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**Front Cover:**

A small glimpse of diversity in mango

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**Back Cover:**
Laboratory cum administrative building & panoramic view of the experimental farm

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Horticulture in the subtropics is one of the vital components of agrarian economy which contributes about thirty-five per cent of the total horticulture production of the country. Cultivation of fruit crops in general and subtropical crops in particular is becoming much more challenging in the context of eroding genetic resources, shrinking cultivable land owing to urbanization and its diversion to other non-agricultural uses, depleting surface and ground water availability, escalating labour costs and limited renewable energy resources. Moreover, economic globalization has thrown umpteen opportunities as well as challenges for subtropical fruit research and industry. Changing climate as a result of global warming has impacted the phenophases of mango, guava, aonla, bael, jamun and understanding the shifts in phenophases of these fruit crop will help in mitigating the impact of weather vagaries on productivity. Emergence of market driven economy warrants paradigm shift in the research approaches on subtropical fruits, taking in loop all the stakeholders including farmers, traders, consumers and entrepreneurs. Basic biotechnological tools comprising genomics, metabolomics and recombinant DNA technologies offer ample opportunities in addressing the emerging as well as perennial problems confronting fruit crops in subtropics.

Genetic erosion due to rapid urbanization is being addressed through *ex situ* as well as on-farm conservation efforts for saving the heirloom mango varieties. The Institute has taken up initiatives to motivate, associate and support local communities towards conservation of existing genetic wealth of mango in one of its world famous hot spot, *i.e.*, Malihabad. Successful efforts have been made by the Institute to strengthen on-farm conservation of mango varieties through custodian farmers. The Institute also facilitated registration of farmers’ varieties of mango.

Early, delayed and/or recurrent flowering, abnormal fruit set, variations in fruit maturity and transformation of reproductive shoots into vegetative ones are becoming common phenomenon affecting productivity of mango, guava and other fruits. The ICAR-CISH, Lucknow is addressing issues related to mango and guava production through integrated approaches. Mango wilt is fast emerging as one of the most challenging and complex problems causing concern to mango industry. Guava wilt, since its emergence, has defied solution. Identification of nematode and insect incited guava wilt has added another dimension to crop patho-system scenario, making it much more perplexing. The Institute is also dealing with the several newer issues, *viz.*, marker assisted breeding, transgenics, improved production technologies, GIS mapping and secondary agriculture, *etc*. Effective orchard space utilization through efficient canopy management is a *sine-qua-non* for increasing productivity, for which intensive research efforts are underway. Besides, releasing a pruning responsive variety Lalit in the past, the Institute has also developed two improved guava varieties Dhawal and Lalima, suitable for high density planting systems. Shweta has been recommended for commercial cultivation in Punjab besides Lalit being adapted by farmers on a very large scale in states like Andhra Pradesh, Maharashtra and Karnataka. So far, the Institute has released two cultivars of mango, four of guava and two of bael, which are widely accepted and adopted by orchardists. Further, two jamun selections with high pulp content have also been identified.

The Institute has a unique distinction of maintaining world’s largest germplasm collection of mango (762 accessions) and guava (135 accessions along with 6 *Psidium* species). The Institute is making concerted efforts to enrich its germplasm on bael, jamun, karonda, wood apple, khirni, jackfruit, etc. Metabolomic profiling of these nutraceutically rich fruit crops will go a long way in making these crosses for pharmaceutical industry. Besides, at the Institute there are several promising hybrids/selections of different mandated fruit crops in the advance stage of evaluation. The Institute has also developed several production technologies, which have improved farm productivity as well as incomes of the stakeholders at large. Consequently, the institute through its consistent efforts and its linkages with other research institutions and development agencies will pave the way for overall development of subtropical horticulture.

I am immensely grateful to all the staff members for putting their efforts in respective spheres and laud the sincere efforts of the publication committee in timely compilation and editing of this Annual Report. The help rendered by Mr. Prashant Tiwari, Data Entry Operator, in type setting is also appreciated. The Institute expresses its heartfelt gratitude to Hon’ble Secretary (DARE) and Director General, ICAR, New Delhi, Dr. S. Ayyappan and Deputy Director General (Horticultural Science), ICAR, New Delhi, Dr. N.K. Krishnakumar for their help, encouragement and suggestions provided from time to time.

Place: Lucknow
Date: 27-06-2015

(SHAILENDRA RAJAN)
Acting Director
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Genetic resource management and improvement

The Institute has the largest germplasm collection of mango in the world having 762 accessions in its field gene bank. Besides, the Institute also has a good number of accessions of other subtropical fruits including underutilized ones.

Nine promising mango seedlings were collected from Darbhanga, Samastipur and Muzaffarpur districts of Bihar. Thirty-three farmer's varieties of mango were identified from Malihabad and its adjoining areas and vegetatively multiplied for conservation. Fifty-nine accessions of mango were evaluated for fruit characteristics. Database was updated with the information on 42 accessions of mango. A total number of 50,554 flowers were crossed using 20 cross combinations on 15,400 panicles. Thirteen cross combinations gave rise to 208 hybrid seedlings. Six hundred and thirty-six hybrid seedlings were evaluated for fruit weight, length, width and thickness, peel weight, stone weight, pulp per cent, stone length, width, thickness and TSS. Data indicated that a good number of hybrids were more than 300 g in fruit weight and > 20 °B TSS. One hundred and fourteen hybrid seedlings were raised from 13 cross combinations attempted in 2014 and planted in field for evaluation of F₁ progeny, targeting traits such as quality, peel colour, dwarfing and abiotic resistance.

Thirty-seven mango types, comprising 27 heirloom varieties from Malihabad region and 10 commercial varieties grown in north and eastern India were assessed for molecular diversity using SSR markers that amplified 2-13 alleles individually, cumulatively amplifying 124 alleles across the studied mango population. Genetic dissimilarity ranged from 0.035 to 0.892, arranging varieties in three major clusters, wherein, majority of the unique heirloom mangoes from Malihabad were found different from the eastern part of the country. Commercial varieties, like Gulabkhas and Langra were placed in a separate group along with Bombay Green, Himsagar, Dashehari, etc indicating their dissimilarity with heirloom varieties at molecular level. Polymorphic SSR (MillHR04, MillHR05, MillHR07, MillHR09, MillHR10, MillHR12, MillHR17, MillHR18, MillHR19, MillHR23, MillHR24, MillHR26, MillHR32, MillHR34) were used for local mango varieties from Mall-Malihabad region, commercial varieties and polyembryonic types, amplifying alleles in the range of 176-294 bp. A total number of 135 unique KEGG pathways were identified in pooled Chausa samples, out of which majority of CDS were grouped into starch and sucrose metabolism (36), amino sugar and nucleotide sugar metabolism (30), arginine and proline metabolism(29), lycolysis/gluconeogenesis (24), etc., which were responsible for fruit quality attributes.

Salinity tolerance of Nekkare, 13-1 and Kurukkan was found higher (EC 2-4 dsm⁻¹) over other polyembryonic mango cultivars. Proline and glycine betaine content was higher in leaves (4.5-6.0 mg g⁻¹ DM) than roots (1.2-3.5 mg g⁻¹ DM) with elevated salt stress levels. However, their contribution to osmotic adjustment in all polyembryonic cultivars seem to be very low and they might be related to protective rather than contributing to osmoregulatory functions. Kurukkan, 13-1 and Nekkare exhibited least reduction in water potential at higher salinity levels. Mango rootstock 13-1 exhibited maximum leaf wax content (14.09 mg g⁻¹ FW) at higher salinity levels.

Fifteen trait-specific guava accessions were collected from Varanasi, Allahabad and Kaushambi districts of U.P. Selections, viz., CISH-GS-35 and CISH-GS-14, from half-sib population were found to be high yielder with attractive fruit surface, colour and TSS (13.1 °B). Two hundred and four hybrids were evaluated for pulp colour measured as CIE L*, a* and b* values in the fruit pulp. CIE a* value ranged from -2.08 to 18.91 in the pulp, suggesting a range of pink colour for selection in the hybrid population. TSS and seed hardness ranged from 7.5-16 °B and 7.21 to 19.32 kg cm⁻², respectively. Twenty three accessions of guava were characterized for fruit characters during the winter season. Eight hundred and seventy interspecific wilt resistant rootstock of guava were clonally multiplied and used for...
grafting the scions of different cultivars, viz., Allahabad Safeda, Apple Colour, Lalit and Shweta. Nine hundred and thirty-six hybrids developed using cross combinations, viz., CISH-G-1 × MS, MPUAT SEL-II × MS, CISH-GS-S-9 × MS, CISH-G-1 × Purple Guava, GN Seedling × Lalit, GN Seedling × MS, Shweta × Purple Guava, Shweta × G-1, T-35 × Purple Guava, Lalit × T-9 were established in field for fruit quality and seed hardness evaluations. Two new improved guava cultivars, viz., Dhawal (half-sib selection from Allahabad Safeda guava, having round fruits which weigh 200-250 g, TSS 13.4 °B, acidity 0.42 per cent and vitamin C more than 250 mg per 100 g fruit) and Lalima (selection from half-sib population of Apple Guava, having fruit weight of 190 g & TSS 13.7 °B) were identified for release.

Papaya seeds were produced by controlled pollination to maintain genetic purity of identified lines. Four papaya cultivars were sibmated for production of true to type seeds. Genetic modification of papaya was attempted with hairpin truncated coat protein gene. A total number of 90 putative embryos regenerated into shootlets. Besides, 27 independent putative transgenic lines have been developed, which are being acclimatized under in vitro conditions. SEM has been carried out in transformed embryos to know the status of embryonal fasciation. It revealed that long term stay of embryos under cytokinin led to fasciation. Incorporation of antiethylene substance, such as AgNO₃, completely controlled the embryonal fasciation.

Twenty-two accessions of aonla collected from different parts of Madhya Pradesh were evaluated for yield and quality parameters. CISH-A-33 was found to be the most promising accession in terms of yield (55.45 kg/tree) and neutrectaneal values (ascorbic acid - 490.13 mg/100g pulp; polyphenol - 1.718 TAEg/100 g; FRAP value - 235.76) followed by CISH-A-31 having a yield potential of 41.76 kg/tree with high neutrectaneal value (ascorbic acid-418.12 mg/100 g; polyphenol-1.427 TAE g/100g and FRAP value-214.04). Bael accession CISH-B-18 was found to be high yielder (73.32 kg/plant) having medium sized fruit (1.88 kg), high TSS (42.4 °B), high total sugar (22.53%) with appreciable total carotenoids (3.79 mg/100g) and tannins (3.79%). Out of 76 seedling of bael germplasm evaluated, CISH-SB-30 was found the most promising in terms of yield (51kg/plant), medium sized fruit (1.57 kg), total soluble solids (38.96 °B) and total sugar (18.51%). The contents of marmelosin, psoralen and riboflavin analyzed in seven bael cultivars revealed that NB-5 had the highest amount of marmelosin (256.7 µg/g). Pant Shivani had highest psoralen (179.0 µg/g). Similarly, riboflavin was found highest in NB-17 (5.0 µg/g).

Seedless accession of Jamun CISH-J-42 showed highest pulp content (98.29 %). The minimum seed weight was noticed in CISH-J-42 (1.71 g). The maximum pulp weight and pulp percent was noticed in CISH-J-37 (21.66 g and 92.22 %).

**Improved crop production technologies**

Shoot tip pruning in cv. Dashehari during June 2013 coupled with paclobutrazol application in the first week of September resulted in initiation of 13.33 per cent vegetative and 86.67 per cent reproductive shoot. The fruit yield (2.55 kg / 40 shoots), fruit weight (316.09 g), and size (130.44 mm length and 60.75 mm girth) of fruits harvested from the treatment were significantly superior to October pruned trees.

The highest fruit yield in cv. Dashehari (9095 kg/ha) and TSS (19.9 °B) was recorded in the treatment of NPK + Zn, Cu, Mn, B (50 % soil + 50 % foliar application). Significantly, lower acidity and higher ascorbic acid content were recorded in the treatment NPK + micro nutrients Zn, Cu, Mn, B (50 % soil + 50 % foliar application). Maximum organic carbon and available N was recorded in the treatments NPK + FYM + Bio-fertilizers and NPK + FYM + Bio-nutrients (Zn, Cu, Mn and B), respectively. Higher dehydrogenase (4.38 µg TPF/g/hr) and fluorescent diacetate activity (443 mg fluorescin/ kg/hr) were recorded in treatment combination of NPK + Zn, Cu, Mn, B + FYM (soil application). Higher water holding capacity (WHC) was found in surface layers as compared to lower depths across different treatments. Application of soil and foliar (50% each) in respect of Zn, B and Cu in Dashehari mango was better than 100 per cent soil application.

Fertigation scheduling in mango indicated the highest fruit yield of 118.4 in 75 per cent RDF. Range of TSS, acidity and ascorbic acid content was 18.43 to 19.83 °B, 0.15 to 0.20 per cent and 32.14 to 37.22 mg/100g, respectively, across different treatments.
The highest organic carbon and available N contents were recorded in the treatment 10 kg FYM + 100, 50, 100 g N, P, K / tree / year of age + Azotobacter + PSM + Trichoderma harzianum + organic mulching. Zinc and Mn content of leaves increased significantly in the treatments incorporating soil/foliar application of these nutrients. The concentration of N, P, Fe, Cu and B in the leaves of cv. Dashehari increased due to different treatments, however, there was no significant response of the treatments. Higher porosity (45.6 to 51.1%) was recorded in the surface layer (0-10 cm) followed by 41.9 to 47.5 per cent at 10-20 cm and 38.4 to 48.7 per cent at 20-30 cm depths, respectively.

The highest actinomycetes population, dehydrogenase and fluorescent diacetate activities were recorded in treatment containing 10 kg FYM + 100, 50, 100 g N, P, O, and K/O/tree/year of age + Azotobacter + PSM + T. harzianum + organic mulching. Bacterial and fungal populations and soil respiration (70.0 mg CO₂/kg/day) were highest in treatment containing 10 kg FYM + 50 g N + 25 g P, O, + 50 g K, O / tree /year of age + Azotobacter + PSM + T. harzianum + organic mulching.

Significant flower damage and fruit drop at pea stage was noticed due to prolonged winter and unseasonal rains during February - March along with high wind velocity (7-8 m/s). Maturity of fruits was delayed by about 15 days.

The levels of non-structural carbohydrate (total sugar, starch and reducing sugar) in root and shoot of cultivars Langra and Amrapali was found to be higher (3.09- 6.29 mg/g DW). However, in Amrapali there was non-significant difference during different years. On the other hand, levels of non-structural carbohydrates in shoot were maximum during 'ON' year at flower bud differentiation (FBD) stage as compared to 'OFF' year of fruiting.

During FBD, Amrapali had higher osmotic potential (-3.39 MPa) than Langra (-5.38 MPa). Symplastic content was also more in Amrapali (76%) than Langra (60%) at FBD, as a result apoplastic content showed reverse pattern in the varieties as indicated by lower value in Amrapali (24%) than Langra (40%).

The simulation model on autocorrelation of fruit yield of Langra trees (100) over five years was studied for time series modelling. The log transformed values gave better prediction of yield may be due to minimum mean square value (0.30) value as compared to very large mean square (4677.21) value in without log transformed values.

Mango fruit yield in association with different intercrops ranged between 42.3 kg/tree with panicum grass as intercrop to 53.6 kg/tree with fern as intercrop, but it exhibited non-significant differences in respect to fruit yield (42.3 - 53.6 kg/tree), fruit number/tree (198.3 - 244.3 fruits/tree), average fruit weight (208.1 - 247.2 g/fruit), TSS (19.2 - 22.8 °B), acidity (0.16 - 0.19 %) and vitamin C (16 - 22 mg/100 g) under different treatments. Thus, different intercrops did not affect the fruit yield of mango adversely. Out of various intercrops evaluated in association with mango trees, shatavari (Asparagus racemosus) and fern (Nephrolepis tuberosa) appeared to be the most promising ones when compared with other intercrops. Based on two years pooled data, turmeric intercropped soil showed highest microbial activity followed by Amorphophallus and the lowest was recorded in ginger intercropped soil.

Integrated plant nutrient management in guava indicated that the highest fruit yield (72.5 kg/tree) was recorded in 10 kg FYM + 120, 60, 50 g N, P, O, and K/O/tree/year of age + Azotobacter + PSM + T. harzianum + organic mulching. The levels of Cu, B and Mn concentration in the leaves increased significantly with soil or foliar application of these nutrients. Highest bacterial, fungal and actinomycetes populations were found in treatment containing 10 kg FYM + 50 g N + 25 g P, O, + 50 g K, O / tree /year of age + Azotobacter + PSM + T. harzianum + organic mulching. Soil organic carbon varied between 0.21 and 0.62 across different depths and planting densities. Mean water holding capacity was estimated as 21.44 per cent.

Crop protection

Hopper population appeared from 02nd Standard Meteorological Week (SMW) and continued up to 48th SMW. Its population was very low i.e. 0.19-0.39 and 0-1.62 during 1-10th and 38-52nd SMW, respectively. The population of thrips could not be noticed on mango during
40-52\textsuperscript{nd} and 1-8\textsuperscript{th} SMW. The maximum population (1.02 to 4.61) was recorded during 13-21\textsuperscript{st} SMW. The population of mealy bug on mango first appeared during 5\textsuperscript{th} SMW and continued up to 26\textsuperscript{th} SMW. The maximum number of mealy bug was observed during 13-15\textsuperscript{th} SMW in the range of 4.73-9.58. The highest population of fruit fly was noticed during July-September 2014, attaining a peak (150.7 adults/trap/week) during 31\textsuperscript{st} SMW. The population of scale insect on mango was positively correlated with maximum temperature \((r = 0.475**)\), minimum temperature \((r=0.380**),\) sunshine hours \((r = 0.301*)\) and evaporation \((r = 0.348*)\). Peak infestation of midge on mango \((2.35/panicle)\) occurred during 13\textsuperscript{th} SMW. Population was positively correlated with sunshine hours \((r=0.330*)\) and negatively with maximum relative humidity \((r = -0.391**)\) and minimum relative humidity \((r = -0.472**)\). Peak infestation of midget on leaf was noticed during 19\textsuperscript{th} SMW. The leaf webber infestation was positively correlated with minimum temperature \((r = 0.487**),\) minimum relative humidity \((r = 0.448**)\) and rain fall \((r = 0.600**).\) Fruit borer incidence was observed during the 18\textsuperscript{th} to 31\textsuperscript{st} SMW (2014-2015). Its peak infestation (40.8\%) was recorded during 21\textsuperscript{st} SMW. Based on the three years data of hopper population dynamics and thermal indices including, Growing Degree Days (GDD), Heliothermal units (HTU) and Photothermal Units (PTU), linear regression prediction models were developed for mango growing belt of Lucknow region. The thermal indices, particularly, during flowering and fruit set, varied across the seasons which influenced the hopper population.

Quinalphos \((2 \text{ ml/L})\) was effective against leaf webber (70\% mortality) and was at par with lambda cyhalothrin 5 EC \((1 \text{ ml/L})\) followed by dichlorvos 76 EC, spinosad 44.2 SC 0.2 ml/L and chlorfenapyr 10 SC 1 ml/L, which effected 61.67, 60.0 and 58.34 per cent mortality, respectively. Lambda cyhalothrin \((1 \text{ ml/L})\) was effective against fruit borer in mango and was at par with quinalphos \((2 \text{ ml/L})\), resulting in 90 per cent mortality of the pest. Chlorantraniliprole, diafenthiuron and chlorfenapyr caused 16.80, 37.14, 51.72 per cent population reduction of mealy bug, respectively. The garlic extracts was also found highly effective causing 86 per cent reduction over initial population. Mango cultivars viz., Indonesia, Phasl Murshidabad, Sonia Malda, Kishenbhog, Bathuie, Baramasi, Creeping Band and Nazuk Badan were found tolerant to fruit borer infestation. Highest number of webs were recorded on Bombay Green \((108.5 \text{ webs/tree})\) followed by Bhoodia \((136.5 \text{ webs/tree})\) and Kishan Bhog \((133.5 \text{ webs/tree})\).

Unseasonal rains (six rainy days with 60.2 mm rainfall) during February and March 2015 created highly unfavourable weather conditions for the development of powdery mildew of mango. Peak disease incidence (12.5 \%) and severity (PDI 3.75) was recorded during the 13\textsuperscript{th} SMW in fixed plot studies. The lowest incidence of anthracnose (13.2 \%) and severity (2.55 \%) on mango was noticed during June. Average blossom blight incidence and severity in and around Lucknow was 65.4 per cent and 35.4 PDI, respectively. Initial disease symptoms were observed on emerging panicles during the last week of February 2015. Ceratocystis fimbriata and Lasiodiplodia theobromae were recognized as major and minor wilt pathogens, respectively. C. fimbriata was found to have high frequency of occurrence in the plants displaying sudden wilt symptoms. Scoyld beetles were also noticed in wilted trees. Severe gummoss on the trunk and major branches was observed before the onset of complete wilt. Reddish-brown to dark brown or black discoloration of vascular bundle and foul smell were the common symptoms. Slow wilt affected trees, on the other hand, exhibited poor growth without gum oozing. Branch drying affected trees died within a period of 8 to 30 months. Application of thiophanate methyl as soil drench @ 300 g/tree in tree basins along with pruning of affected branches and smearing with copper oxychloride paste followed by propiconazole spray (@ 0.1\%) coupled with incorporation of FYM and fertilizer (100 kg, 1.0 kg di-ammonium phosphate and 500 g of muriate of potash per tree) resulted in recovery of affected trees with the emergence of new flushes.

Incidence of shoulder browning was poor due to late onset and deficit monsoon. Colletotrichum gloeosporioides and Alternaria alternata, were identified as potential pathogens of mature fruits causing fruit rot during ripening and storage. Propiconazole and starch were found most effective in management of the disease.

Heterorhabditis sp., designated as CISH-EPN-
05, was isolated from mango orchards located in Sitapur district. *Photorhabdus luminescens*, an endosymbiotic bacteria, was isolated from the gut of *Heterorhabditis* sp. using nutrient agar medium. Commercial formulation of *S. abbasi* was done using 1.47 per cent calcium chloride and 2 per cent sodium alginate. Infective juveniles were entrapped in the gel matrix. The shelf-life studies of *S. abbasi* on sodium alginate beads revealed that the IJs could survive for 3 months at 15 °C without any mortality.

Dichlorovos along with sealer-cum-healer and copper oxychloride, dichlorovos with copper oxychloride and profenofos were found superior with 52.5, 49.9, and 45.6 per cent reduction in infestation, respectively in the management of bark eating caterpillar of guava. Surveys conducted in the two locations in Badaun region revealed the predominance of root-knot nematode, *Meloidogyne incognita* in guava orchards. Population of root-knot nematode in the soil ranged from 2-20 second stage juvenile per 100 cc soil sample. *Hoplolaimus indicus, Helicotylenchus dihystera and Rotylenchulus reniformis* were commonly occurring in the rhizosphere of healthy and wilted plants but the population was by and large very low ranging between 0-25 per 100 g soil sample collected from Farrukhabad District. Low population of *Fusarium oxysporum* was also found in this region (2.43-6.79%). High population (5-10) of grub identified as *Holotrichia* sp. belonging to family Melolonthidae was also isolated from the plants exhibiting wilting of peripheral branches in the guava plantations located in Sarai Mansoor (Allahabad) and Salahpur (Koshambi). Sixty soil samples were collected from 0-5, 5-10, 10-15 and 15-20 cm soil depths from some wilt infected (25, 50, 75 and 100%) and healthy guava orchards. DTPA-extractable micronutrients contents ranged between 1.27 to 2.79 ppm Zn, 5.23 to 8.42 ppm Cu, 7.05 to 23.11 ppm Mn and 1.83 to 3.51 ppm Fe, respectively. The mean Zn, Cu, Mn and Fe contents in 35 soil samples (18 from Allahabad, 9 from Badaun and 8 from Farrukhabad) were 0.71, 1.6, 4.4 and 10.0 ppm, respectively.

**Post harvest management**

Dashehari mango fruits treated with 50 ppm salicylic acid could be stored up to 9 days at room temperature without much deterioration in quality, whereas, fruits treated with 250 ppm ethyl in hot water at 52±2 °C could be stored at 25±2 °C with 85 to 90 per cent R.H. up to 21 days.

Four per cent drumstick leaf powder fortified raw mango (*cv.* Sukul) chutney contained highest total carotenoids and scored 6.43 organoleptically after nine months of storage as compared to chutney without leaf powder, which scored 7.52. A probiotic drink, developed from raw mango fruits through lactic acid fermentation, was ready to serve after 4 days with acceptable organoleptic score (7.9). Fish meal supplement, produced from pasteurized peel and stone of discarded mango fruits and aonla pomace by inoculation with *Saccharomyces cerevisiae and Lactobacillus* sp. and fermented at room temperature, had positive effect on growth of fish. The amount of lupeol in Dashehari, Amrapali, Mallika and Chausa was estimated by HPLC as 1082, 505, 167 and 65 µg 100 g⁻¹, respectively.

Cellulase was mass produced by *Aspergillus niger* using mango peel as substrate and immobilized in calcium alginate beads through entrapment technique. Maximum ethanol production (6%) was observed with mango kernels inoculated with yeast cells immobilized on mango stone shell pieces. The amount of reducing sugar, released by amylase enzyme isolated from *Aspergillus niger* NAIMCCF-02958, using mango kernel as substrate, was highest (15.86 %) in mango kernel at 5 per cent substrate concentration, pH 6.5 and 3 per cent of enzyme concentration (93.26 U/ml) after 3 hours of incubation at 50 °C. Out of five fungi (*Penicillium restrictum, Penicillium crustosum, Aspergillus niger, Aspergillus oryzae* and *Aspergillus fumigates*) screened, highest tannase production was recorded through *Aspergillus fumigates* (0.53 U/ml) followed by *Aspergillus oryzae* (0.52 U/ml). Co-culture of *Aspergillus oryzae* and *Fusarium solani* resulted in better production of a-amylase (6.41 U/ml) than *Aspergillus niger* and *Aspergillus oryzae* (3.89 U/ml) using mango kernel as substrate (30%) under solid state fermentation conditions at pH 5.5 and temperature 35 °C after 6 days of incubation.

HPLC techniques for the estimation of lambda-cyhalothrin and quinalphos residues in mango were standardized and validated using reverse phase C-18 column and PDA detector. The limits of detection (LOD) and the limits of quantification (LOQ) for lambda-cyhalothrin and
quinalphos were 0.05 and 0.2 µg ml⁻¹ and 0.1 and 
0.2 µg/ml, respectively. Lambda-cyhalothrin 
persisted in fruit up to 15 days after applications 
at 1.0 and 2.0 ml/L of water to Dashehari mango 
trees during third week of May with residual half-
lives of 3 days for both the doses. Pre-harvest 
interval of 12 and 15 days was suggested for 
normal and double doses, respectively, based on 
its MRL value of 0.1 mg/kg.

Post harvest dip treatment of guava fruits 
(cv. Allahabad Safeda), harvested at 110 days after 
fruit set, with 1 mM salicylic acid for 5 min resulted 
in better quality fruits after 9 days of storage 
under ambient conditions (12±2 °C and 80±5 % 
R.H.) as compared to 1 mM acylated salicylic acid 
treated fruits. Allahabad Safeda fruits, treated 
with 1 mM salicylic acid for 5 min, could be stored 
up to 21 days at 10±2 °C and 85-90 per cent R.H. 
without any disease. Oxalic acid, malic acid, citric 
acid, succinic acid and ascorbic acid were analysed 
in three guava cultivars (Allahabad Safeda, Sardar 
and Lalit) using HPLC. Ascorbic acid was the 
major organic acid detected and succinic acid was 
found in least quantities. Gallic acid, caffeic acid, 
sinapic acid, ferulic acid, epicatechin, 4-
hydroxybenzaldehyde and kaempferol were 
identified as phenolic compounds in these guava 
cultivars using HPLC. Gallic acid, kaempferol and 
epicatechin were the major polyphenols in guava.

Bael fruits of CISH B-1 and CISH B-2 got 
ripened at 7 and 14 days after ethrel treatment 
(500 ppm) in hot water at 52±2 °C for 10 min. TSS 
and total phenols increased upon ripening, while 
acidity, marmelosin and psoralen decreased. A 
probiotic drink was prepared from mature unripe 
bael fruit through lactic acid fermentation. The 
bael pieces separated from drink were utilized 
for preparation of oiled pickle and preserve. The 
contents of marmelosin, psoralen, thiamine and 
rutinol were found in varying proportions in 
seven bael cultivars (Pant Shivani, Pant Sujata, 
Pant Aparna, NB-5, NB-9, NB-16 and NB-17) at 
the time of harvest using HPLC.

Sensory score of squashes, prepared by 
blending litchi and grape (Pusa Navrang) 
separately in 3:1 and 1:1 ratio each, after 6 months 
of storage indicated higher preferences for 1:1 
blend than for 3:1 blend in both aonla-litchi and 
aonla-grape squashes. Probiotic drinks, prepared 
from aonla and sugarcane, had 4.2 and 17.4 °B 
TSS, 0.94 and 2.05 per cent acidity, 28.2 and 14.3 
mg 100/ml ascorbic acid, and 558 and 215 mg 100/
ml total phenolics, respectively.

The Lactobacillus loads of probiotic drink, 
puree (control) and puree (sweet), prepared from 
banana, were 8.21 x 10⁵, 2.36 x 10⁶ and 4.25 x 10⁶ 
CFU/ml, respectively, at 0 day. Storage analysis 
up to 4 weeks depicted a decrease in ascorbic acid 
and total phenolics and increase in reducing 
sugars. The nisin content of banana probiotic drink 
was 0.166 mg/ml after 4 weeks of storage with 
zero microbial load. The Lactobacillus load was 5.75 
x 10⁶ and 2.92 x 10⁶ CFU/ml in drink and pickle, 
respectively, prepared from purple mulberry 
(variety MI-497) through lactic acid fermentation 
at 37 °C for 2 days. The drink had 3.8 °B TSS, 0.72 
per cent acidity, 1.2 mg 100/ml ascorbic acid and 
9.1 mg 100/ml anthocyanins. The corresponding 
values for pickle were 4.5 °B, 0.63 per cent, 11.9 
mg 100/ml and 208 mg 100/ml, respectively.

Dehydrated jamun fruits, subjected to lactic 
acid fermentation at 37 °C for 2 days, were 
separated from liquid part after proper 
development of acidity and utilized for 
preparation of oil and sweet pickle after mixing 
with spices/sugar and vinegar. Oil and sweet 
pickle had 20.0 and 18.5 °B TSS, 0.40 and 3.0 per 
cent acidity, 23.8 and 17.8 mg 100/ml ascorbic acid, 
respectively. The microbial load was found to be 
nil in both the pickles. RTS prepared from jamun 
and aonla juices in 9:1 ratio was found the best on 
sensory score (8.72), followed by blend in the ratio 
of 8.2 (8.3). After 6 months of storage, the drink 
contained 16 °B TSS, 0.3 per cent acidity as citric 
acid, 9.2 mg 100/ml ascorbic acid, 6.2 per cent 
reducing sugar, 21.6 mM/ml antioxidants and 1.9 
mg 100 ml⁻¹ anthocyanin. The aonla and jamun 
based tea formulation contained 2.38 mg 100/ml 
ascorbic acid and 11.90 mM/ml antioxidants.

**Market analysis and export**

A total of 81.12 thousand MT of mangoes 
were disposed off from Lucknow during 2014, 
out of which 61.85 per cent was traded in the 
markets outside Uttar Pradesh and Delhi 
accounted for 19.80 per cent. The study on weekly 
disposal patterns indicated that highest disposal 
of 24.23 per cent was during June 20 to 26, 2014 as 
against 17.86 per cent during 2013.

The total arrival of mango during 2014 season 
in Lucknow market was 85.75 thousand MT. Highest arrival (70.40%) was recorded in
Lucknow market during June followed by July (25.53%). Its price was highest (Rs. 1600 per q) in May followed by June (Rs. 1425) and July (Rs. 1396). The average weighted price during the entire mango season was Rs. 1425 per q, which was highest between 2004-2014 period. Cultivar Dashehari was traded in 19 markets of the country as against Banganpalli in 21, Langra in 16, Chausa in 11 and Totapuri in 16. Delhi accounted for 77.9 per cent of total Dashehari trading during 2014 followed by Lucknow (4.1), Jaipur (3.2), Srinagar (2.5) and Nagpur (2.2). Average wholesale price during the season was highest in Srinagar (Rs. 3,314 per quintal) followed by Delhi (Rs. 2,783), Nagpur (Rs. 2,771), Lucknow (Rs. 2,196) and Jaipur (Rs. 1,945). Highest price for Dashehari was found at Chennai market (Rs. 6,565) followed by Delhi (Rs. 5,380) and Mumbai (Rs. 4,906) markets.

Cultivar Langra was also traded extensively in Delhi (78.5%) followed by Kolkata (8.1%) and Patna (7.4%). The weighted average seasonal price in Kolkata and Patna markets was Rs. 3,573 and 3,669 per quintal, respectively, as against Rs. 2,803 per quintal in Delhi market. The highest average weighted seasonal price per quintal was in Chennai (Rs. 6,781) followed by Gangtok (Rs. 6,203), Guwahati (Rs. 4,525) and Bhubaneswar (Rs. 3,925) markets.

Chausa was the least traded at 124.38 thousand MT, out of which Delhi’s share was 80.0 per cent followed by Mumbai (13.1%), Kolkata (2.9%) and Chandigarh (1.3%). The weighted seasonal average price of the cultivar over all the markets was Rs. 4,362 per quintal, which was highest over all the major cultivars traded throughout the country. Highest weighted average seasonal price of Rs. 8,035 per quintal for the trading of 0.09 thousand MT was worked out for Bhubaneswar.

