka

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Chilli (*Capsicum annuum* L.) is an important spice-cum-vegetable crop of the Solanaceae family, grown inall parts of the world. In recent days, mulching operation gaining lot of importance as it ultimately improves soil fertility, fruit quality and decreases weed problems. A field experiment on Effect of mulching in varieties of chilli (*Capsicum annum* L.)in Northern dry-zone of Karnataka was conducted at the Vegetable Science Research Block, University of Horticultural Sciences, Bagalkot, Karnataka. Results revealed that among the six varieties supplied with mulching treatment, tallest plants were recorded in 'Meghana' (80.00cm), followed by 'Haritha' (79.33cm) and 'Khyati' (75.00cm). Number of primary branches per plant was highest in 'Trisha' and Gg 6409 (2.67). Similarly, number of secondary branches per plant was high in 'Meghana' (19.67), followed by 'Gg 6409' (18.00). As for fruit characters,'Meghana' had the longest fruits (21.00cm), followed by 'Gg 8107' (17.00cm). Maximum fruit weight was recorded in 'Gg 8107' (13.00g).Highest number of fruits per plant was seen in 'Meghana' (184), followed by 'Gg 6409' (172.67) and 'Haritha' (160). Highest yield per plant was observed in 'Meghana' (2.15kg), followed by 'Trisha' (1.38kg) and 'Gg 8107' (1.36kg). Maximum yield per hectare was found in 'Meghana' (60.33t/ha), followed by 'Gg 6409' (58.00t/ha), while it was lowest in 'Trisha' (39.00t/ha). Thus, yield was superior under mulch.'Meghana' and 'Gg 6409' yielded higher under mulch compared to the other varieties. It is thus clear that mulching in chilli cultivation iimproved growth and yield.

S3P34 A645

Evaluation of Zucchini varieties under high altitude high rainfall areas of Coorg region of Karnataka

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Zucchini (*Cucurbita pepo*) or Summer squash, a member ofCucurbitaceae family, comes in many different varieties with a distinct shape, color, size and flavor. The delicate flavor, soft shell and creamy white flesh of summer squash is a perfect addition to any summer meal. It is a powerful antioxidant and an anti-inflammatory agent with lot of vitamin C. The potassium in zucchini helps to lower blood pressure and its manganese also helps the body

produce collagen, which allows for healthy skin. Zucchini are usually served cooked, and can be steamed, boiled, grilled, baked, barbequed or fried. They can be used to bake bread, and zucchini flowers are a deep fried delicacy. Keeping these in view, an experiment was conducted at Central Horticultural Experiment Station (CHES) farm Chettalli at Kodagu district, Karnataka, India to assess the scope of Zucchini cultivation and varietal performance in high altitude high rainfall areas. The experimental station is situated at 1050 m above mean sea level with annual rainfall of 150 cm; mean temperature ranges between 15^0C and 32^0C; deep, dark brown, well drained sandy loam to sandy clay loam soil. The present investigation was carried out during winter season (November – February) under open field condition. The experiment was laid out in Randomized Block Design (RBD) with eight varieties viz., Sanorita, KSP-2, Yellow Zucchini, Yellow, Sunny House, Champion, Dark Green and Green Zucchini and each with four replications. Seedlings were transplanted in mulched raised bed with drip irrigation and recommended cultural practiced were uniformly followed in all the varieties. The growth, yield and yield contributing characters were observed. There was significant difference observed in growth, yield and yield contributing characters of Zucchini varieties. The results revealed that among the eight varietiesevaluated, Zucchini var. Dark Green recorded the highest number of fruits (4.127kg per plant) and fruit yield (114.6t/ha) which was significantly different when compared to other varieties. There were no major pests and disease problem noticed in all Zucchini varieties during the growing season. However, lower level incidence of leaf miner insect pest, powdery mildew disease and calcium deficiency at later stage were recorded. The leaf miner insect pest and powdery mildew disease were controlled by foliar application of Azadirachtin (3000ppm) and Hexaconzole (0.1 %), respectively.

S3P35 A658

Protected cultivation of seed spices for biotic and abiotic stress management

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India is a big country with the second highest number of the population, facing problems of climate change, decreasing land holdings, increasing pressure on natural resources i.e. land & water. There are about twenty seed spices grown in India, the important among them are coriander, cumin, fennel, fenugreek, ajwain, dill, celery, anise, nigella and caraway. Almost all the seed spices are winter season crops (rabi) need cool weather conditions for better growth and development. However, frost leads to major damage to these crops. Late winter rainfalls also adversely affect the quality and quantity of production by infestation of disease, pests, etc. These crops are very tender and sensitive to abiotic and biotic factors mainly seed, soil and air born fungal diseases and insects which may damage whole crop at any stage depending on weather parameters.Frost at post flowering stage causes heavy yield loss due to mortality of tender inflorescence. To save the crop, farmers make excessive use of fungicide which

increases the residual toxicity leading to rejection of export lots in international market. Protected cultivation, drip fertigation, low cost protected structures is the solution for comprehensive management of biotic & abiotic stresses in seed spices in the Semi-arid region of Rajasthan and Gujarat. All kind of protected technologies may not be economical and suitable to the various groups of farmers in India, because of their very high initial, running and maintenance cost, but some protected technologies are low cost, simple and highly profitable for Indian farmers for production of different high value seed spices crops and nursery raising in profitable agri-business models.

S3P36 A689

Improve Yield and Quality of Nagpur Mandarin by Mechanical Pruning in High Density Planting

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Nagpur Mandarin is an important and major fruit crop grown in Central India and area under this crop is 1.47 lakh hectares. Area under high density planting in Nagpur mandarin is increasing in Vidarbha region. Pruning plays an impotent role in canopy management as well as improving the yield and quality of Nagpur mandarin. Pruning experiment was undertaken during 2013-14, 2014-15 and 2015-16 on five, six and seven-year-old Nagpur mandarin plantation respectively under high density planting at 6m X 3m spacing. Tractor driven mechanical tree pruner was used for pruning the Nagpur mandarin orchard. It is most suitable tools for uniform and timely pruning of Nagpur mandarin orchard. In Vidarbha region, *ambiabahar*(Jan-Feb flowering and Nov-Dec. harvesting) and *mrigbahar*(June-July flowering and Feb-Mar. harvesting) are predominantly using for good crop of Nagpur mandarin. Pruning practice is mostly adopted just after the harvesting of previous crop. Pruning experiment was framed on *ambiabahar* with objective to find out the suitable time of pruning and severity of pruning for better yield, quality and productivity of Nagpur mandarin. Three times of pruning (First week of December, third week of December and first week of January) and four severity levels (No pruning, Pruning at 8 feet height, Pruning at 10 feet height and Pruning at 12 feet height) were tried. Pooled data of three years revealed that the interaction effect ofpruning severity and time was found significant in respect of Number of fruits per plant, fruit yield and fruit size. Significantly maximum number of fruits plant^{-1} (367.11), fruit yield per plant(55.55 kg), fruit yield per hectare (31.07 t ha^{-1}) and fruit weight (154.88g) was recorded in treatment P_3T_2 (pruning at 10 ft height during third week of December). However, significantly maximum fruit diameter (83.20mm) was recorded in treatment $P2T_3$ (pruning at 8 ft height during first week of January). Whereas, non-significant result was found in respect of TSS.

S3P37 A697

Seed spices: Remunerative crops to enhance farmer's income

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India, is known for "Land of Spices" since ancient, is the largest producer, consumer and exporter of spices in the world. Currently India produces 5.9 million tons of spices comes from 3.1 million hectare acreage (2014-15, GOI). Spices play a vital role in agricultural export with 8.4 million ton valued at 2.5 billion US$ (2015-16), is equivalent to six per cent to total agricultural export from India. About 63 types of spices are produced in the country, of these 20 are being classified as seed spices and among these, 10 are considered as NRSCC's mandate crops. The major seed spices grown in the country are coriander, cumin, fennel and fenugreek. These spices are mostly grown in Rajasthan and Gujarat. These two states contribute more than 80 per cent of total seed spices production in the country, therefore known as seed spices bowl of the India. Seed spices are highly remunerative crops to all the stakeholders' right from producer to the final consumer. In today's scenario cultivation of high volume traditional crops like wheat and mustard is not proving economical to the farmers. Therefore diversification to high value crops like seed spices in cropping pattern will pay more returns to the farmers. From the cultivation of cumin, coriander, and fennel farmers can earn an average net returns over cost C2 of Rs. 40000, 50000 and 60000, respectively with input- output ratio of 2.70, 2.88 and 3.16 respectively. Seed spice cultivation yielded higher returns compared to traditional high volume crops in respective area of cultivation. Therefore, in an endeavour to double the farmer's income by 2022, diversification towards seed spices with value addition through processing is highly advocated.

S3P38 A732

Nutrient management under high density planting in mandarin

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An experiment` on nutrient management under high density planting in mandarin was conducted at AICRP (Fruits') DrPDKV, Akola during period 2016-17. The results revealed interaction effect of spacing and nutrition was significant on growth parameter, plants under treatment spacing S_3L_2 (6x4 m) with 50% N (inorganic source) + 50% N (green manure) application had maximum growth parameter (height 1.749m, spread E-W 0.82 m and N-S 0.77 m, canopy volume 0.45m^3 and plant girth 10.70 cm) of mandarin plants. However nutrition level and or spacing did not affected growth.Application of 75% inorganic source + 25% (organic source-FYM) significantly improved leaf nutrient status (P -0.15%,K-1.75%,Ca-

2.58%,Mg0.34%), so also spacing as well as nutrient and spacing have significant effect on leaf nutrient status.

S3P38 A733

Cause and control of Physiological disorders of fruits - a major constraint for fruit quality

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A large number of disorders adversely affect the quality of fruits produced in the tropics. Prominent among those which have caused a serious concern in India with regard to maintenance of consistently superior quality of fruits are the jelly seed in Amrapali mango, aril browning in pomegranate and corky tissue of sapota cv. Cricket ball. Unlike many diseases which show characteristic symptoms externally, these disorders are not manifested outwardly and are noticed only when the ripe fruits are cut open. It is estimated that the extent of losses due to these disorders could range from 30-70% depending on the climatic parameters and geographical location. However, the actual extent of losses could be even higher due to the characteristic nature of these disorders which makes precise estimation of the losses extremely difficult. Since the symptoms of the disorder are manifested in ripe fruits after they are cut open, these disorders have largely remained a problem of the consumer and consequently, the producer and seller are not affected. As a result, in spite of the fact that the extent of fruit loss is very large, research and development efforts at controlling these disorders have not received the importance they actually deserve. However, the situation is completely different when the fruit is intended for the export market as even a small incidence of the disorder becomes a serious issue since the entire consignment of fruits is liable to be rejected by the importing country. As India strives to improve her export performance in future years, work on determining the causative factor and development of control measures for management of fruit disorders have gained paramount importance. It is in this context, this paper describes the work carried out by us at ICAR-IIHR, Bengaluru during the past decade with regard to our success in not only determining the cause of these disorders but also in developing appropriate pre-harvest treatment solutions to overcome the disorders effectively. Results and implications of our findings for the successful management of the fruit disorders will be discussed.

*****Retired

S3P39 A734

Effect of combined application of Fertigation and consortium of biofertilizers on soil pH in banana cropping system

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An experiment was conducted at ICAR-Indian Institute Horticultural Research, Bengaluru, during 2010-2012 to study the effect of combined application of Fertigation and consortium of biofertilizers on soil pH in Banana cropping system. The cultivar Robusta (AAA) was the planting material with a combination of twelve treatments laid out in a randomised block design with three replications. Two years data revealed that among the treatments the combination of 50% recommended dose of fertilizers through fertigation with 300 g of consortium of biofertilizers could maintain the soil pH towards neutral in main (6.62 at 90 days and 6.67 at harvest) and *ratoon* (6.86 at 90 days and 6.80 at harvest) crops at 30-45 cm depth. The observations at different growth stages (90, 180 days, at flowering and at harvest) indicated that the fertigation considerably reduced the soil pH at higher doses as compared to the lower doses at all the three depths (0-15cm, 15-30cm and 30-45cm) in both the crop cycles. Similarly, the fertigation treatments combined with higher doses of consortium of biofertilizers recorded pH towards neutral. It was also observed that, the soil pH steadily decreased up to 180 days of plant growth and there after the pH increased towards neutral condition. However, such drastic reduction or increase in the pH was not noticed at the treatment of farmyard manure combined with 300g of consortium of biofertilizers.

S3P40 A737

HiFoliar and potassium nitrate spray influences fruit characters and production in *ber* (*Zizyphusmauritiana*Lamk.) cv Seo in Central India

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A study was conducted in the well-established*ber*orchard at ICAR-Central Agroforestry Research Institute, Jhansi, during 2012 and 2013 to assess the performance of foliar spray ofHiFoliar Nutrient and potassium nitrate (KNO_3) on fruit characters and production of *ber* cv Seo in Bundelkhand region of Central India. The study comprising of twelve treatments (T_1- HiFoliar0.2%, T_2- HiFoliar0.3%, T_3- HiFoliar0.4%, T_4- KNO_3 0.5%, T_5- KNO_3 1.0%, T_6- HiFoliar0.2% + KNO_3 0.5%, T_7- HiFoliar0.2% + KNO_3 1.0%,

T_8HiFoliar0.3% + KNO_3 0.5%, T_9- HiFoliar0.3% + KNO_3 1.0%, T_{10}- HiFoliar0.4% + KNO_3 0.5%, T_{11}- HiFoliar0.4% + KNO_3 1.0% and T_{12}- Control- water spray) with four replicationswas laid out under completely randomized block design.The HiFoliar Nutrient and potassium nitrate was sprayed three times at the interval of fifteen days starting in December.The observations were recorded on fruit and yield parameters such as fruit weight, fruit volume, fruit size, pulp weight, stone weight, pulp/stone ratio, total soluble solids,number of fruits and fruit yield.The findings revealed that in *ber*HiFoliar Nutrient was only effective when used with KNO_3.In general, most of the fruit characters influenced by application of treatment T_5(KNO_3 1.0%)and T_{11}(HiFoliar0.4% + KNO_3 1.0%)except pulp/stone ratio and TSS wherein treatment T_9(HiFoliar0.3% + KNO_3 1.0%) was most effective. The study concludes that three spray of treatment T_5(KNO_3 1.0%) at the interval of fifteen days at marble stage of fruits enhances growth, fruit quality and yield of ber cv. Seo.

S3P41A738

Standardizing date of planting and harvesting for organically grown *Kalmegh*

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Kalmegh(*Andrographispaniculata*Nees.),also known as the King of Bitters, is a highly traded medicinal crop sourced largely from wild harvest. It is also gaining commercial importance and being cultivated throughout India with an annual industrial consumption to the tune of 3296 tonnes during 2006-07. It has been widely used for traditional medicine in Asian countries like China, India, Thailand and Malaysia for the treatment of sore throat, flu and upper respiratory tract infections. The four major diterpenoide constituents of *kalmegh* are Andrographolide (AP1), 14-deoxyandrographolide (AP2), neoandrographolide (AP3) and neoandrograpanin (AP4) with varying degrees of anti-inflammatory, anti-infective and anticancer activities. Organic production technology has been standardised for this crop at ICAR-IIHR, Bengaluru. There is a need to standardise date of planting and harvesting for organic production for higher biomass yield and Andrographolide content. Hence studies were conducted during 2014-15 to find out the best date of planting and harvesting in organically grown Kalmegh at ICAR-IIHR. Local variety of *kalmegh* was used for nursery-raising with *Trichoderma*-enriched FYM. Thirty five day old seedings were used for planting and *Trichoderma*-enriched FYM at 22.5 t / ha was applied as basal dose to raise the crop. Seedlings were planted at different months (July to November) and harvested at 120 DAP and subsequently two ratoons at two months interval *viz*.,180 and 240 days after planting. Significant differences were recorded in growth and yield and andrographolide contents due to date of planting and stage of harvest. July planting had better plant growth characters at 120 days after planting. Planting in July and harvesting 120 DAP (main crop) and two cuttings taken at 60 days interval produced maximum cumulative dry biomass yield of 3848 kg/ha with

a B:C ratio of 1.55. Active principles such as Neoandrographolide 14-Deoxy Andrographolide, Neoandrographonin, and Andrographolide contents were analysed in dry herbage at 120,180 and 240 days after planting. There was significant difference in Total Andrographolide content which varied from 4.352 to 4.801; 4.184 to 4.902 and 3.993 to 4.813% at mainharvest, (120 DAP),first ratoon (180 DAP) and second ratoon (240 DAP) respectively due to different dates of planting. It can be concluded that planting in the month of July and harvesting at 120 DAP with subsequent two ratoons at 60 days interval were best for organic production in *kalmegh.*

S3P42A739

Effect of fertigation, irrigation and mulching on growth and nutrient uptake pattern in African marigold

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The field investigation was conducted during *kharif* and *rabi* 2016 at IIHR, Bengaluru for studying "Effect of fertigation, irrigation and mulching on growth and nutrient uptake pattern in African marigold (*Tageteserecta* L,)". The experiment was laid out in split plot design. Main plot having three irrigation treatments of 1.0, 0.8 and 0.6 evaporation replenishment (ER) through drip irrigation and sub plots having six treatments of fertigation and mulching viz., S_1 with 100 % recommended dose of fertilizers (RDF) (100:75:75 kg NPK/ha) with mulch ,S_2 with 75% RDF with mulch,$S_3$100 % RDF without mulch, S_4 75% RDF without mulch, S_5 soil application of 100 % RDF normal fertilizers with mulching and S_6 soil application with 100 % RDF normalfertilizers without mulching. The results revealed that among these treatments significant increase in growth parameters like plant height(54.57 cm), plant spread(98.57 cm),number of branches(14.47), flower weight(12.36gr), flower diameter(6.23cm), yield (16.52tn/ha), number of flowers per plant(93.93) and shelf life(4.50 days) were recorded in case of 1.0 ER+ 100% RDF through fertigation with mulch and nutrient uptake of nitrogen (279.19 kg/ha),phosphorous (79.30 kg/ha), potassium (396.48 kg/ha) and micro nutrients like iron (3.83 kg/ha), manganese(0.74 kg/ha), zinc(0.62 kg/ha) and copper(0.31 kg/ha) were also recorded highest in 1.0ER+100% RDF with mulchcompared to soil application of normal fertilizers. And these results are on par with the treatment of 0.8ER+ 100% RDF with mulch. Mulching treatments show 20.61% increased yield than non-mulchingtreatments. By using 0.8 ER Irrigation we can reduce the water wastage up to 20% and also increase productivity of crop.

S3P43A60

Effect of different orchard floor management practices on weed population in guava (*Psidiumguajava* L.) orchards

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The orchard soil management practices involving paddy straw mulching, white polythene mulch, black polythene mulch, chemical weed management, mechanical weeding was investigated to ascertain its effects on weed growth during the summer and rainy season months in guava orchard under north-western plains of India. The weedy plot was also kept for comparative assessment of different orchard floor management practices. The results revealed significant effect on grassy as well as broad leaf weeds in the orchard. Although the black polythene mulch kept the area weed free throughout the season, but the paddy straw mulch exhibited promising results with 69.1 and 93.2 % reduction in total weed biomass during 1st and 2nd year of application, respectively. The white polythene mulch was proved to be failure owing to heavy weed growth under the mulch followed by disintegration of polythene sheet. Chemical weed management as well as mechanical weeding also reduced the intensity of weeds but resurgence of weed resulted significantly higher weed biomass than paddy straw mulch. Higher cost: benefit ratio in paddy straw mulch exhibited potential to manage the orchard floor in guava orchard.

S3P44A283

Optimization of the processes of sterilization and minimize phenolic compounds in Micropropagation ofGerbera (*Gerbera jamesonii*Bolus)

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Micropropagation is the most common application of plant biotechnology which offers not only mass multiplication but also conserve elite or rare plants. Gerbera (*Gerbera jamesonii*Bolus), is one of the choicest flower among the flower growers and traders in India. It has wide applicability in the floral industry as cut flower and potted plant. It is perennial plant that represents the Asteraceae family. Objective of the present study was developing protocol for Gerbera Micropropagation in *in-vitro* cultures. Three sterilizants (70% alcohol, sodium hypochlorite and mercuric chloride) were used as different time duration. Among the tested methods, sodium hypochlorite (20%) for 5 minute and mercuric chloride (0.01%) for 3 minute proved to be the most effective for sterilization. Increasing time duration of sterilization with mercuric chloride leads more phenolics. To minimize phenolic compounds ascorbic acid (40mg/l) found best as compared to citric acid. The Floral parts were used as explants; After sterilization *ex-plant* were cultured onMurashige and Skoog (MS) medium supplemented with different concentration (1.0-10.0 mg/l) BAP in combination with concentration (1.0 mg/l & 0.5) of α-naphthalene acetic acid (NAA). BAP (1.0 and 3.0 mg/l) with NAA induced the explants to form callus. On the other hand when the explants were cultured in higher concentration (5.0 mg/l) of BAP produced shoots and 5.0 mg/l BAP with 1.0 mg/l NAA was found to be the best for shoot proliferation of the three explants optimum response was obtained from flower buds. Further multiplication of shoots occurred upon transfer of shoot clumps to BAP containing MS medium.

S3P45A4

Kiwi Fruit: a potential fruit crop in North East India- Problems and prospects for enhancing the productivity and rural economy of small and marginal farmers

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Kiwifruit recently introduced in the North-East Indian Hill states has assumed tremendous popularity and preference among growers as well as consumers due to its easy maintenance and marketing besides having high nutritional and medicinal values. It has wide scope for its expansion in all states of this region barring Tripura and Assam which have warmer and tropical climate. Kiwifruit has already attained commercial identity in local, national as well as international markets with Arunachal Pradesh establishing as the largest producer from this region, while other states also prioritized this fruit for area expansion under Horticulture Technology Mission. Despite congenial climate and soil, lack of quality planting material, package of practices, precision farmingtechnologies and trained manpower are major constraints in enhancing productivity of Kiwi Fruit. ICAR Roving Team for temperate fruits recommended a road map for cultivation of these fruits in North Eastern Hill Region and an

extensive survey of Kiwi growing areas is done. Adoption of modern horticultural practices for growing Kiwi fruit in this region should benefit its rural economy comprising mainly small and marginal farmers who have been practicing subsistence agriculture or shifting cultivation such as *Jhum*.The studyenvisages major technologies developed for increased productivity of Kiwi fruit, priority areas, economic estimate and organic productionfor its precision farming. It is suitable for horticulture based integrated farming system and large cardamom based cropping system with Kiwi has become more popular in several North-East states.

S3P46A745

Alternate bearing in litchi (*Litchi chinensis*Sonn.) trees

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Alternate bearing habit, a common phenomenon prevalent in some of the fruit trees is observed in litchi cv. China also. Two litchi varieties (Shahi and China) were evaluated for three years (2015 to 2017) at the Research Farm of ICAR-NRC on litchi, Muzaffarpur,

Bihar.The annual growth cycles or phases of the crop under study was divided into sub-cycles e.g. vegetative growth flush (after harvest and during winter season), flowering and fruit development etc. and leaf gaseous exchange parameters, chlorophyll content and carbohydrate statuses of the leaves as well as fruiting branches (stem) were compared between good fruiting year (on-year) and low/no fruiting year (off year). The leaf arrangement in alternate bearer 'China' litchi is bushy in appearance which imparts shade on preceding leaves, and shaded leaves had a lower photosynthetic rate, so the plant performance and particularly flower induction were adversely affected in 'China' litchi than the regular bearer 'Shahi' litchi. The majority of buds on non-floral shoots of off-crop trees produced inflorescences, whereas most buds on non-floral shoots of on-crop trees remained inactive through spring bloom.Results revealed that the 'China' litchi has lower photosynthetic rate (*Pn*), transpiration rate (*e),* internal CO_2 concentration (*Ci*), stomatal conductance (*gs*) and Leaf temperature (*TL*) than 'Shahi' litchi. Floral shoots had more *Pn*, *e* but less *Ci*, *gs*over non-floral shoots. The floral shoot of 'China' litchi had higher *chlorophyll a* content during flowering over FBD stage ('Shahi' showed continuous reduction till flowering). Shahi' litchi had more concentration of *Chl a* and *Chl b* in the leaves over cultivar 'China. The total non-structural carbohydrates or starch was found to be accumulated before flower initiation and leaf flushing in both the cultivars. Floral shoots of 'China' litchi had reduced reducing sugars, total carbohydrates and proline content during FBD over vegetative growth phases or during flowering than the litchi cv. Shahi. 100% flowering in the alternate bearer 'China' litchi can be assured by spray of KNO_3 (1-2 %) provided normal flushing in August and mild or no flushing during November-December. Further, carbohydrates and pollination can be more easily controlled by proper N fertilization and girdling and floral induction can be encouraged by application of paclobutrazol and KNO_3 during September-October which brings no flushing or mild flushes during FBD that led to flowering in most of branches. This research is the first to provide evidence that

several mechanisms in addition to inhibition of summer vegetative shoot growth, including inhibition of spring bud break, inhibition of floral development at the level of gene expression, and abscission of potential floral buds, contribute to the perpetuation of alternate bearing in late maturing cultivars of litchi.

S3P47A505

Evaluation of ferns for commercial and landscape uses

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Fern are excellent landscape materials and can be used as groundcovers, specimen plants, group planting,background planting and border planting. They can be used as fillers in bouquets and flower arrangements. The objective of the study was to evaluate the performance of ferns and to identify those that can be recommended for commercial cultivation. Eleven species of ferns belonging to different genera viz.,*Adiantum tenerum, Asplenium nidus,Aspleniumlongissimum,Aspleniumscolopendrium, Diaplaziumacrostichoides*, *Nephrolepisbiserrata* 'Furcans', *Nephrolepisexaltata* 'Chidisii', *Nephrolepisexaltata*Botoniensis Compacta, *Nephrolepiscordifolia*, *Nephrolepisbiserrata-Miniata*and *Pterisensiformis* were evaluated for growth pattern and various landscape and commercial uses. Vegetative characters likeplant height and spread was highest in *Aspleniumnidus* and maximum number of leaves were observed in *Adiantum tenerum*.Based on growth pattern they were classified under tall, medium and dwarf groups.*Asplenium nidus* and *Nephrolepisbiserrata-Miniata*came under tall category. The species which came under medium category were *Aspleniumlongissimum, Diaplaziumacrostichoides*, *Nephrolepisbiserrata* 'Furcans', *Nephrolepisexaltata* 'Chidisii', *Nephrolepisexaltata*Botoniensis Compacta,*Nephrolepiscordifolia,Pterisensiformis*and *Aspleniumscolopendrium*where as*Adiantum tenerum*came under dwarf category.All species evaluated were found to be suitable for pot plants.*Nephrolepisbiserrata-Miniata,Nephrolepisbiserrata* 'Furcans', *Nephrolepiscordifolia, Asplenium nidus* and*Diaplaziumacrostichoides*can be recommended as house plants.*Nephrolepisbiserrata-Miniata, Nephrolepisbiserrata* 'Furcans' and *Nephrolepiscordifolia*can be used as border plants in landscapes.*Nephrolepisexaltata*Botoniensis Compacta, *Aspleniumlongissimum, Pterisensiformis*were observed to be attractive in hanging baskets.*Nephrolepisbiserrata-Miniata,Nephrolepisexaltata* 'Chidisii', *Nephrolepisexaltata*Botoniensis Compacta and *Diaplaziumacrostichoides*are suitable for bouquets and flower arrangements.

S3P48IS62

Agronomical and post-harvested evaluation of the essential oils of Sicilian rosemary (Rosmarinus officinalis L.) biotypes

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Rosmarinus officinalis L. is an evergreen shrub belonging to the *Lamiaceae* family. It spontaneously grows in the coastal areas of the Mediterranean sea, in North Africa and Southeast Asia. In Italy it is located between 0 and 800 m a.s.l. Several studies have highlighted the various applications of the essential oils of this species due to their biological and medicinal properties. The yield and quality of the essential oils of rosemary depend mainly on the chemotype, the environmental conditions and the cultivation techniques. The aim of this study was to evaluate the qualitative and quantitative characteristics of the essential oils of wild *Rosmarinus officinalis* biotypes, using different dry methods. Five types of dry methods were used for the tests: a) standard air-drying of the samples; b) drying of the samples carried out below a roof system exploiting natural air ventilation; c) oven-drying of the samples at 30 °C; d) oven-drying of the samples at 40 °C; e) oven-drying of the samples at 50 °C. The results highlight qualitative and quantitative differences with regards to the dry methods and essential oils.

S3P49A764

Varietal trial of garden pea variety (Pusa Shree) in the Thoubal District of Manipur

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Among the vegetable pulses Pea has been one of the most important crop in the state of Manipur and has great prospect to popularize suitable good varieties particularly in Thoubal District. But as there is dearthof farmers choice of varieties to suit their cropping system the evaluation of new varieties is considered very important. Therefore, a new Garden Pea variety Pusa Shree was tested in comparison with an existing popular variety Arkel in respect of some important characters viz. No. of pods/plant, No. of seeds/plot, No. of branches, plant height, duration and yield. The trials were conducted as an farm trial at seven farmers' fields at different locations of Thoubal District during the rainy season of 2016. It was found that the Pea variety was superior in terms of duration being shorter, preferable plant height in terms of non-lodging due to short, statured nature, No. of seeds/pod. But it was found to have lesser number of pods/plant and as a result inferior yield. Farmers showed their preference of the variety due to its short duration and taste which was not included in the evaluation but could be known from their feedback.

S3P50A759

Effect of precision farming practices on growth and yield of green capsicum in open field conditions

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Capsicum (*Capsicum annuum* L.) is also called as bell pepper or sweet pepper and is one of the popular vegetable crops grown in milder climate areas. A field experiment was conducted at ICAR-Indian Institute of Horticultural Research during *Rabi*of 2010 and 2011 to study the effect of various precision farming practices on capsicum variety Indra. The experiment was laid out in a randomized block design withsix treatments on a module basis.The best module had the combination of precision farming practices such as raised bed system, drip irrigation, polyethylene mulching, foliar application of major and micronutrients. The pooled analysis revealed that the combination of all above mentioned precision farming practices resulted in significantly higher yield of 48.6t/ha compared to normal practice of non-fertigated, furrow irrigated non-mulched control (27.3t/ha). Yield was significantly reduced when either fertigation was not given (38.4t/ha) or polyethylene mulching was not followed (36.9t/ha) compared to all precession farming practice treatment (48.6t/ha). Mean fruit weight did not vary significantly among the treatments (100-115g), whereas number of fruits were significantly higher when all the practices of precision farming practices were followed (11.5/plant).

S3P51A140

Effect of mulching on yield and nut quality of coconut (*Cocos nuciferae* L) variety, West Coast Tall in coastal plain zone of Odisha

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Coconut is the most imperative crop in coastal plains of Odisha. Even though coconut crop has wide scope for planting due to favorable climate for crop growth, production and productivity is very less in coastal plain zone due to improper management and high leaching during rainy season. Heavy weed population around root zone during rainy season hamper reproductive growth and no greenery during dry period causes excess evaporation of water from root zone with major nutrient loss, which results in irregular flowering, flower & fruit drop and reducing the yield of coconut nuts. Keeping the above setback in mind, an experiment has been conducted with four treatments and five replications at Sidhapatana village of Pattamundai block of Kendrapara district during the year 2015-16 & 2016-17. Treatments such

as T1 - mulching with 200 Gauge (50 micron) poly mulch, T2 – Mulching with Coconut leaf, T3 - Green mulch by planting cow pea (*Vigna sinensis*) and T0 - without mulching in root zone as traditional practices has been taken to find out the yield of nuts by different mulch treatments in eight year old plantation of West Coast Tall (WCT) variety. The treatments did not affect rate of transpiration, stomata dispersion resistance and leaf water potential of coconut palms. After two years of observation it is found that after pollination of coconut flower it will take eleven months to complete fruit set by poly mulching and T1 has highest nut yield i.e. an average of 86 nuts per plant having a nut weight of 175 g each. Whereas T0 as control treatment without mulching took twelve and half month to complete fruit set after pollination and an average nut yield was 51 nuts per plant having nut weight of 145 g each. T2 & T3 have 70 nuts & 68 nuts per plant respectively by taking on an average twelve months for complete fruit setting after pollination and having nut weight of 155 g in T2 & 148 g in T3. So Mulching with 200 Gauge (50 micron) poly mulch during dry spell and during rainy season may be recommended for coastal plain zone of Odisha as it has highest potential for increased nut yield and nut size.

S3P52A192

Studies on effect of micronutrients and cycocel application on growth and yield of Okra (*Abelmoschusesculentus.*L) cv. ParbhaniBhendi.

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An investigation on the effect of micronutrients and cycocel on growth and yield of Okra cultivar Parbhani Bhendi was carried out at Fruit Research Station, Himayat Bagh, Aurangabad (Vasantrao Naik Marathawada Krishi Vidyapeeth) during summer season of 2015. The experiment was laid out in factorial randomised block design with eighteen treatments and three replications.The treatments based on combination of two factors including micronutrients viz. M_1-Mg (0.5%), M_2- Mn (0.5%), M_3-Fe (0.5%), M_4-Zn (0.5%),M_5-M_1+M_2+M_3+M_4(0.5%) and CCC (00,500 and 750 ppm). The application of micronutrients and cycocel was carried out at 30 and 45 days after sowing.The result showed that the foliar application of micronutrients in treatment M5 viz. combination of M1, M2, M3 and M4 was beneficial with respect to the growth attributes & yield attributes like height of plant (122.88cm), number of branches per plant (7.47), number of leaves per plant (31.96), leaf area index (2.06), girth of stem (2.85cm), length of internode (3.96cm), number of internode on main stem (37.66), number of node at which number of flower appears (3.23) and yield attributes number of flowers per plant (32.01), fruit set (86.84%) number of pods per plant (27.80), number of picking (13.18), yield per picking (1.52 mt/ha), fruit yield per plot (5.62kg), marketable yield per plot (4.73kg), marketable yield per ha (18.32 mt/ha), total yield (20.70 mt/ha). Increase in concentration of growth retardant i.e. CCC @ 750 ppm decreased the growth of vegetative parameters.The present investigation infers that foliar application of micronutrients M5 i.e.

M_1+M_2+M_3+M_4(0.5%) and CCC@750 ppm at 30 and 45 DAS is beneficial decreasing vegetative growth which resulted in increasing yield of Okra.

S3P53 A211

Precision horticulture: a system approach to farming

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Precision horticulture a new emerging site specific technology; it involves application of latest technology and principles to manage spatial and temporal variability within field. Precision horticulture is information and technology based farm management system to identify, analyse and manage variability within field for optimum profitability, sustainability and protection of land resources. Precision horticulture is most effective technique for reducing cost because it adding the right amount of treatment at the right time and right location. Demand of environmental conservation of the globe is necessitating us to modify agricultural management practices for sustainable conservation of natural resources such as water, air and soil quality, while staying economically profitable and eco-friendly nature. All-together, market-based global competition in agricultural products is challenging economic viability of thetraditional agricultural systems, and requires the development of new and dynamic production systems. **Precision Horticulture** is about managing variations in the field accurately to **grow more food** using **fewer resources** and **reducing production costs.** All aspects of the environment; soil**, weather, vegetation, water** vary from place to place. And all these factors determine crop growth and horticulture success. Farmers have always been aware of this, but they lacked the tools to measure, map and manage these variations precisely. Thus, **Precision Horticulture can make a difference to food production facing the challengeof a rising world population and can help farmers to achieve.** It creates the scope of introduction and adoption of modern technologies in agriculture like precision farming which is largely depend on GPS (Global Positioning System).

S3P54 A214

Effect of time and level of pruning in guava (*Psidiumguajava* L.)

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An investigation on the effect of the effect of time and levels of pruning in guava (*Psidiumguajava*L.) was undertaken with an objective to study the effect of time and levels of pruning on growth yield and quality in guava.The field study was carried out at the Fruit Research Station Himayatbagh, Aurangabad, VasantraoNaikMarathawadaKrishiVidyapeeth, Parbhani. The experiment was laid out in Factorial Randomized Block Design with ten treatments and three replications. There are classified of four level of pruning (10 cm, 20cm and 30cm) and unpruned with 10 June, 20 June, 30 June and control pruning time.The parameter related with growth attributer leaf, characters, flowering attributes fruiting attribute and quality attributes.The result showed that the level of pruning and time of pruning significantly increase the growth of plant. The maximum height of plant (91 cm) number of shoot per plant (69), numbers of leaves per shoot (18.5), weight of pruned material (460.678), leaf area (73.01cm^2), chlorophyll a (1.74 mg/100gm), chlorophyll b (0.63 mg/100gm), total chlorophyll (236 mg/100g) was recorded in pruning level 300m and date of pruning 10 June. While the minimum value of growth attribute was recorded in unpruned treatment. The minimum weight of fruit (204.1 g), length of fruit (7.58cm), diameter of fruit (6.15cm), number of fruit per plant (236.0), weight of fruit per plant (141.7g), yield (29.37 mt/ha) was found in level of pruning 30 cm and date of pruning 10 June. The minimum recorded in unpruned treatment.The maximum TSS (11.8^0 Brix), sugar (11.4%), weight of 100 seed (10.13g) and minimum acidity (0.48%) number of seed per fruit (170.0) was recorded in 30 cm pruning level and date of pruning 10 June. While minimum TSS, sugar, weight of seed and maximum acidity and number of seed per fruit was recorded in unpruned treatment.Therefore based on present experiment it can be conducted that for getting fruit yield as well as higher net realization with superior quality guava should be pruned lightly with 30 cm pruning level which pruned on 10thJune.

S3P55 A216

Effect of foliar application of micronutrients on growth and yield of guava (*Psidiumguajava* L.) cv. L-49.

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An investigation on the effect of foliar application of micronutrients on growth and yield of guava (*Psidiumguajava* L.) cv. L-49. The field study was carried out at the Fruit Research Station, HimayatBagh, Aurangabad, VasantraoNaikMarathwadaKrishiVidyapeethParbhani during 2015. The experiment was laid out in Randomized Block Design (RBD) with twelve treatments and three replications. The treatments are classified of different micronutrients viz., B(0.3%), Fe(0.4%), Mg(0.7%), Mn(0.5%), Zn(0.5%) and Cu(0.4%) and its different combinations spray at two times 50 per cent fruit set stage and 15 days after first spray.The parameters related with leaf characteristics viz., leaf area, leaf area index, physiological attributes viz., chlorophyll content, fruit attributes viz., fruit weight, fruit volume, diameter of fruit, diameter of seed cavity, pulp thickness, and yield characteristics viz., fruit set per cent, fruit retention per cent, fruit drop per cent, number of fruit per plant(kg) and yield per hectare(tonnes) were studied.The result showed that the effect of spray of different micronutrients was significantly affected at leaf attributes. The highest leaf area (84.5cm^2), leaf area index (3.38), chlorophyll 'a' (1.23), chlorophyll 'b' (1.23), total chlorophyll (3.88), was maximum in T_{11}.The maximum fruit weight (260g), fruit volume (246.51ml), diameter of fruit(8.68cm), diameter of seed cavity(7.53cm), pulp thickness(1.43cm). The maximum yield per tree (63.78kg) and yield per hectare is (25.40 tonnes) observed. in T_{11}(H_3BO_4(0.3%)+$FeSO_4$(0.4%)+$MgSO_4$(0.7%)+$MnSO_4$(0.5%)+$ZnSO_4$(0.5%)+$CuSo_4$(0.4%) while, highest number of fruit per plant (260.17), fruit retention per cent(67.13%) and minimum fruit drop (32.89%) observed in treatment T_{10}(H_3BO_4(0.3%)+$FeSO_4$(0.4%)+$MgSO_4$(0.7%)+$MnSO_4$(0.5%)+$ZnSO_4$(0.5%),.Therefore based on present research it may be conclude that among the different micronutrients T_{11} treatment was significantly superior over control is related to most of the leaf, physiological, fruit attributes and yield of guava, so in application of boric acid @ (0.3%), ferrous sulphate @ (0.4%), magnesium sulphate @ (0.5%), zinc sulphate @ (0.5%), magnesium sulphate @ (0.7%), manganese sulphate @ (0.5%), copper sulphate @ (0.4%) at the fruit set stage and 15 days after first spray improve the plant growth and yield of mrigbahar guava.

S3P56 A222

Different sources of potassium and their method of application influences growth, yield and quality of Grapes cv.Sharad Seedless (*Vitis vinifera* L.)

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Potassium (K) is one of the important essential elements for vine growth and yield. It is important nutrient for grapes not just because it increases yield but also influences the quality by increasing sugar content. Grape growers are applying fertilizers through soil and also through fertigation. But, the information on to what extent they can apportion the fertilizer application through these methods to improve nutrient us efficiency is not available. Hence, a field experiment was conducted during 2016-17 to study the effect of combined application of different sourcesof potassium(SOP, KNO_3 and 19 all) and their method of application (direct soil application and fertigation on growth, yield and quality on cv. Sharad seedless.Eight different combinations of treatments were imposed in an annual growth cycle of the vine. Among the treatments, highest mean pruned weight after forward pruning and dry matter content in canes were recorded in the treatment with 40% KNO_3 through fertigation + 60% SOP through soil. Significant difference was recorded for percent fruitful canes (58.5%) and number of bunches (42) among treatments with maximum in treatment which has 40% K (SOP) through fertigation and 60% K (SOP) through soil application. While the percent fruitfulness and number of bunches was minimum in treatment where 60% K (SOP) was applied through soil and 40% K (SOP) through fertigation and also 100% application of potassium through soil and/or fertigation. Highest TSS, Brix-acid ratio and lowest acidity were recorded in the treatment with 60% SOP through fertigation + 40% SOP through soil.Yield per vine was highest in treatment which has 40% K application through fertigation and 60% through soil application with different sources of potassium.

S3P57 A223

Effect of high density planting and nutrition on growth, yield and quality of tissue culture Banana (*Musa paradisiaca* l.) cv. Grand Naine under Transitional Zone of Karnataka.

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A field experiment was carried out to study the effect of high density planting and nutrition on growth, yield and quality of tissue culture banana (*Musa paradisiaca* L.) cv. Grand Naine under transitional zone in the experimental plot at College of Agriculture, Navule,

Shivamogga during the year 2015-16. The different doses of fertilizers along with different number of suckers per hill were used during this study. The plants provided with 75% recommended dose of fertilizers along with double sucker per hill (T_5) recorded the maximum plant height (178 cm), pseudostem girth (64.75 cm) at the time of shooting, whereas, plants provided with 100% recommended dose of fertilizers along with single sucker per hill (T_{10}) recorded the maximum leaf area (8.74 m^2) andnumber of functional leaves (13.96) and minimum light interception (68.74%) at the time of shooting. The early shooting (227.75 days) and early maturation of bunches (103.22 days) was observed in the plants supplied with 100% recommended dose of fertilizers along with single sucker per hill (T_{10}). The per cent light interception was found higher (86.68 %) in close spacing system of planting in comparison with conventional planting system (68.74 %) at all stages of crop growth. The maximum banana yield of 152. 94 t/ha was obtained in plants of double sucker per hill along with 75 % recommended dose of fertilizers. The plants supplied with 75% recommended dose of fertilizers along with double sucker per hill had the maximum benefit cost ratio of 1:3.01.

S3P58 A225

Improving bunch and berry quality of Red Globe grapes through application of alternate flower /berry thinning chemicals

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Cultivation of Red Globe, colored seeded grape variety isgaining importance in mild tropical climate of India due to its bold and attractive berry color and size and also due to its high shelf life. Being a seeded variety, application of higher concentration of GA_3 for flower thinning is not recommended and even if it is applied it hampers the bunch quality adversely. If the flowers are thinned before fruit set, the bunches will become too compact and it may lead in production of very small berries and even lead to rotting of bunches. As Red Globe is sensitive to GA3 application, there is a need to standardize alternate flower thinning chemicals. To address this problem, an experiment was conducted during 2016-2017 to standardize flower thinning chemicals in Red Globe to improve the bunch and berry quality parameters. Different organic and inorganic chemicals viz., 0.5 % Olive oil (T1); 0.3% Caffeine (T2);0.1 % Hydrogen Cyanamide (T3); 0.1 % Dinitro Ortho Cresolate (T4);0.5% Copper Sulphate (T5) were sprayed during full bloom stage and were controlled with manual berry thinning at 8-10 mm stage (T6) and untreated control (T7). Among different treatments, spraying of olive oil and $CuSO_4$ could produce less compact bunches. However, the average bunch weight, berry diameter and berry length was highest on vines sprayed with caffeine and olive oil. Bunch compactness was highest on control vines and least bunch weight was also recorded on control vines. Though the treatments like $CuSO_4$ and hydrogen cyanamide could produce loose clusters with good

bunch weight, scorching of rachis was observed indicating their toxicity. Among the treatments studied the bunches treated with olive oil and caffeine could produce good quality bunches.

S3P59 A226

Standardization of GA_3concentrationforreducing bunch compactness by improving rachis elongationin Crimson Seedless grapes (*VitisVinifera*L.)

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Crimson Seedless is a colored seedless grape, which is gaining popularity in India due to its attractive colour, good bunch and berry quality with better shelf life. In cultivation of any seedless grape variety, application of GA_3 at different stages is very much essential to produce good quality berries and bunches. However, this variety is highly sensitive to excess application of GA_3 and following GA_3 schedule similar to that of Thompson Seedless grapes adversely affects bunch quality. Hence, there was a need to standardize mild dose of GA_3 just for rachis elongation which will help to reduce bunch compactness to a greater extent. Hence, an experiment was initiated to standardize concentration of GA_3 for rachis elongation of Crimson Seedless grapes. Three different concentrations of GA_3 {viz., 5 ppm (T1), 7.5 ppm (T2) and 10 ppm (T3)} were sprayed during pre-bloom stage and compared with unsprayed control (T4). Among different treatments, pre-bloom spray of GA_3@5 ppm could produce less compact bunches with highest average bunch weight (519 g), berry weight (4.92g); berry length (25.85 mm) and TSS (18.58^0B). However, the bunches sprayed with 7.5 ppm and 10 ppm GA_3 could also produce good quality bunches average berry weight and TSS was less. Because of severe coiling of rachis at 7.5 ppm and 10 ppm GA_3 spraying, the bunches were too straggly compared to spraying of 5 ppm GA_3. The control bunches without GA_3 spray produced very compact clusters with less average bunch weight (433 g), berry weight (3.98g), berry diameter (16.87 mm) and berry length (22.57 mm).

S3P60 A245

Arka Microbial Consortium for tomato production

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Arka Microbial Consortium is a carrier based product which contains Nitrogen fixing, Phosphorus and Zinc solubilizing and plant growth promoting microbes as single formulation. The novelty of this technology is that farmers need not apply nitrogen fixing, phosphorus solubilizing and growth promoting bacterial inoculants individually. It can be conveniently,

applied either through seed, soil, water and nursery media like cocopeat. This technology considerably reduces the cost of cultivation, besides the synergistic effects of the formulated microbes can help in sustainable vegetable production. In this regard, Krishi Vigyana Kendra, Tumkur has taken Frontline demonstration by adopting the technology developed by, Indian Institute of Horticultural Research, Hessarghatta FYM 25t/ha+ 75% RDF 250:250:250 NPK Kg/ha + arka microbial consortium 12.5 Kg/ha was demonstration was undertaken in tomato crop in farmers field of Tiptur taluk of Tumkur district. As a result the yield of tomato has been increased by 12.5% (540 Q/ha in demonstrated plot as compared to 480 Q/ha in check plot). The farmers opined that there was reduction on cost of fertilizer upto 10-15%. The reason for the higher biomass with application of organic manures and biofertilizers might have helped the plant metabolic activity through the supply of important micronutrients such as zinc, iron, copper, manganese etc. These nutrients are involved in biochemical synthesis of many phytoharmones, besides *Azosprillum* have a role in nitrogen fixation and phosphorus solubilizing bacteria helps in solubilization and mobilization of phosphorus in soil and *Tricoderma* present in arka microbial consortium might have helped in controlling soil borne disease.

S3P61 A249

Feasibility of growing China aster (variety, ArkaKamini) as intercrop in coconut with modified agro-techniques under coastal sandy soil

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A study on feasibility of growing China aster (variety,ArkaKamini)as intercrop in coconut with *in-situ* moisture conservation materials in littoral sandy soils of west coastwas conducted in a 40-year-old WCT garden at ICAR-CPCRI, Kasaragod, Kerala, during *rabi*- 2015. The experiment consisted of four moisture conservation treatments *viz*., M1-Coconut husk, M2-Coir pith, M3-Shredded coconut leaf and M4-control laid out in FRBD with five replications.The *in-situ* coconut wastes were buried in the trenches of 60 cm depth opened in inter row space, soil was covered and planting was taken up.Significantly, higher vegetative growth attributes such as plant height (48.6 cm),canopy spread (22.3 cm^2), number of primary branches (13.78), number of secondary branches (15.72), number of leaves (98.5) and leaf area per plant (4077.3 cm^2) measured at 90 days after planting, physiological growth parameters *viz.*,LAI (0.84), SLW(39.78 mg cm^{-2}), NAR (511.01 mg cm^{-2} day^{-1}) and CGR (0.381 mg cm^{-2} day^{-1})recorded at peak vegetative growth were found to be significantly higher in coconut husk (M1) with the maximum flower yield (2.50 tones/ha) and more number of flowers per plant (43.8) when compared to control (1.36 tones/ha and 35.6 respectively). The higher soil moisture retention capacity of coconut husk throughout the growth period of china aster had

resulted in higher growth and yield attributes.The highest coconut equivalent yield(15641 nuts/ha) and B:C (2.04) was reported by intercropping of china asterwith coconut husk as*in-situ*moisture conservation material when compared to control (8503 nuts/ha and 1.2 respectively). Studies on soil properties showed that there was no significant influence of moisture conservation materials on soil pH, EC, OC, total N, available P and K.

S3P62 A250

Performance of Marigold (variety, Arka Agni) as intercrop in coconut with *in-situ* moisture conservation materials in littoral sandy soils of west coast

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Experiment was conducted at ICAR-CPCRI, Kasaragod, Kerala, during *kharif*- 2015to study the performance of Marigold (variety, Arka Agni) grown as intercrop in coconut(40-year-old WCT garden) with *in-situ* moisture conservation materials in littoral sandy soils of west coast. The experiment consisted of four moisture conservation treatments *viz*., M1-Coconut husk, M2-Coir pith, M3-Shredded coconut leaf and M4-control laid out in FRBD with five replications. The *in-situ* coconut wastes were buried in the trenches of 60 cm depth opened in inter row space, soil was covered and planting was takenup. The various vegetative growth attributes such as plant height (143.8 cm),canopy spread (94.7 cm^2), number of primary branches (27.4), number of secondary branches (106.1), number of leaves (661.9) and leaf area per plant (45976.3 cm^2) measured at 90 days after planting, physiological growth parameters *viz.*,LAI (20.2), SLW(4.61 mg cm^{-2}), NAR (364.7 mg cm^{-2} day^{-1}) and CGR (5.89 mg cm^{-2} day^{-1})recorded at peak vegetative growth were found to be significantly higher in shredded coconut leaf (M3) with the maximum flower yield (6.70 tones/ha) and more number of flowers per plant (93.2)when compared to control (3.69 tones/ha and 63.1 respectively). The higher soil moisture retention capacity of shredded coconut leaf throughout the growth period of marigold had resulted in higher growth and yield attributes. Studies on soil properties showed that there was no significant influence of moisture conservation materials on soil pH, EC, OC, total N, available P and K. The coconut equivalent yield under intercropping of marigold with *in-situ*-moisture conservation materials was significantly highest in shredded coconut leaf (16746 nuts/ha) with highest B:C ratio (1.81) when compared to control (9228 nuts/ha and 0.91 respectively).

S3P63 A254

Bunch yield of'Grand Naine' (AAA) banana asinfluenced by the varied components of precision farming systems

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'Grand Naine' banana cultivar has recently been introduced in Assam from tropical parts of India for commercial cultivation. It is a superior selection of 'Giant Cavendish' banana, however, its suitability and ameliorative measures are yet to be ascertained under agro-climatic conditions of Assam. Banana is a heavy feeder of nutrients and as a mesophytic plant it requires high soil moisture for good growth and development leading to production of a heavy bunch.Drip fertigation results in high water use efficiency, uniformity of plant, reduced application cost for fertilizers, reduced labour demand, and reduced weed infestation, control erosion, reduced salinity hazards and more crop productivity per unit area. The present study was programmed in 2014-15 to evaluate the efficacy of the varied components of precision farming systems comprising drip irrigation (80% ER), fertigation (75% RDF), micronutrient foliar spray (Commercial formulation 'Tracel'2%) ,bunch spray of sulphate of potash (2%) as well as black LDPE film (50µ) mulch over the traditional system of soil nutrient application (110g N, 33g P_2O_5 and 330g k_2O) and flood irrigation (15 day intervals) in 'Grand Naine' banana. Components of precision farming significantly increased bunch yield. The highest bunch weight (21.68 kg) as well as highest yield (66.91 t/ha) were recorded in all combinations of precision farming components with drip-fertigation. Micronutrient foliar spray, bunch spray with potassium and black LDPE film mulch. Computation of Harvest Index reveals highest Harvest Index of 32% in all combinations of precision farming components as against the lowest of 30% in traditional system of banana culture depicting the superiority of the precision farming system over the latter.

S3P64 A266

LEDs IN FLORICULTURE- A way to increase the effective flower production

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Natural sunlight is the cheapest source available, but for horticulture it is not always attainable in sufficient quantities. Therefore, the use of artificial light has become very common in order to increase production and quality. Under artificial lighting technologies, LED lighting is one of the technology that can help in producing crops and flowers in a more effective and sustainable way around the world. The benefits of LEDs are that the spectrum and intensity can be selected and adjusted, the energy efficiency is higher than most conventional light sources and their small size, durability, long lifetime, cool emitting temperature, and the option

to select specific wavelengths for a targeted plant response make LEDs more suitable for plant-based uses than many other light sources. These advantages, coupled with new developments in wavelength availability, light output, and energy conversion efficiency, can bring about a revolution in horticultural lighting. Light quality plays a major role in the appearance and productivity of ornamental and food specialty crop species. Far-red light, for example, is important for stimulating flowering of long-day plants (Deitzer *et al*., 1979; Downs, 1956) as well as for promoting internode elongation (Morgan and Smith, 1979). Blue light is important for phototropism (Blaauw and Blaauw-Jansen, 1970), for stomatal opening (Schwartz and Zeiger, 1984), and for inhibiting seedling growth on emergence of seedlings from a growth medium (Downs, 1956). The interactions are complex and continue to be unraveled at the molecular level (Devlin *et al.*, 2007), but much of our understanding of these responses comes from studies with narrow-waveband lighting sources, in which LEDs provide obvious advantages. Thus, one potential role of LEDs in horticulture could be to enhance desired characteristics for specific crops. The artificial LED lightings increase the possibility of year-round production of ornamental plants, which will subsequently increase the income of growers related to ornamental industry. Light-emitting diodes pave the way for a better understanding of the interaction between light and pests, diseases, natural enemies and plants, as they make possible the use of very narrow wavelengths. LEDs as an option for reducing the use of growth retardants and obtaining better product quality in ornamental pot plants. Production of secondary metabolites increase with higher blue light ratio. Secondary metabolites production are increased and act against Reactive Oxygen Species (ROS) and pathogens, precondition the plant for environmental changes so they can cope with stress more efficiently.

S3P65 A270

Effect of planting time and fertilizer dose on growth, yield and quality of bitter gourd grown under polyhouse and net-house conditions

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An experiment was conducted to study the effect of planting time and fertilizer dose on growth, yield and quality of bitter gourd var. Pusa Rasdar under two different protected structures. Experiment was laid out in factorial randomized block design with 3 replications. The treatments were formulated with 4 fertigation levels (15:7:16, 20:12:21, 25:17:26 and 30:22:31 kg NPK ha^{-1}) and three dates of planting (15^{th} August, 1^{st} September and 15^{th} September) under two different protected structures. Among the two protected structures the highest numbers of fruits per plant (8.03), fruit weight (198.76g), yield per plant (1655.5g) and yield per $1000m^2$ (66.22q) were recorded in nethouse. However, fruit length (13.29cm), fruit diameter (5.78cm),fruit weight (201.82g), flesh thickness (1.15cm), nitrogen (152.39mg/100g), phosphorus (35.33mg/100g), potassium (318.56mg/100g), calcium (14.69mg/100g), iron (0.26mg/100g), zinc (0.57mg/100g) and manganese (0.36mg/100g) were recorded highest under naturally ventilated polyhouse. The number of fruits (8.92), yield per plant (1981.4g) and yield per $1000m^2$ (79.26q) reported highest with application of higher level of fertigation

(30:22:31 kg NPK ha^{-1}) under nethouse. Whereas, highest number of fruits (10.08), fruit weight (216.02g), fruit length (13.55cm), total fruit per plant (2205.1g), yield per $1000m^2$ (88.21q) were noticed in 15th Aug planting under insect-proof nethouse. The combination of 15th Aug sowing with 30:22:31 kg NPK ha^{-1} shown highest interaction effect for number of fruits per plant (11.47), fruit weight (235.26g), yield per plant (2697.7g), yield per $1000m^2$ (107.91q) under nethouse. The highest interaction effect was noticed by the combination of 15th Aug planting with 30:22:31 kg NPK $ha^{-1}$for nitrogen (236.10mg/100g), phosphorus (41.00mg/100g), potassium (346.33mg/100g), of calcium (19.33mg/100g), iron (0.32mg/100g), zinc (0.64 mg/100g) and manganese (0.42 mg/100g) under polyhouse.

S3P66 A271

Effect of planting time and fertilizer dose on growth, yield and quality of cucumber grown under polyhouse and net-house conditions

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Anexperiment was conducted to study the effect of planting time and fertilizer dose on growth, yield and quality of cucumber var. Pusa Seedless Cucumber-6 under two different protected structures. Experiment was laid out in factorial randomized block design with 3 replications. The treatments were formulated with 4 fertigation levels (15:7:16, 20:12:21, 25:17:26 and 30:22:31 kg NPK ha^{-1}) and three dates of planting (15th August, 1st September and 15th September) under two different protected. Among the two protected structures highest numbers of fruits per plant (15.67), fruit length (13.02cm), fruit weight (121.99g), yield per plant (1927.2g), yield per $1000m^2$ (128.49q), nitrogen (51.64 mg/100g), phosphorus (22.64 mg/100g), potassium (140.67 mg/100g) calcium (8.59 mg/100g) was noticed in polyhouse. The highest number of fruits (17.27), yield per plant (2237.4g) and yield per $1000m^2$ (149.16q) reported by application of higher level of fertigation 30:22:31 kg NPK ha^{-1} under polyhouse. Whereas the highest number of fruits (17.97), fruit weight (124.96g), fruit diameter (3.26cm), yield per plant (2264.3g) and yield per $1000m^2$ (150.96q) were noticed in 15th Sept planting under polyhouse condition. the combination of 15th Sept planting with 30:22:31 kg NPK ha^{-1} had shown highest interaction effect and produced highest number of fruits per plant (20.20), fruit weight (134.11g), yield per plant (2709.1g), yield per $1000m^2$ (180.61q), nitrogen (59 mg/100g), phosphorus (27.33 mg/100g), potassium (150.0 mg/100g) and calcium (11.29 mg/100g) under polyhouse .

S3P67 A272

Effect of Plant Growth Regulators in Vegetable Crops.

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Plant growth regulators (PGR) are the organic substances, which are produced naturally in plants, synthesized in one part and usually translocated to other parts where in very small quantity affects the growth and other physiological function of the plants. PGR's can bring changes in the phenotypes of plants and affect the growth from seed germination to senescence.The role of PGR's become more vital and provide an immediate impact on crop improvement and are less time consuming. Prajapati *et al*., (2015) has suggested that PGR's lead to quantifiable advantages for the user and are non-toxic and environmentally safe The naturally occurring plant growth regulators are Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid and synthetic growth regulators are IBA, 2,4-D, NAA, 2,4,5-T, Morphactin etc. Auxin was the first hormone to be discovered in plants. Auxins are used to induce apical dominance, parthenocarpy, flowering, prevention of abscission and eradication of weeds.Gibberellins are used for stem enlargement, induction of seed germination and for overcoming dormancy. Cytokinins induce flowering in short day plants and delays leaf senescence. Abscisic acid is used as growth inhibitor, whereas ethylene is used as fruit ripening hormone. It is also used to modify the sex expression, fruit set and for inducing male sterility in vegetable crops**.** Meena (2015) has reported in cucurbits that when GA_3 (1500-2000ppm), $AgNO_3$ (300-400ppm) and AgS_2O_3 (300-400ppm) is sprayed at 2-4 leaf stage induces male flower production in cucurbits.It has an immense potential in vegetable production to increase the yield, synchronization in flowering, earliness, cold and high temperature fruit setting, sex modification, increase post-harvest life and resistance to biotic and abiotic stresses of vegetables.