The share of Delhi, Nagpur, Jaipur, Bengaluru, Hyderabad, Kolkata and Chennai in the total trading of Banganpalli was 63.8, 8.0, 5.3, 5.3, 5.0, 2.5 and 2.5 per cent, respectively. The highest weighted average seasonal price was worked out for Shimla Rs. 3,991 per quintal, followed by Raipur (Rs. 3,943) and the lowest in Hyderabad (Rs. 1,962). Totapuri was traded in 16 markets around the country. Delhi accounted for 84.8 per cent of the total trading. The highest weighted average seasonal price of Rs. 4,487 per quintal was worked out in Guwahati followed by Hyderabad (Rs. 3,300) and the lowest in Nagpur (Rs. 1,200). Alphonso has become the largest traded cultivar (355.17 thousand MT during 2014) in only six markets of the country. It had largest market share (46.8%) in Bengaluru followed by Delhi (33.1%) and Mumbai (17%). However, highest price of the cultivar (Rs. 20,649) was realized in Ahmedabad.

The export of fresh mango fruits to 53 countries during 2013-14 was 37.30 thousand MT, depicting a sharp decline of 33 per cent over the previous year. However, the value of the fruits attained all time high of Rs. 285.43 crores. The decline could mainly be attributed to the reduction in the exports to UAE (39%) and Bangladesh (38%). Value of exports to U.K. increased by 39.8 per cent. In case of quantity of mango exports, modified exponential function provided the best fit with a R² value of 0.735. The modified exponential function provided the best fit for value of mango exports with R² of 0.946.

India exported 229.51 thousand MT of mango products worth Rs. 1,418.85 crores during 2013-14. Pulp and jam were the major mango products with a share of 62.22 and 32.32 per cent in quantity and 54.48 and 39.17 per cent in value terms, respectively. Jam was mainly exported to Netherlands (28%) and Saudi Arabia (13%). Mango pulp was exported to 83 countries during 2013-14. Saudi Arabia continued to be the highest importer of mango pulp from India (31.08%) followed by Yemen (14.68 %) and Netherlands (9.96%). The modified exponential function for the growth pattern in mango pulp export provided the best fit with a R² value of 0.870.

The import of mango and its products was highest (2922.05 MT worth Rs. 788.71 lakh) during 2009-10. It closed at 482.43 MT worth Rs. 296.99 during 2013-14 indicated an overall drop of 83 per cent in quantity and 62 per cent in value. India imported 7.52 MT of mangoes worth Rs. 20.49 lakhs mainly from Bangladesh (82%) during 2013-14. 312.93 MT of juice worth Rs. 22.88 crores was imported mainly from Sri Lanka (29%), Bangladesh (22%), Bhutan (20%) and UAE (18%). Mango jam (127.44 MT worth Rs. 56.02 lakhs) was imported mostly from Bangladesh (48%) and U.K. (26%). The pulp was exclusively imported from China. The squash was imported mainly from
Netherlands (42%), USA (25%) and New Zealand (20%).

The total arrival of guava in Lucknow market during 2014-15 was 3.08 thousand MT as against 3.00 thousand MT during the previous year. December 2014 accounted for 29.49 per cent of total arrivals followed by January 2015 (22.72%) and November 2014 (15.66%). The maximum price of guava (Rs. 800 per quintal) was realized during October 2014 followed by November 2014 (Rs. 630 per quintal), December 2014 (Rs. 500) and January 2015 (Rs. 505). The weighted annual average price was Rs. 547 per quintal. Guava was mainly traded in 14 markets of the country. Total trading of guava in major markets of the country was 54.84 thousand MT. Delhi was the single largest market in the country for guava as it traded 34.71 per cent of the total trading followed by Kolkata (19.21%), Mumbai (7.42%), Hyderabad (8.77%) and Bhopal (6.09%). The trading of guava was highest during January 2015 (22.97%) followed by December 2014 (17.62%) and February 2015 (14.52%). The weighted average annual price was highest in Bengaluru market (Rs. 5,541 per quintal) followed by Ahmedabad (Rs. 4000), Bhubaneswar (Rs. 3,294), Raipur (Rs. 3,160) and Kolkata (Rs. 3,148) markets. Least price was realized in Jaipur market (Rs. 1,912).

The export of guava was mainly concentrated in Middle East. The export of guava has steadily been declining after attaining the peak (1381.91 MT) during 2011-12 and closed at 969.87 MT depicting a decline of 30 per cent. On the contrary, the value of the export has increased from Rs. 3.176 to 4.15 crores during 2011-12 to 2013-14. Sudan accounted for 25 per cent of the total quantity and 33 per cent of total value of the fruit exported during 2013-14, followed by Yemen (19%) and Saudi Arabia (18%). UAE and Oman were other importing countries.

India exported a total of 4210.01 MT of guava products worth Rs. 20.78 crores during 2014-15. Jelly was the most exported guava product (3487.48 MT worth Rs. 18.10 crores). RTS was another item exported form the country. Netherlands and Indonesia were the major importers of guava jelly by accounting for 28 and 27 per cent, respectively. RTS was mainly exported to Tanzania and Sudan.

Transfer of technology

Besides, the targeted research in the area of crop improvement, crop production, crop protection and post-harvest management, transfer of technology related steps were taken in the mandated crops. The Institute organized different theme oriented programmes, wherein more than 2500 farmers/students/trainers were sensitized. The Institute also organized trainings sponsored by ATMA. Farmers and state government officials, bankers, students and women (1413) during the period visited the Institute. The Institute also participated in several state and national level events and addressed the problems of the farmers through improved crop production technology capsules. Technology showcasing through demonstrations, scientists-farmers interaction, exposure visits for the benefit of farmers, extension workers/students counseling, postal queries, farmers helplines call, training programmes and TV talks was undertaken.

Meetings

The Nineteenth Research Advisory Committee (RAC) Meeting of ICAR-Central Institute for Subtropical Horticulture(CISH), Lucknow was held under the Chairmanship of Dr. K.E. Lawande, Vice Chancellor, Dr. Balasaheb Konkan Krishi Vidyapeeth, Dapoli, District Ratnagari, Maharashtra from 26 to 27 June, 2014 at Rehmankhera, Lucknow.

The 35th Institute Research Committee (IRC) meeting of ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow was held on 13 and 15 January, 9 and 10 April, 23 April, 12 May, 2 to 4 June, 7 June, and 10 to 12 June, 2014.

The 36th Institute Research Committee (IRC) meeting of ICAR-Central Institute for Subtropical Horticulture(CISH), Lucknow was held on January 15, 20-24, February 2-7 and 9, 2015, especially with reference to reorientation of on-
going in-house projects under the Chairmanship of Dr. S. Rajan, Director, CISH.

**Awards and Recognitions**

Scientists of the Institute received awards and recognitions from different scientific/development agencies and societies. Director/Scientists of the Institute acted as Chairman, Co-Chairman, Rappoteur and members in organizing committees of different seminars/symposia/conferences/workshops/meetings.

**Linkages and Collaborations**

The Institute has in place MOUs with different National and International organizations such as DCCNCPAH, Ministry of Agriculture, DBT, DST, NMPB, PPV&FRA, UPCST, UPCAR, AMAAS, NICRA. The Institute also has MOUs to facilitate capacity building initiatives with Amity University, Lucknow; Lucknow University, Lucknow; Dr. Babasaheb Bhimrao Ambedkar University, Lucknow; Integral University, Lucknow; Deemed to be University, Sam Higginbotham Institute of Agriculture, Technology and Science, Allahabad; SVPUA&T, Meerut and Bundelkhand University, Jhansi for pursuing B.Tech., M.Sc. and Ph.D. degrees of students.

**PFDC**

PFDC was established through National Committee on Plasticulture Application in Horticulture (NCPAH) at the Institute during 2001-2002 and was continuing activity during the year. The main activities of the centre include technology development and refinement in hi-tech horticulture, technology dissemination and validation, microirrigation, plastic mulching, greenhouse technology, publication of scientific literature and organizing workshop/seminar and trainings for state officials and farmers. PFDC organised 05 training programmes in different districts of Uttar Pradesh on drip irrigation, polyethylene, mulching and protected cultivation of vegetables wherein 300 farmers and government officials participated.

**Other activities**

The Institute organized National Seminar-Workshop on “Physiology of Flowering in Perennial Fruit Crops” in association with Society for Development of Subtropical Horticulture (SDSH) in partnership with ICAR-Central Institute for Subtropical Horticulture, Lucknow at the Rehmankhera Campus during May 24-26, 2014. The Institute also organized a two-day Seminar-cum-Mango Diversity Fair and Kisan Gosthi at ICAR-Indian Institute for Sugarcane Research, Lucknow on 28 and 29 June, 2014. The theme of the programme was value chain management of mango for enhanced profitability to growers and ensuring quality mangoes to the consumers benefitting all the stakeholders of the mango production to consumption chain. The ICAR-CISH, Lucknow also conducted an ICAR sponsored Winter School on ‘Recent trends in value addition of subtropical fruits for nutritional security and secondary agriculture’ from November 5-25, 2014 at the Division of Post Harvest Management for the researchers, teachers and extension specialists already acquainted with post harvest management of fruits or relevant disciplines of SAUs, ICAR institutes and other public organizations and aimed at upgrading their knowledge and skills.

The Institute organized Hindi activities including Chetna Mass from September 15 to October 13, 2014. During the Chetna Mass several competitions were organized to enhance the use of Hindi in office. A three-day training programme on “Nursery, pre and post harvest management of subtropical fruits for enhanced productivity and profitability” was organized under Tribal Sub Plan of Government of India by Dr S. K. Shukla, Coordinator (TSP) and Principal Scientist (Horticulture) along with a team of resource persons from ICAR-CISH, Lucknow and KVK, Banswara for fifty farmers of tribal belts of Banswara and Dungarpur area during February 10 to 12, 2015.

**Revenue generation**

A total of rupees 55.42 lakhs was generated by the Institute during the financial year 2014-15.
INTRODUCTION

The Institute

The ICAR-Central Institute for Subtropical Horticulture (CISH) was started as Central Mango Research Station on September 4, 1972 under the aegis of the Indian Institute of Horticultural Research, Bengaluru. The Research Station was subsequently upgraded to a full-fledged Institute as Central Institute of Horticulture for Northern Plains on June 1, 1984. The Institute was later renamed as Central Institute for Subtropical Horticulture on June 14, 1995. It is serving the nation on different aspects of research and development on mandated subtropical fruit crops and associated cropping systems aimed at developing integrated farming systems. The Institute has two experimental farms located one at Rehmankhera, approximately 25 km away from the city and another at Raebareli (R.B.) Road right in the city of Lucknow. The experimental farm at Rehmankhera has an area of 132.5 ha comprising of 4 blocks (block I - 15.5 ha, block II - 35.5 ha, block III - 37.42 ha & block IV - 44.08 ha), while the R.B. Road campus has an area of 13.2 ha. The Institute was shifted to its present laboratory-cum-administrative building at block-II at Rehmankhera during May, 1999.

The Institute has modern nursery facilities, well established experimental orchards and equipped laboratories to meet the emerging challenges in the niche areas of research on subtropical fruit crops. The well established modern scientific nursery unit of the Institute is producing quality planting materials of mango, guava, aonla and bael with traceability incorporated for supply of core/genuine planting materials to the farming communities and backstopping of Krishi Vigyan Kendras for establishing mother blocks. Simultaneously, concerted endeavors for human resource development through capacity building are also put in place.

Recognizing the importance of capacity building and in harmony with ICAR focus ‘Student Ready’, the Institute has in place MOUs with Integral University, Lucknow, Deemed to be University, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad, Dr. Babasaheb Bhimrao Ambedkar University, Lucknow, Bundelkhand University, Jhansi and Lucknow University, Lucknow for pursuing research at the Institute leading to the award of M.Sc. and Ph.D. degrees to their students. The Institute has also been recognized by IGNOU, New Delhi as one of its study centers for offering one year Diploma Course on Value Added Products from Fruits and Vegetables and a Certificate Course on Organic Farming. The National Horticulture Mission has also identified the Institute as a nodal centre for imparting training on rejuvenation of old and unproductive mango orchards and high density planting system in guava. The Institute also renders other quality services to the growers, viz., responding to queries on orchard related problems through Kisan Call Centre No. 1800-180-1551 and 09415751200 each day from 10.00 am to 5.00 pm and phone-in-live programme (0522-2841082) every Friday (from 10.30 am to 4.00 pm), site-specific diagnostic services of soil and nutrient constraints, pests and diseases problems, on-farm visits, production and supply of bio-control agents, hand holding of KVKs and other agriculture / horticulture universities including the one in Nagaland and taking care of other multi-stakeholders. The Institute continues to be an active partner with the National Horticulture Mission and National Horticulture Board units for its outreach activities of promoting integrated development of horticulture.

Vision

Augment the share of agriculture sector in general and horticulture in particular in the GDP of the country and its export basket.

Mission

Conduct basic and strategic research to develop cost effective and viable technologies for production of subtropical fruit culture as a component of integrated farming strategy.

Mandate

- Undertake basic and strategic research to enhance productivity and develop value chain for major and minor subtropical fruits.
- Act as national repository of mango and guava.
- Act as a centre for human resource
development and provide consultancy to the stakeholders.

Objectives

- Management of genetic resources of mandate fruit crops.
- Crop improvement through breeding and genetic engineering.
- Enhancing productivity through improving quality of planting materials using modern propagation techniques and rootstocks, good horticultural practices, including mechanization and management of biotic and abiotic stresses.
- Reduction in post harvest losses and enhance profitability through integrated pre- and post-harvest management practices, value addition and product diversification.
- Human resource development, transfer of technology, capacity building and evaluation of its socio-economic impact.

Significant Achievements

Crop improvement and biotechnology

- The Institute is conserving the world’s largest germplasm collection of mango numbering 762 accessions, collected from different indigenous and exotic sources, used in the mango improvement programme.
- A regular bearing mango hybrid CISH-M-1 (Amrapali x Janardhan Pasand) released as ‘Ambika’ has been advanced for multi-location testing through AICRP (STF) network and at progressive farmers’ fields for assessing its performance. The fruits of this variety have yellow color with red blush, firm pulp and scanty fibers and late maturing. It has good potential for domestic and export markets.
- Another regular bearing mango hybrid H-39 (Amrapali x Vanraj) having yellow peel color with red blush, firm pulp and high TSS (24 °B) and carotenoids content released as ‘Arunika’ has also been advanced to multi-location testing through AICRP (STF) network and progressive farmers’ fields for assessing its performance.
- Mango hybrid H-1084 was found promising, which is presently under evaluation.
- Mango cv. Elaichi, continued to manifest freedom from floral malformation, is being used in trait specific breeding programme.
- Molecular characterization of 200 mango cultivars/accessions/heirloom varieties of mango have been completed.
- One hundred and thirty five accessions of guava and seven Psidium spp. are conserved in the field genebank.
- Two open pollinated seedling selections of colored guava, CISH-G-3 and CISH-G-4, released as ‘Lalit’ and ‘Shweta’ for commercial cultivation are being mass-propagated. Shweta, especially has found favor with the Punjab and Haryana growers and is becoming popular there. Fruits of Shweta have attractive pink blush, white pulp, few soft seeds, high TSS (14 °B) and good yield potential. Fruits of Lalit are attractive, saffron yellow with red blush, medium size and firm with pink pulp. It has 24 per cent higher yield than the popular Allahabad Safeda.
- Wilt resistant hybrid rootstock of guava (P. molle x P. guajava L.) developed by the Institute earlier was advanced for field evaluation by grafting on commercial scions in wilt endemic areas / multi-location testing through AICRP (STF) network and KVKs.
- Institute has 36 accessions of bael conserved in the field genebank. Two promising selections, CISH-B-1 and CISH-B-2 having good table and processing qualities are being popularized through multiplication and supply of quality planting materials to the growers.
- The Institute continued to conserve germplasm accessions in the FGB of litchi (35) and underutilized fruits representing aonla (22), karonda (20), jamun (40), kharnee (10), tamarind (10), mahua (12), wood apple (12), mulberry (10), custard apple (8), carambola (2), lasora (3), and rose apple (2). During the period, 20 accessions of strawberry were introduced from ICAR-IIHR, Bengaluru for evaluation under Lucknow conditions.

Crop production

- The propagation techniques under polyhouse conditions for some underutilized fruits like jamun, karonda, kharnee were optimized.
- Medium density planting system (400 plants/ha) in Dashehari mango led to three fold increase in the yields (15-18 tonnes/ha) over
conventional planting (100 plants/ha) having average yield of 6 tonnes/ha.

- Crown thinning in mango resulted in higher yields (80 kg/plant) in Mallika in the following year as compared to 55 kg in control.

- Rejuvenation techniques for old and unproductive mango and guava trees continued to be demonstrated in farmers’ fields. During the year, the technique was demonstrated to about 200 farmers of north Bihar in partnership with KVK, RAU, Pusa.

- Soil application of paclobutrazol @ 4 g/tree (3.2 ml/m canopy diameter) was found to manage the problem of irregular bearing in mango cv. Dashehari resulting in increased flowering and fruiting during the expected ‘Off’ year. Mulching along with application of paclobutrazol (1.6 ml/m canopy diameter) was found effective in improving yields.

- Soil application of one kg each of N, P and K/tree/year to 10 year old Dashehari mango trees increased the yields. Trench application of fertilizers around the tree in July was found efficient in nutrient use.

- Techniques for high density planting system and canopy management in guava were popularized.

Crop protection

- IPM modules for mango insect pests and diseases have been developed and standardized. Entomogenous fungus, *Verticillium lecanii*, egg parasites, *Agrostocetus* spp., *Gomatocerus* sp. and *Polyneima* sp., and predators, *Chrysopa lacciperda*, *Mallada boninensis* and *Coccinella septumpunctata* were found potential bio-control agents against mango hoppers.

- Critical limits of weather parameters (temperature and relative humidity) for forecasting the epidemics of mango hoppers and powdery mildew were profiled.

- Mango bacterial canker disease (MBCD) could be checked by targeted spray of streptomycin (200 ppm) at 10 days intervals. Antagonists *Bacillus coagulans*, *Pseudomonas* spp. and *Acenetobacter* spp. continued to be potent bio-control agents against MBCD pathogen.

- Post-harvest diseases of mango, *viz.*, anthracnose and stem end rot could be controlled by dipping of the fruits in hot water (52±2°C) for 15 minutes.

- Though *Gliocladium roseum* was found frequently associated with guava wilt disease, *Fusarium oxysporum* f. sp. *psidii* was more potent in inciting the epidemics. Association of nematodes was frequently found with wilt problems in Badaun and Lakhimpur Kheri, which is being critically investigated.

- Aspergillus niger (AN 17) and *Trichoderma harzianum* are being regularly used in the Institute’s nursery for substrate fortification.

- Four endophytic bacteria and lac based compounds were found effective against root knot nematode, whereas the potency of entomopathogenic nematode has been demonstrated against insect pests under *in vitro* conditions.

- A multiplex PCR with four sets of primers for *Colletotrichum gloeosporioides* was optimized.

Post-harvest management

- Maturity indices for commercial mango cvs Dashehari, Langra, Mallika, Amrapali and Chausa were optimized.

- Low cost mango, guava and bael harvesters have been fabricated and the mango harvester developed earlier by the Institute was revisited, refined and parameterized.

- A low cost foldable ripening chamber has been designed and developed.

- Three temperature gradients for storage, *viz.* 12, 15 and 10°C, were worked out to enhance the shelf life of Dashehari, Langra and Chausa fruits up to 3, 2 and 3 weeks, respectively.

- Uniform ripening of mangoes could be achieved by dipping of the fruits in 250 - 750 ppm ethrel in hot water (52 ± 2°C) for 5 minutes depending upon maturity.

- Pre-harvest sprays of calcium chloride dihydrate (2%) at 10 days interval were found effective to reduce the jelly seed formation in mango.

- Corrugated fiber board (CFB) boxes of 2 and 4 kg capacities were fabricated and found to be effective for packaging and transport of mango and guava fruits.

- Guava fruits cv. Allahabad Safeda could be stored for 28 days at 5 °C in 0.25 per cent ventilated LDPE bags.
Methodologies for preparation of raw mango squash (panna) and instant mango panna powder have been optimized, demonstrated and popularized.

Protocols for freeze drying of mango and aonla slices, osmo-freeze drying of mango slices and spray drying of aonla juice were developed.

Recipe for oil-less mango pickle and sweet papaya chutney with shelf life of nine months were developed and popularized.

The techniques for preparation of sweetened and brined (salted) aonla segments were optimized.

Protocols for the preparation of mahua (Bassi latifolia), mango and mulberry wine were developed.

Mango peel could be utilized for the production of compost, fibre, pectin, vinegar and pectinase and cellulase enzymes.

Residues of different insecticides and fungicides, used at various stages of mango development, were analysed and waiting periods for safe consumption of fruits were suggested.

Ahemedabad, Chennai, Gangtok and Guwahati were identified as alternative potential markets for Dashehari mangoes.

Transfer of technology

The Institute organized twenty-two sponsored training programmes on different aspects of crop production, crop protection and post harvest technologies. Under the precision farming development centre of ICAR-CISH, training were given on drip irrigation, polyethylene mulching and protected cultivation of vegetables in different districts of Uttar Pradesh. Exposure visits of farmers, students and officials from different parts of the country were organized for creating awareness about the technologies developed by the Institute. A scientific nursery programme, with traceability issue integrated is being pursued and target groups were sensitized about different aspects of quality planting material production. Institute organized various gothies and participated in State and National level events to disseminate the technologies developed. Field demonstrations, counseling, postal queries, phone-in-live and TV/Radio talks were also undertaken. The Institute's technologies were showcased by scientists at various demonstrations, displays and exhibitions.

AKMU (Agriculture Knowledge Management Unit)

The Institute has a well developed Agriculture Knowledge Management Unit (AKMU) cell. The Institute website (www.cish.res.in) was periodically updated and consolidated to provide contextual information about its farmer-friendly activities and information to the public. The website contains detailed information on its organization set-up, cadre, staff, pay scales, immovable property, status of employees, ongoing research projects, achievements made, facilities available, package of practices developed for nursery management and higher productivity, technologies perfected, mango germplasm characterization and documentation, services offered, tenders, tender-cum-auction of crops, etc. Besides general information, it also contains media resource section wherein ICAR-CISH technologies, farmers’ advisories and alerts, videos of mango technologies and press releases are uploaded for the use of media persons and farmers / entrepreneurs / students / other stakeholders. The website is visited by people both nationally as well as internationally, queries being received are responded accordingly. The FMS-IMS sysem has become operational at the Institute. The Institute has also 100 mbps connectivity through NKN.

Library

The institute has a well established library which caters to the requirements of scientists, research workers and students of M.Sc., Ph.D. programmes registered from different universities. It is well equipped with books, periodicals, reports, reprints and CD-ROMs pertaining to different aspects of horticulture crops along with computer, internet and reprographic facilities. The facilities of database search has been provided through CABI Horticulture Abstracts (online) and AGRIS and has been automated through LSEASE software of LIBSYS. The existing collection (3734) of scientific and technical books was further enriched by the addition of 127 books during the period (2014-15) under report. At present, Institute’s library subscribes 35 journals, out of which 9 are international journals available.
in print form + online (IP basis) and 26 are Indian journals available in print form. As the Institute is accessing various journals through CeRA platform, 27 national and 21 international journals were discontinued for subscription to avoid duplication of resources. More than 200 Annual Reports and other magazines are being received from ICAR Institutes, State Agricultural Universities and International Institutes on exchange information basis. A good connectivity for accessing CeRA, one new platform j-gate is introduced recently. The library has also attended to send various reprints as per requests of various scientists from different SAUs, DAUs and ICAR institutes through CeRA platform.

Organizational Set-up

The Institute’s functioning is organized through three Divisions, viz. Crop Improvement and Biotechnology, Crop Protection and Post Harvest Management. A proposal for creation of Division of Crop Production is under the consideration of the Council. Precision Farming Development Centre (PFDC) is also located at this Institute for promoting aspects of hi-tech horticulture. Besides, focusing on thematic research areas, interdisciplinary/inter Institute collaboration team approaches are being harmonized for optimizing outputs. The organizational set-up of the Institute is as below.
### Financial Set-up


<table>
<thead>
<tr>
<th>S.N.</th>
<th>Name of the Head Capital</th>
<th>NON PLAN</th>
<th>PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Works</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(A) Land</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(B) Building</td>
<td>0.00</td>
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</tr>
<tr>
<td></td>
<td>i. Office building</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>ii. Residential Building</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>iii. Minor Works</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>Equipments*</td>
<td>5.00</td>
<td>4.90</td>
</tr>
<tr>
<td>3</td>
<td>Information Technology</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>Library Books and Journals</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>Vehicles &amp; Vessels</td>
<td>5.00</td>
<td>0.00</td>
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<tr>
<td>6</td>
<td>Livestock</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>7</td>
<td>Furniture &amp; Fixture</td>
<td>5.00</td>
<td>4.98</td>
</tr>
<tr>
<td>8</td>
<td>Others</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>A</td>
<td>Total Capital Expenditure</td>
<td>15.00</td>
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<td></td>
<td>Grant-in Aid Salaries(REVENUE)</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Establishment Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(A) Salaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Establishment Charges</td>
<td>1251.00</td>
<td>1236.75</td>
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<td></td>
<td>ii. Wages</td>
<td>45.00</td>
<td>44.04</td>
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<td>iii. Overtime Allowance</td>
<td>0.15</td>
<td>0.07</td>
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<tr>
<td></td>
<td>(B) Loans &amp; Advances</td>
<td>0.30</td>
<td>0.30</td>
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<tr>
<td></td>
<td>Total Establishment Expenses</td>
<td>1296.45</td>
<td>1281.16</td>
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<tr>
<td></td>
<td>Grant-in Aid General(REVENUE)</td>
<td></td>
<td></td>
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<td></td>
<td>Pension &amp; Retirement Benefits</td>
<td>315.00</td>
<td>303.17</td>
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<tr>
<td>2</td>
<td>Traveling Allowance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(A) Domestic TA/Transfer TA</td>
<td>8.00</td>
<td>7.98</td>
</tr>
<tr>
<td></td>
<td>(B) Foreign TA</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Total-Traveling Allowance</td>
<td>8.00</td>
<td>7.98</td>
</tr>
<tr>
<td>3</td>
<td>Research &amp; Operational Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(A) Research Expenses</td>
<td>18.00</td>
<td>17.98</td>
</tr>
<tr>
<td></td>
<td>(B) Operational Expenses</td>
<td>12.00</td>
<td>11.98</td>
</tr>
<tr>
<td></td>
<td>Total Res. &amp; Operational Exp.</td>
<td>30.00</td>
<td>29.96</td>
</tr>
<tr>
<td>4</td>
<td>Administrative Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(A) Infrastructure</td>
<td>35.00</td>
<td>34.98</td>
</tr>
<tr>
<td></td>
<td>(B) Communication</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>(C) Repairs &amp; Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Equipments, Vehicles &amp; Others</td>
<td>15.00</td>
<td>14.98</td>
</tr>
<tr>
<td></td>
<td>ii. Office building</td>
<td>14.94</td>
<td>14.52</td>
</tr>
<tr>
<td></td>
<td>iii. Residential Building</td>
<td>0.76</td>
<td>0.75</td>
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<td></td>
<td>iv. Minor Works</td>
<td>4.30</td>
<td>4.27</td>
</tr>
<tr>
<td></td>
<td>(D) others (excluding TA)</td>
<td>25.00</td>
<td>23.83</td>
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<td></td>
<td>Total-Administrative Expenses</td>
<td>97.00</td>
<td>95.33</td>
</tr>
<tr>
<td>5</td>
<td>Miscellaneous Expenses</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>A. HRD</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>B. Other items (Fellowships, Scholarships etc.</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>C. Publicity &amp; exhibitions</td>
<td>2.00</td>
<td>1.94</td>
</tr>
<tr>
<td></td>
<td>D. Guest House-maintenance</td>
<td>5.00</td>
<td>4.10</td>
</tr>
<tr>
<td></td>
<td>E. Other Miscellaneous</td>
<td>1.85</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>Total -Miscellaneous Expenses</td>
<td>8.85</td>
<td>7.47</td>
</tr>
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</table>
**Revenue Receipts (2014-15)**

<table>
<thead>
<tr>
<th>Head</th>
<th>Target</th>
<th>Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Produce</td>
<td>31.90</td>
<td></td>
</tr>
<tr>
<td>Sale of product</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Sale of publication</td>
<td>0.56</td>
<td></td>
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<tr>
<td>Guest House charges / License fees</td>
<td>3.79</td>
<td></td>
</tr>
<tr>
<td>Training/consultancy</td>
<td>1.51</td>
<td></td>
</tr>
<tr>
<td>Electric &amp; Water charges</td>
<td>2.79</td>
<td></td>
</tr>
<tr>
<td>Transport charges</td>
<td>5.05</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>9.52</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>65.60</td>
<td>55.42</td>
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</table>

**Staff Position (as on 31.03.2015)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Sanctioned</th>
<th>Filled</th>
<th>Vacant</th>
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<tbody>
<tr>
<td>RMP</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Scientific</td>
<td>48</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>Technical</td>
<td>48</td>
<td>33</td>
<td>15</td>
</tr>
<tr>
<td>Administrative</td>
<td>24</td>
<td>18</td>
<td>06</td>
</tr>
<tr>
<td>Skilled Supporting Staff</td>
<td>44</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
<td>124</td>
<td>41</td>
</tr>
</tbody>
</table>

**Staff Changes**

**Promotion**

**Technical**

1. Shri Vijay Kumar Verma, Sr. Technician (T-2) granted one advance increment (on ad-hoc basis) w.e.f. 29.06.2011.
2. Shri Virendra Pratap Singh, Sr. Technician (T-2) granted merit promotion to the post of Technical Assistant (on ad-hoc basis) (T-3) w.e.f. 29.06.2011.
3. Shri Vijay Kumar, Sr. Technician (T-2) granted merit promotion to the post of Technical Assistant (T-3) w.e.f. 29.06.2012.
4. Shri Arvind Kumar, Technical Officer (T-5) granted merit promotion to the post of Sr. Technical Officer (T-6) w.e.f. 26.12.2012.
5. Shri Balak Ram, Technical Assistant (T-3) granted merit promotion to the post of Sr. Technical Assistant (T-4) w.e.f. 15.03.2013.
6. Dr. Raghuvir Singh, Shri Abhay Dikshit and Shri Sanjay Kumar, Assistant Chief Technical Officer granted merit promotion to the post of Chief Technical Officer w.e.f. 01.07.2013, 01.01.2014 and 01.07.2014, respectively.
7. Shri Radhey Lal, Technician (T-1) granted merit promotion to the post of Sr. Technician (T-2) w.e.f. 03.12.2013.
8. Shri Mishri Lal, Technician (T-1) granted merit promotion to the post of Sr. Technician (T-2) w.e.f. 04.12.2013.
9. Smt. Priti Sharma, Technical Officer (T-5) granted merit promotion to the post of Sr. Technical Officer (T-6) w.e.f. 30.06.2014.
10. Shri Virendra Kumar Yadav, Sr. Technician (T-2) granted merit promotion to the post of Technical Assistant (T-3) w.e.f. 03.08.2014.

**Administrative**

1. Shri G.P. Mishra, Presonal Assistant to Private Secretary on 19.01.2014.
2. Shri Ram Prakash, Jr. Clerk granted IIIrd MACP w.e.f. 01.09.2008.
3. Shri B.C. Lohani, Sr. Clerk granted IIIrd MACP w.e.f. 27.09.2014 up to 30.11.2014.

**Joining**

**Scientific**

1. Ms. Veena G.L, joined as Scientist (Fruit Science) w.e.f. 09.04.2014.
2. Sh. Murlidhara B.M. joined as Scientist (Fruit Science) w.e.f. 09.04.2014.
3. Dr. Kanchan Kumar Srivastava joined as Sr. Scientist (Fruit Science) w.e.f. 12.08.2014.
4. Dr. Israr Ahmed joined as Scientist (Biotechnology) w.e.f. 12.08.2014.
5. Ms. Antara Das joined as Scientist (Biotechnology) w.e.f. 13.10.2014.
6. Dr. Swati Sharma, joined as Scientist (Fruit Science) w.e.f. 13.10.2014.
7. Dr. Shyam Raj Singh joined as Sr. Scientist (Horticulture) w.e.f. 4.12.2014.
8. Dr. Shailedra Rajan, Head Crop Improvement & Biotechnology took over the charge of Acting Director w.e.f. 23.09.2014 (A.N.).

9. Shri Pawan Singh Gurjar joined as Scientist (Fruit Science) w.e.f. 16.03.2015.

10. Dr. Ghanshyam Pandey, Pr. Scientist took over the charge of Head (Incharge) of Crop Production, w.e.f. 10.11.2014.

Administrative
1. Shri Ashish Srivastava joined as Finance and Accounts Officer w.e.f. 21.07.2014.

Probation
1. Dr. H. Kesava Kumar, Scientist (Nematology) probation period was cleared on 01.09.2012.
2. Mr. M. Balaji Rajkumar, Scientist (Entomology) probation period was cleared on 29.01.2014.

Administrative
1. Shri Rahul Bhatt, Assistant probation period was cleared on 07.06.2014.

Transfer
Scientific
1. Dr. Sridhar Gutam, Sr. Scientist (Pl. Physiology) was transferred to ICAR Complex, Patna w.e.f. 05.05.2014 (A.N.).
2. Dr. Swati Sharma, Scientist (Fruit Science) transferred to ICAR-NRC Litchi, Muzaffarpur, Bihar w.e.f. 28.02.2015 (A.N.).
3. Dr. H. Ravishankar, Director, ICAR-CISH after completing his tenure on 23.09.2014 was relieved for ICAR-IIHR, Bengaluru for the post of Principal Scientist.

Administrative
1. Shri G.D. Amola, Finance & Accounts Officer was transferred to ICAR-IVRI, Bareilly and relieved from this Institute on 22.07.2014.
2. Shri Firoz Khan, SAO transferred to ICAR-IARI, New Delhi and relieved from this Institute on 03.09.2014.

Superannuation

Technical
1. Shri C.P. Dwivedi, Sr. Technical Officer (T-6) (LT) superannuated on 30.06.2014.
2. Shri Mashaooq Ali, Technical Officer (T-5) (Carpenter) superannuated on 30.08.2014.
3. Shri Balak Ram, Technical Assistant (T-3) (LT) superannuated on 30.08.2014.
4. Shri B.P. Shukla, Senior Technical Officer (T-6) (LT) superannuated on 30.08.2014.
7. Shri. Ram Dulare, T-4 (FT) superannuated on 31.01.2015.

Administrative
1. Shri Ram Naresh, Private Secretary superannuated on 30.04.2014.
2. Shri Bhuwan Chandra Lohani, Sr. Clerk superannuated on 30.11.2014.

Supporting
1. Smt. Dashwanti Singh, Skilled Supporting Staff superannuated on 30.06.2014.
2. Shri Ram Narayan, Skilled Supporting Staff superannuated on 31.07.2014.
3. Shri Hamid Ali, Skilled Supporting Staff superannuated on 30.08.2014.
4. Shri Shri Ram, Skilled Supporting Staff superannuated on 30.09.2014.

Voluntary Retirement
Supporting
1. Shri Rajaram, Skilled Supporting Staff retired from service voluntarily w.e.f. 17.10.2014.
Mango (Mangifera indica L.)

Germplasm collection, characterization, evaluation and documentation

Collection: A survey was conducted at Darbhanga, Samastipur and Muzaffarpur districts of Bihar and scion sticks were collected from the nine promising seedlings for multiplication and evaluation. Thirty-three farmers’ varieties of mango were identified from Malihabad and adjoining areas and vegetatively multiplied for conservation.

Characterization and documentation: Fifty-nine accessions of mango were evaluated for fruit characteristics. Database was updated with information on 42 accessions of mango.

Field genebank

Total of 762 mango accessions are maintained in the field genebank. Thirty-three accessions have been multiplied for planting during the current year.

Table 1. Hybridization carried out during 2015

<table>
<thead>
<tr>
<th>Cross combination</th>
<th>Number of panicles</th>
<th>Number of flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambika x 13-1</td>
<td>200</td>
<td>499</td>
</tr>
<tr>
<td>Ambika x Tommy Atkins</td>
<td>200</td>
<td>598</td>
</tr>
<tr>
<td>Amrapali x 13-1</td>
<td>200</td>
<td>655</td>
</tr>
<tr>
<td>Amrapali x Elaichi</td>
<td>1350</td>
<td>4560</td>
</tr>
<tr>
<td>Amrapali x Sensation</td>
<td>2256</td>
<td>7838</td>
</tr>
<tr>
<td>Amrapali x Tommy Atkins</td>
<td>2350</td>
<td>7743</td>
</tr>
<tr>
<td>Dashehari x Sensation</td>
<td>2655</td>
<td>9500</td>
</tr>
<tr>
<td>Dashehari x Tommy Atkins</td>
<td>1760</td>
<td>5698</td>
</tr>
<tr>
<td>Dashehari x Vanraj</td>
<td>629</td>
<td>2426</td>
</tr>
<tr>
<td>EC 95862 x 13-1</td>
<td>150</td>
<td>421</td>
</tr>
<tr>
<td>Elaichi x Amrapali</td>
<td>700</td>
<td>1750</td>
</tr>
<tr>
<td>Goa x 13-1</td>
<td>50</td>
<td>107</td>
</tr>
<tr>
<td>Neelum x Ambika</td>
<td>800</td>
<td>2496</td>
</tr>
<tr>
<td>Neelum x Tommy Atkins</td>
<td>1100</td>
<td>3451</td>
</tr>
<tr>
<td>Pahutan x 13-1</td>
<td>300</td>
<td>821</td>
</tr>
<tr>
<td>Philipino x 13-1</td>
<td>150</td>
<td>426</td>
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<tr>
<td>Philipino x Tommy Atkins</td>
<td>50</td>
<td>146</td>
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<tr>
<td>Starch x 13-1</td>
<td>100</td>
<td>252</td>
</tr>
<tr>
<td>Ambika x 13-1</td>
<td>200</td>
<td>499</td>
</tr>
<tr>
<td>Ambika x Tommy Atkins</td>
<td>200</td>
<td>598</td>
</tr>
<tr>
<td>Grand Total</td>
<td>15,400</td>
<td>50,554</td>
</tr>
</tbody>
</table>

Hybridization

Total number of 50,554 flowers were crossed using 20 cross combinations on 15,400 panicles (Table 1). Thirteen cross combinations attempted during 2014 gave rise to 208 hybrid seedlings (Table 2).

Table 2. Cross combinations attempted and their objectives (2015)

<table>
<thead>
<tr>
<th>Cross combination</th>
<th>Q+C</th>
<th>RB</th>
<th>WA</th>
<th>AB</th>
<th>MF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambika x Tommy Atkins</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Amrapali x Elaichi</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amrapali x Sensation</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amrapali x Tommy Atkins</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashehari x Sensation</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashehari x Tommy Atkins</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashehari x Vanraj</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC 95862 x 13-1</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaichi x Amrapali</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goa x 13-1</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neelum x Ambika</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neelum x Tommy Atkins</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pahutan x 13-1</td>
<td>+</td>
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<tr>
<td>Philipino x 13-1</td>
<td>+</td>
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<td>+</td>
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</tr>
<tr>
<td>Starch x 13-1</td>
<td>+</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Q= Quality, C=Coloured fruits, RB= Regular bearing, AB= Abiotic stress (salt induced), WA=Wider adaptability, MF=Malformation resistance

Evaluation of hybrids

Six hundred and thirty-six hybrid seedlings were evaluated for fruit weight, length, width and thickness, peel weight, stone weight, pulp percent, stone length, width, thickness and TSS. Data indicated that many hybrids were more than 300 g in fruit weight and > 20 °B TSS. One hundred fourteen hybrid seedlings were raised from 13 cross combinations attempted in 2014 and planted in field for evaluation of F1 progeny targeting traits such as quality, peel colour, dwarfing and abiotic stress (Table 3).

Establishment of hybrids

Hybrid seedlings raised from hybrid cross combinations attempted in 2014-15 were planted in the field for evaluation of F1 progeny of mango targeting improvement in traits viz., quality, peel
colour, dwarfing and abiotic resistance in rootstock.

Molecular characterization

Molecular and morphological diversity in heirloom mango varieties

Thirty-seven mango types comprising 27 heirloom varieties from Malihabad region and 10 commercial varieties grown in north and eastern India were assessed for molecular diversity using SSR markers that amplified 2-13 alleles individually, cumulatively amplifying 124 alleles across the studied mango population. Genetic dissimilarity ranged from 0.035 to 0.892, which helped in arranging the varieties in three major clusters, wherein majority of the unique heirloom mangoes from Malihabad were found different from the eastern part of the country (Fig. 1). Clustering pattern revealed that commercial variety Dashehari was distinct from heirloom varieties. Gulabkhas and Langra were placed in a separate group along with Bombay Green, Himsagar, Dashehari, etc. indicating their dissimilarity with heirloom varieties at molecular level. Furthermore, the hierarchical clustering of

<table>
<thead>
<tr>
<th>Cross combination</th>
<th>Number of Panicles</th>
<th>Number of Flowers</th>
<th>Number of fruits harvested</th>
<th>Number of seeds germinated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amrapali x Sensation</td>
<td>800</td>
<td>3552</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Amrapali x Tommy Atkins</td>
<td>850</td>
<td>3874</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>Amrapali x Vanraj</td>
<td>579</td>
<td>2568</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Bangalora x Arunika</td>
<td>464</td>
<td>1953</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bangalora x Tommy Atkins</td>
<td>100</td>
<td>468</td>
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<td>0</td>
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<td>Bappakai x 13-1</td>
<td>50</td>
<td>172</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Dashehari x Sensation</td>
<td>650</td>
<td>3136</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Dashehari x Tommy Atkins</td>
<td>3740</td>
<td>14325</td>
<td>87</td>
<td>58</td>
</tr>
<tr>
<td>Dashehari x Vanraj</td>
<td>1248</td>
<td>4145</td>
<td>22</td>
<td>15</td>
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<tr>
<td>Goa x 13-1</td>
<td>550</td>
<td>2112</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Kurukkan x 13-1</td>
<td>200</td>
<td>697</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Neelum x Ambika</td>
<td>550</td>
<td>2390</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>Neelum x Tommy Atkins</td>
<td>500</td>
<td>1925</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,281</strong></td>
<td><strong>41,317</strong></td>
<td><strong>208</strong></td>
<td><strong>140</strong></td>
</tr>
</tbody>
</table>

**Table 3. Planting of hybrid seedlings for evaluation from hybridization carried out during 2014**

**Fig. 1. Dendrogram depicting genetic relationship of heirloom mango varieties from north India**
the varieties based on fruit morphology assembled these into four groups was largely explained by fruit size. The maximum agreement indicated seemingly good fit as thirteen varieties were arrayed in common grouping pattern. Appreciable dissimilarity among the heirloom varieties demonstrated by molecular analysis, underline the importance for on-farm conservation of heirloom varieties.

**SSR characterization of important mango resources**

Polymorphic SSR Markers (MillHR04, MillHR05, MillHR07, MillHR09, MillHR10, MillHR12, MillHR17, MillHR18, MillHR19, MillHR23, MillHR24, MillHR26, MillHR32, MillHR34) were used to genotype local mango varieties from Mall-Malihabad region alongwith commercial varieties and polyembryonic types amplifying alleles in the range of 176-294 bp. **MillHR09** was unsuitable for mapping studies as amplifying only 2 alleles 293-294 bp (variation due to insertion/deletions).

**Molecular characterization using organelle DNA for mango genetic resources**

Mango genetic resources (10) were sequence characterized by *psbB, psbD* (genes for PSII) and *rps12-20* (ribosomal proteins) markers (chloroplast DNA). Approximately, 800 bp product amplified in PCR was sequenced and 700 bp sequence was aligned using ClustalW and identification of signature sequence and few point mutations (Fig. 2). High scores of pair wise alignments were recorded.

Forty-eight accessions of mango were characterized with IISR markers. Diversity indices were studied and relationships among the accessions from different eco-geographical zones are being worked out.

---

**Fig. 2.** Mango genetic resource characterization using cpDNA marker (*rps12-rpl20*)

A: Visualization of PCR product on agarose; M: step up Ladder; 1: Munajjar Amin, 2: Matka Gola, 3: Pan; 4: Nayab; 5: Allahabadi Chausa; 6: Surkh Emamauddin, 7: Badrul Samar B&C: Alignment of *rps12-rpl20* sequences for 5 samples [deletions displayed by arrows]
Identification of metabolic pathways responsible for important fruit quality traits using transcript profiling

Mapping of the coding DNA sequence to their respective biological pathways were performed through 'Kyoto Encyclopedia of Genes and Genomes' incorporated in Blast2GO. A total number of 135 unique KEGG pathways were identified in pooled Chausa samples out of which majority of CDS were grouped into starch and sucrose metabolism (36), amino sugar and nucleotide sugar metabolism (30), arginine and proline metabolism (29), glycolysis/ gluconeogenesis (24), etc. responsible for fruit quality attributes (Table 4).

Table 4. Classification of identified fruit quality genes in mango transcriptome

<table>
<thead>
<tr>
<th>KEGG pathway</th>
<th>Number of genes in total transcriptome</th>
<th>Number of DE genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant hormone signal transduction</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>Starch and sucrose metabolism</td>
<td>36</td>
<td>14</td>
</tr>
<tr>
<td>Galactose metabolism</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Terpenoid backbone biosynthesis</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Glycolysis/gluconeogenesis</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>Amino sugar and nucleotide sugar metabolism</td>
<td>30</td>
<td>12</td>
</tr>
</tbody>
</table>

Understanding the mechanism of flowering

A total of 58,094 and 50,945 transcript contigs were obtained for two samples, respectively. Prediction of CDS from transcript contigs were done using ORF-predictor. The longest of the six frames was selected. A total number of 51,224 and 43,037 CDS were predicted for samples, respectively. The functional annotation was performed using 51,224 and 43,037 predicted CDS by aligning the CDS to non-redundant database of NCBI using BLASTX. It resulted in the annotation of 40,796 and 31,834 with e-value less than 1e-5 and annotated CDS were mapped on GO database.

Differential gene expression studies for identifying key transcription factors

NOISeq was used for the identification of differentially expressed genes from count. Based on the common hit accession of functionally annotated CDS in pooled Chausa and pooled Amrapali samples, a total of 10,985 CDS were expressed in both the samples for differential expression analysis. Out of the 10,985 CDS, 8,319 coding sequences were found to be significantly down-regulated, while 2,666 were found to be significantly up-regulated in the two pools.

Augmentation of genetic resources with polyembryonic accessions

Four collected accessions from NBPG regional station, Thrissur, (IC 47068, IC 202234, IC 470613 and 470624) were planted in the field genebank (FGB).
Physiological traits to salinity tolerance

Response of polyembryonic cultivars viz. Bappakai, Goa, Kurukkan, Moovandon, Nekkare, 13-1, Kitchner, Peach, Starch and Chandrakaran to different salinity levels were evaluated. Symptoms of salt injury appeared within one month and all plants died except Nekkare, 13-1 and Kurukkan at higher EC (2-4 dsm⁻¹). Salinity factor index (SFI) revealed that these cultivars showed more tolerance to salt stress for longer period at high level of salinity. Marked decline in root: shoot ratio (dry mass basis) was observed. Maximum reduction in the ratio was in Goa and minimum in 13-1 with increasing salinity level. Electrolyte leakage showed severe membrane damage (25-40%) in the stressed plants.

Proline and glycine betaine content was higher in leaves (4.5 – 6.0 mg g⁻¹ DM) than roots (1.2 – 3.5 mg g⁻¹ DM) with elevated salt stress. However, their contribution to osmotic adjustment in all polyembryonic cultivars seemed to be very low and they may be related to protective rather than contributing to osmoregulatory functions in mango. Chlorophyll a, b and total were estimated in different cultivars under different salinity levels. Chlorophyll b reduced drastically as compared to chlorophyll a, consequently, the chlorophyll a/b ratio marginally increased with increasing salinity levels. Total chlorophyll did not reduce significantly up to 7 days of salt stress. However, significant varietal differences were noticed with respect to chlorophyll content with the progression of salt stress. After 15 days of salt stress, only Kurukkan, Nekkare, 13-1 and Chandrakaran had greater amount of chlorophyll content (2.34 – 5.39 mg g⁻¹ FW) in leaf compared to other cultivars (0.47 – 2.5 mg g⁻¹ FW).

Leaf water potential estimated under salt stress conditions indicated that the level of water potential varied from -7.46 to 11.08 ψw in control plants of different cultivars. Its level was drastically reduced after seven days of stress application and maximum reduction (-19.78 ψw) was noticed in Starch, whereas Kurukkan, 13-1 and Nekkare exhibited least reduction in ψw, i.e., from -10.04 to -11.77, -11.08 to -12.82 and -7.46 to -8.48, respectively at higher salinity level. However, after 15 days the level of ψw decreased markedly in all the cultivars and maximum reduction (-17.72 ψw) was observed in Kitchner as compared other cultivars.

Mango rootstock 13-1 exhibited maximum wax content (14.09 mg g⁻¹ FW) at higher salinity level as compared to minimum (5.03 mg g⁻¹ FW) in control plants. Kurukkan exhibited leaf wax content as high as 8.06 mg g⁻¹ FW when it was exposed to different gradient of salt stress. On the other hand, its level significantly decreased at higher salinity level in some cultivars namely Starch (10.0 – 5.0 mg g⁻¹ FW) and Chandrakaran (8.93 to 0.0 mg g⁻¹ FW).

PCR validation of genes for abiotic stress in mango using genomic resources

Primers were used from public databases to identify genomic regions corresponding to abiotic stress responsive genes viz. 14e3e3, peroxidase, NAC and MYB domain containing transcription factor. Among these, >1000 bp product was confirmed in 14e3e3, and 650 in case of sHSP and 250 bp product in NAC regulon, implying their role in transcription regulation (Fig. 5).

Satellite imagery for changing pattern of mango diversity

Multi temporal Lansat data was used for LULC change analysis of Mangifera indica within Lucknow district. Change detection study was conducted with the present satellite data with reference to 1972 and area under mango was estimated. Study indicated that area under mango was less in 1972, as the plants were smaller in canopy and interspecies diversity was high, which decreased with the passage of time although the...
estimated area under mango increased many fold due to enlarged tree canopy size.

**Development of software for analysis of phenology data on mango**

A web-based computer program was developed to summarize, compare and analyze data collected through modified BBCH scale data. Phenological data on 15 varieties was collected to analyze phenophases and influence of weather parameters.

**On farm conservation of mango diversity**

Efforts have been made to strengthen on-farm conservation of mango in Malihabad. National Fruit Catalogue of Tropical Fruit Tree Diversity was prepared and published. Tropical Fruit Trees & Farmers’ Traditional Knowledge-community primer on good practices for diversity management was prepared. Information on the Custodians of Tropical Fruit Tree Genetic Resources in India was collected and published. Thirty-seven heirloom varieties of Malihabad were documented. About 250 farmers participated in the training programme on on-farm conservation, value chain for non-commercial varieties. Varieties suitable for pickle (70) were selected by the community members. Information of community varieties were arranged for publication which was quite helpful in sharing knowledge with people related to marketing of fruits. Identification and recognition of custodian farmers was extended to the communities other than identified under TFT project. Elite planting materials of farmers’ varieties were distributed to 15 farmers for on-farm conservation. Six community nurseries were developed for multiplication of community varieties. About 10000 grafts of 50 varieties identified for grafting community varieties were prepared with the help of nursery outside the community.

**Mango informatics**

Information on accession of 42 Field Gene Banks (FGB) of *Mangifera indica* grown in different ecologies of the country was collected and added in the database. District level information on varieties, cultural practices, medicinal usage, mango disease and pest information was collected from 72 districts. Details of 159 custodian farmers were compiled. In the patent database, 550 records were updated with the details from different patent offices. Four hundred and eighty-five phytochemicals of mangoes were updated along with relevant information on medicinal and nutritional values of mangoes to human health. About 10,000 ESTs, 330 Nucleotides and 100 proteins were updated in the database. Modified database scheme has been developed for uploading data received from the partners. For the information of GIS based analysis, vector layer and thematic maps were generated for mango database and geo-referenced query models related to variety suitability and other aspects influencing mango production in the country.
Expert system for identification of insect pests and nutritional disorder and their management

The expert system identifies insects/pests viz., inflorescence midge, fruit fly, scale insects, shoot borer, stem borer, hopper, mealy bug, etc. The system not only provides query/symptom based identification option of insect pests but also image based re-confirmation option for high identification accuracy. It also exhorts the appropriate management/control options for the pests. In order to minimize the error of pest identification, the image of damaged part of tree and/or insect is included for re-confirmation from the users utilizing visual symptoms before reaching the final conclusion. An expert system has also been developed for the identification of micro-nutrient disorder based on plant/tree visual symptoms. It follows the traditional query based approach. This expert system helps in identifying the deficiency of potassium, boron (black tip, internal necrosis), manganese, zinc and copper and provides advisory for management of these disorders.

Guava (Psidium guajava L.)

Germplasm collection, evaluation and field genebank

Collection: A survey was conducted during January - February 2015 in Varanasi, Allahabad and Kaushambi districts of U.P. and fifteen trait-specific accessions were collected and grafted for evaluation.

Evaluation: During 2014-15 cropping season, CISH-GS-35 and CISH-GS-14, selections made from half-sib population were found to be high yielder with attractive fruit surface, colour and TSS (13.1 °B). Two hundred and four hybrids were evaluated for pulp colour measured as CIE L*, a* and b* values in the fruit pulp. CIE a* value ranged from -2.08 to 18.91 in the pulp, suggesting a range of pink colour for selection in the hybrid population. TSS and seed hardness ranged from 7.5-16 °B and 7.21 to 19.32 kg cm², respectively.

Maintenance of field genebank

Thirty accessions were clonally propagated and replaced with wilted plants in field genebank. One hundred and thirty-seven accessions including six Psidium species were being maintained in the field genebank.

Characterization: Twenty-three accessions of guava were characterized for fruit characters during the winter season crop.

Clonal multiplication of resistant source including wild relatives

Eight hundred and seventy interspecific wilt resistant rootstocks of guava were clonally multiplied. These rootstocks were used for grafting the scions of different cultivars viz., Allahabad Safeda, Apple Colour, Lalit and Shweta in the germplasm nursery.

Hybridization

For developing varieties of guava with pink pulp and peel, incorporation of genes with 10 cross combinations were attempted and hybrid seedlings raised were planted for evaluation. Nine hundred and thirty-six hybrids developed using cross combinations viz., CISH-G-1 x MS, MPUAT SEL-II x MS, CISH-GS-9 x MS, CISH-G-1 x Purple Guava, GN Seedling x Lalit, GN Seedling x MS, Shweta x Purple Guava, Shweta x G-1, T-35 x Purple Guava, Lalit x T-9 were maintained in the field for fruit quality and seed hardness evaluation.

Release of new improved cultivars

Dhawal

It is a half-sib selection from Allahabad Safeda seedling population developed at the Institute. It is a heavy bearer (about 20% higher than Allahabad Safeda) and produces round, smooth, medium to large fruits which ranged from 200-250 g in weight. Mature fruits develop light yellow colour on ripening. Pulp is white, sweet in
taste having muskiness, TSS 13.4 °B, acidity 0.42 per cent and vitamin-C more than 250 mg per 100 g fruit. Seeds are soft, moderate in number and having 0.93 g /100 seed weight (Fig. 6).

Lalima

A selection from half-sib selection from Apple guava has been found promising (fruit weight 190 g and TSS 13.7° B). It has attractive crimson colour fruits, higher proportion of coloured fruit, good yield with higher shelf life (Fig. 6).

Papaya (Carica papaya L.)

Evaluation of growth, fruiting behaviour, quality and yield

Sibmating of identified varieties

Four papaya cultivars viz., Pusa Delicious, CO-7, Red Lady and Nigeria were sibmated for production of true to type seeds. The total number of 315 flowers were sibmated and 195 flowers set into the fruits (61.90 %). The fresh seed weight per fruit was 11.54 to 49.75 g, however, dry seed weight per fruit ranged between 2.57 to 7.86 g in all the cultivar while maximum hundred dry seeds weight of 2.15 g was obtained in Pusa Delicious.

Growth, flowering and fruiting behavior

The maximum tree height (2.51 m) was recorded in cultivar Red Lady followed by Pusa Delicious (2.45 m). Maximum canopy spread in E-W (2.50 m) and N-S (2.41 m) was recorded in cultivar Red Lady followed by Pusa Delicious. Maximum tree circumference (34.8 cm) was recorded in Pusa Delicious. The stalk colour of inflorescence was observed light green in all the selected cultivars. The height to first fruiting ranged from 66.00 to 85.00 cm among the cultivars under evaluation.

Fruit quality and yield

The fruit weight ranged from 1.60 to 2.27 kg while, maximum fruit weight of 2.27 kg was recorded in cultivar Pusa Delicious, the minimum fruit weight (1.60 kg) was observed in cultivar Nigeria. The fruit length varied from 24.51 to 29.70 cm and fruit breadth between 8.33 to 23.68 cm. Maximum pulp thickness (3.37 cm) was recorded in Red Lady, while minimum in Nigeria (2.70 cm). Maximum seed cavity (9.10 cm) was in Red Lady, while it was minimum in Pusa Delicious (7.37 cm). The total soluble solids (TSS) ranged from 8.10 to 10.30 °B. The maximum TSS was recorded in cultivar Red Lady (10.3 °B). The fruit yield ranged from 45.08 to 67.91 kg per plant for all the four cultivars while maximum fruit yield per plant was recorded in cultivar Pusa Delicious (67.91 kg) while, minimum in Red Lady (45.08 kg).

Genetic transformation of papaya with hairpin loop of tr-cp gene of PRSV

A total number of 940 globular embryos of papaya cv. Pusa Delicious were infected with Agrobacterium tumefaciens strain LBA4404 harbouring marker free hairpin loop of truncated Cp (341bp) gene in a binary vector. A total number of 90 putative embryos have been regenerated into shootlets. Besides, 27 independent putative transgenic lines have been developed, which are
being acclimatized under in vitro condition. A total of twenty primary transgenics were found positive for hp-cp gene. Sequencing of hairpin loop of truncated coat protein gene from the transgenic plants have been accomplished. SEM was carried out in transformed embryos to know the status of embryonal fasciations. It revealed that long term stay of embryos under cytokinin led to fasciation. Incorporation of anti ethylene substance such AgNO₃ completely controlled the embryonal fasciation (Fig. 7).

**Aonla (Emblica officinalis Gaertn)**

**Germplasm evaluation**

Twenty-two accessions of aonla collected from different parts of Madhya Pradesh were evaluated for yield and quality parameters. CISH-A-33 (Fig. 8) was found to be the most promising accession in terms of yield (55.45 kg/tree) and neutraceuticals (ascorbic acid-490.13 mg/100 g fruit; polyphenol-1.718 TAEg/100 g; FRAP-value-235.76) followed by CISH-A-31, having a yield potential of 41.76 kg/tree with high neutraceutical value (ascorbic acid-418.12mg/100 g; polyphenol-1.427 TAEg/100 g; FRAP value-214.04). CISH-A-35 also showed high neutraceutical values (gallic acid-7.05 mg/g; caffeic acid-301.0 µg/g). CISH-A-17 was the most vigorous in terms of height (6.98 cm) and girth (63.88 cm). However, maximum canopy spread (5.15 m x 4.91 m) was recorded in CISH-A-15.

**Bael (Aegle marmelos Correa)**

**Germplasm collection, evaluation and management**

The areas of Janetha, Kadiapur, Amawa, Kakaraha, Risia, Rasoolpur and Jogapur in Baharich districts of U.P. were surveyed for the purpose. Seven accessions were marked and passport data were collected. Two bael accessions of village Jogapur, Block Fakarpur (Fruit weight 1.16 kg, TSS 40.8 °B, total carotenoid 1.83 mg/100 gm) and Village Jogapur, Amwa ka Purwa Block (Fruit weight 1.15 kg, TSS 39.8 °B, total carotenoid 1.77 mg/100gm) appeared promising.

**Germplasm evaluation**

Thirty-six vegetatively multiplied bael accessions were planted in the field genebank for evaluation. CISH-B-18 was found to be high yielder (73.32 kg/plant) having medium sized fruit (1.88 kg), high TSS (42.4°B), high total sugar (22.53%) with appreciable total carotenoids (3.79mg/100g) and tannins (3.79%).

**Evaluation of seedling bael germplasm**

Out of 125 seedlings, 76 came into bearing. CISH-SB-30 (Fig. 9) was found the most promising in terms of yield (51kg/plant), medium sized fruit (1.57 kg), total soluble solids (38.96 °B) and total sugar (18.51%).

**Evaluation of bael cultivars for neutracetical contents**

The contents of marmelosin, psoralen and riboflavin were analyzed in seven bael cultivars at the time of harvest. Cultivar NB-5 had the highest amount of marmelosin (256.7 µg/g) followed by cv. NB-17 (225.2 µg/g), while lowest amount of marmelosin was found in cv. NB-9 (42.2 µg/g). The content of psoralen was highest in cv. Pant Shivani (179.0 µg/g) followed by cv. NB-16 (130.1 µg/g) and lowest in cv. Pant Sujata (12.6 µg/g). Similarly, the amount of riboflavin was highest in cv. NB-17 (5.0 µg/g) followed by cv. NB-16 (2.6 µg/g) and lowest in cv. Pant Sujata (0.035 µg/g). Quality wise cvs. NB-16 and NB-17 were found slightly superior.
**Jamun (Syzygium cuminii Skeels)**

**Physico-chemical characteristics**

Physico-chemical parameters of different accessions/varieties of Jamun indicated that CISH-J-37 had maximum fruit weight (23.50 g) followed by CISH-J-36 (21.00 g). The fruit size ranged from 4.71 to 13.06 cm² while the length:breadth ratio of the fruit ranged between 1.24 to 1.76 among different accessions/varieties. Seedless accessions CISH-J-42 had the highest pulp content (98.29 %). The minimum seed weight was noticed in CISH-J-34 (1.71 g) followed by CISH-J-585 (1.77 g), while maximum seed weight was recorded in Konkan Bhadoli (2.31 g). The maximum pulp weight and its per cent was noticed in CISH-J-37 (21.66 g and 92.22%) followed by CISH-J-36 (19.21 g and 91.53%), while the minimum pulp weight and pulp per cent was recorded in CISH-J-35 (5.42 g and 73.36%). The seed content was minimum in CISH-J-37 (7.78%) followed by CISH-J-36 (8.46 %) and CISH-J-576 (11.14%). The maximum seed per cent was noticed in CISH-J-35 (26.63%). Pulp:seed ratio was 2.75 to 12.07, which showed the wide variability among genotypes. The maximum TSS was recorded in Gokak-I (15.6 °B) followed by CISH-J-37 (15.2 °B), while the minimum TSS was observed in CISH-J-23 and CISH-J-576 (10.0 °B). The maximum fruit yield was recorded in CISH-J-37 and CISH-J-35 (53.63 and 53.60 kg), while the minimum fruit yield was recorded in CISH-J-42 (8.65 kg).
Mango (*Mangifera indica* L.)

**Canopy architecture management**

The penetration of solar radiation during October, 2014 – March, 2015 through tree canopy was maximum in October pruned trees followed by June pruned trees drenched with paclobutrazol (3.2 ml/m canopy diameter), while minimum in un-pruned trees (Fig. 10).

![Fig. 10. Response of pruning and paclobutrazol application on percent interception of total radiation](image)

The percentage of vegetative and reproductive shoots was 13.33 and 86.67 per cent, respectively in June pruned trees of mango *cv.* Dashehari. October pruned trees had 73.62 per cent vegetative shoots and 26.38 per cent reproductive shoots while un-pruned control trees exhibited 35.76 per cent vegetative shoots and 64.24 per cent floral shoots. Yield, average individual fruit weight and length and girth of fruits harvested from June pruned trees were significantly higher (2.55 kg/40 shoots, 316.09 g, 130.44 mm and 60.75 mm, respectively) than October pruned and un-pruned trees. Difference in TSS and ascorbic acid content was found non-significant among the treatments, while the acidity was significantly lower in fruits of June pruned trees after seven days of fruit storage.

**Integrated plant nutrient management**

**Effect of INM on bearing orchard**

**Yield and quality**

Ten INM treatments imposed on 36 years old Dashehari trees indicated that the highest fruit yield (9095 kg/ha) and TSS (19.9 °B) was in the NPK + Zn, Cu, Mn, B (50% soil + 50% foliar application) vis-a-vis untreated ones (3968 kg/ha and 18.6 °B, respectively). Acidity and ascorbic acid content in fruits ranged from 0.133 to 0.208 per cent and 27.91 - 38.07 mg/100 g in different treatments. Significantly lower acidity and higher ascorbic acid content were observed in the trees subjected to NPK + micro nutrients Zn, Cu, Mn, B (50% soil + 50% foliar application) treatment.

**Soil nutrient status**

Organic carbon and available N content in the soil under various INM treatments varied between 0.437 - 0.594 per cent and 68.1-93.3 mg/kg at 0-25 cm soil depth. Organic carbon and available N increased significantly in the surface soil by application of N along with FYM. Maximum organic carbon and available N were recorded following application of NPK + micro nutrients Zn, Cu, Mn and B). Available P varied from 16.15 to 23.80 mg/kg in different treatments. Available K increased significantly in all K treatments as compared to untreated ones. DTPA extractable Fe, Mn, Zn and Cu contents in the surface soil of the tree basin increased due to micronutrient fertilization. However, the effect of the treatments was non-significant.

**Soil biological properties**

The dehydrogenase and fluorescein diacetate activity across the treatments ranged between 1.35 to 4.38 µg TPF/g/hr and 236 to 443 mg fluorescin/kg/hr, respectively (Fig. 11). Highest dehydrogenase (4.38 µg TPF/g/hr) and fluorescent diacetate activity (443 mg fluorescin/kg/hr) was recorded in soil supplemented with NPK + Zn, Cu, Mn and B + FYM.

**Soil physical parameters**

Whereas the top soil layer (0-10 cm) had 1.29 to 1.44 g/cm³ bulk density, the subsurface (20-30 cm) soil recorded 1.36 to 1.51 g/cm³. Particle density ranged between 2.4 and 2.8 g/cm³. Higher WHC was found in top layer as compared to lower depths across different treatments. An impact of different treatments on WHC was recorded with highest and lowest value as 23.70 and 19.97 per...
Porosity ranged between 38.9 to 52.0 per cent porosity across depths and treatments. Porosity was low at lower depths due to compaction.

**Relation between soil physical parameters and microbial activity**

Linear regression analysis showed positive and significant correlation among the soil physical and biological properties (Fig. 12 & 13). Dehydrogenase activity (DHA) was significantly correlated with porosity ($r = 0.93^{**}$), WHC ($r = 0.48^{**}$), BD ($r = 0.88^{**}$) and PD ($r = 0.71^{**}$). BD and WHC could explain 49-69 per cent variations in FDA while porosity could predict 44 per cent variation in FDA.

**Leaf nutrient status**

Iron, Mn, Zn and Cu contents were in optimum range in all the treatments, however, their concentration was higher in the respective treatments. The B concentration in leaf was below the optimum range even in B applied treatments. There was non significant effect of treatments on Fe and Mn contents of leaves. Foliar application of B, Zn and Cu had significantly higher concentration of these elements in the leaves as compared to control. Foliar application or soil + foliar application (50% each) was found better than 100 per cent soil application in respect of Zn, B and Cu.
Fertigation schedule

Fertigation at different critical phenological stages in mango cv. Dashehari indicated that highest yield (118.4 kg/tree), was obtained with 75 per cent RDF as compared to lowest yield (101.8 kg/tree) in untreated ones. The treatments differed significantly with TSS, acidity and ascorbic acid content in fruit pulp. A range of TSS, acidity and ascorbic acid content was 18.43 to 19.83 °B, 0.15 to 0.20 per cent and 32.14 to 37.22 mg/100 g, respectively, across different treatments.