S3P68A274

Effect of Foliar Application of Different Sources of Calcium on Yield and Quality of Tomato Under Polyhouse Condition

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A poly house experiment was conducted at Zonal Agricultural and horticultural research station (ZAHRS), Navile, Shivamogga during *kharif* 2016 in order to know the effect of foliar application of different sources of calcium on growth and yield of tomato (*Lycopersicum esculantum*).Three sources of calcium ($CaCl_2$, $CaNO_3$ and calcium ammonium nitrate)with three levels each (0.20, 0.50 and 0.80%) were applied as a foliar spray in a Complete randomized design (CRD) with three replications and ten treatments. Results of the experiment indicated that foliar application of tomato crop with different calcium sources increased the yield, yield attributes and quality of tomato significantly over the control. However foliar spray of 0.5 per cent CAN resulted in production of higher fruit yield to the tune of 91.98 t ha^{-1} and significantly higher fruit weight (111.89g) was also recorded due to foliar application of 0.5 per cent CAN. The highest lycopene content(79.66mg/kg of tissue) and fruit firmness(0.33kg cm^{-2}) was found significantly high in the treatment with 0.5 per cent CAN as foliar spray. Compared to other sources of Ca and control significantly least physiological loss in fruit weight (0.62- 3.69%) was recordedin the treatment that received 0.5 per cent CAN as a foliar spray. The least fruit yield, fruit weight and quality of tomatowere observed in control applied with water spray. Thus this experiment conclusively proves that nutrient supplementation with Ca (0.5% CAN as FS) as foliar spray will enhance the tomato yield and quality.

S3P69 A276

Effect of Cosmetic Treatments on Seed Quality Enhancement

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Cosmetic treatment is a specialized group of treatments that mainly focuses on improvement in physical appearance and quality of seeds. Seed quality enhancement means the application of physical, physiological, biological and chemical agents to the seed in order to enhance the physical, physiological, biochemical and health qualities of seed. Cosmetic treatments include seed coating, seed pelleting and seed coloring. Seed coating with diverse materials like

insecticides, nutrients etc., which results in uniform seed germination and development of uniform crop stand have been demonstrated in many crops. These finally display enhanced productivity coupled with good seed quality attributes. Seed pelleting is a physiological seed enhancement methods used on many horticulture crops to improve rate of seed germination and seedling performance so as to reduce the seed wastage and facilitate the delivery of seeds.Seed coloring is also an enhancement technique mainly done to improve its marketability, brand identity and to enable the farmers for easy identification of the varieties based on hue. It also acts as insect and bird repellant. In storage, seed lots of different years could be easily identified and adulteration of seeds can be checked.

S3P70 A306

Circumventing phenolic exudation and poor survival in micropropagation of marigold

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Marigold, *Tagetes erecta* L. (Asteraceae), is one of the popular ornamental crops grown mostly for loose-flower production and garden display. Marigold is usually propagated through seed, but some germplasm (including male sterile lines -Petaloid and gynomonoecious forms) can only be maintained through vegetative propagation.Year-round production and long-term maintenance of quality planting material can be possible by employing efficient tissue culture techniques. However, exudation of phenols from marigold explants and poor *ex vitro* survival of plants are a major hindrance inmicropropagation. Therefore, the present investigation was carried out to standardize a protocol for controlling phenolic exudation from nodal explants, as also to enhance *ex vitro* survival of two petaloid male sterile cultivars, 'Siracole Orange' and 'Siracole Yellow'. Nodal explants were inoculated onto six MS-based induction media supplemented with various concentrations of ascorbic acid (0, 25, 50, 75, 100 and 125 mg/l). Sprouted axillary-buds were transferred to MS media without any growth regulators for further maintenance.Elongated microshoots were sub-cultured onto half MS liquid medium supplemented with four levels of auxins (0.5 or 1.0 mg/l of NAA or IBA), along with the Control. Finally, rooted plantlets were transferred to different hardening modules for evaluation.Exudation of phenolic compounds from the explants was significantly controlled by incorporating 125 mg/l ascorbic acid into culture induction medium supplemented with BAP (0.5 mg/l) + NAA (0.1 mg/l) in both the genotypes. Highest rooting percentage (99.5%), maximum number of roots (42.75), early root induction (6.87 days) and highest plantlet survival (98.75%) was observed in a medium supplemented with 0.5 mg/l IBA. Among the hardening strategies employed, lowest mortality (1.9%), maximum plant-height (12.49 cm) and leaf number (20.6) was noted inplants hardened in disposable polypropylene tumblers.

S3P71 A317

Photo-selective netting: An effective tool for flower crop production

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Netting is frequently used for protecting agricultural crops from excessive solar radiation (shade-nets), environmental hazards (e.g., hail-nets) or pests (bird- or insect- proof nets). It is either usedas such over net-house constructions, or combined with greenhouse technologies. Black nets were commonly used until now for shading, while clear, transparent nets are being used for protection from environmental hazards or pests. In collaboration with Polysack Plastic Industries, Israel, we have developed a new group of protective nets that can alter both quality and quantity of light intercepted by the plants growing underneath, in addition to providing desired protection. Photo-selective netting is an emerging approach thatprovides additional benefits besides the usual protective functions of nettings. These nets are unique in that these spectrally-modify as well as scatter transmitted light. Photo-selective net products are incorporated with various chromatic additives and light dispersive/ reflective elements into the netting material during manufacture. These nets include "colored-Color Nets" (e.g., red, yellow, green and blue net products) as well as "neutral-Color Nets" (e.g., pearl, white and grey) absorbing spectral bands shorter or longer than those in the visible range. Spectral manipulation is aimed specifically at promoting photo-morphogenetic-physiological responses, while light-scattering improves light penetration into the inner canopy. Radiation-use-efficiency increases when the diffuse component of incident radiation is enhanced under shade.Several flower crops like Lisianthus (*Eustoma grandiflorum*), Gerbera (*Gerbera jamesonii*) and *Trachelium* were found to develop longer and thicker flowering stems under red and yellow nets, while shorter flowering stems under a blue net, compared to an equivalent black shade-net. Additionally, the red net induced shorter-time-to-flowering in some species. The extent of responsiveness varied among species and cultivars. The highly dispersive pearl net has been recently reported to enhance branching in potted*Myrtus communis* plants, while in *Crowea* 'Poorinda Extasy' it increased the number of flowers per branch, compared to that with a black net of the same shading capacity. Thus, photo-selective light-dispersive shade nets provide a unique tool that can be further integrated into protected cultivation practices.

S3P72 A348

Prediction of post-harvest soil-test values for marigold under integrated plant nutrition system (IPNS) in an Inceptisol

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Marigold (*Tagetes patula* L.) is one of the commercially exploited loose-flower crops grown in India. It is highly responsive to primary nutrients, necessitating a sound fertilizer strategy to ensure agronomic, environmental and economic sustainability. Soil-test based IPNS approach for nutrient management requires regular estimation of soil-test values (before and after harvest of each crop cycle) and needs extremely efficient soil-testing services and infrastructure. This is not feasible from the farmers' point of view.Therefore, prediction of soil nutrients left behind after marigold cultivation was accomplished through multiple linear regression (MLR) modeling, as, it can envisage post-harvest soil-test values based on the initial soil-test values, fertilizers applied and the yield targeted. A field trial was conducted with French marigold var. Pusa Arpitaas a test-crop during 2014-2015 at the research farm of Indian Agricultural Research Institute, New Delhi. The experiment was laid out in Fractional Factorial Randomized Block Design, based on Ramamoorthy's inductive-cum-targeted yield methodology. MLR analysis upon the harvest of marigold showed higher values for coefficient of determination ($R^2 \geq 0.87$, 0.89 and 0.82), least root mean square error (RMSE ≤ 6.61, 1.94 and 12.44 kg) and lowest relative error values (RE ≤ 3.87, 11.4 and 2.35%) for N, P and K, respectively. Analysis of R^2, RMSE and RE of the calibration model showed that N and K fell in the category of 'Excellent' and P in 'Good' prediction accuracy. Therefore, these predicted values obtained with multivariate analysis, can be put to use for predicting and recommending with confidence fertilizer doses for any succeeding crop, thus eliminating the need for soil testing after harvest of a crop.

S3P73 A382

Combining ability studies of yield components and fruit quality in muskmelon (*Cucumis melo* L.)

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Fusarium oxysporum f. sp. *melonis,* cause wilt of muskmelon,is a serious production constraint throughout the world.Ten parents (eight resistant and two susceptible to fusarium wilt) were crossed in half diallel mating design to produce 45 F_1 hybrids and were evaluated for general and specific combining ability (GCA, SCA) for fruit yield and quality during 2015-16 and 2016-17spring-summer season.The mean squares due to GCA and SCA effects were highly significant for all the traits under study which indicatedpresence of additive and non-additive variance for controlling expression of these traits. The mean sum of squares due to GCA×E and SCA×E was non-significant for all the traits except fruit shape index and TSS juice. The ratio of variance due to GCA and SCA (σ^2_g /σ^2_s) was less than unity and hence greater role of non-additive gene effects. GCA effects showed Punjab Sunehri as good combiner for seed cavity, flesh thickness, fruit firmness and dry matter. It was among top three combiners for eight traits including rind thickness, β-carotene and TSS. Whereas, SM-2012-12 was best for fruit yield, number of fruit vine^{-1} and fusarium wilt incidence while, KP_4HM-15for days to first pistillate flower opening, days to first fruit ripening, TSS and ascorbic acid.The results indicated that*per se* performance of parents in general had positive correlation with GCA effects.The best hybrid combinations that reflected the high positive SCA values were MM-321×NDM-21 for total fruit yield; MS-1×SM-2012-12 for average fruit weight; PS×KP_4HM-15 for number of fruit vine^{-1}; PS×Kajri Sel. 1 for days to first fruit ripening;KP_4HM-15×Kajri Sel. 1 for TSS; PS×IC-267375 for flesh thickness;PS×SM-2012-12 for rind thickness, seed cavity and titrable acidity; PS×MM-314 for firmness;PS×Kajri Sel. 1 for ascorbic acid; Kajri Sel. 1×MM-202 for dry matter and MS-1×Kajri Sel. 1 for β carotene. On *per se*, SCA effects and resistance to fusarium wilt incidence, hybrids KP_4HM-15×Kajri Sel. 1, KP_4HM-15×MM-202, Kajri Sel. 1×MM-202 and Kajri Sel. 1×MM-202were identified as promising. These hybrids are recommended for multilocation testing to assess their suitability for commercial cultivation under fusarium wilt prone areas.

S3P74 A386

Effect of foliar application of different sources of calcium on growth, yield, quality and nutrient content of tomato under polyhouse condition

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Poly house experiment was carried out at Zonal Agricultural and Horticultural Research Station (ZAHRS), Navile, Shivamogga during *kharif* 2016 to study the response of tomato fruit to different sources and levels of calcium. Three sources of calcium [$CaCl_2$, $CaNO_3$ and calcium ammonium nitrate (CAN)] with three levels each (0.20, 0.50 and 0.80%) were applied as a foliar spray in a Complete Randomized Design (CRD) with three replications and ten treatments. The results of experiment indicated that foliar application of calcium through different sources increased the growth, yield, and quality of tomato significantly over the control (water spray). Among the treatments, treatment receiving 0.5 per cent CAN as foliar spray was recorded highest plant height (149.21cm), number of branches (24.47), stem diameter (5.47 cm) and yield parameter like fruit diameter (4.72), number of fruits per plant (58.67) and quality parameters like total soluble solids (5.00 ^{o}brix) and titrable acidity (0.23%). The nutrient content and uptake of Ca (0.84%, 77.26 kg/ha) and Mg (0.43%, 39.55kg/ha) by tomato fruits was recorded highest due to foliar spray of 0.5% CAN compared to control. The next best source of calcium for foliar spray found to be $CaCl_2$ @ 0.8%which shows higher growth, yield, quality and nutrient content of tomato fruit.

S3P75 A387

Growing apple with efficient water management in cold arid region (Ladakh)

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Water use efficiency and equitable water distribution in regions likeLadakh where due to its geographic location not favoring abundant monsoon rainfall, poor waterholding capacity of soil and scanty vegetation make it difficult. Therefore, for saving water in such region where limited crops are grown, water management is utmost important. Appleis most widely planted fruit crop with good shelf lifenext to apricot in Ladakh,where farmers are focusing for growing this fruit crop as long-term investment and as an important nutritional aspect for huge diploid

army units. Long day hours with high light intensity and relatively warm day with cool nights and low relative humidity from April to October making this crop suitable for this region. Keeping the concept "per drop more crop" in mind, Defence Institute of High Altitude Research,Ladakh has conducted an experimental trial with good quality apple varieties viz. Gala-Gala, Royal Delicious and Top Red. Important water saving aid like blackmulching, drip irrigation and Hydrogel separately and in combination with each other are used in all three varieties. Primarily, from first year data it was found that near about two times of the water utilized by varieties Gala-Gala and Top Red can be saved in Royal delicious varieties with Drip irrigation in combination with black mulching and Hydrogel (60g) for achieving same vegetativegrowth in terms of plant height, leaf area, number of leaves, number of branches, shoot diameter and chlorophyll content. Proven proper vegetative growth in Royal Delicious, it can be assumed that in coming years,this variety will give good flowering and fruiting with efficient water management.

S3P76 A399

Assessment of Growing Media on Bulb and Bulbing Characteristics of Lilium (*Lilium longiflorum)* cv. Bach

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The present investigation was carried out at Model Floriculture Centre, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, U.S. Nagar, (Uttarakhand) during 2014-15.

The main aim of the study was to assess ideal growing media for lilium bulb and bulblets production under protected condition in Tarai regions of Uttarakhand. Four media treatments viz., 100% soil (T_1), 100% coco peat (T_2), sand + coco peat 1:1 (T_3) and soil + coco peat 1:1 (T_4) were tested on bulb and bulbing attributes of cv. Bach. Each treatment comprised of 10 bulbs per pot. Experiment was laid out in randomized block design with three replications. Among four potting media, treatment comprising of 100% coco peat was found superior than otherfor mother and daughterbulb growth and development. Maximum mother and daughter bulbdiameter and weightwere recorded with coco peat. Highest daughter bulblets production was also recorded in media enriched with coco peat. However, minimum bulblets production was recorded in media containing 100 % soil (T_1). Based on this study it was reckoned that media enriched with coco peat is better for lilium bulb and bulblets productionin protected condition.

S3P77 A419

Evaluation of different rootstocks for grapefruit (*C. paradisi* Macf.) cultivars under subtropical conditions of northern India

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Standardization of rootstocks for two promising grapefruit cultivars, Marsh Seedless (MS) and Redblush(RB,) for commercial cultivation under subtropics of northern India still lags behind. Hence, in the present study, we assessed influence of seven rootstocks,*viz*., Rough Lemon (RL), Attani (AT), *Jattikhatti* (JK), *Billikichili* (BK), Sour orange (SO), RLC-4 and Troyer (TR) on MS and RB as the scion*vis-à-vis*plant growth, physiology, biochemistry,fruit yield and quality. Both plant-height and canopy-volume in MS were maximum on SO (3.29m and 124.08m^3, respectively), while in RB, highest values were obtained on RL (3.11m and 104.59m^3, respectively). Further, MS showed highest internal carbon dioxide concentration (C_i) and transpiration rate (E) on RL (323.5µmol CO_2 mol^{-1} and 2.38mmol H_2O $m^{-2}s^{-1}$, respectively), while, RB exhibited maximum C_i(291.50µmol CO_2 mol^{-1})andE(3.01mmol H_2O $m^{-2}s^{-1}$)on JKand AT, respectively. Leaf chlorophyll content in MS wasobserved to be the highest onRL (66.00 SPAD value), whereas, RB showed the highest value(64.00 SPAD) on SO. Additionally, maximum total phenol content in leaf for MS and RB was found on TR and JK (197.85 and 160.14mg catechol/100g fresh wt., respectively). Highest yield for MS and RB was observed on AT and RL (32.87 and 45.18 kg / tree, respectively). Further, maximum fruit weight in MS was noticed on RLC-4 (493.03g), while in RB on AT, it was 398.60g. Highest TSS in MSwas recorded on AT(8.4°Brix), whereasRBshowed the highest value(8.5°Brix) onBK. It may be concluded that the rootstock influences these traits, prompting further, critical investigations for identifying suitable rootstocks for the said condition.

S3P78 A420

Effect of organic farming on growth and flower yield in tuberose (*Polianthes tuberosa* L.) cv. Prajwal

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The present investigation was carried out at Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, during 2014-2016. The experiment was laid out in Randomized Block Design comprising eleven treatment combinations of various nutrients, with three replications. The treatments consisted of foliar spray of *panchagavya*, humic acid and Effective Microorganisms (EM), with a combination of FYM and

vermicompost. Among the various treatments, plants receiving a treatment combination of Vermicompost @ 5t ha^{-1} + Humic Acid @ 0.2% (T_9) were found to be the best in all the growth and physiological characters studied, *viz.*, plant height (65.45cm), number of side-shoots $plant^{-1}$ (9.19), number of leaves $plant^{-1}$ (95.34), leaf area (65.85cm^2), chlorophyll content (0.921mg g^{-1}) and dry matter production (28.75g $plant^{-1}$), and, yield attributes, *viz*., days to 50% flowering (100.34 days), number of spikes per plant (4.75), spike length (57.36cm), rachis length (20.94cm), number of florets per spike (33.12), floret length (6.88cm), floret diameter (4.50cm), hundred-floret weight (101.71g), flower yield per plant (79.73g $plant^{-1}$), flower yield per plot (1.12kg), flower yield per hectare (9.01 t) and number of bulbs per plant (5.01).

S3P79 A425

Uptake of Spiromesifen applied to soil in cabbage and tomato

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Spiromesifen [3-(2,4,6-trimethylphenyl)-4-(3,3-dimethylbutyl-carbonyloxy)-5-spirocyclo-pentyl-3-dihydrofuranon-2] is a miticide/ insecticide belonging to the chemical class of spirocyclicphenyl-substituted tetronic acid. It is a non-systemic insecticide active against mites and whiteflies. Soil drenching is a process where pesticides are directly applied to the base of the plant. This may up the risk of the pesticides leaching onto the surface or into the groundwater, and possibly affect the subsequent crop. Therefore, it is essential to study the uptake of Spiromesifen in the plant and its degradation in soil. Spiromesifen (Oberon 240SC) as soil-drench was applied to cabbage and tomato crops @ 125g a.i./ha. Samples of cabbage (fruit and soil) and tomato (fruit, stem, leaves, root and soil) were collected at 0, 1, 3, 5, 7, 10, 15, 20, 25, 30, 40 or 50 days after treatment. Analysis of Spiromesifen residue was done GC-MS. Spiromesifen residues were not detected in the tomato fruit, stem or leaf, or in the cabbage-head samples. In cabbage and tomato root samples, the residue was 3.589 and 6.263 mg/kg, respectively, and persisted for 30 and 50 days, respectively. Half-life (of degradation) of Spiromesifen in the roots was 8.5 and 14.6 days, respectively. Spiromesifen residue levels in cabbage and tomato field-soils were 10.583mg/kg and 11.848mg/kg, respectively, persisting for 50 days in both the soils. The half-life of degradation of Spiromesifen in field-soil was 11.4 and 13 days for cabbage and tomato, respectively. The major metabolite, Spiromesifen-enol, was not detected in our study. Spiromesifen residues are, thus, unlikely to persist in soil for long or enter into the food chain through soil.

S3P80 A426

Dissipation of fluopyram and tebuconazole on grapes and into soil

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Fluopyram *N*-{2-[3-chloro-5-(trifluoromethyl)-2-pyridyl] ethyl}-α,α,α-trifluoro-o-toluamid and tebuconazole (RS)-1-(4-Chlorophenyl)-4,4-dimethyl-3-(1*H*, 1,2,4-triazol-1-ylmethyl) pentan-3-ol are systemic fungicides. Systemic fungicide is one which is absorbed into the plant tissue and is translocated within the plant to effectively eradicate pathogenic fungi. Grape is commonly affected by fungal diseases such as powdery mildew and downy mildew. Fluopyram + Tebuconazole combination-formulation plays a major role in controlling these diseases. An experiment was laid out to study dissipation-pattern of fluopyram and tebuconazole on grape vines and in the soil upon application of Luna Experience 400 SC (Fluopyram200 + Tebuconazole200) at Standard and Double Dose of 125 and 250g a.i/ha, respectively. Grape was analyzed at 0, 1, 3, 5, 7, 10 or 14 days after the second application. Extraction and purification of samples was done by the QuEChERS analytical method, and analyzed by gas chromatography mass spectrometry (GC-MS). The limit of quantification in the method was 0.05mg/kg for both the compounds. Recovery of fluopyram and tebuconazole was in the range 81.1-99.0% in grape, and 83.24-94.26% in the soil. Initial residues of fluopyram on grape were 4.203 and 6.056 mg/k, and tebuconazole at 5.528 and 7.830 mg/kg in treatments at Standard and Double Dose, respectively. Half-life of fluopyram was 4.6 – 6.0 days and tebuconazole, 4.4 - 6.2 days. Maximum residue limit (MRL) of fluopyram and tebuconazole in grape was recommended at 1.5 mg/kg and 0.5 mg/kg, respectively. Based on results in this study and MRL values, grapes harvested after a pre-harvest interval of 17 and 25 days were considered safe for human consumption from treatments at Standard and Double Dose, respectively. Soil from the field analyzed at harvest contained fluopyram at 0.336 and 0.480 mg/kg, and tebuconazole at 0.137 and 0.177 mg/kg, in Standard and Double Dose treatments, respectively. The metabolite, fluopyram benzamide, was not detected in any of the samples.

S3P81 A436

Effect of variousnitrogen and phosphorus levels on yield and economics of Indian spinach under open-field and shade-netconditions

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The study carried at University Department of Horticulture, Dr. PDKV, Akola,during 2016, was laid out in Factorial Randomized Block Design with three factors,*viz.*,Factor A at two levels of growth conditions: C_1:open field condition, C_2: shade-net condition;Factor B at four levels of nitrogen: 50kgha^{-1},75kgha^{-1},100kgha^{-1} and 125kgha^{-1}; and, Factor C at three levels of phosphorus: 20kgha^{-1},40kgha^{-1} and 60kgha^{-1}, with two replications and twelve treatment combinations.Observations were recorded on yield-contributing traits. Post-harvest characters related to yield,*viz.*,leaf area, leaf moisture content, fresh weight of plant, fresh green-yield per plot and fresh green-yield per hectare were highest under Treatment C_2T_{12} (shade-net with 125kgNha^{-1} and 60kgPha^{-1}); whereas, maximum dry-weight of plant was observed in Treatment C_1T_{12} (open-field condition with 125kgNha^{-1}and 60kgPha^{-1}).Traits desired for quality in the Indian spinach,*viz*., chlorophyll content in leaf and ascorbic acid content at crop-harvest were found to be maximum under Treatment C_1T_{12}(open-field condition with 125kgNha^{-1} and 60kgPha^{-1}). Observations were recorded on growth parameters. Maximum vegetative growth, *viz*., germination percentage (77%), plant height (28.72cm), number of leaves per plant (19.06), leaf:petiole ratio (1.21), and number of cuttings (4.88) was seen inTreatment C_2T_{12} , *viz.*, shade net condition with 125 KgNha^{-1}and 60 KgPha^{-1}. We report here significantly low number of days taken to attain harvestable maturity (21.14 days for first cutting). Traitsfor yield,*viz.*,leaf area (106.38cm^2), fresh weight of plant (45.14g), fresh green-yield per plot (34.21kg) and fresh green-yield per hectare (1154.81q) were highest under Treatment C_2T_{12} which, in general, appeared promising for high yield and better-quality produce, besides having a higher B:C ratio (7.1) compared to the othertreatments under shade-net.

S3P82 A437

Effect of shading on growth and yield in Indian spinach under various levels of nitrogen and phosphorus in Vidarbha region

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The present study on effect of shading on growth and yield in the Indian spinach was carried out at University Department of Horticulture, Dr. PDKV, Akola, during 2016 in Factorial Randomized Block Design, with three factors *viz.,* factor A, at two levels of growing conditions *viz.*, C_1 :open field condition, C_2 : shade net condition, factor B at four levels of nitrogen *viz.*, 50Kg N ha^{-1},75Kg N ha^{-1},100,125 Kg N ha^{-1} and factor C at three levels of phosphorous *viz.*, 20KgPha^{-1},40KgPha^{-1},60 KgPha^{-1} under two replications, twelve different treatments combinations.The observations were recorded in respect of growth parameters. The maximum vegetative growth in terms of germination percentage (77%), plant height (28.72cm), number of leaves per plant(19.06), leaf petiole ratio(1.21), and number of cuttings(4.88) was recorded under treatment C_2T_{12} *viz.,* shade net condition with 125 KgNha^{-1}and 60 KgPha^{-1}. With report here significantly low number of days taken for attaining harvestable maturity (21.14 days for first cutting). Traitsfor yield,*viz.*,leaf area (106.38cm^2), fresh weight of plant (45.14g), fresh green-yield per plot (34.21kg) and fresh green-yield per hectare (1154.81q) were maximum under Treatment C_2T_{12},*viz.,* shade-net with 125kgNha^{-1} and 60kgPha^{-1}.

S3P83 A439

Vegetable grafting: a multi-dimentional approach for crop management in vegetables

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Grafting in vegetables is an approach popularized comparatively recently among vegetable growers worldwide. Initially, the technique purported to controlsoil-borne diseases which are even now of much importance in the practice of intensive agriculture. However, with modification in grafting approaches and other related researches, it has now become a multifaceted approach and is used for several purposes.Grafting is an important, integrated pest-management strategy to manage soil-borne pathogens and other pests of solanaceous and

cucurbitaceous crops, using suitable rootstocks. Important diseases being managed by grafting are caused by fungi such as *Verticillium* and *Fusarium*, oomycetes such as *Phytophthora* by bacteria, particularly *Ralstonia*, and, by root-knot nematode. Grafted seedlings are highly favored in hydroponics where once infected with noxious diseases, diesease-spread is very rapid.Due to a limited availability of arable land, and a high market-demand around the world, vegetables are frequently cultivated under unfavorable soil and environmental conditions like thermal stress, drought and flooding, contamination by persistent organic pollutants and low soil-temperature and high-salts in soil, especially under protected cultivation (where successive cropping or continuous farming is routinely practiced). One way to reduce loss in production caused by abiotic stresses in vegetables is to graft them onto rootstocks capable of reducing the effect from external stresses on the shootthroughvigorous uptake ofsoilnutrients,avoidanceof infection by soil pathogens and tolerance to abiotic stress.Vegetablegraftinghas alsobeenadoptedforproduction of safe, organic and environmentally-friendly produce and to minimize uptake of the undesirable agrochemical residues. Traits such as firmness, texture, flavour and content of health-compounds can be affected by grafting as a result of translocation of metabolites associated with fruit quality to the scion through the xylem, and/or, modification of physiological processes of the scion.

S3P84 A440

Uptake and translocation of flubendiamide in capsicum plant

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Flubendiamide (N2-[1,1-dimethyl-2-(methylsulfonyl) ethyl]-3-iodo-N1-[2-methyl-4-[1,2,2,2-tetrafluoro-1-(trifluoromethyl) ethyl] phenyl]-1,2-benzenedicarboxamide) is an insecticide used effectively for control of lepidopteron pests in a number of vegetable crops. Des-iodo flubendiamide is the major metabolite of flubendiamide. Flubendiamide is used both as foliar spray and soil-drench. It is highly persistent in soil, and may enter into the food chain ifthe crop has grown on contaminated soil. An experiment was carried out to study uptake and translocation of flubendiamide in the capsicum plant. Flubendiamide (Fame 480 SC) as soil-drench was applied at 0.5ml/l twice, at a 10-day interval. Its residues were tested in the plant root, leafs, stem and fruit besides the field soil at 0 (within 2 hrs), 1, 3, 5, 7, 10, 15, 20, 30, 40, 50, 60 and 70 days of treatment. Extraction and purification of the samples was carried out by the QuEChERS analytical method, and samples were analyzed by HPLC. Limit of the quantification of the method was 0.01mg/kg. Flubendiamide was not detected in the capsicum plant system as the stem, leafs and fruit were free from residues, on all the days of sampling. However, in the root,the residue was 0.98mg/kg on Day 1 and remained so upto 70 days.

Residue in the soil on Day 0 was 3.05mg/kg, persisted upto 70 days, and degraded at a half-life of 16.3 days. Residues of flubendiamide in the root may have come from the soil-drench application as well as through absorption from the soil. However, it did not translocate from the root to the leaf, stem or fruit of the capsicum plant. These results suggest that even if flubendiamide persists in the soil for a long time, it is not likely to move into the food chain through uptake by the plant.

S3P85 A441

Integrated nutrient management in sapota (*Manilkara zapota* L.)

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Sapota [*Manilkara zapota* (L.) P.Royen] cv. Kirthabarthi is one of the important commercial fruit crops of the world.Proper nutrient management is an important factor to be considered for sustainable productivity, and it is necessary to maintain satisfactory soil-fertility for growth and yield in this crop. An investigation was carried out to study the effect of integrated nutrient management in sapota. The experiment was laid out in Randomized Block Design, with eight treatments replicated thrice. Treatments comprised farmyard manure, vermicompost, recommended dose of fertilizers (RDF) and effective microorganisms (EM), besides aControl. Results revealed that application of vermicompost @ 12.5kg tree^{-1} + RDF (1000:1000:1500g NPK tree^{-1}) + EM (1:250 dilution) recorded maximum positive response for yield and yield attributes,*viz.*, fruit length (9.46 and 9.34 cm for the first and second season, respectively), fruit girth (17.44 and 17.26 cm for the first and second season, respectively), fruit volume (88.57 and 83.24 cc for the first and second season, respectively), mature-fruit weight (97.02 and 91.68 g for the first and second season,respectively), fresh weight of pulp (71.49 and 67.25 g for first and second season, respectively), peel weight (15.04 and 14.83 g for the first and second season, respectively), number of fruits tree^{-1}(722 and 701 for the first and second season, respectively), number of fruits kg^{-1} (10.31 and 10.91 in the first season and second season, respectively), yield tree^{-1}(70.04 and 64.27 kg for the first and second season, respectively) and yield hectare^{-1} (10.93 and 10.02 tonnesfor the first and second season, respectively) .

S3P86 A449

Pod-set and pollen viability studies in yard-long bean (*Vigna unguiculata* subsp. *sesquipedalis*)

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A study was conducted on yard-long bean (*Vigna unguiculata* subsp. s*esquipedalis*)hybrid VS 50 (Kakkamoola Local) x VS 26 (Vellayani Jyothika),to assess the rate of fruit-set at two, and to identify the better time-interval for effective pollination in yard-long bean hybrids. Hand-pollination was carried out, with VS 50 as the female parent and VS 26 as the male parent, for seven consecutive days at two time intervals, 6.30–7.30am and 7.30–8.30am. Higher rate of fruit-set (36.8%) was observed in the treatment under 6:30–7:30am compared to that at 7:30–8:30am (23.8%). Pollen viability was determined for the parents, VS 50 (Kakkamoola Local) and VS 26 (Vellayani Jyothika), at 6.30, 7.30 and 8.30am. Highest pollen viability was observed in both the parents (VS 50 and VS 26)at 7.30am. Therefore, the best time interval for effecting crosses in yard-long bean, as per our study, is 6.30-7.30am.

S3P87 A459

Soil conservation methods for Trans-Himalayan cold desert region-Ladakh

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An arid region is an area characterized by a severe lack of available water, to the extent of hindering or preventing the growth and development of plant and animal life. The cold arid region in Jammu and Kashmir is confined to Ladakh region, geographically located between 320 15’ to 360 North latitude and &750 15’ to 800 15’ East longitude. Due to its high altitude, the climate is extremely cold and dry. On an average soil loss from India land surfaces is 16 t/ha/year. J&K state is only next to Rajasthan in terms of highest percentage of degraded land (18.08%).The strategies for soil conservation must be based on: covering the soil to protect it from raindrop impact; increasing the infiltration capacity of the soil to reduce runoff; improving the aggregate stability of the soil; and increasing surface roughness to reduce the velocity of runoff and wind. Seabuckthorn act as an effective soil binder and helps in sand dune fixation in Nubra valley of Ladakh and has the ability to fix nitrogen directly from air through the nodules in its roots. *Juniperuspolycarpos*at lower altitude and *J. indica*at higher altitude are ecologically the more suitable species for the successful implementation of conservation programmes. *Salix spp.* (willows) and *Populas spp.* (poplars) which give a bushy growth under Ladakh conditions should be vigorously planted.

S3P88 A462

Adoption of Black Plastic Mulch technology in trans-Himalayan Ladakh

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Farmers' readiness on adoption of black plastic mulch (BPM) as a new production technology was assessed in trans-Himalayan Leh Ladakh. Black plastic mulch sheet was distributed to farmers in Phey village after imparting training at Defence Institute of High Altitude Research in May 2016. They were asked to grow tomato (var Tolstoi) and compare the effect of BPM with traditional system. Feedback was taken from the farmers after the cropping season in October 2016. The main benefit observed by the farmers was suppression of weeds. Only one weeding was required with BPM as compared to three or four weedings under traditional system. The irrigation interval increased to 11 days with BPM as compared to 7 days interval without the mulch. Approximately 12 to 15 days early crop was obtained with BPM which resulted in better marketing opportunity. Tomato yield increased to double with BPM as compared to the traditional system. Mulching technology was found very successful in Ladakh and farmers were ready to purchase BPM sheet. As a result of the technology demonstration in Phey village, high demand for BPM has come up in Ladakh. The study showed that farmers in trans-Himalayan Ladakh are receptive to now crop production technology.

S3P89 A478

Identification, Validation and Resolution of Nutritional Problem of Apple

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It was hypothesized that current problem in cultivation of apple is uptake of calcium and deficiency of boron. For validation of the hypothesis soil and leaf sampling was carried out in thirty apple orchards belonging to three physiographic zones in district Kulgam viz., high, mid and low altitude zones. The apple orchard soils from district Kulgam were moderately acidic in high altitude areas to neutral in low altitude areas. Organic carbon content was high in all the three zones and increased with the increase in altitude. Soil available nitrogen, potassium, zinc, copper, iron and boron increased with the increase in altitude while as reverse trend was observed in case of phosphorus and magnesium, however, calcium did not exhibit any

relationship with altitude. Foliar nutrients followed the similar trend with altitude except calcium. Coefficient of determination (R^2) of regression plots was high in all the nutrients except calcium (R^2 = 18.04%) which depicts possible problem in its uptake. Besides calcium, boron was also included in the validation experiment as most of the apple orchards of the valley go for about 3 foliar sprays of B in a year. For validation and resolution of problem, a field experiment was conducted in Red Delicious apple orchard in district Kulgam to study the response to different levels of foliar application of calcium and boron. The experiment was laid out in randomized block design with four levels of calcium-chloride spray (C_0-0 mg kg^{-1}, C_1-1000 mg kg^{-1}, C_2-2000 mg kg^{-1} and C_3-3000 mg kg^{-1}) and four levels of boron spray (source boric acid) (B_0-0 mg kg^{-1}, B_1-500 mg kg^{-1}, B_2-1000 mg kg^{-1} and B_3-1500 mg kg^{-1}). Three sprays each of calcium chloride and boron were given and the experiment was replicated thrice. Leaf samples were collected treatment wise and analyzed for all the essential nutrients. The treatment combination of C_2B_1 (spray of calcium chloride @ 2000 mgkg^{-1} and boron @ 500mg kg^{-1}) recorded maximum yield, hence the best combination for apple.

S3P90 A481

Analytical profile study for characterisation and classification of Apple growing soilsof temperate Jammu and Kashmir, India

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The sustainable use of soil resourcerequires an extensive knowledge about its genesis,morphology and physico-chemical characterization. The systematic and scientific study of morphology and taxonomy of diverse soil types provides information about the nature and type of soils, their constraints, capabilities and their suitability for various uses. The *in-situ* examination for morphological characteristics like depth, diagnostic horizons, colour, structure, boundaryand physico-chemical description of soil profiles forms the basis for classifying the soils. In India, the diverse agro-climatic zones of Jammu and Kashmir offer the advantage of growing different fruit crops like apple, pear, peach, almond etc. However, the crop production and soil managements greatly differ with kind of soil and their physico-chemical behavior. Factors like soil which acts a medium and site-characteristics influence to a large extent the tree health and fruit production.The most important soil considerations for deep and ramified fruit trees like apple are water table (soil depth) and water drainage.The physiographic features likerelief, altitude, slope and aspect have pronounced effect directly or indirectly on physico-chemical properties as well as nutrient supplying capacity of the soils. The scientificanalytical study of inherent heterogeneity and complexity of soils under dynamic interactions of such variable soil properties for morpho-genetic classification and soil diagnostic characterization in apple orchards under temperate conditions is necessary to generate information pertinent to soil-site suitability for sustainable production.

S3P90A498

Effect of time and technique of grafting for quality production of nursery plants of Amrapali Mango (*Mangifera Indica* L.)

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The present investigation was conducted at Horticultural Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, during 2013-14 under subtropical climatic conditions of western Uttar Pradesh with a view to find out the response of Amrapali mango to time and techniques of grafting. The experiment was carried out in factorial RCBD with five replications in each treatment. There were four grafts in each replication of all 9 treatment combinations**.** The treatment combinations comprised of three times of grafting i.e.**(**25th July, 10th August and 25th August) with three methods ofgrafting*viz*, veneer grafting, softwood grafting and epicotyl grafting. Results revealed that epicotyl grafting performed on 10thAugust **r**ecorded minimum time (15.70 days) for bud sprouting while softwood grafting performed on 25th August recorded maximum time (20.80 days) for bud sprouting.**Veneer** grafting performed on 10th August was found to be the best technique in terms of sprouting percentage (79.60 %), graft height (33.39cm) and number of leaves per graft (30.78) after one and six month of grafting. Therefore, veneer grafting should be preferred over softwood and epicotyl grafting in order to get better survival and over all sprout growth for commercial propagation of quality plants of Amrapali mango.

S3P91 A506

Factors affecting aeroponics in flower crops

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Aeroponics is an advanced soilless culture that provides controlled environment for growth and development of a plant. Crops can be planted and harvested year-round in this system. Here, roots are exposed to more air which reduces anaerobic respiration and,

consequently consumption of photo-assimilates by roots. Performance of a plant in aeroponics depends upon nutrient solutioncomposition, temperature, pH, EC, duration and amount of nutrient-spray solution applied, which vary from crop to crop. Nutrient solution composition must be balanced in order to supply all the essential nutrients optimally. Nutrient composition/source also determine nutrient interaction, pH and EC of the solution and, thereby, absorption by roots. In gladiolus, an experiment was conducted using three different nutrient solutions and it was observed that plants responded well to CPRI and NFT solutions compared to half-strength MS medium. For most crops, pH of the solution ranging from 5.8 to 6.5 ensures good growth and availability of nutrients. High or low concentrations result in toxicity or deficiency of nutrients. Root-zone temperature too influences nutrient uptake, root metabolism and root growth. Optimum root-zone temperature for most crops is 18°-24°C. Frequency of spraying and amount of nutrient solution sprayed are important factors to maintain high RH for nutrient uptake by roots and, therefore, survival of the plant. Aeroponic system is expensive, and lack of knowledge in this area limits its adoption by farmers. Development of low-cost, efficient and easy-to-handle aeroponics system will popularize this technology. Aeroponic culture can be an ideal alternative to sustainable and environment friendly agriculture.

S3P92 A515

Quality of coriander leaves as influenced by growing conditions

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Coriander, *Coriandrum sativum* Linn. (Apiaceae) is one of the earliest spices known to humanity for its intrinsic aromatic and fragrant qualities of both seeds and leaves. In India, it is grown in an area of 624780 ha with a production of 572990 tonnes. Coriander leaves are popularly used in cooking and garnishing. Apart from seeds, leaves and stems of the plant are found to contain carminative and antiseptic properties. Leaves are rich in vitamins especially Vitamin A and C, antioxidants like β-carotene, dietary fiber, fats, protein and minerals (calcium, phosphorus, manganese, zinc, iron and magnesium). All the nutrients packed in it is the reasons for its potential health benefits. However, there is limited research on management aspects for the efficient utilization of coriander leaves for its various end uses. Keeping this in mind, a study was conducted in the plains of Kerala to investigate the performance of coriander leaf for its quality aspects in open and rain shelter conditions. The study suggested significantly higher vitamin C and chlorophyll content in coriander grown in open condition (225.25mg/100g and 2.56mg/100g) respectively compared to that grown under rain shelter (106.0 and 1.53 mg/100g). Whereas volatile oil ranged from 0.05-0.08 % and were on par in both the growing conditions.Further research is required to evaluate the suitability of various growing conditions on the quality of coriander leaves that can highlight the nutritional and functional properties of coriander leaves.

S3P93 A516

Studies on various cultural practices for the improvement of fruit quality in grapes cv. Crimson Seedless

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The Grape variety, Crimson Seedless suffers from uneven colour development, which has bearing effect on marketability and economic returns. To address this problem, the effect of various viticultural practices *viz*., berry thinning (at 8-mm berry size), basal leaf removal, bunch covering and ethrel application @ 500 ppm (at veraison stage) either in single or in different combinations on berry colour development and quality attributes were studied in 3 years old vines of cv. Crimson Seedless during 2015-16. Among the treatments, highest mean bunch weight (699.83 g), bunch volume (615 cm^3), the better cluster compactness (1.79), berry diameter (18.31 mm) and 50 berry weight (230 g) were recorded under the combinations of berry thinning + ethrel (500 ppm) + basal leaf removal. With regard to quality attributes, the highest TSS (20.87 $^{\circ}$B), total anthocyanins (3.19 mg/g FW), Brix-acid ratio (83.53), lower acidity (0.63 g/L) and higher pH (4.25) were recorded under combination treatments of berry thinning, ethrel and basal leaf removal as compared to control. The highest colour intensity (3.48) was recorded by the combination of berry thinning, ethrel application and basal leaf removal. The results suggested that the treatment with combination of berry thinning (at 8 mm size), ethrel (500 ppm) and basal leaf removal was effective in improving the bunch and berry quality attributes in Crimson Seedless grapes.

S3P96 A562

Studies on the effect of different chemicals and paclobutrazol on growth characters, flowering physiology and fruit yield in mango (*Mangifera indica* L.) cv. Imam Pasand

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A field experiment was conducted to assess the effect of different chemicals, soil application of paclobutrazol and combined application of paclobutrazol with chemicals as foliar spray on flowering physiology and yield in mango cv. Imam Pasand at Department of Fruit Crops, Horticultural College and Research Institute, Periyakulam during 2011 and 2012.

The experiment was laid out with 16 treatments and two replicationsin a randomized block design. The soil application of paclobutrazol @ 0.75.a.i. m^{-2} of tree canopy diameter during September month along with foliar spray of KNO_3 @ 1 per cent twice during October and November at 20 days interval was very effective in suppressing the tree height (2.69m), canopy spread (5.10m N-S, 4.17m E-W), shoot length (9.37cm), internodal length (2.07 cm), earliness of flowering (93.15 days) and hastened maturity (110.50 days) compared to other treatments and control. In respect of physiological parameters, soil application of paclobutrazol along with KNO_3 foliar spray increasedthe specific leaf weight (0.510 g cm^{-2}), leaf nitrogen (1.75%), phosphorus (0.16%), potassium (0.86%), chlorophyll 'a' (1.56 mg g^{-1}), chlorophyll 'b' (1.10 mg g^{-1}), total chlorophyll (2.66 mg g^{-1}) and significantly reduced the specific leaf area (30.73 cm^2 g^1). The same treatment registered the lowest gibberellic acid (1.39 µg g^{-1}). The soil application of paclobutrazol alone was found equally effective in suppressing the vegetative growth and induction of early flowering (97.60 days) and hastened maturity (110.75 days). In both the treatments *viz*., foliar spray of KNO_3 combined with soil application of paclobutrazol @ 0.75.a.i. m^{-2} of tree canopy diameter and application of paclobutrazol alone which recorded the highest yield characters *viz.*,panicle length (34 cm & 33.63 cm), hermaphrodite flowers (12.62% & 12.58%) and fruit yield (33.50 kg $tree^{-1}$ and 31.40 kg $tree^{-1}$) respectively were on par and statistically significant.

S3P99 A607

Advances in organic fruit production

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India ranks 16thin the world organic acreage and contributes 0.75 per cent with an area of 0.5 million ha. With the increasing population, the cultivable land resource is shrinking day to day. Green Revolution in the post independence era has shown path to developing countries for self-sufficiency in food but sustaining agricultural production against the finite natural resource base demands has shifted from the "resource degrading" chemical agriculture to a "resource protective" biological or organic farming. The major components of organic farming are: manures, green manures, intercropping, mulching, vermiculture biotechnology, biofertilizers, homa farming/agnihotra, biodynamic farming, biocontrol etc. It has been reported that the application of different organic manures on mango trees is useful for improving the growth characteristics, yield characteristics and quality characteristics of fruits. In Bombai' litchi combinations with farm yard manure + *Azotobacter* + phosphorous solubilizers + potash mobilizers showed higher total soluble solids and total sugar content, whereas vitamin C content was higher where a combination of neem cake + Azospirillum + phosphorous solubilizers + potash mobilizers was applied.Research workshowed that in apple

cultivar Red Delicious, farm yard manure @ 100 kg/tree showed higher yield, fruit weight and acidity, whereas total soluble solids and total sugar contentwas higher in control. Food and nutritional security is a serious global concern. Neither conventional farming with inorganic alone nor organic farming only with the use organic input can face this challenge. The combination of organic and inorganic is undoubtedly the best option.

S3P100A609

Response of number of air layers per shoot and its time of operation in pomegranate

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The experiment was carried with the objectives;1) to study the effect of number of air layers per shoot and its time of operation in pomegranate and 2) to find out the retention of appropriate number of layers per shoot and its time of operation for higher success in pomegranate. The experiment was laid out in Factorial Randomized Block Design (FRBD) with two factors, i.e. number of air layers per shoot *viz*., L_1 two layer per shoot, L_2 four layer per shoot, L_3 six layer per shoot and L_4 eight layer per shoot and time of air layering *viz*., M_1 July, M_2 August, M_3 September and M_4 October which were replicated four times with sixteen treatment combinations.The pomegranate propagation was significantly influenced by number of air layers per shoot treatment. L_1significantly showed better response for root initiation, rooting percentage, length of root, fresh weight of root, dry weight of roots and number of leaves, However, number of roots, root volume, height of rooted air layered, survival percentage was maximum in treatment L_2.Also success of propagation was significantly influenced by different time i.e. months layering in M_1 i.e. July was found significantly superior over all the other treatments for root initiation, rooting percentage, length of root, fresh and dry weight of root and number of leaves, However, number of root, root volume, height of rooted air layered and survival percentage is maximum in M_2 i.e. August. The interaction effects of number of air layer per shoot and its time of operation in pomegranate showed that better response for pomegranate air layers the treatment combination L_1M_1 propagation was found significantly influenced by root initiation, rooting percentage, length of root, fresh weight of root, However, number of roots, root volume observed in L_2M_1 i.e. four layer per shoot during July month for pomegranate success and survival for per hectare area.

S3P101 A611

Effect of plant growth regulators and $AgNO_3$ on growth, flowering and yield of ridge gourd

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An investigation on "Studies on effect of Plant Growth Regulators and $AgNO_3$ on growth, flowering and yield in Ridge gourd (*Luffa acutangula* L. Roxb) cv. Kokan Harita" was undertaken using growth regulators Gibberellic Acid (GA_3) at 50, 75 and 100 ppm, Ethrel at 200, 300, 400 ppm and chemical Silver Nitrate ($AgNO_3$) at concentration of 100, 200 and 300 ppm. The growth regulators and chemical were applied to plants at 2 to 4 leaf stage. The results showed that, the Treatment T_7 (Ethrel 200 ppm) was found most effective to increase the nodal position of first male flower (9.26^{th} node) and lower nodal position of first female flower (6.6^{th} node). The treatment T_9 (Ethrel 400 ppm) recorded maximum days (38.48) for appearance of first male flower and minimum days (33.33) for appearance of first female flower. The maximum number of female flowers (28.96) were produced in treatment T_9 (Ethrel 400 ppm) and minimum male flowers (190.22) were produced in treatment T_8 (Ethrel 300 ppm). The treatment T_8 (Ethrel 300ppm) was found most effective treatment for suppressing the sex ratio (7.11).The results showed that, the maximum number of fruits per vine (24.42) were produced in treatment T_8 (Ethrel 300 ppm). Days to first fruit set were significantly reduced (38.75 days) in treatment T_9 (ethrel 400 ppm). The highest percentage of fruit set (88.65 percent) was recorded treatment T_2 (GA_3 75 ppm). Minimum days from fruit set to horticultural maturity (11.24) were recorded by $AgNO_3$ 300 ppm (T_6). Maximum fruit length (27.69 cm) and diameter of fruit (3.60 cm) were recorded in treatment T_4 ($AgNO_3$ 100 ppm) along with maximum average weight of fruit (115.20 gm). The results regarding yield have shown that, treatment T_8 (ethrel 300 ppm) gave highest yield per vine (2.53 kg) and maximum (23.42 tons) yield per hectare.

S3P102 A631

Effect of different mulching materials on growth and yield ofMarigold (*Tagetes erecta L.*)

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African marigold (*Tagetes erecta L.*) is one of the most important and popular flowering annuals cultivated commercially in various parts of India. To effectively augment the weed control, water and fertilizer use efficiency and flower yield in marigold cultivation, the present

experiment was laid out in the Randomized block design (RBD) with three replications. Different plastic mulching material *viz.*, black polythene film of 100µ thickness and white polythene film of 100µ thickness and organic mulching materials viz., paddy straw, leaf litter and coir pith were laid as treatments along with hand weeding un-weeded controls. The marigold F_1 hybrid "Maxima Yellow" was used for this study. Both organic and plastic mulches significantly influenced all growth and yield parameters of marigold when compared to control treatments. Among all the treatments, mulching with coir pith performed better with the highest values of growth parameters viz., plant height, plant spread, number of branches/ plant, number of leaves/ plantand DMP (115.82 g/plant). Flowering was early in coir pith mulching. The maximum number of flowers per plant (42.38), diameter of flower (10.98 cm), weight of single flower (12.85 g) and flower yield (550.73 g/plant) were recorded in mulching with coir pith. The plastic mulches performed better with respect to weed biometrics. The least weed population and weed dry matter as well as the highest weed control index (74.20) were observed in mulching with black polythene film of 100µ thickness respectively.By considering the ability of mulching treatments in weed control and their influence in augmenting growth and yield parameters and weed biometrics it can be concluded that mulching with coir pith can be adopted as the best floor management option in marigold cultivation.

S3P103 IS45

Estimation the benefit/cost ratio of various plant growth regulators in phalsa (Grewia subinaequalis D.C.)

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The present investigation entitled "Economic feseabilty of various plant growth regulators in phalsa (*Grewia subinaequalis* D.C.)" was conducted at Main Experiment Station, Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh during 2014-2015 in Randomized Block Design and replication three and ten treatments T_1 - Control (Water spray), T_2-GA_3 50 ppm, T_3-GA_3 100 ppm,T_4-GA_3 150 ppm,T_5-NAA 50 ppm,T_6-NAA 100 ppm,T_7 –NAA 150 ppm, T_8 Ethrel 50 ppm, ethrel T_9 100 ppm, ethrel T_{10} 150 ppm. Phalsa is a abiotic and biotic stress resist crop, we can do phalsa cultivation without any special care. Phalsa is salt-tolrent and drought resistance and pest tolerant crop so that its cultivation is so cheap or less expensive. GA_3 @ 150 ppm fetches highest gross income, net return and benefit cost ratio was found, however NAA 150 ppm GA_3 100 ppm and ethrel 100 ppm were also significantly increased the income and benefit/cost ratio. Foliar application of GA_3 @150 ppm effective to increase vegetative growth, yield and quality parameter respectively and ethrel @100 ppm was found best in improvement of sugar content in phalsa fruits. All plant growth regulators significantly improved yield and higher benefit-cost ratio over control in specific amount or dose as per above.

S3P104 IS47

Effect of Foliar Feeding Of Plant Growth Regulators on Growth, Fruiting Behaviour and Quality Improvement Of Phalsa (Grewia Subinaequalis D.C.)

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The present investigation entitled "The effect of foliar feeding of plant growth regulators on growth, fruiting behaviour and quality improvement of phalsa (*Grewia subinaequalis* D.C.)'' was conducted at Main Experiment Station, Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh during 2014-2015 in Randomized Block Design and replication three and ten treatments T_1 - Control (Water spray), T_2-GA_3 50 ppm, T_3-GA_3 100 ppm,T_4-GA_3 150 ppm,T_5-NAA 50 ppm,T_6-NAA 100 ppm,T_7 – NAA 150 ppm, T_8 Ethrel 50 ppm, ethrel T_9 100 ppm, ethrel T_{10} 150 ppm. Growth attributes like shoot length, number of shoots per plant, number of leaves per shoot, inter nodal length, yield attributes like number of fruits per node, number of fruiting nodes per shoot, fruit yield per plant (kg), fruit yield per hectare (q). Physico-chemical characters like as fruit length & width, weight of 50 fruits, pulp-stone ratio, ascorbic acid content, etc. were increased and acidity per cent was reduced with the application of GA_3 @ 150 ppm, however total soluble solids and sugars (reducing, non-reducing, total sugars) content were improved by ethrel 100 ppm and it is also effective in reducing acidity. It was observed that the foliar application of GA_3 @150 ppm at pre bloom stage and fruit setting effective to increase vegetative growth, yield and quality parameter respectively and ethrel @100 ppm was found best in quality improvement in phalsa fruits. Hence GA_3 150 ppm or ethrel @ 100 ppm can be recommended for phalsa growers produce very good quality phalsa fruits but overall basis GA 150 ppm is most effective.

S3P105 A6

Effect of recipes and cultivars on standardization of guava RTS

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The fruits of guava cvs. Lucknow -49,Red fleshed and Apple guava were collected from the winter season crop(2007). Fully matured fruits were sorted, washed, cut into pieces andpassed through pulper after mixing with water (1:1)to get guava pulp. RTS was prepared by mixing this pulp with strained sugar syrup (sugar + water +acid heated just to dissolve), homogenized, cooled to 40°C, added 750 ppm sodium benzoate,filtered,bottled, crown corked, pasteurized (82°C for 15 min) and then cooled. Six recipes consists of 1)10% pulp ,11% T.S.S, 0.3% acidity; 2)10% pulp,11% T.S.S 0.4% acidity; 3) 10% pulp, 12% T.S.S ,0.3% acidity;

4)10% pulp,12% T.S.S, 0.4 % acidity; 5) 10% pulp,13 % T.S.S, 0.3 % acidity; 6) 10% pulp,13%T.S.S ,0.4% acidity were used for preparation of guava RTS beverages. Physico-chemical and sensory quality characters(color, flavor, taste, overall acceptability), were recorded on 0, 30th and 60th days of storage. Maximum TSS (13.43) was observed in recipe 3 on 0 and 30th day while on 60th day maximum TSS(18.26) was recorded in recipe 1. Among cultivars, highest TSS was observed in cv.Lucknow-49(14.63) followed by Apple guava(14.27) and lowest in Red Fleshed guava(13.90). Similarlyhighest pH was observed in recipe 3 (2.90) on 0 day and 30th day whileon 60th day maximum pH was recorded in recipe 2 (2.80).Highest pH was recorded for cv. Lucknow(3.21) followed by Apple guava(2.63) and lowest in Red flesh guava(2.23).Ascorbic acid (mg/100mg) was maximum on 0day and 30th day in recipe 3 (20.03) and recipe 1 (12.00) respectively, and maximum ascorbic acid on 60th day was observed in recipe 1(12.00). Highest ascorbic acid content was observed in cv. Lucknow- 49(8.00)followed Apple guava (13.59) and lowest observed in red fleshed guava(10.98).

S3P106 A7

Lemon(*Citrus limon* Burm.) cv. Assam Lemon fruit quality and leaf-soil nutrient availability affected by different pruning intensities and nutrient management

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Lemon is one of the most economically important groups of citrus, grown in developed and developing countries and certainly constitutes one of the main sources of vitamin C. Assam Lemon is one of the important varieties of lemon, extensively grown in the north-eastern parts of India.A field experiment was laid out in two factorial Randomized Block Design with four levels of pruning and seven levels of nutrient, consistingrecommended dose of fertilizers (RDF) and different combinations of organic manure (Vermicompost), inorganic fertilizer, bio-fertilizer (Azotobacter), mycorrhiza (VAM) and their interaction to study their effect on final fruit quality and leaf-soil nutrient availability during 2013 to 2015 on 9 year old lemon plants under different growing seasons. The investigation revealed that all the physico-chemical parameters viz. fruit weight (154.67g, 169.33g and 158.67g), puncture force (0.56, 0.64 and 0.59N), juice yield (55.18, 55.83 and 55.41%), total soluble solid (6.33, 6.93 and 6.60^{o}Brix), titrable acidity (0.79, 0.84 and 0.80%), Ascorbic acid (52.45, 52.78 and 52.65 mg/100g of pulp) were found highest in combination of highest level of pruning with 75% RDF + Vermicompost + Azotobacter + Vesicular ArbuscularMycorrhiza at Ambe, Mrig and Hasthbahar respectively.Among the three season of cropping Mrig bahar recorded the best with respect to final fruit quality. However, the maximum availability of leaf and soil nutrients was recorded in treatment with 75% RDF + Vermicompost + Azotobacter + Vesicular Arbuscular Mycorrhiza.

S3P107 A46

Effect of inorganic and bio-fertilizers on growth, yield and nutrient uptake in gherkin (C*ucumis anguria* L.)

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An experiment was conducted to find out the effect of inorganic and bio-fertilizers on growth, yield and nutrient uptake in gherkin (C*ucumis anguria* L.)at farmer's field of Haveri district, Karnataka state during 2014-15. Experiment consisted of fourteen treatments with three replications and Factorial Randomized Complete Block Design. The results revealed that application of 100% recommended dose of NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*recorded highest vine length (143.33cm), maximum number of leaves (47.23/plant), branches(2.72/plant),early flowering (28.0 days) with highest fruit yield (12.70 t/ha).Whereas the lowest vine length (115.67cm), number of leaves (28.83/plant), branches(1.33/plant), delay flowering (37.00) and lowest yield (4.97 t/ha) were recorded in control. Significantly maximum nutrient uptake with soil fertility status of N 194.60 kg/ha, $P_2O_5$55 kg/ha and K_2O 237 K kg\ha was recorded in application of biofertilizer and inorganic fertilizer such as 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*and lowest uptake of nutrients with low soil fertility status (NPK) were recorded in control.

S3P108 A52

Effect of organic sourcesof nutrients on seed quality parameters of chilli (*Capsicum annuum*l.)Cv. PKM 1

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An experiment was conducted atthe Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore from 2012 – 2013to study the effect of organic source of nutrients on chilli cv. PKM 1.The experiment consisted of two main plot treatments and seven sub plot treatments replicated three times in a Split Plot Design. Chilli seeds bioprimed with liquid *Azospirillum* 15% for 6 h and the control seeds were sown in protray nursery and were transplanted to the main field 35 DAS. The field was applied with different organic sources of nutrients like FYM100%, poultry manure100%, vermicompost100%, 50%farm yard

manure + 50%poultry manure, 50%farm yard manure + 50%vermicompostand 50%poultry manure + 50%vermicompost.The seeds obtained from the experimental plots such as inorganic source of nutrients, 100% vermicompost and 100% poultry manurewere analysed for the further seed quality parameters*viz*., germination percentage, root length, shoot length, dry matter production and vigour index. Seeds were stored in cloth bag and 700 gauge polythene bag without any pre storage treatments. As the period of storage increased, seed deterioration was also faster. Seed germination as well as seed vigour parameters such as root and shoot length, dry matter production and vigour index of the stored seeds were maximum in organic seed. Seeds stored in 700 gauge polythene bags showed higher seed quality parameters like germination, vigour and proteinwhen compared to seeds stored in cloth bag, after 6 month of storage.

S3P109 A53

Effect of Foliar Application of Micronutrients on Yield of Mandarin Orange (*Citrus Reticulata* Blanco.)

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Experiment on effect of foliar application of micronutrients (Zn, Fe, B, Mn and Cu) on mandarin orange on yield parameter was carried out during 2015-16 at lower pulney hills of Tamil nadu. Fifteen treatments are used alone or in combination with control (water spray) were used as foliar spray solution at vegetative, flowering and fruit set stage. The experiment was laid out in randomized block design (RBD) with three replication and two trees under each replication. Data were recorded in T_{15} treatment is significant increase the fruit set 52.49 per cent, number of fruits per tree 81.05 and yield (7.82Kg/tree). The result revealed that foliar application of micronutrients found very effective for increased yield attributes.

S3P110 A58

Effect of different budding dates under open and shade net conditions in Nagpur mandarin

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Studies were carried out at experimental orchard of AICRP (Tropical Fruits) Dr. PDKV, Akola, Maharashtra on shield budding in Nagpur mandarin in shade net and open field conditions at 15 days interval from 15th November to 30th January to standardized date of

budding in Nagpur mandarin under open field and shade net condition in Vidarbha region. Height of bud graft, length of scion, number of leaves on scion was best under open field condition, similarly maximum bud take per cent, bud survival percent, leaf area and chlorophyll content was better under open field condition than shade net condition. Budding done at 15 December under open field condition gave the maximum height of bud graft, length of scion, No. of leaves on scion, bud take per cent, bud survival per cent, leaf area and chlorophyll content than all other treatments.