Effect of INM on young orchard

Plant growth

Ten INM treatments were imposed on 8 years old Dashehari trees including check. Resultant tree height, stem girth and canopy spread ranged from 3.65-3.90 m, 55.0 to 67.2 cm, 3.75 to 4.95 m (east-west) and 3.65-4.25 m (north-south), respectively, in different treatments. Growth parameters were not affected significantly.

Soil and leaf nutrient status

The data on soil nutrient status indicated that organic carbon content was low (0.312-0.402%) in all the treatments irrespective of organic matter addition. Available N was also low (46.20 to 71.00 mg/kg) in all the treatments because of coarse texture and low organic carbon content of the soil. However, significant increase in available N content was recorded following incorporation of organic matter. The highest organic carbon and available N contents were recorded in the treatment containing 10 kg FYM + 100, 50, 100 g N, P, K / tree / year of age + Azotobacter + PSM + Trichoderma harzianum + organic mulching. Buildup of available P, K, Mn, Zn and Cu in the soil was not significantly affected. Zinc and Mn content of leaves increased significantly following incorporation of these nutrients in soil/leaves. Though concentration of N, P, Fe, Cu and B in the leaves increased but there was non significant response to the treatments.

Fig. 13. Relation of FDA (mg fluorescin/kg/hr) to some soil physical properties in bearing mango orchard soil
Physical properties

The mean (0-30 cm soil depth) water holding capacity and true density of mango orchard soil was 21.88 per cent and 2.57 g/cm$^3$ across different treatments and depths, respectively. A range of 1.28-1.43, 1.36-1.44 and 1.32-1.59 g/cm$^3$ bulk density was recorded at 0-10, 10-20 and 20-30 cm soil depths, respectively. Wide variations in porosity were observed across different treatments with highest porosity (45.6 to 51.1%) at the surface layer (0-10 cm) followed by 41.9 to 47.5 and 38.4 to 48.7 per cent in 10-20 and 20-30 cm depths, respectively (Fig. 14). Soil respiration was positively correlated to bacterial and actinomycetes populations ($r = 0.73^*$ to $0.79^*$). Dehydrogenase activity (DHA) and FDA showed significant positive correlation with BD ($r = 0.79^{**}$ and $0.68^*$).

Microbial population and activity

The dehydrogenase and fluorescein diacetate activity ranged from 0.70 to 2.62 µg TPF/g/hr and 132 to 299 mg fluorescin/kg/hr, respectively. The highest actinomycetes population, dehydrogenase and fluorescent diacetate activities were recorded in treatment containing 10 kg FYM + 100, 100 g N, P$_2$O$_5$ and K$_2$O/tree/year of age + Azotobacter + PSM + Trichoderma harzianum + organic mulching (Fig. 15). Bacterial and fungal populations and soil respiration (70.0 mg CO$_2$/kg/day) were highest in treatment containing 10 kg FYM + 50 g N + 25 g P$_2$O$_5$ + 50 g K$_2$O / tree/year of age + Azotobacter + PSM + Trichoderma harzianum + organic mulching.
Understanding the mechanism of flowering

Dynamics of vegetative shoots associated with flowering

Vegetative flushes were not observed during October, 2014 January, 2015. However, around 5 per cent vegetative flush emerged during February and 10–15 per cent vegetative flush in March in cultivars Dashehari and Amrapali. During 2015, flowering continued up to first week of March. The fruit set started in the second week of March due to extended cold spell during December (first fortnight) to February (9.93 to 12.0 °C). On the other hand, soil moisture (22.4 -33.5%) increased during February to March as compared to last three months of phenological stages. Severe flower damage and fruit drop (pea stage) was observed due to prolonged winter and unseasonal rains during February and March with high wind velocity (7-8 m/s). Maturity of fruits during last year (2013-14) was delayed by 15 days. However, there was non significant effect on yield and quality parameters under changing climatic conditions (Fig. 16).

Alteration of non-structural carbohydrates in shoots and roots of mango trees

Non-structural carbohydrate (total sugar, starch and reducing sugar) were monitored in root and shoot of cultivars Langra and Amrapali. It was high (3.09– 6.29 mg/g DW) in roots during ‘OFF’ year and low (2.70 – 4.20 mg/g DW) during ‘ON’ year in cv. Langra. However, it was maximum in shoot during ‘ON’ year at flower differentiation stage as compared to ‘OFF’ year of fruiting. Significant difference was not observed in non-structural carbohydrates in cv. Amrapali during different years of cropping.

Osmotic regulation at different phenological stages of mango cultivars

Cultivar Amrapali had more osmotic potential (OP) (-3.39 MPa) than Langra (-5.38 MPa) at FBD stage. Symplastic content (R’s) was also more in cv. Amrapali (76.00%) than cv. Langra (60.00%) at FBD. On the other hand apoplastic content (R’a) showed reverse pattern in cultivars as indicated by lower value in cv. Amrapali (24.0%) than cv. Langra (40.0%). Langra exhibited lower Turgor loss point (TLP) (-5.56 MPa) than cv. Amrapali (-5.41 MPa). It indicated early turgor loss in leaves of former cultivar than later one during the critical period of flowering process. However, cv. Amrapali showed lower TLP in subsequent stages of flower development which might indicate that Amrapali with lower TLP may be able to maintain osmoregulation at lower leaf water potentials (Fig. 17).

Sugar metabolism enzymes in roots

NAD and NADP dependent sugar metabolism enzyme viz., sorbitol dehydrogenase (SDH) estimated in root during different phenological stage of tree showed that the activity of this carbon metabolism enzyme was relatively low in ‘OFF’ years’ tree as compared to ‘ON’ years’ tree in cv. Langra. However, the roots of cv. Amrapali did not exhibit any set pattern in SDH activity.

RUBP carboxylase activity at different stage of flower bud differentiation

RUBP carboxylase activity measured in nine cultivars during pre-FBD and at FBD revealed maximum activity in cv. Amrapali (6.04 ± 0.05 and
Variation in endogenous phytohormones during flower bud development

Estimation of Indole-3-Acetic Acid (IAA), Zeatin Riboside (ZR), Dihydro Zeatin Riboside (DHZR) and Abscisic acid (ABA) in leaves and terminal buds of cvs. Amrapali and Langra under inductive environment conditions during flower bud differentiation (FBD) indicated that Indole-3-Acetic Acid (144.50 ng/g f.wt) and Abscisic acid (272.48 ng/g f.wt) were higher in leaves and buds of Langra compared to Amrapali (56.03 - 125.37 ng/g f.wt). On the other hand, cytokinin, particularly DHZR in flower bud of cv. Amrapali had higher concentration (263.32 ng /f wt) as compared to cv. Langra (239.23 ng/g f.wt).

Interestingly, phytohormone levels were higher in apical buds than in leaves. The C:N ratio was higher in shoots (10.12 ± 1.08) of cv. Amrapali than leaves (6.90 ± 0.87). Thus, the regularity in bearing of mango may be associated with level of endogenous hormones along with C:N ratio.

Prediction of mango yield over time

The simulation model incorporating autocorrelation of fruit yield of cv. Langra trees (100 trees) over five years was studied for time series modelling. The estimated results were significantly negative which indicates that mango tree yield over the years is negatively correlated. On the other hand, the polynomial curve provided appropriate models and was suitable for polynomial of order less than four and this model was found to predict satisfactory information on orchard yield. Thus, yield of mango may increase or decrease over years and input management may be provided accordingly. The log transformed value of fruit yield of 100 trees for five years was also compared with those of without log transformed values. The log transformed value gave better prediction of yield, which might be due to minimum mean square (0.30) value as compared to very large mean square (4677.21) value without log transformed parameter.

Development of mango based intercropping system

Fruit yield and quality parameters

Six intercrops evaluated for their performance in the orchard of mango cv. Dashehari revealed that fruit yield in association with different intercrops ranged from 42.3 kg/tree with panicum grass as intercrop to 53.6 kg/tree with fern as intercrop. It however, exhibited non-significant differences in respect of fruit yield (42.3 - 53.6 kg/tree), fruit number (198.3 - 244.3 fruits/tree), average fruit weight (208.1 - 247.2 g/fruit), TSS (19.2 - 22.8 °B), acidity (0.16 - 0.19%) and ascorbic acids (16 - 22 mg/100 g) under different treatments, indicating that different intercrops did not adversely affect the fruit yield of mango.

Yield and income

Out of various intercrops evaluated in association with mango trees, shatavari (Asparagus racemosus) and fern (Nephrolepis tuberosa) appeared to be the most promising as compared to other intercrops. Shatavari gave 8.2 t/ha of tuberous roots with the total income assessed at Rs 8.2 lakh/ha, while fern produced 8,98,854 leaves in three cuts giving a total income of Rs 2.69 lakh/ha. Panicum maximum (guinea grass) proved to be relatively good proposition for fodder production in mango orchards as it gave two cuts during summers and three cuts during rainy season giving a total yield of 28.6 t/ha and a total income of up to Rs 585,800/ha.

Microbial activity

Soil biological health, in mango orchard with different crops, was measured through dehydrogenases and fluorescein diacetate activities (FDA). Soil of orchard with turmeric intercrop recorded highest dehydrogenase (4.18 µg TPF/g/hr) and fluorescein diacetate activities (461 mg fluorescin/kg/hr) followed by Amorphophalus (3.56 µg TPF/g/hr) for dehydrogenase activity and Vetiver grass (396 mg fluorescin/kg/hr) for FDA.
GUAVA (*Psidium guajava* L.)

Integrated plant nutrient management

Fruit yield and quality

Nine INM treatments imposed on seven year old trees of guava cultivar Shweta revealed that fruit yield increased significantly in the treatments over control and varied from 41.2 to 72.5 kg/tree in various treatments. The highest fruit yield of 72.5 kg/tree was recorded in the treatment comprising of 10 kg FYM + 120, 60, 50 g N, P₂O₅ and K₂O/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching which was at par with other treatments having NPK with or without FYM and minimum being in the control. The average fruit weight varied between 161.7 and 204.0 g among various treatments and was significantly higher in the treatments having full dose of NPK along with FYM or micronutrients. TSS of the guava fruits varied from 10.2 to 12.2 °B across the treatments. Ascorbic acid content ranged between 204.3 and 221.7 mg/100 g, the maximum value being in the treatment 120, 60, 50 g N, P, K / tree / year of age + foliar application of Zn, B, Mn and Cu. There was no significant effect of the treatments on TSS, ascorbic acid content and fruit acidity.

Soil and leaf nutrient status

Organic carbon and available N content of soil ranged from 0.341 to 0.380 per cent and 61.83 to 76.77 mg/kg, respectively in various treatments. There was no significant effect of treatments on organic carbon, available N and P build-up in the soil. Available K increased significantly (136.77-173.55 mg/kg) in the treatments consisting of FYM + N P K or FYM + micronutrients. A significant increase was observed in DTPA extractable Mn, Zn and Cu in the soil when nutrients were imposed in the soil/leaf. Fe content was not affected by the treatments. However, significant effect of the treatments was not observed on N, K, Zn and Fe concentration in the leaves. P concentration in leaf was significantly higher (0.180%) in the treatment consisting of 10 kg FYM + 120, 60, 50 g N, P₂O₅ and K₂O/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching over control. Cu, B and Mn concentration in the leaves increased significantly with soil or foliar application of the nutrients over control.

Soil microbial activity

The dehydrogenase and fluorescein diacetate activity ranged between 1.85 to 3.80 µg TPF/g/hr and 187 to 417 mg fluorescin/kg/hr, respectively (Fig. 18). Highest dehydrogenase (3.80 µg TPF/g/hr) and fluorescein diacetate activity (417 mg fluorescin/kg/hr) were recorded in 10 kg FYM + 120, 60, 50 g N, P₂O₅, and K₂O/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching treatment. Highest soil respiration (70.1 mg CO₂/kg/Day) was recorded at half NPK dose. Highest bacterial, fungal and actinomycetes population were found in treatment containing 10 kg FYM + 60, 30, 25 g N, P₂O₅ and K₂O tree year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching (Fig. 18).

Soil physical parameters, organic carbon and micronutrient stock

Deeper depths of soil layer (20-30 cm) had higher bulk density (1.33-1.47 g/cm³) than top (0-10 cm) layer (1.25-1.39 g/cm³) across guava planting densities. Wide variations in WHC (20.71-24.19%) and porosity (44.53-53.0%) across space and density were observed. Soil organic carbon stock of 4.89, 5.35 and 6.0 mg/ha was found at respective soil depths. Soil organic carbon varied between 0.21 and 0.62 per cent, porosity between 33.9 and 47.0 per cent and bulk density between 1.41 and 1.53 g/cm³ across different depths and planting densities. Mean water holding capacity was 21.44 per cent.
Fig. 18. Dehydrogenase, FDA, soil respiration and microbial populations (bacteria, fungi, and actinomycetes) in young guava orchard soil
Mango (*Mangifera indica* L.)

**Insect pests**

**Population dynamics**

**Hopper**

Hopper population appeared from 02nd Standard Meteorological Week (SMW) and continued up to 48th SMW. The average number of hoppers per panicle ranged from 0.23 to 12.04. Its population was very low, i.e. 0.19-0.39 and 0-1.62 during 1-10th SMW and 38-52nd, respectively (Fig. 19).

**Thrips**

The population of thrips during 2014-15 started to appear from 9th-10th SMW and continued up to 39th SMW. The average number of thrips per panicle ranged between 0.01-4.61. The thrips population could not be noticed during 1-8th and 40-52nd SMW. The maximum population (1.02 to 4.61) was recorded during 13-21st SMW. (Fig. 19).

**Mealy bug**

The incidence of mealy bug(*Drosicha mangiferae*) in mango orchards was first seen during 5th SMW and continued up to 26th SMW. The average number of mealy bugs per panicle ranged from 0.08–9.58. The population was not observed during 1-4th and 27-52nd standard weeks. The maximum number of mealy bugs (4.73-9.58) was observed during 13-15th SMW (Fig. 19).

**Fruit fly**

The fruit fly catches in pheromone traps differed significantly during the period. The highest population was noticed during July-September 2014, attaining a peak (150.7 adults/trap/week) during 31st SMW. However, gradual decline in population occurred during December 2014-January 2015.

**Scale insect**

Scale insect infestation persisted throughout the year. Peak infestation of scales was recorded during 41st SMW. Infestation of scale insect on mango was positively correlated with maximum temperature (r = 0.475**), minimum temperature (r = 0.380**), sunshine hours (r = 0.301*) and evaporation (r = 0.348*).

**Midge**

Inflorescence midge was recorded during the 7th to 19th SMW. Peak infestation (2.35/panicle) occurred during the 13th SMW. Population was positively correlated with sunshine hours (r= 0.330*) and negatively with maximum relative humidity (r= -0.391**) and minimum relative humidity (r= -0.472**). Infestation on leaf was recorded during 16th to 23rd SMW. Peak infestation could be noticed during 19th SMW. It was found to correlate positively with maximum temperature (r = 0.457**), sunshine hours (r = 0.513**), evaporation (r = 0.473**) and negatively with minimum (r = -0.477**) and maximum relative humidity (r = -0.690**).

**Leaf webber**

Leaf webber infestation during 23rd to 42nd SMW had its peak (42.9 webs/tree) in the 37th SMW. It was positively correlated with minimum temperature (r = 0.487**), minimum relative humidity (r = 0.448**) and rain fall (r = 0.600**).

**Fruit borer**

Fruit borer incidence observed during 18th to 31st SMW (2014-2015) revealed its peak infestation (40.8 per cent) during 21st SMW.
Prediction model

Hopper

Based on the three years data of hopper population dynamics and thermal indices including Growing Degree Days (GDD), Heliothermal units (HTU) and Photothermal Units (PTU), linear regression prediction models were developed for mango belt encompassing Lucknow region (Fig. 20a,b,c).

The thermal indices particularly during flowering and fruit set, varied across the seasons. Normally with the progress of reproductive phase in mango viz., flowering, panicle emergence, fruit set and development, hopper population shot up based on existing hydrothermal conditions. Application of thermal indices confirmed that variations in mango hopper population can be predicted with more than 80 per cent accuracy.

Evaluation of newer pesticide molecules and botanicals

Leaf webber

Evaluation of eight insecticides against leaf webber and their comparison with lambda cyhalothrin (5 EC 1ml/lit) as a standard check revealed that quinalphos (2ml/lit) was most effective against leaf webber (70% mortality) and was at par with standard check followed by dichlorvos 76 EC 1.5 ml/l, spinosad 44.2 SC 0.2ml/lit and chlorfenapyr 10 SC 1ml/lit, which effected 61.67, 60.0 and 58.34 per cent mortality, respectively. Study indicated that quinalphos, spinosad and chlorfenapyr can also be used as an effective alternative to lambda cyhalothrin 5 EC (Fig. 21).

Fruit borer

Lambda cyhalothrin (1ml/lit) was effective and at par with quinalphos (2ml/lit) resulting in 90 per cent mortality of the pest. Diazinon (0.6g/lit) caused 60 per cent mortality.
Mealy bug

Efficacy of chlorantraniliprole, diafenthiuron and chlorfenapyr with unique mode of action was tested against mango mealy bug (*Drosicha mangiferae*) under field conditions and compared with other insecticides commonly used in mango ecosystem. It indicated that chlorantraniliprole, diafenthiuron and chlorfenapyr caused 16.80, 37.14 and 51.72 per cent population reduction, respectively. However, trees treated with a carbosulfan 25 EC (standard check) recorded maximum mortality (74.07%) followed by quinalphos, profenofos with 60.56, 59.05 per cent, respectively.

Aqueous extracts of ginger, garlic and chillies (10 g /100 ml) were tested against mealy bug along with sticking agent. The garlic extracts was highly effective causing 86 per cent reduction over initial population.

Germplasm evaluation

Fruit borer

Mango cultivars *viz.*, Indonesia, Phasla Murshidabad, Soria Malda, Kishenbhog, Bathuie, Baramasi, Creeping Band and Nazuk Badan were classified as tolerant during 2014-2015. Conversely cvs., Langra Bhagaloor, Bhoodia, Langra Gorahpur and Mithai (above 50 per cent infestation) were classified as susceptible.

Leaf webber

Out of 42 cultivars screened against leaf webber, incidence was not observed on cvs. Vanraj, Bombay Batli, Mallika, Jardalu, Bombay Bhadaiy and Ambika. Highest number of webs were recorded on Bombay Green (108.5 webs/tree) followed by Bhoodia (136.5 webs/tree) and Kishan Bhog (133.5 webs/tree).

Diseases

Powdery mildew (*Oidium mangiferae*)

Unseasonal rains (six rainy days with 60.2 mm rainfall) during February and March, 2015 were highly unfavourable for development of powdery mildew. Consequently, average incidence was recorded as 4.25 per cent with severity of 1.42 PDI in Unnao, Hardoi, Lucknow and Sitapur districts.

In fixed plots, peak disease incidence (12.5%) and severity (PDI 3.75) was recorded during 13th SMW (Fig. 22). Low temperature (28.9°C) and high relative humidity (87.3%) during the month of March, 2015 reduced the incidence of powdery mildew. Disease incidence and severity were significantly influenced by temperature, evaporation rate, wind velocity and maximum R.H. (Fig. 22).

Fig. 22. Incidence and severity of powdery mildew in fixed plots

Anthracnose (*Colletotrichum gloeosporioides*)

Lowest disease incidence (13.2%) and severity (2.55%) were observed during June. Recurrent infection occurred on new flushes during the first week of July, which continued till November, 2014. However, highest incidence (34.5% and severity, PDI -23.83) was recorded during January, 2015. Infection on emerging flushes occurred during the last week of February and March 2015 due to rains (six rainy days with 60.2 mm rainfall) and prevalence of high relative humidity. Disease incidence and severity were significantly influenced by temperature. Severity enhanced with less sunshine and high R.H. The infection was positively correlated with rain, high relative humidity and moderate temperature (Fig. 23).

Fig. 23. Incidence and severity of leaf anthracnose in fixed plots
**Blossom blight (Colletotrichum gloeosporioides and Alternaria alternata)**

The disease severity was well pronounced in dense, old and unmanaged orchards, where high relative humidity prevailed for longer period after rain during February – March 2015 as compared to open orchards. Average disease incidence and severity in and around Lucknow was 65.4 per cent and 35.4 PDI, respectively. Initial disease symptoms were observed on emerging panicles during the last week of February 2015. Disease incidence (66.4%) and severity (42.0%) attained peak during the 12th SMW and were influenced by RH, maximum temperature, sunshine and wind velocity (Fig. 24).

Disease incidence (66.4%) and severity (42.0%) attained peak during the 12th SMW and were influenced by RH, maximum temperature, sunshine and wind velocity (Fig. 24).

**Wilt (Ceratocystis fimbriata and Lasiodiplodia theobromae)**

**Disease Incidence**

Out of 441 orchards surveyed in 25 districts included in roving survey programme, wilt incidence was recorded on 28 trees (12 to 65 years old) in 20 orchards located in 12 districts. *Ceratocystis fimbriata* was isolated from 23 wilt affected trees and *Lasiodiplodia theobromae* from 4 trees. Presence of scolytid beetles was also recorded from 14 locations. On the basis of frequency of isolation, *C. fimbriata* and *L. theobromae* might be considered as the major and minor wilt pathogens, respectively.

**Symptoms**

Three types of symptoms viz. sudden wilt, slow wilt and branch drying were commonly observed in the affected trees (Fig. 25). *C. fimbriata* was found to have high frequency of occurrence in the plants displaying sudden wilt symptoms. Leaves in the plants affected with sudden wilt remained attached to the twigs even after complete wilting. Severe gummosis was noticed on the trunk and major branches before the onset of complete wilt (Fig. 25). Reddish-brown to dark brown or black discoloration of vascular tissues and foul smell were the common symptoms (Fig. 26a,b). On the other hand, slow wilt affected trees exhibited poor growth without gum oozing and leaf shedding was also gradual (Fig. 27). Branch drying affected trees were completely killed in a period of 8 to 30 months.
**Associated fungi**

*C. fimbriata* was isolated from soil, root and trunk portions of wilt affected trees. Success rate of isolation of *C. fimbriata* was higher on carrot discs placed in moist chamber as compared to potato dextrose agar medium in petri plates (Fig. 28). The fungus was identified on the basis of its cultural and morphological characters (Fig. 29).

**Pathogenicity**

*C. fimbriata* was inoculated into stem, roots and soil under net house conditions (Fig. 30). Appearance of wilt symptoms was noticed within 150-160 days in seedlings inoculated in stem, as compared to 195-220 days in the seedling subjected to root zone inoculation. Symptoms corresponded well with naturally wilted trees.

**Management**

Trees exhibiting initial symptoms of Ceratocystis wilt at Rehmankhera farm, Lucknow, Rudali, Faizabad and Patarsa, Kanpur Nagar were treated with thiophanate methyl as soil drench @ 300g/ tree (in the basin of trees). Drying/ affected branches of such trees were pruned and cut ends were pasted with copper oxychloride, followed by propiconazole spray (@ 0.1%) on the aerial portion. Treated trees were administered 100 kg FYM and fertilizer dose (1.0 kg di-ammonium phosphate and 500 g of muriate of potash per tree). After 2-3 months, all treated trees showed recovery sign with the emergence of new flush.

**Shoulder browning**

**Incidence**

Incidence of shoulder browning during 2014 was poor due to late onset and deficit monsoon. Isolation frequency of *C. mangiferae*, *C. gloeosporioides* and *A. alternata* in the samples, was 78, 65 and 26.3 per cent, respectively. *Colletotrichum gloeosporioides* and *Alternaria alternata* could cause infection in mature fruits, resulting in fruit rot during ripening and storage. *Capnodium mangiferae* was found to grow only superficially.

**Pathogenicity**

Out of three fungi, only *C. gloeosporioides* and *A. alternata* were found to cause infection. Symptoms appeared within 12 to 16 days of inoculation. Brown to dark brown lesions developed due to *C. gloeosporioides*, which gradually progressed and covered about 45 per cent area of fruits. *A. alternata* caused dark brown to black lesions, but lesions could not develop in size and hardly covered 2 per cent infected area on epicarp. *C. mangiferae* neither caused infection nor could grow superficially (Fig. 31).

**Management**

Out of 9 treatments (Propiconazole 25 EC @ 0.1% (Result), Propineb 70WP @ 0.3% (Antracol), Thiophanate methyl 70 WP @ 0.1% (Roko), Dimethoate 30 EC @ 0.06% + Gum acacia (0.3%), Starch (2%), Myclobutanil 10 WP @ 0.1% (Index), Iprovalicarb 5.5 + Propineb 61.25 WP @ 0.1% (Melody duo), Difenoconazole 25EC @ 0.1% (Score), gum acacia @ 0.3% + dimethoate @ 0.2% and Tree oil @ 1.0%), only Propiconazole and
that the IJs could survive for 3 months at 15 ºC without any mortality. *Orthaga euadrusalis* and *Drosicha mangiferae* sprayed with a suspension of *Photorhabdus luminescens* did not yield any mortality of insect larva under laboratory conditions.

**Guava (Psidium guajava L.)**

**Insect pests**

**Bark eating caterpillar**

**Bio-efficacy of insecticides**

The bio-efficacy of five insecticides was tested using 6 treatments and with standard control, dichlorovos along with sealer cum healer and copper oxychloride, dichlorovos with copper oxychloride and profenofos were found superior with 52.5, 49.9, and 45.6 per cent reduction in infestation, respectively (Fig. 32).

Entomopathogenic nematodes and its endosymbiont

**Isolation and identification**

Only one sample tested positive for the presence of entomopathogenic nematodes, out of twenty-five soil samples collected from mango orchards of Sitapur district. Based on the characteristic colour of the insect cadaver and luminescence studies, it was identified as *Heterorhabditis* sp. and designated as CISH-EPN-05 and added to CISH-EPN collection. *Photorhabdus luminescens* - an endosymbiotic bacteria was isolated from the gut of *Heterorhabditis* sp., using nutrient agar medium. Identification of EPNs based on molecular parameters related to D2D3 regions was carried out. DNA was extracted and PCR amplified. The PCR product (1000 bp), thus obtained was purified using Geneaid PCR cleanup kit and sequence characterized for confirming the species.

**Mass multiplication, formulation, shelf life studies of EPN’s and bioefficacy studies of its endosymbiont**

Modified wout’s agar media was standardized for mass production of *Steinernema abbasi*. In-vitro mass production of *S. abbasi* on modified wout’s agar medium yielded a nematode density of 4500 IJs/g of medium. Commercial formulation of *S. abbasi* was done using 1.47 per cent calcium chloride and 2 per cent sodium alginate. Infective juveniles were entrapped in the gel matrix. The shelf life studies of *S. abbasi* on sodium alginate beads indicated

starch were found most effective (9.75 PDI) followed by gum acacia + dimethoate (10.50), myclobutanil (11.25) and difenoconazole (11.50) as compared to control (32.25 PDI).

**Fig. 31. Pathogenicity of *C. gloeosporioides* and *A. alternata* on mango cv. Amrapali fruits**

**Fig. 32. Per cent reduction of bark eating caterpillar infestation over control**

**Status of wilt in commercial guava cultivation zones**

**Nematode and fungal fauna associated with guava plants**

Surveys were conducted in commercial guava cultivation zones in five districts Badaun, Farrukhabad, Varanasi, Allahabad and Koshambi regions with a view to assess the status of wilt *vis-à-vis* associated/inhabiting biota occurring in the region. Prevalence of wilt and the associated biota varied from region to region.

Surveys at two locations in Badaun region revealed the predominance of root-knot nematode, *Meloidogyne incognita*. Its population in
the soil ranged from 2-20 second stage juvenile per 100 cc soil sample. Typical root galling along with wilting was also noticed. Root galls of varying size were also recorded on healthy, wilted and sick plants. However, the size of gall varied with respect to plant health status. Healthy and unhealthy plants manifested root galls ranging from <1-2 mm and > 2-5 mm, respectively. Root gall were largely found rotten in the plants exhibiting typical wilt symptoms. Population of other nematode viz., *Helicotylenchus dihystera* (0-4), *Hoplolaimus indicus* (0-6) and *Rotylenchulus reniformis* (0-15) was relatively low. Plants exhibiting wilt symptoms and encumbering predominant population of root-knot nematode population revealed the relatively higher frequency of *Fusarium oxysporum* (1.6-87.6) in comparison to healthy plants, where its population ranged between 1.2-3.1. Guava cv. Shweta grafted on wilt resistant root stock (*Psidium molle, P. guajava*) was also found exhibiting typical root gall and wilting symptoms (Fig. 33).

Guava plantations in Farrukhabad region were by and large healthy, barring the plantations located in Ghatiaghat region. Around six to seven nematode genera were found associated with the guava plant rhizosphere. Out of nine locations surveyed, partial wilting was noticed only at one location. Plants were largely found exhibiting the infestation of Bark eating caterpillar and the associated wilting of peripheral branches. Severe infestation of bark eating caterpillar was also found on wilted trees. Plants exhibited typical external symptoms of nematode infestation, *i.e.* stunted growth, fewer and unhealthy branches and typical symptoms of drooping leaves during mid part of the day. *H. indicus, H. dihystera* and *R. reniformis* were commonly found occurring in the rhizosphere of healthy and wilted plants but the population was by and large very low ranging between 0-25 per 100 g soil sample. Population of *F. oxysporum* was also found low in this region (2.43-6.79).

Nemic population complex in Allahabad, Varanasi and Koshambi region comprised of *H. indicus* and *H. dihystera*. Plants exhibiting wilt were largely found infested with bark eating caterpillar and stem borer. Population of grub was also recorded from the plant exhibiting wilt symptoms. Interestingly, insect population was also isolated from plants exhibiting wilt symptom. High population (5-10) of grub, identified as *Holotrichia* sp., belonging to family Melolonthidae was also isolated from the plants exhibiting wilting of peripheral branches (Fig. 34). It was also isolated from guava plantations located in Sarai Mansoor (Allahabad) and Salahpur (Koshambi). Presence of *Hoplolaimus indicus, Helicotylenchus dihystera, Rotylenchulus reniformis* and *Fusarium oxysporum* (2.4-3.6-7-9) irrespective of the plant health status, was largely low (ranging from 0-25).

**Management of guava wilt**

Six treatments comprising of neem cake (1/2 kg), neem cake (1/2 kg) along with *T. harzianum* (10 g) and FYM (1/2 kg), FYM 1/2 kg along with 10 g *Trichoderma harzianum*, 10 g *T. harzianum* grown on 1/2 kg FYM were imposed once, twice and thrice in the plant basin. Observations on wilting were taken at fifteen days interval during April 2014 to March, 2015. Lowest percentage of wilt (3.75) was recorded in the plants subjected to incorporation of neem cake thrice. However, 57.5, 56.25, 75, and 77.5 per cent diseased plants were found in the plants subjected to FYM ½ kg. (once), oil cake ½ kg. (twice), TH 10 g. grown on FYM ½ kg (once), FYM + TH 10g (thrice). Lowest population of *F. oxysporum* (6.62, 7.93, 8.33) was recorded in the plant subjected to the application of neem cake ½ kg (once), TH 10 g grown on FYM ½ kg (once) and FYM + TH 10g (thrice).
Rhizospheric population of nematode and fungal population encountered in guava plants with and without intercrop (Mustard)

Population of nematode and fungi was analyzed on the fields having intercropping with mustard in the guava orchards. Nematode population belonging to *Meloidogyne* sp., *H. indicus*, *H. dihysterla, R. reniformis* was found to range between 0-8,0-5 and 0-10 in the rhizosphere of guava (without mustard), mustard alone and guava with mustard, respectively. The corresponding figures for *F. oxysporum* were 14.2, 25.2 and 20.83, respectively.

**Nutrient analysis of guava wilt affected orchard**

A sum of 60 soil samples were collected from 0-5, 5-10, 10-15 and 15-20 cm soil depths from some wilt infected (25, 50, 75 and 100%) and healthy guava orchards. DTPA-extractable micronutrients (Zn, Cu, Mn and Fe) contents ranged between 1.27 to 2.79 ppm Zn, 5.23 to 8.42 ppm Cu, 7.05 to 23.11 ppm Mn and 1.83 to 3.51 ppm Fe, respectively.

The mean Zn, Cu, Mn and Fe contents in 35 soil samples (18 from Allahabad 9 from Badaun and 8 from Farukkabad were 0.71, 1.6, 4.4 and 10.0 ppm, respectively. Histographic distribution showed majority of the soil samples had Zn content in the range of 0.50 per cent at higher frequency level, wider distribution pattern was observed in case of Fe, Cu and Mn had <2 and <5 ppm at higher frequency levels (Fig. 35).
MANGO (*Mangifera indica* L.)

**Storage**

**Enhancing shelf life of mango by use of safe chemicals**

Dashehari fruits treated with salicylic acid (SA) (50 ppm) had 11.48 per cent CPLW and 0.42 kg/cm² firmness as compared to untreated ones (C), having 14.51 per cent CPLW and 0.39 kg/cm² firmness on the 9th day of storage under ambient conditions (34±2 °C and 85±5% R.H.). The salicylic acid treated fruits had 22.37 °B, 0.14 per cent and 4.93 mg/100g TSS, acidity and total carotenoids, compared to 21.50 °B, 0.13 per cent and 4.98 mg/100 g TSS, acidity and total carotenoids in untreated fruits on the 9th day of storage respectively (Fig. 36).

**Ripening of Dashehari mangoes under different temperatures**

Fruits, treated with 250 ppm ethrel in hot water (52±2 °C) and stored at 25±2 °C with 85 to 90% R.H., ripened after 21 days with firmness, TSS, titratable acidity, total carotenoids and spoilage of 0.68 kg/cm², 18 °B, 0.65 per cent, 4.62 mg/100 g and 12.33 per cent, respectively (Fig. 37). On the other hand, ethrel treated fruits could be stored up to 28 days at 10±2 °C temperature. The spoilage was not observed up to 21 days at this temperature. However, these fruits could not be stored thereafter even for a day under ambient conditions.

**Value addition**

**Preparation of carotenoids fortified mango chutney**

Mango chutney using *cv.* Sukul was prepared by adding drumstick leaf powder (rich in carotenoids) at 0, 2 and 4 per cent level and stored up to 9 months at room temperature. At zero day ascorbic acid and total carotenoids ranged between 18.36 - 20.91 and 2.07 - 2.76 mg/100 g. Highest total carotenoids content was found in addition of 4 per cent leaf powder (2.92 mg/100 g) and lowest in without leaf powder (2.16 mg/100 g) after nine months of storage (Fig. 3). However, chutney without leaf powder scored highest (7.52) organoleptically followed by 2 and 4 per cent leaf powder addition having a score of 6.70 and 6.43, respectively at the end of storage period.

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**Fig. 36.** Changes in weight loss and spoilage during storage of Dashehari mangoes treated with salicylic acid (SA), salicylic acid + inoculated (SA+Inn), control+inoculated (C+Inn) and control (C) fruits.

**Fig. 37.** Changes in total carotenoids content in mango chutney during storage (T-1 = 0%, T-2 = 2% and T-3 = 4% drumstick leaf powder)
Estimation of lupeol content in mango

Highest amount of lupeol (1082 µg 100 g\(^{-1}\)) was found in Dashehari as compared to Amrapali (505 µg 100 g\(^{-1}\)), Mallika (167 µg 100 g\(^{-1}\)) and Chausa (65 µg 100 g\(^{-1}\)) using HPLC with reverse phase C-8 column, PDA detector set at 210 nm and mobile phase of acetonitrile : acetic acid (99.99 : 0.01, v/v) at a flow-rate of 0.8 ml min\(^{-1}\).

Development of probiotic drink from raw mango

A probiotic drink, having 5.7 X 10\(^8\) CFU/ml Lactobacillus load, 4.8 °B TSS, 0.61 per cent acidity and 12.2 mg/100 ml ascorbic acid, was developed from raw mango fruits through lactic acid fermentation. It was found acceptable (7.9 score) during sensory evaluation.

Development of fish meal probiotic supplements from mango peel and pulp and aonla pomace (In collaboration with NBFR, Lucknow)

The leachets of pasteurized peel and stone of discarded mango fruits and aonla pomace were inoculated with Saccharomyces cerevisiae and Lactobacillus sp., fermented at room temperature and used as supplemental meal for feeding of fishes. The results indicated positive effect of probiotic supplements on growth and development of fish.

Waste utilization

Use of immobilization technique for mass production of enzyme through solid state and submerged fermentation

Cellulase was mass produced by Aspergillus niger using mango peel as substrate and immobilized in calcium alginate beads through entrapment technique. The catalytic properties of the immobilized CMCase were compared to free enzyme. The activity of the immobilized CMCase was 89.87 per cent of free enzyme, while for \(\alpha\)-glucosidase it was 96.45 per cent of the free enzyme.

Biofuel production from mango kernel using cell immobilization technique

Mango kernels were inoculated with yeast cells immobilized on wood shaving, mango stone shell pieces, nylon fiber, glass beads, calcium alginate beads, nylon thread, nylon net and compared for ethanol production. Maximum ethanol production (6%) was observed with yeast cells immobilized on mango stone shell pieces.

Enzyme-mediated production of sugars from mango kernel starch: statistical process optimization

Fermentation conditions were optimized for reducing sugar production by amylase enzyme isolated from Aspergillus niger NAIMCCF-02958 using mango kernel as substrate. Amylase isolated from Aspergillus niger was used to hydrolyze the acid pretreated (0.5% HCl) mango kernel starch. The experimental value of released reducing sugar was highest (15.86 %) in mango kernel at 5 per cent substrate concentration, 6.5 pH and 3 per cent of enzyme concentration (93.26 U/ml) after 3 hours of incubation at 50 °C. ANOVA and the three dimensional plots confirmed interactions among the parameters.

Screening of fungi for tannase production using mango kernel as substrate

Out of five fungi (Penicillium restrictum, Penicillium crustosum, Aspergillus niger, Aspergillus oryzae and Aspergillus fumigates) screened, the highest tannase production (0.531519 U/ml) was recorded through Aspergillus fumigatus followed by Aspergillus oryzae (0.520554 U/ml).

Comparison of microbial consortia for production of \(\alpha\)-amylase from mango kernel

Co-culture of Aspergillus oryzae and Fusarium solani resulted in better production of \(\alpha\)-amylase (6.41 U/ml) as compared to co-culture of Aspergillus niger and Aspergillus oryzae (3.89 U/ml) using mango kernel as substrate (30%) under solid state fermentation conditions at pH 5.5 and temperature 35 °C after 6 days of incubation.

Food safety

Pesticide residue analysis

Lambda-cyhalothrin: Lambda-cyhalothrin dissipated from 2.01 and 3.45 mg/kg at normal (1.0 ml/l water) and higher (2.0 ml/l water) doses, respectively, after 2 h of its application to 0.07
and 0.11 mg/kg after 15 days of its application to ‘Dashehari’ mango trees (Fig. 38). Residues could not be detected in mature fruit and pulp after harvest beyond 30 days of application. The residual half-lives in fruit were calculated as 3.26 and 3.14 days for normal and higher doses, respectively. Pre-harvest interval of 12 and 15 days could be suggested for normal and double doses, respectively, based on its EU MRL value of 0.1 mg/kg.

Fig. 38. First-order exponential curves of dissipation of lambda-cyhalothrin residues in mango fruit

Standardization of analysis of lambda-cyhalothrin and qunalphos in mango by HPLC

HPLC technique for the estimation of lambda-cyhalothrin residues in mango was standardized and validated using reverse phase C-18 column, PDA detector set at 230 nm and acetonitrile:water (80:20, v/v) as mobile phase at a flow-rate of 1.0 ml/min. The average recovery of lambda-cyhalothrin from mango pulp and fruit ranged between 84 to 98 per cent after adding 0.5, 1 and 2 µg/ml concentrations with a minimum limit of detection (LOD) 0.05 µg/ml and the limit of quantification (LOQ) 0.2 µg/ml.

Similarly, the HPLC analysis of quinalphos residues in mango consisted of reverse phase C-18 column, PDA detector set at 254 nm and acetonitrile:water:acetic acid (82.5:17:0.5, v/v/v) as mobile phase at a flow-rate of 1.0 ml/min. The average recovery of quinalphos from mango pulp and fruit ranged between 82 to 97 per cent after adding 0.5, 1 and 2 µg/ml concentrations with a minimum limit of detection (LOD) 0.1 µg/ml and the limit of quantification (LOQ) 0.2 µg/ml.

Market analysis

Disposal patterns of mango from Lucknow

A total of 81.12 thousand MT of mangoes were disposed off from Lucknow during 2014, which was second highest over 9 year period. During the current period, 61.85 per cent of the fruit was traded in the markets outside Uttar Pradesh as compared to 38.15 per cent within the state. Delhi accounted for 19.80 per cent depicting a drastic reduction against the previous year (30.11%). This could be due to late arrivals of Dashehari mangoes in the market. Disposals to Maharashtra and Madhya Pradesh increased by 38 and 20 per cent, respectively (Fig. 39). The export to Nepal directly from Lucknow belt has also shown an increasing (18%) trend.

The study on weekly disposal patterns indicated that mango season during 2014 again got delayed by about 10 days due to delayed fruit maturity owing to extended cold spell during the winters of 2014. The highest disposal of 24.23 per cent was during June 20 to 26, 2014 as against 17.86 per cent in the same period during the 2013.

Arrival and price structure of fruits in major wholesale markets of the country

Lucknow wholesale market

The total arrival of mango during 2014 season in Lucknow market was 85.75 thousand MT. It was highest (86.70 thousand MT) during 2010. The mango season in Lucknow started from January owing to arrival of Banganpalli followed by Pairy cultivars from Southern states. It kept on increasing up to May, after which actual arrivals of Dashehari started. Highest arrival (70.40%) was recorded in Lucknow market during June followed by July (25.53%). Its price was highest (Rs. 1600
per q) in May followed by June, 2014 (Rs. 1,425) and July, 2014 (Rs. 1,396). The average weighted price during the entire mango season was Rs. 1,425 per q, which was highest during 2004-2014 period.

**Major markets of the country**

Dashehari was the most traded cultivar (27.5%) during 2012 of total mango trading of 1076.35 thousand MT, after which its share dropped to 26.3 per cent of total mango trading of 992.41 thousand MT during the current year. Though trading volume in Banganpalli also dropped by 25 per cent during the year it still maintained its first ranking. An increase in the trading of Langra (22.8%) and Chausa (149%) cultivars was noticed. Cultivar Dashehari was traded in 19 markets of the country as against 21 in Banganpalli, 16 in Langra, 11 in Chausa and 16 in Totapuri.

Delhi accounted for 77.9 per cent of total Dashehari mangoes trading in India during 2014 followed by Lucknow (4.1%), Jaipur (3.2%), Srinagar (2.5%) and Nagpur (2.2) (Fig. 40). Average weighted wholesale price during the season was high in Srinagar (Rs. 3,314 per quintal) followed by Delhi (Rs. 2,783), Nagpur (Rs. 2,771), Lucknow (Rs. 2196) and Jaipur (Rs. 1,945). Highest price of Dashehari was in Chennai market (Rs. 6,565) followed by Gangtok (Rs. 6,110), Guwahati (Rs. 5,380) and Mumbai (Rs. 4,906) markets, though the traded volume was quite low. These markets could be potential markets for trading of Dashehari mangoes from Lucknow region.

Total trading of cv. Langra in the country was 156.87 thousand MT. It was also traded extensively in Delhi (78.5%) followed by Kolkata (8.1%) and Patna (7.4%), owing to its cultivation in Uttar Pradesh, Bihar and West Bengal (Fig. 41). The weighted average seasonal price in Kolkata and Patna markets was Rs. 3,573 and 3,669 per quintal, respectively, as against Rs. 2803 per q in Delhi market. The highest average weighted seasonal price per quintal was in Chennai (Rs. 6,781) followed by Gangtok (Rs. 6,203), Guwahati (Rs. 4,525) and Bhubaneswar (Rs. 3,925) markets. The traded volume in first two markets, which offered highest price for the cultivar, was very low (0.19 and 0.07 thousand MT, respectively). Due to comparative price advantage these markets could be exploited by Uttar Pradesh producers.

Chausa was the least traded amongst North Indian cultivars at 124.38 thousand MT out of which Delhi’s share was 80.0 per cent followed by Mumbai (13.1%) Kolkata (2.9%) and Chandigarh (1.3 %) (Fig. 42). The weighted seasonal average price of the cultivar over all the markets was Rs. 4,362 per quintal, which was highest over all the major cultivars traded throughout the country. Its price was Rs. 4,481 and 3,980 per quintal in Delhi and Mumbai.
markets, respectively. Highest weighted average seasonal price of Rs. 8,035 per quintal for the trading of 0.09 thousand MT of the cultivar was worked out for Bhubaneswar. Hence this market could be profitably exploited.

Banganpalli, due to early arrival in the country, had the price advantage. Consequently it was traded in the highest number of markets (21), maximum volume (284.40 thousand MT) and weighted average seasonal price (Rs. 3,466 per quintal) over all the markets. The share of Delhi, Nagpur, Jaipur, Bengaluru, Hyderabad, Kolkata and Chennai in the total trading of this cultivar was 63.8, 8.0, 5.3, 5.3, 5.0, 2.5 and 2.5 per cent, respectively. The highest weighted average seasonal price was worked out for Shimla (Rs. 3,991 per q) followed by Raipur (Rs. 3,943) and the lowest in Hyderabad (Rs. 1,962).

Totapuri was traded in 16 markets around the country. Delhi accounted for 84.8 per cent of the total trading as compared to 5.5, 1.4, 1.3 and 1.3 per cent in Nagpur, Bengaluru, Bhopal and Ranchi, respectively. The highest weighted average seasonal price of Rs. 4,487 per quintal was worked out in Guwahati followed by Hyderabad (Rs. 3,300) and the lowest in Nagpur (Rs. 1,200) and Ranchi (Rs. 1,391).

Alphonso, a premium cultivar of mango for export, has become the largest traded cultivar (355.17 thousand MT) during 2014. However, it was traded in only six markets of the country. Bengaluru had the largest market share (46.8%) followed by Delhi (33.1%) and Mumbai (17%). The highest price of the cultivar (Rs. 20,649) was realized in Ahmedabad.

Kesar was the least traded mango cultivar at 40.96 thousand MT in only two markets of the country (Ahmedabad and Mumbai). Ahmedabad accounted for 87.4 per cent. The weighted average seasonal price in Mumbai was Rs. 5,335 per quintal as against Rs. 4,592 per quintal in Ahmedabad.

Export and Import performance

Export of fresh fruit

The export of fresh fruits from India to 53 countries during 2013-14 was 37.30 thousand MT depicting a sharp decline of 33 per cent over the previous year. However, the value of the fruits attained all time high of Rs. 285.43 crores. The decline could mainly be attributed to the reduction in the exports to UAE (39%) and Bangladesh (38%) (Fig. 43). On the other hand, the value of exports to U.K. increased by 39.8 per cent. The growth pattern in mango export was studied by fitting linear, modified quadratic, exponential and modified exponential growth functions. In case of quantity of mango exports, modified exponential function provided the best fit with a $R^2$ value of 0.735. The regression coefficients were significant at 5% level. The negative coefficient for square term indicated decelerating growth. All the functions for the value of mango exports provided satisfactory $R^2$ values (>0.89). However, modified exponential function provided the best fit with a $R^2$ value of 0.946.

Export of mango products

India exported 229.51 thousand MT of mango products worth Rs. 1,418.85 crores during 2013-14. Pulp and jam were the major mango products with a share of 62.22 and 32.32 per cent in quantity and 54.48 and 39.17 per cent in value terms, respectively. Jam was mainly exported to Netherlands (28 %) and Saudi Arabia (13 %). Mango pulp was exported to 83 countries during 2013-14. The exports of pulp have been declining after attaining a peak (186.20 thousand MT) during 2009-10. There was an overall decline of 23.31 per cent up to 2013-14, when the exports were 142.80 thousand MT. However, value of exports was Rs. 773.01 crores, which was next only to peak of Rs. 814.01 crores during 2010-11. Saudi Arabia continued to be the highest importer of mango pulp from India (31.08 %) followed by Yemen (14.68 %) and Netherlands (9.96%) (Fig. 44). The export of fresh fruit to these countries during 2013-14 is shown in Fig. 44.
growth pattern in mango pulp export was studied by fitting linear, modified quadratic, exponential and modified exponential growth functions. Except for the linear function, the other three functions provided satisfactory $R^2$ values (>0.700) for quantity of pulp exported. However, the modified exponential function provided the best fit with a $R^2$ value of 0.870. The regression coefficients for trend as well as square term were significant at 5% level. The negative values for the square term indicated a decelerating growth in the dependent variable. All the functions provided satisfactory $R^2$ values for value of pulp export (>0.800), however, modified exponential function had the highest $R^2$ value of 0.874 and provided the best fit.

An attempt was made to generate supply response functions by regressing the quantity of fresh mango and its pulp on lagged quantity and lagged price as well as current price. In case of response function for quantity of mango exports from India, the regression coefficients were significant for current price and lagged quantity at 15 and 5 per cent levels with a $R^2$ value of 0.385, which was not sufficient. However, in the second function, the regression coefficient for lagged price was significant at 10 per cent level with a $R^2$ value of 0.315, which also was not acceptable. Similar functions were fitted to generate supply response models for the mango pulp exports from India. It indicated that inclusion of lagged price and lagged quantity in the model provided a $R^2$ value of 0.840 with non-significant coefficient for the lagged price. On the other hand, the regression coefficients for the current price and lagged quantity were significant at 5% level with a $R^2$ value of 0.888. Therefore, the function was best fit and was acceptable.

**Imports**

The imports was highest (2922.05 MT worth Rs. 788.71 lakh) during 2009-10. It closed at 482.43 MT worth Rs. 296.99 during 2013-14, indicating an overall drop of 83 per cent in quantity and 62 per cent in value. Even though the country is a major exporter, it imported 7.52 MT of mangoes worth Rs. 20.49 lakhs mainly from Bangladesh (82%) during 2013-14. Juice (312.93 MT worth Rs. 22.88 crores) was imported from 12 countries, mainly Sri Lanka (29%), Bangladesh (22%), Bhutan (20%) and UAE (18%). Mango Jam, another important product (127.44 MT worth Rs. 56.02 lakhs), was imported from 6 countries, mostly from Bangladesh (48%) and U.K. (26%). The pulp was exclusively imported from China. The squash was imported from six countries mainly from Netherlands (42%), USA (25%) and New Zealand (20%).

**GUAVA (Psidium guajava L.)**

**Storage**

**Enhancing shelf life of guava by use of safe chemicals**

Guava fruits (cv. Allahabad Safeda), harvested at 110 days after fruit set, were subjected to post harvest dip treatments with salicylic acid and acylated salicylic acid (both 1 mM) for 5 min and stored under ambient conditions (12±2 °C and 80±5% R.H.). The cumulative physiological loss in weight (CPLW) and firmness were 9.36 and 9.66 per cent and 5.2 and 4.4 kg/cm$^2$, respectively after 9 days in the fruits subjected to 1 mM salicylic acid and 1 mM acylated salicylic acid treatment.

**Storage of guava at low temperature**

Allahabad Safeda fruits, treated with 1 mM salicylic acid (SA), acylated salicylic acid (ASA) and water for 5 min and stored up to 21 days at 10±2 °C and 85-90 per cent R.H., had 12.5 kg/cm$^2$ firmness, 8.9 °B TSS, 0.34 per cent acidity and 191.33 mg/100 g ascorbic acid (Fig. 45). The texture was better and CPLW was least in salicylic acid treated fruits during 21 days of storage compared to control and ASA treated fruits. In both the
treatments there was no disease on the fruits during the storage.

Identification of nutraceuticals

Identification of organic acids and phenolic compounds

Oxalic acid, malic acid, citric acid, succinic acid and ascorbic acid contents were analysed in three guava cultivars (Allahabad Safeda, Sardar and Lalit) using HPLC. Ascorbic acid was the major organic acid detected and succinic acid was found in the least quantities. Allahabad Safeda had the highest amount of ascorbic acid (183.4 g 100 g⁻¹) and Lalit had the lowest (95.4 g 100 g⁻¹).

Gallic acid, caffeic acid, sinapic acid, ferulic acid, epicatechin, 4-hydroxybenzaldehyde and kaempferol were analysed in three guava cultivars (Allahabad Safeda, Sardar and Lalit) using HPLC. Gallic acid, kaempferol and epicatechin were the major polyphenols detected in guava. Gallic acid (421 µg g⁻¹) and kaempferol (13.1 mg g⁻¹) were found highest in Lalit, while epicatechin (19.2 µg g⁻¹) was maximum in Allahabad Safeda. All the three phenolic compounds were found in lowest quantities in Sardar.

Market analysis

Lucknow wholesale market

The total arrival of guava in Lucknow market during 2014-15 was 3.08 thousand MT as against 3.00 thousand MT during the previous year. December 2014 accounted for 29.49 per cent of total arrivals followed by January 2015 (22.72%) and November 2014 (15.66%). The arrivals during monsoon season were 9.43 per cent, out of which August had 5.56 per cent share. The maximum price of guava (Rs. 800 per q) was realized during October 2014 followed by November 2014 (Rs. 630 per q), December 2014 (Rs. 500) and January 2015 (Rs. 505). The weighted annual average price was Rs. 547 per quintal.

Major markets of the country

Guava was mainly traded in 14 markets of the country. Total trading of guava in major markets of the country was 54.84 thousand MT, which was marginally (6.73%) higher than the previous year, but significantly lower (43.15%) than the trading in 2012-13. Delhi was the single largest market in the country for guava as it traded 34.71 per cent of the total trading of the fruit followed by Kolkata (19.21%), Mumbai (7.42 %), Hyderabad (8.77 %) and Bhopal (6.09 %) (Fig. 46). The trading of guava was highest during January 2015, December 2014 and February 2015 as they accounted for 22.97, 17.62 and 14.52 per cent of total trading during the year, respectively. On the other hand, August and September 2014 accounted for only 6.90 and 6.66 per cent of total trading. The weighted average annual price was highest in Bangaluru market (Rs. 5,541 per quintal), followed by Ahmedabad (Rs. 4000), Bhubaneswar (Rs. 3,294), Raipur
(Rs. 3,160) and Kolkata (Rs. 3,148) markets. Least price was realized in Jaipur market (Rs. 1,912).

Exports

The export of guava was mainly concentrated in Middle East. It has steadily been declining after attaining the peak (1381.91 MT) during 2011-12. There was an overall decline (30%) during 2013-14 in comparison to 2011-12. On the contrary, the value of the export has increased steadily during this period. It increased from Rs. 3.18 to 4.15 crores during 2011-12 to 2013-14 period. Sudan accounted for 25 per cent of the total quantity and 33 per cent of total value of the fruit exported during 2013-14 followed by Yemen (19%) and Saudi Arabia (18%). UAE and Oman were other importing countries.

India exported a total of 4210.01 MT of guava products worth Rs. 20.78 crores during 2013-14. Jelly was the most exported guava product (3487.48 MT worth Rs. 18.10 crores). RTS was another item exported from the country. Netherlands and Indonesia were the major importer of guava jelly by accounting for 28 and 27 per cent, respectively. RTS was mainly exported to Tanzania and Sudan.

BAEL (Aegle marmelos Correa)

Storage and ripening

The fruits of CISH B1, ripened 7 days after dip treatment in hot water at 52±2 °C with 500 ppm ethrel for 10 min, had TSS of 31.33 °B, acidity 0.42 per cent, total phenols 2.42 mg/100 g tannic acid equivalent (TAE), marmelosin 32.53 µg/g and psoralen 12.41 µg/g. The fruits of CISH B2 ripened in 14 days after the same treatment with TSS 8.47 °B, acidity 0.39 per cent, total phenols 2.17 mg/100 g TAE, marmelosin 9.43 µg/g and psoralen 0.88 µg/g. TSS and total phenols increased upon ripening, while acidity, marmelosin and psoralen decreased.

Value addition

Development of probiotic products from bael

A probiotic drink was prepared from mature unripe bael fruits through lactic acid fermentation. It had 6.4 °B TSS, 0.52 per cent acidity (as lactic acid), 0.7 mg/100 ml ascorbic acid and 312 mg/100 ml total phenolics. The product obtained an average sensory score of 7.45 out of 9. The bael pieces separated from drink were utilized for preparation of oiled pickle and preserve. Pickle, prepared through addition of salt, sugar, vinegar, mustard oil and spices, obtained a score of 7.62 out of 9. Similarly, preserve prepared had very crispy texture and high acceptability (8.08 score out of 9).

Quantification of nutraceuticals

Among the seven bael cultivars (Pant Shivani, Pant Sujata, Pant Aparna, NB-5, NB-9, NB-16 and NB-17) tested for nutraceuticals by HPLC at the time of harvest, cv. NB-5 contained highest amounts of marmelosin (256.7 µg/g) and thiamine (66.8 µg/g), whereas, cv. Pant Shivani had maximum amount of psoralen (179.0 µg/g) and cv. NB-17 maximum amount of riboflavin (5.0 µg/g). Pant Sujata had the lowest amounts of psoralen (12.6 µg/g) and riboflavin (0.035 µg/g). Minimum amounts of marmelosin (42.2 µg/g) and thiamine (11.9 µg/g) were recorded in cvs NB-9 and NB-17, respectively.

AONLA (Emblica officinalis Gaertn.)

Storage

Shelf life extension of aonla by use of safe chemicals

Shelf life of aonla fruits could be enhanced up to 9 days by treating them with acylated salicylic acid (1 mM) (T). The weight loss was maximum (10.54 %) in cv. NA-7 and minimum (7.55%) in cv. NA-10 on the 9th day of storage. Spoilage was also less during storage in acylated salicylic acid treated fruits (Fig. 47).

Value addition

Development of blended squash from aonla

Blended squash from aonla was prepared with litchi and grape (purple variety) separately in 3:1 and 1:1 ratio each. The ascorbic acid and total phenolic content were highest (152 mg/100g and 652 mg/100g, respectively) in aonla-litchi squash 3:1 ratio. Initial sensory evaluation of the product revealed that aonla-litchi (1:1) blend
scored maximum (8.4), followed by 8.1 for aonla-grape (1:1). Sensory score after 3 and 6 months of storage also indicated higher preferences for 1:1 blend than for 3:1 blend in both aonla-litchi and aonla-grape squashes.

Estimation of phenolic compounds

Gallic acid, catechin, epicatechin, caffeic acid, 4-hydroxybenzaldehyde and kaempferol were identified in varying proportions in eleven aonla cultivars / accessions (NA-10, Kanchan, Lakshmi-52, A-1, A-2, A-4, A-8, A-15, A-31, A-35 and UK-3) through HPLC. Gallic acid, caffeic acid and kaempferol were the major phenolic compounds found in all cultivars. Accession CISH-A-35 contained the highest amount of gallic acid (7.05 mg/g), whereas, accession CISH-UK-3 had the lowest (1.75 mg/g). The content of caffeic acid was highest (326.0 µg/g) in cv. NA-10 and lowest in accession CISH-A-8 (82.7 µg/g). The amount of kaempferol was maximum (63.9 mg/g) in accession CISH-A-31, while it was minimum in cv. Kanchan (1.60 mg/g).

Development of probiotic drinks from aonla and sugarcane

Probiotic drinks prepared from aonla and sugarcane had 4.2 and 17.4 °B TSS, 0.94 and 2.05 per cent acidity, 28.2 and 14.3 mg/100 ml ascorbic acid and 558 and 215 mg/100 ml total phenolics.

Development of aonla based seed spice products (Work done in collaboration with NRCSS, Ajmer)

Aonla based seed spice squashes were prepared using 20 per cent aonla blended with 25 per cent extract of dill, fennel and coriander seeds separately. The ascorbic acid and total phenolic contents along with sensory evaluation of aonala-dill, aonla-fennel and aonla-coriander squashes were 63.1, 65.2 and 73.3 mg/100 ml; 685, 679 and 735 mg/100 ml; and 7.2, 8.2 and 8.2, respectively. The probiotic drink, prepared from residue of spice seeds (dill, fennel and coriander) left after water extraction through lactic acid fermentation, had 4.0 °B TSS, 0.36 per cent acidity, 3.5 mg/100 ml ascorbic acid and 2.4 mM/ml antioxidant value. The probiotic drink having Lactobacillus load (2.78 x 10^9 CFU/ml) was highly acceptable on sensory score (8.25 out of 9). The residue mixture of spice seeds was also utilized for preparation of sweet chutney using aonla juice, sugar, salt, cumin seed powder, black pepper powder and citric acid. It had 50 °B TSS, 1.0 per cent acidity, 96 mg/100 g ascorbic acid and 1.08 per cent total phenolics. The product, though good in taste, could not acquire good acceptability due to high amount of fibre.

Dill capsule, containing 200 mg of dill powder had 13.1 mg total phenolics and 53.6 mg gallic acid equivalent (GAE) total antioxidants. Dill prash, prepared using dill powder, honey and spices, had 70 °B TSS, 1.67 per cent acidity, 20.6 mg/100 g ascorbic acid and 2.52 per cent total phenolics.

The aonla and fenugreek based tea formulation contained 3.57 mg/100 ml vitamin C and 8.06 mM/ml antioxidants. Aonla-dill based tea formulation contained 3.3 mg/100 ml ascorbic acid and 42 mM/ml antioxidants after six months of storage. Aonla-fenugreek based khichri
formulation contained 35 per cent dietary fibre, 2.38 mg/100 g vitamin C and 24.35 mM/ml antioxidants.

Aonla-dill cider with alcohol (4%), ascorbic acid (3.57 mg/100 ml), reducing sugar (4.24 g/100 ml) and tannins (0.37 g/100 ml) was prepared. Aonla-dill parag (a chewing formulation) was developed. It contained 3.50 mg/100 g ascorbic acid and 28 mM/ml antioxidants after six months of storage.

**Value addition**

**BANANA** (*Musa paradisiaca*)

**Development of probiotic products from banana**

Probiotic drink and puree were prepared from banana. The *Lactobacillus* loads of drink, puree (control) and puree (sweet) at 0 day were $8.21 \times 10^6$, $2.36 \times 10^5$ and $4.25 \times 10^5$ CFU/ml, respectively. The TSS of the drink and puree (control) was 10.8 °B, while sweet puree had 19.0 °B. The titratable acidity ranged from 1.33 to 1.64 per cent, ascorbic acid from 42.8 to 54.1 mg/100 ml, total phenolics from 67.0 to 73.5 mg/100/ml and reducing sugars from 1.1 to 4.6 per cent. Storage analysis up to 4 weeks revealed a decrease in ascorbic acid and total phenolics and an increase in reducing sugars. The nisin content of banana probiotic drink was 0.166 mg/ml after 4 weeks of storage with zero microbial load.

**MULBERRY** (*Morus alba*)

**Development of probiotic mulberry drink and pickle**

Mulberry (cv. MI-497) was subjected to lactic acid fermentation at 37 °C for 2 days. Berries were separated out for pickle while liquid served as probiotic drink. The *Lactobacillus* load was $5.75 \times 10^7$ and $2.92 \times 10^5$ CFU/ml in drink and pickle, respectively. The drink had 3.8 °B TSS, 0.72 per cent acidity, 1.2 mg/100 ml ascorbic acid and 9.1 mg/100 ml anthocyanins. The corresponding values for pickle were 4.5 °B, 0.63 per cent, 11.9 mg/100 ml and 208 mg/100 ml, respectively.

**JAMUN** (*Syzygium cumini L.*)

**Development of jamun pickle by lactic acid fermentation**

Jamun fruits, subjected to lactic acid fermentation at 37 °C for 2 days and separated from liquid part after proper development of acidity were mixed with 5 per cent salt and kept in electric dehydrator for intermediate moisture level. The fruits were then utilized for preparation of oil pickle and sweet pickle using spices. Sweet pickle also contained sugar and vinegar besides other ingredients. Oil and sweet pickle had 20.0 and 18.5 °B TSS, 0.40 and 3.0 per cent acidity (as lactic acid), 23.8 and 17.8 mg/100 ml ascorbic acid, respectively. The microbial load was found to be nil in both the pickles.

**Development of jamun-aonla blended ready-to-serve beverage**

Ready to serve beverages were prepared by blending juices of jamun and aonla in three ratios (9:1, 8:2, 7:3). RTS prepared from jamun and aonla juices (9:1) scored 8.72 out of 9 followed by blend in 8:2 ratio (8.3 out of 9). After 6 months of storage the drink contained 16 °B TSS, 0.3 per cent acidity as citric acid, 9.2 mg/100 ml ascorbic acid, 6.2 per cent reducing sugar, 21.6 mM/ml antioxidants and 1.9 mg/100 ml anthocyanin.

The aonla and jamun based tea formulation contained ascorbic acid and antioxidants at a level of 2.38 mg/100 ml and 11.90 mM/ml, respectively.
Impact assessment of guava varieties developed by CISH

Impact assessment of Lalit and Shweta varieties of guava released by the Institute was undertaken in Nashik, Satara, Sangli and Pune districts of Maharashtra during October, 2014 and Anantpur, Khammam, Mehboobnagar of Andhra Pradesh and Hyderabad of Telengana during March, 2015. The farmers cultivated guava particularly new cultivars under high density system (our recommendation of 1.5 x 2 m), although the densities varied a lot. Generally guava were planted at a distance of 1.8 x 2.4, 1.5 x 2.7, 1.5 x 2.4, 1.8 x 2.1, 1.8 x 2.7, 1.2 x 3.0 m, etc. Due to plantation at close distance and injudicious pruning, many of the orchards were over-crowded resulting into sub-optimal yields. One of the farmers reported that with a variable cost of Rs. 0.30 lakh, he could trade guava worth Rs. 2.1 lakh per acre. All guava plantations were under drip irrigation. Some farmers used it for fertigation. The farmers had established ponds to feed the drip system. Even though the farmers shifted to guava, they continue to follow package of practices of pomegranate albeit with some modifications. These included use of 700 g spray of blue copper, Bordeaux paste, streptocycline, etc. without knowing as to why these chemicals were used. Some farmers did not take adequate care of Lalit and Shweta plants resulting into emergence of off-shoots from the rootstock, which overtook the main scion and reduced the quality of the orchard. It was also observed that none of the farmers used traps for the control of fruit fly, rather they used spray of chlorpyriphos. The incidence of guava canker was also noticed in one of the orchards. The farmers used only 700 g per plant NPK mixture of 10:26:26 and SOP to supplement potash. It is evident that none of the farmers used balanced/recommended doses of fertilizers for guava. All the farmers harvested guava fruits at hard green turner stage for long distance market. The farmers were not averse to fruiting during monsoon season and did not make any effort to escape rainy season crop. The farmers were pruning guava trees to maintain their dwarf stature. However, some of the farmers pruned the trees during September resulting into development of vegetative shoots, which led to loss of winter crop. Besides Lalit and Shweta, farmers are also cultivating L-49, G. Vilas Pasand and VNR-1. It was observed that 40 per cent fruits of Lalit had rough skin, with poor colour development. However, Shweta had well developed medium sized fruits. This could be because of excess irrigation through drip (discharge of 16 to 25 L water per hour for two hours a day). G. Vilas Pasand and Lalit were processed to a limited extent because of their lower availability. One nurseryman was supplying grafted plants of L-49, G. Vilas Pasand, Lalit and Shweta extensively throughout north and central Maharashtra. He took the plants from ICAR-CISH, Lucknow and established mother block of Lalit and Shweta and other varieties for the purpose. He sells the plant at the rate of Rs. 40.
fruited in the year 2011 and the reported yield was 4-5 kg/plant. The guava variety Allahabad Safeda was preferred most due to its better demand in the market. However, the quality of Lalit fruits was also reported good and preferred for processing. Allahabad Safeda and Shweta were preferred for table purposes. The varieties were sold @ Rs. 15/kg from the field itself. Farmers reported that at initial year, traders were worried about sale of fruits of Lalit variety due to its red pulp, but they were happy later because by mixing of fruits of all the varieties they were obtaining more price in the market.