S3P111 A35

Influence of nutrient deficiencies on growth and leaf nutrient content of gerbera cv. Savannah through solution culture

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Gerbera is one of the commercial cut flowers cultivated all over the world. India is the best country to produce excellent quality gerbera flowers under low cost protected structures. Due to its continuous feeding habit it shows many deficiency disorders in the green houses. Hence, the present investigation was carried out to know the influence of nutrient deficiencies on growth and nutrient content of gerbera cv.Savannah through solution culture. Plants were treated with complete modified Hoagland solution and deficiencies were manifested with a complete nutrient formula minus one of the nutrient. Plants treated with nitrogen deficiency solution showed significant reduction in growth in terms of plant height, leaf number, leaf area, root length and specific leaf weight followed by P, K, Ca, Fe, and Mg. Root length of phosphorous deficient plants and shoot/root ratio of iron deficient plants were increased. Visual deficiency symptoms were expressed except for manganese deficiency during the period of study (60 DAT).Leaf analysis at 60 DAT revealed that plant in deficientsolution, content of individual mineral element was significantly reduced. Some interactions between nutrients has resulted in increase of N content in K deficient treatment, P content in Zn deficient treatment, K, Ca and Mn content in Mg deficient treatment, Mg content in K deficient treatment, S content in N deficient treatment, B content in Ca deficient treatment, Fe content in Cu deficient treatment, Zn content in Fe deficient treatment and Cu content in Fe deficient treatment.

S3P112 A74

Effect of Organic Manures on Growth, Root yield and Quality of Beet root (*Beta vulgaris* l.) Cv.crimson globe in Alkali soils.

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The field experiment was carried out at the college farm, College of Horticulture Mojerla, during rabi season during 2015. The experiment was laid out in a randomized block design with three replication with 11 treatments viz., T1: FYM (100%), T2: Vermicompost (100%), T3: Neem cake (100%), T4: Poultry manure (100%), T5: Green manure (100%), T6: FYM (50%) + Vermicompost (50%), T7: FYM (50%) + Neem cake (50%), T8: FYM (50%) + Poultry manure (50%), T9: FYM (50%) + Green manure (50%), T10: RDF, T11: Control. The data were recorded on different qualitative and quantitative characters. Among the yield parameters the root length and harvest index were maximum with FYM (50%) + poultry manure (50%) where as root diameter was maximum with poultry manure (100%). The highest root: shoot ratio was recorded with FYM (50%) + poultry manure (50%) followed by vermicompost (100%).The results of the present investigation revealed that among different organic manures tried, application of poultry manure (100%) is reported higher plant growth, root yield, NPK uptake, maximum net returns where as application of FYM (50%) + neem cake (50%) recorded better quality of beetroot.

S3P113 A90

Performance of different spacing on growth, yield and quality of lima bean

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A field experiment was carried out at Department of Horticulture, Dr. PDKV, Akola during the year 2015-2016 to study the effect of plant spacing on growth, yield and quality of lima bean. The experiment was laid out in Randomized block design with seven treatments and three replications. It was observed that growth and yield parameters were significantly influenced by different plant spacing. Plant height was found to be maximum in closer plant spacing of 0.75 m × 0.75 m whereas leaves per plant, primary and secondary branches per plant and leaf area were found to be maximum in wider plant spacing of 1.5 m × 1.0 m. Yield contributing characters were found to be maximum in the plant spacing of 1.0 m ×0.75 m. Parameter in respect of quality, seed protein content was non-significantly affected by plant spacing. Considering the cost economics, plant spacing of 1.0 m x 0.75 m was found to be most remunerative as per the B:C ratio.

S3P114 A91

Vegetable-Soybean: An Emerging Horticultural Crop

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Vegetable-soybean is a unique type of soybean (*Glycine max* (L.) Merr.)belonging to the family leguminaceae, featured with larger size of seeds with pleasant aroma. Green pods are harvested at immature seed stage before podsturn to yellow. Vegetable-soybean preference is as a vegetable is increasing because of the green colour, soft texture,less bitter to taste with heavy flavour, used in culinaryas cooked or blanched.Vegetable-soybean is a rich source of ascorbic acid, beta-carotene and high protein content with low amount of anti-nutritional factorstrypsin inhibitors and phytates than soybean. Vegetable-soybean is evolving as novel vegetable in vegetarian diet as proteinaceous food, it has highest yield of protein than peas. Vegetable-soybean is a new budding underutilized vegetable crop, suitable to varied agro-climatic condition. In this context, there is need to explore the potential germplasm, breeding lines, genetic stock as vegetables types for the genetic improvement of vegetable-soybean quality traits.

S3P115A95

Studies on integrated nutrient management on growth and yield of pineapple under coconut based cropping system

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The experiment was conducted at AICRP on palm experimental blocks, Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during the years 2010-11 and 2011-12 to study the effect of integrated nutrient management on growth and yield of pineapple cv. Kew under coconut based cropping system. The experiment was laid out in randomized block design with three replications and seven treatments. Recommended dose of fertilizer was followed as NPK @ 600:200:600 kg ha^{-1},where three-fourth nitrogen was applied solely as urea and one-fourth substitution of nitrogen was done through different organic sources namely vermi compost, mustard cake, groundnut cake, neem cake and farm yard manure. The maximum plant height (115.4 cm), canopy spread (148.2 cm) and leaf number (56.7) were observed in N @ 600 kg ha^{-1} through application of ¾ N as urea and ¼ N as mustard

cake. Highest flowering percentage (71.1%), fruit weight (1.53 kg plant^{-1}) and fruit yield (53.08 t ha^{-1}) were also noticed in N @ 600 kg ha^{-1} through application of ¾ N as urea and ¼ N as mustard cake. Fruit qualitative parameters with maximum quantity were also recorded with the application of N @ 600 kg ha^{-1}; ¾ N as urea and ¼ N as vermi compost. Hence integrated nutrient management with N @ 600 kg ha^{-1}; ¾ N as urea and ¼ N as mustard cake in pineapple showed positive influence on growth, yield and quality parameters and may be considered as the best treatment combination when grown as intercrop under coconut based cropping system.

S3P116 A96

Role of growth regulators on yield and quality of winter guava cv.

Allahabad safeda

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An experiment was conducted at the department of Horticulture, Khalsa College, Amritsar(Punjab) during the year 2016-17 to study the role of foliar spray of NAA(50,75,100 ppm), 2,4-D (30,40,50ppm) and Urea(1%, 1.5% and 2%) on yield and quality of guava cv. Allahabad safeda. The design of experiment was Randomised block design (RBD) with factorial arrangement. The results of the study indicated that foliar spray of 50 ppm 2,4-D was the best for increasing yield(47.39Kg/tree). Various quality parameters namely total sugars(10.46%),reducing sugars(4.99 %), non-reducing sugars(5.47%) and TSS(11.05^{0}Brix) were also improved with the application of 50 ppm 2,4-D.Maximum fruit length at harvest (8.90 cm), fruit weight(203.0 g) were recorded under foliar application of 100 ppm NAA.

S3P117 A123

Phosphate solubilizing and mineralizing abilities of bacteria isolated from rhizospheric soils of walnut trees from Kashmir, India

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Phosphorus is the second important key element which plays an indispensable role in respiration, photosynthesis, energy storage, transfer and several other processes in living plants.Phosphorus is present in both organic and inorganic forms in soil but its availability is restricted as it occurs in insoluble form. Only 0.1% of the total P is available to plants because of its poor solubility and fixationin soil. In this regard phosphate-solubilizing bacteria (PSB)

have been seen as best eco-friendly means for P nutrition of crop. The study was aimed to isolate and characterize the selected phosphorus solubilizing bacteria from rhizospheric soils of walnut. The soil samples used for bacterial isolation were collected from Anantnag, Kashmir in sterilized polythene bags. Soil samples were prepared by inoculating 1.0 g of each soil into 100 ml of sterile distilled water. Homogenization of soil was carried out by keeping it on shaker for 1hour at 60 rpm. After 1hour, samples were removed aseptically, diluted and their dilutions were plated by drop plate method on to Pikoviskayas growth medium. The plates were incubated aerobically at 30ºC for 5 days and appearance of clear zone around the bacterial colonies was taken as indicator of phosphate solubilization. Colonies with distinct clear zones were re-streaked on Pikoviskayas medium for pure culture isolation. 10 isolates were assigned as PSB1, PSB2, PSB3,PSB4, PSB5, PSB6, PSB7, PSB8 PSB9 and PSB 10. Out of which, PSB3,PSB4,PSB6,PSB7,PSB10 showed higher zone of clearance. After an incubation of 2-5 days, individual colonies were characterized based on their morpho-cultural characters.

S3P118 A126

Hydroponics-a new trend in vegetable cultivation

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Hydroponics or soil less culture is an efficient technology for growing plants in nutrient solutions, with or without the use of an artificial medium to provide mechanical support. The main aim is to obtain maximum yield by supplying sufficient quantity of nutrients and optimum microclimatic conditions. It is mainly used for high value vegetable crops like cucumber, tomato, capsicum, lettuce, watermelon, muskmelon etc., in order to produce high quality vegetables. Main attraction of hydroponics is that, it does not demand any fertile soil for the production of crops. Most commonly used methods are -nutrient film technique and deep flow technique. In nutrient film technique, the plants are more benefited as there is a direct exposure of roots into the nutrient medium. Deep flow technique involves the circulation of the nutrient solution around roots and is ideal for leafy vegetables. The changing health concern of people also demands high quality food and this can be provided by hydroponics. It can be considered as a best alternative in areas where serious soil and water problems are there like soil borne pest and diseases, soil and water salinity, chemical residues in soil and water etc. The advantage of hydroponics is that, it plays a major role in industrial farming, no soil depletion, climate and soil independent.

S3P119 A127

Organic farming: A sustainable approach to manage Agro-Ecosystem

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Increased crop production largely relies on the type of fertilizers used to supplement essential nutrients for plants. Fertilizer application is required to replace crop land nutrients that have been consumed by previous plant growth with the ultimate goal of maximizing productivity and economic returns. Now a days, there is increased emphasis on the impact on soil environment due to continuous use of chemical fertilizers. The impact of chemical fertilizer application on agricultural land is seen not only in terms of the soil quality but also on the survival of soil organisms dwelling there in. Organic farming system in India is not new and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes and other biological materials along with beneficial microbes to release nutrients to crops for increased sustainable production in an eco friendly pollution free environment.

S3P120 A139

Floating island: ensuring sustainability of agriculture and wetland ecosystem

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Wetland ecosystems are among the world's most productive environments; cradles of biological diversity that provide the water and productivity upon which countless species of plants and animals depend on survival. Kanjli is one of the wetland in Punjab that was considered significantly important and thus included under Ramsar convention. Kanjli wetland, situated at 31°25'N, 075°22'E covering 183ha area was added in the Ramsar list on 22nd January 2002 as site number 1160 criteria 3 with the support of WWF's living waters program. The wetland site is degrading at geometric progression rate due to accidental outflows of pollutants from industries, inflow of fertilizers as runoff from agricultural fields and sewage from towns. Invasion and growth of weeds in the wetland area is also a cause of concern. The removal of metals, such as copper and zinc from wetland has been identified as a priority. The

study primarily aims at sustainable utilization of lake resources and public participation for sensitizing opinion of locals about the importance of wetlands through wetland agriculture. The present study effectively attempts to address livelihood issues linked with wetlands and include innovative action programs for creation and implementation of floating islands involving community as a whole. This study examines the potential of developing and applying a novel "floating Island" concept for the provision of enhanced lake water treatment, particularly with regards to copper, zinc and fine particulate removal to ensure ecosystem sustainability and agriculture as well.

S3P121 A183

Effect of different levels of fly ash and vermicompost ongrowth and yield of lemongrass (*Cymbopogon flexuosus* Nees)

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An investigation was undertaken to study the effect of different levels of fly ash and vermicompost on growth and yield of lemongrass (*Cymbopogon flexuosus* nees) during 2014-2015 at Central Institute of Medicinal and Aromatic Plants (CIMAP), Boduppal, Hyderabad. The experiment was carried out in Randomized Block Design with three replications.The data was recorded on plant height (cm), number of tillers, number of leaves, leaf area (cm^2), herb yield (t/ha), essential oil content (%) and essential oil composition (%). The results revealed that T_7 (FA 6 t/ha + VC 4t /ha) recorded significantly maximum plant height (154.6 cmand 123.7 cm), number of tillers (42 and 54), number of leaves (142 and 182), leaf area (207.4 cm^2 and 159.4cm^2), dry matter (31.5 % and 27.8 %), herb yield (17.8t/ha and 13.7 t/ha) at 90 and 180 days, respectively. Non-significant differences were observed for essential oil content and composition. Hence, the experiment demonstrated that the treatment T_7 with fly ash 6 t/ha and vermicompost 4 t/ha may be considered as the best treatment for obtaining higher plant growth, herb yield and oil content of lemongrass.

S3P122 A207

Precision farming in grape - a review

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Precision horticulture is a farming system is an integrated information, technology and management of crop production which is site specific and based on increasing productivity and profitability and minimizing impacts on the environment. This technology is recently now used in Viticulture. Main objective of precision viticulture is to increase wine production of grape by improving the size and vigour of grapes. This technology in precision viticulture is divided

in two sections, the first sectiongeolocatingand remote and proximal sensing and the second section on variable-rate technologies(VRT).It had been reviewed that GPS (Global Positioning System) technologyrequired precision in crop mapping, soil sampling, anddistribution of fertilizers at different rates.Remote sensing techniques can beusedin thedescription of grapevine canopy, grape size, and vigour. It allows evaluation of the variability present in grapevine.Also satellite and aircraft become best tools for producing maps for variable fertilizer-rate applications. Wireless sensor network technology(WSN) provides real-time monitoring of important variables in grape production and providethe required information to the users. The new grapesensesensor technology captures pictures of the canopy,collect information of the height along the row.The VRT technology provides an information of use of agronomic inputs, which impact on costs, quality, and environment. This technologyreduces the cost in crop production, by improving crop quality and yield, process traceability and environmental sustainability.

S3P123 A208

Approaches to reduce juvenility in fruit crops

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The length of the juvenile phase for tree fruit crops extend from at least three years (peach) to 15 or more years (Avocado). In woody perennials unlike fruit trees, the length of the juvenile period is influenced by environment and is inversely correlated with vigor as reported in apple and pear. Accordingly, environmental conditions that reduce vigorous growth, such as mineral deficiency, low light, water stress, defoliation or cold stress, tend to delay the transition from the juvenile to adult phase, whereas the conditions that allow for vigorous growth can shorten the period of juvenility. Various approaches like cultural methods (grafting, use of dwarfing rootstock, bending, soil solarization), chemical method (plant growth regulators, use of chemicals) and biotechnological manipulation of endogenous, genetic flowering pathways using genetic transformation methods (*Agrobacterium*-mediated) were employed to shorten the juvenility in fruit crops. In deciduous fruit trees, the effective antisense expression of *MdTFL1* induces precocious flowering of apple and also *MdTFL1* plays a key role in the regulation of juvenility, flower induction and flower development in apple. The reduction of the generation time by the use of this transgenic approach to supress endogenous *TFL1* like genes may be applicable to many other woody plants that have a long juvenile phase. More recently, *LFY* and *AP1* have been ectopically expressed in citrus which drastically reduce the juvenile phase. In grapes, the effect of cytokinin and chlormequat on the precocious formation of inflorescence

primodia in the latent buds of 3-month-old seedlings has been observed. As the long juvenility period in fruit crops has become barrier to both producer and breeder to evolve new improved varieties with having high quality and superior yield. Hence, future research emphasis should be on developing methods for accurately identifying the end of the juvenile phase and to accelerate development of seedlings in the juvenile phase by inducing flowers on seedlings aftercompletion of juvenile phase.

S3P124 A219

Influence of soil physico-chemical properties on zinc fractions distribution of areca plantations in Karnataka

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A soil survey was conducted in three talluks (Davangere, Channagiri and Honnali) of areca growing tracts of Karnatakato asses status of DTPA-Zn, its different fractions and its relationship with other properties of soil. Soil analysis for physical and chemical properties revealed that these soils belongs to sandy loam to sandy clay loam texturewith neutral to alkaline pH, having low EC with low to medium organic matter (0.45 – 2.49 %) content and cation exchange capacity ranged from 8.72 – 22.08 Cmol (p+) kg^{-1}. The DTPA-Zn content was sufficient and varies from 0.22 to 3.36 mg kg^{-1}. Zinc fractions like WS-Zn, SORB-Zn, ERMn-Zn, CA-Zn, OM-Zn and Fe&AlOX-Zn were varied from0.06-1.51, 0.32- 13.72, 0.95-7.51, 0.09-7.30, 0.03-1.48 and 1.75 – 8.15 mg g^{-1}. The relation of DTPA-Zn with pH, organic matter, and cation exchange capacity was significantly positive. Among the zinc fractions significantly positive correlation was noticedbetween ERMn-Zn and Fe&AlOX-Zn with pH, SORB-Zn, Fe&AlOX-Zn and OM-Zn with organic matter and ERMn-Zn and Fe&AlOX-Zn fractions with DTPA-Zn.

S3P125A224

Role of novel plant growth regulators in fruit crops

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Plant hormones are small molecules derived from various essential metabolic pathways, which are present at very low concentrations and act either locally, or near the site of synthesis, or in distant tissues. Plant hormones include the new generation PGRs like brassinosteroids (BRs),jasmonic acid (JA) and salicylic acidin addition to the classical hormones like auxins, cytokinin (CK), gibberellic acid (GA), abscisic acid (ABA) and ethylene.There are also several

groups of new growth regulating compounds, such as non-classical PGRs: strigolactones, oligosaccharides, glycoproteins, polyamines, melatonin and hormone metabolites, modified auxins like azido-auxins, modified cytokinins like thidiazuron, CPPU(ChloroPyridyl Phenyl Urea). New types of PGRs like Prohexadione- Ca, Paclobutrazol, AVG(Aminoethoxy vinyl glycine), 1-MCP (1-Methylcyclopropene), α-aminoisobutyric acid also have the advantages obtained by the action of positive physiological effects on the plants. The new generation fungicidesbelonging to strobilurins (trifloxystrobin, azoxystrobin, etc.), triazoles (propiconazole, epoxiconazole, tebuconazole, penconazole, etc.), have been found to have phytotonic effects in many crops.Foliar application of bioregulators and chemicals may improve the physiological efficiency and play a significant role in raising the productivity of the fruit crops and also has defense mechanism against stress conditions.Thus, the application of new generation plant growth regulators and chemicals may improve the physiological efficiency of the crop growth and development mainly on delaying senescence, ethylene regulation, chlorophyll retention, pest and disease resistance, postharvest shelf life and quality in fruit crops.

S3P126 A287

Effect of Apical Pinching and Pgr On Growth of Okra (*Abelmoschus Esculentus* L. Moench.)

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The present investigation entitled "Studies on apical pinching plant growth regulators on growth and seed production in okra (*Abelmoschus esculentus* L. *Moench*.) cv.Parbhani Kranti**"** was conducted at the field of Vegetable Research Scheme (VRS), VNMKV, Parbhani, during *kharif* season of 2015. Climatic conditions during the period of experimentation were favourable. The experiment was laid out in Factorial Randomized Block Design (FRBD) and with three replications. The experiment consisted of Factors A - apical pinching treatment number AP_1-20, AP_2- 30 DAS, AP_3- No pinching andFactors B - Plant Growth Regulators P_1 (NAA-1000 ppm), P_2 (NAA-200 ppm) P_3 (N-Triacontanol 1ml / lit), P_4 (N-Triacontanol 2ml / lit) P_5 (Brassinosteroids 1 ml / lit), P_6 (Brassinosteroids 2 ml / lit), P_7 (Cycocel 100 ppm), P_8 (Cycocel 200 ppm), P_9 Control (No application of PGR) treatments. Okra seeds were sown on 20 August-2015 keeping row to row spacing 45 cm and plant to plant 30 cm. Result of present investigation revealed that, in general, apical pinching plant growth regulators were effective increase yield of okra.Among 20,30, days after sowing apical pinching which reducing the height and increase number of branches, number of leaves, leaf area, number of node on main stem, length of pod, width of pod, seed yield per plant, seed yield per plot and 1000 seed weight of plant.To application of different concentration plant growth regulators tried, N-Triacontanol 2 ml / lit of treatment superior result in respect of plant height, number of node on main stem, 50 per cent flowering, number of flowers per plant. However, Cycocel-200 ppm exhibited more

number of leaves and number of branches per plant, less number of days required first flower initiation, 50 per cent flowering.

S3P127 A292

Precision Agriculture - A Way to Input Use Efficiency for Crop Productivity

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Agriculture production system is an outcome of complex interactions of seed, soil, water and agro chemicals. Therefore, judicious management of all inputs is essential for the sustainability of such a complex system. Precision agriculture (PA), as the name implies, refers to the application of precise and correct amounts of inputs like water, fertilizers, pesticides etc. at the correct time to the crop for increasing its productivity and maximizing its yields. I feel the wealth and security of the country comes from its land and hence what is needed is sustainable, high-tech and high-productivity agriculture which will be remunerative and help provide both food and energy security for the country. India is characterized by small farms. More than 80% of total land holdings in the country are less than 2 ha (5 acres). Most crops are rain fed, with only about 45% of the land irrigated. According to some estimates, around 55% of total population of India depends on farming. Also without mechanization farming is hard, back-breaking work. This has resulted in most farmers' children choosing other vocations. Also farmers get more money in selling their land to builders, malls and factories than they would from farming. This has made it even more imperative to increase productivity so that the shrinking farmlands can feed the billion plus people of India in the future. India, though one of the biggest producers of agricultural products, has very low farm productivity.Productivity needs to be increased so that farmers can get more remuneration from the same piece of land with less labour. Precision agriculture may provide a way to do it. Precision agriculture merges the new technologies borne of the information age with a mature agriculture industry. It is an integrated crop management system that attempts to match the kind and amount of inputs with the actual crop needs for small area within a farm field. The new technologies now available allow the concept of precision agriculture to be realized in a practical production system. The potential of precision farming for economic and environmental benefits could be visualized through reduced use of water, fertilizers, herbicides, pesticides besides the farm equipment. A precision farming approach recognizes the site-specific differences within the fields and adjusts management actions accordingly.

S3P128 A334

Mapping of major nutrients in traditional and non-traditional areca nut gardens through GIS technique and site-specific nutrient recommendations

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Spatial distribution of nitrogen, phosphorus and potassium was studied in 232 acres of an areca nut garden representing different eco-systems, *viz*., traditional, tank-fed, borewell-fed and canal-irrigated gardens in Shivamogga, Chickamagaluru and Davanagere districts of Karnataka. Geo-referenced soil samples were collected from a depth of 30cm in each grid of size 50x50 m. Status of each of the nutrients under each location has been mapped and data analyzed on major nutrients in the GIS environment. Traditional belts are acidic, while the others are basic in soil reaction. In all these gardens, nitrogen was found to be low. Larger variations were seen in phosphorus and potassium status of the soils. Over 60% samples accounted for medium-status of phosphorus in the traditional, tank-fed and borewell-fed soils, while, canal-irrigated belts accounted for more than 60%t medium-to-high phosphorus status. Humcha, Konandur and Chikkingala soils had over 60% low-potassium status, while, soils in the other locations showed more than 70% medium-to-high status. Using variable values for nutrients in each grid, site-specific recommendations (based on soil test values - STV) were worked out. The standard package of recommendation and the site-specific recommendation based on STV approach were compared. It was concluded from the above results that areca nut garden soils across locations need to be supplied with a slightly higher level of nitrogen, lesser potassium, and no perceptible change in application of phosphorus.

S3P129 A359

Efficient plot size for oil palm (*Elaeis guineensis* Jacq.) field experiments

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Oil palm is a perennial oil yielding crop mainly grown under humid tropical conditions. It tops among all oil producing crops with a very high oil yielding potential of 4-6 tons per hectare in India at present. This being a heavy feeder requires very high quantities of nutrients and water throughout its life cycle. For standardization of water and nutrient requirements of oil palm field experimentation is essential. In order to get accurate results from the field experimentation optimal plot size is very important. No much work has been done on these lines to find out the optimum size of the plot for field experimentation in oil palm. In the present study, two statistical methods were employed and compared to find out the optimal plot size for conducting field experiments in oil palm under Indian conditions using 6 year yield data from

ICAR-Indian Institute of Oil palm Research. Oil palm yield is measured in FFBs (fresh fruit bunches) and the FFB number and yield data of individual palms was collected from 10 different cross combinations having three replications and 270 palms. Two statistical procedures were employed on these data viz., Mean Square Error (MSE) and Maximum curvature method. The results indicated that both the methods were effective in identifying the optimum plot size for oil palm field experiments. From both these methods, 7 palms per plot were found to be the optimum size in oil palm for field experiments. If secondary data is available for any other tree crops, one of these two methods can be employed for finding out the efficient plot size.

S3P130 A381

Role of PGRs on post shooting foliar spray to increase the productivity and profitability of banana (*Musa paradisiaca* L.) cv. Grand Naine

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An experiment entitled "Role of PGRs on post shooting foliar spray to increase the productivity and profitability of banana (*Musa paradisiaca* L.) cv. Grand Naine" was conducted at Regional Horticultural Research Station, Navsari Agricultural University, Navsari (Gujarat) during the year 2015-2016. The experiment was laid out in Randomized Block Design (RBD) with twelve treatments and three replications. The treatments included GA_3 @ 50 mg l^{-1} (T_1), GA_3 @ 100 mg l^{-1} (T_2), NAA @ 50 mg l^{-1} (T_3), NAA @ 100 mg l^{-1} (T_4), Ethephon @ 0.1 mg l^{-1} (T_5), Ethephon @ 0.2 mg l^{-1} (T_6), CPPU @ 1 mg l^{-1} (T_7), CPPU @ 2 mg l^{-1} (T_8), Brassinosteroid @ 1 mg l^{-1} (T_9), Brassinosteroid @ 2 mg l^{-1} (T_{10}), SOP @ 1.5% (T_{11}) and Control (T_{12}). The first spray was given immediately after complete opening of the bunch and second spray was given at 20 days after first spray.The results of present investigation revealed that the banana bunches when sprayed with Ethephon @ 2 ml l^{-1} shortened the maturity period of cv. Grand Naine banana. Whereas, bunches sprayed with Brassinosteroid @ 2 mg l^{-1} found effective in higher bunch size (length and girth), finger size (length and girth), finger weight, weight of third hand, bunch weight and fruit yield.The minimum physiological loss in weight and maximum shelf life and pulp: peel ratio of banana fruit was observed when bunches were sprayed with CPPU @ 2 mg l^{-1}.From the economic point of view the highest net return was obtained in the bunches sprayed with Brassinosteroid @ 2 mg l^{-1} while the maximum BCR was noted in the bunches sprayed with GA_3 @ 100 mg l^{-1}.

S3P131 A389

Pruning in guava (*psidium guajava* l.) And appraisal ofConsequent flowering phenology using modified bbchScale: source-sink relationships

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The guava (*Psidium guajava* L.) is an evergreen fruit species well adapted to a wide range of soils and agro climates and is acclaimed as 'Super fruit' owing to its high nutritional profile. Tree management strategy to increase shoots numbers (fruiting units) and induces profuse flowering for crop manipulation is very important for profitable guava cultivation. Under the changing climatic scenario and adoption of hi-tech horticultural practices, there is an urgent need to modify BBCH scale vis a vis phenophases under location specific climatic, soil and pruning conditions. The characterization of phenological stages is essential to achieve high fruit quality, since management practices like pruning, application of fertilizers, thinning, other management practices, harvesting time etc. depend upon the recognition of certain critical phenological stages affecting productivity. Therefore, this study was carried out with the objective to describe the modified phonological growth stages of guava in terms of temporal arrangement based on BBCH scale resulting from pruning operations at Division of Horticulture, Hisar during 2014-15 and 2015-16. The guava cv. 'Lalit' having pink pulp and prolific bearing habit that has found favour with the orchardists especially in HDP systems in Maharashtra was selected for the collection of phenological data, analysed and interpretation in appraising the suitability of BBCH scale in order to describe phonological patterns under pruning's along with changing weather parameters. The duration of flowering ranged 78 to 93 days from the opening of the flower and took 150 and 153 days for the fruit maturity in the pruning's carried out during February and September as compared to unpruned control (129-146 days). The 50 per cent flowering was hastened and occurred in 43 days and took 136 days for fruit maturity in May pruning trees. This may be because of May pruning produced the fruits during November to January and the prevailing low temperatures delayed the process of fruit maturity at the same time increasing the fruit size with better quality with higher yields arising from efficient and prolonged sink activity under low temperatures. This clearly indicated the effect of pruning though delayed the emergence of buds but hastened the post-flowering phenophases due to increased source and reduced sink because of thinning, tip pinching operations, and efficient translocation of photosynthates in the pruned shoots to the potential sinks (fruitlets). The impact of weather parameters impacting degree days in relation to modified BBCH scale was also estimated for better understanding of flowering phenology in this study.

S3P132 A391

Studies on effect of photosynthetically active radiation (PAR) from LEDs on growth and flowering attributesof *Chrysanthemummorifolium*cv. Zembla

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An investigation wascarried out to study the effect of photosynthetically active radiation (PAR) from LEDs on growth and flowering attributes of chrysanthemum cv. Zembla. The experiment was conducted during February to May, 2015 in a growth chamber in field laboratory of CPCT, IARI at New Delhi. Chrysanthemum cv. Zembla under different photoperiodic treatments of day length extension illuminating from photosynthetically active radiation from LEDs for 6, 9, 12, 15 days @ 15h/day under growth chamber. Light intensity was fixed by making two different LEDs panels (white and 80% red +20% blue) to achieve an interception of light @ 110-120 µmol $m^{-2}sec^{-1}$ from 80% red 20% blue PAR distributed over the plants in uniformity inside the growth chamber. LEDs light exposure was given for 15 hours as log day (LD) treatment except for control. The results obtained from the investigated showed that increase in photoperiod by 15 days using long days from LEDs there weresignificant increased in plant height (43.05 cm), inter-nodal length (2.60 mm), number of leaves (24.50) and leaf area (224.83cm^2) cv. Zembla. Days to flower bud induction and Time taken for flower opening varied significantly among the treated plants with long day, 15 days exposure through LEDs revealed that days to flower bud induction and flower opening took maximum time (54 days and 65.75 days, respectively) compared to control (61.25 days and 70.75 days). Early flowering response was noticed which was advanced by 5 days as compared with control. Bud and flower diameter (5.78 mm and 80.74 mm, respectively) were maximum. However, plants exposed under PAR (80% red +20% blue) from LEDs at 15 days also significantlyincreased plant growth characters and might resulted in long day effect without disturbing the required minimum dark period for flower induction.

S3P134 A435

Effect of organic manures and inorganic fertilizers on growth and yield in *tinda*, round gourd (*Praecitrullus fistulosus*)

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A field experiment was conducted to study the effect of organic manure and inorganic fertilizers on growth and yield in round gourd,*tinda*. Thirteen treatments comprised organic manures, viz., FYM (25t ha^{-1}), Vermicompost (2.5t ha^{-1}), *Neem*cake (1000kg ha^{-1}), *Azospirillum*, and *Phosphobacteria* (2kg ha^{-1}), along with the recommended dose of inorganic fertilizers, @50:20:20kg NPK ha^{-1}. The experiment was laid out in Randomized Block Design, with three replications. The study revealed that 75% NPK with vermicompost @2.5t ha^{-1},combined with Azospirillum and Phosphobacteria@2 kg ha^{-1} recorded the highest vine length (207.22cm), number of laterals (18.96), leaf area (110.86cm^2), number of fruits (14.41), single-fruit weight (50.68g) and yield per plant (722.69g).

S3P135 A443

Yield and yield parameters as influenced by various sources of water-soluble fertilizers in a hybrid of chilli (*Capsicum annuum*L.)

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An investigation was made to study theeffect of water-soluble fertilizers on yield parameters in a hybrid of chilli (*Capsicum annuum* L.) during2015-2016 at Pudhukuraipettai Village in VirudhachalamTaluk of Cuddalore District.Foliar-feeding of water-soluble fertilizers (WSF), NPK,@ 19:19:19, 18:18:18 or 13:40:13 wasdone at 0.5% and 1.0% concentration. Five sprays each were given starting 30 DAT at 15-day intervals, along with 100 and 75 per cent recommended dose of NPK(120:80:80 kg ha^{-1}) constituting thirteen treatments, in the chilli hybrid. Experimental plots were laid out in Randomized Block Design, and replicated thrice. Results showed that100% RDF + WSF 1.0% NPK @ 13:40:13 recorded highest number of fruits per plant, fruit length, fruit girth, fruit weight, yield per plant and yield per hectare.

S3P136 A487

Effect of plant growth retardants on growth, yield and carotenoid content in african marigold

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African marigold (*Tagetes erecta* L. Family: Asteraceae) is one of the most popular and commercial annual flower crop grown throughout different states of India. Excessive vegetative growth, tall and lanky nature of plants leads to poor flowering habit resulting in lower yield. Hence, the present study was carried out to study the effect of plant growth retardants such as Alar and Cycocel on growth and yield of two varieties of African marigold. An experiment was conducted at Department of Pomology and Floriculture, College of Agriculture, Padannakkad during monsoon (May) 2016 and pre-monsoon (January) 2017. The experiment was laid out in split plot design with 2 main plots –varieties (V_1, V_2) and 7 subplots-growth retardant chemical treatments (C_1,C_2, C_3, C_4, C_5, C_6, C_7). During both the seasons, variety Maxima Yellow F_1 performed well in terms of yield and quality parameters. Among the varieties V_2 (Maxima Yellow F_1) showed minimum plant height (77.70 cm, 42.12 cm), mean flower weight (12.99 g, 8.09 g), maximum number of flowers per plan t(46.50, 34.44) during both season and V_1(Pusa Narangi Gainda) showed maximum carotenoid content (4.8E-05 mg g^{-1}) in flowers during the second season and were significantly different. Among the different chemical treatments, characters such as plant height, number of flowers per plant, total yield per plant and carotenoid content showed significant difference Minimum plant height was observed in C_5-Cycocel 1500 ppm (82.97 cm) followed by C_6-Cycocel 2000 ppm (83.90 cm) and C_2-Alar 1000 ppm (84.80 cm) during first season and C_3-Alar 1500 ppm (50.47 cm) followed by C_2-Alar 1000 ppm (52.10.cm) and C_4-Cycocel 1000 ppm (52.50.cm) during second season. Maximum number of flowers per plant was observed in C_4-Cycocel 1000 ppm (46.86) during first season and C_6Cycocel 2000 ppm (26.78) during second season. Carotenoid content in flower petals has shown significant variability within treatments and was found maximum in C_3-Cycocel 1000 ppm (8.9E-05 mg g^{-1}) treatment during both seasons.

S3P137 A488

Physical and chemical attributes of new introduced apple varieties in high density plantation system under Kashmir conditions

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Jammu and Kashmir State being endowed with natural advantages of topography and climate with enormous diversity of agro-climatic conditions has immense scope for horticultural development. Among the temperate fruits, apple ranks first covering 43.30 per cent area and 80.18 per cent production. Yield of apple has shown an increase from 4.12 to 10.00 MT/ha (1975-2016). Though it appears to be highest among the apple producing states in the country, yet it is far below the level achieved by advanced countries where productivity is of 50-60 MT/ha. So to solve the problems of low productivity, poor quality, less colour and irregular bearing habits in current apple plantations in Kashmir valley, four apple varieties namely Super Chief Sandidge, Gala Red Lum, Fuji Zehn Aztec and Golden Clone B were imported from Italy on M9T337 rootstock and planted in spring 2013 at a distance of 1.5× 3m on four wire trellis system (2222trees/ha). The varieties were studied for their various quality attributes viz. fruit size, fruit weight, TSS acidity etc. Results show that wide variation existed in the studied cultivars. The fruits of variety Fuji Zehn Aztec showed a flat shape with L/D ratio of 0.77, while the fruits of Golden Clone B were round in shape with L/D ratio of 0.90. The maximum fruit weight (193.99 g) and TSS (14.12 ^{o}Brix) was observed in variety Super Chief Sandidge while the minimum fruit weight was observed in Fuji Zehn Aztec (157.62g) and lowest TSS in Golden Clone B (11.37^{o}Brix). The highest titrable acidity (0.38%) was noticed in Golden Clone B and lowest in Super Chief Sandidge (0.20%).

S3P138A524

Response of Nagpur Mandarin to Potassium Fertilization

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The potassium requirement of citrus is high as its uptake is more than any other nutrient element. High rate of K is needed to achieve not only highest total fruit production, but also the greatest percentage of fruit suitable for marketing. A high-unbalanced N:K ratio is associated with poor fruit set and poor carrying quality. An investigation was conducted during 2014-15 and 2015-16 to study the effect of different levels and sources of potassium (MOP and SOP) on growth and yield of Nagpur mandarin. The experiment was laid out in Randomized Block design with seven different treatments of sulphate of potash and murate of potash which

were replicated thrice. The response of plant growth in term of plant height, plant spread and canopy volume to the potassium fertilization did not influence significantly. The fruit yield was influenced significantly due to different potassium fertilization treatments. The highest number of fruits harvested per plant (958.56 fruit plant^{-1}) with application of 800 g plant^{-1} K_2O through MOP. The maximum fruit yield per plant and per ha (149.97 kg plant^{-1} 41.54 tons ha^{-1} respectively) was recorded in same treatment. Similarly, leaf and soil nutrient status was influenced significantly by different treatments.Considering the findings of three years of investigation it can be concluded that, though fruit yield and leaf nutrient status was influenced significantly due potassium fertilization, there was no significant variation observed among different sources of potassium. Potassium @ 800 g plant^{-1} through Murate of potash gave the highest fruit yield and monitory profit (2.70 B: C ratio).

S3P139 A548

Performance of tomato (*Solanum lycopersicum* L.) hybrids under modified naturally ventilated polyhouse in North Western Himalayan region

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Polyhouse cultivation of vegetables has only recently begun to be used in India. Among the fourteen hybrids of tomato grown under polyhouse condition for evaluation during the spring-summer season, maximum fruit yield was recorded in 15-2 × Palam Pride followed by 1-2 × 16-B and minimum in Heem Sona. Highest average fruit yield was recorded in NS 241 whereas lowest average fruit weight was recorded in Tolstoi. Maximum plant height was observed in 7711 followed by 7ST-275, Rakshita and 15-2 × Palam Pride. 15-2 × Palam Pride flowered earliest, while Rakshita flowered most late. Hybrid 1-2 × 16-B was earliest to first harvest. Maximum fruit shape index was recorded in RBW-123, RBW-133 and Heem Sona whereas minimum fruit shape index was recorded in BWR-5 × Hawaii-7998. Hybrid 7ST-275 recorded highest pericarp thickness as well as maximum number of nodes. Maximum internodal length was recorded in 7711 whereas minimum was recorded in RK-123. Plant survival was highest in 15-2 × Palam Pride, 1-2 × 16-B and BWR-5 × Hawaii-7998. 15-2 ×Palam Pride recorded maximum number of flower cluster per plant and maximum number of locules per fruit was recorded in BWR-5 × Hawaii-7998. Heem Sona recorded the maximum TSS content, Rakshita recorded maximum acidity and ascorbic acid. Overall performance of 15-2 × Palam Pride and 1-2 × 16-B was judged best for polyhouse commercial production under local conditions.

S3P140 A628

Effect of organic amendments on different chemical properties of soils in vegetable growing area of Solan (Himachal Pradesh)

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A laboratory incubation experimentwas conducted in the Department of Soil Science and Water Management, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (H. P.) during 2014. Eight types of soil samples were collected from vegetable growing area of Solan district on the basis of soil texture from the depth of 0-15 cm and treated with three organic amendments (Farm yard manure, vermicompost and city waste compost) and one control. The experiment was laid out in completely randomized design (factorial) with three replications. The study was undertaken to investigate the effect of organic amendments on differentwater-soluble ions, humus fractions and cation exchange capacity. Soil sampling was done from each treatment at an interval of 30, 60, 90 and 120 days of incubation for determination of these parameters. Among humus fractions humic acid content was more than fulvic acid. Humic acid and fulvic acid were increased with time, whereas humin decreased with the passage of time. Water soluble Ca and sulphate were significantly influenced with the use of organic amendments whereas water soluble Mg, K, Na, chloride, carbonate and bicarbonate were not affected significantly. Cation exchange capacity was also influenced significantly on addition of amendments.Farm yard manure and vermicompost improved soil properties more effectively compared to city waste compost. The increase was more pronounced during first two months.

S3P141 A701

Perspectives on Precision Horticulture Technologies and Difficulties

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Precision farming is a data-based management system and a science whereby growers can use technology to fine-tune crop production practices. It involves the application of technologies and principles to manage spatial and temporal variability associated with all the aspects of agricultural production for improving crop performance and environmental qualities. It helps growers to determine exactly when and what to plant and what kind of inputs to use, how to control the environment, lighting, irrigation and nutrition for optimum yield and monitor how crops are growing by greenhouse bay, zone and bench. Precision horticultural technologies, such as Global Positioning Systems (GPS), Geographic Information Systems

(GIS), Remote Sensing, Variable Rate Technology (VRT)**,** Yield Monitors, Yield Mapping and Guidance Systems for variable rate application, made it possible to manage within-field variation on large scales at different levels in the supply chain. This is applied for water management, surface covered cultivation, controlled environment structure, organic farming, precise space utilization, micro propagation / tissue culture, IPM/INM. Results of the study show that many opportunities are there and along with that a lots of challenges are also prevailing for adoption of precision horticultural techniques around the world like small farm size, lack of success stories, lack of local technical expertise, knowledge and technical gap, high cost of obtaining site specific data.Precision practices may be different from one place to another place, depending upon the creative mindset of farmers, practitioners, scientists and consultants local to the area of interest. But, in the overall perspective, with the introduction and adoption of modern technologies, horticulture sector is expected to achieve a vertical growth and will be a better tool of tomorrow for the present farmers.

S3P142A713

Effect of GA_3 on Growth, Flowering and Yield of Different Varieties of Chrysanthemum

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A field experiment was conducted at College of Agriculture, Nagpur (M.S.) during *kharif* season of the year 2012-2013 to study the effect of GA_3 spray at 30^{th} and 60^{th} day after planting on growth, flowering and yield of four chrysanthemum varieties *viz.* Sonali Tara, Shubhra, PandhriRewadi, Piwadi Rewadi. The result revealed that, vegetative growth of plant in respect plant height, number of branches plant^{-1}, and spread of plant. Plant height was recorded to be maximum in variety Piwadi Rewadi.Number of branches and spread of plant were recorded to be maximum in variety shubhra. Flowering parameters like days required to first flower bud initiation, days to fully opened flower, days to 50 percent flowering and days require first harvesting were recorded in variety Shubhra. However, yield parameters number of flowers plant^{-1} were found to be maximum in variety Shubhra and flower yield plant^{-1} (g), flower yield plot^{-1}(kg)and yield of flower ha^{-1} (t) were recorded maximum in variety Piwadi Rewadi. Plant growth, flowering and flower yield were recorded to be highest in treatment 150 ppm GA_3.

S3P143 A206

Effect of boron and zinc application on fruit set and yield of 'red delicious' apple cultivar

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The aim of this study was to examine the effectof boron and zinc application of 15 years old 'Red Delicious' apple trees on fruit set and yield. This investigation was carried out during the period 2014-2015 at the experimental farm of UUHF Bharsar, Uttarakhand. Boron application to soil at the rate of 20g tree^{-1}as boric acid before bud break stage. Moreover, the boric acid 0.2 per cent in combination with zinc sulphate 0.1 per cent applied through foliar spray at pink bud stage.The results revealed that the boron application to soil at the rate of 20g tree^{-1} with foliar spray of boric acid 0.2 percent in combination with zinc sulphate 0.1 per cent significantly increased the pollen germination (69.08 %), fruit set (41.62 %), yield (72.89 Kg tree^{-1}) and with minimum fruit drop (48.78 %). From current investigation, it is screened out that the application of zinc sulphate and boric acid as foliar spray in combination with basal dose of boric acid gave beneficial response as compared to single application under high hills of Uttarakhand.

S3P144 A475

Effect of Preharvest Application of Growth Regulators on Yield and Yield Attributes of Grape cv. Red Globe (*Vitis vinifera* L.)

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Grape (*Vitis vinifera L.*) is one of the important fruit crops cultivated in India for its appeal, taste and nutritional values. Productivity of grapes is highly influenced by genotype, climate and horticultural practices viz., training, pruning and application of plant growth regulators during berry development. The present study was taken up by preharvest application of growth regulators *viz.*, GA_3 (10 and 20 ppm), CPPU (4 ppm) and Brassinosteroid (2 ppm) on grape cv. Red Globe to find out their influence on yield and yield attributes during summer cropping and winter cropping by directed spray of growth regulators on bunches either alone or in combinations. The growth regulators were applied as single spray when berry diameter was 3-4 mm or 8-10 mm or two sprays; first spray @ 3-4 mm and second spray @ 8-10 mm. The field experiment was laid out in Factorial Randomized Block Design (FRBD) with two factors *i.e.* growth regulators (nine levels) as one factor and stage of application (three levels) as second factor thus comprising a total of 27 treatment combinations and replicated twice. Application of growth regulators generally improved the yield and yield attributes in grape cv. Red Globe. The combination of GA_3 at 20 ppm and CPPU at 4

ppm recorded higher bunch length in both winter and summer cropping season (28.26 cm and 23.66 cm respectively). Bunch spraying of 20 ppm GA_3 at berry diameter stage of 8-10 mm resulted in the highest bunch weight (783.04 g), yield per vine (17.23 kg) and yield per hectare (21.53 t) in the winter cropping season. In summer season crop, bunch spray with GA_3 at 20 ppm + Brassinosteroid at 2 ppm at berry diameter stage of 8-10 mm stage recorded the highest bunch weight (978.50 g), yield per vine (16.63 kg) and yield per hectare (20.79 t).

S3P145 A476

Effect of Integrated Nutrient Management on Yield and Yield Attributes of Grape cv. Red Globe (*Vitis vinifera* L.)

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Grape is one of the most important commercial fruit crops in India and it serve as a good source of minerals and vitamins. Grape cultivation in Tamil Nadu is distinctly different from other regions, as it is pruned twice a year to obtain two crops per year. In grapevines, nitrogen plays a key role in vegetative growth, phosphorus in fruit bud differentiation and root growth and potassium for cane maturity, crop quality and shelf-life of bunches and also, the proportion of requirement of N, Pand K are different at different stages of vine growth. Use of inorganic fertilizers alone as a source of nutrients destroys the soil health in the long run and at the same time, it is not economical to meet the nutrient requirements of the vines through organic sources alone. Combining organic manures and inorganic fertilizers has generally been more effective in producing a positive plant response than separate application of each. The field experiment was taken up to find out the influence of combined application of organic manures and inorganic fertilizers at different levels on yield and yield attributes of grape cv. Red Globe during summer season cropping (January – May 2016) and winter season cropping (August to December 2016). The field experiment was laid out in Randomized Block Design (RBD) with thirteen treatments and replicated thrice. In the present study, the treatment T_2 (30 kg FYM + 100: 150: 150 g NPK/ vine) recorded the highest number of bunches per vine (23.00 and 20.13) and maximum yield per vine (17.25 kg/vine and 15.51kg/vine) in both summer season and winter season crop respectively. The maximum bunch weight was registered in T_9 (30 kg FYM + 150: 150: 450 g NPK/ vine) in both the seasons (820.12 g and 814.6 g respectively). The results revealed that the nutrient levels had significant influence on the yield and yield attributing characters of grape var. Red Globe during both summer and winter season cropping.

S3P146 A385

Effect of NPK Doses on the Yield of Dragon Fruit *Hylocereuscostaricensis*[F.A.C. Weber] Britton & Rose) in The New Alluvial Zone of West Bengal

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An experiment was conducted comprising eight fertilizer treatments viz.,T_1 = $N_{250}P_{150}K_{100}$, T_2= N_{300} P_{200} K_{150}, T_3 = $N_{350}P_{250}$ K_{200}, T_4= N_{400} P $_{300}$ K $_{250}$, T_5= N_{450} P_{350} K_{300}, T_6 =N_{500} P_{400} K_{350}, T_7 = N_{550} P $_{450}K_{400}$, T_8 = Control and Organic manure @20 kg/ pillar containing four plants was laid out in Randomized Block Design with 4 replicationsat the adjacent area of faculty of Horticulture Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia district, West Bengal during the year 2016-2017 to standardizethe proper NPK fertilizer dose for higher yield and quality of dragon fruit in of The New Alluvial Zone of West Bengal. There was significant difference in terms of fruit yield per pillar, average fruit weight and no of fruits. The maximum number of fruits per pillar (62.25), average individual fruit weight (274.89 g), and fruit yield (27.48t/ha) were observed in T5. The minimum number of fruits per pillar (14.00) and fruit yield andaverage individual fruit weight (3.36 t/ha,150 g) was found in control in (T8). The highest TSS (19.01%) was recorded in control and lowest (11.23%) in T2.

S3P147 A610

Evaluation of spur types and colour strains of apple

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Apple is the major temperate fruit of Himachal Pradesh and over a period of 40-45 years of its cultivation, this crop has achieved a status of an industry; in various operations like planting, training, pruning, orchard management, harvesting, grading, packaging and finally for sale, labour is engaged throughout the year. Delicious group of cultivars has been the main stay of apple industry. With passage of time and changes in climatic condition these cultivars are producing low yield, showing biennial bearing tendency, susceptibility to spring frost and frequency of fluctuating temperature has increased. Further cultivars of this specific group mature within a short period and causes a glut in market. A number of early colour strains and

spur types were introduced and evaluated for more than ten years at main campus of University of Horticulture and Forestry, Nauni-Solan. Higher yield was observed for cultivars Vance Delicious, Top red, Hardiman, compared to Starking Delicious. Pollinizing cultivars namely Tydeman's Early Worcestor matures the earliest whereas some new strains of delicious matured about more than 15-20 days earlier than Starking Delicious. Both Starkspur Golden and Golden Spur Delicious matured very late. Based on evaluation, Top Red and Vance Delicious (Standard type) and spur type Redspur performed better at low altitude where colour development is a problem. Further the cultivars matured early, colour was more intense compared to Starking Delicious. Among pollinizing spur types Starkspur Golden produced higher yield and quality too was better than Golden Spur Delicious.

S3P148 A483

Nourishment of ornamental geophytes undersoil and soilless system

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Ornamental geophytes are bulbous plants bestowed with commercial value for cut flowers, potted plants, bulbs and use in landscape gardening, their contribution is significant in floriculture sector at global level. The growth and development of commercial bulbous plants like lilies, tulip and gladiolus etc. are greatly affected by nutrient imbalance. Information on nutrition of ornamental geophytes in soil and soil less system is reviewed. There are number of factors that influence the nutrient availability and uptake by plants in both soil and soilless systems. Crop production is influenced by soil fertility and other growth factors like light, water, temperature and physical condition of soil. Nutrient loss is more due to leaching, volatilization, fixation and removal by weeds. Management of nutrition in problematic soil is difficult as observed in spider lily when grown in black calcareous soil. Hence it would be advantageous to go for soilless system for high value ornamental geophytes. Soilless system is generally setup under protected condition in a small area, and requires low amount of fertilizers. Nutrient solutions are precisely delivered at root zone under controlled environment. Even, the use of low cost commercial fertilizers as nutrient source reported to be economical to produce quality flowers and corms of gladiolus in Nutrient Film Technique. Nutrient loss is meagre and recycling ensures better nutrient utilization. Soilless system also influenced by factors like nutrient solution concentration and composition, electrical conductivity, pH and temperature. Optimizing the nourishment of ornamental geophytes in soilless systems would give insight to efficient nutrient management. Eventually, better nutrition would improve quality and quantity of cut flowers and bulbs of ornamental geophytes.

S3P149 A490

Flowering and fruiting pattern of litchi (*Litchi chinensis*Sonn.) in Wayanad, Kerala

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Wayanad (11.6854° N, 76.1320° E) region of Western Ghats has been identified as a potential area for litchi cultivation. Unlike the traditional litchi growing belt of North India, flowering of litchi in Wayanad commences from August-September. This being an offseason, the produce normally from Wayanad fetches premium price in the market. Surveys conducted during 2015-16 identified 32 collections. During the study, only 26 plants flowered and flowering period lasted for 12-35 days. Seventy-five per cent of the collections flowered in August/September whereas, 7.14 per cent flowered in February/March. Flowering in both seasons was seen in 17.85 per cent of the collections. The fruits varied in length (2.8 to 3.8 cm), width (2.1 to 3.2 cm) and weight (16.9 to 25.8 g). Majority of the collections had medium skinned fruits (80 per cent) and mature fruits were pinkish red to greenish yellow in colour. Fifty per cent of collection had medium thick aril, while 25 per cent of each collection had thin and thick aril. Aril weight and seed weight (100 seeds) ranged from 12.1 to 17.1 g and 210 to 297 g respectively. The collections consisted of regular bearers (55 per cent) and alternate bearers (45 per cent) with yield ranging from 1 kg to 30 kg/plant.

S3P150 A582

Grafting eggplant onto *Solanum torvum* Swartz rootstock for better survival and performance during rainy season under south Gujarat conditions

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Surati Ravaiya type eggplant is one of the delights in south Gujarat cuisine; however inconsistency in the performance of such type (s) particularly during rainy season deprives people from its delicacy. So, looking into the vigorous root system and tolerance to various biotic and abiotic stresses of *Solanum torvum*, grafts of two types of *Surati Ravaiya* eggplant (Pink and purple) were prepared onto this rootstock and compared the performance with normal

analogues of these types during rainy season, 2014 and 2015. Grafted plants in both the types of eggplant recorded significantly higher survival percentage of more than 80 per cent compared to their normal counterparts. Heterostyly polymorphism- an important phenomenon governing fruit set in eggplant was also regulated by graft-scion relationship leading to higher percentage of long styled flowers and significantly better fruit set compared to their non-grafts. Grafting onto *Solanum torvum* also contributed significantly to enhance crop duration of both pink and purple type eggplant thus produced more number of pickings in a season. Grafting also registered less infestation with short and fruit borer compared to their normal counterparts. Better plant survival and fruit set; more number of fruits and pickings and less shoot and fruit borer infestation were the important parameters favoured by grafting, hence responsible for better performance over non-grafted ones.

S3P151 A599

Feasibility of substituting cocopeat with rice husk and saw dust compost as a nursery medium for growing vegetable seedlings

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The present study reports the feasibility of partial substitution of coir dust in Arka fermented cocopeat with sawdust and rice husk as a nursery media. Compost was produced by mixing different ratios of raw coir dust, saw dust and rice husk following IIHR protocol. The chemical analysis of compost samples showed that among different treatments, substitution with 25% rice husk compost recorded lowest C/N ratio (36.56) and tannin concentration (327 mg/100g). To determine the best compost for nursery media, germination of tomato in portrays was carried out. Among the different treatments, substitution with 25% rice husk recorded higher germination of 94.79% whereas 100% coir dust recorded germination percentage of 91.91%. Further a pot experiment was conducted to study the effect of these nursery media on the growth of tomato seedlings along with the application of soil less Mycorrhiza @ 5%. Among the different treatments, substitution with 10% rice husk recorded higher shoot length (36 cm), root volume (2.7 ml) and higher root length in 25% substitution with rice husk (31.5 cm) whereas 100% coir dust recorded shoot length (21.4 cm) root length (13.7 cm) and root volume of 0.7 ml at 45 DAS. Substitution with 10% rice husk produced the best and intact plugs compared to other treatments. The findings from our study indicate the feasibility of substituting 10-25% of cocopeat with rice husk compost as a nursery media and further enrichment of this nursery media with Mycorrhiza improves growth and survival rate of tomato seedlings.

S3P152 A600

Precision Farming in Vegetable Crops

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In spite of significant progress achieved during the last two decades in vegetable production in India, the average productivity of these crops is still low as compared to the best yields at national and world level, indicating the scope to enhance the yield in different vegetable crops by many folds along with its quality. Precision farming technologies can play a very crucial role not only in increasing the productivity but also for judicious and optimum use of the resources. Precision farming is generally defined as information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource. It is the technology under which, the inputs are applied "at right time, in right amount and at a right place"for benefiting crops, soils and ground water and to enhance crop productivity. Precision farming calls for an efficient management of resources through location specific high-tech interventions such as micro-irrigation, fertigation, protected cultivation, soil and leaf nutrient based fertilizer management, mulching for in-situ moisture conservation, micro-propagation, genetically modified crops, use of biofertilizer, vermiculture, high density planting, soil-less culture etc., which can be used for precision farming of vegetables to bridge the existing yield gaps due to continued use of traditional production technologies. It has been reported that adoption of precision farming technology increased the net return by 39 per cent and 28 per cent in tomato and brinjal cultivation respectively.

S3P153 A230

Cultivation of Capegooseberry (*Physalis peruviana* L.) Under South-East Rajasthan conditions

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Capegooseberry (*Physalis peruviana* L.) is indigenous to South America but was cultivated in South Africa in the region of the Cape of Good Hope during the 19th century, imparting the common name Capegooseberry". Its somatic chromosome number; 2n=24. It is the only important annual herbaceous, minor tropical fruit crop of India. The crop has potential for use as nutraceutical. Capegooseberry is a member of solanaceae family. This family has many tribes and contributes many plants which are important to mankind as food or medicine. Cape gooseberry is a self-pollinated, herbaceous in nature and reaches 2 to 3

feet in height under favourable growing conditions. After the flower falls off, the persistent calyx expands, forming a straw- coloured husk much larger than the fruit enclosed, which take 70 to 80 days to mature. Fruits of capegooseberry are small with 1-3.5cm in diameter, they are very juicy, aromatic yellow orange in colour and round in shape at maturity. Capegooseberry has high significance for diversification of fruit bowl in market. It is usually cultivated as a short cycle (3-4 months), annual crop but in absence of frost it can be perennial. Capegooseberry is tropical crops in it requires warmer climate and dry weather at the time of fruit development and maturity stages. It is susceptible to frost. It is growing well under well fertile and drained soil with a pH range of 6-7. Capegooseberry is usually propagated by seed.Seeds may be sown in poly bags (22x15cm with 150 gauges) 6 weeks prior to transplanting; about 250 g seeds are equired for one hectare area, its seeds are small and seedlings are planted when they are 15-20cm tall during eptember-October. Fertilizer ingredient require 15 tonnes FYM, 120kg N_2, 80kg P_2O_5 and 60kg K_2O for per ha. apply after planting. Intercultural practices such as weeding should be done after in which 30 days of planting. It's should be irrigated once in 12-15 days in winter and 6-8 days in summer. Capegooseberry fruits 80-90 days taken to first harvesting from transplanting. When persistent calyx, fruit stalk dried completely and fruit colour changes into yellow colour its optimum stage for harvesting. The average yield is 30-40 q/ha. Pest and disease can not harmful effect on the crop during growing condition also yield. Though, Cape gooseberry is important in view of its horticultural crops its fruit fetch in the market at high prices. It needs to be accentuated in order to cultivation adoption of this crop to also help in improve socio-economy of the farmer. Cultivation adoption is worth adoption under S-E Rajasthan conditions.

S3P154 A162

Comparison of indoor and outdoor methods of cultivation on the yield parameters of *Auricularia polytricha*(Mont.) – Wood ear mushroom

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Auricularia polytricha,the black Jelly or wood ear mushroom, due to their high medicinal and nutritional values offers high income to local growers and consumers. Its occurrence is very common in dead wood logs and tree stumps in ambient conditions and hence, there is a possibility of growing this mushroom outside the lab conditions. In this context, an outdoor trial was conducted in College of Agriculture, Vellayani to study its performance and compare with the indoor method of cultivation. Indoor method of cultivation of *Auricularia polytricha* took minimum of 34.40 days for completing spawn run compared to outdoor cultivation (34.80 days). Time taken for pinhead formation was found to be significantly different between two methods. Indoor cultivation method took 43.10 days to produce pinheads whereas, outdoor cultivation method took 44.20 days. There was no significant difference between two methods with respect to time taken for first flush. However indoor method took 51.5 days to produce

first flush and outdoor method took 52.0 days. Total cropping period was higher in indoor method (88.3 days) than outdoor method (81.3 days) and they were significantly different. Indoor method had higher average weight of sporocarp (3.8 g) as compared to outdoor method (3.5 g). Number of sporocarps was also highest in indoor method (34.4) followed by outdoor method (34.1). Total yield from three harvests was also highest in indoor method (0.136 kg) compared to outdoor method (0.123 kg) and they were found to be significantly different. Biological efficiency (BE) was higher in indoor method (13.6 %) than outdoor method (12.3%).

S3P155A193

Nano zinc oxide boosting growth and yield in tomato: Rise of "Nano fertilizer era

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Globally the soils are Zn deficient and plants are not in a position to accumulate enough Zn in edible parts that can meet the human nutrition requirement. Nanotechnology is one of the most important tools in modern agriculture. Nanoagriculture involves the use of nanosized particles with unique properties (increased uptake by plants as they are small in size and have high rate of penetration through plant cell membrane) to boost crop productivity. In the present study, an attempt was made to study the effect of nano zinc particle for improving yield and Zn content in tomato plant. Initially seed priming concentration were standardized invitro using nano ZnO (400ppm) and granular zinc sulphate (800ppm). Further standardized seed priming concentrations with different combinations of treatment such as seed priming, seed priming+ foliar spray and foliar spray were studied under field condition to evaluate their effect on biomass and Zn accumulation. The obtained results based on the physiological and yield parameters showed that the usage of nano zinc fertilizers through any of the method of application has significant positive effect compared to zinc sulphate. ICP-OES anaylsis of plant digested material revealed that uptake of ZnO NPs is higher than the granular $ZnSO_4$. The present study addresses the potential of nano scale particles on plant system opens an avenue for its potential use as future "nano fertilizers". Thus, nanotechnology is one of technologies where lot of scope exists to improve the plant nutrition.