**Impact of mango rejuvenation technology developed by ICAR-CISH**

Impact was assessed in the rejuvenated orchard situated in Meerut (U.P.), Banswara (Rajasthan) and Sangareddy (Telangana) during September, 2014 to March, 2015. Data collected from 21 farmers in Meerut and Lucknow districts of U.P. indicated that rejuvenation was done in Dashehari and Chausa varieties. The rejuvenated trees were above 40 years of age. After rejuvenation, the average yield of Dashehari was 60-80 kg/tree in the Lucknow district, however, it was 30 kg/tree in Meerut area. Overall, 60 per cent rejuvenated trees survived. In the Meerut district, alternate row rejuvenation was also performed. Stem borer was the main reason for mortality of mango trees. However, in some areas rejuvenated mango orchards were removed by the farmers due to the problem of brick kiln. Rejuvenated Dashehari and Chausa mango trees in Banswara (Rajasthan) and Sangareddy (Telangana) indicated that overall 80-90 per cent tree survived. Remaining trees died due to the infestations of stem borer, dieback, leaf eating caterpillar, sooty mould, etc. In Baghpat district of U.P., rejuvenated mango trees were removed during the year 2007-08 due to the infestation of dieback, stem borer and production of poor quality fruits due to the opening of a large number of brick kiln in the area.

**Extension Intervention**

**Exhibitions** : Institute participated in various state as well as National level exhibitions and displayed Institute’s achievements and technologies on mandated crops as per the following detail. Exhibitions were highly effective in communicating the knowledge among visitors.

<table>
<thead>
<tr>
<th>Event/Occasion</th>
<th>Place</th>
<th>Organizer</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd Mango Festival &amp; Farmers’ Market</td>
<td>Habibullah’s Orchard, Saidanpur, Barabanki</td>
<td>Habibullah State, Times of India, Radio City, NABARD</td>
<td>June 22, 2014</td>
</tr>
<tr>
<td>10th International Agriculture &amp; Horti Expo-2014</td>
<td>Pragati Maidan, New Delhi</td>
<td>NNS Media Group, NHM, APEDA, NSIC &amp; Air India</td>
<td>July 25-27, 2014</td>
</tr>
<tr>
<td>National Meet &amp; Jaggery Carnival</td>
<td>ICAR-IISR, Lucknow</td>
<td>ICAR-IISR, Lucknow &amp; UP Sugar Mills Association</td>
<td>November 01-02, 2014</td>
</tr>
<tr>
<td>5th Global Symposium on Gender in Aquaculture &amp; International Workshop on Aquatic Animal Disease Surveillance &amp; Exhibition</td>
<td>ICAR-NBFR, Lucknow</td>
<td>ICAR-NBFR &amp; Asian Fisheries Society, Indian Branch (AFSIB), Mangalore, ICAR</td>
<td>November 12-15, 2014</td>
</tr>
<tr>
<td>Lucknow Mahotsava</td>
<td>Sanskritik Sthal, Near Pasi Quila Chauraha, Lucknow</td>
<td>Council of Science &amp; Technology, UP</td>
<td>November 25 to December 07, 2014</td>
</tr>
<tr>
<td>12th Agriculture Science Congress &amp; India Expo</td>
<td>ICAR-NDRI, Karnal</td>
<td>ICAR-NDRI, Karnal, NAAS, ICAR &amp; NABARD</td>
<td>February 03-06, 2015</td>
</tr>
<tr>
<td>Purvanchal Regional Agriculture Fair, Farmers Gosti &amp; Exhibition</td>
<td>ICAR-CPRS, Patna, Bihar</td>
<td>ICAR-CPRI, Shimla &amp; Indian Potato Association, Shimla</td>
<td>February 19-21, 2015</td>
</tr>
</tbody>
</table>
Demonstrations

1. Improved grafting methods for multiplication of mango, guava and aonla were demonstrated among various farmers group during their visit to the Institute’s experimental field.

2. Demonstration during gosthi organized at orchard of Shri Amar Habibullah, Saidanpur, Barabanki on shoots thinning in rejuvenated mango trees in village Saidanpur, Barabanki on June 22, 2014.

3. Demonstration on control of stem borer and leaf webber in mango during mango gosthi at village Bhatoya, Malihabad on August 08, 2014.

Gosthi

- One-day ‘Farmers Gosthi’ under farmers awareness programme at Dwarika Nath Senior Secondary School, Bhatoya, Malihabad on August 08, 2014. More than 100 farmers participated in the gosthi.

- A Sensitization programme on “Management of mango stem borer and leaf webber” was organized for mango growers of Malihabad on August 7, 2014 at Dwarika Nath Senior Secondary School, Village Bhatoya, Malihabad.

Farmers/Students/Extension Functionaries Exposure Visit

- One thousand four hundred thirteen (1413) farmers including 22 development officers, 50 bankers, 224 students and 33 women farmers visited Institute’s Experimental field and laboratory under Farmers/extension functionary /students exposure visit (33 groups) during April 2014 to March 2015. They were shown Institute’s experimental farms, processing hall and packaging laboratories to make them aware about our research activities and developed technologies.

- About 41 farmers and extension functionaries from different parts of India visited the Institute and were counseled about their doubts faced during their technology implementations in the field.

Postal Queries

Growers’ queries related to various aspects of subtropical fruits were attended through correspondence. Extension folders and bulletins related to scientific cultivation of mango, aonla, guava and papaya were provided to the orchardists.

Farmers’ Helpline

Farmers’ queries (97 Calls) particularly related to availability of grafted plants of fruits (25.22%), insect management (24.25%), disease control (14.55%), malformation in mango (9.70%), fruit drop (4.85%), fruit settings (3.88%), nutritional deficiency (3.88%), irrigation (2.91%), cultivation of litchi & guava (2.91%) and intercrops (2.91%) were attended to provide solutions through telephonic conversation on Kisan Call and Media Resources Centre of the Institute.

Assessment of drought situation in the wake of deficient rains and the resultant impacts on the crop status, soil nutrient status, occurrence of pests/ diseases affecting the crop yield

Following directives of Director General, ICAR in respect of assessment of drought situation / moisture deficiency in the wake of uneven/ intermittent / deficient rains across the country and the resultant impacts on the crop status, occurrence/ emergence of pests / diseases, soil nutrient status affecting the crop yield, Director, ICAR-CISH constituted six committees to address
the issues and suggest appropriate measures to ameliorate the problem. The teams visited 4 villages in Mall block, 3 in Malihabad block, 2 in Kakori block, 4 in Baxi-ka-Talab of the Lucknow district, 2 in Sidauli block of Sitapur district, 4 in Mohan block of Unnao district, 2 in Badaun district and 4 villages in Allahabad district of Uttar Pradesh between August and September 2014 with a view to i) understand the impact of deficient monsoon on mandate crop yields; ii) develop contingency plan/alternatives to sustain farm activities; iii) understand the emerging pests/diseases and their impacts on crop yields; and iv) orchard nutrition/soil health status and the measures required for improving profitability to the orchardists. A total of 737 farmers participated in these meetings and interacted with the scientists. Following actions/suggestions were made.

- Soil testing is essential to know the nutrient status of orchards and its supplementation for good yield and quality.
- Adoption of good agricultural practices in mango and guava.
- Use of Cultar (paclobutrazol) in irregular and non-bearing old orchards of mango cv. Langra.
- Integrated nutrient management in mango and guava.
- On-farm compost production, its application, integrated nutrient management in mango and guava, inter cropping and adoption of organic farming practices.
- Use of genuine planting materials for establishment of new orchards and new varieties of mango and guava released by ICAR-CISH and other institutes under NARS.
- Management of major insect-pests and diseases in mango and guava.
- Use of methyl eugenol pheromone traps to control fruit fly in mango and guava.
- Adoption of post harvest management practices (good sorting, grading and packaging practices) for realizing reasonable prices of their produce in the markets.
- Training and other farmers' advisory services need to be strengthened in the fruit growing regions of the state.
- Interaction with farmers and Meeting/Goshthi was also organized on September 02, 2014 at Said Nagali, Hasanpur (Amroha) (120 farmers participated); September 03, 2014 at KVK, Saharanpur (140 farmers participated); September 04, 2014 at Bijnor (54 farmers participated) and September 05, 2014 at KVK, Baghra (Muzaffarnagar) (210 farmers participated).

**Mango Fair organized by Institute**

- Two hundred mango varieties were displayed in Lucknow Mango Festival at Barabanki, June 22, 2014.
- Six hundred varieties of mango were displayed in Second Kerala Mango Festival at Cochin, June, 26-29, 2014.
- Six hundred varieties of mango were displayed in Custodian Farmers Workshop at Lucknow, June, 28-29, 2014.
- 150 varieties of mango were displayed in Mango Festival at NAASC, New Delhi, July 5, 2014.
- 300 varieties of mango were displayed in mango festival organized at New Delhi, July 12-13, 2014. Forty two important varieties were selected from the four communities with the consensus of community members and grafts were multiplied for distribution among community members.
### Trainings organized during April 2014 to March 2015

<table>
<thead>
<tr>
<th>Topic</th>
<th>Sponsored</th>
<th>Duration &amp; Place</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value addition and waste utilization in mango</td>
<td>BSKKV, Dapoli</td>
<td>June 2-30, 2014, Lucknow</td>
<td>2 students</td>
</tr>
<tr>
<td>Awareness training programme on diversity conservation for community farmers</td>
<td>ICAR-CISH and Society for Conservation of Mango Diversity (SCMD)</td>
<td>July 5, 2014, NAAS, New Delhi</td>
<td>400 participants</td>
</tr>
<tr>
<td>Awareness training programme on diversity conservation for community farmers</td>
<td>PPV&amp;FRA and ICAR-CISH</td>
<td>August 3, 2014, Kasmandi, Lucknow</td>
<td>42 farmers</td>
</tr>
<tr>
<td>Awareness training programme on diversity conservation for community farmers</td>
<td>ICAR-CISH and SCMD</td>
<td>August 12, 2014, Md. Nagar Talukedari, Lucknow</td>
<td>151 farmers</td>
</tr>
<tr>
<td>Awareness training programme on diversity conservation for community farmers</td>
<td>ICAR-CISH and SCMD</td>
<td>August 13, 2014, Goparamau, Lucknow</td>
<td>121 farmers</td>
</tr>
<tr>
<td>Cultivation Management of Subtropical Fruits</td>
<td>ATMA, Muzaffarpur, Bihar</td>
<td>August 25-29, 2014, Lucknow</td>
<td>15 farmers</td>
</tr>
<tr>
<td>Production &amp; Protection of Subtropical Fruits</td>
<td>ATMA, Valsad, Gujarat</td>
<td>September 12-16, 2014, Lucknow</td>
<td>20 farmers</td>
</tr>
<tr>
<td>Training on Agri-preneurship for agricultural graduates</td>
<td>Agri-clinic and agri-business cell, Gomti Nagar</td>
<td>September 19 &amp; 24, 2014, Lucknow</td>
<td>70 graduates</td>
</tr>
<tr>
<td>Awareness training programme on diversity conservation for community farmers</td>
<td>SCMD and DHAN Foundation</td>
<td>September 20, 2014, Kasmandi Kalan, Lucknow</td>
<td>18 farmers</td>
</tr>
<tr>
<td>Awareness training programme on diversity conservation for community farmers</td>
<td>SCMD</td>
<td>October 4, 2014, Kasmandi, Lucknow</td>
<td>20 farmers</td>
</tr>
<tr>
<td>Diversity orchard planting</td>
<td>ICAR-CISH and SCMD</td>
<td>November 1, 2014, Para, Lucknow</td>
<td>31 farmers</td>
</tr>
<tr>
<td>Micro-irrigation in horticulture crops</td>
<td>PFDC, CISH</td>
<td>November 18-19, 2014, Lucknow</td>
<td>50 farmers</td>
</tr>
<tr>
<td>Production, Protection &amp; Postharvest technology of Subtropical Fruits</td>
<td>ATMA, Siwan, Bihar</td>
<td>December 08-12, 2014, Lucknow</td>
<td>20 farmers</td>
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<tr>
<td>Awareness programme for on-farm conservation</td>
<td>ICAR-CISH and SCMD</td>
<td>December 17, 2014, CISH, Lucknow</td>
<td>212 farmers</td>
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<tr>
<td>Micro-irrigation, polyethylene mulching and protected cultivation of vegetables related to precision technology of horticulture crops</td>
<td>PFDC, ICAR-CISH</td>
<td>December 23-24, 2014, Barabanki</td>
<td>50 farmers</td>
</tr>
<tr>
<td>Micro-irrigation, polyethylene mulching and protected cultivation of vegetables related to precision technology of horticulture crops</td>
<td>PFDC, ICAR-CISH</td>
<td>January 16-17, 2015, Hardoi</td>
<td>50 farmers</td>
</tr>
</tbody>
</table>
The ICAR-CISH, Lucknow organized ICAR sponsored Winter School on ‘Recent trends in value addition of subtropical fruits for nutritional security and secondary agriculture’ from November 5-25, 2014 at the Division of Post Harvest Management. The programme was meant for the researchers, teachers and extension personnels of SAUs, ICAR institutes and other public organizations with the objective of upgrading their knowledge and skills. It also served as a common platform for healthy interactions, discussions pertaining to aspects on pre and post harvest management practices of harvesting, handling, storage, ripening, transportation, packaging, value addition, food safety, marketing, financing, etc.

Dr. (Mrs.) Neelima Garg was the Course Director, while Dr. Ajay Verma and Dr. A.K. Bhattacharjee were Course Coordinators. The Winter School was attended by 21 participants representing 8 states covering 19 Institutions comprising of SAUs, KVKs and ICAR institutes. A total of 40 theory classes, 14 practical sessions and 7 field visits were organized during the programme. The faculty consisted of 25 scientists from four divisions of ICAR-CISH, retired faculty NDUAT, CIMAP, CFTRI, FSSAI, UPCST, State Department of Hort., Biotech Park and four guest speakers.

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Production, Protection &amp; Postharvest technologies of Subtropical Fruits</td>
<td>ATMA, Madhepura, Bihar</td>
<td>January 19-23, 2015 Lucknow</td>
<td>12 Farmers</td>
</tr>
<tr>
<td>Micro-irrigation, polyethylene mulching and protected cultivation of vegetables related to precision technology of horticulture crops</td>
<td>PFDC, ICAR-CISH</td>
<td>January 28-29, 2015 Kanoj</td>
<td>50 farmers</td>
</tr>
<tr>
<td>‘High Density Plantation of Subtropical Fruits</td>
<td>ATMA, Samastipur, Bihar</td>
<td>February 24-28, 2015, Lucknow</td>
<td>22 farmers</td>
</tr>
<tr>
<td>Micro-irrigation, polyethylene mulching and protected cultivation of vegetables related to precision technology of horticulture crops</td>
<td>PFDC, ICAR-CISH</td>
<td>March 11-12, 2015, Varanasi</td>
<td>100 farmers</td>
</tr>
<tr>
<td>Training on Agri-preneurship for agricultural graduates</td>
<td>Agri-clinic and Agri-bussiness cell, Gomti Nagar</td>
<td>March 27 &amp; 28, 2015, Lucknow</td>
<td>35 graduates</td>
</tr>
</tbody>
</table>
Training

The following scientists / officers were deputed for trainings in the country during the period under human resource development component.

- Ms. Antara Das and Dr. Swati Sharma attended one-month orientation training at ICAR-CISH, Lucknow (October 13 to November 12, 2014).
- Ms. Antara Das attended three months professional attachment training at ICAR-IIHR, Bengaluru (November 14, 2014 to February 13, 2015).
- Ms. Antara Das participated in a short course on ‘Recent Advances in Molecular Markers and Population Genomics’ held at ICAR-NBFGR, Lucknow (March 10-19, 2015).
- Dr. Ashok Kumar attended ten-day training on sensors and actuators for precision farming at ICAR-CIAE, Bhopal (March 2-12, 2014).
- Dr. Atul Singha participated in ICAR sponsored Winter School on ‘Waste recycling and resource management through rapid composting techniques’ organized by ICAR-Indian Institute of Soil Science (IISS), Nabibagh, Bhopal, Madhya Pradesh (December 3-23, 2014).
- Dr. Gundappa attended International Training Programme on Pest Risk Analysis at National Institute of Plant Health Management, Rajendranagar, Hyderabad (September 2-11, 2014).
- Dr. Gundappa attended training on MIS-FMS system at ICAR-Indian Agricultural Statistics Research Institute, New Delhi (December 22-24, 2014).
- Mr. Muralidhara, B.M. attended three month professional attachment training at ICAR-Central Institute for Arid Horticulture, Bikaner (May 8 to August 8, 2014).
- Dr. Swati Sharma attended three months professional attachment training at ICAR – National Research Centre for Grapes, Pune (November 14, 2014 to February 14, 2015).
- Dr. V.K. Singh participated in one-day training and awareness programme on J-Gate@CeRA at NASC, Pusa, New Delhi (September 29, 2014).
- Ms. Veena, G.L. attended three month professional attachment training at ICAR-Indian Agriculture Research Institute, New Delhi (May 12 to August 12, 2014).
- Ms. Veena, G.L. and Mr. Muralidhara, B.M. attended one month orientation training at ICAR-CISH, Lucknow (April 9 to May 5, 2014).

Lectures delivered

- Dr. A. K. Bhattacherjee on Phalon mein pesticide avshe se suraksha sambhandhe upay at training programmes on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow, July 29, September 15, November 11, 2014 and January 22, 2015.
- Dr. A. K. Bhattacherjee on Saghan bagvani phalodyan mein pesticide avshe se suraksha sambhandhe upay at training programme on High density orcharding of subtropical fruits at ICAR-CISH, Lucknow on February 27, 2015.
- Dr. A. K. Bhattacherjee on Aam ke peeraknasion ke avshe evam unka rashtriya evam antarashtriya vyapar par prabhao in Stakeholders’ Consultation Meeting on Value Chain Management of Mango, Mango Diversity Fair and Kisan Goshthi at ICAR-IISR, Lucknow, June 28-29, 2014.
- Dr. A.K. Misra on Ecofriendly management of guava wilt in Model Training Course in
Division of Plant Pathology, ICAR-IARI, New Delhi on October 8, 2014.

- Dr. A.K. Misra on Production and protection technology on fruit crops in Annual Zonal Workshop of KVKs under Zonal Project Directorate, Zone–IV at ICAR-IIPR, Kanpur on May 19, 2014.
- Dr. A.K. Misra on Recent practices in the management of priority diseases of mango and guava in National Symposium on Recent Advances in Diagnosis and Management of Diseases of Field and Horticultural Crops and Zonal Meeting of Indian Phytopathological Society at NDUA&T, Kumarganj, Faizabad, February 28 – March 01, 2015.
- Dr. A.K. Misra on Aam, amrud evam aonla me ekikrit keet prabandhan in the training on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on September 15 and December 09, 2014.
- Dr. A.K. Misra on Disease problem in mango to Rohtas Farmers at ICAR-CISH, Lucknow on February 10, 2015.
- Dr. A.K. Singh on Papeete ke bagwani in the training programmes on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on September 12, December 08, 2014 and January 19, 2015.
- Dr. Ajay Verma on Uttar Bharat me aam ke gharelu evam niryat bazaar ki sambhavna hotu muulya shrnkhla evam bazaar suchna pranali in Stakeholders’ Consultation Meeting on Value Chain Management of Mango, Mango Diversity Fair and Kisan Goshthi at ICAR-IISR, Lucknow, June 28-29, 2014.
- Dr. Ashok Kumar delivered a lead lecture on Low cost protected cultivation of horticultural crops under high rainfall areas of North Eastern Himalayan hills In National Seminar on ‘Sustainable Horticulture vis-à-vis Changing Environment’ at SASRD: Nagaland University, Medziphema, Nagaland, February 26-28, 2015.
- Dr. Gundappa on Aam, amrud mein ekikrit keet prabandhan in training on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on August 28, 2014.
- Dr. Gundappa on Aam, amrud mein ekikrit keet prabandhan in training on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow, February 24-28, 2015.
- Dr. G. Pandey on Layout, planting and care of subtropical fruits in training programmes on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on August 25, September 12, December 08, 2014 and January 19, 2015.

Dr. G. Pandey on "Layout, planting and maintenance of subtropical fruit orchard in the training programme on High density planting of subtropical fruits at ICAR-CISH, Lucknow on February 25, 2015.

Dr. Gundappa on "aam amrod me ekikrut keet prabhandan in farmers training on High density oricharding of subtropical fruits at ICAR-CISH, Lucknow, December 8-12, 2014.

Dr. Gundappa on "Aam ke jaal keet evam thana bhedak keet ka prabhandan in sensitization programme organized at Bhatoi village, Malihabad on August 7, 2014.

Dr. Gundappa on "Aam mein keet prabhandan in farmers training on Aam ki kismon ki sanrakshhana se jude kisanoem ka kshamatha ka samvardan held at ICAR-CISH, Lucknow on December 17, 2014.

Dr. Gundappa on "Insect pest management in mango at Thari, Hawamau, Parinagar, Amrouli, Mohmdnagar Talukedar, Sarsanda, Mukbalpur, Bakhshikeda, Mehandikheda, Bikamau khurd, Chak Prutvipur, Kativar, Hardaurpur, Kashipur and Misani villages as a part of one month village visit programme.

Dr. Gundappa on "Insect pests of mango: Borer pests and Insect pests of mango: Gall midges and shoot gall psylla in training on Modern plant protection techniques for control of insect pests in mango at ICAR-CISH, Lucknow, January 16-18, 2015.

Dr. Gundappa on "Insect pests of mango: Phal evam Shakabhaji mein keetoen ki pahachan evam prabhandan in one day workshop on Integrated horticulture development mission and state level technology transfer held at Barabanki, December 3-4, 2014.

Mr. M. Balaji Rajkumar on "Identification of insect pests and their management in vegetables and flower crops during farmers meet at Barabanki organized by Department of Horticulture, UP on November 11, 2014.

Mr. M. Balaji Rajkumar on "Integrated pest management in guava during training programme conducted for orchardists on cultivation of guava and other horticultural crops at ICAR-CISH, Lucknow on December 12, 2014 and March, 13, 2015.

Mr. M. Balaji Rajkumar on "Insect Pest management in the technical session of Mango Growers’ Kisan Goshthi at ICAR-CISH, Lucknow on December 17, 2014.

Mr. M. Balaji Rajkumar on "Insect pests of mango and their management: Sucking pests, Mango fruit flies, quarantine importance and Ecofriendly management and Insect pests of mango and their management: leaf webber and leaf eating caterpillars at training programme on Modern plant protection techniques for control of insect pest in mango at ICAR-CISH, Lucknow, January 16-19, 2015.

Mr. M. Balaji Rajkumar on "Integrated pest management on mango at training on
Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on January 22, 2015.

- Dr. Maneesh Mishra on Somatic embryogenesis in mango, guava and papaya in Brain Storming Meeting on Somatic Embryogenesis and Bioreactors at ICAR-CPCRI, Kasargod, Kerala on August 2, 2014.
- Dr. Neelima Garg on Unnat taknikon dwara phalon ka muulya bardhan for training programmes on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on August 28, September 15, December 11, 2014 and January 20, 2015.
- Dr. Neelima Garg on Enterpreneurship development through value addition of fruits in Academic exposure visits of agricultural graduates and trainee agripreneurs at ICAR-CISH, Lucknow on July 7, September 24, and December 3, 2014.
- Dr. P.K. Shukla on Integrated post harvest disease management of fruits in training programme organized by ICAR-CISH for farmers of Siwan, Bihar, December 8-12, 2014.
- Dr. P.K. Shukla on Integrated post harvest disease management in mango in training programme organized by ICAR-CISH for farmers of Lucknow districts on December 17, 2014.
- Dr. P.K. Shukla on Role of insects in development and dispersal of diseases of mango in training programme on Modern plant protection techniques for control of insect pests in mango at ICAR-CISH, Lucknow, January 16-19, 2015.
- Dr. S.K. Shukla delivered a lead lecture on Advances in production technology for mango and guava under climate change in National Seminar on ‘Sustainable Horticulture vis-à-vis Changing Environment’ at SASRD-Nagaland University, Medziphema, Nagaland, February 26-28, 2015.
- Dr. S. Rajan on Plagiarism in scientific writings and Why research papers are accepted or rejected
at College of Biotechnology, Sardar Vallbhbhai Patel University of Agriculture & Technology, Meerut on February 12, 2015.


- Dr. S. Rajan delivered lead lecture on Is natural and induced off season flowering and fruiting are environmentally controlled in National Seminar-cum-Workshop on Physiology of Flowering in Perennial Fruit Crops’ at ICAR-CISH, Lucknow, May 24-26, 2014.


- Dr. V.K. Singh on Amrood ki saghan evam atisaghan bagwani in the training programmes on Production, protection and post harvest management of subtropical fruits at ICAR-CISH, Lucknow on August 27, September 13, December 09, 2014 and January 20, 2015.

- Dr. V.K. Singh imparted professional attachment training to Dr. Prashant Hiraman Nikumbhe, Scientist (Fruit Science) from ICAR-CISH, Lucknow, May 12 to August 11, 2014.

Trainings imparted

- All the scientists of Post Harvest Management Division imparted training on Value addition and waste utilization in mango to two 3rd year B. Tech. (Agri. Engg.) students Mr. Ritesh Kumar and Mr. Mithilesh Kumar from College of Agriculture Engineering and Technology, Dapoli for four weeks, ICAR-CISH, Lucknow, June 2 – 30, 2014.

**Trainings organized**

- Dr. S. Rajan organized five days training programme on ‘Production, Protection & Postharvest Management of Subtropical Fruits’ (sponsored by ATMA, Bihar) from December 08-12, 2014.
- Dr. S. Rajan organized Capacity building programme for mango farmers and members of Society for Conservation of Mango Diversity for on-farm conservation on December 17, 2014.
- A training programme on ‘Modern Plant Protection Techniques for Control of Insect Pests in Mango’ was organized by Division of Crop Protection from January 16-19, 2015 at ICAR-CISH, Lucknow.
- A Sensitization programme was organized by Division of Crop Protection on ‘Management of mango stem borer and leaf webber’ for mango growers of Malihabad on August 7, 2014 at Dwaraka Singh Senior Secondary School, Village Bhatoia, Malihabad.
- Drs. G. Pandey, S.K. Shukla, Barsati Lal and H. Keshava Kumar organized three-day training on ‘Nursery production and pre & post harvest management of subtropical fruits for enhanced productivity and profitability’ under Tribal Sub Plan at KVK, Banswara for fifty farmers of tribal districts of Banswara and Dungarpur area of Rajasthan from February 10-12, 2015.
- Dr. Ashok Kumar organized one-day awareness programme on ‘Advanced production technology of subtropical horticultural crops’ for 150 farmers under NEH plan at SASRD, Nagaland University, Medziphema Campus, Nagaland on February 26, 2015.
- Dr. V.K. Singh organized five trainings on different topics related to precision farming technology of horticultural crops at different districts of Uttar Pradesh under PFDC.

**Workshops/Seminars Organized**

- Dr. V.K. Singh and Dr. G. Pandey organized National Seminar-cum-Workshop on Physiology of Flowering in Perennial Fruit Crops from May 24-26, 2014 which was organized by the Society for Development of Subtropical Horticulture (SDSH), ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow.

**Student guided**

- Dr. Neelima Garg guided Mr. Devendra Kumar for his Ph.D. on Biochemical characterization of cellulases from mango peel using microbial system. Thesis submitted to Lucknow University, Lucknow.
Awards

- Dr. A.K. Misra was conferred Rajiv Gandhi Rashtriya Gyan Vigyan Maulik Pustak Lekhan Puraskar by the Rajbhasha Vibhag, Ministry of Home Affairs, Govt. of India at Rashtrapati Bhavan, New Delhi from Hon’ble President of India, Shri Pranab Mukherjee on September 14, 2014.


- Dr. Neelima Garg received best poster paper award (second prize) for the paper entitled ‘Developing ketchups from mango and guava fruits and storage study thereof’ in 2nd National Seminar on Hi-Tech Horticulture: Challenges and Opportunities, Babasaheb Bhimrao Ambedkar University (BBAU), Lucknow, February 26-27, 2015.


- Dr. V.K. Singh was awarded merit certificate of appreciation in 2014 for best performance of project entitled ‘Management studies for irregular bearing in mango’ during the last three years (2008 - 2011) funded by U.P. Council of Agricultural Research, Lucknow on July 10, 2014.

- Ms. Veena G.L. received the SADHNA-2014 Jagar Nath Raina Memorial all India best research award for her Master’s work from Society for Advancement of Human and Nature, Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh.

Recognitions

- Dr. S. Rajan was elected Fellow of the Horticultural Society of India during 2014-15.


- Dr. A.K. Singh was appointed as a Chief Guest for Jaiv Vividhata Jagrukta Gosthi - 2014 at Van Parisar, Malihabad, Lucknow organized by Forest Department on July 9, 2014.

- Dr. A.K. Singh was appointed as external examiner to evaluate the thesis and conduct the *viva-voce* of three M.Sc. (Ag.) students in the discipline of Horticulture at NDUA&T, Kumarganj, Faizabad on July 18, 2014.

- Dr. A.K. Singh was appointed as external examiner to evaluate the thesis and conduct the *viva-voce* of M.Sc. students in the discipline of Horticulture at GBPUA&T, Pantnagar, Uttarakhand on August 8, 2014.

- Dr. A.K. Singh was nominated as a Chairman of committee for DPC of Scientists at ICAR-CISH on October 13, 2014.
• Dr. A.K. Singh was invited as subject expert and delivered a talk on ‘Aam me samajik karyao’ in Kishan Mela on KVK, Virendra Nagar, Dhaura, Unnao on November 17, 2014.

• Dr. A.K. Singh was nominated as a member of assessment committee for the assessment of technical staff of group I (workshop, Category - I&II) on February 18, 2015.

• Dr. A.K. Misra was as Guest of Honour in National Symposium on ‘Recent Advances in Diagnosis and Management of Diseases of Field and Horticultural Crops’ and Zonal Meeting of Indian Phytopathological Society at NDUAT, Kumarganj, Faizabad, February 28 - March 1, 2015.


• Dr. Anju Bajpai acted as Rapporteur in Theme 2: Molecular events during flower induction during National Seminar-cum-workshop of Flowering in Perennial Fruit Crops at ICAR-CISH, Lucknow, May 24-26, 2014.

• Dr. H. Kesava Kumar was honored as an outstanding participant in the short training course on ‘Current strategies to use entomopathogenic nematodes in IPM’ at UAS-R, Raichur, Karnataka during December 2-11, 2014.

• Dr. H. Kesava Kumar served as Rapporteur for the technical session five in National Symposium on ‘Nematode Management: A Challenge to Indian Agriculture in the Changing Climate’ at YASHADA, Pune, January 8-10, 2015.

• Dr. Neelima Garg acted as rapporteur during special session on Popularization of NHB and NABARD schemes at National Seminar-cum-Workshop on Physiology of Flowering in Perennial Fruit Crops at ICAR-CISH, Lucknow on May 24-26, 2014.

• Dr. Neelima Garg served as expert to evaluate the publications of Dr. (Mrs.) Leelawati, Associate Professor for promotion to the post of Professor under CAS by CCSHAU, Hisar.

• Dr. Neelima Garg acted as convener for Technical Session on Post Harvest Management and Value Addition in 2nd U.P. Agricultural Science Congress organized by UPCAR, Lucknow during June 14-16, 2014.

• Dr. Neelima Garg served as member, DPC for considering placement / promotion cases of Scientist of ICAR-Indian Institute of Pulses Research, Kanpur.

• Dr. Neelima Garg was invited as an expert for selection of Young Scientists Award (Home Science Discipline) for 9th Uttarakhand State Science and Technology Congress 2014-15.

• Dr. Neelima Garg acted as resource person for the topic Food additives and safety in National Workshop on Food Processing and Preservation Techniques: Traditional and Contemporary Approach, BBAU, Lucknow, October 17, 2014.

• Dr. Maneesh Mishra was invited as member, Expert Committee on Agriculture & Allied Sector, U.P. Council of Agricultural Research, Government of U.P.

• Dr. Maneesh Mishra was invited as DBT Nominee, IBSC, CSIR-National Botanical Research Institute, Lucknow nominated by DBT, Govt. of India.

• Dr. Maneesh Mishra attended 12th plan EFC meeting held at ICAR, Krishi Bhawan, New Delhi.

• Dr. Maneesh Mishra was invited as member, DPC of ICAR-NRC Litchi, Muzaffarpur on July 26, 2014.


• Dr. P. Barman was recognized as an external examiner for Ph.D. thesis evaluation and final "viva-voce" of Mr. P.M. Suresh, Ph.D. Scholar in the discipline of Horticulture - Fruit Science, Agricultural College & Research Institute, TNAU, Madurai, Tamil Nadu on December 09, 2014.


Dr. R.A. Ram acted as Expert Advisor for interview of Technical Assistant (Agriculture) at UPPSC, Allahabad, December 11-12, 2014.

Dr. R.A. Ram participated as a Member in Technical Advisory Committee of Central Institute of Horticulture, Nagaland, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, February 18-20, 2015.

Dr. S. Rajan acted as Co-Chairperson, Session 7, Challenges to production technology of horticultural crops in Global Conference on Technological Challenges and Human Resources for Climate Smart Horticulture - Issues and Strategies at NAU, Navsari, Gujarat during May 28-31, 2014.

Dr. S. Rajan chaired Technical Session on Crop Improvement in 2nd Group Discussion of the AICRP on Fruits held at Maharana Pratap University of Agriculture & Technology, Udaipur, during February 26 - March 1, 2015.

Dr. S. Rajan acted as Task Force Member for validation of DUS test guidelines for guava and litchi (PPV&FRA, GOI, New Delhi).