S3P156 A29

Response of spider lily as influenced by planting time and nitrogen

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A field investigation was carried out at Satpuda Botanic Garden, College of Agriculture, Nagpur in 2013 in factorial randomized block design to study the response of spider lily as influenced by planting time and nitrogen. The treatments comprised of three levels of planting time *i.e.* 15thJanuary, 15thFebruary and 15thMarch and four levels of nitrogen *i.e.* 0, 200, 300 and 400 kg N ha^{-1} with three replications. It was revealed that the vegetative growth *viz.* leaves per plant and length and width of leaf, quality parameters *viz*., longevity of flowers and weight of bulbs per plant and yield parameters *viz*. flowers stalk^{-1}, flower stalks plant^{-1} and flowers ha^{-1} in spider lily were influenced non-significantly due to different planting times. However, with respect to nitrogen levels, significantly maximum leaves plant^{-1}, length and width of leaf, flowers stalk^{-1}, flower stalks plant^{-1}, flowers ha^{-1}, longevity of flowers and weight of bulbs plant^{-1} were noted with the application of 400 kg N ha^{-1}, whereas, all these parameters were recorded minimum under the control treatment *i.e.* 0 kg N ha^{-1}. Interaction effect of planting time and nitrogen was found non-significant in respect of all these parameters except days for 50 per cent flowering and it was observed earliest under 15thMarch planting with 0 kg N ha^{-1}, whereas, 15th January planting with 400 kg N ha^{-1} required maximum days for 50 per cent flowering in spider lily.

S3P157 A10

Effect of different cutting length and IAA concentrations on rooting success of Indian hog plum (*Spondias pinnata* L.)

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A field experiment on rooting success of Indian hog plum was laid out in two factorial randomized block design with 12 treatments and 3 replications which include three levels of cutting length (10, 15 and 20 cm) and four different IAA treatments (500, 1000, 1500 ppm IAA and no treatment). Each cutting was treated with different concentrations of IAA for 15 seconds. Investigation revealed that 15 cm length cuttings treated with 1500 ppm IAA gave the best results in term of earliest bud (13.27 DAP) and leaf initiation (16.32 DAP), highest cuttings success (66.67%), shoot length (34.89 cm), root length (13.49 cm), collar diameter (20.50 mm),

root number (9.53), root diameter (6.91 mm), fresh shoot weight (45.47g), fresh leaf weight (14.07g), dry shoot weight (21.15g), dry root weight (2.67g) and also in total biomass (29.80g/plant), whereas non-treated cuttings gave lowest performance in all aspects.

S3P158 A30

Growth, quality and flower yield of jasmine as influenced by time and severity of pruning

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An experiment to study the influence of severity and time of pruning on growth, quality and flower yield of jasmine was carried out at Satpuda Botanic Garden, College of Agriculture, Nagpur from December, 2013 to August, 2014 with sixteen treatment combinations in Factorial Randomised Block Design. The treatments comprised of four different time of pruning *viz*., 2nd week of December, 4th week of December, 2nd week of January and 4th week of January and four levels of pruning *viz*., light pruning (45 cm above ground level), medium pruning (30 cm above ground level), heavy pruning (15 cm above ground level) and no pruning (control). The treatments were imposed on two-year-old plants of *Jasminum sambac* (L).The results revealed that, days for emergence of first flower were significantly minimum when pruning was done during 4th week of January. Whereas, longevity of intact flower, diameter of flower bud, flower bud index and shelf life of flower were non-significantly influenced by time of pruning. In respect of severity of pruning, sprouts plant^{-1}, diameter of primary shoot, leaves primary shoot^{-1}, productive shoots plant^{-1}, weight of 100 flower buds, flower yield plant^{-1} and mean corolla tube length were found significantly maximum when the plants were pruned at 30 cm above ground level. Interaction effect of time and severity of pruning on all the characters of jasmine under study was found non-significant.

S3P159 A37

Studies on response of African marigold to plant growth regulators for seed production

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A field experiment was conducted at College of Agriculture, Nagpur, India during summer season of the year 2012-2013to study the response of African marigold to two plant growth regulators viz. $GA_3$and NAA at four different concentrations of 100, 200, 300 and 400 ppm as foliar spray for higher and better-quality seedproduction. The result indicated that, significantly maximum vegetative growth with respect to height of plant at 60 DAT, seed yield plot^{-1}, seed yield ha^{-1}, weightof seeds flower^{-1} and longevity of intact flower were recorded with

GA_3 300 ppm treatment and it was statistically at parwith all other levels of GA_3 and NAA 100 ppm. NAA 400 ppm treatment recorded significantly maximumbranches plant^{-1}. Significantly early first flower bud initiation and 50 per cent flowering were observed with GA_3 300 ppm treatment.

S3P160 A38

Influence of growth regulators on growth and flowering of African marigold

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An experiment was conducted during summer season of the year 2012-2013 to study the influence of growth regulators on growth and flowering of African marigold. The experiment consisted of nine treatments *viz.*,GA_3 at 100, 200, 300, 400 ppm; NAA at 100, 200, 300,400 ppm and control with three replications each. The results revealed that, significantly maximum plant height was recorded with GA_3 300 ppm treatment and it was statistically at par with all other levels of GA_3 and 100 ppm NAA. Whereas, NAA 400 ppm treatment recorded significantly maximum stem diameter, branches plant^{-1}, spread of plant, flowers plant^{-1} and it was found minimum in the control treatment. With respect to flowering characters days to first flower bud initiation, days to fully opened flower, days 50 per cent flowering were recorded significantly minimum with GA_3 300 ppm treatment whereas, it was found maximum in the control. Longevity of intact flower was recorded maximum under GA_3 300 ppm treatment compared to control.

S3P161 A39

Effect of auxins on rooting and establishment of African marigold (*Tagetes erecta* L.) cuttings

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An experiment was conducted during winter season of 2013-2014, for the optimization of auxin required for the rooting of African marigold cuttings and establishment of auxin treated cuttings after transplantation in Randomized Block Design with three replications. The treatment consisted of three different concentrations of NAA and IBA alone or in combinations. Maximum root size (9.14 cm) was observed with 200ppm IBA cutting^{-1}, whereas number of roots cutting^{-1} (49.83) was recorded maximum with NAA 200ppm. The root weight was maximum (0.77 g) with NAA 200ppm. Survival percentage of cuttings increased (92.80 %) with the combination of 200ppm NAA +200ppm IBA. After transplanting of rooted cuttings in the field, maximum plant height (58.33 cm) was observed with IBA 200ppm, while, number of branches was maximum plant^{-1} (19.2) with IBA 400ppm. The plant

biomass was maximum (351.68g) with IBA 400ppm. First bud initiation (21.5 days) and 50 percent flowering (47.2) was achieved with NAA 100 ppm + IBA 100 ppm and IBA 200 ppm accounted for maximum flower size (6.8 cm). Maximum flower numbers per plant(68.7) and yield of flower hectare^{-1} (23.23 t) was recorded maximum with 400ppm IBA.

S3P162 A43

Studies on different dates of sowing on growth, seed yield and quality of gum cluster bean

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A Field experiment was conducted in the year 2014-2015 during the *summer* season to study the effect of different dates of sowing on growth, seed yield and quality of gum cluster bean. These crops were sown on different dates viz. 1st January, 15th January and 1st February. Among these 1st February sown crop was found significantly superior in respect of plant height (86.49 cm), number of branches per plant (6.15), leaf area (20.86cm^2), pod length (6.15cm), number of clusters per plant (10.53), number of pods per cluster (10.69), number of pods per plant (105.55), weight of dry pod per plant (29.21 g/plant), weight of dry pod per plot(701.22 g/plot), weight of dry pod yield per hectare (21.63 q/ha), number of seeds per pod (7.54), hundred seed weight (3.46 g), seed yield per plant (22.62 g), seed yield per hectare(16.75 q/ha), seed endosperm (38.99%), protein content (29.91 mg/g) and available soil nitrogen after harvesting (137.78 kg/ha).

S3P163 A45

Performance of different spacing on growth, seed yield and quality of gum cluster bean under summer conditions

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An experiment was carried out during summer season of year 2014 to determine the growth, seed yield and quality of gum cluster bean as influenced by different planting spacings. The study was conducted with three spacings viz. 30 x 30 cm, 45 x 30 cm and 45 x 45 cm. Among these,45 x 45 cm spacing was found significantly superior in respect of average maximum plant height (20.20 cm, 54.36 cm and 86.29 cm at 30, 60, 90 DAS), number of branches per plant (5.57), leaf area (21.48 cm^2), yield parameters like, number of days to 50% flowering (62.21), number of cluster per plant (13.40), number of pods per cluster (13.59), number of pods per plant (124.57), pod length (6.72 cm), weight of dry pod per plant (43.87 g/plant), weight of dry pod per plot (1184.0 g/plot), weight of dry pod yield per hectare (23.38 q), number of seeds per pod (7.89), hundred seed weight (4.24 g), seed yield per plant (40.23

g/plant), seed yield per hectare (20.27 q), quality parameters like, seed endosperm (42.82 %), seed protein (26.98 mg/g) except number of days to first flowering.

S3P164 A746

Response of LA lilium hybrid cv. Fangio to foliar application of various groups of nutrients

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Plant growth and vigour including yield and qualitative characters are critically influenced by the application of nutrients. Different nutrients have different roles in plant metabolism and response of plant varies according to the nutrients applied. In this experiment different groups of nutrients, that are used in Murashige & Skoog medium preparation (MS media) are applied either alone or in combination as foliar spray on LA (Longiflorum x Asiatic) lilium hybrid cv. Fangio and the growth parameters were studied. It was observed that the vegetative growth of Lilium hybrid cv. Fangio was comparatively higher when applied with MS macro + MS vitamins. Similarly, the earliness such as days to bud emergence, days to bud break, days to colour break, early flowering etc was seen with application of MS micronutrients + MS vitamins. But, foliar application of MS macronutrients + MS micronutrients + MS vitamins in combination showed either the best result in important characters such as leaf width, basal stem diameter, bud length, bud width, bud duration, etc. or, statistically at par in all other attributes.

S3P165 A456

Effect of combined application of soil and foliar application of nutrients on growth and nutrient uptake of chilli hybrid (*Capsicum annuum* L.)

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An investigation was carried out to study the effect of combined application of inorganic and water-soluble fertilizers on growth parameters and nutrient uptake of chilli hybrid (*Capsicum annuumL.*)"during 2015-2016 in the Pudhukuraipettai Village at Virudhachalam Taluk in Cuddalore District. Foliar feeding of various sources of water soluble fertilizers NPK viz.,19:19:19, 18:18:18 and 13:40:13 were tested at two concentrations(0.5% and 1%)along with 100 and 75 per cent recommended dose of NPK (120:80:80 kg ha^{-1}) with 5 sprays, each starting from 30 DAT at 15 days interval, formed thirteen treatments in chilli hybrid cv.Sierra. The experimental plots were laid out in Randomized Block Design and

replicated thrice. The observations on various growth parameters and nutrient uptake for major nutrients were recorded and subjected to statistical analysis. The results obtained showed that 100% RDF + WSF 1.0% NPK @ 13:40:13 recorded the highest plant height, number of primary branches, stem girth, number of leaves per plant, leaf area, leaf area index, chlorophyll content and dry matter production. Uptake of major nutrients was found to be the highest due to foliar application of 1 per cent water soluble fertilizer (5 sprays) along with 100 per cent recommended dose of fertilizer.

S3P166 A749

Deciphering the effect of inoculation of *Paraburkholderia tropica* P-31 on the microbial community structure of phosphorus-deficient soils by metagenome analysis

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Soil is a living body and plays dynamic role in the environment. It has been estimated that each gram of soil contains at least 10 billion bacterial cells, the majority of which are not cultivable using conventional techniques. This has led to the development of next-generation sequencing techniques that have allowed the analysis of the uncultivable soil microbial populations through approaches such as community metagenomics, metatranscriptomics, and metaproteomics. In this study, an efficient phosphate solubilizing bacterial strain *Paraburkholderia tropica* P-31 (Order Burkholderiales Family Burkholderiaceae), originally isolated from pomegranate rhizosphere was inoculated in phosphorous deficient soils having different pH levels *viz.,* acidic (4.3), normal (6.7) and alkaline (9.3), to gain an insight on the changes in the microbial community structure as a result of the introduction of *Paraburkholderia tropica* P-31. Inoculation was carried out *in vitro* conditions in individual soil samples of 100 g each and the metagenomic DNA was isolated after seven days of inoculation. Metagenomic libraries were constructed and the V3-V4 regions of the 16S rRNA gene were sequenced in an Illumina Hi Seq platform. It was observed that as a result of inoculation, the relative abundance of order Burkholderiales,was higher in the inoculated P-deficient acidic soil compared to the inoculated P- deficient normal and alkaline soils. The P-deficient normal soil supported the highest overall bacterial diversity, measured in terms of Operational Taxonomic Units (OTU's), followed by P deficient acidic and alkaline soils respectively. This observation supports the fact that the introduced bacteria has a preferential pH range for colonization and can cause community level changes that may vary with the nature of the soil.

S3P167 A752

Impact of Micro-Nutrients on Earliness and Flowering of Ornamental Sunflower(*Helianthus debilis* Nutt.)

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Ornamental sunflower (*Helianthus debilis* Nutt.) is a garden plant. It is grown in beds and borders as well as in pots. Besides, the flowers are used as loose and cut flowers which occupy a significant place in domestic flower markets of the country. Management of balanced nutrients has become vital importance. It can be stated that micronutrients are going to play a major productive and qualitative role in bringing stability and sustainability in the production system during the next few decades particularly in respect of flower crops.A field investigation was conducted in the Department of Floriculture and Landscaping, Orissa University of Agriculture and Technology, Bhubaneswar on ornamental sunflowerduring December 2015 to May 2016.The field trial consisted of eight treatments of micronutrients along with control. The micronutrient treatment consisted of single application of zinc (0.5% $ZnSO_4$),manganese (0.25% $MnSO_4$) and boron (Borax @ 0.1%) separately or along with foliar application of micronutrient mixture (Zn+Mn), (Zn+B), (Mn+B) and (Zn+Mn+B) at 30 and 45 days after planting. Plants sprayed with distilled water served as control. The results of the study revealed that application of (Zinc Sulphate+ Borax) recorded significant improvement in flower size (4.72cm dia) and number of ray florets per flower (20.77)as compared to control.The difference was not significant, but application of Borax @ 0.1% significantly reduced the time taken for flower bud initiation(33.68 days) and days to flowering from the date of transplanting (40.43 days) as compared to control which took 40.31 and 51.33 days respectively for the same. In over all performances, the foliar application of Zinc Sulphate+ Borax was proved to be the best.

S3P168 A767

Standardizing cultivation practices for *Mucuna utilis* (L.) – an important medicinal plant

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Mucuna utilis belongs to family Fabaceae, having high medicinal value. The seeds are known to contain high content of L-3,4-dihydroxyphenylalanine (L-DOPA), which is a direct precursor of dopamine to increase dopamine levels in the body. L-DOPA is used to treat Parkinson's disease (PD). Hence in local

health traditions and in allopathy the seeds are in high demand, hence cultivation practices were standardized at ICAR-IIHR, Bangalore. Dates of sowing were standardized and found that sowing of seeds during June second week was found to be optimum for this region compared to July and August dates of sowing. Planting density was studied in field and found that 10,000 plants per ha on pandal system with support recorded the highest seed yield. The time of harvest for L-DOPA was also standardized and found that harvesting seeds at physiological maturity yielded 7.1% more L-DOPA than at full maturity. Cultivating *Mucuna utilis* on surface was compared with training the vine on pandal with support. Results on seed yield confirmed that vines cultivated on support system yielded maximum (3.6 tons/ha) nearly twice the seed yield cultivated on surface. Several accessions of *Mucuna utilis* were evaluated for L-DOPA content and found that native accessions registered higher L-DOPA in seeds than other entries. The weed suppression effects of *Mucuna* was also studied and found that perennial weeds such as *Cynodon dactylon, Cyperus rotundus, Partheium hysterophorus* and *Tridax procumbens* were significantly reduced by more than 84% compared to control. These aspects are discussed in paper.

S3P168 A768

Standardizing growth medium for *Plecranthus vettiveroides* - an endangered medicinal herb

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Plecranthus vettiveroides (Family: Lamiaceae) commonly known as 'Hrivera' is declared as an endangered species by 'Convention on International Trade in Endangered Species'. The herb is cultivated for its roots. The aromatic roots are used for extraction of oil which is used in treating digestive disorders, skin affections and respiratory problems. The herb is also used in treating allergies, bronchitis, and rheumatism including carminative properties. The oil is used in curing arthritis, gout and other disorders. The herb is in great demand hence efforts were made to standardize growth media for its commercial cultivation. Different media consisted of cocopeat, cocopeat with sand and sand with different proportion of soil mixed with compost. Observations were recorded on plant height, number of branches/plant, number of leaves/plant, biomass of root and stem. Results indicated that height was significantly higher in 25% sand mixed with 75% soil along with compost. However sand and soil mixed in equal proportion along with FYM recorded significant higher number of leaves/ plant, fresh leaf, stem and root biomass. These results are discussed in the paper

S3P169

Investigations on the effect of planting methods and fertilizer levels on yield and economics in vetiver (*Vetiveria zizanioides* (L.) Nash): An industrial aromatic plant

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A field experiment was conducted at Medicinal and Aromatic Plants Unit, Saidapur Farm, Department of Horticulture, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka to study the effect of planting methods and fertilizer levels on yield and economics in vetiver (*Vetiveria zizanioides* (L.) Nash Syn. *Chrysopogan zizanioides*) during July 2015- July 2016. The experiment was laid out in split plot design with three main plot and six sub plot comprising of eighteen treatment combinations with two replications. The main plot consisted of three planting methods; P_1– Ridge and furrow method, P_2– Bed method and P_3– Bag method. The sub plot consisted of six fertilizer levels; F_1- 25:25:25 kg NPK/ha, F_2- 50:25:25 kg NPK/ha, F_3- 75:25:25 kg NPK/ha, F_4- 25:50:25 kg NPK/ha, F_5- 50:50:25 kg NPK/ha and F_6- 75:50:25 kg NPK/ha. For all the treatments, farm yard manure @ 10 tonnes per ha was applied. Among the planting methods, bag method (P_3) recorded significantly higher number of roots per plant (316.97), root length (50.12 cm), dry root yield (4085.78 kg/ha) and essential oil yield (85.34 kg/ha) compared to other planting methods. Among fertilizer levels, 75:50:25 kg NPK/ha (F_6) recorded significantly higher number of roots per plant (260.97), root length (45.98 cm), dry root yield (3453.19 kg/ha) and essential oil yield (73.32 kg/ha) compared to other fertilizer levels. The maximum B:C ratio (1:3.80) was recorded in bag method of planting with the fertilizer level of 75:50:25 kg NPK/ha.

S3P169

Effect of foliar application of micronutrients on fruit character of mandarin orange (*citrus reticulata* blanco.) under lower pulney hills.

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Experiment on effect of foliar application of micronutrients (Zn, Fe, B, Mn and Cu) on mandarin orange on fruit character was carried out during 2015-16 at lower pulney hills of Tamil nadu. Fifteen treatments are used alone or in combination with control (water spray) were used as foliar spray solution at vegetative, flowering and fruit set stage. The experiment was laid out in randomized block design (RBD) with three replication and two trees under each replication. Data were recorded in T_{15} treatment is significant increase the number of vesicles per fruits 12.50, Seed weight (3.12g) per fruit, No. of seeds (24.02) per fruit, , Pulp weight (50.20g) and Juice content (53.20ml) where as Rind thickness recorded in T_1 3.09 mm. The result revealed that foliar application of micronutrients found very effective for increased yield attributes.

S3P170A761

Cost effective organic production Technologies for Medicinal crops from ICAR- IIHR

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Medicinal plant-related trade in our country is estimated to be around US $1 billion per year. Out of 960 species recorded in trade only 36 species are under cultivation and rest of them are collected from wild. There is an urgent need to bring these plants under cultivation for safe residue free raw material for the herbal industries and also for day to day healthcare and for home remedies. Organic production technologies not only gives residue free raw material suiting the need of industries but also improves water penetration, water holding capacity, improvement in soil structure, microbial biomass, nutrient availability in soil. ICAR-IIHR has developed organic production technologies for cultivation of medicinal crops which are being exported like *Coleus forskohlii, Andrographis paniculata*. Also technologies for *Ocimum*

sanctum and *Ocimum basilicum* have been completed for two years. Organically grown *Coleus forskohlii* gave a mean yield of 1.85 t/ha of dry root yield with a forskolin content of 0.9% and BC ratio of 2.625. The technology has drastically reduced the coleus wilt to less than 7%. In Kalmegh organic production technology has given mean dry biomass yield of 3848 kg /ha/year with an andrographolide content of 2.9 to 3.1% with a B: C ratio of 1.55. This technology helps the growers in realising higher B: C ratio, increased yield and active ingredient content with reduced disease and pest incidence.

Session –IV
Products and Value-addition
(Post harvest management, Processing and product development, Nutraceuticals and Bio-fortification)

S4P1 A738

Evaluation of the potential of survival and growth of probiotic strains in RTS mango beverage

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Experiments were conducted to study the survival and growth potential of probiotic strains in Ready-to-Serve (RTS) mango beverage. Twelve probioticstrains, isolated as well as procured from different sources were evaluated in this study. Out of the twelve strains, six strains showed the ability to grow with different growth rates in the RTS Mango beverage as evident from the OD values. Further evaluation revealed that among the six strains, only three strains*viz*., *Lactobacillus helveticus* MTCC 5463, *L. rhamnosus* MTCC 5946 and *Saccharomyces boulardii* showed high multiplication rate and population of10^7cfu/mlor higher was attained within six days of incubation. These three strains were inoculated in the pasteurized RTS Mango beverage having initial total sugar content and acidity of 13.5% and 0.24%, respectively. Growth of *L. helveticus* MTCC5463 resulted in a nominalincrease in acidity in the medium, while *Lactobacillus rhamnosus* MTCC 5946 showed a significantly high build up of total acids(1.026%).*Saccharomyces boulardii* caused an intermediate increase in acidity(0.678%)but showed a lower biomass build up over a period of four days. These results indicate that *Lactobacillus helveticus* MTCC 5463 could be attempted for developing probiotic based fruit beverages. Preliminary sensory evaluation results revealed that the RTS mango beverage prepared without any added acidity and inoculated with *L. helveticus* cells having 10^8 cells/ml showed moderate to high acceptability on a 9-point hedonic scale. Further studies are being carried out to establish the probiotic potential of RTS mango beverage using *L.helveticus*.

S4P2 A151

Nagpur mandarin Fizzy drink: A better substitute for commercial carbonated beverage

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Soft drink consumption has increased substantially over the last 50 years.Carbon dioxide adds that special sparkle and bite to the beverage and also acts as a mild preservative. Carbon dioxide is a uniquely suitable gas for soft drinks because it is inert, non-toxic, relatively inexpensive and easy to liquefy.Citrus fruits include oranges, lemons, limes and grapefruits, in addition to tangerines and pomelo; Not only are the citrus fruits in this diverse group delicious and refreshing, but also contain nutritional and anticancer compounds like flavonoids andVitamin C.Nutritional carbonated drinks are in demand due to rising health consciousness. Therefore, the present investigation was carried out with an objective of preparing and observing storage of Nagpur mandarin fruit juice based carbonated drink (Fizzy drink) in comparison with a commercial carbonated beverage. Study was undertaken using 10 to 15% orange juice in carbonated drinks with a carbonation level of 3 to 5 kg/cm^2 pressure of mixing at 4^0 C temperatures. The prepared Nagpur mandarin fizzy drink was analyzed for physico-chemical parameters and microbial load. The product had a good total soluble solid content (15%) in all storage periods. Vitamin C and sulphur dioxide contents recorded a decreasing trend while, limonin and browning content showed an increasing trend during storage both under ambient and refrigerated conditions.No microbial growth was observed in the products during storage at both ambient and refrigerated conditions. The study therefore recommends that there is a need to popularize nutritionally superior Nagpur mandarin based carbonated drink (Fizzy drink) for commercial exploitation.

S4P3 A156

Adoption of post-harvest techniques for horticultural crops

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India is the second largest producer of fruits and vegetables after China. However, it is still lacking behind in per capita consumption of fruits and vegetables. In the recent years the intenseefforts were made to increase the yield of crops but not much emphasis was laid to stop the 20-40% post-harvest losses of horticultural crops especially fruits and vegetables. Since horticultural crops are delicate in nature and are having high water content, these are supposed to be perishable in nature and are more prone to microbial attacks.Hence, these crops require a scientific approach in their post-harvest management practices including techniques for harvesting, time of harvest, packaging and transportation channel to reach consumer hands with minimum or no spoilage. Appropriate time of harvest prevents both immature and over-mature produce to harvest, better harvesting techniques prevent bruising losses from the produce and appropriate packaging material, methods and transportation channels help in preventing losses during transport and to supply a fresh and damage free produce in consumer hands. Proper post-harvest management techniques could help the farmers to increase the production and value of their produce after harvesting. These techniques not only prevent the spoilage losses of their produce but could also help farmers to get high price of their produce.

S4P4 A239

Effect of pre-treatments on minimally processed cauliflower

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An experiment was conducted to study the effect of pretreatments on the shelf- life of minimally processed cauliflower. Chemicals like sanitizer, antioxidants, texture improving activity were chosen for dip treatment of the cut florets. Freshly cut cauliflower florets were dipped for five minutes in solutions viz., sodium hypochlorite (200 ppm), hydrogen peroxide (2000 ppm), calcium chloride (2000 ppm), ethylene diamine tetra acetic acid (300 ppm) and ascorbic acid (1000 ppm). Treated produce was then surface dried and packed in trays overwrapped with cling film and stored at 8 °C. Among the treatments, calcium chloride treated florets had highest shelf life with a very good overall acceptability till 8 days of storage. Undipped control samples lost their acceptability on the fifth day of storage due to change in surface colour and cut end browning. Calcium chloride treatment also resulted in nominal

changes vitamin C, total antioxidants and microbiological quality. In general, the total phenolics level increased in all treatments by the end of storage period. It could be inferred that calcium chloride can be used in fresh - cut industry for enhancing the shelf life of minimally processed cauliflower.

S4P5 A331

Influence of plant growth promoters on growth, yield, quality andpost-harvest life in China aster(*Callistephus chinensis* L. Nees.)

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An investigation was undertaken at Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore, to study the influence of plant growth promoters on growth, yield, quality and post-harvest life in China aster (*Callistephus chinensis* L. Nees.). Plant growth promoters used in the study were: gibberellic acid (GA_3 @ 100, 150 and 200 ppm), salicylic acid (SA @ 50, 100 and 150ppm), brassinolide (BA @ 0.5, 1.0 and 1.5 ppm) and triacontanol (TR @ 1.0, 2.0 and 3.0 ppm). These growth regulators were applied as foliar spray at two stages, *viz.*, 45 days and 60 days after transplanting, and water spray was used as the Control. Application of GA_3 at 150ppm promoted various growth and yield parameters. Spray of GA_3 at150ppm caused increased plant height (69.03cm) and number of branches per plant (9.25). GA_3spray @ 150ppm promoted early bud-initiation (65.45 days), early flowering (72.47 days after transplanting), number of days taken to 50% flowering (81.36 days after transplanting) and days taken to full-flowering (88.2 days after transplanting). Quantitative traits, *viz*., number of flowers per plant (52.2), individual-flower weight (3.92g), flower diameter (6.91cm), flower-stalk length (37.95cm), yield per plant (210.03g), flower yield per plot (6.44kg**)** and estimated yield ha^{-1} (16.1 tonnes) increased significantly with application of GA_3 at 150ppm. Longest duration of flowering (58.22 days) was recorded in the **treatmentGA_3 at 150ppm,and maximum** longevity of flowers on the plant **(**12.57**days)** were observed in the **treatmentGA_3 at 150ppm.**Among post-harvest treatments, flowers maintained in non-ventilated 200-gauge polyethylene bags receiving pre-harvest spray of 150ppm GA_3 enhanced the shelf life of flowers (8.68 days), while, minimum shelf-life was recorded in the Control (3 days in the open). The study concluded that among all the treatments tested, GA_3applied @ 150ppm performed the best, and positively influenced growth, yield, quality and post-harvest shelf-life in China aster.

S4P6A411

Effect of different pre-cooling and storage temperatures on shelf-life in mango cv. Alphonso

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An experiment was conducted to study the effect of different pre-cooling and storage temperatures on shelf-life in mango cv. Alphonso, during May 2016 at R.F.R.S., Vengurle, and Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, with five pre-cooling temperatures (P_1 – Control: 27-30˚C); P_2 – 21±2˚C; P_3- 18±2˚C; P_4 – 15±2˚C; and, P_5 - 12±2˚C), and, at four storage temperatures (S_1 – Ambient temperature: 27-30˚C; S_2 - 18±2˚C; S_3 – 15±2˚C; and, S_4 - 12±2˚C). After pre-cooling, the fruits were stored for 21 days at different storage temperatures and,after yet another 21 days were again brought to the above pre-cooling temperature by air cooling. Thereafter, the cooled fruits were placed for ripening for seven days at room temperature. The experiment was laid out in FCRD, with two replications. The interaction P_5S_4 (pre-cooling at 12±2˚C and storage at 15±2˚C) showed minimum physiological loss in weight (PLW) (9.11 %), followed by P_5S_3 (11.48 %); The interaction P_5S_3 recorded minimum shrivelling (0.00 %) and interaction P_5S_4 recorded minimum spoilage (4.00%) at 28 days of storage. Interactions P_5S_3 and P_5S_4 resulted in highest shelf-life (28 days) compared to that in P_1S_1 (7 days). The interaction P_5S_3 and P_5S_4 proved to be significantly superior to the rest.

S4P7A417

Novel chemotypes of ginger (*Zingiber officinale*)for various end-uses

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Zingiber officinale is a medicinal herb used all around the word as a spice. The present investigation was carried out with an objective of evaluating somaclones in ginger for yield and quality. All the somaclones exhibited significantly higher yield over the parent cultivars, and 36% of the somaclones recorded a yield higher than the National Check variety, Varadha. Highest mean yield (t/ha) was recorded in SE86-81(41.13),while, 50% of the somaclones showed higher quality attributes than the Check varieties. Quality attributes such as driage, volatile oil, oleoresin, starch and crude fibre content varied significantly in the somaclones. 50% of the somaclones showed significantly higher driage (%) compared to the three Check varieties. Significantly high driage (25.53%) was recorded in C86-139. All the somaclones possessed high driage percentage than the parents and the three Check varieties. Significantly

high dry-yield (t/ha) was recorded in 50% of the somaclones, over the Check varieties. SomaclonesC86-139 (5.75), SE-HP9 (5.16), SE86-81 (5.23) and SE86-40 (5.36) had significantly higher dry-yield than the three Check varieties. Somaclones differed significantly in oleoresin content (%) with the highest in C86-124 (5.94). All the Check varieties (including the National Check variety, Varadha), recorded significantly lower oleoresin content than the highest oleoresin-yielding somaclone C86-124 (5.94). Content of volatile oil (%) varied significantly among somaclones, with the highest(2.40%) in SE86-40. The ginger somaclones differed significantly in starch content. 80% of the somaclones showed higher starch content than the Check varieties. Significantly high starch content was recorded in C86-139(48.98. Compared to the Check varieties, somaclones showed lower crude fiber (%) content. Among the somaclones, variation in starch content was low with just three somclones showing significant difference. Variability in quality attributes in ginger somaclones is reported. Seven somaclones were high-yielders, four showed high driage,while, four had high dry-yield per ha and were suited for dry-ginger purpose. Three somacloneshad higher oleoresin content and are suitable for oleoresin extraction. Somaclones SE86-40 andSE86-131 had higher volatile oil content and both are high-yielders and are suitable for the essential oil industry. C86-124 and C86-139 showed high starch content.

S4P8A590

Potentiality of organic nutrient sources for improving yield and bioactive principle of ashwagandha (*Withania sominifera*) as well as soil biochemical properties

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Ashwagandha(*Withania somnifera* L. Dunal) is one of the important medicinal plants having tremendous marketing potential particularly organically produced. In this context, cultivation of ashwagandha under organic nutrient management practices is quite relevant for quality produce while avoiding excessive use of synthetic fertilizers and chemicals. A field experiment was conducted at the farm of ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat, India during the *Kharif* season of the year 2016 to study the effect of different nutrients source on yield and quality of ashwagandha and subsequently changes in soil fertility and biochemical properties. The experiment was laid out in randomized block design in three replications. The treatments comprised of different organic manures (FYM, Vermicompost and Castor cake) and microbial consortia along with recommended dose of fertilizer and control. Application of organics improves root yield and bioactive principle in ashwagandha. Root girth, root length, fresh root weight, dry root weight and root yield (fresh and dry) of ashwagandha were significantly affected by the treatment of different organic manures and the highest fresh root (1505 kg ha^{-1}) and dry root (767 kg ha^{-1}) yield was recorded under the treatment receiving castor cake + microbial consortia followed by application of vermicompost

+ microbial consortia. Notable increase in total withanolide in root was observed by the application of castor cake + microbial consortia (0.947 mg g^{-1}) followed byvermicompost + microbial consortia (0.927 mg g^{-1}). Significant improvement in soil fertility status (mineral N, available P and S) and soil biochemical parameters like microbial biomass carbon, soil respiration and enzyme activities were observed under the organic treatments. The results indicated that organic sources of nutrients not only improve the yield and quality of the produce but also sustain soil quality by improving it.

S4P9A594

Effect of pre-harvest sprays of forchlorfenuron and boron on fruit cracking and quality of pomegranate (*Punica granatum* L.) cv. Kandhari

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An investigation on pre-harvest spray of forchlorfenuron (CPPU) and boron along with some *in-situ* soil moisture conservation techniques was carried out on seven-year old plants of pomegranate cultivar Kandhari trained as four stems grown under rainfed conditions of Himachal Pradesh. Experimental plants were subjected to 11 treatments *viz*., mulching, CBOC (crescent bund with open catchment pits), CPPU at 5 or 10 ppm, H_3BO_3 at 0.2 or 0.4%, mulching + CPPU at 5 ppm or H_3BO_3 at 0.2%, CBOC + CPPU at 5 ppm or H_3BO_3 at 0.2% and control. These treatments were applied separately in mid-March (*in-situ* soil moisture conservation) and mid-May (forchlorfenuron and boron). Growth parameters like plant height, plant spread, trunk girth and annual shoot growth were observed maximum under the treatment CBOC + H_3BO_3 at 0.2%. However, leaf area and leaf chlorophyll content were maximum under the treatment CBOC + CPPU at 5 ppm. Physiological characteristics such as photosynthetic rate and transpiration rate were higher in the plant under crescent bund with open catchment pits. The extent of fruit cracking was reduced to the lowest level (2.8%) from 11.67% in control and highest fruit yield (26.8 kg/plant) was recorded when the plants were given foliar application of CPPU at 5 ppm under CBOC. The least russet formation (1.33 on 10 point scale) occurred in fruits from plants given the treatment of CPPU at 5ppm +CBOC. The maximum fruit length (86.2 cm) and fruit breadth (88.3 cm), fruit weight (419.74 g), aril weight (279.21 g), aril percentage (66.52), juice content (67.93 ml/100 g), ascorbic acid content (16.84 mg/100g) were obtained from plants applied with CPPU at 5ppm + CBOC. The lowest titrable acidity (0.49%), highest TSS (15.210 B) and TSS/acid ratio (31.07) was recorded in fruits from plants under the treatment of H_3BO_3 at 0.2% with mulching. Total sugar, reducing sugar were recorded highest under the treatment H_3BO_3 at 0.2% with CBOC and lowest in control.

S4P10A605

Preparation and quality evaluation of mixed fruit leather

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A process was standardised for preparation of mixed fruit leather from mango and guava. Different combinations of mango and guava pulp viz. 75:25, 50:50, 25:75 and control (100 mango and guava pulp) were used followed by drying of pulp in a cabinet drier at a temperature of 55 to 60°C up to around 15% moisture level. All the treatments were analyzed for physicochemical characteristics, sensory (color, texture, flavor and overall acceptability) and microbial testing. The maximum moisture content (15.21%) was found in (50:50) ratio and minimum in 12.74% in 100% mango pulp. Highest ascorbic acid 74.18mg/100g was recorded in fruit bar made using Mango+Guava (25:75) ratios. Highest total sugar (62.57%) and titratable acidity content (1.92%) was found in the blend (50:50) ratios. Highest yield (35.28%) was recorded in 100% mango pulp. Overall sensory score among different ratios ranged from 73 to 82. The highest score 82.00 was recorded in fruit bar made using mango pulp 50% and guava pulp 50%. Blended fruit bar were found microbially safe for all treatment combination. It was observed that mango and guava blend (50:50) ratio scored highest as per organoleptic quality. However on the basis of nutritional analysis (25:75) ratio was found best over control.

S4P11A690

Enhancement of green-life of bananas using 1-methylcyclopropene at ambient and low temperatures without affecting ripening and quality

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Preclimacteric full (95%) mature and full three quarter (85%) mature Grand Nain (*Musa* AAA; Cavendish subgroup) and Poovan (*Musa* AAB; Mysore subgroup) were gassed with 1-methylcyclopropene (1-MCP) at 1 µL/L concentration for 12 h and stored at ambient and low (13.5 ^{o}C) temperatures. Physiological and biochemical parameters of the bananas were observed during preclimacteric, colour breaking and ripening stages. The treatment increased the green-life of full mature Grand Nain and Poovan fruits for 10 days more at ambient temperatures (25 - 27 ^{o}C) and 29 and 26 days more at 13.5 ^{o}C over the control of existing NRCB technology. Similarly, treatment of full three quarter mature bananas with 1-MCP increased green life for 20 days at ambient temperature and 44 and 26 days at 13.5 ^{o}C. The enhancement of green life of 95% and 85% mature bananas of both genotypes at 21 ^{o}C was

similar to storage at ambient temperatures. Physiological parameters of CO_2 and ethylene release of 1-MCP treated bananas were similar to untreated control fruits till preclimacteric stage and showed increment coinciding with colour breaking. Biochemical behaviour in terms of activities of main pectin depolymerising enzymes polygalacturonase and pectin lyase and chlorophyll catabolising enzyme chlorophyllase in treated fruits were optimal relative to fruits not treated with 1-MCP. Assessment of ripening behaviour and quality features of ethylene induced ripening of 1-MCP treated bananas of both genotypes did not differ from the untreated control fruits. The acidity and total soluble solids of treated and untreated fruits of Grand Nain and Poovan fruits were in the range of 0.28 - 0.31%&25.8 - 26.5 ^{o}B and 0.54 - 0.57% & 20.13 - 21.7 ^{o}B respectively.Thus, the biochemical treatment technology has the potential utilisation to delay the ripening and minimising the post-harvest loss of bananas.

S4P12IS14

The quality of grapes and the efficiant ways in winemaking

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The quality of grapes is the determining factor in choosing the method of wine production. In present study we investifated this problem in relation to the red autochthonous grape cultivars from the South cost zone of the Crimea. The sensor profile of the wines, the component composition and properties of grapes and wines were analyzed using colorimetric and potentiometric methods. It is now well established that if the grapes are characterized by the following parameters: the concentration of sugar is 21,5-25,5 Brix, the percentage of the extractable anthocyanins is more than 45 %, the technological reserve of phenolic compounds is about 2,0-3,5 $g \cdot L^{-1}$, then wines with a harmonious, velvety taste, intense ruby color, developed aroma are obtained by the mash fermentation to 1/3 residual sugars with a dose of sulfur dioxide at 80±5 $mg \cdot L^{-1}$ and the subsequent fermentation of the must. If the parameters of grapes are different from those indicated, then for extraction of phenolic components from the grape skin and formation of harmonious taste of wines it is recommended to: (1) decrease the dose of sulphur dioxide in mash to 65±5 $mg \cdot L^{-1}$, (2) use a complex of pectolytic enzymes (1300-1500 $nkat \cdot L^{-1}$) and / or the condensed tannin preparations (0,2 $g \cdot L^{-1}$) during the mash fermentation. The use of pectinases preparations increases the concentration of anthocyanins in wines by 35-60%, the intensity of the velvety taste descriptor by 1,5-2,1 times and the volume of wines from 100 kg of grapes by 6-15 %.

S4P13IS15

Fruit chemical composition of distant hybrids of peach and nectarine with almond

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Distant hybridization has a great importance for breeding cultivars resistant to fungal diseases. Using of peach wild-growing species and almond makes it possible to increase polymorphism degree of the hybrid generation and sort out genotypes that possess complex of economically valuable characteristics.The researches were being conducted in 2004-2016 in Nikita Botanical Gardens, Yalta, Russian Federation. The study object was fruit chemical composition of 13 distant hybrids, bred using as follows: *Prunus persica* (L.) Bastch., *Prunus persica* (L.) Bastch. var. *nucipersica* (Suckow) Schneid., *Prunus mira* Koehne., *Prunus davidiana* (Carr.) Franch., *Prunus amygdalus* Batsch. As a control cultivar Stark Sunglo was chosen.These hybrids are characterized with high resistance to the complex of fungal diseases, but taste qualities of their fruits much worse than the control nectarine cultivar Stark Sunglo has. In this way research purpose was to investigate fruit chemical composition of hybrids of nectarine and peach with almond. It was demonstrated that simple hybrids of nectarine with almond have higher concentration of leicoantociane in comparison with the control cultivar. Dry matter, titratable organic acids and ascorbic acid of these hybrids are close to nectarine Stark Sunglo, while monosaccharides and total sugars is a bit less. The pericarp of complex distant hybrids (670-89, 1027-89) in comparison with juicy pulp of the control cultivar, is more characterized with higher concentration of dry matter, ascorbic acid, titratable organic acid and leicontocianes. The concentration of monosaccharides and total sugars in fruits of mentioned hybrids is close to the control parameters. High taste qualities of the hybrids, close to control cultivar characteristics had been successfully resulted by 4 or 5 generation. Acknowledgement: This study was funded by a research grant № 14-50-00079 of the Russian Scientific Foundation.

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S4P14IS32

Development of protein fortified ready to serve mango drink by utilization of whey protein and its storage study

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The study was conducted for utilization of whey protein in the preparation of protein fortified ready to serve mango drink. Different combinations of mango pulp, whey protein were used for screening and evaluated the as per organoleptic quality and nutritive value. Based on above study the ratio of 90:10, 80:20, 70:30 and control (mango pulp) were used for RTS drink and it stored for a period of 6 months at room temperature. Organoleptic quality of prepared product was carried out by using the nine point's hedonic scale. Biochemical changes were observed at 0, 2, 4 and 6 month of storage. The total soluble solids, acidity, reducing sugar

increased while ascorbic acid and protein content decreased during the storage. Organoleptic score maximum in (8.3 out of 9) for (90:10) ratio however antioxidant (FRAP) and percent of protein (6.17 mM/ml and 0.54) highest in 70:30 ratio at six month of storage. No microbial growth was observed during storage of protein fortified ready to serve mango drink. It was observed that (90:10) ratio scored highest as per organoleptic quality. However on the basis of nutritional analysis 70:30 ratio was found best among all.

S4P15IS38

Effect of Forced Air Pre-Cooling Operations on Post Harvest Shelf-Life of Mango (Mangifera Indica L.) CV. Kesar

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An experiment was carried out to study the effect of forced air pre-cooling operation on post harvest shelf-life of mango cv. Kesar at the Center of Excellence on Post Harvest Technology, Navsari Agricultural University, Navsari. The freshly harvested matured (TSS > 9.2) Kesar mangoes were sorted and transported to center, where the fruits were desapped and washed followed by treatement of forced air pre-cooling with combinations of three levels of forced air temperature and three levels of pre-cooling time. The post harvest quality of treated mangoes were compared with untreated mangoes during the storage under 11±1ºC temperature and 90-95% Relative Humidity. The outcome of the study reveled that Kesar mango treated with forced air pre-cooling process showed significantly lower and slower rate of physical and chemical changes than control fruits. The fruits treated with pre-cooling at 8ºC for 8h proved to be most effective with respect to more number of days taken to ripe, longer shelf life, lower spoilage and higher percentage of marketable fruits. It recorded less physiological loss in weight and more fruit firmness even after 20 days of storage. The pre-cooling process was also found effective in slower increase in TSS, reducing sugar and total sugar, while slower decrease in ascorbic acid and acidity during storage. The organoleptic rating with regard to colour, taste and overall acceptability was also found significantly higher for fruit treated with forced air pre-cooling treatments at 8ºC for 8h treated fruits.

S4P16A747

Developments in osmotic dehydration technique for value-addition in fruits and vegetables

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Fruits and vegetables play an important role in human nutrition. However, due to their perishable nature, there is a need for adopting efficient preservation technique for the conservation of these high value commodities so that they can be transported to far off places besides its use in the off season. The application of osmotic dehydration technique helps in creating compact, nutritious and attractive products from fruits and vegetables. However, there are several factors which play a significant role in determining the final product quality as well as mass transfer kinetics e.g. type of fruits and vegetables, variety, stage of maturity, temperature, concentration of the solution and the type of the osmotic substance as well as conditions such as vacuum and pressure. It has been found that by suitable optimization of above parameters on various fruits such as mango, papaya, pineapple, banana, guava, jackfruit, *aonla* and vegetables like carrot, muskmelon, beet root,there was tremendous scope for transforming these commodities as snack food. Application of combined processing has paved a way for utilisation of even raw fruits into nutritious products by additional infusion of fruit juices in to solid matrix. Osmo-dried products can also be used as an ingredient for making other kind of food products such as juices, ice creams and bakery products.

S4P17A762

Nutrient composition of four promising avocado collections from India

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A large collection of elite seedlings of avocado was made at the Central Horticultural Experimental Station (CHES) of ICAR-Indian Institute of Horticultural Research (ICAR-IIHR) at Chettalli, Karnataka, India to develop elite avocado lines suitable for cultivation under Indian conditions. Four of the clones,CHES PA-II-1, CHES PA-II-4, CHES PA-IV-4 and CHES PA-VII-1,all of unknown origin, were analyzed for nutritional parameters and

antioxidant activity. Proximate composition of the avocado fruits, dietary fibre, sugar content, phenol and flavonoid profile and antioxidant activity in these collections were estimated and are reported in the present paper. Avocados are especially known for their high fat-content (13-42%). The major sugars were galactose, glucose and sucrose, and, the sugar alcohol sorbitol.Essential fatty acids, linolenic acid and linoleic acid, were the predominant fatty acids present. Total phenols and flavonoid content was far higher in the skin and seeds of avocado fruit, with correspondingly high antioxidant activity in these parts.

S4P18A136

Shelf life studies in sweet orange cv. Nucellar at ambient temperature storage

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An investigation on the shelf life studies in sweet orange cv. Nucellar was conducted in the laboratory of Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during 2011-12. The treatments are classified on combination of Gibberllic acid 100ppm with 6% and 12% wax emulsion, fruits were packed in modified atmosphere packaging with 5% vents and without vents, treated fruits were stored at ambient temperature. The result showed that, at the 49th day of storage, minimum per cent loss in weight (10.99 per cent) and minimum decay loss (9.28) of fruit was recorded in the treatment T_1 i.e. MAP with vents + GA_3 100 ppm + 6 % wax. Maximum TSS content of fruit (12.14 per cent) was found in treatment T_{10} i.e. MAP without vents + GA_3 100 ppm +12 % wax. The maximum acidity was found in the treatment T_1 (0.49 per cent), whereas minimum in treatment T_{10} (0.43 per cent). Maximum reducing sugar(6.47%) and total sugar (11.93%) was found in T_{10} i.e. MAP without vents + GA_3 100 ppm +12 % wax. The maximum ascorbic acid (47mg/100ml juice) was recorded in T_1, whereas minimum (43.10mg/100ml juice) observed in T_{10}.From the present investigation, it can be concluded thatthe fruits treated with the treatment T_1 $GA_3$100 ppm in combination with 6 % wax, packed in 100 gauge polyethylene bags and stored at ambient temperature was found significantly more effective to increase the shelf life up to 44 days of sweet orange fruit.

S4P19A147

Effect of pre harvest treatment on flower quality and vase life of Asiatic lilium cv. Eye Liner.

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Asiatic lily is one of the most important ornamental bulbous plant. It has a great economic potential for cut flowers trade. An experiment was conducted at Modern Floriculture Centre, G.B Pant University Agriculture and Technology, Pantnagar to study the effect of pre harvest sprays on flower quality and vase life of Asiatic lilium cv. Eye Liner with nine treatments and three replications. Results of the study revealed that two pre harvest foliar sprays of Benzyl Adenine @ 100 µM significantly increased basal bud length (107.72 mm), bud diameter (32.95 mm), upper bud length (73.33 mm), bud diameter (22.78 mm), basal flower diameter (192.80 mm) and upper flower diameter (134.36 mm) . The maximum vase life (14.83 days) and water uptake was found GA_3@ 250ppm/L (142.83 ml).

S4P20A149

Combination of different drying technologies for better and less time intensive process for onion dehydration and value addition.

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Onion (*Allium cepa*L.) is third largest produced vegetable in the world. Onion contains good medicinal compounds for cataract, cardiovascular disease and cancer due to its hypocholesterolemic, thrombolytic and antioxidant effects. Processing and preservation of onion is very important for improving financial status of farmers. Onions are commonly dried with convective drying by hot air which is costly and inefficient causing longer drying time and high expense of energy. Keeping this in view, various types of treatments comprising combination of different technologies are applied as vacuum drying followed by infrared drying, convection drying (forced air convection type)followed by infrared drying in infrared bulb dryer, Set 1 of microwave dose followed byconvection drying, Set 2 of microwave dose followed byinfrared drying, Set 3 of microwave dose followed byvacuum drying. Combination of technologies was also optimized for decreased drying time and high product and reconstitution quality for dehydrated onion slices compared to convective drying. The effect of different combinations and technologies for onion drying is studied on dehydration ratio,

rehydration ratio, % water in rehydrated sample, co-efficiency of reconstitution and colour of the dehydrated product. Onions subjected to microwave followed with convection drying showed good colour retention and microwave followed with infrared showed highest value of dehydration ratio, vacuum drying followed with infrared showed highest value of co-efficiency of reconstitution.

S4P21A150

Effect of holding solutions and gamma radiation on vase life of chrysanthemum (*Chrysanthemum morifolium*R.) Cv. Little Pink

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A study was undertaken to evaluate the effect of different holding solutions in extending the vase life of chrysanthemum flowers cv. Little Pink obtained from plants treated with varying doses of gamma radiation (1-4.5Kr) placed in six different holding solutions viz., distilled water, two levels of citric acid, hydroxyquinoline sulphate,silver nitrate and tea extract. It was observed that both, doses of irradiation as well as holding solutions, have an independent highly significant effect on enhancing the vase life of chrysanthemum cut flower. Further it was also observed that effect of the interaction of two parameters on the vase life of flower has also been significant. The results have revealed that the maximum vase life of flower, maximum vase life of leaves, total solution uptake was observed to be the highest for the plants treated with 1Kr gamma radiation and their flowers placed in T3 (HQS 200 ppm) holding solution. Maximum fresh weight of flower as well as dry weight of flower was recorded in the treatment 1Kr with T2 (Citric Acid 300 ppm). Citric acid and HQS are easily available and economically affordable and thus, can be used on commercial level by florists, farmers and also for further experiments.

S4P22A154

Effect of embedding media and drying method for dry flower of Dutch roses

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Rose belongs to the family Rosaceae and genus Rosa. The genus Rosa comprises nearly 120 species and 30,000 cultivars. Rose flowers are diverse having exquisite shape, size, beautiful colors and delightful fragrance. In India roses are grown for cut flowers, for making garlands, bouquets, in flower arrangement, vase decoration, hair adornment, for worshipping, to prepare gulkand, pankhuri and to extract essential oil, attar and rose water. The experiments were carried out during the year 2013-14 and 2014-15 at University Department of Horticulture, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra to find out suitable drying technique for Dutch roses.

Maximum dry flower weight, difference in flower weight, per cent loss of moisture, diameter of dry flower and reduction in diameter of flower was observed when tight bud stage flowers were dried by embedding in silica gel and minimum in half bloom stage for the same during both the years. A half bloom harvest stage flower of Gold Strike dried by embedding in silicagel recorded maximum loss of moisture, while it was minimum in tight bud harvest stage flowers of Bordo. Half bloom stage flowers of Gold Strike embedded in silica gel recorded maximum per cent loss of moisture, per cent reduction in diameter of flowers. Half bloom stage flowers of Gold strike took minimum time when embedded in silica gel for drying, while it was maximum when tight bud stage flowers of Bordo were air dried. Drying of flowers of Tropical Amazon at half bloom stage by embedding in silica gel recorded maximum sensory score for colour, appearance, shape, and acceptance whereas texture and brittleness was found by embedded drying in sand in comparison with tight bud stage flowers dried by air drying method. Half bloom stage of harvest and silica gel as embedding medium is significantly superior over all other stages and drying methods.

S4P23A155

Effect of ethylene on ripening behaviour of banana. cv. SafedVelchi.

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An investigation on the effect of ethylene over ripening behaviour of banana. cv. Safed Velchi was undertaken at the Department of Horticulture, College of Agriculture, Dapoli during May to July, 2012. The experiments were laid out in CRD with seven treatments *viz*., T_1- 100ppm ethrel; T_2- 200ppm ethrel; T_3- 300ppm ethrel; T_4- 400ppm ethrel; T_5- 500ppm ethrel; T_6- Lime application; T_7- Control. Banana bunches were harvested at 135 days after flowering, i.e. proper stage of maturity and utilized for ripening study at ambient storage condition.Across different concentrations, ethrel helped in enhancing ripening of banana fruit i.e. advancement of days. However, the shelf life of fruit in T_5 (6.33 days) was observed to be less followed by T_4 (6.67days). Therefore, increase in concentration of ethylene may reduce the shelf life of banana.In commercial point of view if farmer wants to ripe banana (cv.Safed Velchi) as per market demand within 5-7 days after harvesting, then fruit should be treated with 500ppm ethrel; within 8-10 days, then it should be treated with 400ppm ethrel; within 10-11 days, then it should be treated with 300ppm ethrel; within 11-12 days, then it should be treated with 200ppm ethrel; within 12-13 days, then it should be treated with 100ppm ethrel; within 14-15 days, lime application treatments were found to be beneficial.Thus, ripening of banana fruits can be hastened by 6 days depending upon requirement by treating the fruits at appropriate concentrations of ethrel.

S4P24A256

Value chain analysis of kinnow cultivation in North-Western India

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The recent re-emergence of agrarian crises has again drawn the attention of policy makers towards diversification.Kinnow cultivation is one of such important crops which has obtained the status of important orchard crop in Punjab, Rajasthan and Haryana, is credited to bring golden revolution in North-Western India.During 2004-05 to 2014-15 kinnow area was 19360 ha to 48182 ha and production

has increased from with 290400 to 1108618 tones (NRCC, 2015). This shows the higher adoption of crop by the farmers.Thus present study is attempts to examine the production, marketing, Financing (along value chain), risk and their mitigation staratigies along value chain of one of the alternative and diversify crops (i.e kinnow) considered for the farmers in these states.The major value addition practices are cleaning, grading and waxing, which increase the self life kinnow fruit more than one month. The study have been carried out in Fazilka, Bathinda and Sirsa district of Punjab and Haryna with a sample of 180 farmers selected equally from three villages in two tehsils of the districts. The study revealed that kinnow is profitable crop as benefit-cost ratio and net present value at10per cent rate of discount were worked out to be 1.67, Rs. `264354 andinternal rate of return 31 per cent. The study also reveals that the channel with least number of intermediaries was found to be most efficient as compared with the channels with more number of middlemen. The farmers get finance from internal value chain and external value chain financing. The study also shows that the farmers which are linked with value chain; have better option for taking credit with low interest rate. The major risks faced by the farmers were natural events and disaster,pest and diseases andchange in output price. The mitigation strategies adopted by the farmers wereinvestment on new equipment,personal savings and crop diversification. The farmers faced various problems such as inefficient marketing process and lack of storage facility, etc. The study suggested that in order to realize the benefits of such new crops, there is need to regulate the markets with better marketing facilities, better credit facilities, development of producer organization and better extension service for diseases and pest, contract. Besides, development of kinnow agro-processing industry can go a long way for enhancing and stabilizing profitability in the kinnow production.

S4P25A305

Antimicrobial activity of leaf extract and essential oil in betelvine(*Piper betle*) cultivars

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Medicinal plants have been used for preventative and curative purposes from prehistoric times, particularly in South Asian countries.*Piper betle* L., commonly known as betel vine, belongs to the familyPiperaceae. The leaves are widely used in traditional medicine for treating stomach ailments, infections, in catarrhal & pulmonary affections, and, as a general tonic, digestive and carminative. In the present study, antimicrobial activity of betel vine was assessed in the methanolic leaf extract and essential oil in leaf.Cultivars Godi Bangla, Desawari, Swarna Kapoori, Meetha Pan and Halisar Sanchi were collected from IIHR-Central Horticulture Experimental Station (CHES), Hirehalli, Tumakuru, Karnataka. Antibacterial activity was tested against six bacterial pathogens human of humans, namely,*Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Lactobacillus acidophilus, Propionibacterium acnes*& *Streptococcus mutans.*Antifungal activity was tested using

Candida albicans at various concentrations of the methanol extract and the essential oil, using minimum inhibitory concentrations (MIC), minimum bactericidal concentration(MBC) and minimum fungicidal concentration (MFC) assays.MIC of bacterial pathogens in the leaf extract ranged from 0.156mg to 5mg/ 100µl, and that of the fungal pathogen was 0.625mg/100µl in all the cultivars. Leaf extract showed significant antimicrobial activity in all the cultivars tested. Cvs. Desawari, Swarna Kapoori, Meetha Pan and Halisar Sanchi showed greater antimicrobial activity against *P. aeruginosa*, with MIC of 0.156mg/100µl. MIC of essential oil against bacterial pathogens ranged from 0.048mg to 10mg/ 100µl, and that of the fungal pathogen *C. albicans*was 0.078mg to 10mg/100µl. 'Swarna Kapoori'was found effective against *E. coli*, *S. aureus*and*P. acnes*, while,Meetha pan was found effective against the fungal pathogen *C. albicans*, with the lowest MIC values. Methanol extract of cv. Godi Bangla against *P. aeruginosa* and Desawari against *S. mutans* showed no bacterial growth, exhibiting bactericidal activity. Similarly, essential oil from cvs. Godi Bangla and Swarna Kapoori was found bactericidal against*E. coli*. Essential oil from'Meetha Pan'had significant bactericidal activity against *P. aeruginosa* and *S.aureus*.Higher antimicrobial activity was recorded in the essential oil than in the leaf extract.

S4P26A324

Studies on effect of drying, super-critical extraction and microencapsulation on 6-gingerol and 6-shogaol content in ginger cv. Rio de Janeiro

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The aim of this investigation was to standardize a process technology and to study the effect ofdrying,supercritical extraction (SC-CO_2) and microencapsulation on the quality of ginger oil (6-gingerol and 6-shogaol, the bio-active components present in ginger). Fresh ginger rhizome slices contained 2.4% and 0.12% of 6-gingerol and 6-shogaol, respectively. Experiment on drying was conducted by slicing the ginger rhizomes into 2±0.5 mm slices. Variables selected for drying were: pre-treatments [dipping in 2% ethyl oleate (EO) + 5% potassium carbonate solution (K_2CO_3) for 1 min; dipping in 0.3% sodium metabisulphate + 1% calcium chloride solution for 10 min; Control], and drying methods (open-yard sun drying; solar-tunnel drying and dehumidified-air drying). Optimal pre-treatment and drying method worked out to be dipping in 2% EO + 5% K_2CO_3 with dehumidified-air drying ata maximum conc. of 8.06% and 0.43% of 6-gingerol and 6-shogaol, respectively. Variables selected for SC-CO_2 extraction were: milling methods (normal pulverizer, water-cooled pulverizer and liquid-nitrogen milling) and co-solvents (ethanol, methanol and n-hexane). Optimal milling method and co-solvent were found to be liquid-nitrogen milling and ethanol co-

solvent,yielding the maximum 6-gingerol and 6-shogaol content of 17.55% and 0.97%, respectively. Variables selected for microencapsulation of ginger oil, namely, coating materials [gum Arabica (80g); gum Arabica +maltodextrin+modified starch (53.6+12.8+12.8 g); and, sodium alginate+chitosan (26.7+53.4g)), and, inlet air temperature (150, 160 and 170ºC) along with 20ml ginger oil. Optimized bio-active components (6-gingerol and 6-shogaol) in the microencapsulated ginger powder were found in concentrations of 8.2% and 0.52%, respectively, using sodium alginate + chitosan as a coating material at 170ºC.