Dr. S. Rajan acted as Member of the expert committee for reviewing the guidelines for crop varieties under AICRP (PPV&FRA, GOI, New Delhi).

Dr. S. Rajan served as Member of National Editorial Board, Indian Journal of Horticulture (Horticulture Society of India, New Delhi).

Dr. S. Rajan served as Associate Editor, Journal of Applied Horticulture, Lucknow.

Dr. Tarun Adak acted as Rapporteur under the Theme (four): Climate change and likely effects on flowering in National Seminar-cum-Workshop on ‘Physiology of Flowering in Perennial Fruit Crops’ at ICAR-CISH, Lucknow during May 24-26, 2014.

Dr. Tarun Adak acted as a Co-programme coordinator and served as a member in publication committee in organizing 2nd International Conference on ‘Bio-resource and Stress Management’ at Hyderabad during January 7-10, 2015.

Dr. V.K. Singh was nominated as Member in Joint Inspection Committee, MoA, GOI for field evaluation of nursery, area expansion and implementation of various centrally sponsor scheme at UP on July 28, 2014.


Ms. Veena, G.L. was recognized as an external examiner for the course ‘Processing of Horticulture Produce’ PHT 301(2+1) offered for III year B.Sc. (Hort.) students from the University of Horticultural Sciences, Bagalkot, College of Horticulture, Bidar, Karnataka.
Institute has linkages with various National and International organizations such as DAC-NCPAH, Ministry of Agriculture, DBT, DST, PPV & FRA, UPCST, UPCAR, NAIP, AMAAS, NICRA, NCIPM and UNEP/GEF. The Institute has in place MOUs to facilitate capacity building initiatives with Amity University, Lucknow and Integral University, Lucknow for pursuing research as part of M.Sc. and Ph.D. degrees of their students.

Institute is also recognized by IGNOU, New Delhi as one of the study centers for offering a Certificate course on Organic farming. National Horticulture Mission has identified the Institute as nodal centre for imparting training on rejuvenation of old and unproductive mango orchards.

The externally and foreign funded projects in operation at the Institute are listed below:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Project Title</th>
<th>PI</th>
<th>Period</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hi-tech horticulture for efficient utilization of resource through precision farming (PFDC)</td>
<td>Dr. V.K. Singh</td>
<td>2002-2015</td>
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<tr>
<td>2.</td>
<td>Developing from mango waste (peel and kernel) enzyme catalyzed –microbe mediated processes for biofuels</td>
<td>Dr. (Smt.) Neelima Garg</td>
<td>2014-2017</td>
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<td>3.</td>
<td>Development of national data base on mango</td>
<td>Dr. S. Rajan</td>
<td>2013-2018</td>
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<tr>
<td>5.</td>
<td>Intellectual property management and transfer/commercialization of agriculture technology scheme</td>
<td>Dr. S. Rajan</td>
<td>2008-continue</td>
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<td>7.</td>
<td>Consortium research platform on borer in network mode</td>
<td>Dr. Gudappa</td>
<td>2014-2017</td>
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<td>8.</td>
<td>Network project on organic horticulture</td>
<td>Dr. R.A. Ram</td>
<td>2014-2017</td>
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<tr>
<td>10.</td>
<td>Technology Mission for integrated development of horticulture in North-Eastern State Subproject - Organic/biodynamic cultivation of horticultural crops in N.E. region including Sikkim</td>
<td>Dr. R.A. Ram, Dr. R.P. Medhi - Director, Sikkim</td>
<td>2003- Continue</td>
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<tr>
<td>11.</td>
<td>Characterization of aonla varieties for developing DUS test guidelines</td>
<td>Dr. Devendra Pandey</td>
<td>2012-2015</td>
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<td>12.</td>
<td>Validation of DUS descriptors of bael (Aegle marmelos Correa)</td>
<td>Dr. Devendra Pandey</td>
<td>2012-2015</td>
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<tr>
<td>National Initiative on Climate Resilient Agriculture (NICRA)</td>
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<tr>
<td>15. Understanding the changes in host-pest interactions and dynamics in mango under climate change scenario</td>
<td>Dr. P.K. Shukla</td>
<td>2011-2017</td>
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<td><strong>SHM</strong></td>
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<tr>
<td>17. Establishment of mushroom spawn production laboratory</td>
<td>Dr. P.K. Shukla</td>
<td>Sept., 2012-2015</td>
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<tr>
<td><strong>UPCAR</strong></td>
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<tr>
<td>18. Collection, evaluation and conservation of elite jackfruit (<em>Artocarpus heterophyllus</em> Lam.) germplasm (s)</td>
<td>Dr. Ghanshyam Pandey</td>
<td>2014-2017</td>
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<td><strong>NCIPM (ICAR)</strong></td>
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<td><strong>FOREIGN AIDED PROJECTS</strong></td>
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<td><strong>UNEP/GEF-PDF-B</strong></td>
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PFDC was established through National Committee on Plasticulture Application in Horticulture (NCPAH) at the Institute during 2001-2002 and, at present, is a continuing activity. The principal activities of the centre include technology development and refinement in hi-tech horticulture, technology dissemination and validation, micro-irrigation, plastic mulching, greenhouse technology, publication of scientific literature and organization of workshops/seminars as well as trainings for state officials and farmers.

**Greenhouse production of tomato vis-a-vis open field cultivation**

Protected cultivation provides a viable option for peri-urban horticulture in long term commercial production of high value vegetable crops even during ‘off season’. For evaluation of yield and quality enhancement of tomato *cv.* Arka Samrat (semi determinate) under polyhouses, planting was done at a spacing of 45 x 60 cm with black polythene mulching (100 micron). Less fluctuation in temperature and RH inside the polyhouse created favourable conditions for better performance of tomato. Tomato plants grown inside polyhouse hastened flowering, fruiting and maturity. Polyhouse grown tomatoes were about 25 per cent bigger than the fruits of the plants grown in open field conditions. Higher total yield of Arka Samrat (6.96 kg/sqm) under polyhouse was obtained in the production cycle of 200 days.

Two tomato varieties (Dev and Badshah) were grown under net-house, polyhouse and open field conditions. Variety Dev produced an yield of 137.9 ton/ha under black and 158.63 ton/ha under silver mulching. Variety Badshah produced 143.25 and 169.5 ton/ha yield under black and silver mulching, respectively, as compared to 124.5 ton/ha under open condition.
**Inter cropping of cole crops in mango**

Cole crops, *viz.*, cabbage *cv.* Fast Ball, cauliflower *cv.* Girja, broccoli *cv.* Sakata and knol khol F1 hybrid were tried as intercrop combination in mango. The yield obtained under silver and black mulching *vis-à-vis* control was cabbage - 38, 67 and 34 ton/ha, respectively; cauliflower - 75, 67, 45 ton/ha, respectively; broccoli - 57, 49 and 35 ton/ha, respectively; knol khol - 42, 37 and 24 ton/ha, respectively.

**Intercropping in headed back guava *cv.* Lalit planted at 3 x 6 m**

Canopy management was tried in guava *cv.* Lalit planted at 3 x 6 m by heading back at a height of 1.5 m from the ground level during the month of January 2015. New shoots emerging below the cut portion were pruned to 50 per cent of their total length to provide an open umbrella shape of canopy. The vacant spaces between the rows were intercropped with brinjal.

**Vegetable cultivation under silver and black mulching**

Cultivation of cauliflower *cv.* Girja, cabbage *cv.* Fast Ball, broccoli *cv.* Sakata, knol khol F1 hybrid was undertaken to evaluate the efficacy of silver and black polyethylene mulching. Increased yield with better curd/ head weight and quality of cole crops were achieved under silver mulching. The yield under silver mulching was obtained in 78.0, 91.5, 68.25, 32.0, 30.0 ton/ha of knol khol, cauliflower, cabbage, broccoli and red cabbage, respectively, as compared to black mulch (66.0, 54.25, 57.0, 22.0, 24.0 ton/ha). On the contrary, reduced yield with poor quality in case of unmulched control was observed *viz.* 25.5, 47.0, 46.75, 23.25 and 54.00 ton/ha of knol khol, cauliflower, cabbage, broccoli and red cabbage, respectively.
LIST OF PUBLICATIONS

Research papers


• Garg, N., Yadav, P., Kumar, S. and Dikshit,


**Popular articles**


**Reviews**


**Abstracts**


- **Muralidhara, B.M., Singh, R.S., Bhargava R. and Hare Krishna (2014).** Biochemical and nutraceutical compounds in date palm cultivars. *In: 6th Indian Horticulture Congress an International Event on Horticulture for Inclusive Growth, November 6-9, 2014, TNAU, Coimbatore, p. 31.*


- **Muralidhara, B.M., Verma, J.P. and Veena, G.L. (2015).** Estimation of antioxidant activity of ten date palm (*Phoenix dactylifera*) cultivars. *In: 2nd National Seminar on Hi-tech Horticulture: Challenges and Opportunities,


**Chapter in Books**


- Kumar, K. (2014). Aam ke moolya shrankhalaa mein poshan prabandhan. In: Aam me Muulya Shrinkhala Prabandhan ke


Chapter in Training Manuals


Bulletins and Folders


**Training Manuals**


**Edited Books**


**Edited Proceedings**

**Division of crop improvement and biotechnology**

1. **PROGRAMME**: Genetic resources management and improvement of subtropical fruits
   - **Programme Leader**: H. Ravishankar (up to Sept., 2014) S. Rajan (w.e.f. Oct., 2014)
2. **Project**: Genetic resources management and improvement of mango and guava
   - **PI**: S. Rajan
   - **Co-PIs**: Ram Kumar, G. Pandey, Maneesh Mishra, Anju Bajpai, Muthukumar. M.
   - **Collaborators**: Achal Singh, Pushpa Chethan K., Gundappa
3. **Project**: Development of stable hermaphrodite types in important gynodioecious papaya varieties of commercial value
   - **PI**: A.K. Singh
   - **Co-PIs**: H. Ravishankar (Up to Sept., 2014), Balaji Rajkumar
4. **Project**: Improvement of aonla and bael for high yield and nutraceutical value
   - **PI**: D. Pandey
   - **Collaborator**: A.K. Bhattacherjee, Ram Kumar
5. **Project**: Identification of rootstocks in mango for tolerance to abiotic stress
   - **PI**: H. Ravishankar (up to Sept., 2014) S. Rajan (w.e.f. October, 2014).
   - **Co-PIs**: A.K. Singh, V.K. Singh, Kailash Kumar, Tarun Adak
6. **Sub-project**: Evaluation of mango germplasm for Rubisco and associated enzyme activities.
   - **PI**: H. Ravishankar (up to Sept., 2014), S. Rajan (w.e.f. October, 2014)
   - **Co-PIs**: V.K. Singh
   - **Collaborator**: Tarun Adak

**Division of crop production**

6. **PROGRAMME**: System approach to optimize resource use for enhancing productivity and quality of fruits
   - **Programme Leader**: Kailash Kumar (up to October, 2014), Ghanshyam Pandey (w.e.f. November, 2014)
7. **Project**: Integrated water and nutrient management system in mango and guava.
   - **PI**: Kailash Kumar
   - **Co-PIs**: S.K. Shukla, Tarun Adak, AtulSingha
   - **Collaborators**: V.K. Singh, Ajay Verma, Achal Singh, P.K. Shukla, Bharati Killadi
8. **Project**: Understanding the mechanism of flowering in mango
   - **PI**: V. K. Singh
   - **Co-PIs**: H. Ravishankar (up to Sept., 2014), S. Rajan, Anju Bajpai
   - **Collaborators**: Kailash Kumar, Tarun Adak
9. **Project**: Development of mango based cropping system for enhanced factor productivity
   - **PI**: S.K. Shukla
   - **Co-PIs**: Prannath Barman, Tarun Adak, Atul Singha, Kailash Kumar, Ajay Verma
   - **Collaborators**: Achal Singh, P. K. Shukla, Balaji Rajkumar
10. **Project**: Canopy architecture management for higher productivity in mango
    - **PI**: Prannath Barman
    - **Co-PI**: V.K. Singh
    - **Collaborators**: Kailash Kumar, A. K. Singh, H.C. Verma, Tarun Adak, Gundappa
11. **Project**: Development of decision support system for enhancing mango productivity.
    - **PI**: H.C. Verma
    - **Co-PI**: Ram Kumar
    - **Collaborators**: Kailash Kumar, V.K. Singh, Tarun Adak, Gundappa
12. **Project**: Impact of mango rejuvenation technology developed by CISH, Lucknow
    - **PI**: Barsati Lal
    - **Co-PIs**: Subhash Chandra, Ajay Verma, Achal Singh
    - **Collaborators**: Prannath Barman
12. **Project:** Impact of mango and guava varieties developed by CISH, Lucknow  
**PI:** Subhash Chandra  
**Co-PIs:** Barsati Lal, Ajay Verma, Achal Singh  
**Collaborators:** Prannath Barman

**Division of crop protection**

**III. PROGRAMME:** Integrated insect pest, nematode and disease management in mango, guava and papaya  
**Programme Leader:** A.K. Misra

13. **Project:** Integrated insect pest management in mango and guava  
**PI:** Balaji Rajkumar  
**Co-PI:** Gundappa  
**Collaborator:** H. Kesava Kumar, R.M. Khan, P.K. Shukla

14. **Project:** Etiology and management of wilt and shoulder browning of mango  
**PI:** P.K. Shukla  
**Co-PI:** A.K. Misra, Achal Singh, H. Kesava Kumar, Tarun Adak  
**Collaborators:** Kailash Kumar, Tarun Adak

15. **Project:** Development of forewarning system for decision support in management of hopper and mealy bug of mango  
**PI:** Balaji Rajkumar  
**Co-PIs:** Gundappa, H.C. Verma, Achal Singh  
**Collaborator:** S.K. Shukla

16. **Project:** Development of forewarning system for decision support in management of anthracnose, blossom blight and powdery mildew of mango  
**PI:** P.K. Shukla  
**Co-PIs:** H.C. Verma, Achal Singh  
**Collaborator:** S.K. Shukla, Tarun Adak

17. **Project:** Integrated management of guava wilt disease  
**PI:** R.M. Khan  
**Co-PI:** S. Rajan, Maneesh Mishra, P.K. Shukla, H. Kesava Kumar, Tarun Adak, A.K. Bhattacharjee

**Division of postharvest management**

**IV. PROGRAMME:** Product diversification and waste utilization of fruits for livelihood security  
**Programme Leader:** Neelima Garg

18. **Project:** Development of value added products from fruits  
**PI:** Pushpa C.K.  
**Co-PI:** Bharati Killadi, Neelima Garg, A.K. Bhattacharjee

19. **Project:** Fermentation of fruits and fruit industry waste for value addition  
**PI:** Neelima Garg  
**Collaborators:** Pushpa C.K.

**V. PROGRAMME:** Integration of pre and post harvest systems for quality fruits  
**Programme Leader:** Ajay Verma

20. **Project:** Shelf Life Enhancement of subtropical fruits  
**PI:** Bharati Killadi  
**Co-PI:** Pushpa C.K, Neelima Garg

21. **Project:** Analysis of pesticide residues in soil and mango fruits  
**PI:** A.K. Bhattacharjee  
**Collaborators:** V.K. Singh, Atul Singha, Gundappa, Balaji Rajkumar

22. **Project:** Market intelligence and export promotion of subtropical fruits  
**PI:** Ajay Verma

23. **Project:** Design and development of machinery for fruit crops  
**PI:** A.K. Verma  
**Co-PI:** Bharati Killadi  
**Collaborators:** Bharati Killadi, Ajay Verma, Devendra Pandey, Ram Kumar, A.K. Singh, Neelima Garg
Advisory/Consultancy

Scientists of the institute rendered scientific/technical services on crop improvement, production, protection and post-harvest management technologies of mango, guava, management technologies of mango, guava, papaya, bael and aonla to the orchardists from different parts of the country. Information on scientific cultivation of jamun and other underutilized fruit crops was also provided to farmers. The scientists and technical officers of the institute visited different locations and provided technical know-how to the growers on scientific methods of cultivation, rejuvenation of old and unproductive orchards, high density planting, nutrients, insects pests and diseases, postharvest management aspects, etc.

Technologies Commericalization

- Management and Information Services were strengthened at CISH to change basic approach to research and IPR protection.
- Aonla cider was commercialized to Centre of Technology Education and Development, Amethi, Uttar Pradesh on the 21st of September, 2014 for Rs. Three lakhs only.
- A one-day ICAR-CISH technology showcasing was organized as a part of technology commercialization and transfer on the 26th of March 2015. A Memorandum of Understanding was signed on the same day for two technologies viz. Aonla Tea and Aonla Biscuit with Centre of Technology Education and Development, Amethi, UP for Rs. One lakh only.

IPR and Patents

- Two provisional patent applications were submitted to patent office, New Delhi.
- Therapeutically important fruit beverage comprising of mulberry aonla blend rich in potassium anthocyanin, antioxidants and vitamin C and having improved storage stability (Appl No. 195/DEL/2015) by Yadav Preeti, Garg Neelima and Kumar Sanjay.
- 37 Farmers’ mango varieties were identified and submitted for registration under PPV&FRA, New Delhi.
- Four different Memorandum of Understanding (MoUs) were developed for technology as varieties, procedure/process and as a product for developing partnership.
Research Advisory Committee (RAC)

The Nineteenth Research Advisory Committee (RAC) Meeting of ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow was held under the Chairmanship of Dr. K.E. Lawande, Vice Chancellor, Dr. Balasaheb Konkan Krishi Vidyapeeth, Dapoli, District Ratnagari, Maharashtra on 26 and 27 June, 2014 at Rehmankhera, Lucknow. It was the first meeting of the Research Advisory Committee of the Institute constituted in 2014. The Chairman as well as the other members of the Committee appreciated the work being done in the sphere of mango, guava, aonla and bael. The following members attended in the deliberations along with the scientists of respective Divisions.

1. Dr. K.E. Lawande : Chairman
2. Dr. C.A. Viraktamath : Member
3. Dr. Ramesh Chand : Member
4. Dr. P.K. Aggrawal : Member
5. Shri S.S. Mehta : Member
6. Dr. A.N. Ganesamurthy : Member
7. Dr. T. Janakiram : Ex-Officio Member
8. Dr. H. Ravishankar, : Member
9. Dr. R.M. Khan : Member Secretary

Significant decisions

After in-depth discussion with the scientists on the progress of research during the year, the RAC made following major recommendations.

Division of Crop Improvement and Biotechnology

- Institute should develop a comprehensive document on the environment vis-à-vis flowering trends in mango for the possible utility of the data particularly with reference to yield prediction(s).
- Work on development of trait specific data bank and frost tolerance in mango need to be initiated.
- Genetic diversity of bael in Garchiroli, Maharashtra needs to be explored and appropriately utilized.
- The effect of climate change on alternate bearing behavior and Jhumka panicle must also be brought out.

Division of Crop Production

- For raising the total factor productivity in mango based cropping system, possibilities of incorporating spider lily and strawberry as intercrop may also be included.
- The project on impact assessment of guava varieties is not planned as per principles of economics. Only nursery component is studied. Whole project needs relook and proper planning.
- Since IIHR claims that the formulation developed for spongy tissue control works effectively to control jelly seed in Amrapali, this should be tried by ICAR-CISH.

Division of Crop Protection

- Institute should lay emphasis on basic and applied aspects of eco-friendly strategies for management of pests and diseases of major economic significance as well as the new ones emerging on account of changing agro-ecological pattern.
- Guava wilt being a devastating disease particularly, in the Indo-Gangetic plain, the same is required to be managed through IDM strategies. Development and subsequent popularization of wilt resistant rootstock appears to be a permanent solution for the disease.

Postharvest Management

- In view of the realization of problems arising from excessive and indiscriminate use of hazardous chemicals including calcium carbide, multiple residue analysis of calcium carbide, its byproduct and other harmful chemicals, salicyclic acid etc., needs to be undertaken.
Work on biofuel using mango kernel, other wastes does not seem to be in synchrony with the contemporary concept since it is not a proper candidate for biofuel. This needs to be critically re-examined. Similarly, work on mango wine too should be dropped.

Mango productivity at small, medium and large farms need to be delineated, including those of absentee landlords.

General Comments

Institute should develop a status paper on the abuse(s) of technology particularly in respect of ‘Rejuvenation Technology’ standardized, perfected and advocated by the Institute.

Thought should be given to work out the modalities for India GAP to replace Euro GAP with regard to mango. A brainstorming dialogue may be organized.

A bulletin on cool chain management, do’s and don’ts, warning, legal issues, etc. be brought out and a perspective plan for the next five years vis-à-vis potential future in respect of novel value added products be developed.

Institute Research Committee (IRC)

The 35th Institute Research Committee (IRC) Meeting of ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow was held on 13 and 15, January, 9 and 10 April, 23 April, 12 May, 2 to 4 June, 7 June, 10 to12 June, 2014. Dr. H. Ravishankar, Director and Chairman while reviewing, discussed a range of issues concerning subtropical horticulture, its role in impacting the gross agricultural productivity and the impressive contribution to horticulture sector has been making over the years towards country’s economic growth. He also outlined the policy of the Council for synchrony of institutes with focused attention relating to Farmer’s First approach.

Significant decisions

Parameters for evaluation of wilt resistant root stock, optimization of in vitro protocols for its mass multiplication and markers for identifying polyembryony in mango need to be developed.

Database pertaining to feed back with regard to stability of red pulp content of Lalit variety supplied to Maharashtra, Andhra Pradesh and Tamil Nadu should be developed.

Good types of papaya available so far need to be critically evaluated for further elimination of recessive types.

Work on estimation of marmelosin and psoralein needs to be carried out for profiling of superior accessions of bael.

Off season varieties of mango should be pruned in July followed by paclobutrazol application during September. Its application should be with respect to crop load of previous year, nutritional back up and tree age.

The cost benefit ratio of different mango based cropping system module needs to be analyzed from the point of view of compatibility, soil health and profitability.

Blossom blight should also be included in the loop as it appears to be a critical factor influencing fruit set.

Impact of mango rejuvenation technology with special reference to productivity vis-a - vis farmer’s income and gap analysis of technology adoption should be taken into account. More work on establishing scientific basis for rejuvenation and canopy management is underscored.

Based on historical data gathered over the years with respect to pest / disease scenario, forecasting modules should be developed. Due focus is needed on emerging problems viz., shoot gall psylla, leaf webber, fruit borer, etc.

Mango varieties having higher carotenoid content should be tried along with nutritional profiling of the product(s) undertaken.

Work may be intensified on blended juices with their nutritional and functional food profiling.

Microbial safety as well as stability of the product should be critically looked into.

Information should be generated in respect of varieties developed by the Institute related to spoilage, use of salicyclic acid, oxalic acid and ethylene production.
Chlorpyriphos residue analysis should be worked out in the ground water samples of the mango orchards also.

- Analysis of fruit samples for residues of calcium carbide/by-products of its decomposition in edible portion is crucial, which needs to be taken up.
- Gap analysis of mango export trade needs to be worked out.

The 36th Institute Research Committee (IRC) meeting of ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow was held on January 15, 20-24, February 2-7 and 9, 2015 especially with reference to reorientation of ongoing in-house projects. Dr.S. Rajan, Director, ICAR-CISH and Chairman, IRC while addressing to the scientists brought to fore the decision taken at ICAR regarding curtailment of number of projects being run at various ICAR Institutes. The Chairman also emphasized the need to drop certain activities under different projects and merger of various activities being undertaken to avoid the duplication on one hand and adequate utilization of human resources on the other hand. Having cognizance of the policy decision of ICAR, exigency of research requirement vis-a-vis emerging scenario in terms of agro-ecological upheavals and availability of funds, twenty five projects were merged into five projects following dropping/addition of certain activities. Decision was taken that the reorientation of on-going in-house projects will be implemented from April, 2015:

**Revised In-House Project**

1. Management of genetic resources for genetic on improvement of subtropical fruits for higher productivity and quality.
2. Integrated nutrient, water, space and canopy management for improving productivity of subtropical fruits.
3. Diagnosis of new and emerging biotic stresses, development of prediction models and devising strategies for integrated management schedules for higher productivity.
4. Devising technologies for minimizing postharvest losses, value added products and marketing of subtropical fruits.
5. Improving knowledge and skill of stakeholders for enhancing production of subtropical fruits.

**Institute Management Committee (IMC)**

The twenty-fifth meeting of Institute Management Committee (IMC) of ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow was organized under the Chairmanship of Dr. Shailendra Rajan, Director, ICAR-CISH at the Rehmankherra Campus on 30 March, 2015. Following members of the committee attended the meeting.

<table>
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<tr>
<th>Name</th>
<th>Designation</th>
<th>Institute/Dates</th>
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<tbody>
<tr>
<td>Prof. Anil Kumar Singh, Prof. &amp; Head, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005</td>
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<tr>
<td>Prof. B.R. Salvi, Associate Director of Research, Regional Fruit Research Station, (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth), Vengurla-416 516</td>
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<tr>
<td>Prof. Selvarajan M., Prof. of Horticulture, Department of Horticulture, Horticultural College &amp; Research Institute, Periyakulam-625 104, Tamil Nadu</td>
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<td>Dr. Shatrughan Pandey, D-13A/6, 1st Floor, Platinum Greens, Ardee City, Gurgaon – 122 002</td>
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<tr>
<td>Dr. Ajay Kumar Dubey, Associate Prof. &amp; Head, Department of Horticulture, CSAUAE&amp;T, Kanpur-208 002</td>
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<tr>
<td>Nominee of The Director, Directorate of Horticulture &amp; Food Processing,U.P., Udyan Bhawan-2, Sapru Marg, Lucknow – 226 003</td>
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<tr>
<td>The Finance &amp; Accounts Officer, ICAR-Indian Institute of Sugarcane Research, Raebareli Road, P.O. Dilkusha, Lucknow - 226 002</td>
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Welcoming the members of IMC, Dr. Shailendra Rajan, Director, ICAR-CISH, Lucknow presented the highlights pertaining to the activities/progress made by the Institute during the period, along with action taken report on the recommendations of 24th IMC. Dr. Neelima Garg, Principal Scientist, Division of Postharvest Management presented the report in respect of achievements made, particularly, with reference to the development of value added products during the period. Progress made by the Institute was reviewed and approved by the IMC.
Director also presented the case of renovation / construction of additional wing of guest house before committee members for their approval. Guest house-cum-training hostel was constructed more than 20 years ago and needs to be renovated in view of the large number of training programmes (on an average 20 nos. per year) being organized for the farmers. Besides, a number of visitors / dignitaries also keep visiting the Institute throughout the year. Further, Institute also does not have separate facilities for women trainees. Committee members were also apprised of background information in respect of budgetary allocation made under works. An amount of Rs. 50 Lakh has already been approved in XII plan EFC for special repairs in the existing guest house-cum-training hostel at RB Road Campus of the Institute. Hence, keeping in view the requirement, committee members pressed for the construction of four additional double bed rooms.

Following the presentation of the case by Director, IMC agreed to recommend the proposal provided the expenditure for works on the items mentioned below is met out within the approved allocation and broad frame work under EFC:

- Renovation of lecture hall in training hostel-cum-guest house including multimedia system and air-conditioning, renovation of rooms and toilet, furnishing of rooms and dormitory, up-gradation of electrical system, renovation of kitchen and dining hall and corridors and construction of additional building (additional rooms).
PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, SEMINARS, SYMPOSIA ETC.

Conferences / Congress
- Ms. Veena G.L. and Mr. B.M. Murlidhara participated in the ‘6th Indian Horticulture Congress - an International Meet’ held at TNAU, Coimbatore, November 6-9, 2014.

Meetings
- Dr. V.K. Singh attended Cost Fixation Meeting of Different Components under State Horticulture Mission at Directorate of Horticulture and Food Processing, U.P., Udyan Bhawan, Lucknow, April 25, 2014.
- Dr. R.M. Khan, attended workshop on Priority Setting, Monitoring and Evaluation in National Agricultural Research System: Status, Experiences and Way forward held on May 27, 2014 at New Delhi.
- Dr. R.M. Khan attended two days workshop on “Impact of capacity building programs under NAIP” on June 6-7, 2014 at AP Shinde Auditorium, NASC Complex, Pusa, New Delhi.
• Dr. A.K. Misra attended Meeting of IPM Package at National Institute of Plant Health Management, August 26-27, 2014.

• Dr. R.M. Khan attended RFD meeting, held on August 28, 2014 in ICAR, New Delhi for finalizing Annual Action Plan of CISH 2014-2015.

• Dr. V.K. Singh participated in two days Kisan Mela/Bagwani Sangosthi at Unnao, October 9-10, 2014 and visited farmers field on October 9, 2014.

• Dr. V.K. Singh attended 40th State Committee Meeting at National Horticulture Board, Lucknow, October 10, 2014.


• Dr. Tarun Adak attended the State Level Review Meeting on ‘Gramin Krishi Mausam Sewa’ at IMD, Meteorological Centre, Amausi Airport, Lucknow, October 30, 2014.

• All the scientists and technical officers of the Institute attended meeting with Hon’ble Union Agriculture Minister, Shri Radha Mohan Singh at ICAR-IISR, Lucknow and Dr. A.K. Misra presented Institute’s achievement as In-charge Director, November 9, 2014.

• Dr. Neelima Garg attended ‘10th Indian Fisheries and Aquaculture Forum’ held at ICAR-NBFGR, Lucknow, November 12-15, 2014.

• Dr. A.K. Singh attended ‘Brain Storming Session on Prospect of Underutilized Fruit Crops in Uttar Pradesh’ at UP Council of Uttar Pradesh, Lucknow, November 14, 2014.

• Dr. Kailash Kumar participated in Scientific Advisory Committee meeting of KVK, Amberpur, Sitapur for reviewing the achievements for 2013-14 and finalizing the programme for the year 2015-16 on November 22, 2014.


• Dr. S. Rajan, Acting Director and R.M. Khan Chairman, PME attended the Review meeting of Midterm Achievements pertaining to RFD 2014-2015 held on November 24, 2014 under the Chairmanship of DDG (Hort. Science) at NASC Complex New Delhi.

• Dr. Kailash Kumar participated in Scientific Advisory Committee meeting of RaoVirendra Kumar Singh KVK, Dhaura, Unnao for reviewing the achievements of the year 2013-14 and finalizing the programme for 2015-16 on November 26, 2014.

• Dr. S. Rajan, Acting Director and R.M. Khan attended the meeting on Vision 2050 and Project prioritization held on November 26-27, 2014 under the chairmanship of DDG (Hort. Science) at KAB-II, New Delhi.

• Dr. Anju Bajpai and Dr. Maneesh Mishra attended ‘Indo Australia Partnership Meet on Mango Research (Genomics)’ at ICAR-IARI, New Delhi, December 4 _ 5, 2014.

• Dr. A.K. Singh attended ‘19th Research Workers Group Meeting of AICRP on Arid Zone Fruits’ at Sri Karan Narendra Agriculture University, Jobner, Rajasthan, December 12-14, 2014.

• Dr. Ajay Verma attended a Meeting on “Assessment of Post Harvest Losses in many and Banana” at ICAR-IIHR, Bengaluru, December 15, 2014.

• Dr. A.K. Misra attended Institute Management Committee meeting (IMC) of ICAR-NRC Litchi, Muzaffarpur, Bihar, December 19-20, 2014.

• Dr. H. Kesava Kumar participated in the Farmers’ Fair and Showcasing of Institute technologies to farmers at ICAR-IISR, Lucknow, January 8-10, 2015.

• Dr. Tarun Adak attended 2nd International Conference on ‘Bio-resource and Stress Management’ at Hyderabad, India, January 7-10, 2015.

• Ms. Antara Das participated in ‘National meet on distant hybridization for horticultural crop improvement’ organized at ICAR-IIHR, Bengaluru (January 22-23, 2015).
Ms. Veena G.L. and Mr. B. M. Murlidhara participated in ‘National Meet on Distant Hybridization for Horticultural Crops’ held at ICAR-IIHR, Bengaluru, January 22-23, 2015.


Dr. Tarun Adak attended International Conference on ‘Natural Resource Management for Food Security and Rural Livelihoods’ at NASC, Complex, New Delhi, February 10-13, 2015.

Dr. R. A. Ram attended International conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition at CIH, Medziphema, Nagaland, February 17-19, 2015.

Dr. H. Kesava Kumar participated in ‘National Meeting on New/Safer Molecules and Biocontrol Technologies for Integrated Pest Management in Crops’ at Karnataka Veterinary Council Auditorium, Hebbal, Bengaluru, February 23, 2015.

Dr. R.M. Khan attended one day workshop of PME In-charges of the ICAR Institutes to sensitize on effective implementation of PME cells in the light of new guidelines held on February 23, 2015 at NASC Complex, Pusa, New Delhi.


Dr. G. Pandey and Dr. Kailash Kumar participated in State Level Horticulture Sangosthi on ‘Quality Mango Production and Marketing’ at HETC, Malihabad, Lucknow, February 25-26, 2015.


Dr. S. Rajan, V.K. Singh, P.K. Shukla and Gundappa attended ‘2nd Group Discussion of the AICRP on Fruits’ held at Maharana Pratap University of Agriculture & Technology, Udaipur, February 26 - March 1, 2015.

PFDC, ICAR-CISH, Lucknow participated and exhibited showcasing of PFDC technology in ‘State Level Fruit, Vegetable and Flower Exhibition 2015’ at Saifai, Etwah, February 28 to March 1, 2015.

Dr. A.K. Misra attended Selection Committee Meeting of Scientists Merit Promotion under Career Advancement Scheme at ICAR-IARI, New Delhi, March 4, 2015.


Dr. A.K. Misra attended ‘Executive Meeting of Indian Phytopathological Society’ at ICAR-Indian Institute of Spices Research, Kozhikode, Kerala, March 15, 2015.

Seminars/Symposia

Scientists of the Institute participated in National Seminar-cum-Workshop on ‘Physiology of Flowering in Perennial Fruit Crops’ held at ICAR-CISH, Lucknow, May 24-26, 2014.