S4P27A363

Nanotechnology as a tool to improve the vase life of cut flowers

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Nanoparticles and nonporous materials can be used to carry ethylene action inhibitors, control growth and development of microorganisms and introduce a new generation of packaging coverage that controls gases and harmful UV rays while increasing strength, quality and packaging appearance. Nano silver formulations of different producers differ in their particle sizes, color, pH and odor. Since the antibacterial activity of NS is partly a function of particle size. Recently nanosilver (NS) was tested as a pulse and vase solution treatment for cut flowers and has been reported to be effective as an antimicrobial agent and as an ethylene inhibitor. Nano silver particles (NS) are used in various applications as anti microbial. Their use as a pulse and vase solution treatment for cut flowers is relatively new. Studies have investigated the effectiveness of NS in extending the vase life of some cut flowers, including carnations, gerberas,Lilium and roses. The positive effect of a NS pulse treatment was attributed to inhibition of bacterial growth in the vase solution and at the cut stems ends. However, physiological activity of Ag+ from NS is also a possibility as with other cations (e.g. K^+, $Ca2^+$), Ag+ can have positive effects on plant stem hydraulic conductivity. Also, Ag+ is considered to be a general inhibitor of aquaporins, improving water relations. Besides antibacterial and acidic effects, NS could act as anti-ethylene agents.

S4P28A405

Role of botanicals in extending vase-life incut flowers

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A ‘botanical’ is a plant or plant-part valued for its therapeutic properties, flavour or scent. Products made from botanicals used for maintaining or improving health are called botanical products or phytomedicines. These days,synthetic germicides such as silver

thiosulphate (STS), silver nitrate ($AgNO_3$) and 8-hydroxyquinoline citrate (HQC) are expensive, and not easily available in the local market. Germicidescontaining silver can pollute the environment and damage human health. Thus, it is important to develop natural preservative solutions from sources of biological origin as alternative biocides to extend vase-life of flowers.Essential oils are aromatic, oily liquids extracted from various aromatic plant-parts such as flowers, buds, seeds, leaves, twigs, bark, wood, fruits and roots. It isthe organic natural compounds that have strong antimicrobial properties against pathogens owing to their high levels of phenolic compounds such as carvacrol, thymol and eugenol. The antifungal mechanism of essential oils is due to inhibition of DNA, RNA, protein and polysaccharide synthesis. Use of herbal essential-oils can delay aging in flowers and improve their durability through a reduction in microbial populationsin the solution and stem-end, therby improving water uptake.*Piper betle* leaf extract positively influenced factors affecting vase-life in cut-flowers. It also improved flower quality by increasing solution uptake and lowering microbial load/ vascular blockage.

S4P29A432

Anthocyanin profiling and determination of antioxidant activity insome coloured grape hybrids

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Anthocyanins, belonging to the flavonoid group of polyphenols and often used as natural food colourants, are currently in demand as an important food constituent, mainly due to their health promoting attributes. The present study was conducted on 11 newly-developed, coloured grape hybrids byICAR-IARI, New Delhi. Efforts were made to identify and determine the levels of various anthocyanin fractions. HPLC chromatogram indicated ten peaks for anthocyanins, which varied significantly from 37.68 to 247.68µg g^{-1} in terms of C3G equivalent. Maximum peak height was seen inPeak-5 representing malvidin-3-glucoside. Maximum anthocyanin content was observed in'Hy.16/2A-R_1P_{18}'. Antioxidant activity in the hybrids was measured using three different assays, i.e., DPPH, FRAP and CUPRAC. Hybrid 'Hy.16/2A-R_1P_{19}' was the most potent antioxidant-rich genotype in terms of FRAP and CUPRAC, and also showed the second highest DPPH activity, after 'Hy.ER-R_2P_{36}'. Statistical analysis was performed using SPSS 12. Means were compared using Duncan's Multiple Range Test. Genotypes identified in terms of their potential for higher levels of bioactive compoundsmay offer protection against various chronic diseases, andcan be further used for improving other grape genotypes.

S4P30A513

Yield and quality of *Nata-de-coco* as influenced by substrates and additives

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Coconut(*Cocos nucifera* L) contains a unique range of oils, protein, carbohydrates including dietary fibre, sugars, minerals, water and an aqueous sap from inflorescence. The price of raw coconut is decided by the price of copra and oil in the international market. Coconut water is an important by-product of copra and oil industry, which is merely, wasted at the copra production centres. Bacterial cellulose produced by *Acetobactor xylinium* at the air liquid interface of coconut water is popularly known as *Nata-de-coco*. It is a chewy, translucent, jelly like foodstuff prepared by fermentation of matured coconut water. It is mostly sweetened as a candy or dessert, and can accompany various stuffs like drinks, ice cream, puddings and fruit mixes. *Nata* is gaining popularity because of its high dietary fibre content and low calorific value.Raw *Nata* is transparent without any colour and flavour.. Screening of different substrates and improving colour and flavour of *Nata-de-coco* by adding underexploited tropical fruits and vegetables and addition of natural flavours can go long way in improving palatability and consumer acceptability of the product. An experiment was conducted to evaluate the suitability of substrates and additives to improve yield and consumer acceptability of *Nata-de-coco* using different fruit juices. Among various fruit juices used as substrates, more yield of *Nata* was obtained when coconut water was blended with watermelon juice. The *Nata* produced was organoleptically best when coconut water was *blended* with pineapple juice. Quality in terms of texture and appearance was superior when coconut water was blended with lovi-lovi juice.

S4P31A518

Ultrasonication: an advanced technology for food preservation

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Nowadays many traditional methods like pasteurization, sterilization and drying are used for food preservation. These methods pose some problems like loss of nutrients and

vitamins, enzymatic browning, prolonged processing time, fruit juice suspension and microbial spoilage. The demand for high quality food in terms of natural flavour and taste, free from additives and preservatives, has spurred the need for the development of a new food processing technology. Sonication is one of the advanced technologies which can overcome these problems. Sonication is a non thermal technology in which sound waves having frequency more than 18 kHz are applied for processing and preservation of food without affecting the nutritional quality. Increasing consumer demand for minimally processed food products having good quality, natural flavour and taste which are free from additives and preservatives, paves the way for the development of non-thermal food preservationmethods. Ultrasound proves its potential applications for fresh horticulture products in drying, fruit juice extraction, detection of foreign bodies, filtration and to control microbial contamination without compromising with their quality aspects. Thus, ultrasound can be one of the viable techniques for quality assurance and food safety.

S4P32A535

Packaging and storage condition of cauliflower (*Brassica oleracea var. botrytis*) to enhancemarketable period.

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Five packaging treatmentsviz., perforated HDPE, non-perforated HDPE, perforated LDPE, non-perforated LDPE and cling film were used for packing cauliflower and stored in cold storage (0-2°C, R.H. 90-95%) and cool bot cool room (8-10°C, R.H. 55-60%). The effect of the packaging material and the storage conditions on the physiological loss in weight (PLW), colour, texture and firmness, spoilage and marketability, ascorbic acid content, acidity and total soluble solids were studied at definite intervals. Perforated HDPE maintained the best post-harvest life of 31 days followed by perforated LDPE in cold storage with no significant difference between them. Till the 14th day of storage, the cauliflower in the cold storage packed in non-perforated HDPE had the least PLW (0.03%), excellent colour rating of 4.9 and good texture and firmness with a rating of 4.89 was observed with perforated HDPE in cold storage. The ascorbic acid content of the cauliflower till 14 days of cold storage was 30.76 mg/100g and 30.23mg/100g in perforated HDPE and perforated LDPE packaging respectively as compared to 42.25 mg/100g in freshly harvested cauliflower. Similarly the TSS of the cauliflower till 14 days of cold storage was 7.25 and 7.21°Brix in perforated HDPE and perforated LDPE packaging respectively as compared to 7.8°Brix in freshly harvested cauliflower.The least increase (0.16 to 0.25 mg/ml) in acidity was observed in perforated HDPE followed by perforated LDPE pack till 14 days of cold storage. There was no significant difference between the performance of perforated HDPE and perforated LDPE in different cold storage condition.

4P33A550

Improving post harvest quality and shelf life of rainy season guava (*Psidium guajavaL.*) by application of various pre harvest treatments

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Post harvest quality of rainy season guava crop is a major factor considered among guava growers and traders. These fruits are very poor in quality, having poor shelf life and fruits are infested with pests and diseases particularly fruit flies and anthracnose.To overcome these problems, the study on the effect of pre harvest treatments on post harvest quality of rainy season guava cv. 'L-49' was carried out during June. The study consists of nine pre-harvest treatments viz. $CaCl_2$ 2%, $CaSO_4$ 2%, Polythene bag, Brown paper bag, $CaCl_2$ 2% + Polythene bag, $CaCl_2$ 2% + Brown paper bag, $CaSO_4$ 2% + Polythene bag, $CaSO_4$ 2% + Brown paper bag and Control. The treated fruits were harvested at fully ripe stage and stored at ambient condition. Pre harvest treatment of $CaCl_2$ 2% + Polythene bag proved the most efficient in improving shelf life and fruit quality with respect to fruit size, weight, firmness, TSS, ascorbic acid, sugars and TSS : acid ratio, free from blemishes of pathogen and attack of fruit flies. Combination of $CaCl_2$ 2% + polythene bag showed the lowest physiological loss in weight of guava fruits. Fruits with this treatment can be stored up to 9 days against 4 days in case of untreated fruits when stored under ambient temperature condition. It can be concluded that the combination of pre harvest treatment with $CaCl_2$ 2% + Polythene bag is suggested to the guava growers and traders to get a profitable price.

S4P34A596

Development of nutraceutical beverages of ginger

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Ginger (*Zingiber officinalis*) is an important commercial crop belonging to the family Zingiberaceae, grown for its aromatic rhizomes which are used both as spice and medicine.It is one of the excellent spice crops cultivated in Asia and India, accounting for 50 % of the world's ginger production. Kerala has a prominent position as a ginger growing state and produces Cochin and Calicut ginger renowned for their intrinsic qualities. Though ginger has

versatile applications, the extent of value addition and product diversification is very limited at present. Therefore, an investigation was carried out to prepare therapeutic beverages such as ginger Ready – to – Serve (RTS), ginger - lime RTS, ginger - lime - aloe RTS and squash of ginger extract blended with acid lime. The RTS prepared from different proportions of ginger extract, sugar and water revealed that the treatment containing15% ginger extract and 15% sugar formed the best product in terms of overall acceptability. In case of ginger lime blended RTS, the treatment containing equal quantities of ginger extract and lime juice (50 g) with 20 % sugar resulted the best product with highest organoleptic score followed by the treatment containing 50 g ginger extract, 40 g lime juice, 150 g sugar and 760 ml water. Blended RTS beverage containing 50 g ginger extract, 40 g lime juice, 10 g aloe vera juice in combination with 15 % sugar was organoleptically superior. Blended squash prepared from ginger and acid lime containing 100 g each with 800 g sugar and 200 ml water was the most acceptable in terms of colour, flavor and body.

S4P35A617

Medicinal *Kaempferia* species: emerging drugs

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Medicinal *Kaempferia* species belongs to the family Zingiberaceae. The genus contains approximately 50 species distributed from India to Southern China and Malaysia which are source of valuable bioactive compounds. Among them, *K. parviflora*, *K. rotunda* and *K. galanga* are mostly used for medicinal purpose. *K. parviflora* also known as Thai Ginseng is an important medicinal plant under this genus, indigenous to the north-eastern part of Thailand. Rhizomes of *K. parviflora* have been used as traditional medicine for rectifying male impotence, body pains and gastrointestinal disorders among local people of Thailand. Methoxyflavones are the major pharmacologically active constituents reported in this species. In India it is found growing wild in Manipur and Nagaland. *K. rotunda* is an important medicinal plant in the ancient system of traditional medicine in India and Indonesia used against abdominal pain, wounds, diarrhoea and colic disorder. The main bioactive constituent is cretopoxide useful in inhibition of tumors. *K. galanga* is a highly priced medicinal plant from this genus which forms a component of over 59 ayurvedic medicines and is extensively used in pharmaceutical industries, perfumery, cosmetics and as spice ingredients.There are only few studies available on the breeding systems and pollination mechanisms of these species. Taxonomic identification to the species level is difficult in this genus without floral parts. These species which have potential for commercial exploitation are at present collected from wild which may lead to their extinction. Extensive studies on the growth and development and pharmacological properties are required for further cultivation and utilization of these under exploited *Kaempferias* in medicine.

S4P36A635

Influence of water balance on vase life of cut flowers in Gerbera

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Gerbera is one of the important commercial flower crop. It is gaining popularity among the flower connoisseurs for its flower colour, form and size which are suitable in varied floral flower arrangement. As we have observed that every year several varieties are being introduced in the country and cultivated. Commercial viability of any cut flower variety in the market needs to be evaluated for an important parameter viz.vase life.This parameter is highly influenced by both pre and post harvest factors which further influence the freshness of the cut flowers as a result of water balance through uptake of water and transpiration loss of water. Therefore in the present study, vase life of cut flowers of five recent varieties of gerbera was evaluated. Flowers harvested at ray floret fully expanded stage were evaluated in distilled water under room temperature (26^{o}-30^{o}C) and relative humidity (45-58%). Results revealed that maximum vase life of 10days with larger flower diameter of 11.4cm and a very good stem strength were obtained in var. Rosalin cut flowers which showed the higher water balance of 2.4g, fresh weight of 20g,water uptake 9.2 and transpiration loss of water of 6.8g. Cut flowers of gerbera var. Dana Ellen exhibited shorter vase life of 8.4 days with smaller flower diameter of 10.3 cm and poor stem strength, negative water balance of -1.6g, lower fresh weight of 15g ,water uptake of 7.8g and transpiration loss of water of 9.4g.

S4P37A133

Shelf life studies in sweet orange cv. Nucellar at low temperature (at 6-7°C) storage

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An investigation on the shelf life studies in sweet orange cv. Nucellar was conducted in the laboratory of Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during 2011-12. The treatments are classified on combination of Gibberllic acid 100ppm with 6% and 12% wax emulsion, fruits were packed in modified atmosphere packaging with 5% vents and without vents, treated fruits were stored at low temperature. The result showed that, at the 70th day of storage minimum per cent loss in weight (9.27 per cent) and the minimum decay loss (9.26) of fruit was recorded in the treatment T_1 i.e. MAP with vents + GA_3 100 ppm + 6 % wax. Maximum TSS content of fruit (12.54 per cent)

was found in treatment T_{10} i.e. MAP without vents + GA_3 100 ppm +12 % wax . The maximum acidity was found in the treatment T_1 (0.49 per cent), whereas the maximum reducing sugar (5.19%) and total sugar (12.03 %) were found in T_{10} i.e. MAP without vents + GA_3 100 ppm +12 % wax. The maximum ascorbic acid (44.53mg/100ml juice) was recorded in T_1. From the present investigation, it can be concluded that the fruits treated with the treatment T_1 $GA_3$100 ppm in combination with 6 % wax, packed in 100 gauge polyethylene bags and stored at low temperature was found significantly more effective to increase the shelf life up to 69 days of sweet orange fruit.

S4P38A178

Effect of pre harvest foliar spray of growth regulators on pre and post harvest parameters in ornamental sunflower genotype M-17R

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An experiment was conducted to study the effect of pre harvest foliar application of growth regulators on the pre and post harvest flower quality in ornamental sunflower during the year 2012-13, at College of Horticulture, GKVK campus, UHS, Bagalkot. At 60 DAS highest plant height was with GA_3 @ 150 ppm (154.73 cm) followed by GA_3@ 200 ppm (146.20 cm) and GA_3 @ 250 ppm (145.53 cm).Sodium silicate @ 250 ppm (4508.77 cm^2) registered maximum plant spread at 60 DAS. Foliar application of GA_3 @ 150 ppm (25.00) produced highest number of leaves which was at par with Sodium silicate @ 250 ppm, GA_3 @ 200 ppm and GA_3 @ 250ppm recording 24.87,24.80 and 24.67 leaves respectively. Calcium sulphate @ 200 ppm registered highest leaf area of (4930.30 cm^2) which was at par with Sodium silicate @ 250 ppm, Calcium sulphate @ 300 ppm, Chlormequat chloride @ 500 ppm,Sodium silicate @ 350 ppm, and Chlormequat chloride @ 1000 ppm with 4792.64,4735.04, 4721.75, 4503.05 and 4430.02 cm^2 respectively. Gibberellic acid (GA_3) @ 150ppm favoured longest flower stalk length (35.93 cm) followed by GA_3@ 200 ppm (35.53 cm). Sodium silicate @ 250 ppm significantly increased the flower head diameter (11.37 cm).Total number of marketable flowers per hectare increased with the foliar application of Sodium silicate @ 250 ppm (11.55) lakh flowers ha^{-1}followed by Sodium silicate @ 350 ppm (10.93) lakh flowers ha^{-1}.Sodium silicate @ 250 ppm increased the post harvest vase life of cut flowers (5.90) and was at par with Sodium silicate @350 ppm, Chlormequat chloride @ 1500ppm and Chlormequat chloride @ 1000 ppm recording 5.70, 5.67 and 5.53 days respectively. From the above results four best pre-harvest treatments selected for further studies were Sodium silicate @ 250 ppm, Sodium silicate @ 350 ppm, Chlormequat chloride @1000 ppm and Chlormequat chloride @ 1500 ppm

S4P39A233

Effect of different cooking methods on antioxidant activity of selected vegetables

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To determine the effect of different cooking methods on antioxidant activity of selected vegetables, six commonly consumed vegetables (potato, spinach, knolkhol (stem), cabbage, cauliflower and kale) were subjected to different cooking methods (steaming, boiling and microwave treatment) and their antioxidant activity was evaluated on the basis of total phenolic content, ascorbic acid content and total antioxidant capacity (measured by DPPH radical scavenging activity, FRAP and reducing power assays).In all the vegetables, cooking led to decrease in the above-mentioned parameters with decrease dependent on the type of cooking method and vegetable. The loss in these parameters was also found to increase with increase in cooking time, regardless of the method. Total antioxidant capacity and total phenolic content in cooked vegetables followed the order steamed > boiled > microwaved. However, in case of ascorbic acid content, cooked vegetables followed the order steamed > microwaved > boiled. In general, cooking results in loss of bioactive compounds and to obtain maximum benefits from these compounds steaming should be the method of choice and it is vital to reduce cooking time to conserve antioxidants.

S4P40A34

Use of chitosan to improve the production and quality of cut flowers

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Chitin isone of the most abundant natural amino polysaccharides extracted from the exoskeleton of members of crustacean's family and insect, fungal cell walls, etc and the deacetylated form of chitin is chitosan. Chitin and its derivatives have become a promising alternative treatment due to its natural character, antifungal activity and elicitation of defence responses in plant tissue. Due to its wide application, the use of chitosan in floriculture industry is gaining more importance in recent days which reported to act as a plant growth promoter in some flower crops including orchids. The degree of deactylation and concentration of chitosan had varying effects on the growth and development of orchid cultured *in vitro*. In gladiolus, corm treated with 1.5% chitosan increased the corm sprouting, numbers of flowers per spike, number of cormlets and vase life. Chitosan in combination with citric acid and salicylic acid increased the vase life of gerbera flowers. In Curcuma (*Curcuma alismatifolia* × *Curcuma cordata*) foliar application of fertilizers along with 80 mgL^{-1} chitosan lead to increase in plant height, number of leaves per plant, inflorescence length, diameter of rachis, and diameter of peduncle. Chitosan spraying significantly reduced the severity of leaf spot disease in orchids. Application of chitosan to *Dendrobium* orchid increased the size of florets and length of the inflorescence, but did not affect the display life of cut orchid.

Regardless of the molecular weight of the compound, chitosan treated freesia plants had more leaves and shoots, early flowering, and formed more flowers and corms. Thus chitosan had a positiveinfluence on productionand quality of cut flowers.

S4P40aA40

Brewing waste: A potential source of bioplastics

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A large amount of agro-industrial waste is produced annually around the globe from beneficiated agricultural products or in food industrialization. Due to its significant nutritional value and high concentration of organic compounds confers a high biochemical oxygen demand to the waste's degradation. Brewing industry is among these activities, which includes in its production stage, the processing and fermentation of sugary fruit and vegetable feedstocks like barley malt other grains and generating several products. Materials derived from biological sources including starch, cellulose, fatty acids, sugars, proteins, and other sources can all be consumed by microorganisms, especially by bacteria which can convert these raw materials into various monomers that are suitable for polymer production. These monomers have been used to produce various bio-based plastics including Poly Lactic Acid. These polymers often are biodegradable and thus considered sustainable, environmentally friendly, and less petroleum dependent. In this study, first lactic acid fermentation occurs and lactic acid bacteria metabolize the sugars present in brewery waste. Lactobacilli culture was grown in an oven at 37 ˚C for 40-72 hours. Two filtration methods were implemented in the overall filtration process, a two-stage strainer and a vacuum filter with 0.45 µm filter papers. The lactobacillus and other small contaminants were removed from the samples after using the vacuum filter, ending the production of lactic acid in the sample. The polymerization temperature of lactic acid is approximately 120 ˚C and above this temperature individual lactic acid molecules start to polymerize and form polylactic acid. Samples were heated to 150˚C and monitored over a two hour period to yield an amorphous polylactic acid with a low degree of polymerization. Further polymerization methods will be pursued in future research.

S4P41A48

Effect of fruit thickness and different syrup concentration on osmotic dehydration of carambola(*Averrhoa carambola L.*)

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The present investigation to study the effect of fruit thickness and different syrup concentration on osmotic dehydration of carambola (*Averrhoa carambola*L.) using sugar as an osmotic agent was carried out during the year 2016-17.The experimental variables selected for optimization of syrup solution concentration and fruit thickness consists of four concentrations of syrup viz., 60, 65, 70, and 75 ° Brix, and two fruit thickness of 0.5 cm and 1 cm. An increase

in syrup concentrations from 60 ° to 75 °Brix with 0.5 cm fruit thickness increased the weight loss, solid gain and dehydrated yield of carambola segments. Among the treatments steeping of 0.5 cm segments in 75 °Brix syrup recorded maximum moisture loss (64.44 %), maximum weight loss (57.64 %), superior solid gain (9.8 %) and highest dehydrated yield (18.44 %).

S4P42A49

Natural food colours from horticultural crops

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Natural source of food additives play a prominent role in improving human health conditions. Pigments of plant origin are gaining importance globally as a potential source of natural food colours for their versatility and so as to avoid a variety of health hazards caused by synthetic colours. Natural food colour is any dye obtained from any vegetable, animal or mineral, that is capable of colouring food. Plant based colours come from various parts of the plants. The leaves, roots, flowers, fruits all provide colouring agents. Some horticultural crops like turmeric, annato, saffron, paprika, marigold, corn flower and so on can be utilized for extraction of chlorophyll, anthocyanin and carotenoids to colour the food. The general health trend continues to be significant in the years to come. The demand on the natural colour industry will not only be for organic colours but also for a generally higher level of information with regard to production methods, specifically HACCP, as well as traceability of all ingredients. FAO is responsible for regulating the natural food colours which are safe to eat. So the quality criterion is an important factor for using natural food colours.

S4P43A56

Effect of shrink wrap packaging on shelf life of passion fruit (*Passifloraedulis* Sims.)

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Mature yellow type passion fruit were used at the turning stage for evaluating shelf life and quality through shrink wrap packaging. Fruits free of damage and bruises, were washed in clean tap water followed by immersion in 100 ppm chlorine solution for 15 minutes. The chlorinated fruits were spread out on perforated trays to remove excess surface moisture.The surface dried fruits were subjected to two forms of shrink wrapping *viz.*, shrink wrapping of individual fruits and also shrink wrapping of areca plates containing fruits using 15, 19 and 25µ thickness polyolefin film. Shrink wrap packaging of passion fruit (wrapped individually

and also in areca plates) prolonged the shelf life significantly. Individual shrink wrapping of passion fruit gave significantly longer shelf life as compared to fruits wrapped in areca plates and control, irrespective of the film thickness. Individually shrink wrapped passion fruit with 25µ thickness polyolefin film gave highest shelf life (26.66 days) whereas the lowest shelf life (7.00 days) was observed in control samples (unwrapped fruits). Fruits wrapped in areca plates became unmarketable after two weeks of storage, irrespective of the film thickness. Physiological loss of weight (PLW) increased in all the treatments during storage. Biochemical constituents such as, total soluble solids (TSS), reducing, non-reducing and total sugars increased, while, titratable acidity, vitamin C and total carotenoids decreased in all the treatments during storage. Total phenols and total flavanoids increased during first week and decreased during subsequent weeks. Sensory quality of passion fruit improved during storage.

S4P44A114

Use of eco-friendly biocide to enhance vase life and post-harvest quality of cut stem of Bird of Paradise (*Strelitzia reginae*Ait).

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Bird of Paradise is presently well known and popular cut flower, provides exotic view and touch to a special event due its remarkable appearance. The florets of the flower are covered with hard boat shaped bract which is a hindrance to open the florets in vase. Vase solution containing sugar and biocide helps to open the florets. But most of the biocides used in commercial floriculture industry are not safe for our ecosystem. Due to presence of heavy metals, application of few biocides have been banned as a possible pollutant. Some of the compounds such as silver nitrate and silver thiosulphate have shown environmental risks and health hazards. While others such as hydroxyquinoline have shown plant phyto-toxic effects. Therefore, laboratory experiment was conducted during 2012-13 to find out an alternate non-toxic and inexpensive compound for large scale application in floriculture industry.In the present study cut stems of Bird of Paradise were kept in vase solution of different treatment combinations of sucrose, aluminium sulphate and citric acid including the recommended vase solution (10 per cent sucrose + 150 ppm citric acid + 250 ppm 8-hydroxyquinoline citrate) and control (distilled water). Perusal of data reveals that cut stems treated with vase solution of 2 per cent sucrose + 300 ppm $Al_2(SO_4)_3$ is best for number of florets open/stem, per cent of floret open, vase life and other physiological and quality parameters.The result also indicated that aluminiumsulphate is a safe and eco friendly biocide that can be widely used in floriculture industry.

S4P45A131

Effect of post harvest application of different chemicals and packaging materials on shelf life of pear cv. Punjab Beauty

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Present study was undertaken in the laboratory of Department of Horticulture, Khalsa College, Amritsar during the year 2015-16. The fruits of semi-soft pear (*Pyrus communis)* cv. Punjab Beauty were harvested from the healthy trees at physiologically mature stage in the last week of July from a well maintained Govt. Orchard and Nursery, Attari Dist, Amritsar. Study comprised of seven treatments as $Cacl_2$(1,2 and 3%),GA_3 (25,50 and 75 ppm) and control. Two kg of fruit was selected for laboratory analysis for each treatment and these fruits were dipped in different concentrations of $Cacl_2$ andGA3,however, fruits were dipped in plain water under control. Then the fruits were packed in CFB and wooden boxes and kept under cold storage at 0° to 3.3°C and 90% relative humidity. The fruits from each treatment were analysed for physico-chemical characteristics after 0, 20, 40 and 60 days of cold storage period. The results revealed that $Cacl_2$ 3% was found to be significant in prolonging the shelf life of soft pear fruits than all other treatments and also maintained the marketable acceptability up to 40 days of storage under CFB by retaining the fruit firmness, reducing PLW and spoilage losses than control.

S4P46 A148

Characterization of sweet and bitter apricot (*Prunus armeniaca* L.) kernels for quality performance

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Apricot kernels procured from local dealers of Kashmir valley were analyzed for proximate composition followed by oil extraction using solvent extraction method. The proximate composition of kernels showed that sweet apricot kernel had high moisture content (6.2%) wheras crude fat, crude protein and crude fiber content was high in bitter apricot kernels (14.64, 34.52 and 3.63%respectively). Three solvents (petroleum ether, n-hexane and acetone) were used for oil extraction at different time and temperature combinations. Use of n-hexane

resulted in high oil yield in both sweet (39.16%) and bitter apricot kernels (36.57%). Extracted oil was further analyzed for chemical properties which showed that both types possessed similar properties in terms of specific gravity, peroxide value, iodine value, saponification value, acid value and refractive index and values recorded were 0.846, 5.22, 98.2, 189.53, 6.74, 1.46 respectively in sweet apricot kernel oil and values recorded were 0.863, 4.78, 98.72, 191.43, 6.79 and 1.47 respectively in bitter apricot kernel oil. The fatty acid profile showed that bitter apricot kernels had higher value of oleic, linoleic and linolenic acid as 68.23, 28.4 and 1.30 respectively.

S4P47A161

Efficacy of chitosan coating to control the post-harvest disease in fruit crops

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Chitosan, is a name given to deacetylated form of chitin, a natural biodegradable compound derived from crustaceous shells such as crabs and shrimps with polycationic nature. Chitosan has been proven to control numerous pre and postharvest diseases on various horticultural commodities. Both soil and foliar plant pathogens (fungal, bacterial and viral) can be controlled by application of chitosan. The use of synthetic fungicides in several countries after harvest is prohibited. Therefore, together with consumer demand for the food free from pesticide residue, the use of alternative means to combat postharvest decay of fruit has gained momentum. Chitosan possess properties of an ideal coating for fruit. Spraying of chitosan significantly reduces postharvest fungal rot and maintained the keeping quality of several fruits crops. Pre harvest spray of chitosan increases the fruit firmness and ripened at a slow rate as indicated by anthocyanin content and titratable acidity. Strawberries subjected to treatment with chitosan sustained better fruit quality with higher levels of phenolics, anthocyanins and flavonoids, reduced rhizopus and pencilium rot incidence than untreated fruits. Chitosan coated citrus fruits showed reduced incidence of botrytis, penicilium and maintained fruit firmness, exhibited less decay and weight loss, showed higher titratable acidity, ascorbic acid and total soluble solids than the non coated fruits. In papaya up to 60% reduction of Colletotrichum in chitosan coated fruits was observed. Mango fruits coated with chitosan reduced the incidence of postharvest disease loss. Pre-harvest application of chitosan reduced incidence of botrytis in grapes. The commercial chitosan formulations are easily accessible and therefore can be adopted to mitigate the post harvest diseases in major fruit crops. There is need to study the mode of action coupled with molecular approaches for better understanding the Chitosan efficacy in future research.

S4P48A179

Evaluation of ornamental sunflower for value addition

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An experiment was conducted at College of Horticulture, GKVK, campus, Bengaluru, UHS, Bagalkot during 2012-13 to study the suitability of ornamental sunflower for dry flower production. Highest flower weight loss was with corn meal and silica gel (90.75 and 88.45 per cent). Silica gel followed by borax powder took least number of days for drying of flower heads (9.40 and 12.60 days respectively). Colour retention in dried ornamental sunflower was highest with control treatment and silica gel with a score of 4.63 and 4.44. Flower appearance was best with silica gel (4.44) which was at par with control with a score of 3.81. Best texture score of (4.31) was with silica gel followed by control (shade), corn meal and alum powder which recorded 3.63, 3.31 and 3.25 respectively. Best flower shape after drying period as with silica gel (4.38).The results reveal silica gel and corn meal as best drying agents in ornamental sunflower

S4P49A212

Variability of antioxidant activity in fruits of *Annona* species

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Annonaceous fruit plants are well known for their antioxidant activity. Among this group, Bullock's heart (*Annona reticulata* L.), Sugar apple (*Annona squamosa* L.) and Soursop (*Annona muricata* L.)areimportant and these species are underutilized fruits grown in India. These three species are suited to varying agro-climatic conditions but they are maintained as a neglected crop in homesteads of Kerala. Hence considering theirimportance in antioxidant activity, a study was conducted in the Kerala Agricultural University during 2014-16 to assess the variability of antioxidant activity of fruits in the three species. The study involved survey of the trees in homesteads of central zones of Kerala covering Ernakulam, Thrissur and Palakkad districts. Growth, yield and quality parameters of 71 accessions in the age group of four to eight years were assessed during the study. The results indicated that antioxidant activity in Bullock's heart varied from 1.26 to 2.86 mg of ascorbic acid/g of sample, having a CV of 19.45 per cent. In custard apple it ranged between 1.64 to 2.86 mg (CV of 16.54 %) of ascorbic acid/g of sample. Whereas in soursop, the antioxidant activity was in the range of 3.52 to 4.52 (CV of 6.95%) mg of ascorbic acid/g of sample. Considering the three species, it was evident

that the soursop (*A. muricata*) fruits contained maximum antioxidant activity. The soursop accessionAM 25 (4.5 mg of ascorbic acid/g of sample)recorded the maximum antioxidant activity among the 71 accessions evaluated. The study reveals that there is scope for selecting accessions having high content of anti oxidant activity so as to utilize them in anti-cancer treatment

S4P50 A311

Ultrasound waves: A novel technology in food industry

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Now-a-days several traditional, time-tested methods of food preservation like pasteurization, sterilization, drying, etc. are practised. However, these pose some problems like loss of nutrients/ vitamins, enzymatic browning, prolonged processing-time, fruit-juice suspension, microbial spoilage, etc. To overcome these problems, a green technology called sonication is now available. Sonication is a non-thermal technology in which sound waves of frequency exceeding 18 kHz are applied for processing and preserving food, without affecting its nutritional quality. Increasing consumer demand for minimally-processed food products of good quality, natural flavour and taste and free from additives/ preservatives has paved the way for the developing non-thermal methods of food preservation. Ultrasound waves prove their potential for application to fresh horticulture produce in drying, fruit juice extraction, detection of foreign bodies, filtration and control of microbial contamination, without compromising quality. Thus, ultrasound can be one of the viable techniques for quality assurance and food safety.

S4P51A312

Anthropometric considerations for farm tools/ machinery design for workers in central Chhattisgarh region

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Anthropometric body dimensions play a significant role in human-machine interaction. The overall working efficiency of human-machine environment and any resultant discomfort has a severe impact when using farm tools and machinery in the field. Our study presents anthropometric data on agricultural workers of Chhattisgarh that will help develop/ modify improved tools and machinery, suitable for the people of Central region of the State. A total of

952 subjects (548 male and 404 female) from 25 villages were selected at random from three districts. Thirty-four body dimensions useful for agricultural equipment design were selected and measured. Average weight of the female worker was found to be about 10.1% lower than the male agricultural worker, whereas, the average stature of the male was nearly 6.8% higher than that of the female. A similar trend was observed in most of the body-dimension measures. Comparison of the data collected with other neighbouring states suggested a non-significant difference among various body-dimensions. Efforts have been made to illustrate applications of anthropometric data for design of farm equipment with some examples.

S4P52A350

Effect of pre-treatments on quality in solar-dehydrated grape pomace

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This study was focussed on analyzing physico-chemical and nutritional quality of a solar-dried grape pomace as affected by eight chemical pre-treatments. Based on preliminary tests, grape pomace was dipped for 5 minutes in 1% (w/v) calcium chloride (T_1), 1% (w/v) citric acid (T_2), 1% (w/v) potassium metabisulphite (T_3), 2% (w/v) sodium chloride (T_4), and, 1% (w/v) citric acid+0.5% (w/v) potassium metabisulphite (T_5); 1% (w/v) calcium chloride+0.5% (w/v) citric acid (T_6); 1% (w/v) potassium metabisulphite+1% (w/v) calcium chloride (T_7); and, water solution (T_8). Quality characteristics of dehydrated grape pomace, viz., moisture content, TSS, sugars, titratable acidity, total polyphenols and anthocyanins content, recovery %, dehydration ratio, rehydration and reconstitutability ratio, as affected by the pre-treatment process, were studied. Results showed that dehydrated grape pomace pre-treated with 1% (w/v) potassium metabisulphite+1% (w/v) calcium chloride (T_7) recorded highest recovery per cent (26.32), rehydration ratio (1.57), reconstitutability ratio (0.41), TSS (8.69°B**)**, reducing sugars (12.84%), total sugars (16.63%), minimum acidity (0.66%) and lowest dehydration ratio (3.79), with preferred moisture content (5.60%), followed by 1% (w/v) citric acid+0.5% (w/v) potassium metabisulphite (T_5). Higher total polyphenol (17.21mg/100g) and anthocyanin (62.08mg/100g) content was recorded with 1% (w/v) citric acid+0.5% (w/v) potassium metabisulphite (T_5).

S4P53A362

Hexanal formulation improves storage life and post-harvest quality of mango fruits

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Hexanal is a volatile compound, identified for its unique action on phospholipase-D, thereby extending the shelf life of fruits and vegetables. It is a six-carbon aldehyde molecule produced during tissue disruption through the lipoxygenase pathway using phospholipids as substrate. The influence of hexanal formulation on delaying ripening as well as its impact on quality attributes of mango cultivars Banganapalli and Alphosno was studied at the Department of Fruit Crops, HC & RI, TNAU, Coimbatore. Treatments included preharvest hexanal formulation spray at 15 and 30 days before harvest , postharvest dip for two minutes, combination of spray and dip and control (no spray and dip) storage at both ambient and cold storage conditions. Observatins on physiological parameters revealed physiological loss in weight, respiration rate, ethylene evolution rate and fruit firmness of fruits subjected to combination of preharvest spray and postharvest dip with heaxanal formulation and kept in cold storage were superior as compared to control under ambient storage condition. Treatments with hexanal formulation significantly influenced total sugars, total carotenoids and total flavonoids in the fruits. Ascorbic acid content and total antioxidant activity was enhanced in pre-and postharvest hexanal formulation treatments as compared to control by 11% and 28%. The effect of hexanal formulation as preharvest spray and postharvest dip extended the shelf life of mango fruits from 5 days to 10 days in ambient storage and from 12 days to 20 days in cold storage. Pre-and postharvest hexanal formulation treatments along with cold storage offers significant promise to reduce post harvest losses in mango.

S4P54A371

Effect of pre-treatments and storage conditions on quality and shelf life of minimally processed tender jackfruit (*Artocarpushetrophyllus* Lam.)

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Minimal processing involves a series of operations like washing, cleaning, sorting, slicing or chopping followed by pre-treatments, packaging and storage. The resultant effects of this technique are 100% edible, ready to cook product which can be prepared and consumed in less

time. Moreover, it takes care of garbage disposal in urban and rural areas and thereby eliminates the problem of environmental pollution in urban areas. Tender jackfruit, widely consumed as vegetable in Kerala, is an ideal produce which can be subjected to minimal processing operations. Tender jackfruit about 45 days after fruit set, was harvested, cleaned and surface sanitizedwith100ppm chlorine for 15 minutes. The surface sanitized fruits were peeled to remove the thick rind and the hard core. Minimal processing of tender jackfruit revealed that the edible portion amounted to only 40% and the inedible parts like peel and core constituted 47.82 and 13.04% respectively. The edible portion was diced, rinsed in warm water (50 ± 2^{o}C), followed by pretreatment with anti browning agents like citric acid and ascorbic acid (0.5%) separately, in combination with an antimicrobial agent, sodium benzoate (0.005%) for 30 minutes. The pre-treated, tender jackfruit pieces, after draining out excess surface moisture, weighing about 250g, were enclosed in two types of packaging materials *viz*.low density poly ethylene bags (200 gauge) and rigid plastic trays over wrapped with cling film. Tender jackfruit, after primary processing and packaging, was stored at ambient (30 ± 5^{o}C) and low temperature (5 ± 2^{o}C).Primary processed tender jackfruit treated with 0.5% anti browning agents(citric acid/ascorbic acid) in combination with 0.005% sodium benzoate, when packed in LDPE bags and plastic trays over wrapped with cling film, recorded a maximum shelf life of nine days when stored at low temperature. The same samples when held at ambient temperature became unmarketable after three days. Whole tender jackfruit (control samples) could be stored up to five days at ambient and low temperature. Physiological loss of weight increased in all the samples during storage. Control samples stored at low temperature recorded maximum physiological loss in weight. Total carbohydrate, ascorbic acid, titratable acidity and total phenols decreased during storage in all the treatments. Bacterial and fungal population showed an upward trend during storage, whereas *Escherichia coli* and *Staphylococcus aureus* could not be detected in any of the samples. Tender jackfruit when minimally processed after pre-treatment with 0.5% ascorbic acid in combination with 0.005% sodium benzoate, followed by enclosing in plastic trays over wrapped with cling film and subsequently held at low temperature (5 ± 2^{o}C), was beneficial in prolonging shelf life and maintenance of quality.

S4P55A412

Developing nutraceutical beverages of ginger

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Ginger (*Zingiber officinalis*) is an important commercial crop of the Zingiberaceae family, grown for its aromatic rhizomes which are used both as spice and medicine. It is one of the excellent spice crops cultivated in Asia, and India accounts for 50% of world ginger production. Kerala has a prominent position as a ginger-growing state and produces 'Cochin' and 'Calicut' gingers renowned for their intrinsic qualities. Though ginger has versatile applications, the extent of value-addition and product diversification is very limited at present.

Therefore, an investigation was carried out to prepare therapeutic beverages such as ginger Ready-to-Serve (RTS) beverages, ginger-lime RTS, ginger-lime-aloe RTS, and squash of ginger extract blended with acid lime. The RTS prepared from different proportions of ginger extract, sugar and water revealed that treatment containing15% ginger extract and15% sugar formed the best product in terms of overall acceptability. In the case of ginger-lime blended RTS, treatment containing equal quantities of ginger extract and lime juice (50g) with 20% sugar resulted in the best product (with the highest organoleptic score), followed by the treatment containing 50g ginger extract + 40g lime juice + 150g sugar and 760ml water. Blended RTS beverage containing 50g ginger extract + 40g lime juice + 10g *Aloe vera* juice, in combination with 15 % sugar, was organoleptically superior. Blended squash prepared from ginger and acid lime containing 100g of each, with 800g sugar and 200ml water was the most acceptable in terms of colour, flavor and body.

S4P56A511

Assessment of quality characteristics upon enzyme assisted prickly pear juice clarification

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Prickly pear fruit contains betalain pigments which have good potential for use as natural food colourants. The aim of this work was to optimize enzyme concentration, incubation temperature and time for the treatment of the prickly pear pulp to improve the juice clarity with colour enhancement. Prickly pear pulp was treated with pectinase enzyme at different concentrations (0.01 to 0.09%), incubation temperatures (40 to 60 °C) and time (60 to 180 min). The effect of these enzymatic treatments on clarity, colour index, ascorbic acid, betalain content and appearance of juice were studied through response surface methodology by employing second order central composite rotatable design. The coefficient of determination (R^2) for all these quality characteristics was greater than 0.9. Statistical analysis showed that all the selected response parameters were significantly ($P<0.0.5$) correlated to enzyme concentration, incubation temperature and time. Incubation temperature was the most important factor affecting the characteristics of the prickly pear juice. An increase in enzyme concentration and time was associated with an increase in all the selected quality characteristics. Based on the response surface analysis, the optimum condition for clarifying prickly pear juice were determined as 0.042% enzyme concentration with an incubation temperature of 47 °C and incubation time of 125 min. The resulted juice had a much higher amount of betalain content and ascorbic acid with better clarity, colour index as well as appearance.

S4P57A531

Quality attributes of guava nectar as affected by pulp concentration and storage conditions

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An investigation was carried out to find out the effect of pulp concentration and storage conditions on chemical constituents of nectar. For preparation of nectar guava cv. 'Lalit' was selected because of its pinkish pulp colour and delicious taste. Nectar was prepared using five different pulp concentrations viz. 14%, 16%, 18%, 20% and 22% and stored under two storage conditions i.e. refrigerated and ambient. Both pulp concentration and storage temperature significantly affected quality of nectar. Guava pulp at 18% concentration was found best for nectar preparation among all treatments. A significant difference was found in chemical constituents of nectar during storage. Minimum changes in total soluble solids, acidity and sugars were recorded in 18% pulp treatment during storage. Maximum quality with longest shelf life of 120 days was observed with the treatment of 18% pulp and storing under refrigerated conditions.

S4P58A727

Evaluating bael [*Aegle marmelos* (L.) Correa] cultivars for yield and quality under Lucknow conditions

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Bael, botanically known as *Aegle marmelos* (L.) Correa has become a potential fruit crop in most parts of our tropical and sub-tropical India. Its popularity as a fruit of waste lands especially in arid and semi-arid tracts is far more than *aonla, jamun*, custard apple and many other, known under-utilized fruit crops principally because of its medicinal and high market value, ever increasing demand for *sharbat* (juice) and candy making; and, above all the long shelf life of fruits provided the fruits are harvested along with stalk without any internal or external damage while harvesting. *Bael* fruits can easily be stored without much effort under ambient conditions for a month and transported to distant parts of the country. In the recent past, during last few decades, a number of improved *bael* cultivars have been developed which show distinct variability in productivity and quality parameters. Keeping this in view, an experiment was conducted during 2006-2016 at ICAR-CISH Lucknow in randomized block design to evaluate the performance of nine bael cultivars, viz.NB-5, NB-9, NB-16, NB-17,

CISH B-1, CISH B-2, Pant Aparna, Pant Sujata, Pant Shivani. The findings indicated that NB-9, NB-16, CISH B-1, CISH B-2 and Pant Aparna started fruiting from third year while NB-5, NB-17 and Pant Shivani from fourth year and Pant Sujata from fifth year after planting. Growth parameters revealed tree height ranging from 5.12 m to 6.72 m with maximum in NB-17; tree girth from 77 to 92.75cm, plant spread in east west direction from 5.25 to 6.96 m, while in north-south direction in between 4.88 and 7.05 m after ten years. The pooled means for fruit yield revealed maximum average yield in CISH B-1 (48.07 kg/tree) followed by NB-9 (45.4 kg/tree). The differences in fruit yield of bael cultivars viz. NB-9, NB-16, NB-17 and CISH B-2 were not significant. Total soluble solids ranged in between 34 ^{0}B and 44.3^{0}B while total sugar ranged in between 11 and 14.99%. Total phenol content ranged in between 1.93 and 2.68% in different cultivars. Large fruited types included cultivars like NB-17, CISH B-2 and Pant Shivani with fruit weight ranging from 1.95 kg to 2.12 kg/fruit. The cultivars, viz. NB-5, NB-9, CISH B-1, Pant Aparna and Pant Sujata fell in the medium fruit-size group, with the average fruit weight from 0.8 kg to 1.2 kg/fruit. NB-16 produced the smallest size fruits (0.598 kg/fruit). As regards seed contents, it ranged from 58.5 to 147 seeds/fruit. CISH B-2 had the minimum seeds, i.e., 60 per fruit among large fruited types while CISH B-1 had the minimum seeds (58.5/fruit) among cultivars with medium size fruits. On the basis of overall performance, CISH B-1 and CISH B-2 both proved to be superior *bael* cultivars under Lucknow conditions.

S4P59IS54

Effect of storage duration and osmo-conditioning on microbiological status and germination of muskmelon seeds cv. MS-1

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Maintenance of sustainable productivity can be ensured by designing climate ready vegetable crops particularly for drought and salt stress besides tailoring extreme temperature resilient cultivars. Osmo-priming, treatment with osmolytes to break the dormancy related to ageing and temperature, has been utilized for enhancing germination in several crops. This study showed enhancement in germination by osmo-conditioning with two potassium salts individually and their combination (1:1) in muskmelon genotype, MS-1 seeds stored for four years duration under ambient conditions. The combined salt treatment resulted in significantly enhanced germination over all treatments for seeds stored upto two years duration i.e. for 2015 and 2016. Likewise, the root morpho-traits; root length (5.21 cm plant^{-1}), volume (0.02 cm^{3} plant^{-1}), surface area (1.138 cm^{2} plant^{-1}) and number of laterals of the 10 days old seedlings were recorded to be maximum for the combination of osmolytes. The storage duration had

positive correlation with seed surface bacterial and fungal populations which may possibly had been acquired during post-harvest storage and handling. A significantly higher cfu ml^{-1} microbial counts (both bacteria and fungi) were recorded for 2013 harvested seeds on nutrient agar, RB agar and potato dextrose agar media. However, the viable counts decreased for 2014 and 2015 harvested seeds. These results indicate that the surface microflora responsible for deterioration of the seed health increased as a function of storage time. Therefore, osmo-conditioning can be useful to ensure rapid germination and uniform establishment.

S4P60A241

Designing of microwave-vacuum drying system for osmotically pre-treated fruits

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Microwave- vacuum hybrid drying technology combines the advantages of both low-temperature evaporation of moisture with faster moisture removal by vacuum and rapid volumetric heating by microwave. Osmotic dehydration technique has gained more attention due to its potential application as a pre-treatment to the drying. The main advantages of osmotic dehydration include better appeal, nutrient retention and prevention of microbial spoilage. The experimental setup was designed for Microwave – Vacuum dryingfor osmotic dehydration of selected fruits. The designed set up consisted of 800W commercial microwave oven. The power output of the oven can be varied using a voltage variation system in the designed circuit. A desiccator for the vacuum environment was bought which was of polycarbonate material in which the sample was kept and the desiccator was placed inside the microwave cavity. In order to develop a vacuum inside the desiccator, thehose pipe was used to connect between desiccator to a vacuum pump. The vacuum wascontrolled by a pressure regulator. The monitoring of vacuuminside the chamber was indicated by a vacuum gauge. The desiccator was covered using the cap and the air tight condition was maintained. The condensation of the water vapor cooling unit was done with a cooling line attached using the hose pipe. During experiment, the sample dipped in the osmotic solution which was drained and spread evenly over the perforated plateinside the desiccator for microwave vacuum drying. The vacuum pump was turned on and adjustment was done at the pressure regulation valve. The microwave power was turned on and was adjusted using the designed variable system. The electronic balance which was attached to the system used to indicate the weight loss of sample at fixed interval of time. The osmotically treated sample was subjectedto drying at different levels of vacuum and microwave power.

S4P61

Extension of shelflife of banana fruit (cultivar *Yelakki*) by 1-methylcyclopropene in combination with chlorine dioxide and polyhexamethylene guanidine during ambient storage

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The effect of the anti-ethylene compound 1-methylcyclopropene (1-MCP) in combination with sanitizers such as chlorine dioxide (ClO_2) and polyhexamethylene guanidine (PHMG) on the ripening of harvested banana fruit (cultivar *Yelakki*) was investigated. Banana fruits harvested at second stage were pretreated with the above chemicals in combination and stored in corrugated fiber board boxes at ambient condition. 1-MCP treatment delayed peel colour change and fruit softening, and extended shelf life by suppressing respiration and C_2H_4 production. Banana fruit ripening was delayed when exposed to 10-20 ppm of 1-MCP for 6 h, and increasing (20 ppm) concentrations of 1-MCP were generally more effective for longer periods of time. It was also observed that the ripening rate and other biochemical changes had delayed significantly in the 1-methylcyclopropene treated fruits, whereas, the chlorine dioxide (200 ppm) and polyhexamethylene guanidine (2 per cent) treatments had reduced the pathological breakdown of fruits, extended the shelf life up to 15 days and retained the acceptable quality when stored at ambient condition. Thus, application of 1-MCP in combination with chlorine dioxide and polyhexamethylene guanidine can greatly extend the postharvest life of banana fruit.

Session –V Stress Management

(Crop Modelling and Forecasting, Host-plant Resistance, Diagnostics and Epidemiology, Novel Approaches to Stress Management)

S5P1A66

Prototype of Pesticide Residue Analysis in Bitter Gourd

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Bitter gourd (*Momordica charantia* L.), one of the most accepted vegetable cultivated throughout India, possesses high nutritive and medicinal value. Nevertheless, the major constraint faced in the cultivation of this cucurbit is the incidence of fruit fly and downy mildew disease, where the use of pesticides against these is found very common to increase the productivity of the crop. However, pesticides are toxic substances and persistent in character and the problem of pesticide residues in the fruit is one of the most serious challenges to public health. Hence, a study was conducted to analyse the residue of pyraclostrobin (0.5g/l), cymoxanil (2g/l), chlorantraniliprole (0.3ml/l) and their fungicide - insecticide combinations which are at presently recommended against downy mildew and fruit fly of bitter gourd. As the residue analysis provides a measure of the nature and level of any chemical contamination in the fruit sample and its level of persistence. Fruit samples were collected on 0, 3, 5, 7, 10, 15, 20 and 25 days of harvest after treatment of pesticide and the extraction of the samples were carried out using acetonitrile containing 1% acetic acid and cleaned up with PSA and magnesium sulphate. The extract was analysed by LC-MS / MS at Pesticide Residue Lab, College of Agriculture, Vellayani, Thiruvananthapuram . The average initial residues were in the range of 0.16 and 0.26 ppm of pyraclostrobin and chlorantraniliprole. The residues of pesticides fell below detection level (BDL) at 2h after spraying of cymoxanil, pyraclostrobin + chlorantraniliprole and cymoxanil + chlorantraniliprole whereas in the case of spraying with chlorantraniliprole and pyraclostrobin, the residue fell BDL on 3rd and 5th day after spraying. Hence, it can be concluded that bitter gourd when treated with recommended dosage of the above pesticides were safe for consumption especially on 3rd day after spraying. Conversely, vegetables should always be subjected to a random inspection in order to monitor and regulate the use of sprays to curtain residue levels above the maximum residue limits.

S5P2 A120

Attraction of *Psorosticha zizyphi* (Stainton) adults toCitrus leaf miner pheromone lures from central India

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Citrus leaf folder, *Psorosticha zizyphi* (Stainton) (Lepidoptera: Oecophoridae: Depressariinae) is a pest of citrus especially on nursery seedlings.Young foliage may be completely destroyed and this is considered to cause a serious setback to tree vigour. Sudden outbreaks of the leaf folder was observed during June, 2015 with dry spells on mature Nagpur mandarin, Pommelo, Rangpur lime, Acid lime, curry leaf trees in certain pockets in central India apart from orchards in Central Citrus Research Institute (CCRI) farm. Routine monitoring for citrus leaf miner, *Phyllocnistis citrella* Stainton using indigenously synthesized pheromone-baited delta traps with graded yellow sticky card (20x15 cm^2) (chemical synthesis in collaboration with IICT, Hyderabad) were installed at CCRI farm. In our preliminary observation, male moths of *P.zizyphi* were attracted to these lures along with *P.citrella* male moths. Later, ten delta traps loaded with lure were installed in citrus orchards (each unit of 0.3ha area) along with yellow sticky cards (without lure) simultaneously. Observations were taken over a period of 5 months (July-October & February). Mean monthly trap catch (mean ±SE) was 36.3 ± 1.592, 21.9 ± 1.242 and 26.8 ± 0.742 adults in Acid lime, Nagpur mandarin and Pommelo blocks in the month of August while 24.0 ± 1.491, 19.6 ± 0.884 and 14.0 ± 0.365 in September, respectively. The mean monthly male moth trap catch (average of trap catch during July, August, September, October) from un-baited traps installed in acid lime, Nagpur mandarin and Pommelo blocks were 3.6±0.54, 2.2±0.46 and 2.8±0.48, respectively. Since, our preliminary observation of attraction of leaf folder male moths to *P.citrella* pheromone lures is reported for the first time; it is possible that further monitoring for attraction of *P.zizyphi* to the major components of the *P.citrella* pheromone and its validation could be utilized for eco-friendly management of these two foliage pests.

S5P3 A170

Epidemics of Grape Stem Borer*Celosterna Scabrator* Fabr (Cerambycidae: Coleoptera)

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Grape (*Vitis vinifera L.*) is one of the important fruit crops of temperate zone which has acclimatized to tropical and sub tropical agro climatic conditions prevailing in India. In India, grapes are cultivated in an area of 118.74 thousand ha with a total production of 2,585.35 thousand MT and productivity of 21.77 tons/ha.

Karnataka is the second largest grape growing state with an area of 20.46 thousand ha with a production of 302.39 thousand MT and productivity of 14.78 tones/ha. Grape growing regions are located in two agro-climatic regions in the state., *viz* North Interior Karnataka and South Interior Karnataka. North interior Karnataka comprises Vijayapura, Bagalkot, Belgaum, Koppal, Bidar and Gulbarga districts. In 2014-15, Vijayapura district contributed an area of 8906 ha, with a production of 1,06,536 tons, and average productivity 20 t/ha.

Among various constraints of grape cultivation insect pests are the major one. Among these the stem borer of grape *Celosterna scabrator* Fabr (Cerambycidae: Coleoptera) is a serious pest and becoming one of the limiting factors in grape cultivation and attaining a major pest status in the recent past.

Studies were conducted during 2015-16 and 2016-17 on stem borer incidence in Vijayapura district. Roving and fixed plot surveys were conducted between June to December months covering orchards from all the five taluks by selecting the orchards between the age groups of two years to fourteen years. Vines with live tunnels (Ejecting fresh excreta in the form of pellets and frass), inter veinal chlorosis on leaves, wilting of vines with less bearing of bunches were considered for estimation of pest incidence. Two to ninety percent incidence was observed during the study period. Presence of alternate hosts around the orchards, water stress conditions, drought for two consecutive years and lack of prophylactic measures are attributed to the epidemics of grape stem borer.

S5P4 A259

Responses of Papaya Seedlings (*Carica papaya* L.) to Water Deficit Stress: Changes in Root Anatomy, Osmolyte Accumulation and Antioxidant Status

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Water deficit stress in crop production systems is more deleterious than the other abiotic stresses under changing climatic scenarios. Understanding of physio-biochemical response of plants under low water stress is of potential in identifying markers for stress tolerance in selection and breeding, and in delineating mechanism of crop tolerance to stress. The present study was conducted to appraise the effects of water deficit stress on root anatomical features,osmolyte accumulation and antioxidant activity in papaya seedlings (*Carica papaya* L.) cvs. Arka Surya, ArkaPrabhat, CO-4 and Red Lady differing in tolerance. Water deficit stress was imposed by withholding irrigation for 10 days. Compared with well-watered conditions, the water deficit stress caused distinct contraction in vascular system characterized by reductions in vascular bundles and cortex diameters with decline in xylem vessels number in the stressed plants, and cv. CO-4 maintained relatively higher cortex diameter and cv. ArkaPrabhat higher vascular bundle cross sectional area and xylem vessel number as compared to unstressed plants. The stress conditions also led to development of oxidative stress as evident from excessive production of reactive oxygen species (ROS) which led to reduced growth in all papaya cultivars; nevertheless, the negative effects of water deficit stress were more prominent in cvsRed Lady and Arka Surya. Water deficit stress induced significant accumulation of osmolytes like glycine betaine, sucrose, glucose and amino acids besides upregulation of enzymatic defense systems in cvsArkaPrabhat and CO-4. The results indicated that the ability of papaya plants to tolerate water deficit stress is the consequence of maintenance of better cortex diameter and xylem vessel number in roots and are reflections of high osmolyte pools and antioxidant status.

S5P5 A260

Bioefficacy of Entomopathogenic Nematodes on Insect pests of Horticultural crops

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Insect pests are one of the major constraintsin maximizing the productivity of horticultural crops. Pest control in agro ecosystems mainly relies on the use of chemical pesticides, which however raises concerns about public safety, soil and water pollution, insecticide resistance and effects on non-target organisms. This alarming situation has increased the pressure to shift from chemical intensive management to alternative control strategies. Entomopathogenic nematodes (EPN) (Rhabditidae: Steinernematidae and Heterorhabditidae) fit nicely into integrated pest management programmes because they are non-toxic to humans, relatively specific to their target pests and can be applied with standard pesticide equipment. Considering their environmental benefits, the Environmental Protection Agency (EPA) in USA, Australia and many other countries have exempted EPN from registration.To exploit the biocontrol potential of EPN against major insect pests of horticultural crops, surveys and experiments were conducted to isolate native EPN species and evaluate their efficacy against key insect pests. Four native strains of *Heterorhabditis indica* and one strain of *Steinernemacarpocapsae* were isolated from open fields, orchards and protected systems. When tested for virulence *in vitro*, they caused 100% mortality of test insects within 72 hrs. Virulent strains were identified as *H. indica*(IIHR Hi-2) on grubs of banana pseudostem weevil *Odoiporuslongicollis*(LC_{50}-42.18 IJs/larva), brinjal ash weevil *Myllocerussubfasciatus*grubs (LC_{50}-34.52IJs/larva) and adult weevils (LC_{50}-138.42IJs/larva) and south american leaf miner *Tutaabsoluta*(LC_{50}-5.04); *S. glaseri* on *Bactocerarufomaculata*(LC_{50}-10.02) and *S. carpocapsae*on *Plutellaxylostella*(LC_{50}-7.43 IJs/larva).This study also necessitates further evaluation of EPN under field conditions. Considering the wide spectrum potential of EPN, it is possible to manage many pests with a single biological control agent which will help to eliminate the use of highly toxic pesticides in the agro-ecosystem, thereby maintaining its bio diversity.

S5P6 A261

Rhizospheric interventions with biopesticides to manage root knot nematode, *Meloidogyne incognita* in tomato (*Solanum lycopersicum* L.)

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Plant parasitic nematodes continue to threaten horticultural crops throughout the world, particularly in tropical and sub-tropical regions. Overall average annual yield loss of the world's major horticultural crops due to damage by plant parasitic nematodes is estimated at 13.54%. Primarily as pathogens by themselves and secondarily as predisposing agents for easy entry of pathogenic fungi and bacteria from soil into the host plants, nematodes cause huge economic losses quantitatively and qualitatively.Tomato (*Solanumlycopersicum* L.) is a major vegetable crop in India contributing to 9.4% of total vegetable area and 11.4% of total vegetable production. However, the biotic stress induced by root knot nematodes, *Meloidogyneincognita* has assumed a serious dimension in tomato hampering its productivity from 30.57 to 46.92%. These nematodes also make the plant more vulnerable to attack by many soil-borne, destructive diseases in tomato.Field studies were conducted for two consecutive years (2015 and 2016) under All India Coordinated Research Projects on Vegetables at ICAR-Indian Institute of Horticultural Research, Bengaluru to assess the bio-efficacy of liquid formulation of two biopesticides*viz.,Bacillus myloliquefaciens* (IIHR Ba-2) 1% A.S. and *Bacillus subtilis*(IIHR Bs-2) 1% A. S. for the management of *M. incognita*intomato. In both the years, substrate treatment with *B. amyloliquefaciens*or *B. subtilis*@ 5 ml/ kg cocopeat in protraysand soil application of 5 tons of FYM enriched with either of themat 5 l /ha recorded significantly higher yield (+ 28.48 to 33.3 % over control) and lower nematode population in soil and roots of tomato (- 63.94 to 71.84 % over control). The study clearly indicated the biocontrolpotential of biopesticidesand demonstrated its appropriate delivery mechanism through enrichment in FYM for managing nematodes and reaping maximum yield in tomato under field conditions.

S5P7 A299

Behavioral responses of predatory gall midge, *Triommata coccidivora* (Diptera: Cecidomyiidae) to conspecific induced volatiles

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Predatory gall midge, *Triommata coccidivora* (Felt) has been identified as one of the potential predators of mealybugs. The natural incidence of these predatory gall midges was observed up to 75-100%. These gall midges were found predating on major mealybug species of fruit crops *viz. Maconellicoccus hirsutus, Ferrisia virgata, Rastrococcus iceryoides, Planococcus citrii.*

Using olfactometer and cage choice assays, we studied behavioral responses of female gall midge *T. coccidivora* to volatiles emitted from host fruit (custard apple) infested with mealybugs(*M. hirsutus*) subsequently predated by gall midge, *T. coccidivora*. The main objective of this study was to investigate chemical cues that induce behavioural responses in female *T. coccidivora*. Choice bioassays were conducted by using predated mealybug (*M.hirsutus*) with host fruit and unpredated mealybug with host fruit. We found significantly more *T. coccidivora* females were attracted to the predated mealybug with host fruit (*P=0.04, t=2.16, df=5).* Similarly, the female gall midges spent significantly more time (*P=0.003,t=4.33,df=5*)on predated mealybug along with host fruit. Further, choice tests were conducted mealybug infested host fruits with different levels of predation *viz*., 0%, 25%, 50%, 75%, 100% by gall midges. Here, the female gall midges clearly exhibited their preference for 75% predation irrespective of host fruit presence. Y-tube olfactometer choice assays with predatory gall midges also showed significant preference for 75% predated mealybug with host fruit (*P=0.009,t=2.41,df=49*).Choice assays for mealybug species specificity by *T. coccidivora* between *M. hirsutus* on custard apple and *F. virgata* on custard apple showed significant preference for *M. hirsutus* (*P=0.015,t=2.94,df=5*). Detailed studies using GCMS/ GC-EAD to identify potent chemical cues that induce behavioral responses in female *T. coccidivora* are being envisaged.

S5P8 A301

Safe-to-eat bitter gourd through integrated management of powdery mildew

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Bitter gourd is the most widely cultivated vegetable crop in Kerala. Fungal diseases pose a major production constraint for the crop of which, powdery mildew (*Erysiphe cichoracearum*), is the most severe causing up to 61% yield reduction. Plant protection measures currently in vogue are either not effective or undesirable, as, these use highly toxic chemicals leaving behind considerable levels of residual toxicity in/on fruits. Hence, experiments were conducted during 2013-2016 to identify an effective management strategy against the disease. The treatments included three systemic fungicides, *viz*., Tebuconazole, Difenoconazole and Carbendazim; two contact fungicides, *viz*., wettable sulphur, *neem* oil (Azadiractin Plus) and two bio-agents, *Trichoderma viride* and *Pseudomonas fluorescens*. Based on results of the first experiment, Tebuconazole, wettable sulphur, *neem* oil and *Trichoderma viride* were selected for further studies. It was found that Tebuconazole, wettable sulphur and *Trichoderma viride* were highly effective and reduced disease severity by 85.7%, 85.35% and 72.1%, respectively. *Trichoderma* spp. is rarely used against foliar diseases because of its low survivability on leaf surface. However, in the case of powdery mildew, as the pathogen grows on the leaf superficially, *Trichoderma* comes into direct contact with it and can also survive on superficial mycelium. *Trichoderma viride* was isolated from the leaf surface of bitter gourd up to 15 days after spraying. Population of this bio-agent on leaves

ranged from 31.7 to 0.7 x10^2cfu cm^{-2} of leaf area from Day one to Day 15 after spraying, respectively. Analysis for residues of Tebuconazole left behind on the fruits showed that the compound was degraded to below-detectable-levels within three days after spray.

S5P9 A326

Biopesticide interventions for management of nematode-induced disease complex in protected horticulture

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Protected cultivation is an intensive crop-production system for raising vegetable and ornamental crops round-the-year with higher productivity, better quality and early maturity. It involves growing crops in the controlled environment of greenhouse, shade-net, plastic tunnel and mulch. Continuous cultivation of the same crop species, constantly high temperature/ humidity and use of high agronomic inputs provide a conducive condition for introduction/ rapid multiplication of nematodes and associated disease complexes. In polyhouse cultivation of vegetables, the root knot nematode, *Meloidogyne incognita*, spreads from 10% to 60% of the area because of monoculture and causes yield loss of 45% – 60%. To contain nematode damage in horticultural crops, farmers resort to indiscriminate use of chemical nematicides, thus posing serious hazards to environment and biotic life. As horticultural produce, especially fruits and vegetables, are eaten fresh/ raw/ uncooked, consumers in both domestic and export markets expect residue-free produce. With area under protected cultivation continuing to increase in India, producers welcome alternative measures for containing nemic problems. ICAR-Indian Institute of Horticultural Research, Bengaluru, has developed effective biopesticide formulations and standardized integrated nematode management packages for mitigating nematode problems in protected horticulture. Enrichment of one ton of FYM or Vermicompost or *neem* cake with 2 kg each of *Pseudomonas fluorescens, Paecilomyces lilacinus* and *Trichoderma viride/ harzianum* (enriched organic mixture) applied at 1 kg/m^2 at the time of bed-preparation, and repeat-application at 50 g/m^2 at regular intervals of 30 days in a standing crop drastically reduced damage from root knot nematode in capsicum, gerbera and carnation grown under the polyhouse. The biopesticide formulation can also be sprayed on plants or supplied through drip/ drenching @ 5ml/litre at regular intervals of 30 days. With use of bio-pesticides, farmers are able to reduce the chemical pesticide application by 30% – 40% and obtain yield increases of 20% – 30%, with a cost:benefit ratio of 1: 2.5. Use of biopesticides for mitigating the nematode menace, and success stories recorded in capsicum, gerbera and carnation in farmers' polyhouses will be discussed.

S5P10 A393

A bio-intensive management strategy for thrips on bell pepper under polyhouse conditions

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Bell pepper (capsicum) occupies the foremost rank inpolyhouse cultivated horticultural crops in India as it has become a lucrative trade globally. In India, the crop is intensively cultivated. under polyhouse conditions in many parts.To capture International Market, Green House Technology is the basic need. Its productivity, however, is low owing to severe damage by several insect pests and diseases at various stages of crop growth resulting in significant yield loss. Among the insect pests,thrips is the major economically important one. Damage by thrips*Scirtothrips dorsalis* significantly reduces the quantity and quality of the crop.incurring heavy loss to the grower irrespective of chemical pesticide sprays. This necessitated the need to develop a pest management strategy that is effective, sustainable and chemical pesticide free producesuch as Bio- intensiveIPM (BIPM).Bio intensive IPM is defined as 'A systems approach to pest management based on an understanding of pest ecology that begins accurate diagnosis of the source, nature and initiation of pest problem and then depends on a range of preventive tactics such as physical, cultural and biological controls to keep pest populations within acceptable limits.A BIPM strategy for management of thrips on capsicum was initiated at IIHR, Bangalore. . The experiment was carried out on green capsicum var.Indra. The BIPM strategy developed included preventive cultural and mechanical measures followed before and after taking up the crop combined with microbial control with need based botanicalsin the main crop for effective management of the pest. Parallel to this treatment a control treatment was carried out in a similar polyhouse where no control measures were adopted for insect pest management. Observations at 10days interval onthe pest population and it effect on the plant wererecorded in the main crop after planting which was continuedup to 150 DAP. Rating of plant damage due to thrips feeding on the terminal leaves was the protocol followed to determine the damage caused by thrips to the crop in the preset study. Results indicated significant reduction in thrips population in the BIPM treatment as against control. A mean rating of 0.4 thrips /plant was recorded in the BIPM treatment ascompared to 4.8 ratingrecorded in the control. In the BIPM treatment an initial rating of 0 was recorded that increased to 1.0rating after 5 months of transplantation and sustained till the crop ended..In controlwithin a month after transplantation rating increased recorded was 1.0 that increased to 4.0 within two months DAP.Rating of 2.0 and above significantly reduces the quantitative and qualitative yield of the crop. Acorresponding increase in yield was recorded din the BIPM treatment as compared to control.

S5P11 A394

Promising microbial control agents for management of Myllocerus *subasciatus* Guerin Infesting Brinjal (Solanum melongena L.)

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Ash weevil, *Myllocerussubfasciatus*, is an important pest of eggplant in Asia and Southeast AsiaSevere infestation of the pest in nursery, early period after transplantation and at the time of flowering causes drying of the plant. Eggs, grubs and pupae are soil borne while the adults feed on the leaves. Unsatisfactory results are reported with chemical pesticides and there is a need to look into alternate control measures that could be effective. The potential efficacy of two species of microbial agents *Beauveria* sp and *Pseudomonas* sp. was tested under simulated field conditions in potted plants againstearlyinstars larva by soil drenching method. Three spore concentrations @10^8,10^7 and 10^6 cfu /ml were selected for the study. Results carried out after 72 hrs indicated that both species of microbes caused significant mortality to the larvae as compared to control. . The highest mortality of 93 per cent was recorded in the Beauveria *s*p followed by 86 percent in Pseudomonas treatment. Thepresent study infers that both the species of microbes are promising biological control agents' that could be utilized for effective and sustainable management of *M.subfasciatus* on brinjal.

S5P12 A396

An Epidemiological Model to study the Disease Development in Viral Diseases in Horticultural Crops

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Viral diseases in plants are mainly spread by vectors. In anepidemicsituation, the plant and vector populations can be divided into two categories – healthy and infectious. The interactions between the healthy plant (vector) and the infectious vector (plant) help in spreading the disease among the healthy sub-populations of both plants and vectors. In this study non-linear, time-deterministic predictive model has been formulated for characterising the population dynamics in viral disease epidemics in horticultural crops.The population dynamics of the interacting sub-populations (healthy and infectious) of the host and vector population have been modelled in the form of rate of change in the various population categories represented by differential equations. A case study has been presented for modelling the spread ofpapaya ring spot virus (PRSV) disease in papaya. The parameters of the model have been estimated from published literature. The model has been simulated by varying the initial values and the parameter values

and the effect of the same has been studied on the spread of the disease. The effect of weather fluctuations or climate change is reflected in the change in parameters like birth/ death/ migration rates of vectors, inoculation rate, acquisition rate etc. The model helps in understanding the effect of various parameters on the disease spread and helps in taking timely management decisions against impending situation of the disease.

S5P13 A404

Impact of climate change on pollinators and their ecosystem services: Implications in horticultural crops

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Pollination is one of the most important ecosystem services, contributing to biodiversity as well as global food security. A majority of horticultural crops, including fruits and vegetables, are cross-pollinated and depend on insects for pollen transfer. Being ectothermic, temperature of their surroundings determines the activity of the insects and, thereby, climate change, characterized by elevated temperatures; this could impact their biology, foraging behavior and pollination efficiency drastically. Behavioural responses of the honey-bee and other pollinators to avoid climate extremes significantly reduces their pollination efficiency. Crops such as mango experience periods of mass-blooming over relatively short periods, requiring adequate number of pollinators for that particular duration. Insects and plants react differently to changes in temperature, creating temporal and spatial mismatches potentially detrimental to both the plant and the pollinator. Studies at ICAR-Indian Institute of Horticultural Research, Bengaluru, India, during 2012-2016 clearly indicated temperature as the most important abiotic factor that significantly affected pollinator activity. Species variation as a response to rising temperatures has been recorded. At temperatures beyond 30^0C, foraging activity of *Apis florea* was more adversely affected compared to that of the Dipteran pollinators in mango. Variability in foraging attributes of honey-bees visiting flowers in onion and watermelon crops grown at different temperature gradients, was documented. It was also evident from our studies that plant-pollinator equilibrium is vulnerable to climate-mediated deviations in the host-plant phenology as well as the pollinator species involved. Probable effects of climate change on ecosystem services provided by honey-bees and other native pollinators, and their impact on productivity of horticultural crops, will be discussed.

S5P14 A406

Bio-evaluation of nematicidal *Bacillus thuringiensis* against *Meloidogyne incognita* infesting tomato roots

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Bacillus thuringiensis is a widely used biopesticide around the world. Recent investigations have shown that some genes of Bt like *cry*5, 6, 11, 21 and 55 are active against parasitic nematodes infesting crop plants. In our study, Bt isolates from various parts of the country were screened against the key nematode pest, Root Knot nematode, *Meloidogyne incognita*. Five out of the 10 isolates screened *in vitro* showed 100% mortality of the second-stage juveniles (J2) at 120 h. Further, these five nematicidal Bt isolates, along with the Reference Strain and Positive Control, were used for testing the bioefficacy *in vivo*, wherein a talc formulation was prepared and added @ 5g/kg soil, and, J2 of *M. Incognita* (approx. 1000) were released into it. Galling intensity was observed after three months. Maximum (37.03%) decrease in galling intensity when compared to the Control was observed in the treatment 27A. This was followed by another isolate, KLP, which exhibited 29% decrease in gall intensity compared to that in the Control. Thus, these isolates can serve as potential bionematicides in sustainable management of nematodes infesting horticultural crops.

S5P15 A463

Development of varieties for resistant to bacterial wilt (*Ralstonia solanacearum*) in brinjal (*Solanum melongena* L.)

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Brinjal is an important solanaceous vegetable crop grown in both tropical and sub-tropical regions of the world except in higher altitudes where it succumbs to frost injury. In India it is cultivated in an area of 6.64 lakh hectares with an estimated production of 12,552MT tones(NHB, 2015-16). Brinjal has got wide consumer preference based upon its color, shape and size. Varieties with green long fruits are most preferred in Southern states (Karnataka, Kerala, Tamil Nadu Telangana and Andhra Pradesh). Bacterial wilt (*Ralstonia solanacearum)* is one of the most devastating diseases and is major production constraints, causing yield losses up to 100% in hot and humid regions country. The pathogen is difficult to control because it is seed and soil borne and also has a wide host range. Breeding varieties with bacterial wilt

resistance will go a long way to combat this malady.To achieve this objective a systematic breeding work from 2009 to 2014 was carried at IIHR, Bangalore has resulted in development three advanced breeding lines *viz*; 37-36-4-4, 37-36-4-20 and 37-36-3-16 with yield potential of 40, 36 and 34 t/ha respectively with resistance to bacterial wilt. Three varieties were grown in wilt sick soil and evaluated for bacterial wilt along with check varieties where in the bacterial population were maintained at 1 x 106cfu/ ml/ and or a gram of soil. Percent survival was recorded at 30, 60, 90 and 120 days interval. After rigorous evaluations for three years from 2012 to 2014 three varieties such as Arka Harshitha, Arka Avinash and Arka Unnathi were developed and identified at institute during September 2015 and are being tested under AICRP for multilocation trials.

S5P16 A469

Octopamine - Ecdysone rush: A trigger to wing development in padded aphids

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Octopamine is a neurotransmitter which is found in insects, stimulates the production of Ecdysone (moulting hormone) when the insects experience some stress. Aphids display alate and non-alatemorphs. The alate morphs typically possess a full set of wings and other physiology adapted to flight. The wing development in the aphids is due to several important factors such as environmental stress, natural enemies, nutrition depletion and density. These different factors surge a neurotransmitter, Octopamine to stimulate the production of a hormone, Ecdysone, which is responsible for the formation of wings in the padded aphids. Thus, study was done about the field population dynamics of wing aphids in relation to predators, where we have taken padded aphids of different instars along with unpadded ones as controls and experiments were performed. It was found that the large numbers of winged aphids were present when a particular population was attacked or if a predator was at the vicinity and the time required for forming wings was faster; the body odour of the predator was enough to instigate the wing development in the aphids. By using LC-MS and extraction methods, it was found that there was a significant increase in Ecdysone and Octopamine levels. Hence, Octopamine, an insect stress hormone, is responsible for triggering and lessening the time take for wing formation in aphids.

S5P17 A472

Efficacy and persistence of dazomet residues in poly house soil for control of root knot nematode

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Dazometis a broad spectrum soil fumigant which is widely used for control of cyst nematodes and root knot nematodes present in soil especially in polyhouse soil. It generates gaseous methyl isothiocyanate (MITC) in presence of adequate soil moisture which is toxic to the nematodes. It is generally applied prior to planting following which the soil is kept covered with polythene to prevent escape of MITC and to facilitate maximum control of nematodes. The rate of conversion of dazomet to MITC depends on soil temperature, so in tropical and sub tropical regions it is likely that the MITC formed from applied dazomet evaporate off quickly and thereby its nematicidal action be limited. Thus the present study was conducted to evaluate the persistence of dazomet in polyhouse soil and thereby determine its efficacy.

Dazomet was applied @ 30 g per m^2 in soil inside a polyhouse after irrigating it lightly the previous day and covering tightly with polythene sheet. Initial residues of dazomet was 48.03 ppm on 0 day which dissipated and due to conversion to MITC gradually reduced to below detectable levels on the 15^{th} day after soil application. The residues of dazomet dissipated with a half life of about 6.5 days in soil. Soil sample analysis for plant parasitic nematodes pre and post treatment with dazomet revealed 92.3 per cent reduction in root knot nematode, *Meloidogyne* sp. population due to fumigation with MITC. Thus the residues of dazomet were found to persist long enough in soil to give effective control of nematodes.

S5P18 A554

Screening for resistance to downy mildew caused by *Pseudoperonospora cubensis* (Berk. and Curt.) Rostov. in cucumber (*Cucumis sativus* L.)

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Downy mildew, a foliar disease caused by *Pseudoperonospora cubensis* (Berk.and Curt.) Rostov. is one of the most destructive diseases of cucumber (*Cucumis sativus* L.). Moderately resistant cultivars are available, but yield losses are high without the use of fungicides. High level of resistance is needed to reduce the need for fungicides. The objective of this study was to identify new sources of resistance to downy mildew among the germplasm,

elite cultivars and breeding lines of cucumber available at the ICAR-Indian Institute of Horticultural Research. A total of 15 accessions were tested in the Division of Vegetable Crops, during 2015 and 2016 under natural field epidemics. The highly resistant and highly susceptible accessions were further evaluated in replicated experiments using artificial inoculation through seedling assay technique. Results from the test study confirmed the results of the initial screening at natural epidemics and artificial screening using seedling assay technique. The highly resistant accessions *viz.*, IIHR-177-1-1-S7, IIHR-82-1-S6 and IIHR-297-1-1-1 recorded < 10 percent disease index (PDI). These accessions were found to significantly outperform the check variety, Swarna Agethi in all respects including yield, quality and downy mildew resistance. High yielding and resistant accessions have also been identified that could be used in developing improved cultivars through marker assisted selection.

S5P19 A577

Symptomatology and molecular characterization of *Mycosphaerella emusae* inciting Sigatoka leaf spot disease of banana var. Nendran in Kerala

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Sigatoka leaf spot disease of banana is spreading at a faster rate in banana growing areas causing a serious threat to banana cultivation in Kerala, the southern most state of Indian peninsula which has a humid tropical climate. This disease produced necrotic lesions on leaves destroying the green tissues resulting in reduction in the photosynthetic area thereby causing yield reduction. The disease also resulted in premature ripening of fruits affecting the fruit quality. The disease was noticed in most of the commercially grown varieties of banana *viz.*, Nendran (AAB), Grandnaine (AAA), Njalipoovan (AB) and Robusta (AAA) during all growing seasons, but become more severe with the onset of rains. The symptomatology of the disease was studied in detail under different agroclimatic zones prevailing in the state and was documented. The symptoms were initially visible as small light green to yellow dashes on the underside of the leaf which changed into faint brown streaks. During the next stage, these streaks became visible as rusty brown on the adaxial side of the leaves which then developed into oval or elliptic brown spots with greyish centre surrounded by definite dark brown borders containing black pin headed like fruiting body embedded in it. Upon heavy infection, the spots coalesced resulting in complete necrosis of the leaves. The presence of the pathogen was confirmed by amplification of the ITS- rDNA region of the fungus using the primers ITS 1 and ITS 4 which yielded in an amplicon size of 600 bp. The amplicons were sequenced and blasted in NCBI which showed 100% sequence similarity to *Mycosphaerella emusae.* Hence, the pathogen inciting Sigatoka leaf spot on banana var. Nendran in Kerala was identified as *Mycosphaerella emusae.*

S5P20 A578

Baseline susceptibility of South American tomato moth, *Tuta absoluta*(Meyrick) (Lepidoptera: Gelechiidae) to insecticides

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The South American tomato moth, *Tuta absolutea* (Meyrick) (Lepidoptera: Gelechiidae), is a highly destructive leaf mining and fruit boring invasive insect pest of tomato in several countries of Latin America, Europe, Africa and Asia. Apart from tomato it also damages other crops belonging to solanaceae family like potato, brinjal *etc*. After the first report of this pest from India in 2014, it has been spreading in different states in alarming proportions. Being a newly introduced pest, its baseline susceptibility of egg and larval stages of the pest to various insecticides belonging to different mode of action groups has been assessed at ICAR-Indian Institute of Horticultural Research, Bengaluru. Based on the toxicity to larval stage of *T. absoluta* (index derived through LC_{50} values), highest susceptibility was observed with spinetoram followed by spinosad, chlorantraniliprole, indoxacarb, flubendamide, cyantraniliprole, azadirachtin, methomyl, lambda cyhalothrin and nuvaluron. Similarly, highest toxicity against eggs of *T. absoluta* was observed with spinetoram followed by spinosad, chlorantraniliprole, indoxacarb, flubendamide, methomyl, cyantraniliprole, azadirachtin, nuvaluron and lambda cyhalothrin. Practical utility of the base line susceptibility data in the management of *T. absoluta* is discussed in this paper.

S5P21 A614

Molecular detection and identification of a *Potyvirus* infecting Amaryllis in India

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Amaryllis (*Hippeastrum hybridum* Hort.) is a popular bulbous ornamental plant grown in gardens and pots for beautiful blooms of various colours, belongs to the family *Amaryllidaceae*. It is grown on a commercial scale in Netherlands, South Africa and USA. Viral disease decreases the quality of flowers and bulbs, which leads to decreased profits to growers and propagators. Amaryllis crop in research plots of ICAR-DFR, Pune, exhibited mosaic symptoms accompanied with light-green to yellow striped symptoms on leaves and affected plants bore small-sized flowers. The symptoms were akin to those reported earlier during 2009 from Lucknow (Raj *et al*, 2009). Field samples were collected and preliminary tests were conducted on EM by leaf dip method. The result indicated the presence of flexuous filamentous particles

of similar size of *Potyvirus*. For molecular identification of the sample, total RNA was isolated using TRI reagent method and RT-PCR was performed using *Potyvirus* NIB gene specific primers. The 850 bp amplicon obtained was cloned, sequenced and the sequence data was analysed by BLASTn to observe the similarities which revealed highest identity of 92% with 100% query coverage with *Amaryllis potyvirus* (Accession: AY566239) reported from Taiwan. Since Amaryllisis propagated through bulbs and the mother stock once infected, act as a source for disease spread in successive generations. Therefore detection of potyviruses in bulbs of Amaryllis cultivars through RT–PCR would be of high practical value for establishing virus-free propagation material for the emerging floriculture industry and to address the quarantine requirements.

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S5P22 A626

Efficacy of Spinetoram 12% SC against South American tomato moth, *Tuta absoluta* (Lepidoptera: Gelechiidae) on tomato

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Insecticide efficacy trials were conducted during 2016 and 2017 at the ICAR-Indian institute of Horticultural Research, Hessaraghatta, Bengaluru on tomato cultivar "Shivam" for the management of *Tutaabsoluta* using spinetoram 12 % SC at three doses *viz.,* 30, 45 and 54 g ai/ha along with two standard checks *i.e.,* flubendiamide 48 % SC @ 60 g ai/ha and lambda-cyhalothrin 5% SC @ 15 g ai/ha.The trial was laid out in a randomized block design with three replications for each treatment. In 2016, all treatments recorded significant reduction of *T. absoluta* larvae compared to the control. Three days after first spraying, spinetoram @ 54 g ai/ha was significantly superior (86.02 % reduction in live mines) over other treatments and effectiveness lasted till 14 days after treatment. Similarly, after the second spray,spinetoram @ 54 g ai/ha was effective over other treatments followed by flubendiamide and lambda-cyhalothrin. By considering average larval mortality over two sprays, highest dose of spinetoram@ 54g ai/ha recorded maximum larval mortality of 85.16 % followed by flubendiamide @ 60 gai/ha (77.51 %) and lambda-cyhalothrin @ 15 g ai/ha (70.52 %) on foliage. Similar to foliage, highest dose of spinetoram@ 54g ai/ha recorded the maximum reduction in *T. absoluta* damage on fruits(95.59 %) followed by other treatments *viz*., flubendiamide @ 60 g ai/ha (92.95 %), lambda-cyhalothrin @ 15 g ai/ha (88.58%),spinetoram

@ 45 g ai/ha (85.63 %) over control. The maximum tomato yield in 2016 recorded was 58.28 t/ha in the treatmentspinetoram @ 54 g ai/ha followed by flubendiamide @ 60 g ai/ha (50.93 t/ha), spinetoram @ 45 g ai/ha (48.23 t/ha) and lambda-cyhalothrin @ 15gai/ha (44.10 t/ha) as against only 33.75 t/ha in control. Similar trend in efficacy of the spinetoram against *T. absoluta* was observed in the 2017 also. Comparative efficacy of spinetoram at different doses in terms of reducing leaf/fruit damage by *T. absoluta* on tomato is discussed in this paper.
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S5P23 A650

Screening of twelve coriander varieties/entries for resistance against aphid under field conditions

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Coriander (*Coriandrum sativum* L.) belongs to family Apiaceae, is a major seed spice crop. It is mainly growing in Rajasthan, Madhya Pradesh, Andhra Pradesh, Gujarat and Assam in a large area as a major *Rabi* season crop and also cultivating in many more states in large to small areas. Coriander is most susceptible crop to aphids in semi-arid region, if plant protection measures not applied on time, it causes nearly 40-50% yield losses.In present situation of agriculture, farmers are using a number of pesticides for aphid control resulting development of pest resistance to various commonly used insecticides, pest resurgence, and outbreaks as well as severe mortality of natural enemies and pollinators particularly honeybees, hence the identification of resistance source against aphids is the main factor to manage the pest. Keeping these in view, a field experiment was conducted at Farm, National Research Centre on Seed Spices, Ajmer to screened out the twelve varieties/entries of coriander *viz*., Gujarat Coriander-1, Gujarat Coriander-2, Sadhna (CS-4), ACr-1, Swati (CS-6), RCr-41, RCr-436, RCr-684, Hisar Sugandh, Pant Haritma, Sindhu (CS-2) and Rajendra Swati for their resistance/ susceptibility against aphid during *Rabi* 2014-15. The experiment was laid out in randomized block design with three replications. Coriander crop was raised using standard crop geometry with package of practices adopted at NRCSS, Ajmer. The observations were recorded from randomly selected and tagged five plants per plot right from germination to harvesting of the crop. The data on various parameters i.e. number of aphid/plant (in initial stage of plant growth up to 30-45 DAS), trichomes on plants, colour and thickness of leaves, plant height etc. were recorded to find out the resistance/susceptibility of host plant against insect. Results revealed that none of the variety was noticed free from aphid infestations under open field conditions. However, the variety Raj Coriander 684 was recorded as least susceptible (1.78 aphids/plant initially and 23.66 aphids/branch) followed by Acr-1 (1.78 aphids/plant initially and 24.2 aphids/branch) against aphid. The maximum aphid infestation was recorded on variety Sadhna (CS-4), followed by Swati (CS-6) categorized as most susceptible varieties, whereas, remaining varieties were considered as moderately susceptible under field conditions.

S5P24 A664

Studies on cultural and morphological characteristics of isolates of *Fusarium oxysporum* f.sp. *vasinfectum* causing Okra wilt

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Abstract

The present study was undertaken to study the cultural characteristics *viz.*, colony growth, pigmentation and sporulation and morphological variation of twenty five *Fusariumoxysporum* f.sp. *vasinfectum* isolates on Potato Dextrose Agar (PDA) medium. It was revealed that among 25 isolates studied, MYS-16 isolate showed highest radial growth (90.00 mm) followed by RMNR-10 isolate (62.42 mm). The isolates produced three types of colony character viz., fluffy, partially apppressed and apppressed. Out of 25 isolates, five isolates were produced fluffy growth, eleven isolates produced partially appressed growth, and nine isolates produced appressed growth. Six isolates produced light yellow to brown pigmentation, 17 isolates produced light yellow pigmentation, isolates like CBP-25 produced pink pigmentation and MDY-13 produced dark yellow pigmentation. Wide range of morphological variation was noticed among all the isolates with respect to size and number of septa in macroconidia. Size of macroconidia varied from 13.50 x 3.25µm to 27.55 x 3.45µm with 2-5 septation. All the isolates produced microconidia, However, size of microconidia varied from 3.25 x1.85 µm to 7.75 x 4.20µm with 0-1 septation. Isolates did not show much variation with respect to shape and colour of the spores. All isolates produced macroconidia which are hyaline, round to oval with sickle shaped , whereas microconidia are small, hyaline, oval shaped with blunt end. Three isolates recorded mean macroconidial length of 10-15 µm which were considered as small spores, 14 isolates recorded mean macroconidial length of 15.1-20 µm which were considered as medium spores and 7 isolates recorded mean macroconidial length of 20.1-25 µm, which were considered as large spores and remaining one isolate MYS-17 recorded mean macroconidial length of >25µm which was considered as very large spore.

Key words: Okra wilt, *Fusarium oxysporum* f.sp. *vasinfectum*, cultural characteristics

S5P25 A671

Electrophysiological response of banana pseudostem weevil, *Odoiporus longicollis* Olivier (Coleoptera: Curculionidae) to Methyl jasmonate, 1-Hexanol and Host plant extract

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The banana pseudostem weevil (BSW), *Odoiporuslongicollis* Olivier (Coleoptera: Curculionidae) is one of the most destructive pests of banana and plantains. Our laboratory bioassay studies showed that out of fifty host plants related volatile chemicals screened against BSW, only methyl jasmonate (MeJA) and 1-hexanol was electrophysiologically and behaviourally active. The aim of the present study was to investigate influence of host plant extract (HPE) on the two semiochemicals MeJA and 1-hexanol singly and in combination in their electroantennogram (EAG) response in BSW. The results showed that HPE alone elicited greater EAG response only in males suggesting that males involvedpredominantly in the host plant selection. Addition of HPE to MeJA increased significantly higher EAG response in females and the response was insignificant in males. Similarly, the addition of HPE to 1-hexanol evoked higher response in females but decreased antennal activity was recorded in males compared to HPE alone.The HPE showed additive effect on MeJA and 1-hexanol in their EAG responses only in female BSW. The result also revealed that 1-hexanol+HPE blend exhibited enhanced EAG response compared to 1-hexanol alone in both sexes. In conclusion, HPE has the potential to be used as attractant for monitoring male population and in conjunction with MeJA for both the sexes of BSW.

S5P26 A672

Electrophysiological and behavioral responses of banana pseudostem weevil, *Odoiporuslongicollis* Olivier (Coleoptera: Curculionidae) to aggregation pheromone, 2-methyl-4-heptanol and host plant kairomones

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Laboratory bioassays were conducted using Electroantennogram and Y-tube olfactometer to study the electrophysiological and olfactory behaviour of banana pseudostem weevil (BSW), *Odoiporuslongicollis* to its aggregation pheromone, 2-methyl-4-heptanol (2M4H) and host plant extract (HPE). The aggregation pheromone and host plant extract from highly susceptible

cultivar Nendran were tested individually and in combination to ascertain the influence of HPE on the 2M4H in the behaviour of BSW in the both bioassays. The EAG results revealed that 2M4H+HPE combination elicited significantly strong response in males in comparison to females over the aggregation pheromone and HPE individually. Dose-dependent response studies indicated differences in response between genders and concentrations. Y-tube bioassay results showed that both sexes responded to host volatiles and males were more sensitive than females and similarly, both the sexes responded most strongly to the odour sources comprising pheromone with host plant volatiles. The EAG investigation provides the basis of olfactory behaviour of BSW, which showed that male weevils strongly responded to 2M4H and addition of HPE significantly enhanced its responsiveness towards its aggregation pheromone. The present studies provide information useful in developing pheromone based lure in conjunction with host plant extract for monitoring and mass trapping of *O. longicollis*.

S5P27 A676

Computational Prediction of Potential MHC binding peptides and Epitope Mapping for Development of Immunodiagnostics for the detection of Groundnut Bud Necrosis Virus.

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Groundnut bud necrosis virus (GBNV) is an important virus affecting several field and horticultural crops in India with incidence of 5 to 80%, and yield losses up to 50%. GBNV a quasi-isometric virus belonging to genus Tospovirus and is vectored by *Thrips palmi* in a propagative manner. Due to instability diagnosis is crucial for this virus using antibody approach, for the effective diagnosis and quick detection antigenic site identification is very important.The nucleocapsid protein gene serves as an eminent source of antigenic peptides (epitopes) that binds to the major histocompatibility complex (MHC) which influences the antibody production. The effective peptides that can bind to the cell surface glycoproteins which mediate immune response by antigen presentation can be elucidated by computational studies. The nucleocapsid protein of GBNV aa analysis of antigenic property, hydrophilic nature, solvent accessibility and exposed surface area found the potential epitopes at 5-KQLTEKKIK-13, 20-SADVEIETE-28 and 180-KEKLGIKNF-188 with score 0.990 by artificial neural network prediction approach. These predicted epitopes may be adequate to evoke immune response and target virus detection. Further analysis showed that the peptide fragments of this nucleocapsid protein point out 268 nanomers out of 276 residues. 14 numbers of high affinity TAP binders were predicted using cascade Support Vector Machine (SVM) based method, where "CALRMMLCI" sequence ranked first with the score 8.520. Predicted MHC class I and class II binding peptides of the nucleocapsid protein which can be dominant element in sero-diagnosis. Besides this analysed the protein residual properties along with the

structure, where total number of negatively (Asp + Glu) and positively (Arg + Lys) charged residues were found to be 32 and 38 respectively. The SOPMA server found that the protein is highly built with the alpha helix (48.55%). The 3D structure modelled with the Swiss Model had 34.02% sequence identity with the template Tomato spotted wilt tospovirus nucleocapsid protein of PDB ID "5IP1".

S5P28 A692

Possible role of lignin in banana for resistance against root lesion nematode (*Pratylenchus coffeae*)

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Lignin, a complex aromatic polymer highly deposited in secondary cell wall of the vascular plants, confers rigidity to cell walls, and is therefore associated with tolerance to abiotic and biotic stresses. To understand the role of lignin against plant parasitic nematode *Pratylenchus coffeae* in high economically valuable banana crop, transcriptome information on *P.coffeae* challenged and unchallenged root tissues of contrasting cultivars for *P.coffeae* resistance has been analyzed. This analysis revealed that 49 genes involved in lignin biosynthesis pathways were differentially expressed in both resistant and susceptible cultivars. Interestingly it was observed that phenylalanine ammonia-lyase, (PAL), trans-cinnamate 4-monooxygenase (C4H), 4-coumarate-CoA ligase (4CL), hydroxycinnamoyl transferase (HCT), caffeoyl-CoA O-methyltransferase (CCoAMT), and cnnamoyl-CoA reductase (CCR) were significantly upregulated with more than 2 fold change in the nematode inoculated root tissues of resistant and susceptible cultivars after challenged with nematodes. But the degree of expression in terms of fold change was high in resistant cultivar. The involvement of lignin in *P.coffeae* resistance mechanism of banana was again reconfirmed through Quantitative real-time PCR (qPCR), histochemical staining and quantification of lignin in root tissues at different day's interval after nematode challenged and unchallenged resistant and susceptible cultivars. These evidences proved the protective role of lignin against *P.coffeae* resistance in banana.

S5P29 A717

First record of Monkey puzzle (*Rathinda amor* Fabricius 1775) as a pest of Litchi (*Litchi chinensis* Sonn.)

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Litchi (*Litchi chinensis*) comes up well in the non-traditional areas *viz*., Karnataka, Kerala and Tamil Nadu. In Kerala, Wayanad situated in the Western Ghats region has been identified as potential area for litchi cultivation. Unlike North Indian condition, flowering in litchi plants in southern parts of India commence from August–September. This being an offseason of the crop, the produce normally fetches premium price in the market when no fruits from North India is available. Fixed plot surveys were conducted in 36 litchi collections, having age varying from 5 to 79 years, in the Western Ghats regions of Wayanad and plains of Thrissur of Kerala to identify pests of litchi. In fifty percent of the collections, profuse flushing started in the months of August –September. The present survey revealed that known insect and mite pests along with yet to be reported insect species are major biotic stress in litchi. An Eriophyid mite (*Aceria litchi*), five lepidopteran defoliators and two coleopteran pest's *viz.*, ash weevil and chrysomelid beetle were recorded. Both the lepidopteran and coleopteran defoliators caused severe damage by feeding the leaf lamina, making rolls, holes and notches. The Monkey Puzzle, *Rathinda amor* (Family: Lycaenidae Order: Lepidoptera) was also observed to cause damage to flushes apart from the other lepidopteran pests. The gravid female butterfly laid eggs singly on the petioles or on the under surface of young leaves. After an egg period of 3-4 days, typical Lycaenid caterpillars with long protuberances emerged, that undergoes five larval instars and becomes pupae. Pupation takes place mostly under the leaves, with the insect body hanging by a girdle of silk and the abdominal end attached to the substrate. The adult butterflies emerged within a week. The total development time from egg to adult formation ranged between 18—21 days (Egg: 3-4 days; Larva: 8—11 days; Pupa: 6-8 days). The caterpillars caused severe defoliation of flushes, earlier instars feeding on new tender leaves or buds and later instars feeding on soft to mature leaves. A single larva could decimate whole flushing branch within one to two weeks. Since litchi produces its leaf flushes, flowers and fruits on the terminals of new growth, the severe defoliation of the new flushes by this pest, may cause substantial yield loss.

S5P30 A725

High-throughput phenotyping of tomato genotypes through digital features using plant phenomics facility

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Plant phenotyping using high throughput imaging techniques enables to overcome the disadvantages of traditional phenotyping methodologies in terms of required efforts and time. The studies in several crops have established the effectiveness of digital features for high throughput phenotyping. In this study, the digital biomass and projected shoot area were quantified across tomato genotypes and growth stages using plant phenomics facility and relationship with the actual plant fresh mass was established. Correlations between plant fresh mass, plant digital biomass and projected shoot area were highly significant at 30, 45 and 60 days after transplanting, but at 75 days no correlations were observed. Confirming that the growth of tomato plants could be monitored through digital imaging using either projected shoot area or digital biomass till 60 days after transplanting across genotypes for high throughput phenotyping. Further, the reduction in digital biomass was observed when the tomato plants were subjected to water stress. The genotypic differences to water stress were observed and two genotypes, 15SB and IIHR 4-3-3, showed least reduction in the digital volume during water stress and showed differences in water use. Three tomato genotypes, RF4A, Arka Meghali and 15SBXLA1777, showed reduction in the digital biomass and also compactness as the period of water stress progressed. The physiological response of the tomato genotypes had a direct bearing on the reduction in digital biomass and the compactness. The relative water content, water potential, osmolyte and MDA content were higher in the genotypes showing lower reduction in digital biomass and compactness. Among the genotypes root volume was highest in genotype RF4A followed by Arka Meghali. The study showed that the differences in root traits had a bearing on physiological response and in turn the digital features during water stress.

S5P31 A295

Probiotic *Lactobacillus* as bio-control agent of post-harvest diseases of banana and papaya fruits

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In the present study, isolation of post-harvest diseases of fruit banana and papaya such as *Fusarium* sp., *Colletotrichum* sp. and *Alternaria* sp. Were isolated from banana and papaya at MGM's Institute of Bioscience and Technology, Aurangabad, Maharashtra, India. On the basis of cultural and morphological characterization, the diseased pathogens were identified as *Fusarium moniliforme and Colletotrichum musae* from banana and *Alternaria alternata* from papaya. Koch's postulates of isolated pathogens were proved on fruits banana and papaya. Commercially used *Lactobacillus* probiotic was found most effective against *Fusarium moniliforme, Colletotrichum musae* and *Alternaria alternata. Lactobacillus* was showed highest percent inhibition 37%, 42% and 48% against *Fusarium moniliforme, Colletotrichum musae* and *Alternaria alternata* respectively.Fresh banana Fruits were treated with 1ml (10^{7} cfu/ml) *Lactobacillus* against *Fusarium moniliforme* and *Colletotrichum musae* were remain uninfected and healthy up to 10 days. In case of Papaya, fresh fruits were treated with 1ml (10^{7} cfu/ml) *Lactobacillus* against *Alternaria alternata* were remain in healthy condition up to 8 days. Good growth and sporulation of pathogens were occurred at 27 ^{0} C temperature while moderate at 20 ^{0} C, poor sporulation at 35 ^{0} C temperature. A Probiotic bacterium *Lactobacillus* increases the shelf life of fruit such as Papaya and Banana. This strain may be developed as new bio-control agent for post harvest disease control of banana and papaya.

S5P32 IS16

Invasive organisms in persimmon collection in Nikita Botanical Gardens

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Invasive species which fall into local natural environment as a result of human activity along with deforestation, pollution of the atmosphere and waters of the world ocean are considered one of the main threats for biodiversity of the planet. Statistical investigations done by the organization "Global Invasive Programme" (GISP) show that the colossal material resources are spent on the liquidation of invasive negative consequences in the world each year. The South Coast of the Crimea is quite isolated area. Main ridge of the Crimean mountains separates it on the North from other part of the peninsula. On the South it is washed by the waters of the Black Sea. But invasive organisms capable to cause the great material damage to horticulture of the Crimea come here due to the active importation of plant material. In early spring 2016 the new pest *Ceroplastes japonicus* Green. was discovered in the collection plantations of persimmon. All detected pests were located exclusively on two persimmon (*Diospyros kaki* Thunb.) cultivars Hyakume and Yankin Tsuru. The presence of the pests has

not yet been fixed on the trees of other species (*D. virginiana* L. and *D. lotus* L.). Unfortunately, in modern conditions the natural barriers are not capable to protect the local ecosystems of the South Coast of the Crimea from new invasive pest species represented a real threat not only for agriculture of the peninsula but for the natural flora as well.

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S5P33 IS24

Climate Change Effects and Quality Makhana (Euryale Ferox Salisb.) Production under Wetland Ecosystem of North Bihar

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A field trial was conducted to study the climate change effects on quality makhana production at ICAR-RCER, Research centre on makhana during 2016-2017. The objectives of the study were developing makhana production strategies to secure sustainable production under climate change or variuos weather conditions. Makhana is wonderful aquatic non cereal food crop at wetland ecosystem. The results revealed makhana is a photo insensitive crop and its growth and development were markedly changed with the change of climates. Fruit number, seed numbers/fruits and yield were gradually increased from January to September. Winter climate restricts commercial production of the October transplanted makhana crop. However, November and December planted makhana produced yield similar to January crop after recovering unfavourable weather of winter.The maximum numbers of fruit (15.33) and yield (62.0Q/ha) was observed in August planted makhana. The gestation period of crop was minimum (105 days) in January planted crop as compared to October planted crop (152 days). Winter makhana (September planted) had higher protein content (9.45 %) after that, it decreases. There was no serius diseases and pest incidence in a year long cultivation of this crop. Makhana aphid was problems at nursery stage for winter crop with out economic loss. The maximum temperature was 43^0C in May (2016) and the minimum temperature was 5^0C in January (2017) during our study. Makhana is all weather crops and 30 cm water is needed in the field during plant growth and development processes.

S5P34 IS26

Integrated approach in Panama wilt disease management in banana in Salem district of Tamil Nadu

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In Salem district, banana is cultivated in an area of nearly 2379 ha. Panama disease, also known as Fusarium wilt of banana (*Musa* spp.), is one of the most notorious of all plant diseases. The first external symptoms of Panama disease are a yellowing of the oldest leaves or a longitudinal splitting of the lower portion of the outer leaf sheaths on the pseudostem. This is followed by a wilt and buckling of leaves at the petiole base. Panama disease is caused by the soilborne hyphomycete, *Fusarium oxysporum* Schlect. f. sp. *cubense*. Hence, more sustainable and environmental friendly method should be established and implemented, such as biological control. The aim of the study is to identify suitable management practices from the beginning stage of the crop. Fungicide carbendazim as 1st treatment and biocontrol agents were used as 2nd treatment. Bioagents were used regularly in monthly interval. As per the observations recorded, disease incidence was less in bioagents used plots. It found that the was disease incidence of 12.5% and recorded yield by 42.75 t/ha with a net return of Rs.4,05,000 and 19kg/bunch was recorded in fungicide treated plots. In Bioagents used as an integrated approach disease incidence of 60.5% with yield of 35.50 tonnes/ha. and net return of Rs.2,99,500, 15 kg/bunch was obtained. Since it is a highly remunerative crop, the farmers can adopt the corm injection with recommended dose of fungicide in different stages in early period. Though fungicides can control the disease, it is not recommended for long term process which is hazardous to soil health and expensive. The conclusion of the study revealed that, application of bioagents, integrated with cultural and mechanical practices like cutting and burning of diseased leaves to avoid aerial spread, sucker treatment to avoid nematode problem, selection of healthy suckers for planting will manage the disease properly with cost effective measures.

S5P35 IS27

Results of introducing central Asian and Transcaucasian peach cultivars in Nikita Botanical Gardens

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Nikita Botanical Gardens is one of the leading research institutions Crimea's. The Crimean Peninsula offers a great variety of ecological conditions conductive to broad-scale development of its horticulture. Among others, these include the unique soil and climatic conditions, existing in only few regions of European continent (the Swiss Alps, North of Italy and others). Peach is the main stone-fruit crop being bred in Nikita Botanical Gardens. Its collection pool amounts to 559 cultivars, 48.5 per cent of these are of foreign origin. Peach introduction in Nikita Botanical Gardens began in the first half of the 19th century and was focused on exploring cultivars and forms from different natural areas. Introduction from Central Asian and Transcaucasian centers of origin was particularly active between 1957 and 1983. At present, the cultivars coming from these regions take up 3.4 and 6.25 per cent, respectively, of the total collection volume. Our purpose was to explore the Central Asian and

Transcaucasian peach cultivars under conditions of the southern coast of the Crimea, as well as to use the best genotypes in the breeding process with the aim of developing new promising cultivars with excellent commercial properties of fruits and enhanced resistance to fungus diseases. The study of peach cultivars from Central Asia and Transcaucasia was carried out in Nikita Botanical Gardens by department of fruit crops. The research on these cultivars resulted in selecting the most promising cultivars and their active use in breeding process. Their involving allowed to obtain new cultivars with excellent pomological and commercial properties of fruits, resistant to fungus diseases: 'Orpheus', 'Tovarishch', 'Fakel', 'Glinka', 'Russkiy', 'Sovyetskiy', 'Lebedev', 'Predgorniy', 'Druzhba Narodov', 'Gulliver' and 'Sokol'.

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S5P36IS28

Peach cultivars with different functional response to water stress

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Today under unstable climatic conditions it`s extremely important to understand functional mechanism of different cultivars in response to water regime. The research purpose was to reveal peach cultivars with special photoactivity characterized with different response to water stress. The study was being carried out in 2015-2016. Introduced peach cultivars that grow on collection and selection areas of Nikita botanical gardens became the research objects. They were compared in July, August and September periods with contrast water regime. Parameters of moisten content in leaves, water loss during fading and ability to renew turgor were determined according to conventional methods. Photosynthetic activity was characterized with fluorescence induction of chlorophyll (Kautsky effect), sampled applying portable fluorimeter "Floratest". In July allowing for favorable water and temperature regimes, photoactivity (variable fluorescence) of peach cultivars differed insignificantly. Forced dehydration of a leaf plate resulted reduction of the variable fluorescence for 10-15% and moisten loss - 29-34%. High photoactivity of pigment apparatus kept functional stability. In August as environmental conditions started to change only cultivar 'Tszyu-Yus-Tszyuy' kept stable photoactivity of pigmental apparatus as a result of the stress dehydration. Inconsiderable decrease of variable fluorescence (26% less) and a high renewal degree of tissue irrigation (up to 97%) indicated that fact. In September high intensity of climatic factors caused significant reduction of photoactivity of 'Zempush' cultivar. More than a half of its photosynthetic characteristics left inhibited and could restore only 60%. But in this study period cultivar 'Zempush' showed good resistance of photosynthetic apparatus to high temperatures. In this way investigation of functional peculiarities of photosynthetic apparatus assisted to mark out peach introduced cultivars with different level of adaptive ability to stress influence.

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S5P37 A65

Analysis of persistence pattern of pesticide residues in bhindi

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Bhindi, also known as lady's finger or okra is an important vegetable crop grown throughout the world for its fibrous fruits or pods. The productivity of the crop in our country is low due to the severe incidence of shoot and fruit borer and *Cercospora* leaf spot disease. It is imperative to state that pesticide application is still the most effective and accepted means for the protection of the crop from pests and diseases, and has contributed significantly to enhance the crop yield. However, the applied chemicals and/or their degradation products may remain as residues in the fruits which become a concern for human exposure. Therefore, a study was conducted at to investigate the persistence pattern of tebuconazole, flubendiamide and their combination which is recommended against *Cercospora* leaf spot and fruit and shoot borer in bhindi. The selected pesticides, were applied at a dose of 1.5ml/l and 0.2ml/l. Samples of fruits were collected on 0, 3, 5, 7, 10, 15, 20 and 25 days at harvest after treatment of pesticide and were analysed at Pesticide Residue Lab, College of Agriculture, Vellayani, Thiruvananthapuram. The extraction of the samples were carried out using acetonitrile containing 1% acetic acid and cleaned up with PSA and magnesium sulphate extract which was then analysed by LC-MS / MS. The average initial residues 2 h after spraying were in the range of 1.29, 0.19 and 1.25+0.25 ppm of tebuconazole, flubendiamide and tebuconazole + flubendiamide respectively. The residues of the pesticides fell below detection level (BDL) only after 5^{th} day of spray application of flubendiamide and in the case of spraying with tebuconazole and combination of tebuconazole + flubendiamide, it fell at BDL only on 10^{th} day after spraying, where it can be concluded that there is a high rate of absorption of pesticides in bhindi and since the fruit is used without peeling, there is a tremendous risk of action of residues on human health. Hence, spraying of pesticides on bhindi should be resorted only on leaves or after the harvest of the crop, since chances of residue is found high on fruits in bhindi.

S5P38 A743

Advances in breeding for biotic resistance in flower crops at ICAR-IIHR, Bengaluru

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Commercial cultivation of flower crops is constrained due to many biotic stresses like insect pests, nematodes and diseases which affect the yield and quality of flower crops. So, emphasis was given to develop resistant varieties for major biotic stresses. In carnation, *Fusarium* wilt affects the crop severely. Through *in vitro* mutagenesis, a mutant was selected and named as Arka Flame which is tolerant to *Fusarium* wilt. In Gerbera, thrips damage affects the quality of the flowers and reduces the marketability. Hybridization with mixed pollen was carried out with selected genotypes. Half sib selections resulted in identification of two varieties namely Arka Ashwa and Arka Nesara having moderate resistance to thrips. Crossandra genotypes were screened against *Phytophthora* wilt after artificial inoculation. No mortality was observed in Arka Ambara and Arka Shreeya. Under artificial screening of China aster germplasm, var. Arka Shashank was found resistant to root knot nematode. In tuberose, root knot nematode causes considerable crop loss. Under artificial screening of germplasm, the var. Swarna Rekha was found resistant to root knot nematode. The selections IIHR-4 and IIHR-12 were found to be tolerant to root knot nematode. In commercial cultivation of Gladiolus, *Fusarium* wilt is a major problem causing significant loss to the farmers. Promising hybrid selections were developed through hybridization and selection. They were screened for resistance under field conditions and with artificial inoculation. The cultivars Arka Amar and Arka Aayush were found to be resistant to *Fusarium* wilt. The cultivars Arka Amar, Arka Aayush, Arka Darshan, Arka Kesar, Arka Kumkum and hybrid selection IIHRG-12 were found tolerant to root knot nematode (*Meloidogyne incognita*). The promising varieties with biotic stress resistance or tolerance in these flower crops can be utilised for breeding programmes and for commercial cultivation.

Key words: Resistance breeding, biotic stress, flower crops

S5P39 A750

Development and field- validation of insect and mite pest risk assessment and advisory system in grapes

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Insect and mite pest risk assessment and advisory system (IMPRAS) was developed on PHP/MySQL based interactive-web-platform to forecast pest risk levels based on forecasting models and to provide automated pest management advisory based on calculated pest risk-level, phenology, and actual/forecast weather conditions, previous sprays given and actual pest level for thrips, mealy bugs, flea beetle, leafhoppers, caterpillars and red spider mites. The field calibration of this advisory system was done during fruiting season 2014-15 and field validation was done during 2015-16 and 2016-17 fruiting seasons. Two different plots were maintained separately as automated advisory plot and expert manual-advice plot for field validation. All the insect and mite pest management measures were done based on IMPRAS in the automated advisory plot. In the expert manual-advice plot, need-based protection measures were followed for the management of insect and mite pests. During 2015-16, the field validation of IMPRAS resulted in equal protection against thrips, leafhoppers and caterpillars in both automated advisory and expert manual-advice plots. However, the mealy bug and mite infestations were lower in expert manual-advice plot. The number of sprays in automated advisory plot (11 sprays) was also higher than the expert manual-advice plot (9 sprays). IMPRAS was recalibrated for automated advisory for mealy bug and mites. During 2016-17, it resulted in equal protection against thrips, mealy bugs, leafhoppers, flea beetle, red spider mites and caterpillars in both automated-advisory and expert manual-advice plot with equal number of sprays (12 sprays) in both the plots. This field validated automated advisory system can help as decision support system to guide the farmers for insect and mite pest management in grapes.

S5P40 A84

Ecofriendly management of various diseases of vegetable pea through SAR chemicals in Kashmir, India

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Pea is an important cool season vegetable and pulse crop of temperate and subtropical regions, grown worldwide as a source of proteins. It plays a significant role in the eco-buildup of agriculture as it enriches the soil by fixing the atmospheric nitrogen. Among the various biotic factors that affect the productivity of the crop, Ascochyta blight, root rot, Alternaria blight and Septoria blight are highly destructive diseases and have recorded the status of major diseases of pea throughout the Kashmir valley. The frequent epiphytotics of the diseases in valley witnessed during past few years have necessitated to employ innovative management of the diseases. Experiment was therefore conducted in pea variety Rachna at SKUAST-K farm in a randomized block design. Six treatments including check namely gibberelic acid (1000 ppm), ethylene (1000 ppm), salicylic acid (1000 ppm), indole acetic acid (1000 ppm) and carbendazim 50 WP (1000 ppm) were used for seed treatment and one spray of all the growth regulators was carried out on the foliage stage of the crop. The data revealed that highest occurrence of wilt disease (8.20) was recorded in carbendazim treatment. Among the foliar diseases; Alternaria blight was highest in check plot with seed treatment by salicylic acid (5.0). Minimum incidence of Ascochyta blight(4.12), anthracnose (2.45) and septoria blight(2.38) were recorded in ethylene (1000 ppm). In foliar application+ seed treatment of growth regulators, Ascochyta blight was significantly impeded by all the chemicals and minimum disease severity was compounded in ethylene(2.75) followed by salicylic acid (3.10) and IAA(3.12) which gave significant control of the disease.

S5P41 A246

Effect of Boron on management of nut splitting in Arecanut

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Arecanut is cultivated primarily for kernel obtained from the fruit. The kernel is chewed by the people in tender, ripe or processed form. It is one of the important cash crops in India. Nut splitting is a physiological disorder seen in well-grown, young and healthy palms and also major problem in some parts of Tumkur. Palms in the age-group of 10-25 years are more susceptible. boron deficiency in the soil was major cause for nut-splitting.

In order to address this problem, Krishi Vigyana Kendra, Tumkur initiated demonstration in the farmer's field through FLD programme with the technology developed from CPCRI Kasargod i.e soil application of farmyard manure @ 12 kg/palm +Recommended Dose of NPK 100:40:140 NPK g/palm + Borax 30g/palm. The demonstration was implemented in arecanut palms of 12 acres in Turuvekere taluk of Tumkur district. By adoption of this technology the nut splitting percentage reduced from 20 to 15 besides yield level increased from 1.18t/ha to 1.40t/ha, which in turn reduced the cost by 25 to 30%. This may be due to nutrient management especially micronutrients boron which plays an important role in enhancing the yield per unit area. Application of balanced nutrients accelerates the growth, which in turn provides efficient framework for high rate of nutrient absorption and net

assimilation for productive metabolism and enhances yield by reducing the effect of nutrient deficiency on palm.

S5P42 A278

Termites as crop pests and their management

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ABSTRACT

Termite or white ant, locally called 'Udai' or 'Deemak', is associated with human civilization from time immemorial. These are represented by three castes (viz., workers, soldiers and reproductives) which live in small to large colonies. Infestation of termites has been observed up to 20-25 percent in rain-fed and up to 10 percent in irrigated crops, however, the damage caused by termites is greater in rain-fed than in irrigated crops. Termites are the major constituents of the forest ecosystem in the tropical and subtropical areas and cause damage to wood and wood products of all kinds. Twenty one species of termites belonging to five families (Termopsidae, Kalotermitidae, Stylotermitidae, Rhinotermitidae & Termitidae and eight genera (*Archotermopsis*, *Neotermes*, *Heterotermes*, *Coptotermes*,*Stylotermes*, *Speculitermes*,*Odontotermes*and *Microtermes*) are reported from Himachal Pradesh.Tomar (2013) studied the rate of infestation of termite in Central India and found that the infestation in wheat, pearl millet, paddy, sorghum and maize crop was 21%, 11%, 12%, 19% and 13% respectively, whereas infestation in the gram, soyabean and pigeon pea was 23%, 7% and 14%, respectively. Various management practices have been used to manage this pest, however chemical control by using chlorpyrifos, imidacloprid and bifenthrin has been a successful method of preventing termite attack in sugarcane, maize, wheat and groundnut. Cultural and mechanical methods which include the use of well rotten FYM, deep ploughing and killing of queen by digging of Termitaria and flooding of trenches with water. Biological methods include the use of entomopathogenic fungus (*Metarhizium anisopliae and Beauveria bassiana)* and entomopathogenic nematodes(*Steinernema* and *Heterorhabditis*) used to suppress the termite population. Botanical methods include the use of aloe vera, neem (neem seed oil or neem powder), wild tobacco, dried chili and red palm oil mixed with papaya extract is used as indigenous control practice.

S5P43 A285

Influence of the sorghum crop on the interaction between bitter gourd gall midge *Lasiopterafalcata* / L. *bryoniae* and its hymenopteran parasitoid *Aprostocetusdiplosidis*

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Recently *Lasioptera* spp (Cecidomyiidae: Diptera) occurred in severe form in bitter gourd producing galls in tender shoots, leaf petiole and stem during 2015-2016 in Coimbatore, Tamil Nadu. The mosquito like fly lays its egg as endophytic in tender shoots resulting in the formation of galls in the stem and petiole of leaf retarding the growth resulting in yield reduction. Three parasitoids collected from the life stages of midge were identified as *Aprostocetus diplosidis* Crawford, *Bracon* sp. and unidentified belonging to Platygastrinae. Among them *A. diplosidis* was a predominant parasitoid contributing major parasitization of the midge up to 31.90 percentage. *A. diplosidis* is a potential parasitoid with wide hosts of several gall midge species including *Contariniasorghicola*. Hence, it is logical to use sorghum as a refuge crop to enhance the population of parasitoid A. *diplosidis* on the alternate host *C. sorghicola* by synchronizing the ear head stage of sorghum with bitter gourd crop period following staggered sowing. A field experiment was initiated with staggered sowing of sorghum in order to synchronize the milky stage earhead of sorghum with bitter gourd cropping period along with control bitter gourd crop. The maggot present in the stem gall of the bitter gourd were observed by destructive sampling for recording parasitization of *A. diplosidis.* The observation was carried out for a period of eight weeks in bitter gourd field with milky stage earheads of sorghum and in bitter gourd field with out the sorghum earheads. The data gathered clearly indicates that the sorghum crop with milky stage earheads in bitter gourd field recorded maximum parasitization of *A. diplosidis* up to 48.4 percent as against 28.1 percent noted in control bitter gourd field. An enhancement of parasitization by *A. diplosidis* up to 20.3 percent shall be effected by raising staggered sorghum synchronize the milky stage with the bitter gourd crop period.

Key words: Bitter gourd, Gall midge, Sorghum, Refuge crop and *Aprostocetus diplosidis*

S5P44 A302

Study on curd rot of cauliflower (*Brassica oleracea* var. *botrytis* L.) caused by *Pythium aphanidermatum*

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Cauliflower is one of the major cool-season vegetables grown in India, with production of 4.694 M mt per year from an area of 0.256 M ha. It is an important vegetable among the family *Brassicaceae* and the 'curd', or tightly-packed flower meristem, is used as a vegetable. The plant is prone to infection with several fungal diseases. Therefore, a survey was conducted during the winter season (December to February) in major cauliflower growing areas of Kerala. Foliage and curd diseases were the most destructive in these areas. Discoloured and rotted curd was collected and the pathogen was isolated as per standard protocols, and, Koch's postulates were verified by inoculating the mycelial discs on the curd. Disease symptoms (curd discolouration) showed up after 5 days of inoculation and, at the later stages a white, mycelial growth was observed on the curd. Upon culturing, the pathogen produced cottony, white mycelia on PDA medium. Further studies showed that hyaline, aseptate hyphae were produced by the fungus and had the characteristic lobed sporangium. It was thus identified as *Pythium aphanidermatum*. *In vitro* evaluation carried out against the pathogen with 8 fungicides showed that Mancozeb 75% WP, copper hydroxide 77% WP, copper oxychloride 50 % WP and Propineb 75 % WP caused 100% inhibition. Trifloxystrobin 25 % + Tebuconazole 50 % showed inhibition varying from 75-80%, 80-87% and 85-88% at 0.02, 0.03 and 0.04 conc., respectively. Chlorothalonil was found to be less effective, with just 40-50% inhibition. Carbendazim and Azoxystrobin were found to be the least effective, causing no reduction in mycelial growth.

S5P45 A303

Management of downy mildew [*Pseudoperonospora cubensis* (Berck & Curt.) Rostov.] of cucumber under protected cultivation

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Cucumber, *Cucumis sativus* L., is one of the most preferred vegetables grown under protected conditions in Kerala. A major foliar disease affecting this crop is downy mildew (*Pseudoperonospora cubensis* [Berk. & Curt.) Rostov.], and farmers use toxic chemical fungicides against the disease. Hence, the present study was conducted during October - April 2015-2016, with an objective of formulating eco-friendly management package against the disease. Field experiments were conducted simultaneously under a polyhouse and a rain-shelter for managing downy mildew, taking 12 treatments and three replications. The treatments included two biocontrol agents (*Trichoderma viride* and *Pseudomonas fluorescens*), cow-dung supernatant, two biofungicides (garlic and Calphomil) and two systemic fungicides (potassium phosphonate + Hexaconazole; and, Cymoxanil + Mancozeb) and one contact fungicide (Mancozeb). Soil solarization inside the protected structures was included as part of the treatment. It was found that soil temperature at 10 cm depth was higher in solarized soil compared to that in non-solarized soil, by 4^{o}C and 3.5^{o}C under the polyhouse and the rain-shelter, respectively. The population of soil microflora was reduced due to solarization under protected structures. Foliar spray with Cymoxanil + Mancozeb mixture was the most effective treatment against downy mildew under both polyhouse and rain-shelter, followed by Mancozeb, and soil solarization + seed treatment, and, soil application + foliar spray with *T. viride*. Highest yield too was recorded in soil solarization and application of *Trichoderma*.

S5P46 A313

Survey on occurrence of powdery mildew disease of gerbera in Kerala

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A purposive sampling survey on hilly tracts of Wayanad, Kerala revealed occurrence of powdery mildew disease in gerbera crop grown under protected as well as open-field condition. Among the fungal diseases of gerbera, powdery mildew causes decisive damage to this ornamental cut-flower crop, leading to a decline in its industrial value. Symptomatology of the disease appears as a white, powdery mat on the upper surface of leaf lamina, and gradually turns pale-yellow to brown. Powdery mildew was seen in two locations of Wayanad, *viz.*, Ambalavayal and Chulliyode. Highest per cent disease severity (PDS) of 50.72 was observed at Chulliyode and 47.2 at Ambalavayal during November-December. In Ambalavayal, the disease was non-significant and no correlation existed between weather parameters and progress of the disease. But, in Chulliyode, significant positive correlation was seen with relative humidity (RH), and a reverse relation existed with temperature and rainfall. Weather data clearly depicted that at low rainfall (96 mm) and above average RH of 80.27% during November-December was a congenial factor influencing disease development. During summer however, decline in RH (78.37%) and rainfall (63.13mm) caused a slight reduction in mean per cent disease severity of 49.12 and 33.6 at Chulliyode and Ambalavayal, respectively. Morohological and cultural characters of the pathogen show presence of two distinct organism, v*iz., Golovinomyces cichoracearum* (*Erysiphe cichoracearum*) and *Podosphaera* sp. as

causative organisms of the disease. *Golovinomyces cichoracearum* produced hyaline, septate mycelia and globose conidia with irregular peripheral-end in a chain form, while *Podosphaera* sp. produced a superficial, hyaline, coenocytic mycelium with oval or ellipsoidal, catenate conidia measuring 22.1-30.18 x 13.36-18.08µm on unbranched, erect conidiophores.

S5P47 A338

Reaction of tuberose germplasm to root knot nematode, *Meloidogyne incognita*, and histological characterization

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Tuberose (*Polianthes tuberosa* L.) is one of the most important commercial bulbous ornamental crops cultivated for use as both cut-flower and loose-flower. Root knot nematode problems in tuberose are widespread and majority of the tuberose fields in North and South India are heavily damaged by the nematode.They have a wider occurrence in the tuberose growing subtropical and tropical regions and reported to cause 10 and 14 per cent reduction in flower number of spikes and spike-weight, respectively. Identification of nematode resistant germplasm and utilizing them for production of high-yielding varieties will be a boon to tuberose growers for maximising the production of quality flowers. Infestation with root knot nematode, *Meloidogyne incognita*, results in plants with chlorotic foliage, general stunting and heavy root-galling below the ground. The present study was undertaken to screen tuberose germplasm for resistance/ tolerance to the root knot nematode, and to study histological changes thereof in the root. The experiment was conducted in Completely Randomized Design, replicated thrice. Thirty accessions of tuberose were screened. Each pot was inoculated with J2 stage of *M. incognita* @ 1000 nematodes/ pot at 15 days after planting. Gall index was recorded on a 0 – 5 scale. Results showed that nine varieties/ germplasm lines, *viz.*, Arka Shringar, IIHR-2, IIHR-4, Variegated, Shringar OP, Suarna Rekha, GK-T-C4, Calcutta Double and Bidhan Rajani-3 were tolerant, while the rest were susceptible. Histological characterization of cross-sections of the roots revealed active, giant cells in the susceptible germplasm, Arka Prajwal, with a dense and multi-nucleated cytoplasm; whereas, in the tolerant germplasm (IIHR-4, Suarna Rekha, Shringar OP and Variegated),giant-cell formation was disrupted. Also, with higher number of phenolic cells or cells with a lignified cell-wall, successful establishment of a nematode feeding-site was prevented.

S5P48 A343

Bioefficacy of Hexythiazox against red spider mite, *Oligonychus coffeae* Nietner, on tea

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The evergreen, long-lived tea plantations provide a relatively steady micro-climate and constant food supply to the mite communities. Loss from tea infested with red spider mite, *Oligonychus coffeae*, in India may be as high as 75%. This has necessitated a search for environmentally/ biologically safe pesticide molecules against the mites. Hexythiazox is one such novel acaricide, and has become an important component in several integrated pest-management programs, especially against the tetranychid mites. Two field-experiments were conducted at the Iyerpady and Lower Paralai estates, near Valparai in Coimbatore District of Tamil Nadu, from November 2012 to April 2013. The aim was to evaluate efficacy of Hexythiazox 5.45 ECat four different doses, in comparison to standard checks against *O. coffeae* in tea. Results showed Hexythiazox 5.45 EC to be very effective @ 50g a.i. ha^{-1} against the red spider-mite, but was not statistically superior to the lower doses, viz., 30g or 25g a.i ha^{-1}. The highest dose tested (50g a.i ha^{-1}) recorded a cumulative mean reduction of 73.32% and 63.41% in the mite population at Iyerpadi and Lower Paralai estates, respectively. Hexythiazox@ 30g a.i. ha^{-1} was equally effective, by recording a cumulative mean reduction of 70.7% and 55.73% in the mite population at Iyerpadi and Lower Paralai estates, respectively. Recommended dose of Hexythiazox@ 25g a.i. ha^{-1} too was on par with the higher doses, and registered a cumulative mean reduction of 69.56% and 51.81% in the mite population, in the first and second field experiments, respectively. Thus, Hexythiazox is a promising candidate chemical for mite management in tea estates.

S5P49 A356

Evaluation of novel formulation of *Beauveria bassiana* (bb 112) and its efficacy against *Aphis gossypii* on tomato using different delivery equipments

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Entomopathogenic fungi (EPF) are regarded as alternative pest management strategy to combat the negative impacts of chemical pesticides. *Beauveria bassiana* (Bals.) Vuill. is a cosmopolitan EPF effective against a wide variety of pests, *viz.* caterpillars, bugs, whitefly, thrips etc. The practical difficulty of exploiting this potent EPF can be overcomed by improved formulations. A study was conducted in this line at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India to evaluate the bioefficacy of different formulations of EPF, *B. bassiana* (Bb 112) against *A. gossypii* on tomato under microplot condition. The effective formulation was selected and its bioefficacy was tested under field condition using different delivery equipments in Kumarapalayam village of Coimbatore district using randomized block design. Two sprays at 14 days' interval were given and the cumulative reduction in aphid population was taken into account. The microplot study revealed that the oil formulation of *B. bassiana* (Bb 112) (Sangamithra, 2015) afforded maximum control of aphids with highest population reduction of 45.50 per cent when compared to talc and crude formulations. Under field condition also, oil formulation of *B. bassiana* (Bb 112) sprayed with Controlled Droplet Applicator (CDA) recorded highest population reduction of aphid (41.02 per cent) with increased yield. The present findings are in accordance with Harichandra and Shekharappa (2009) who reported that efficacy of formulations of *B. bassiana* against sucking pests of okra and registered that *B. bassiana* oil based formulation recorded higher mortality of 93.33 per cent mortality of aphids followed by wettable powder formulation.Hence, the present study implies that the improved formulations applied using improved delivery systems can thereby revelutionalize the biopesticide utility.

S5P50 A367

In vitro mutagenesis in'Neypoovan' banana (*Musa sp*. L., AB) for developing *Fusarium* wilt resistance

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Neypoovan (AB group)is one of the favoured cultivars of banana grown in Southern parts of India. Panama wilt is a dreaded disease of neypoovan cultivar causing enormous loss and resistance breeding is impossible due to sterile nature of cultivar. Induction of mutagenesis through suckers is difficult process.In the present study, EMS treatment was optimized for obtaining *Fusarium* resistant mutants via somatic embryogenesis. The effect of treatment duration of EMS (0.2%, v/v) on plant regeneration capacity of ECS was investigated and found that the number of somatic embryos and plant regeneration was remarkably high at 10 min EMS treatment but with the increase in duration, number of somatic embryos and plant regeneration decreased. About 50 % of plant regeneration was observed at 15 min EMS

treatment duration as compared to control (LD_{50} of EMS = 15 min) and used for regeneration of variants. The sub lethal concentration of fusaric acid and Foc culture filtrate (CF) was determined to be 0.1 mM and 40 %, (v/v) respectively for the regenerated plantlets. A total of 750Neypoovan shoots that regenerated on M4 media (MS basal + 0.5 mg/l BAP) supplemented with fusaric acid (0.01 mM) were sequentially screened on Shoot Induction Medium (SIM-MS basal + 1 mg/l BAP) containing sublethal doses of Fusaric acid and Foc CF. Forty-sevenplants were found insensitive to toxins supplemented media. Following acclimatization and *Foc* inoculation, only four immune mutants were identified.The survived plants subjected for stomatal count showed a significant decreasein stomatal number in one of the mutant (*ie*. 106) compared to the control (ie. 126)and increasedlevel ofperoxidase enzyme activity(*ie*.,0.165 units/g of fresh wt) than control (*ie*., 0.151 units/g of fresh wt). The field evaluation of the mutants is in progress.

S5P51 A370

Role of stress-tolerant phosphate solubilizing bacteria (PSB) as biofertilizer on growth and yield in tomato in the trans-Himalayas, Ladakh

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With alarming use of chemical fertilizer associated with environmental and health hazard, the role of microbial inoculants as substitute to chemical fertilizer has come into play paramount role in maintaining the soil nutrient which include phosphorus. It's thesecond most important nutrient required by plant after nitrogen. The investigation focus on beneficial stress tolerant phosphate solubilising microbe role as biofertilizerwhich may prove their efficacy in stress environment like cold arid region experiencing extreme climate. Phosphate solubilising microbe *Stapylococcussuccinus*subsp. *casei* isolated from Seabuckthorn (*Hippophae rhamnoides* L.) rhizosphere was screened for phosphate solubilisation activity on Pivoskaya agar, forming a clear zone around colony. The isolate were further assessed for stress tolerance viz. 4-40^0 C, pH 4-12, salt (1-5%) $NaCl_2$,KCl, $CaCl_2$ for insoluble phosphate solubilisation potential in liquid pivoskaya broth. The isolate possess plant growth promoting activity like indoleacetic acid, siderophore and HCN production in laboratory condition. Tomato seedling inoculation enhances plant morphological growth significantly at 30, 60 and 90 days after transplant over control in pot experiment. 12 % increase in yield over control were recorded. Hence, the isolate possess potential as microbial biofertilizer development for extreme region arid agriculture system.

S5P52 A373

Immuno- molecular Detection and Gene expression based Study on Spatial Distribution of *Apple chlorotic leafspot virus*(ACLSV) in Apple trees in Kashmir valley

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Apple (*Malus domestica*Borkh.) occupies prime position in area and production among all the temperate fruits growing in Jammu and Kashmir (J&K). Annual production (quantity and quality) of appledependsonbothbioticand abiotic factors. Among biotic factors, apple is susceptible to infectionbyfungi,bacteria, virusesandviroids. Amongviruses andvirus-like pathogens,majorityoftheapple trees are known to be infected by *Apple chlorotic leaf spotvirus* (ACLSV), *Applemosaicvirus* (ApMV),*Applestemgrooving virus* (ASGV), *Apple stem pitting virus* (ASPV) and *Apple scar skin viroid* (ASSVd).The importance of ACLSV is due to its worldwide occurrence and large host range on pome and stone fruit, which are of great economic value. In our study the objective is to confirm virus from different parts (spatial) in different seasons (temporal) of apple tree. Samples ofleaf, whole flower, sepal,petal,anther, stigma with style, bark and root were taken from virus infected plants showing symptoms of ACLSV in spring season and DAS-ELISA based detection revealed that all parts are ACLSV positive, except root and DAS-ELISA values indicated virus expression was more in leaf and whole flower than other parts of apple tree. RT-PCR based detection confirmed the virus from all parts except root. In order to find the relative expressionof ACLSV in different partsof plant, Semi-Quantitative RT-PCR analysis showed variation in gene expression of ACLSV in different parts. The Real Time PCR analysis showed highest expression in leaf and minimum in petal. Our results confirmed that the ACLSV expression is more in leaf and whole flower. The absence in root gives confirmation that there is no chance of transmission from infected to healthy root due to root-root contact in soil. But presence in every part of flower gives indication that it might be pollen or seed transmitted which is to be confirmed. The other future studies need to be done are detection in fruit and seed, whole genome characterization, development of infectious clone, transmission studies etc.

S5P53 A374

Isolation and identification of antagonisticActinobacteria against pathogen of fusarium wilt inBanana

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Fusarium wilt is a disease reducing significantly on banana productivity. The disease is caused by *Fusarium oxysporum*f.sp. *cubense*that attacks most of banana variety in the world. Biocontrol of the disesase has been being developed within the last decades such as the use of Actinobacteria. This research is aimed to isolate and identify antagonistic actinobacteriaagainst *Fusarium oxysporum*f.sp. *cubense*. Actinobacteriawere isolated from rhizospheric soils of banana plants with and without *Fusarium* wilt symptom. Antagonistic activity was carried out by dual culture method for selecting among isolates. Actinobacteriaisolates showing higher antagonistic activity were subjected for morphological and molecular identification. Molecular identification was performed by sequencing of 16S rDNA gene. The research also found three isolates having higher antagonistic activity rather than the others. The three isolates, AcB60, AcB21and AcB32 was identified as *Streptomyces griseoruber*, *Streptomyces chrysomallus*and*Streptomyces alanosinicus* respectively.

S5P54 A384

In vitro mutagenesis of Neypoovan banana (*Musasp*. L., AB) for developmentof Fusarium wilt resistance

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Neypoovan (AB group)is one of the favoured cultivars of banana grown in Southern parts of India. Panama wilt is a dreaded disease of neypoovan cultivar causing enormous loss and

resistance breeding is impossible due to sterile nature of cultivar. Induction of mutagenesis through suckers is difficult process.In the present study, EMS treatment was optimized for obtaining *Fusarium* resistant mutants via somatic embryogenesis. The effect of treatment duration of EMS (0.2%, v/v) on plant regeneration capacity of ECS was investigated and found that the number of somatic embryos and plant regeneration was remarkably high at 10 min EMS treatment but with the increase in duration, number of somatic embryos and plant regeneration decreased. About 50 % of plant regeneration was observed at 15 min EMS treatment duration as compared to control (LD_{50} of EMS = 15 min) and used for regeneration of variants. The sub lethal concentration of fusaric acid and Foc culture filtrate (CF) was determined to be 0.1 mM and 40 %, (v/v) respectively for the regenerated plantlets. A total of 750Neypoovan shoots that regenerated on M4 media (MS basal + 0.5 mg/l BAP) supplemented with fusaric acid (0.01 mM) were sequentially screened on Shoot Induction Medium (SIM-MS basal + 1 mg/l BAP) containing sublethal doses of Fusaric acid and Foc CF. Forty seven plants were found insensitive to toxins supplemented media. Following acclimatization and *Foc* inoculation, only four immune mutants were identified.The survived plants subjected for stomatal count showed a significant decreasein stomatal number in one of the mutant (*ie*. 106) compared to the control (ie. 126)and increased level ofperoxidase enzyme activity(*ie*.,0.165 units/g of fresh wt) than control (*ie*., 0.151 units/g of fresh wt). The field evaluation of the mutants is in progress.

S5P55 A413

Studies on resistance of *Gladiolus* genotypes to geographically diverse pathogen, *Fusarium oxysporum* f. sp. *gladioli*

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Gladiolus (*Gladiolus hybridus* Hort.) is the queen among bulbous flower crops. It is known for its beauty and dazzling coloured, showy florets. In India, this crop covers an area of 11.67 thousand hectares, with production of 92.89 million tons of stem (Indian Horticulture Database, 2014). Despite a large production, this crop is highly susceptible to various *Fusarium* species, leading to heavy losses to the farmer. Therefore, there is a need for continuous screening of gladiolus varieties. There is differential resistance in different varieties of gladiolus, besides the differential virulence existing in various isolates of *Fusarium oxsporium* f. sp. *gladioli*. To evaluate the level of resistance and virulence of the pathogen, an experiment was conducted. Dormant corms of 30 genotypes were treated aseptically under *in vitro* conditions, with three geographically different cultures of *Fusarium*, viz., IARI culture (*Fusarium oxysporium* f. sp. *gladioli* – Culture 1), Pantnagar culture (*Fusarium oxysporium* f. sp. *gladioli* – Culture 2) and DFR Pune culture (*Fusarium oxysporium* f. sp. *gladioli* – Culture 3). For this, a pure culture of fusarium was isolated from various infected corms collected from different regions, and grown

on PDA medium. Disease index was calculated by multiplying width x depth of infected area upto 60 days. Disease index was highest in High Hopes Open, White Friendship, Pusa Swarnima and Sancerre with reference to all three cultures. Infection started at 28 days after treatment of cultures in White Friendship. Green Lilac Open, Melody x Mayur and Pusa Vidushi were more resistant, as, virtually no rot developed on these.

S5P56 A430

In vitro evaluation for compatibility of additives with *Beauveria bassiana* (Balsamo) Vuillemin

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In-vitro evaluation was conducted for testing compatibility of 12 commonly-used additives, at three different concentrations (0.1%, 0.5% and 1.00%) with *Beauveria bassiana* through poisoned-food technique. Results were expressed as radial growth and growth-inhibition in *Beauveria bassiana* on medium treated with the additive. All additives showed inhibition of mycelial growth in *B. Bassiana*,either partially or completely, depending upon concentration. Overall, CMC showed the highest radial-growth, with the least growth-inhibition (77.16mm and 8.03%, respectively), followed by Kaolite (69.07mm and 17.65%, respectively) and silica gel (65.20mm and 22.25%, respectively). From these findings, it can be concluded that CMC can be used further in formulations of *B.bassiana*, with the highest spore-load of $4.67x10^8$ spores ml^{-1}.

S5P57 A431

Molecular characterization and management of phyllody disease in China aster

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Phyllody in China aster, one of the serious diseases associated with phytoplasma, has been frequently observed in fields in India and induces considerable yield loss. China aster

plants showing typical symptoms of this disease, such as chlorosis, reduced leaf-size, shortened internodes, profuse vegetative growth and floral parts transformed into leaf-like structures (phyllody) were collected from a naturally-infected field at University of Agricultural Sciences, GKVK, Bengaluru. Association of phytoplasma was confirmed by PCR assay using the universal primer pair P1/P7, which amplified ~1.8kb corresponding to 16SrDNA region of the phytoplasma from the total DNA extracted from the infected-plant samples. Sequence analysis of amplified fragment from BLAST search revealed 100% nucleotide identity with 16SrDNA sequences of sunflower phyllodyphytoplasma, sweet potato little-leaf phytoplasma and chickpea phyllodyphytoplasma indicating, that, the phytoplasma causing phyllody disease in China aster belongs to 16SrII (Peanut Witches' Broom) phytoplasma group. For management of China aster phyllody, soil application of Carbofuran3G (10kg/acre), followed by foliar spray of Imidacloprid (0.5g/l) and/or Thiomethoxam (0.5g/l) and Acetamiprid (0.5g/l) at 15 days' interval reduced the disease incidence significantly by a decrease in vector population (*Orosius albicinctus*, Leaf hopper).

S5P58 A458

Effect of elevated carbon dioxide and temperature on the growth of South American tomato moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae)

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Predicted increase in temperature and atmospheric Co_2 concentration will influence the growth of crop plants and phytophagous insects. The present study, conducted at the ICAR-Indian Institute of Horticultural Research, Bengaluru, India was aimed at construction of life tables at three different temperatures for *Tuta absoluta* (Meyrick) (Gelechiidae: Lepidoptera) reared on tomato grown under elevated Co_2 (550 ppm) and ambient Co_2 (380 ppm) in open top chambers. Feeding trials conducted on tomato leaf (*var*: NS-501) obtained from two Co_2 showed that the developmental time of *T. absoluta* declined with increase in temperature and delayed when compared to insects reared at elevated Co_2 condition. Finite (λ) and intrinsic rates of increase (r), net reproductive rate (Ro) are more in insects grown under ambient Co_2 condition. As the temperature increased from 28ºC to 30ºC all the factors favouring insect growth and development increased significantly but at 32ºC a suddenly decrease in all parameters were observed both in ambient and elevated Co_2 conditions. Mean generation time (T) was more in insect reared at elevated Co_2 condition and decreased with the rise in temperature. The present results indicate that temperature and CO_2 are vital in influencing the population growth of *T. absoluta* and pest incidence may possibly be higher in future as elevated Co_2 condition delays the growth of insect resulting in increased feeding on the foliage.

S5P59 A477

Integrated disease management of Papaya Ring Spot Virus (PRSV) in papaya

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Papaya (*Carica papaya* L.) is native of tropical America and it is a major fruit crop in India. Papaya is widely grown in the tropics and subtropics of the world and in India it is mainly grown in Bihar, Assam, Maharashtra, Madhya Pradesh, Andhra Pradesh and Tamil Nadu. Among the viruses infecting papaya, Papaya ringspot virus (PRSV) is the major constraint to papaya industry worldwide. In southern India, earlier PRSV was restricted to Karnataka and Andhra Pradesh, the states adjoining Tamil Nadu. However, the virus had entered into Tamil Nadu in 2003 and wide spread occurrence of papaya ring spot disease was noticed in plantations around Coimbatore. Since PRSV is transmitted mainly by aphids, avoiding and eliminating them is main theme of PRSV management. The quick spread of the disease in the field leave little scope for adopting any control measures against the malady and necessitates the integrated management strategy. In the present study, a field trial was carried out during 2015-16 at the College orchard with five treatments including the components *viz*., raising seedlings under net house and application of neem oil, insecticides and micronutrients. Among the five treatments, the treatment T_4*ie*.,Spraying of urea @ 10g/liter + zinc sulphate @1.5g + boron @ 1.0g per litre recorded reduced PRSV incidence of 42.7 % with maximum average yield of 49.68 kg/tree and CB ratio of 3.42 as compared to control with maximum PRSV incidence of 95.6 % incidence with reduced yield of 23.76 kg/tree at 150 DAP and CB ratio of 2.03. The treatment T_1 (Application of neem oil 1% + acephate 1.5 g/l at 15 days interval) recorded 49.8 % PRSV incidence with an average yield of 35.18 kg/tree.

S5P60 A499

New Era of eliminating the ill effects of fungicides through eco-friendly new generation plant based compounds

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The present investigation was carried out to isolate, characterize, bioevaluate and quantify the different molecules isolated from *Iris kashmiriana*. The extracts were prepared as per standard operating procedures by using different solvents of varying polarity. The extracts were then bioassayed against *Venturia inaequalis* by poisoned food technique. The bioassay guided fractionation of crude extracts by column chromatography resulted in the isolation of pure molecules that were characterized by using physical, chemical as well as spectroscopic techniques. The characterized molecules were then evaluated against *V. inaequalis*, at different concentrations (1000ppm to 5000ppm). All the molecules were found potent in limiting the mycelial growth of *V. inaequalis*. Out of the tested molecules the most profound effect was shown by irigenin followed by tectorigenin and least in case of iridin. A rapid and reverse phase high pressure chromatography (RP HPLC) method for quantitative analysis of irigenin, tectorigenin and iridin in the different species of Iris plant was developed. The HPLC showed an excellent performance in separating these compounds in different species of Iris plant. From this study it is clear that irigenin, tectorigenin and iridin are potent compounds which can be used for controlling the growth of *V. inaequalis*

S5P61 A501

Seedling invigouration by halo priming in tomato against salt stress

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A study on seedling invigouration in tomato against salt stress was undertaken with three levels of halo-priming (1, 2, 3% KNO_3) and two levels each of priming duration (24 and 48 h) and salinity (2.5 and 5.0 EC). The interaction between P_2 level of halo-priming and D_2 level of duration resulted in maximum germination rate index (10.88), root fresh weight (0.47 g), root dry weight (0.31 g), seedling dry weight (1.18 g), total chlorophyll (2.87 mg/g), soluble sugar (20.98 mg/g), catalase (0.78 μg^{-1}), peroxidase (0.53 μg^{-1}), superoxide dismutase (55.33 μg^{-1}) and ascorbate peroxidase (4.69 μg^{-1}) activities, whereas maximum seedling survival; leaf area index, potassium and protein content were found in P_1D_2; P_1D_1 and P_2D_1, respectively. P_1 level of halo-priming and S_2 level of salinity performed well for seedling survival (54.17%), root fresh weight (0.41 g) and seedling dry weight (1.08 g), whereas P_2S_2 showed good germination rate index (7.87), germination index (431.67), final germination percentage (86.67%), potassium (26.68 mg/g), protein (0.59 mg/g) and catalase activity (0.65 μg^{-1}) under higher salinity (5.0 EC). The interaction between D_2 level (48 h) of priming duration and S_2 level of salinity was observed to be good for seedling survival (52.33%), germination rate index (8.03), sodium (14.92 mg/g), total chlorophyll (2.12 mg/g), soluble sugar (18.54 mg/g) and catalase activity (0.53 μg^{-1}), while, D_1S_2 expressed good leaf area index (0.62) and potassium (24.84 mg/g) under higher salinity. $P_2D_2S_2$ combination performed well under higher salinity and showed good germination rate index (12.09) and catalase activity (0.80 μg^{-1}), whereas good protein (0.68 mg/g) and chlorophyll content (3.42 mg/g) were observed in $P_2D_1S_2$ and $P_1D_2S_2$, respectively under higher salinity.

S5P62 A502

Evaluation of gladiolus genotypes for resistance to Fusarium wilt

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Fusarium wilt is a major disease in commercial cultivation of gladiolus caused by *Fusarium oxysporum* f.sp. *gladioli* resulting in yellowing and drying of foliage, corm rot and eventual death of plant. A study was conducted with different gladiolus genotypes *viz*., Arka Aayush, Arka Amar, Arka Darshan, Arka Gold, Arka Kum Kum, Pink Friendship, IIHRG-12, *Gladiolus callianthus* and *Pisittacinus* hybrid, which were assessed for resistance to two geographically different isolates of *Fusarium oxysporum* f.sp. *gladioli* i.e. Solan isolate and IIHR isolate. Resistance to *Fusarium oxysporum* f.sp. *gladioli* was appraised by studying percentage of disease incidence, mortality and diseased corms during storage. Results from the trial indicated

highest disease incidence (100.00%) in Pink Friendship inoculated by IIHR isolate. There was no disease incidence in *Pisittacinus* hybrid which was inoculated by Solan isolate or IIHR isolate. Pink Friendship inoculated with IIHR isolate recorded maximum mortality (83.33%). Plants of Arka Gold, *Gladiolus callianthus* and *Pisittacinus* hybrid inoculated with Solan isolate recorded no mortality. *Pisittacinus* hybrid inoculated with IIHR isolate also recorded no mortality. During 60 days storage maximum diseased corms was detected in Pink Friendship (66.67%) inoculated with IIHR isolate. No diseased corms during storage were observed in Arka Gold, *Gladiolus callianthus* and *Pisittacinus* hybrid inoculated by Solan isolate. There were also no diseased corms in *Gladiolus callianthus* and *Pisittacinus*hybrid inoculated with IIHR isolate. The present study infers that *Fusarium oxysporum* f.sp. *gladioli* IIHR isolate is highly virulent and *Pisittacinus* hybrid exhibits resistance to both IIHR and Solan isolates which can be utilized as potential resistance source to *Fusarium* wilt and development of resistant varieties.

S5P63 A545

Comparison of ELISA, RT-PCR and Nanobiosensor assays for the detection of *Cucumber mosaic virus* infecting banana

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Virus indexing is the process of detecting the presence of a known virus in an asymptomatic infected plant. Traditionally, electron microscopy and host plant assay techniques were generally used which are no longer practical for large scale indexing as these are time consuming. Serological assays, PCR, microarray etc are the most common detection techniques practiced in virus indexing laboratories for the production of virus free tissue culture plants. *Cucumber Mosaic Virus* (CMV) infected banana plants often fail to express symptom at early stage and the detection of such samples goes undetected in ELISA due to low virus titre. Studies were conducted to compare the sensitivity of different techniques for the detection of virus causing infectious chlorosis of banana. Healthy and CMV infected isolate were pulverized with liquid nitrogen in a pre-chilled pestle and mortar, homogenized for 90s with 0.1M Potassium Phosphate buffer (pH 7.5) in a ratio of 1:10 (w/v) and centrifuged at 8000 g for 5 minutes. Supernatant was used to quantify total protein in the crude sap using Nanodrop Spectrophotometer. This crude sap was then used as a standard control and also to make lower concentrations of working standards for detection using ELISA and nano-biosensor detection assay. CMV coat protein gene specific primers were used for RT-PCR detection which resulted in bands at 750 bp which were visualized in the gel electrophoresis. In ELISA, enzyme reaction with the substrates producing a solution whose change was measured in Spectrophotometer and the absorbance noted was 0.195 at 405 nm for the working solution with antigen 0.75 mg/ml, thus limiting its detection ability at lower concentration. While, Gold Nano Rods

(GNRs) solution phase Localized Surface Plasmon resonance (LPSR) based biosensor enabled to detect the lowest virus titre of 0.04 mg/ml (40 ppm) in the working solution with a peak shift in UV-Vis spectrum (200-1100 nm). Among the assays, detection through nano-biosensor could be most reliable in terms of detecting virus with specificity, sensitivity, speed and cost.

S5P63a A519

Comparison of ELISA, RT-PCR and Nanobiosensor assays for the detection of *Cucumber mosaic virus* infecting banana

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Virus indexing is the process of detecting the presence of a known virus in an asymptomatic infected plant. Traditionally, electron microscopy and host plant assay techniques were generally used which are no longer practical for large scale indexing as these are time consuming. Serological assays, PCR, microarray etc are the most common detection techniques practiced in virus indexing laboratories for the production of virus free tissue culture plants. *Cucumber Mosaic Virus* (CMV) infected banana plants often fail to express symptom at early stage and the detection of such samples goes undetected in ELISA due to low virus titre. Studies were conducted to compare the sensitivity of different techniques for the detection of virus causing infectious chlorosis of banana. Healthy and CMV infected isolate were pulverized with liquid nitrogen in a pre-chilled pestle and mortar, homogenized for 90s with 0.1M Potassium Phosphate buffer (pH 7.5) in a ratio of 1:10 (w/v) and centrifuged at 8000 g for 5 minutes. Supernatant was used to quantify total protein in the crude sap using Nanodrop Spectrophotometer. This crude sap was then used as a standard control and also to make lower concentrations of working standards for detection using ELISA and nano-biosensor detection assay. CMV coat protein gene specific primers were used for RT-PCR detection which resulted in bands at 750 bp which were visualized in the gel electrophoresis. In ELISA, enzyme reaction with the substrates producing a solution whose change was measured in Spectrophotometer and the absorbance noted was 0.195 at 405 nm for the working solution with antigen 0.75 mg/ml, thus limiting its detection ability at lower concentration. While, Gold Nano Rods (GNRs) solution phase Localized Surface Plasmon resonance (LPSR) based biosensor enabled to detect the lowest virus titre of 0.04 mg/ml (40 ppm) in the working solution with a peak shift in UV-Vis spectrum (200-1100 nm). Among the assays, detection through nano-biosensor could be most reliable in terms of detecting virus with specificity, sensitivity, speed and cost.

S5P64 A551

Occurrence of multiple resistance to fungicides in *Fusarium* species isolated from horticultural crops

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Fusarium is a devastating plant pathogen which causes the wilt disease in many crops resulting in complete crop failure. Carbendazim is a widely used fungicide to manage wilt disease. However there are many reports on emergence of resistance in *Fusarium* species against carbendazim. Resistance to carbendazim has been reported in horticultural crops by us earlier (Kumawat *et al*., 2016). Among 42 isolates of *Fusarium* belonging to different species from horticultural crops (vegetable, fruit and ornamental crops) that were tested for resistance to carbendazim, ten isolates isolated from ornamental crops *viz*. carnation (7), marigold (1) andgladiolus (2) were resistant to carbendazim. They showed cross resistance to other fungicides like benomyl and thiabendazole. In the present study multiple resistance to captan, copper oxy chloride, tebuconazole, bitertanol, mancozeb, chlorothalonil, azoxystrobin, propiconazole, pyraclostrobin was tested. Many isolates showed multiple tolerance to copper oxy chloride (9), tebuconazole (2), bitertanol (2), mancozeb (2), azoxystrobin (1) at 5000 ppm concentration. None of the isolates showed resistance to captan, pyraclostrobin, propiconazole, chlorothalonil. One isolate from carnation was tolerant to 3 fungicides (copper oxy chloride, bitertanol, mancozeb) besides its tolerance to benzimidazoles; followed by one isolate from marigold that was tolerant to COC and mancozeb. Isolate from gladiolus was tolerant to COC and tebuconazole. The resistance in these isolates was observed up to 5000 ppm of COC, tebuconazole, bitertanol, mancozeb, azoxystrobin. The present study showed that besides cross resistance, multiple resistance also occurs in *Fusarium*. The indiscriminate use of fungicides in floriculture has resulted in the development of resistance to these fungicides. To manage the multiple resistance to various fungicides, mixed treatment schedule based on the observation resistance to different group of fungicides needs to be recommended.

S5P65 A566

Identification and diagnosis of tomato mottle mosaic virus in tomato

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Tomato is known to be infected by different plant viruses. Tomato leaf curl virus, tomato mosaic and bud necrosis were found to be common in India. Recently, tomato plants showing characteristic symptoms of mosaic, mottling, chlorosis and deformation in leaves and necrotic lesions on fruits were observed. The symptomatic samples collected from tomato hybrids in farmers field were tested for the presence of virus by electron microscopy, mechanical inoculation and RT-PCR. Virus infected leaf/fruit samples washed with RNase-free sterile double distilled water and sap extracted when examined under Electron microscope, showed the presence of rigid rod-shaped particles. Sap extracted from infected samples was inoculated to different test hosts and on *Nicotina glutinosa*, it produced necrotic pin point lesions and systemic mosaic symptoms on tomato and chilli. Further to identify the causal virus, total RNA was isolated from symptomatic and healthy leaf/fruit samples of tomato using tri-reagent and was used for RT-PCR amplification using *Tobamovirus* specific degenerate primers. RT-PCR amplification resulted in amplification of a single DNA fragment of approximately 0.8kb, from symptomatic samples but not from healthy control and asymptomatic samples. Cloning, sequencing and nucleotide blast search in NCBI showed 87 to 92% similarity with tobamoviruses and more than 90% with tomato mottle mosaic virus (ToMMV). The causal agent of tomato mosaic and mottling was identified as tomato mottle mosaic virus based on Electron microscopy, host range, PCR amplification and sequence analysis. This is the first report of the occurrence of ToMMV on tomato in India.

S5P66 A573

Predatory efficacy of *Nesidiocoris tenuis* (Reuter) against *Tetranychus urticae* (Acarina: Tetranychidae)

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The two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), with its high development rate and fecundity, is one of the most destructive pests of tomatoes in greenhouses as well as open cultivation throughout the world. *Nesidiocoris tenuis* (Reuter) (Hemiptera: Miridae) is a polyphagous predatory bug, which is commonly found in tomato ecosystems. Our study explores in greater detail how feeding changes occurred for each stage when the predators were fed a single prey species. Results of this study indicate that all stages of the bug are highly predacious against *T. urticae*. Male nymphs consumed 11.8, 55.5, 66.3, 75.3, and 78.3 mites at the rate of 5.9, 18.5, 33.2, 37.6, and 39.1 mites per day for instars 1–5, respectively. The rate of consumption by female nymphs was 15.9, 61.8, 81.1, 88.8, and 90.1 mites at the rate of 7.9, 20.6, 40.6, 44.4, and 43.0 mites per day for instars 1–5, respectively. The overall consumption by female bugs (1137–1430 mites) was also higher than that of males (858–1092 mites). Augmentative releases of later instar nymphs of *N. tenuis* against *T. urticae* might therefore assure better mite control.

S5P67 A601

Genetic analysis for watermelon bud necrosis virus (WBNV) in watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai]

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Watermelon is a major cucurbit and an important vegetable crop of India. It is cultivated in an area of 81,890 hectares with the production of 2038.24 thousand metric tonnes. Our productivity levels are constrained by the occurrence of various diseases. Important among them, is a thrips transmitted Watermelon Bud Necrosis disease caused by a Tospo virus. Severe yield losses throughout India have been reported because of this disease. The incidence ranges between 39-100% with a yield loss of 60-100%.Watermelon bud necrosis virus (WBNV) is prevalent in watermelon growing areas particularly in the states of Karnataka, Andhra Pradesh and Maharashtra. At IIHR, efforts are underway to utilize resistance to this disease from a wild citron, IIHR-82.This study was conducted to understand the type of gene action governing the inheritance of resistance to WBNV in populations (P_1, P_2, F_1, and BC1 & BC2) of the cross involving resistant (BIL-53: inbred derived from cross (IIHR-82 x Arka Manik) x Arka Manik) and susceptible (IIHR-140-152) parents. These populations were screened for disease reaction under natural field conditions during summer, 2016 in a randomized complete block design with three replications. Performance of six generations based on mean percent disease incidence (PDI) revealed P_1, F_1 and BC1 to be resistant; F_2 and BC2 exhibited moderate resistance while P_2 was susceptible. The data was subjected to generation mean analysis and the results revealed the non-significance of scaling test indicating adequacy of simple additive-

dominance model and the absence of non-allelic interaction. The additive component was found to be significant and negative in direction, contributing towards resistance. As the additive gene effect is in higher magnitude, selection can be employed for improving resistance.

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S5P68 A604

Studies on the biochemical traits of cauliflower in relation to downy mildew resistance

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Downy mildew (DM), caused by the oomycete, *Peronospora parasitica*, is a destructive disease of cauliflower and other *Brassica* vegetables worldwide. The present investigation was carried out at the Experimental Farm of the Department of Vegetable Science and Floriculture, CSK HPKV Palampur to gather information on the association between downy mildew resistance and biochemical traits. The experimental material comprising of P_1, P_2, F_1, F_2, BC-1, BC-2 generations of six crosses developed by utilizing the four diverse parents *viz*., DPCaY-3, Palam Uphar, DPCaY-8 and DPCaY-6 were evaluated in Randomized Block Design along with standard check in three replications during *rabi* 2015-2016. Data were recorded on total soluble solids (^{o}Brix), vitamin C (mg/100g), total sugars (%) and total phenols (mg/g). Genotypic correlation coefficients were higher than the phenotypic correlations which revealed that though there is a strong inherent association between different characters, the phenotypic expression of the correlation gets modified under the influence of environment.Correlation matrix revealed that plant disease index exhibited significant and positive correlation with total sugars, whereas this association was significant and negative with vitamin C and total phenols. Resistant genotypes have higher vitamin C and total phenols compared to susceptible genotypes.

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S5P69 A613

Recent developments in insecticide formulations for horticultural crops

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Insects are one of the biggest animal populations with a very successful evaluative history. On the other hand, many insects are vectors for many diseases, damage crop and cause serious health and economic issues. In order to combat the numerous losses caused by insects, several chemicals known as insecticides have been used to kill them or inhibit their reproduction and feeding. Insecticide product consists of two parts: active and inert ingredients. Insecticides are formulated in various forms like dust, granules, wettable powder, soluble powder, emulsifiable concentrate, oil solutions, fumigants etc. Scientific community made approaches towards the development of newer molecules which could be easily biodegradable and target-specific with very low mammalian toxicity, which could undergo photo degradation, microbial degradation as well as chemical degradation leaving very less amount of residues in the environment. New dust formulation like air-mixed oil coated and driftless dust are developed which give more deposit of active ingredient to the target area. Formulations like soluble powders have less phytotoxicity and require little agitation. Floating granules are effective to control the aquatic pests. Water soluble packets are developed to overcome the inhalation hazards and also reduces the mixing and handling of toxic chemicals. Microencapsulated products and nano-insecticides being develop to increase efficacy and stability, with advantage of controlled release. Invert emulsions are water in oil type formulations which reduces the surface runoff and have better penetration and absorption. Researchers are currently designing formulations that are similar to conventional formulas, but reducing the particle sizes of the polymers, surfactants and metal to create nano-formulations that are more soluble, slow releasing and do not prematurely degrade.

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S5P670 A634

Status and characterization of Stem bark canker (*Fusicoccum aesculi*) of Pear in Jammu & Kashmir, India

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Pear (*Pyrus communis* L.) is one of the important pome fruits grown throughout the world. Despite the fact that the agro-climatic conditions of valley are ideally suited for its cultivation the productivity is very low compared to other parts of the world due to many biotic and abiotic factors. The major biotic factors include fungal diseases. Among these diseases canker diseases of pear are now assuming alarming status resulting in huge economic losses (Jones and Aldwinkle, 1990). The present studywas therefore, undertaken to study the status and to characterize the pathogens associated with pear canker in Kashmir. A survey was carried out in the months of August and September, 2012 in major pear growing areasof Kashmir valley to record the incidence and intensity of fusicocum canker of pear. Among the different districts surveyed, the orchards in the district Anantnag exhibited the maximum average canker incidence and intensity of 18.96 and 10.10 per cent respectively, followed by orchards of district Kulgam with an average canker incidence and intensity of 14.22 and 8.11 per cent respectively.The orchards in district Baramulla exhibited least incidence and intensity of 10.45

and 5.56 per cent, respectively. Fusicoccum cankers mostly developed on small branches and twigs as small, sunken, reddish brown lesion/area with or without a fissure, which on enlargement became depressed and formed small elliptical cankers, completely girdling the affected branch.Hyphae of the fungi were branched, thick walled, septate, hyaline to light brown, 2.95-3.80 µm in width. The pycnidia were globose to conical with a papillate ostiole. The pycnidial size ranged from 142-190 × 167-240 µm wide, with an average size of 164.32 × 198.75 µm.

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S5P71 A651

Pattern and trend of pest complex of major horticulture crops in Kashmir region

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Pest complex of major horticulture crops in the Kashmir valley (India) is reviewed in light of the previous and the new additions.It is established that more than 30 major pest species are prevalent in the region. Among which some are recorded for the first time from India and some constitute new regional records. These mostly constitute five main orders and belong to 21 families. Some of the new additions to India include *Dryomyza pakistana*, *Protichneumon pisorius*, *Rhamphomyia caudate*, *Myennis octupunctata*, and *Megamerina dolium*.These insects host on important temperate horticulture crops like Apple, Almond, Cherry, Plum, Peach, and Walnut. However as the primary vegetation is been replaced by few commercial crops there has been a shift in the pest complex. Several newly emerging pests including; *Tuberolachnus salicis, Pityogenes scitis, Acronicta rumicis* and othersare now exerting significant economic loss to the regional crops. Patterns of occurrence, seasonality, nature of damage, prominent natural enemies and possible bio-rational management practices of these insects are evaluated and deliberate.

S5P72 A677

Biological and molecular detection of Turnip mosaic virus (TuMV) infecting radish in India

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Turnip mosaic virus (TuMV) is considered one of the most common pathogens of Brassica. TUMV is a Potyvirus with filamentous particles ca. 720 nm, sap-transmissible to a wide host range and transmitted by aphids in a non-persistent manner. Survey conducted in Chikkaballapr, Devanahalli and doddaballapur vegetable growing areas, Radish plants showing symptoms of mosaic, vein banding, ring spot, mottling, and puckering were observed. The symptomatic samples in leaf dip preparation under electron microscopy showed presences of long flexuous particles of 720 nm were observed. For biological characterization and host range determination, sap from infected samples were inoculated to a range of hosts, which showed the symptoms of chlorotic local lesions, mosaic and leaf distortion. For further identification, total RNA extracts from six symptomatic samples and one non-symptomatic sample were subjected to reverse transcription (RT)-PCR assays using One-Step RT-PCR System followed by PCR using potyvirus-specific degenerate primers. The RT-PCR assays using the partial NIb and CP produced amplicons of 850 bp form infected samples but not from healthy control. The obtained amplicons were gel-eluted, cloned and sequenced. BLAST analysis of these sequences revealed that they came from *Turnip mosaic virus* (TuMV). Pairwise comparisons of the CP (450bp) revealed 96 to 98% nucleotide identities, respectively, with corresponding sequences of TuMV isolates. These results revealed the association of TuMV with symptomatic radish mosaic leaf samples

S5P73 A691

Development of Pre-breeding lines with combined resistance to Late Blight and Tomato Leaf Curl Disease in tomato (*Solanum lycopersicum* L.).

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Tomato (*Solanum lycopersicum* L., formerly *Lycopersicon esculentum* Mill.) is the fourth most economically important crop in the world: after rice, wheat, and soybean and widely grown plants in Solanaceae family. Tomato is infected by many diseases in the tropic and subtropics, of which late blight caused by *Phytophthora infestans* and whitefly-transmitted begomo viruses are the major production constraints. Though several control measures have been suggested, adoption of disease resistant tomato varieties/hybrids is the most practical way to combat these diseases. Hence, the present study was carried out to stack genes conferring resistance to late blight and Tomato Leaf curl Disease. Marker assisted selection was employed with gene based markers to develop tomato pyramid lines from the cross between IIHR-2895 and IIHR-2850, carrying Ty3 and Ph2 & Ph3 genes respectively. Marker assisted selection was performed in 164 F_2 segregating population and subsequent advanced generation and different gene combination lines were obtained. Two lines were found to be completely homozygous for three

resistance genes. During generation advance process the lines were evaluated for leaf-curl virus disease by viruliferous whitefly transmission method and detached leaf assay for late blight resistance as well as for horticultural traits. These stable F_6 lines showed a high level of resistance to leaf-curl virus and late blight diseases. These lines showed a disease severity index of (DSI<1) compared to susceptible check Pusa Ruby (DSI >3.4) to leaf-curl virus disease. On late blight disease assay, tested pyramided lines show high level of resistance with mean lesion area of 0.38cm^2 compare to susceptible Pusa Ruby 6.52cm^2 on 7day post-inoculation. The pyramided lines showed wider spectrum and higher level of resistance against tomato leaf curl virus and late blight disease. These pyramided tomato lines developed in this study could be important genetic resources for sustainable tomato production in areas affected by late blight and tomato leaf curl virus disease.

S5P74 A31

Studies on the varietal preference of mango red banded caterpillar (*Autocharis albizonalis* Hampson) in the new alluvial zones of West Bengal

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Numerous pests attack mango during various stages of its development. However, mango red banded caterpillar (*Autocharis albizonalis* Hampson) is the recently emerged pest which gained importance as a major mango pest. It starts infestation when fruits are in the pea to marble size with first peak during last week of March and continued till first week to mid May after which the pest population declines. In the present investigation, fifteen commercial grown mango cultivars were selected to study its varietal preference and RBD with Duncan Multiple Range test was subsequently performed to identify the differential level of varietal preference towards the pest. Pest population studies were also conducted along four directions of the crop canopy during 2009-2010 which showed Himsagar to be the most susceptible variety in 2009 and 2010 showing 2.59% and 2.41% infested fruit respectively. Nevertheless, the infestation of this borer took place from all directions, but maximum attack of this pest took place from the West. The larvae bored into the fruits both at the young marble stage to more mature ones producing a tiny pin head sized circular hole at the distal end of the fruits. The larvae bored multiple tunnels feeding the pulp to reach the seed filling up the inner content by their excreta thereby paved the way for secondary pathogen infestation. The varietal preference of this mango fruit borer showed that variety Bangalora and Arka Puneet registered lower infestation and the lowest being the variety Neeluddin.

S5P75 A36

First report of *Ash gourd Yellow Vein Mosaic* alphasatellitein ash gourd from India

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Ash gourd (*Benincasa hispida* (Thunb.) Cogn.), is the most popular cucurbit crop cultivated in tropical and subtropical regions of Indian subcontinent. Due to their intense cultivation, diseases caused by viruses have increased recently. Yellow vein mosaic disease caused by whitefly transmitting geminiviruses belonging to the genus Begomovirus of the family Geminiviridae is a major constraint in ash gourd production in India. Infected plants show interveinal chlorosis, yellow mottling, puckering and downward curling of leaves, poor fruit set and sterility. A survey was conducted in ash gourd growing belts of Tamil Nadu for occurrence of yellow vein mosaic disease. The begomovirus involvement was demonstrated in fifteen out of eighteen samples tested in PCR using Roja's primer. The viral DNA was amplified by rolling circle amplification and was identified as *Tomato Leaf Curl New Delhi Virus* (ToLCNDV) and the alphasatellite was identified as *Ash gourd Yellow Vein Mosaic Alphasatellite* (AYVMA). Using ToLCNDV DNA A specific primer (LH Viral 5' TCATCAATGACGTTGTAC 3' and TOMR 5' CAGACACCAATCA CATAG 3') for the presence of ToLCNDV was revealed in fifteen samples out of eighteen samples tested. In the present study, ToLCNDV was found associated with an alphasatellite. In the study isolate, ToLCNDV was found associated with an alphasatellite. This is designated as new species and is named as *Ash gourd yellow vein mosaic alphasatellite* (AYVMA) as the nucleotide identity was less than 83%, the threshold value for speciation. The results are important in recording ToLCNDV in majority of the samples and reporting alphasatellite for the first time in Cucurbitaceous crop in India.

S5P76 A54

Bacterial wilt in brinjal

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Brinjal (*Solanum melongena* L.) is an important and widely consumed Solanaceous vegetable crop. Among the diseases of brinjal bacterial wilt is a major disease. Bacterial wilt of brinjal is caused by *Ralstonia solanacearum*, which limits eggplant production from 4.24 to 86.14 per cent,while inislands the disease is devastating in humid and congenial climate and can cause up to 100% losses.*R. solanacearum* is a soil borne pathogen, which invades the host through wounds in roots or underground parts of the plant. Brinjal bacterial wilt is mostly caused by strains belonging to race 1 and biovar 3. The disease occurs on all the type of soil, including sandy and clay soils. Bacterial wilt incidence was mostly prevalent in the acidic soils and in the coastal humid areas. High temperature and moisture are favorable. The external symptom of the infected plants are wilting, stunting and yellowing of the foliage. The internal symptoms are progressive discoloration of the vascular tissue, mainly the xylem at early stages of infection and of portions of the pith and cortex as disease develops until complete necrosis. Slimy viscous ooze typically appears on transverse sectioned stems at the points corresponding to the vascular bundles. As a result collapse and death of the plant take place because of the degradation of occluded xylem vessels and the destruction of surrounding tissues. Many of the commercial varieties are susceptible to this disease at the same time resistance of wilt changes over the regions and the very little success has been attained using chemical control measures. Resistant varieties are most suitable option to reduce crop losses. The dominant and recessive major gene or multiple gene actions help us to decide upon the suitable strategy to develop a resistant variety or hybrid as well as the suitability of donor sources and recurrent parents.

S5P77 A112

Management of corm rot disease of saffron by botanicals and bioagents in Kashmir, India

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Saffron commonly known as kesar or golden condiment is the most expensive and prized spice all over the world and Kashmir is the lone quality saffron producing province of India. It is a legendary, high value cash crop used mainly as a source of secondary metabolites having incredible aromatic and medicinal values. For the past two decades, the area as well as production of saffron in Kashmir has been steadily declined from 8 Kg/ha to 2 Kg/ha. Several biotic factors are known for their adverse effect on saffron cultivation. Among the biotic causes, corm rot is the most destructive disease of saffron world over. It is severely damaging the saffron fields of Pulwama district which is a major saffron growing area of Kashmir province. Field experiments were conducted on *Fusarium oxysporum* f. sp. *gladioli* sick plots at two locations, Nehama and Honipora areas of Pulwama to evaluate the efficacy of neem based botanicals viz., Nemola, Nemoria, Neem Gold, Nebula Churn applied @ 10g/kg of corms. All botanicals were effective against the disease with Nebula Churn producing highest corm weight of 7.16 g and least number of infected corms (0.5) compared to check producing average corm weight of 4.04 g and highest number of infected corms (2.5). Bioagents like *Trichoderma viride, T. harzianum, Pseudomonas fluorescens, Paecilomyces lilacinus* @ 5 g/kg were also effective against the disease with combination of these producing highest corm weight of 5.66 g and least number of infected corms (0.03) compared to check producing average corm weight of 3.17g and highest number of infected corms (2.7).

S5P78 A115

Characterization and *In vitro* evaluation of fungicides, organic preparations and bioagents against *Rhizoctonia solani* causing fruit rot of strawberry (*Fragariae* x *ananassa* Duch.)

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Strawberry, one of the most delicate, sweet and refreshing temperate fruit has grabbed the minds of several farmers and consumers all over the world. However, the crop is being inflicted by many fungal diseases. Hence, a survey was conducted during the winter season of 2015-16 in Wayanad district where rotten fruits with dark and hard to touch lesions were collected. Pathogen was isolated by following the standard protocol and Koch's postulates was verified by inoculating mycelial discs on either sides of fruits. Upon culturing, the fungal isolate produced white thread like mycelia turning brown on maturation with rapid growth. Hyphae was branched at right angles and did not produce spores and the pathogen was identified as *Rhizoctonia solani* based on cultural and morphological characters. *In vitro* evaluation was carried out against the pathogen with nine fungicides where it was found that carbendazim 12% + mancozeb 63% (Saaf), cymoxanil 8% + mancozeb 64% (Curzate M8), propineb 70WP (Antracol) and Bordeaux mixture at all concentrations showed cent per cent

inhibition. Moreover, copper hydroxide 77WP (Kocide) and difenconazole 25 EC (Score) inhibited the pathogen from 54.44 to 75 per cent and 58.88 to 70.55 per cent at 0.1, 0.15 and 0.2 and 0.05, 0.1 and 0.15 respectively. But copper oxychloride 50 WP (Fytolan) recorded less than 45 per cent inhibition, whereas carbendazim (Bavistin) and potassium phosphonate (Akomin) were found to be least effective showing no reduction in mycelial growth. Comparing the efficacy of organic preparations against *Rhizoctonia*, calphomil recorded highest inhibition of 55.33 to 63.88 per cent when used at 0.2 to 0.3 per cent concentrations. Whereas, neem oil was found to be least effective. Panchagavya (2 and 3 %) and baking powder + vegetable oil mixture could inhibit the mycelial growth only by 23.33-25.38 per cent and 22.22 per cent respectively. The fungal biocontrol agent, *Trichoderma viride* could restrict the growth of the pathogen by 66.67 per cent and *Pseudomonas fluorescens* by 33.33 per cent only.

S5P79 A116

Symptomatology and pathogenic potential of *Phoma exigua* causing leaf blight of strawberry (*Fragariae* x *ananassa* Duch.)

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A survey conducted at Thrissur and Idukki district on various fungal diseases of strawberry revealed a severe leaf blight disease during December-January and April-May. The per cent disease incidence (PDI) and per cent disease severity (PDS) in Thrissur in December-January was observed as 21.7 and 12.3 per cent respectively. Whereas the PDI and PDS recorded in Idukki during April-May were 19.7 and 25.9 per cent respectively and 39.8 and 27.54 per cent respectively in Thrissur. Under field conditions, symptoms initiated as leaf blight with small circular brown spots on the leaves which later enlarged on the leaf lamina forming 'V' shaped lesions from the margin and thereafter progressing inwards. Lesions with purple and yellow halo expanded through major veins and whole leaf turned brown. Isolation of the fungus was carried out in laboratory under aseptic conditions from infected samples using standard protocol. In culture media mycelial growth appeared as pale white to grey colonies expanding in a zonate manner with irregular margins. Culture on the reverse side of the plate appeared greyish. Growth of the pathogen in 90mm plates was completed within 12 days of inoculation. Copious amount of dark green to black pycnidia (0.5 to 1cm diameter) started developing within 30 days. For pathogenicity test, mycelial discs and conidial suspension made up to 1 x 10^6 cfu/ml were inoculated on healthy leaves where the pathogen initiated symptoms as black water soaked lesions in three days slowly expanding all over the leaflets. The lesions covered an area of 4.5cm^2 in 8 days. Culture thus obtained after reisolation were subjected to identification by comparing with original culture based on cultural and morphological characteristics. Those which were found similar were maintained as pure culture.

S5P80 A117

Management of fungal diseases of capsicum under protected cultivation

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Capsicum (*Capsicum annum*. L.) is one of the most popular fruit vegetables belonging to the family Solanaceae and is chiefly grown under protected structures. It is rich in Vitamin-A, Vitamin-C and minerals like calcium, magnesium phosphorus and potassium (IIHR, Bangalore). The crop suffers from many diseases caused by fungi, bacteria and viruses among which fungal diseases are the most prevalent. Diseases such as powdery mildew (*Leviellula taurica* (Lev,Arnaced), anthracnose and fruit rot (*Colletotrichum capsici*) (syd). Butler and Bisby, stem and fruit rot (*Fusarium solani* (Mart). Sacc. affecting the crop under polyhouse, cause yield loss up to 50 per cent (Dubey and Singh, 2012). Use of chemical fungicides for control is not acceptable due to various undesirable effects they cause, more ever, it is reported that only 0.1% of the chemical used for crop protection reach the target pathogen, leaving 99.9% in the environment causing hazardous effects to non-target organisms (Pimental 1995). Effective biological management of fungal diseases of capsicum by *Trichoderma viride* and *Pseudomonas fluorescens* has been reported by Ngullie *et, al*., (2010), however it may not be economical if the disease is severe. Hence bio intensive method is suggested for effective and economic management of diseases in protected cultivation (Jeffries and koomen,1992). Field experiments were conducted in polyhouse and rain shelter to evaluate different treatments for the management of major foliar diseases of capsicum. The treatments included soil solarization, bio control agents, systemic and contact fungicides. It was found that even though tebuconazole (0.1%) and mancozeb (0.2%) were the best treatments against powdery mildew and cercospora leaf spot respectively, foliar spray with *Pseudomonas fluorescens* also gave satisfactory control of the diseases.

S5P81 A118

Host range studies of *Choanephora cucurbitarum* (Berkeley and Ravenel) Thaxt, in commonly cultivated vegetables in Kerala

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Choanephora cucurbitarum is a facultative saprophyte, inciting rots and blights in fruits, vegetables, weeds, flowers *etc.*A serious outbreak of *Choanephora* pod rot was noticed during the survey conducted in 2013-2014 at various vegetable fields at College of Agriculture, Vellayani. Symptoms of natural incidence of *Choanephora* rot were observed on different vegetable crops such as cowpea, bhindi, bitter gourd, amaranthus, chilli and brinjal and the pathogen, *C.cucurbitarum*, was isolated from the affected plant parts. On cowpea the symptoms were observed on pods, leaves, flowers and stem, in bhindi the disease was observed in immature fruits and leaves, in bitter gourd on mature fruits, in chilli on both mature fruits and leaves, in amaranthus on inflorescence and on brinjal on mature fruit. Water soaked lesions, wet rotting, white mycelial growth followed by development of sporangia were the commonly observed symptom on all the crops, apart from this symptoms, necrosis was observed in all crops except bitter gourd and blighting was observed on amaranthus inflorescence. Studies on cultural characters of the isolates obtained from different vegetables revealed that on PDA all the isolates grew rapidly to cover the whole petri dish (9 cm) within 24 h and the culture appeared white in colour on the upper surface which on maturity produced black pin heads indicating onset of sporulation. The morphological characters observed in all isolates were similar. All the isolates produced two types of asexual reproductive structures: drooping sporangia and monosporous sporangiola. The size of the monosporous sporangiola ranged from 12-20 × 6-14 µm in size and that of the sporangia measured 90.75-110 µm in size. Based on the cultural and morphological studies the pathogen inciting rots on these vegetables was identified as the *Choanephora cucurbitarum* (Berk. & Ravenel) Thaxt., which was further confirmed by amplification, sequencing and phylogenetic analysis of ITS-rDNA region of the fungal DNA which produced an amplicon of 540 bp.

S5P82 A119

Symptomatology and molecular characterization of *Mycosphaerella emusae* inciting Sigatoka leaf spot disease of banana

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Sigatoka leaf spot disease of banana is spreading at a faster rate in banana growing areas causing a serious threat to banana cultivation in Kerala, the southernmost state of Indian peninsula which enjoys a humid tropical climate. This disease produced necrotic lesions on leaves destroying the green tissues resulting in reduction in the photosynthetic area thereby causing yield reduction. The disease also resulted in premature ripening of fruits affecting the

fruit quality. The disease was noticed in most of the commercially grown varieties of banana *viz.*, Nendran (AAB), Grandnaine (AAA), Njalipoovan (AB) and Robusta (AAA) during all growing seasons, but become more severe with the onset of rains. Symptomatology of the disease was studied in detail under different agroclimatic zones prevailing in the state and was documented. The symptoms were initially visible as small light green to yellow dashes on the underside of the leaf which changed into faint brown streaks. During the next stage, these streaks became visible as rusty brown on the adaxial side of the leaves which then developed into oval or elliptic brown spots with greyish centre surrounded by definite dark brown borders containing black pin headed like fruiting body embedded in it. Upon heavy infection, the spots coalesced resulting in complete necrosis of the leaves. The presence of the pathogen was confirmed by amplification of the ITS- rDNA region of the fungus using the primers ITS 1 and ITS 4 which yielded in an amplicon size of 600 bp. The amplicons were sequenced and blasted in NCBI which showed 100% sequence similarity to *Mycosphaerella emusae*. Hence, the pathogen inciting Sigatoka leaf spot on banana var. Nendran in Kerala was identified as *Mycosphaerella emusae.*

S5P83 A621

Parasitization potential of *Trichogramma* species and feeding potential of *Chrysoperla zastrowi sillemi* on pests of pomegranate and their biosafety

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Laboratory experiments to determine the parasitization potential of *Trichogramma sp* on the eggs of *A. janata* and feeding potential of *Chrysoperla zastrowi sillemi* (Esben-Petersen) on aphid, *Aphis punicae* were carried out in the Department of Agricultural Entomology, TNAU. Among all *Trichogramma* species tested, *T. chilonis* and *T. achaea* showed 100 ± 0.00 per cent parasitization on castor semilooper eggs followed by *T. pretiosum* and *T. japonicum* with 90 ± 3.16 per cent parasitization. The third instar grub of *C. zastrowi sillemi*, with the developmental period of 3.4 days had consumed a maximum of 106.3 nymphs of aphid. Second and first instar grubs of *Chrysoperla* consumed a maximum of 68.1 and 30.7 nymphs during their development period of 3.2 and 2.7 days respectively. An individual *C. zastrowi sillemi* grub consumed a total of 205.1 aphids during its total larval period of 9.3 days. Laboratory experiment was also conducted to assess the bio safety of most efficacious insecticides and botanicals against egg parasitoid *Trichogramma chilonis* Ishii and predatory green lacewing *Chrysoperla zastrowii sillemi* Esben-Petersen. The experiment included seven treatments with three replications. The treatments included were imidacloprid 17.8 SL (0.00712%) (Confidor®), thiamethoxam 25% WG (0.005%) (Actara®), chlorantraniliprole 18.5 SC (0.0037%) (Coragen®), fipronil 5% SC (0.01%) (Regent®), spinosad 45% SC (0.0125%)

(Tracer®), azadiractin 1% EC (0.02%) and untreated check. Chlorantraniliprole 18.5 SC (0.0037%), thiamethoxam 25 WG (0.005%), spinosad 45% SC (0.0125%) and azadirachtin 10000 ppm (0.02%) showed maximum emergence of *Trichogramma chilonis* indicating their bio safety. Likewise, the parasitization rate by *T. chilonis* was also not affected by the treatments. Regarding the toxicity of treatments against green lacewing predator, maximum grub mortality of *Chrysoperla zastrowi sillemi* (80.0 per cent) was noted in thiamethoxam 25 WG (0.005%) whereas, chlorantraniliprole 18.5 SC (0.0037%) and spinosad 45% SC (0.0125%) showed a grub mortality of 50.0 and 40.0 per cent respectively at 24 HAT and found on par with each other. This results stress the need for temporal separation of *Chrysoperla zastrowi sillemi* on infestation with the insecticides.

S5P84 A622

Management of mango stem borer *Batocera rufomaculata* De Geer (Coleoptera: Cermabycidae) using ICAR-IIHR repellent formulation in Karnataka

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Mango is one of the economically important fruit crops of India. Mango stem borer *Batocera rufomaculata* is a major pest causing a damage in the range of 2% to 23%. The major symptom of stem borer is die back of the branch/twigs leading to drying of the whole tree in a span of two years or even less. Alphonso is the most susceptible variety for stem borer. The current management practices are preventive in nature whereas the new formulation of ICAR-IIHR acts as both preventive and curative which is cost-effective and farmer-friendly. Stem borer infested mango trees *cv.* Alphonso were identified and treated with new repellent formulation in Bengaluru, Kolar, Chikkaballapur, Ramanagar and Shimoga districts during April-June 2014. For each location 75 trees were selected wherein 25 each of healthy and infested trees were treated and rest 25 served as control (untreated). Observations on re-infestation of borer were recorded at monthly intervals for a period of 12 months. Stem borer infestation was 12, 24, 20, 15 and 12 percent in Bengaluru, Kolar, Chikkaballapur, Ramanagar and Shimoga districts respectively in untreated mango trees. In treated mango trees the re-infestation of borer was significantly reduced to less than 2 percent suggesting that the formulation was highly effective in managing the borer infestation. The re-infestation was almost nil for a period of eight months.

S5P85 A624

Climate change and its impact on agriculture

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Climate change is perhaps the biggest challenge the world is facing today, and the very existence of man depends on how effectively this challenge is tackled. With this phenomenon, which threats to create havoc with the lives of people across the globe, our health, agriculture, habitation, everything depends on how effectively we are able to tackle this problem. Climate and agriculture are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions of affecting agriculture, including temperature, precipitation and glacial run-off. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. Rising carbon dioxide levels would also have effects, both detrimental and beneficial, on crop yields. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production. Recent scientific evidence suggests that India will be one of the countries that will suffer most from climate change. Food production and food security, fresh water supply, forest biodiversity, coastal settlements, fishing and more will be adversely affected. Unfortunately; the burden of climate change will fall disproportionately on poor communities, namely dry land farmers, forest dwellers and fishermen. According to the report of the Lehman Brothers January, 2007, India will be the biggest loser; it projected an estimated gross domestic product loss of 5% owing to climate change.

S5P86 A625

Effects of *El Nino* and southern oscillation on the production of some horticultural crops

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El Niño is the phase, a deviation from the normal conditions where inspite the trade winds blowing west across the tropical Pacific, the winds weaken in the central and western Pacific and results in unusual warm sea surface temperatures in the central and eastern Pacific. The phenomenon of systematic fluctuations of El Niño and La Niña events are however linked to the oscillations of the ocean atmosphere system in the tropical Pacific region. Global anthropogenic change resulted in the recent change of the humid tropical forests associated with the greater tree mortality and wild fire due to drought caused by El Niño events. Research conducted showed, El Niño enhanced fruit production which consequently consumed stored reserves, limiting the next reproductive event in plants. However, vegetables like tomato and

green peppers showed yield loss during El Niño years than during La Niña periods due to the proliferation of soil-borne pathogens and increase in fruit quality problems like gray wall. The vegetable production during El Niño years showed relatively low decline than the Non- El Niño years although prolonged dry periods and low rainfall is experienced during El Niño years. Nevertheless, this could be corrected easily while heavy rainfall would considerably cause more crop loss than dry spells. Coffee producing regions are affected by the El Niño Southern Oscillation (ENSO)—a climatic phenomenon that causes extreme droughts or excess precipitation in these parts of the world. Consequently, ENSO-related weather shocks are likely to substantially impact world coffee production and, therefore, prices.

S5P87 A165

Banana Skipper (*Erionota* spp.): An exotic invader pest affecting *Musa* spp. in India

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Banana (*Musa* spp), one of the most important fruit crop is commercially grown in Southern Asia and large diversity is found in India. Of late the banana growers across India, especially southern states are baffled with an unprecedented defoliation caused by the soft bodied caterpillars of a butterfly which was hither to unheard in this part of the country. The butterfly, identified as skipper, *Erionota torus* Evans (Lepidoptera: Hesperiidae) and commonly called 'Sikkim Palm dart' / Banana leaf roller, has been wrecking havoc in banana fields causing serious foliar damage **by incision and upward rolling of leaves.** Heavy infestation can damage the whole banana leaf, leaving only the midrib intact. Usually, banana plants can tolerate up to 20 per cent defoliation. However, severe defoliation leaving only the midrib can cause considerable reduction in photosynthetic efficiency of plant resulting in a decreased bunch size and weight. Two species infecting *Musa* spp can be distinguished only by the wing variations (straight outer margin and acute apex of the forewing in *E. thrax*, and the more convex outer margin and rounded apex of the forewing in *E. torus*) and differences in male genitilia. Understanding the behavioural aspects of this butterfly and a search for locally occurring indigenous parasitoids and their inundative releases will bring back the equilibrium of pest with the host plant and keep it under check apart from agronomical, chemical and biological management of *Erionota* spp.

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S5P88 A199

Grafting: A climate resilient technology

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Vegetables are high-value crops and remunerative enough to replace subsistence farming. However, they are very sensitive to climatic vagaries and sudden rise in temperature as well as irregular precipitation at any phase of crop growth can affect the normal growth, flowering, fruit development and subsequently the yield. Grafting has emerged as one of the promising tools and an alternative tool to the slow conventional breeding methods aimed at improving plant performance of various vegetable crops with a capacity to deal with biotic and abiotic stresses. It is considered as a surgical alternative over plant breeding. It provides an opportunity to transfer some genetic variations of specific traits of rootstocks to influence the phenotype of scion. Genetic potential of commercial rootstocks can successfully be exploited against many soil-borne diseases and emerged as a better alternative to chemical sterilants. The physiological mechanism of grafted plant like high antioxidant content, lipoxygenase activity, osmotic adjustment, membrane selectivity, development of adventitious root and aerenchymatous tissue under waterlogged condition has proven to provide broad insight into stress response mechanisms.

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S5P89 A289

Isolation and characterization ofphosphorus *and* potassium solubilising bacteria from rhizosphere of orchard field and its effect on seedlings growth of broccoli (*Brassica oleracea* var. italica L)

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A nursery pre trial was performed to study the effect of bacterial biofertilizers on *Brassica oleracea* var. italica L plant seedling which was further transplanted under citrus orchard. The present study was interpretates the effect of biofertilizers on growth of Broccoli seedlings. Bacterial biofertilizers phosphomicrobes PSB1 and potassium solubilising microbes KSB2 were isolated from the soil of vegetable crops. The strains were screened by employing qualitative plating techniques. The isolates showing maximum zones were screened for further analysis. The microbial inoculants coated seeds were then sown in fields. After 30 days of sowing, the plant growth parameters like morphological parameters were analyzed in *Brassica oleracea* var. italica L plants. The morphological parameters like number of leaves, root length, shoot length, were increased in treatment having potassium solubilizing bacteria (T2) in *Brassica oleracea* var. italica L than other treatments and control plants. The present work suggests that broccoli cultivation could be performed in the spaces between orchards and the space could be utilized giving good income for the farmers by giving increased output.

S5P90 A290

Isolation and Characterization ofPhosphorus Solubilising *Pseudomonas* and Potassium Solubilising *Bacillus* from Rhizosphere of Orchard Field and its Effect on Vegetative Growth and yield of Cauliflower

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A field experiment was performed in the agriculture field of Departmernt of Horticulture in SHUATS, Allahabad to study the effect of bacterial and fungal biofertilizers on vegetative and yield attributing parameters of Cauliflower (*Brassica oleracea botrytis*) plant under citrus orchard. Bacterial biofertilizers included phosphorus solubilising microbes (bacteria and fungus) PSB1, PSF1 and potassium solubilising microbes KSB2 and KSF2 which were isolated from the rhizospheric region of vegetable crops. The strains were screened by employing qualitative plating techniques. The isolates showing maximum zones were screened for further analysis. The microbial inoculants coated seeds were sown in fields. After 90 days of sowing, the plant growth parameters like morphological and Bio-chemical parameters were analyzed in *Brassica oleracea botrytis*plants. The morphological parameters like number of leaves, leaf spread, leaf area, shoot length, fresh plant weight, dry plant weight, phosphorus and potassium in leaves and bio-Chemical parameters like chlorophyll content, protein, carbohydrate, ascorbic acid content, were increased in combined treatment of phosphorus solubilising fungus and potassium solubilizing fungus along with recommended dose of chemical fertilizers in *Brassica oleracea* than other treatments and control plants. The present work suggests that cauliflower cultivation could be performed in the spaces between main crops and the space could be utilized giving good income for the farmers by giving increased output.

S5P91 A294

BIOSAFETYEVALUATION OF NANO EMULSION OF HEXANAL AGAINST *Chrysoperla zastrowi sillemi* (Esben-Petersen)

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India ranks first in the world production of mango with the production of 19.27 million tonnes from 2.5 million hectares which is the largest in the world and it accounts for 21 percent of the total fruit production in the country. One of the major constraints in the production and marketing of mango is the post harvest losses. Many biologically active volatile compounds like hexanal is found to reduce the post harvest losses by checking the over ripening. The key enzyme involved in the ripening of fruits is Phosholipase D (PLD) and the use of hexanal inhibits PLD production in fruit skin which in turn delays the post harvest deterioration. Formulation of hexanal as nanoemulsion with uniform droplet sizes (<100 nm), high kinetic stability and optical transparency would be more effective for fruit preservation. There are several natural enemies in mango ecosystem which helps in controlling mango leafhoppers, aphids, mites, scales, mealy bugs and caterpillars. Hexanal as nano formulation is used as pre harvest spray in mango eco system to enhance shelf life of fruits by protecting the fruits from over ripening. Hence, it is mandatory to assess the biosafety of nanoemulsion of hexanal on the natural enemies associated with mango cropping system. The present study was undertaken under laboratory condition to assess the biosafety of hexanal on *C. zastrowi sillemi* a generalist predator of sucking pests. The nanoemulsion of hexanal was treated with egg and third instar grub stages of green lace wing. The results showed that the nanoemulsion of hexanal had egg hatchability up to 88.50 percent in higher concentration of 0.06 percent where as maximum egg hatchability of 91.44 percent was noted in field recommended concentration of 0.02%. Regarding the biosafety of grubs, nano emulsion of hexanal at field recommended concentration 0.02% showed 91.45 percent survival of the grubs mortality 48 h after exposure

indicating the safe nature of hexanal to the grub of *C. zastrowi*. The successful grubs which pupated after the treatment were observed for the lethal effects if any upto adult emergence. The maximum pupation (96.29%) and adult emergence (100%) was registered in nanoemulsion of hexanal @ 0.02% percent where as the highest concentration of 0.06% had 91.6% pupation and 95.65% adult emergence.

S5P92 A300

Rate of spread of disease of purple blotch of onion (*Alternaria porii*) and their comparison of different growth models under alternate spraying schedule of fungicides

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Field experiment was conducted at university research farm of Bidhan Chandra Krishi Viswavidyalayafor two consecutive years 2011-12 and 2012-13 during rabi season to study the effect of alternate spraying of ten different fungicides against purple blotch of onion, rate of spread and their comparison with their different growth models through which the disease progress curve move over time in prevailing weather conditions. Ten different fungicides like mancozeb @0.25%, propiconazole 0.1%, copper oxychloride 0.25%, tricyclazole 0.1%, hexaconazole 0.1%, tebuconazole 0.1%, chlorothalonil 0.1%, difenconazole 0.1%, ridomil MZ 0.25% on different treatment combinations with three different fungicides in an alternate spraying schedule consisted of seven treatment including untreated control. Disease severity was increased significantly with increase the age of the plant irrespective of different treatments. Disease severity was minimum and bulb yield was maximum in plots were sprayed with three fungicides in an alternate manner at 15 days interval (mancozeb @0.25% - tricyclazole 0.1% - hexaconazole 0.1%) significantly followed by mancozeb @0.25% - difenconazole 0.1% - tricyclazole 0.1%) , benefit cost ratio was also maximum in this fungicide spraying treatments. The fungicidal action was different in the prevailing weather factors which reflected on rate of spread of the disease. Arcsign transformation gave good result to find out the accurate rate of spread of the disease in comparison to other functions in every treatment combination and among three growth models logit, gompit and logistic, gompit fit better to find out the accurate in every treatment ombinations confirmed by high co-efficient of determination(R^2), low residual sum of square (RSS) and low standard error of estimates (SE_{est}).

S5P93 A329

Effect of climate change on ornamentals: Issues & strategies

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Climatechange is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. Global temperatures and patterns of precipitation are rapidly changing and as these environmental conditions have strong effects on most organisms, it is not surprising that climatic change is influencing physiology, behaviour, abundance and distribution of many species. Evidences available suggest that impact will differ from region to region depending upon the current ecological and climatic conditions. Ornamental crops may face a severe impact of climate change on their cultivation manifested as degraded quality, lower yields, poor post-harvest life and more pronounced pest / disease outbreaks. The potential impact of climate change depends not only on the climate *per se*, but also on the ability of a system to adapt. Climate change mitigation programs that are emerging can help meet the costof actions for reducing GHG emissions. Several options for adaptation are available, *viz*., selection/ breeding of varieties tolerant to vagaries of the weather, better input management and cultivation practices, soil-moisture conservation, clean cultivation and efficient irrigation practices. Before resorting to any adaptation options, a detailed investigation on impact of climate change on horticultural crops is, therefore, essential. The potential of perennial urban trees, shrubs and turf grasses for sequestering atmospheric carbon has proved very important for climate-change mitigation.Neither cut-flowers nor ornamentals are essential goods but, in view of the blind race by human for development and economic prosperity, these have a capacity for healing and provide a gateway to connect with nature.

S5P94 A372

Introgression of Scab Resistant genes in Promising Cultivars (Fuji Azitec and Redlum Gala) of Apple(*Malus domestica*Borkh.) in Kashmir Valley

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Apple (*Malus domestica*Borkh.) occupies prime position in area and production among all the temperate fruits growing in Jammu and Kashmir (J&K). Annual production (quantity and quality) of apple depends on both biotic and abiotic factors. Among biotic factors, apple is susceptible to infection by fungi, bacteria, viruses and viroids. Apple scab is one of the most widespread diseases of apple trees caused by *Venturia inaequalis* (Ascomycetes) and causes huge economic losses upto 70%.The increased expenses associated with labour and fungicides justify the investigation of an alternative approach to deal with this disease. The objective of our study was to introduce scab resistant gene in promising cultivars Fuji Azitec and Redlum Gala. Twenty two parents (selections and varieties) and two susceptible varieties were screened under glass house conditions and with leaf detach method in Lab. Fourteen parents were found resistant against scab in both the conditions. Resistant gene(*vf*) specific primers also confirmed the phenotypic screening. Among 14 parents 8 were selected for crossing programme with susceptible varietiesFuji Azitec and Redlum Gala. The F1 developed from crosses were further

screened under glass house conditions and with same gene specific primers to confirm the introgression of scab resistant gene (*vf*) in F1. The results confirmed the introgression of *vf* gene in F1 plants. The future studies are to confirm the expression of resistant gene in F1 to develop promising resistant variety.

S5P95 A408

Root endophytic bacteria associated with the orchid, *Phalaenopsis*

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The monopodial epiphytic orchid *Phalaenopsis*, or 'Moth orchid', is one of the most popular due to its ease of production and availability of blooming plants year-round. Apart from mycorrhizal fungi, previous reports revealed an abundance of endophytic bacteria on the roots of cultivated tropical orchid genera, *Calanthe*, *Acampe* and *Dendrobium*. An attempt was made to analyze diversity of the bacterial community residing in *Phalaenopsis* root using the metagenomics approach. Metagenomic DNA was isolated from the root and sequencing of V3 region of 16S rRNA gene was carried out using Illumina Miseq^{TM} platform, at SciGenom, Cochin. Diversity of bacterial taxonomic category was assessed at different Operational Taxonomic Unit (OTU) levels using Ribosomal Database Project (RDP) pipeline and MG-RAST. At the phylum level, unclassified bacteria were the most abundant (36%), followed by Proteobacteria (33%) and Actinobacteria (28.83%). Firmicutes and Bacteriodetes constituted under 0.1%. Among Proteobacteria, Gammaproteobacteria comprised over 99%. At the genus level, *Rubrobacter* was the most abundant (27.47%), belonging to Actinobacteria group, and well-known to be radiation resistant. The genus *Pseudomonas* was also abundant (21.67%), as already been reported as a competitive endophyte in several plant species including maize, potato, olive and several others. The genus is capable of utilizing more than 200 compounds as carbon source, can fix atmospheric N and solubilize P. Several species of *Pseudomonas* promote plant growth and many are antagonistic to bacterial and fungal plant pathogens. Hence, are exploited as biological control agents in agriculture. In the present investigation, *P. putida, P. fluorescens*and uncultured *Pseudomonas* were detected. Genera *Acinetobacter, Enterobacter* and *Aneurinibacillus* were also present at more than one per cent abundance. Several species of *Bacillus* were also detected, including *B. subtilis, B. pumilus, B. cereus, B. firmus* and other *Bacillus* sp. Species of *Bacillus* are reported to have beneficial traits like plant growth promotion, antagonism against plant pathogens, insecticidal activity, nutrient cycling, especially of nitrogen, phosphorus and potassium. Endophytic bacteria may have an important role in nutrition and general health of the orchid. Of the species detected, 50.83% were uncultivable, proving the importance of metagenomics in assessing diversity/ role of endophytic microbes in plants.

S5P96 A528

Potentiality of *Beauveria bassiana* isolates against South American tomato leaf miner, *Tuta absoluta*(Meyrick) through laboratory bioassay

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The susceptibility of second instar *Tuta absoluta* to seven isolates of *Beauveria bassiana*, were tested under laboratory conditions using the leaf dip method. Significantly highest mortality (80.00%) was recorded in strain-4 with LC_{50} value (1.15 x 10^7 spores ml^1) followed by strain-1 and strain-2 with 62.50% mortality each (LC_{50} value 2.00 x 10^8 spores ml^{-1} and 8.01 x 10^7 spores ml^{-1}, respectively) at 120 hours after treatment. Similar trend of mortality was observed at 24, 48, 72 and 96 hours after treatment. Corrected mortalities at 120 hours ranged from 52.50 to 80% at different hours after treatment.

S5P97 A544

Gold nano-biosensor for the detection of *Cucumber mosaic virus* causing infectious chlorosis disease of banana.

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Gold nanoparticles (AuNPs) possess distinct physical and chemical attributes which make them excellent scaffolds for fabrication of novel chemical and biological sensors. Biosensors developed based on the novel metallic nanoparticles have gained much importance for the early detection of virus infections. Nano-biosensors based on longitudinal and transverse plasmon bands collectively known as Localized Surface Plasmon Resonance (LPSR) enables optical sensing of nanoparticles due to their better light absorption and scattering properties. In the present study, gold nanorod solution was synthesized to conjugate with antibody for developing LPSR nano-biosensor for the detection of *Cucumber mosaic virus* causing infectious chlorosis disease of banana. Seed mediated growth method was used to

synthesize gold nanorods and characterization was done using UV-Vis spectrophotometer. Conventional and molecular methods for diagnosis of plant viruses such as biological indexing and serological assays, PCR, microarray etc are most common detection techniques practiced in various virus indexing laboratories for the production of virus free planting materials. In this study, Gold Nano-biosensor was developed which is more sensitive for the detection of *Cucumber mosaic virus* infection. The GNRs solution phase LPSR based biosensor could detect 0.04 mg/ml (40 ppm) while the detection limit of antigen in Enzyme Linked Immuno Sorbent Assay (ELISA) is 0.7 mg/ml (750 ppm). Thus making GNRs solution based biosensors more sensitive with easy protocol for virus indexing of tissue culture plants and planting materials compared to other indexing methods currently being practiced.

S5P98 A629

Genetic improvement of bio- control agents in horticultural crops

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In order to reduce environmental contamination from chemical pesticides, renewed emphasis has been placed on the development of effective bio-control agents for management of insect pests in horticultural crops. Among the main advantages of biocontral agents are their safety to non target organisms and the environment. Some of the limitations of biocontrol agents, such as slow action, restricted host range and limited persistence in field, can be addressed by various strategies involving genetic manipulation. It involves direct purposeful genetic alterations to enhance the efficacy of natural enemies of crop pests. Though the potential benefits of improved biological control through the use of genetic improvement of arthtropod natural enemies were recognised, but were not further taken up speedily as the main thrust of control was pesticide dependent. Genetic improvement may be achieved by artificial selection, hybridization to achieve heterosis effects or the use of recombinant DNA techniques. Phytoseiid mite, *Metaseiulus occidentalis* is most important natural enemy of spider mites in deciduous orchards in USA. The predatory mite, *Metaseiulus occidentalis* acquired resistance to OP & S through field selection. *Aphytis melinus* is the most important natural enemy of California red scale, *Aonidiella aurantii* damaging citrus. Workers have developed *T. chilonis* strain tolerant to three major insecticides i.e., endosulfan, monocrotophos and fenvalerate and to high temperature (32-38^{o}C). A strain of parasitoid *T. chilonis* possessing enhanced temperature tolerance was developed through artificial selection for use against the sugarcane borer complex in the Punjab. The improved natural enemy can be deployed by 'inoculation' which means the new strain is released one or more times into the environment where it is expected to establish and persist. The development of molecular methods for genetic manipulation of arthropods has created exciting opportunities for altering the genomes of beneficial arthropods.

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S5P99 A630

Eco-Innovative techniques and strategies for climate resilient Horticulture

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Anticipatory research to mitigate adverse impact of climate change, is important for horticulture in India, considering that this industry is in the midst of a revolution, reaching the production level of 250 million tonnes. Impacts of climate variability have, invariably, profound influence on production and quality. The effects of climate change are already being experienced in several parts of the world. Simulation output analyses reveal that crop yield will decrease due to climate change and variability in drylands, but this can be mitigated in large parts by the application of existing knowledge on crop, soil and water management, and by re-targeting and redeployment of the existing germplasms of the crops in the medium term (2017–2050). Climate adaptation has also become the pressing need. Relevant adaptation strategies is of foremost importance to sustain the productivity and profitability of horticulture crops in the climate change scenario, which necessitates synthesis of current knowledge to develop strategies for adaptation and mitigation to achieve climate-resilient horticulture. Strategies like integrated watershed management are an important tool to mitigate the climate change effects through soil conservation, improved water availability and other secondary benefits. Similarly, conservation agriculture practices under the integrated genetic and natural resources management strategy can help minimize the adverse effects of climate change on agricultural productivity.

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S5P100 A678

Heterosis for Yield Attributing Traits in Brinjal (*Solanum melongena* L.)

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Brinjal *(Solarium melongena* L.), also known as eggplant, is commercially important solanaceous vegetable crop of Indian subcontinent. Rich variability exists for both cultivated type and its wild species in the country. It is popular among people of all social strata and hence, it is rightly called as vegetable of masses. To obtain high yield per unit area, exploitation of hybrid vigour is one of the good way and particularly in crop like brinjal. This study was conducted with 21 F1 hybrids and two standard checks at Horticultural Research Station, Pandirimamidi under High altitude and tribal zone of Andhra Pradesh to know the nature and magnitude of heterosis estimated as per cent increase or decrease of F value over standard checks (standard heterosis). total Seventeen and four crosses noticed significant positive heterosis over the checks Ravaiyya and US172, respectively for yield per plant and twenty-one and three crosses registered significant positive standard heterosis over KanakaDurga and US 172, respectively for number of fruits per plant.

S5P101 A711

Stability analysis in horticultural crop research: A re-look

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Crop improvement research, which begins with a search of potential germplasm material having exploitable wide variability for traits, culminates with the release of new cultivars of superior characters based on stability analysis. Normally, in such systematic study, stability models are constructed individually for each of the characters and stability measures are worked out to compare and test the performance of various genotypes/test material over periods/locations. However, it is often seen that a group of genotypes happens to be stable or ideal over years/environment for a particular trait, may not perform better than the existing promising variety (check) for other desirable traits of secondary nature, probably due to the presence of non-linear GXE interaction. Moreover, a varietal release program which recommends a variety locally or across environments may prefer to have an one, which perform the best not only for the trait under study but also equally good (meets the benchmark values) for all other traits, which will be a real success when implemented in a farmer's field. In this direction, an attempt has been made to introduce a combined index based stability approach. Results are discussed in comparison with the existing approach by fortifying the efficacy of the modified approach from user's point of view.

S5P102 A715

Induced γ - irradiation on germination, sensitivity and survivability of papaya (*Carica Papaya* L.) cv. Arka Prabhat and Arka Surya

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Papaya is one of the most important fruit crops valued for its rich nutrient content and cultivated throughout tropical and subtropical regions of the world. Improvement of fruit and yield traits coupled with disease resistance are major objectives in the crop improvement programmes in many parts of the world. Crop improvement efforts made at IIHR, Bengaluru has resulted in the development of advanced generation gynodioecious hybrids Arka Surya and Arka Prabhath. Mutation is one of the methods used for creating variability in plants. Work on mutation to induce variability within the cultivars for improved horticultural traits and PRSV tolerance in papaya has been initiated using the papaya variety Arka Surya and Arka Prabhath at IIHR-Central Horticultural Experiment Station, Hirehalli, Tumakuru. The treatment comprised of ten different levels of γ-irradiation for dry papaya seed (0, 100,200,300,400, 500, 600, 700, 800, 900 and 1000 Gy) and seven levels of γ-irradiation for wet seed treatment (0, 10, 20, 30, 40, 50, 60, and 70 Gy). Each treatment was carried out with five replications and with a sample size of hundred seeds per replication. Observations on the germination percentage and seedling characters were recorded at 30 days after germination. The germination percentage varied from 6 to 90 for different concentrations. The treatment control recorded the highest germination percentage (90%). The treatments 400 and 500 Gy showed little difference in germination. Germination of both varieties was not affected apparently up to 400Gy and at 700Gy germination was drastically reduced (30 %) hence may not be suitable for mass irradiation. Maximum number of leaves was noticed in the concentration of 100 Gy and control. Plant height and stem girth at 15 and 30 days after sowing was noticed to be higher in control and 100 Gy treatments. From the growth data, it was estimated that 600 Gy was the dosage that reduced 50% of growth in height and was recommended for mass irradiation of dry seeds. Papaya seed treated with 60Gy and 70Gy has recorded lowest percentage survival of papaya seedling. However, in higher dosage, seedling growth and germination were markedly reduced and this dosage may not be suitable for mass irradiation. For wet seeds method, results from indicated that 40 Gy was the optimal dosage for mass irradiation. At this dosage, both seed germination and seedling growth was reduced by 50%. Papaya wet seed treatment showed the higher response to sensitivity when comparatively dry seeds. Significant differences were recorded among the treatments for germination, sensitivity and survivability of papaya progenies which are discussed in detail.

S5P103 A164

Cross infectivity of isolates of *Sclerotinia sclerotiorum* on different leguminous vegetable crops and their sensitivity towards bio-agent and newer fungicides

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Seven different isolates of *S. sclerotiorum* (SS) were established from vegetable crops namely brinjal (BSS-1), cauliflower (CSS-1), French bean (FSS-1, FSS-2and FSS-3), dolichos bean (DSS-1) and pea (PSS-1) on potato dextrose agar by hyphal tip method. These isolates were subjected to morphological characterization, cross infectivity test on different leguminous hosts and chemo-sensitivity towards bio-agent and newer fungicides. On the basis of morphological characteristics viz. colony colour and texture, tested isolates were categorized into two groups. Isolates (CSS-1 and DSS-1) producing light white coloured colony with loose texture were kept in one group while isolates (BSS-1, FSS-1, FSS-2, FSS-3 and PSS-1) producing bright white coloured colony with compact texture in another group. Isolate DSS-1 produced lowest number of sclerotia (23 no.) however isolate BSS-1 produced highest number of sclerotia (55 no.) on PDA. Cross infectivity of pathogen isolates (BSS-1, CSS-1, FSS-1, FSS- 2, FSS-3, DSS-1 and PSS-1) were performed on different leguminous vegetable hosts viz. French bean, dolichos bean, cowpea, sword bean and pea adopting leaf detachment method. Under *in vitro* conditions, the surface sterilized leaf and pod of these leguminous vegetables aseptically inoculated with 5 mm mycelial bit of five days old pathogen culture and observed for colonization of pathogen after 2 days of incubation at 18±1^{o}C. It was observed that inoculated pathogen isolates infected all the tested hosts with maximum severity on cowpea leaf. However, infection level was more on pods of dolichos bean than that of pea. It clearly revealed cross infectivity of the pathogen indicating the emergence of this pathogen as broad spectrum covering wide host range. Chemo- sensitivity of isolates were tested with tebuconazole 250 EC, azoxystrobin 23 SC, fluopyram 17.7+ tebuconazole 17.7 SC, fluopicolide + propamocarb hydrochloride 68.75 SC at concentration of 250, 500, 1000 and 1500 ppm followed by poisoned food technique. Among tested fungicides, fluopyram 17.7+ tebuconazole 17.7 SC was found most effective at concentration of 250 ppm for complete inhibition of mycelial growth and sclerotia production in tested isolates of the pathogen. *In vitro* confrontation test was done on isolates of stem rot pathogen with *Trichoderma asperellum* exhibited highest mycelial growth inhibition against PSS-1 (50.46%) and lowest in BSS-1 (26.15%) after 7 days of incubation at 18±1 ^{0}C. These findings highlighted the wide non-host specific emergence of this pathogen in vegetable growing areas and its higher sensitivity towards fluopyram 17.7+ tebuconazole 17.7 SC and *Trichoderma asperellum* under a changing climatic scenario.

S5P104 A163

Characterization of chilli leaf curl virus

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Twelve symptomatic chilli samples showing leaf curl symptoms were collected from chilli fields of PAU, Ludhiana. Type of symptoms exhibited by these samples was recorded. To

prove the association of begomovirus with these samples, PCR based detection method was used. Once the samples were positive for begomovirus presence, the same set of samples were further used as template using virus species tomato leaf curl Palampur Virus (ToLCPV), tomato leaf curl New Delhi Virus (ToLCNDV), tomato leaf curl Karnataka Virus (ToLCKV), specific primers as well DNA-B and *DNA-β primers* were used. The samples (C1 and C4) which were not amplified by universal degenerated primers as well as species specific primers were subjected to RCA followed by PCR using begomovirus specific AV494/AC1048 primers for partial characterization. In six samples *viz.,* C2, C8 and C11 ToLCKV and in sample *viz.,* C7, C10 and C12, ToLCPV along with beta satellite molecules were found to be associated. Similarly, in sample C6 a bipartite ToLCNDV with beta satellite was detected. However, the ToLCPV and ToLCNDV are bipartite viruses and association of beta satellite is unusual but this could be due to the fact that the set of primers used were unable to detect the monopartite virus, which is also associated in the form of mixed infection. In sample C5, ToLCPV alone was detected. In both chilli samples, the expected size amplicon (~575 bp) from core CP region was observed, eluted and cloned in plasmid vector pTZ57R/T. The recombinant plasmids were checked for the presence of insert using M13 F and M13 R primers. An expected size amplicon of ~800 bp was observed in positive clones. Phylogenetic analysis revealed that the two viruses clustered within different clades.

S5P105 A495

Proteomic analysis of black pepper *(Piper nigrum* L.) resistance to *Phytophthora*

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The label free proteomics was attempted to study the total leaf protein profile of black pepper genotypes IISR Shakthi (resistant) and Subhakara (susceptible) during *Phytopthora capsici* interaction. The proteome pattern of resistant black pepper inoculated with *Phytophthora* at 12 & 24 showed differential proteins with 118 up regulated, 123 down regulated & 121 up regulated, 118 down regulated proteins respectively. The susceptible genotype showed 122 up regulated, 43 down regulated proteins at 12hai and 95 up regulated, 44 down regulated proteins at 24 hai respectively. The protein interaction network and the functional enrichment were deduced using String v10.The functional enrichment of defense proteins showed the expression dynamics of ROS related defense proteins, calmodulin, WRKY 19,TIR-NBS-LRR class and constant up regulation of LRR membrane kinase, GA biosynthesis pathway proteins in both the hai in case of resistant genotype. Whereas the susceptible genotype showed the down regulation of calmodulin, ROS related defense proteins in both hai. The definite up regulation of PAL, jasmonate biosynthesis pathway proteins at 12hai and the fungal inhibitor hevein like protein, NB-ARC domain containing disease resistant protein were observed at 24 hai. This pattern indicates the second line of host plant resistance in susceptible genotype. On the other hand the differential proteomic pattern shows the resistant genotype with strong innate defense system than the susceptible genotype. The peptide signature of these important host defense proteins could be the possible candidates

which can be used to develop the protein based QTL in screening and developing resistant varieties against *Phytophthora* in black pepper.

S5P106 IS49

Effect of temperature changes and overwintering mortality on incidence of downy mildew in onion (*Allium cepa* L.)

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By the analysis on the occurrence pattern of downy mildew in onion, this study was performed to offer basic control method for the disease that has adverse influence on the stable onion production. The occurrence of downy mildew disease of 4 early-maturing (EM) and 11 medium-late maturing (MLM) varieties was surveyed from 2013 to 2015. In the year 2013, that the overyearing temperature was the lowest among the 3 years, both withering rate of onion and occurrence rate of the disease were lower than other 2 years. And, the year 2014, that showed warm overyearing temperature, the both rates were higher than 2013. In the year 2014, that showed high temperature and precipitation, The EB varieties showed the highest occurrence rate of downy mildew disease, but ML varieties showed the similar rate with the 1st year's one. Since, after the transplanting of ML (the late of Nov. to the early of Dec.), high precipitation and low temperature caused onion withering. And the plants' death reduced the density of downy mildew spores, and then eventually, the occurrence of the disease was lowered. When the occurrence rates of the 3 years were compared, 'Romang' showed the highest rate as 51.5% in EB varieties, and 'Maguboru (15.5%)', 'Wakkamaru (16.2%)' and 'Wellbingbol (15.9%)' showed higher rates than other varieties in ML group.

S5P107 A361

Immuno- molecular Detection and Gene expression based Study on Spatial Distribution of *Apple chlorotic leafspot virus*(ACLSV) in Apple trees in Kashmir valley

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Apple (*Malus domestica*Borkh.) occupies prime position in area and production among all the temperate fruits growing in Jammu and Kashmir (J&K). Annual production (quantity and quality) of appledependsonbothbioticand abiotic factors. Among biotic factors, apple is susceptible to infectionbyfungi,bacteria, virusesandviroids. Amongviruses andvirus-like pathogens,majorityoftheapple trees are known to be infected by *Apple chlorotic leaf spotvirus* (ACLSV), *Applemosaicvirus* (ApMV),*Applestemgrooving virus* (ASGV), *Apple stem pitting virus* (ASPV) and *Apple scar skin viroid* (ASSVd).The importance of ACLSV is due to its worldwide occurrence and large host range on pome and stone fruit, which are of great economic value. In our study the objective is to confirm virus from different parts (spatial) in different seasons (temporal) of apple tree. Samples ofleaf, whole flower, sepal,petal,anther, stigma with style, bark and root were taken from virus infected plants showing symptoms of ACLSV in spring season and DAS-ELISA based detection revealed that all parts are ACLSV positive, except root and DAS-ELISA values indicated virus expression was more in leaf and whole flower than other parts of apple tree. RT-PCR based detection confirmed the virus from all parts except root. In order to find the relative expressionof ACLSV in different partsof plant, Semi-Quantitative RT-PCR analysis showed variation in gene expression of ACLSV in different parts. The Real Time PCR analysis showed highest expression in leaf and minimum in petal. Our results confirmed that the ACLSV expression is more in leaf and whole flower. The absence in root gives confirmation that there is no chance of transmission from infected to healthy root due to root-root contact in soil. But presence in every part of flower gives indication that it might be pollen or seed transmitted which is to be confirmed. The other future studies need to be done are detection in fruit and seed, whole genome characterization, development of infectious clone, transmission studies etc.

Session –VII

Participatory Technology Development and Adoption

(Technology Assessment, Refinement and Dissemination**,** Technology commercialization, Public-Private Partnership, Socio-Economic and Gender issues)

S7P1 A496

Horticultural exports in the post-liberalization era – The Indian experience

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The liberalization of agricultural trade brought about by the economic reforms of 1991, the subsequent WTO agreement and the proliferating Regional Trading Agreements have opened opportunities as well as challenges for India's horticultural trade. This paper analyses the performance of horticultural exports from the country in terms of growth, instability, dynamics, diversification and stability with respect to commodities and markets and the constraints in terms of the Non-Tariff Measures (NTMs) faced and delineates the opportunities and strategies required to be followed by the sector for a sustainable growth. The horticultural exports from the country have grown significantly in both quantity and value terms during the period from 1991 to 2016. The highest share in the exports of horticultural products from India was accounted by grapes for which the major markets were Netherlands, Russia, United Kingdom, UAE, Germany and Saudi Arabia. Among the vegetables, India accounted for about 9.4 per cent of share in world exports of onion and the main destinations were Bangladesh, Malaysia, UAE and Srilanka. The horticultural exports have shown increased commodity diversification as well as geographical diversification due to increased market access in developed countries. Even though the tariffs have come down there by increasing the exports, the NTMs, especially quality issues in connection with sanitary and phyto-Sanitary regulations have increased in the post- liberalization era. Given the inherent potential and rising competiveness of the India's horticultural sector, the removal of product specific constraints, especially production of commodities of international standards could definitely help in sustaining the growth of horticultural exports.

S7P2 A307

Economic analysis of production and marketing of acid lime in Vijayapura district of Karnataka

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Vijayapura district contributes nearly 60% of acid lime production in Karnataka, besides ranking first in productivity (23.33 t/ha). There appear to be constraints in production, processing and marketing of acid lime in the district. Hence, an attempt was made to assess cost-structure, economic feasibility and marketing costs, and to identify channels of acid lime marketing in Vijayapura district. Representative sampling was done to select *taluks* (2) and villages (8) based on the area of concentration. Farmers were chosen randomly from the villages selected. The total sample size was 60 including 40 farmers and five members each of commission agents, retailers, traders and consumers. Per acre establishment cost upto the bearing period was Rs.1,46,585.51 in Indi *taluk*, and a comparatively high Rs. 1,65,735.59 in Sindagi *taluk*. Maintenance-cost during the bearing period (5^{th} year onwards) per acre per year was Rs. 26,027 in Indi *taluk*, and Rs. 40,810 in Sindagi *taluk*. Average life of the orchard in Vijayapura district was 30 years and average yield was 10 tons/acre in Indi and 9.3 tons/acre in Sindagi *taluk*. Higher yield in Indi *taluk* was mostly due to the long professional expertise of its farmers. Discounted net returns per acre in Indi *taluk* stood at Rs. 587066/- and Rs. 415598/- in Sindagi *taluk*. Payback period was 5.16 and 5.21 years in Indi and Sindagi *taluks*, respectively. Benefit:Cost ratio at 12% discount rate was 2.83 in Indi *taluk* and 2.07 in Sindagi *taluk*, indicating better returns in the former. Similarly, IRR (Internal Rate of Returns) was 28% and 23% in Indi and Sindagi *taluks*, respectively. Three marketing channels were identified whereby producer's share in the consumer's rupee was the highest (76.06%) in Channel-II (producer-retailer-consumer), followed by Channel-I (producer-commission agent cum wholesaler-retailer-consumer) and Channel-III (producer-retailer-processor-consumer). Constraints faced by farmers in production of acid lime as per Garret Score Ranking were: higher initial-investment, non-availability of water during summer, non-availability of labour, lack of consistent power supply, and non-availability of quality seedlings. Similarly, constraints faced in the marketing of acid lime as per Garret Score Ranking were high

commission-charges, price fluctuation, higher transportation-cost, lack of processing units, and lack of availability of quick market-information.

S7P3 A660

Group Dynamic and networks among women SHG members: Antecedent to improving group performance

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Women continue to play a pivotal role in horticulture. They contribute more than half of their time in Agriculture and are responsible for most of the day to day activities related to family welfare. Realizing the importance of women's role in the household and in the economy of the country, the Government of India (GoI) has initiated several steps towards gender mainstreaming. One of these is to encourage the formation of women self-help groups (SHGs) in order to take up activities collectively. However, it has been revealed in studies that SHGs have not sustainably impacted the grassroots. Common hurdles were lack of focus, motivation, market orientation, and skill development. Many communities still believe that SHGs are merely avenues to access institutional credit at lower rates of interest. One important aspect for the success of any group formed is its dynamics. Group dynamics is concerned with the interaction forces among group members in a social situation. It is the internal nature of the group-how they are formed, what are their structures and processes, how do they function and affect individual members and interact with other groups and organizations. The present paper focuses on the type of networks, leadership patterns and roles among three diverse SHGs. The results revealed that Group 'A' was an independent sub-group of a larger group, whereas, group 'B' and 'C' were independent groups. The communication network in group 'A was a mix of Y and wheel types and for group 'B' and 'C', it was wheel type. However, there was stronger communication among members of group 'B' as compared to 'C'. The role of the leaders in 'A' and 'B' were mainly task role and that of 'C' was maintenance role. The data also indicated that the leadership type of the three groups was Transformational, Transactional and Team type respectively.

7P4 A661

Effect of climate resilient technologies in boosting of crop productivity in Tumkur district, Karnataka

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Climate change impact at the global level has become a major concern today. In the regional context, climate change has contributed to unpredictable or erratic rainfall pattern, drying up of local ponds and rivulets, shifting of sowing and harvesting period of crops, emergence of invasive species and incidence of diseases and pests in crops as well as in fodder species. Building resilience in both human and ecological systems to an optimum level is the best possible way to adapt to climatic variation. The study was clearly shown that Rainfall intensity and distribution was severely affects the crop yield of major crops of the district. This study has identified the primary challenges of farmers of Tumkur district for ensuing adaptive capacity and water security in the agriculture systems.A high level of impact from climatic change was recorded in crops like Finger millet, Pigeon pea, Groundnut and fodder trees. Farmers replace the Long duration Finger millet variety GPU-28 with medium duration variety ML-365 that can withstand aberrant rainfall beyond one and half month. Pigeon Pea short duration variety BRG-2 found to be very tolerant to drought situation. Farmers themselves practicing the aerobic paddy that utilizes the very less water compare to traditional |Paddy cultivation. There is an evident that drastic shift in rainfall pattern and distribution in last ten years. Innovative coping mechanisms developed by local farmers against emergence of diseases and pests, invasive alien species, untimely shift of crop sowing and harvesting season, rapidly declining productivity, climatic variability etc. are detailed. There is a need to develop a comprehensive master plan/ contingency cropping plan for strategically planning conservation, addressing poverty and food security in the wake of climate change impacts.

S7P5 A665

Communication behaviour of tomato growers

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Farmers use many information sources and channels for seeking agricultural information on new varieties/hybrids/improved farm practices/technologies. Before final decision making on adoption, they come across a number of information sources to process the information to arrive at a decision. Study was conducted to investigate the preferential sources for information seeking, processing and dissemination behavior of Arka rakshak tomato growers in Mysuru and Kolar districts of Karnataka. Purposive sampling technique was used for the selection of respondents to make a total sample size of 60 farmers from both the districts. Data were collected adopting personal interview technique administering a structured schedule. Relevant statistical tools were employed to analyze the data. The study revealed that researchers/scientists and nursery units were the major sources of information in professional sources category, demonstration farmers of nearby villages/mandals in para professional sources, under the sub head personal cosmopolite sources. Under personal localite category, field day/campaigns/meetings in the own villages, FLD farmer of own villages and friends were the information sources under professional, para-professional and non professional category respectively. Under impersonal cosmopolite category, regular mobile advisory services and television (DD) were the major sources of information. With respect to *information processing behavior*, it was recorded that 'discussing the usefulness of information with professional extension personal' was the information evaluation method. For information storage method, it was found that "memorizing information as such" was the method observed. Under the third category *information dissemination behavior*, it was found that 'discussion with fellow farmers at farm premises', 'sharing experience in the group meetings/training programmes were the major dissemination methods by the respondents. Unfortunately none has followed mass contact method for disseminating the information.

S7P6 A740

Role of Farmers Producers Organizations (FPOs) in Promoting Horticultural Innovations: Experience of Selected FPOs

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With a prime motive of arranging broad-based extension services needed by farmers at the backdrop of contemporary challenges in agriculture, Farmers Producers Organizations (FPOs) are being promoted by Department of Agriculture and Cooperation, (DAC), Ministry of Agriculture and Farmers Welfare, Government of India from 2002 onwards. Recognizing the role of these organizations in collectivizing and social engineering of small and marginal farmers as dynamic and business groups, providing operational scale of economy, developing viable supply and value-chain operational models and thereby, extending livelihood security to the producer members, the development organizations such as State Departments of Agriculture/ Horticulture, Commodity Boards, National Bank for Agriculture and Rural Development (NABARD) etc. apart from secondary (Non-Governmental Organizations NGOs) and tertiary (Private industry) sectors started promoting FPOs. Horticulture is a sunrise sector in India and its growth is tremendous in the recent past, which has been attributed to the growing demand from urban and rural consumers for both fresh and processed horticultural products. Realizing the potentials benefits to the producer members embedded in this model, the development departments, NGOs and private organizations working horticultural commodities started embracing this model in collectivizing horticulturists. As a result, a large number of FPOs are being promoted around vegetables, fruits, ornamental crops. Such scenario necessitates to study the performance of these FPOs in terms of their operational mechanism, the services extended by them to the producer members, challenges faced in extending services, profile of the producer members and their perception towards the services etc., so that successful models can be documented and recommended for replications at similar agro-ecologic and socio-economic situations. In that way, this paper discusses about the performance of two producer companies such as Regode Navachaitanya Jyothi Farmers Producers Company Limited, Medak district, Telangana State, which serves its producer members in promotion of vegetables and Ayakudi Guava Farmers Producers Company Limited, Dindigul district, Tamil Nadu, which extends supply and value chain services to guava producers. Implicative measures for strengthening the services of these companies as well as and strategies for replication of these models are recommended in this paper.

S7P7 A277

Foodterrorism: A Global Concern

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Terrorism as a global challenge has resulted in death of millions and most countries of the world are on high alert for terrorist threats. The act of terrorism can be executed in several ways, food has been used in several cases to disseminate harmful biological and chemical toxins. Deliberate contamination of food for human consumption with biological, chemical, or physical agents or radionuclear materials for the purpose of causing injury or death to civilian populations and/or disrupting social, economic, or political stability defines food terrorism. Food is one of the several vectors used to induce intense prolonged fear with imagined or real future dangers around the world. The examples of food terrorism was witnessed in Jaffa oranges contaminated with mercury in five European countries in 1978 and *Salmonella* in salad bars in the U.S. in 1984 causing 751 injuries. The alleged contamination of Chilean grapes with cyanide in 1989 led to the recall of all Chilean fruits from Canada and USA and the resulting damage amounted to several hundred million dollars and more than hundred growers and shippers went bankrupt. The Public Health Security and Bioterrorism Preparedness and Response Act of 2002: Protecting the Safety and Security of the Food and Drug Supply (Title III) has been enacted. The quality control system at food production and distribution are not designed to determine and detect intentional contamination. If food safety is compromised with chemical or biological agents, the direct result could include significant morbidity and mortality or the indirect result of hunger and inadequate nutrition.

S7P8 A696

Effect of date of planting on pest and disease incidence on Bell Pepper (*Capsicum annum* var grossum Sendt.) in Bengal Basin.

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The effect of three dates of planting viz 1st November,15 th November and 30th November on pest and disease incidence of bell pepper var Indra was started at farmers' field at North 24 Pargonas district in West Bengal for two consecutive seasons (2015-16 & 2016-17) following randomised block design with seven replications. Pest incidence of thrips *(Scirtothrips dorsalis* Hood), aphids (*Aphis gossypii* Glover. and *Myzus persicae* Sulzer), whitefly (*Bemisia tabaci* Gennadius), yellow mite (*Polyphagotarsonemus latus* Banks) and fruitborers (*Helicoverpa armigera* Hubner) were recorded at ten days intervals from fifteen days after transplanting. Crop planted on 30th November showed at highest population of thrips (1.37/5 leaves), aphids (2.00/5 no of shoot), whitefly (2.81/5 leaves), fruit borers (1.35/plant) and chilli leaf curl virus incidence but lowest population of yellow mite

(1.15/plant) .Crop planted on 1st November exhibited lowest population of all the crop pests (thrips (1.22/5 leaves, aphids (1.47/5 no of shoot), whitefly (2.32/5 leaves)and fruit borers (1.15/plant) and chilli leaf curl virus except yellow mite (1.27/5 leaves).Pest and disease incidence were discernible in moderate on 15th November planted crops.Crop planted on 1st November provided the highest yield) of marketable fruits (18.3t/ha) followed by 15 th November (15.2 t/ha) and 30 th November (13.3t/ha) planted crop.Therefore, it supposed to be recommended that planting of bell pepper should completed within 1st week of November in Southern district of Bengal basin with proper protective measure against yellow mite during seedling and early vegetative growth stage.

S7P9 A741

Impact of Training programmes on Adoption of Mushroom production Technology

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Mushroom cultivation has been a profitable venture for the rural women/youth apart from providing employment opportunities and nutritional security. ICAR-Indian Institute of Horticultural Research (IIHR) regularly organizes training programmes for farmers/farm women/youth/entrepreneurs on tropical mushroom production technology. A study was organized to assess the impact of such farmers in terms of knowledge gain, technology adoption etc. A comprehensive questionnaire was developed and administered at the National Mushroom Industry Interface Meet held on 27.10.2016. Analysis of results indicated that the majority of the growers are from urban area (54.8%) followed by rural area (37.6%), male growers (82.6%) followed by female growers (17.4%), entrepreneurs (66.57%) and 98.93% have mobiles. More than 90 % of the growers consumed mushrooms once a week and once a month. More than 86.96% growers felt gain in knowledge followed by technology up gradation (8.7%) and change in food habits (4.35%) after undergoing mushroom training. Major constraints faced by growers are lack of marketing facility (2.79) followed by lack of training (2.63), lack of credit facility (2.6), non-availability of spawn (2.5), contamination (2.33) and non-availability of raw material (2.3). Marketing was mainly done by local marketing (94.6%) followed by retail chains and super bazaars (10.8%). Further success of mushroom industry can be ensured by initiating Mushroom growers association as strong link between the grower community and research institutes, the government departments, financial bodies etc., and in helping the growth and promotion of Mushrooms, as a nutritive food supplement.

S7P10 A104

Use of underutilized fruits in medicinal, nutritional and economic security of tribal's in south western Rajasthan: A case study

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South Western Rajasthan is endowed of plant biodiversity with special mention of semi-arid underutilized fruit and vegetables. The present study emphasized that in ancient times these fruits and vegetables were largely used by the natives of tribal area as a prime source of natural medicine and food using their traditional wisdom. They used them in the form of fresh fruits, dry fruits, fruit juice, fruit powder, *arak*, *chutney*, paste, lotion, pickle, nutritive wine, drugs, *triphala* and *chyavanprash* etc. But in present scenario, because of changing food habits, taste and prevalence of several food myths and taboos, the new generation of tribals discontinued consuming underutilized fruits and vegetables due to lack of awareness about their medicinal and nutritional significance. It has resulted inmalnutrition among those people along with multiple nutrient deficiency disorders. Significantly high prevalence of nutrient deficiency and occurrence of clinical symptoms of protein energy malnutrition (14.4%), anaemia (33.0%), iodine deficiency disorder (17.0%), vitamin A deficiency (22.0), vitamin C deficiency (12.40%), calcium deficiency (18.0%) and zinc deficiency (19.20%) were observed in non-consuming groups of tribals. It was also evident from the study that the consuming group has more traditional wisdom for therapeutic uses of available underutilized fruits and vegetables. Also the study results revealed that the underutilized horticultural crops have the potential to give economic security to tribals by giving employment and by fetching good returns from their sale in raw form as well as value added products.

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Sartaj A. Wani
Sartaj Ahmad Wani
Sasmita Priyadarsini Dash
Sat Pal Sharma
Satasiya R M
Sathappan C T
Satisha G C
Sayan Sau
Sayeed Abdul Hamid Patel
Sehrawat SK
Selvakumar, R
Senthil Kumar R.
Senthilkumar M
Seong-Han Sohn
Sergei Tsiupka
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Seth Sachin G
Sethi K
Shabina N
Shagun
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Shahid Ali Akbar
Shailesh Kumar Singh
Shankhwar B
Sharda Choudhary
Sharma P L
Sharma S D
Sharma V K
Sharmistha Naik
Sheik. Roohi Tasleema
Sheikh Mehraj
Shilpa P
Shilpashree N
Shirgure P S
Shivakumar
Shivakumar S N
Shivani Singh
Shivaprasad S
Shivashankar S.
Shivashankara K S
Shivendu Pratap Singh Solanki
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Shukla S P
Shweta Kumari
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Sidhartha kar
Sikder S
Singh D B
Singh H S
Singh I P
Singh M C
Singh T H
Singh V K
Sirinrat Phuyodying
Siva Kumar V
Sivakumar, V
Sivarama Krishna V N P
Smitha GR
Sofia Penabaz-Wiley
Sonkar R K
Sonu Sheoran
Soorianathasundaram K
Sreelekshmi.S
Sreenivasa Rao E
Sridhar Ramachandra
Sridhar V.
Sridharan S
Srikanth N. Jois
Srinivas, Puli
Sriram S
Sriram Nachiappan
Srivastava A K
Stanzin Angmo
Subhendu Bhadraray
Sudha Appusamy
Sudhakar Rao
Sudhakar Rao D V
Sudhir Kumar
Sudip Kumar Dutta
Sugani Devi
Sujatha A. Nair
Sujayasree O J
Sujith SS
Sukhen Chandra Das

Sumangala H P
Sumathi M
Sumit Deswal
Sunayana S
Sundaram V
Sunil kumar,
Sunila Kumari
Sunisha C
Sunita Dhakar
Sunita Kumari
Sunita Mahapatra
Sunita Patil
Sunitha N D
Suparna Sinha
Supriya Kumari
Surakshitha N C
Suresh Kumar J
Suresh R
Surya Raj
Suryanarayana M A
Sushil Kumar Shukla
Sushma Arya
Sushma Lokhande
Suvalaxmi Palei
Suveditha S
Svetlana Levchenko
Svetlana Plugatar ,
Swathi P
Sweta S. Gawande
Swosti Debapriya Behera
Syed BerjesZehra
Syed Sami Ullah
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Tajeswini H R
Tamanna Perween
Tamasi Koley
Tamilnayagan T
Tanuja Buckseth
Tanushree Sahoo
Tapan Kumar Giri
Tare M Sangma
Tatyana Latsko

Tatyana Shishova
Tayade S A
Tej Kumar J P
Tejashvini A
Tejaswini
Thaneshwari
Thangam M
Thanusha K T
Tithi Dutta
Tiwari R B
Trina Adikary
Tripathi A N
Tripathi PC
Tristan Nondah
Tsering Stobdan
Tsvetelina Stoilova
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Udhaya Kumar D
Ullasa M Y
Uma S
Umadevi P
Umamaheswari R
Umesha K
Upadhyay G P
Upreti K K
Usha Bharathi T
UshaRani T R
Utpal Das
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Vadim Korzin ,
Vaishnavi BA
Vanitha K
Varalakshmi B
Varalakshmi L R
Veena G L
Venkattakumar R
Venu, S A
Venugopalan R
Vera Zykova
Vijay Mahajan
Vijaya D
Vijayakumar S
Vijayakumari

Vijayakumari N
Vijeth S
Vikas Soni
Vikram Yogi
Vinay G M
Vinod Kumar Vashisht
Vinutha. M R
Vivek Hegde
Vivek Kumar Singh
Vladimir Melnikov
Vladimir Vasipov
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Wagh AP
Wineet Chawla
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Yadav D S
Yadlod S S
YaminiVerma
Yashi Sadhwi
Yashwant Kumar
Yogeesha HS
Yogendra Kumar Sharma
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