Scientists of the Institute attended Seminar on ‘Stakeholders Consultation Meeting on Value Chain Management of Mango, Mango Diversity Fair and KisanGoshthi’ held at ICAR-IISR, Lucknow, June 28-29, 2014, which was organized by ICAR-CISH, Lucknow.

Dr. S. Rajan, Dr. Maneesh Mishra, Dr. Neelima Garg, Dr. A.K. Misra, Mr. M. Balaji Rajkumar, Dr. H. Kesava Kumar, Dr. R. A. Ram and Dr. Tarun Adak attended International Symposium on ‘Innovations in Horticulture for Nutritional Security, Conserving Biodiversity and Poverty Alleviation’ held at BBAU, Lucknow, October 16-17, 2014.


Dr. H. Kesava Kumar attended National Symposium on ‘Nematode Management: A
Challenge to Indian Agriculture in the Changing Climate’ at YASHADA, Pune, January 8-10, 2015.


- Dr. A.K. Misra attended National Symposium on ‘Recent Advances in Diagnosis and Management of Diseases of Field and Horticultural Crops’ and Zonal Meeting of Indian Phytopathological Society” at NDUAT, Kumarganj, Faizabad, February 28-March 01, 2015.


- Dr. P.K. Shukla and Dr. Gundappa attended International Symposium on ‘New Dimensions in Agro meteorology for Sustainable Agriculture’ at GBPUAT, Pantnagar, October 16-18, 2014.

Workshops


- Dr. H. Kesava Kumar attended XXIII Biocontrol Worker’s Group Meeting on Biological Control of Crop Pests, Weeds and Nematodes at OUAT, Bhubaneswar, June 27-28, 2014.

- Dr. V.K. Singh participated in ‘Farmers Workshop concurrently with ‘10th International Agriculture & Horti Expo’ at Pragati Maidan, New Delhi, July 25-26, 2014.

- Dr. Kailash Kumar participated in Launching Workshop of ICAR Network Project on ‘Micronutrient Management in Horticultural Crops for Enhancing Yield and Quality’ at ICAR-IIHR, Bengaluru, August 9, 2014.

- Dr. Gundappa attended the launching Workshop of Project entitled ‘Consortium Research Platform on Borers in Network mode’ held at ICAR-IIHR, Bengaluru, August 18-19, 2014.

- Dr. S. Rajan attended Regional Writeshop organized in Kuala Lumpur, Malaysia, November 10-18, 2014.

- Dr. Anju Bajpai attended International Workshop on Aquatic Animal Disease Surveillance, 5th Global Symposium on Gender in Aquaculture and 10th Indian Fisheries and Aquaculture Forum at ICAR-NBFGR, November 12-15, 2014.


National Seminar-cum-Workshop on Physiology of Flowering in Perennial Fruit Crops

The National Seminar-cum-Workshop on “Physiology of Flowering in Perennial Fruit Crops” was organized by the Society for Development of Subtropical Horticulture (SDSH) in partnership with ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during May, 24-26, 2014. Presiding over the inaugural function, Dr. Munna Singh, Vice Chancellor, Chandra Shekar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh remarked that flowering is the major phenological event that exerts direct influence on the fruit production and many a times there also ensue contrasting issues of prolific flowering with no appreciable fruit set. The physiological basis of phenological variations especially under the influence of the root signals, carbon partitioning priorities, hormonal interpolations, molecular events in regulating flowering phenology, especially, need elucidation for management of flowering. Dr. Singh further added that there is lack of information on natural variations in gene expression and even less is known about the functional significance of the existing gene expression variations, especially, in terms of up and down regulation of negative factors in relation to flowering in perennial fruit crops.

Dr. H. Ravishankar, Director, ICAR-CISH, Lucknow in course of his welcome address told that India, acclaimed for its rich genetic diversity of fruit crops, has also assembled reasonably good amount of variability at different centers of NARES in respect of different perennial fruit crops viz., mango, citrus, grapes, guava, banana, aonla, bael, litchi, jamun, several underutilized and temperate fruits for crop improvement. This effort has over the years resulted in development of some trait-specific varieties, which are gradually entering into the production system across the country and paving the way for heralding Golden Revolution. Dr. Ravishankar was of the view that the complex biological phenomenon of converting good flowering into good yield is even less understood in perennial tropical and subtropical fruit crops, although, considerable leads are available in the annals and temperate fruits. Therefore, it was imperative to hold this national seminar in order to deliberate upon the important issues concerning flowering. The relationship between ideotype, tree architecture management and alternate bearing, including climate resilience needed to be discussed for developing strategies for regulation of flowering at will in perennial fruit crops. He further briefed the distinguished participants about the productive use of water and nutrients, site-specific prescriptions, good horticultural practices, better understanding of source-sink relationships, approaches to alter source-sink relationships (pruning, application of growth regulators, etc.), regulatory genes/eliminating or down regulation of negative factors and root dynamics.

The plenary session was Chaired by Dr. S.A.H. Abidi, Ex-Member, A.S.R.B., New Delhi. Other distinguished dignitaries including Dr. K. E. Lawande, V.C., B.S.K.K.V., Dapoli, Maharashtra, Prof. Rajendra Kumar, D.G., U.P.C.A.R., Lucknow, Dr. C.S. Nautiyal, Director, CSIR-NBRI, Lucknow, Shri. S.P. Joshi, Director, Directorate of Horticulture and Food Processing, Government of Uttar Pradesh, Prof. Y.N. Reddy, Ex-Professor, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, Telengana and Dr. Brahma Singh, Ex. Director, DRDO, New Delhi also graced the occasion.
Stakeholders’ Issues, Mango Diversity Fair and Kisan Gosthi

The Institute organized a two-day Seminar-cum-Mango Diversity Fair and Kisan Gosthi at ICAR-Indian Institute of Sugarcane Research, Lucknow on June 28 and 29, 2014. The theme of the programme was value chain management of mango for enhanced profitability to growers and ensuring quality mangoes to the consumers benefiting all the stakeholders involved in mango production to consumption chain.

The chief guest on the occasion, Dr. S. Ayyappan, Secretary, Department of Agricultural Research and Education (DARE), Govt. of India and Director General, Indian Council of Agricultural Research, New Delhi underlined the need to enhance mango production of the country to the tune of 25 million tonnes which is at present around 17 million tonnes. He discussed the problems and expectations of mango growers from Malihabad region as well as from parts of Andhra Pradesh, Tamil Nadu and Telengana. Participating farmers talked about the problems of market linkages and low price of their produce in local markets. The farmers of the Lucknow, in particular, requested the Director General, ICAR, New Delhi to make some arrangement for sending their Dashehari mangoes to south Indian markets quite alike the way Banganpalli of Andhra Pradesh is sold in north Indian markets. Dr. S. Ayyappan assured the farmers that next year arrangements would be made for mango growers-traders interface at 12 places in different parts of the country to develop sustainable mango value chains in the years to come. Processing of mango into value added products, especially mango pulp and drinks enhances the gains manifold, he added.

Dr. N.K. Krishnakumar, Deputy Director General (Horticultural Science), ICAR, New Delhi emphasized the need for producing the quality mangoes, adopting measures of canopy management to control tree size, using the recommended chemicals in proper doses, avoiding the use of banned chemicals and using traps for fruit flies. In order to meet international standards, we have to bring a lot of improvement in production and handling practices, he added. He further exhorted the farmers to form farmers’ groups, make cooperatives/associations in UP on the line of association in Maharashtra for grapes, mangoes, pomegranates, etc. to ensure the better price of their mangoes in local as well as international markets. There is immense scope of expanding mango processing industry in the state, in general, and export of pickles in particular.

Dr. R.R. Hanchinal, Chairman, Protection of Plant Varieties and Farmers Rights Authority, Govt of India appreciated the efforts by farmers for conservation of valuable mango varieties germplasm other than those which are commercial like Dashehari, Langra and Chausa. He firmly believed that the farmers should be sensitized and motivated to conserve valuable mango germplasm/rare varieties and also develop/identify superior farmers’ varieties for which there is a provision of award from PPVFRA, Govt. of India.

Dr. K.E. Lawande, Vice Chancellor, BSS Konkan Krishi Vidyapeeth, Dapoli highlighted the problems of Alphonso mango production in Maharashtra due to climatic changes. Rejuvenation has already made very good impact in the state and the technology is being adopted through National Horticulture Mission. He highlighted the need for bagging of fruits, canopy management, use of paclobutrazol for regular mango bearing, use of potassium orthophosphate for managing jelly formation in mangoes, use of only recommended chemicals, management of fruit fly and stone weevil for promoting mango exports. In view of recent ban on fruit exports from India by UK, he underscored the need for strong growers’ association, registration of farmers, issues of traceability for export and development of Indian standards for quality mango production.
He also advocated the use of ripening chamber, using ethylene gas, for mango ripening for uniform colour development instead of using carbide, a banned and carcinogenic chemical.

Dr. Bangali Babu, former National Director, National Agricultural Innovation Project, ICAR, a special guest on the occasion, in his remarks highlighted the importance of value chain wherein every stakeholder owns up the responsibility of produce till the end of the value chain. He emphasized the need for the creation of at least three mango marketing points at Malihabad, Saharanpur and Varanasi by Government of Uttar Pradesh in public-private partnership mode to sustain the value chain concept in mango on the similar pattern as it is for grapes, oranges in Maharashtra. He was unhappy for non-existence of true and efficient fruit value chain in U.P.

Shri K. K. Gupta, Chief General Manager, Regional Office, NABARD, Lucknow discussed the success of aggregation centres of NABARD created for collection of mango, post harvest handling, washing, grading, packaging and transport to different destinations. He believed that establishment of processing units and ripening chambers at production points or such mango aggregation centres as created by NABARD for utilization of fruits unsuitable for distant transport is the need of the hour. He further added that rejuvenation of mango orchards and replacement of old varieties is essential for quality mango production.

Shri S. P. Joshi, Director, Horticulture and Food Processing, UP Govt, a guest of honour on the occasion, remarked that the focus is on development of processing varieties to enhance the span of availability of mangoes right from May to October. He also informed the participants about the scheme on subsidies for high density mango planting at 5 x 5 m. The existing subsidy was giving 40 per cent in the first year and 20 per cent in the second year. Similarly, subsidy is also available on purchase of cool refer vans, establishment of micro-processing units and creation of cold storage facilities.

During technical sessions, different subject matter experts from ICAR-CISH, viz. Dr. S. K. Shukla, Dr. A. K. Misra, Dr. Neelima Garg, Dr. A. K. Bhattacharjee, Dr. V. K. Singh, Dr. Ajay Verma, Dr. Ram Kumar, Dr. R. A. Ram, Dr. A. K. Singh, Shri Amit Kumar Singh from Agribusiness International, Mr. Vijay Singh, a progressive mango grower from Mal and Er. Pradeep Sonkar, e-mango trader and entrepreneur from Techinflo Software Services shared their experiences.

Souvenir of the seminar and other farmer friendly extension folders were released on the occasion. A mango diversity show and farmers’ fruit markets were also organized. Different types of valuable mango germplasm/varieties were displayed by farmers of Society for Conservation of Mango Diversity, Malihabad and farmers from Tamil Nadu and Andhra Pradesh. On the occasion, an exhibition was also organized, wherein, stalls were put up showcasing the technologies by different agencies like ICAR-CISH, Krishi Vigyan Kendras from Unnao and Sitapur, Punjab National Bank, State Bank of India. Around 400 farmers participated in the event.
**DISTINGUISHED VISITORS**

- Dr. Satyasai, Deputy General Manager, NABARD, Lucknow (04.04.2014).
- Dr. Ashutosh Kumar, Assistant General Manager, Uttar Pradesh, Regional Office NABARD, Lucknow (04.04.2014).
- Dr. T. Jankiram, ADG (Horticulture), ICAR, KAB-II, New Delhi. (May 24-26, 2014)
- Dr. Munna Singh, Hon’ble Vice Chancellor, Chandra Shekar Azad University of Agriculture & Technology, Kanpur. (May 24-26, 2014)
- Shri S.P. Joshi, Director, Department of Horticulture and Food Processing, Government of Uttar Pradesh. (May 24-26, 2014)
- Dr. S.A.H. Abidi, Ex-Member, ASRB, New Delhi. (May 24-26, 2014)
- Dr. Brahma Singh, Ex. Director, DRDO, New Delhi. (May 24-26, 2014)
- Prof. Rajendra Kumar, DG, UPCAR, Lucknow. (May 24-26, 2014)
- Dr. C.S. Nautiyal, Director, CSIR-NBRI, Lucknow. (May 24-26, 2014)
- Dr. Vishal Nath, Director, ICAR-NRC Litchi, Muzaffarpur, Bihar. (May 24-26, 2014)
- Dr. R. K. Pal, Director, ICAR-NRC Pomegranate, Solapur, Maharashtra. (May 24-26, 2014)
- Dr. P.L. Saroj, Director, Directorate of Cashew Research, Puttur, Karnataka. (May 24-26, 2014)
- Dr. M.M. Mustaffa, Director, ICAR-NRC, Banana, Trichy, Tamil Nadu. (May 24-26, 2014)
- Dr. K.C. Bansal, Director, ICAR-NBPGR, New Delhi. (May 24-26, 2014)
- Dr. Nazeer Ahmed, Director, ICAR-CITH, Srinagar, J&K. (May 24-26, 2014)
- Prof. Jitendra P. Khurana, Professor, Delhi University, New Delhi. (May 24-26, 2014)
- Prof. M. Udayakumar, National Professor, UAS, GVKV, Bengaluru. (May 24-26, 2014)
- Dr. H.S. Singh, Head, CHES (ICAR-IIHR), Bhubaneswar. (May 24-26, 2014)
- Dr. P.M. Haldankar, Professor and Head, DBSKKV, Dapoli, Maharashtra. (May 24-26, 2014)
- Prof. M. V. Rasam, Professor and Head, Delhi University. (May 24-26, 2014)
- Dr. T.N. Balamohan, Professor, Horticulture College, Trichy, Tamil Nadu. (May 24-26, 2014)
- Dr. Y.N. Reddy, Emr. Scientist, ANGRAU, Hyderabad. (May 24-26, 2014)
- Dr. A.K. Singh, Head, Horticulture & Fruit Science, IARI, New Delhi. (May 24-26, 2014)
- Dr S.K. Malhotra, ADG (Horticulture), ICAR, KAB-II, New Delhi. (May 24-26, 2014)
- Dr. W.S. Dhillon, Director, Post Harvest, PAU, Ludhiana. (May 24-26, 2014)
- Dr. Ashutosh Kumar, Assistant General Manager, NABARD, Mumbai. (May 24-26, 2014)
- Dr. Gyanendra Mani, Deputy General Manager, NABARD, Mumbai. (May 24-26, 2014)
- Dr. M.S. Ladaniya, Director, NRC Citrus, Nagpur, Maharashtra. (May 24-26, 2014)
- Padma Shri Dr. K. L. Chadha, Ex. Deputy Director General (Hort.), ICAR, B-10/7281, Vasant Kunj, New Delhi-110 070. (28.05.2014)
- Shri N. D. Tiwari, Honourble Ex. Chief Minister of U.P. Government along with his family members and others staff (20.06.2014)
- Dr. K.E. Lawande, Vice Chancellor, Dr. Balasaheb Konkan Krishi Vidyapeeth, Dapoli, District Ratnagari, Maharashtra. (27.06.2015)
- Dr. C.A. Viraktamath, Professor of Entomology (Retd.), UAS, Bengaluru. (27.06.2015)
Dr. Ramesh Chand, Director, National Centre for Agricultural Economics and Policy Research (NCAP&PS), DPS Marg, Pusa, New Delhi-110 012. (27.06.2015)

Dr. P.K. Aggrawal, Regional Programme Leader (South Asia), CCASS Project, IWMI, New Delhi. (27.06.2015)

Shri S.S. Mehta, Progressive Grower, Salem, Tamil Nadu. (27.06.2015)

Dr. A.N. Ganeshamurthy, Principal Scientist and Head, Division of Soil Science & Agricultural Chemistry, ICAR-IIHR, Bengaluru, Karnataka. (27.06.2015)

Dr. T. Janakiram, ADG (Hort-I), ICAR, Krishi Anusandhan Bhawan-II, Pusa, New Delhi-110 012. (27.06.2015)

Dr. K.K. Sastapathy, Ex. Director, ICAR-NIRJAFT, Kolkata. (24.07.2014)

Dr. S.K. Naskar, Former Director, ICAR-CTCRI, Trivandrum. (24.07.2014)

Hon’ble Shri Baid Nath Sahni, Minister for Livestock Development, Govt. of Bihar. (05.09.2014)

Dr. M. Papi Reddy, Commissioner of Horticulture, Govt. of Andhra Pradesh. (12.12.2014)

Prof. Anil Kumar Singh, Prof. & Head, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005. (30.03.2015)

Prof. B.R. Salvi, Associate Director of Research, Regional Fruit Research Station, (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth), Vengurla-416 516. (30.03.2015)

Prof. Selvarajan M., Professor of Horticulture, Department of Horticulture, Horticultural College & Research Institute, Periyakulam-625 104, Tamil Nadu. (30.03.2015)

Dr. Shatrughan Pandey, D-13A/6, 1st Floor, Platinum Greens, Ardee City, Gurgaon-122 002. (30.03.2015)

Dr. Ajay Kumar Dubey, Associate Prof. & Head, Department of Horticulture, CSAUA & T, Kanpur-208 002. (30.03.2015)
Shailendra Rajan, Ph.D.
Director (Acting) (From 23.09.2014 AN)

H. Ravishankar, Ph.D.
Director (Up to 23.09.2014 FN)

**SCIENTIFIC**

**Division of Crop Improvement and Biotechnology**

Shailendra Rajan, Ph.D.
Pr. Scientist (Horticulture) & Head

Devendra Pandey, Ph.D.
Pr. Scientist (Horticulture)

Ram Kumar, Ph.D.
Pr. Scientist (Horticulture)

A.K. Singh, Ph.D.
Pr. Scientist (Horticulture)

Maneesh Mishra, Ph.D.
Pr. Scientist (Horticulture)

Anju Bajpai, Ph.D.
Pr. Scientist (Genetics & Cytogenetics)

H.C. Verma, MCA
Scientist (SS) (Computer Application)

Muthukumar M., M.Sc.
Scientist (Biotechnology)
(Study leave for Ph.D.)

Israar Ahmad, Ph.D.
Scientist (Biotechnology)

Umesh Hudedamani, M.Sc. (Ag.)
Scientist (Plant Breeding)
(Study leave for Ph.D.)

Veena G.L., M.Sc. (Fruit Science)
Scientist (Fruit Science) (from 09.04.2014)

Murlidhara B. M., M.Sc. (Fruit Science)
Scientist (Fruit Science) (from 09.04.2014)

Antara Das, M.Sc.
Scientist (Biotechnology) (13.10.2014)

**Division of Crop Production**

Ghanshyam Pandey, Ph.D.
Pr. Scientist (Hort.) & Incharge Head
(From 10.11.2014)

Kailash Kumar, Ph.D.
Pr. Scientist (Soil Chem./ Fert./ Micro.) & Incharge Head (Up to 10.11.2014)

V.K. Singh, Ph.D.
Pr. Scientist (Plant Physiology)

R.A. Ram, Ph.D.
Pr. Scientist (Horticulture)

S.K. Shukla, Ph.D.
Pr. Scientist (Hort.)

Achal Singh, Ph.D.
Sr. Scientist (Agril. Statististics)

K. K. Srivastav, Ph.D.
Sr. Scientist (Fruit Science) (From 05.05.2014)

S.R. Singh, Ph. D.
Sr. Scientist (Vegetable Science)
(From 05.05.2014)

Barsati Lal, Ph.D.
Sr. Scientist (Agril. Extension)

Ashok Kumar, Ph.D.
Sr. Scientist (Environmental Science)

Sridhar Gutam, Ph.D.
Sr. Scientist (Plant Physiology) (Up to 05.05.2014)

Subhash Chandra, M.A.
Scientist (SG)(Agril. Extension)

Atul Singha, Ph.D.
Scientist (Agril. Microbiology)

Tarun Adak, Ph.D.
Scientist (Soil Physics/Water Conservation )

Prannath Burman, Ph.D.
Scientist (Horticulture)
Division of Crop Protection

A.K. Misra, Ph.D., F.P.S.I., F.I.S.M.P.P.,
F.I.N.S.O.P.P., F.S.D.S.H., F.C.H.A.I.,
F.U.P.A.A.S.
Pr. Scientist (Plant Pathology) & Incharge Head
R.M. Khan, Ph.D., F.P.S.I.
Pr. Scientist (Nematology)

P. K. Shukla, Ph.D.
Sr. Scientist (Plant Pathology)

H. Kesava Kumar, Ph.D.
Scientist (Nematology)

Balaji Rajkumar M., M.Sc.
Scientist (Agril. Entomology)

Gundappa, Ph.D.
Scientist (Agril. Entomology)

Division of Post Harvest Management

Ajay Verma, Ph.D.
Pr. Scientist (Agril. Economics) & Incharge Head

Neelima Garg, Ph.D.
Pr. Scientist (Microbiology)

A.K. Bhattacherjee, Ph.D.
Pr. Scientist (Agril. Chemistry)

Anil Kumar Verma, M. Tech.
Scientist (SG) (Farm Machinery & Power)

Bharati Killadi, Ph.D.
Scientist (Horticulture)

Pushpa Chethankumar., M.Sc.
Scientist (Food & Nutrition)

Swati Sharma, Ph.D.
Scientist (Fruit Science)
From 13.10.2014 to 28.02.2015

Pawan Singh Gurjar, M.Sc.
Scientist (Fruit Science) (From 16.03.2015)

TECHNICAL

S.K.S. Raghav, Ph.D.
Chief Technical Officer (Farm Management)

Santosh Kumar, M.Sc. (Ag.)
Chief Technical Officer (Farm Management)

Raghubir Singh, Ph.D.
Assistant Chief Technical Officer
(Farm Management)

Sanjay Kumar, M.Sc.
Assistant Chief Technical Officer (Lab)

Abhay Dikshit, M.Sc.
Assistant Chief Technical Officer (Lab)

Vinod Kumar Singh, Ph.D.
Assistant Chief Technical Officer (Lab.)

Assistant Chief Technical Officer (Lab.)

Rekha Chaurasia, B.Sc.
Assistant Chief Technical Officer (Lab.)

Anil Kumar Singh, M.Sc.
Assistant Chief Technical Officer (Lab.)

Ram Sharan, B.Sc. (Ag.)
Assistant Chief Technical Officer (Lab.)
(Up to 30.10.2014)

Pradeep Kumar Kulshrestha, B.Sc.
Assistant Chief Technical Officer (Lab.)

S.K. Arun, B.Sc. (Ag.)
Senior Technical Officer (Lab.)

Om Prakash, B.Ed., Ph.D.
Senior Technical Officer (Lab.)

Ramendra Tiwari, B.Tech.
Senior Technical Officer (T.O.) (Ag. Engg.)

Bahadur Singh, Dip. (Refrig. & Aircond.)
Senior Technical Officer (T.O.) (Lab.)

C.P. Dwivedi, M.A.
Senior technical Officer (Lab.)
(Up to 30.06.2014)

B.P. Shukla, M.Sc., L.L.B., B.J.M.C.
Senior Technical Officer (Lab.)
(Up to 30.08.2014)

Chandra Bhal, B.Sc.
Senior Technical Officer (T.O.) (Lab.)

Arvind Kumar, MSc.,
Senior Technical Officer (Lab.)

Priti Sharma, MSc. M. Phil.
Senior Technical Officer (Lab.)
(From 30.06.2014)
Anjani Kumar, B.A.
Technical Officer (Field)

Mashooq Ali
Technical Officer (Workshop)
(Up to 30.08.2014)

Ganga Sharan, B.A., Dip.(Ag. Ext.)
Technical Officer (Lab.)

Swayamber Dutt
Technical Officer

Namita Sharma
Technical Officer
(Up to 30.10.2014)

Ram Dularey
Technical Officer
(Up to 31.01.2015)

**ADMINISTRATIVE**

Shri Firoz Khan, M.Sc., B.Ed.
Senior Administrative Officer (Up to 03.09.2014)

Dhiraj Sharma, M.A. (English), P.G.J.M.C.
Assistant Director (Official Language)

Shri Ashish Srivastava, B.Sc., L.L.B.
Finance & Accounts Officer (From 21.07.2014)

Shri G.D. Amola, B.A., L.L.B.
Finance & Accounts Officer (Up to 22.07.2014)

Shri G.P. Misra, Intermediate
Private Secretary (From 19.04.2014)

Ram Naresh
Private Secretary (Up to 30.04.2014)
Mango Show

The Society for Development of Subtropical Horticulture in collaboration with ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow and RWA, NASC organized a Mango Exhibition-cum-Festival on 05 July, 2015 at the NASC Complex, New Delhi. The function was graced by Hon’ble Secretary, DARE and Director General, ICAR, New Delhi. Deputy Director General (Horticultural Science) and other dignitaries were also present during the event. An information leaflet-cum-folder on Safe Ripening of Mangoes was released on this occasion.

26th Mango Festival at Dilli Haat, New Delhi

The Institute participated in the 26th Mango Festival organized by Delhi Tourism and Transport Development Corporation (DTTDC) from July 11-13, 2014 at Dilli Haat, New Delhi. The festival was divided into institutional participants, farmers participants and competitive section. During the Mango festival, the Institute also demonstrated the process of mango panna preparation. The demonstration was attended by a gamut of visitors ranging from women to dignitaries.

Essay and Debate Competitions

The Institute organized Essay and Debate competitions for the students of class 9 to 12 in various schools of the Lucknow districts to mark the Golden Jubilee Celebrations of the Indian Council of Agricultural Research (ICAR), New Delhi in the month of August 2014. The principal objective of the competitions was to apprise the students about the career opportunities in ICAR. This was the second successive year when ICAR-CISH, Lucknow had organized such competitions amongst the students.

Two hundred students from Vidyasthali Kanar, Babu Triloki Singh Inter College, Kakori and GGIC, Malihabad participated in the competitions. Winners of the competitions were given cash award.
Hindi Chetna Mass and other Hindi activities

The Institute organized Hindi Chetna Mass from September 15 to October 13, 2014. The event started with Hindi Diwas Samaroh wherein Dr. Vinod Chand Pandey, IAS, former Chairman, Uttar Pradesh Hindi Sansthan, Lucknow was the Chief Guest. In his address, he talked about the importance of promoting Rajbhasha. During the Chetna Mass, several Hindi competitions like Essay, Debate, Kavya Paath, Poster Competition, and Hindi Mein Sarwottam Karya Purashkar Yojna were organized. Winners of the competitions were given prizes by Dr. M.L. Agrawal, former Additional Director, Uttar Pradesh Ganna Kisan Sansthan. He also spoke about the role of Hindi as the lingua franca.

During the Hindi Chetna Mass, the Institute organized a Kavi Sammelan wherein 05 noted Kavis of Lucknow and nearby areas enthralled the staff with their poems, recitals.

Institute also organized Hindi Workshops on 03 May, 30 August, 13 October, 2014 and 26 March, 2015 wherein distinguished persons like Dr. Vijay Narayan Tiwari, CSIR-CDRI, Lucknow Dr. A.P. Rai, Director, Geological Survey of India and Dr. M.L. Agrawal, former Additional Director, Uttar Pradesh Ganna Kisan Sansthan, etc. delivered thematic lectures on Word Formation, Unicode, Terminology of Words, etc. To implement and monitor the annual targets, quarterly meetings were also organized from time to time.

Farmers’ training and showcasing of horticultural technologies at KVK, Banswara (MPUAT) under Tribal Sub Plan

A three-day training programme on “Nursery, pre and post harvest management of subtropical fruits for enhanced productivity and profitability” was organized under Tribal Sub Plan of Government of India. It was coordinated by Dr. S.K. Shukla, Coordinator (TSP) along with a team of resource persons from ICAR-CISH, Lucknow and KVK, Banswara for fifty farmers of tribal belts of Banswara and Dungarpur area during February 10-12, 2015. Lectures were delivered by the resource persons on different topics pertaining to crop production, crop protection, post harvest management and value addition in subtropical fruits. Post harvest management technologies were discussed by Dr. G. Pandey, Principal Scientist and I/c Head, Crop Production Division, while insect pest and disease management were discussed by Dr. H. Kesava Kumar, Scientist. Dr. Barsati Lal discussed farm advisory services offered by CISH, Lucknow. Lectures on other topics were delivered by KVK staffs. A Kisan Gosthi was also organized by KVK on February 12, 2015 for about 200 farmers in collaboration with ICAR-CISH, Lucknow, wherein all the Institute's technologies were displayed through posters/live samples/exhibits. Dr. I.J. Mathur, Director of Extension Education, MPUAT was the Chief Guest on the occasion of Kisan Gosthi.
Quality planting material

Emphasis was laid on multiplication and supply of superior clones and newly developed varieties of mango, guava, aonla and bael to SAUs, established progeny orchards, KVKs, progressive nurserymen and research institutions. Elite clones of commercial varieties for mother blocks at SAUs, state horticulture departments, progeny orchards, research institutions were provided. Training of farmers and entrepreneurs on propagation skills in latest techniques and utilization of modern propagation structure for healthy and quick graft production was imparted. Quality planting material of mandated crops has been supplied to more than 42 KVKs for establishment of mother blocks across locations of Bihar, M.P., Maharashtra, Rajasthan, U.P. and Uttarakhand states.
## RFD


**Name of the Division:** Horticulture  
**Name of the Institution:** Central Institute for Subtropical Horticulture, Lucknow  
**RFD Nodal Officer:** Dr. R.M. Khan

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- **Example 1:** While exploration of different germplasms was available to assess additional traits, more accessions were collected.
- **Example 2:** Several additional accessions came into fruition during the season.
- **Example 3:** Due to the selection of specific crops out of the identified database, the performance of the crops was assessed.
- **Example 4:** During the period of interaction with farmers, the poor efficacy and farmer’s feedback were noted.
### Development of PCR Based Disease Diagnostics for Detection of Anthracnose of Mango

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### Planting Materials of Mango, Amla, Basil, and Guava for a Conventional System

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### Value Addition

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### Total Composite Score: 97.83

Grade: Excellent

Procedure for computing the Weighted and Composite Score:

1. Weighted Score of a Success Indicator = Weight of the corresponding Success Indicator x Raw Score / 100
2. Total Composite Score = Sum of Weighted Scores of all the Success Indicators

Due to the demand for entrepreneurs' Technology for probiotic vegetable drink & pickles, and amla products were developed.
**Section 1: Vision, Mission, Objectives and Functions**

**Vision**

To conduct basic and strategic research in frontier areas for development of cost effective and viable technologies.

**Mission**

Augmenting the share of agriculture sector in general and horticulture in particular in GDP in the country and its export basket.

**Objectives**

1. Improving productivity through collection, conservation and evaluation of genetic resources

2. Enhancing productivity, profitability through improved production, disease management and quality planting material and value addition

3. Human resource development and transfer of technology.

**Functions**

- To enhance the productivity of subtropical fruit crops and improve the livelihood options in a sustainable manner.

**Section-2: Inter se priorities among key objectives, success indicators and targets**

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<th>Objectives</th>
<th>Weight</th>
<th>Action</th>
<th>Success Indicators</th>
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## Section 3: Trend values of the Success Indicators

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<th>Target value for 2013-14</th>
<th>Projected values for 2014-15</th>
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### Section 4: Acronyms

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<td>Human Resource Development</td>
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<tr>
<td>2.</td>
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<td>Intellectual Property Right</td>
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<td>3.</td>
<td>PCR</td>
<td>Polymerase Chain Reaction</td>
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<td>TOT</td>
<td>Transfer of Technology</td>
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### Section 4: Description and Definition of Success Indicators and Proposed Measurement Methodology

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<th>Measure -ment</th>
<th>General Comments</th>
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<td>Valuable germplasm of mango and guava available in the country would be collected.</td>
<td>Trait specific germplasm would be conserved in the field genebank.</td>
<td>Number</td>
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<td>Germplasm evaluated for specific traits</td>
<td>Germplasm collected and conserved would be rigorously evaluated for specific traits including colour, shelflife etc.</td>
<td>Germplasm evaluated for specific traits would be identified and subsequently incorporated and utilized for developing trait specific varieties</td>
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<td>3.</td>
<td>Compatible intercrops</td>
<td>Intercrops would be evaluated in mango orchards.</td>
<td>Based on performance/evaluation with respect to additional income in mango orchards, crops would be identified</td>
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<td>4.</td>
<td>Treatment schedule</td>
<td>Insecticides/fungicides would be tested against shoulder browning in mango</td>
<td>Treatment schedule would be developed based on the data collected on disease incidence.</td>
<td>Number</td>
</tr>
<tr>
<td>5.</td>
<td>Insecticides tested</td>
<td>Insecticides would be tested against the pests (hopper, mealybugs and thrips)</td>
<td>Treatment schedule would be developed based on the data collected on pest incidence.</td>
<td>Number</td>
</tr>
<tr>
<td>6.</td>
<td>Fungicides tested</td>
<td>Fungicides would be tested against the disease (blossom blight, anthracnose and powdery mildew)</td>
<td>Treatment schedule would be developed based on the data collected on disease incidence.</td>
<td>Number</td>
</tr>
<tr>
<td>7.</td>
<td>Designing of primers</td>
<td>Primers would be designed for development of disease diagnostic of <em>Colletotrichum gloeosporioides</em>, the causal agent of anthracnose of mango.</td>
<td>Development of PCR based disease diagnostics for detection of anthracnose of mango</td>
<td>Number</td>
</tr>
<tr>
<td>8.</td>
<td>Quality planting materials of mango, aonla, bael and guava</td>
<td>Varieties of mango and guava developed at the Institute and elite planting materials of aonla and bael would be multiplied through conventional methods.</td>
<td>Planting material would be made available to end users.</td>
<td>Number</td>
</tr>
<tr>
<td>9.</td>
<td>Technologies/ products developed</td>
<td>Development of different products from mandate crops.</td>
<td>New value added products from mandate crops would be developed</td>
<td>Number</td>
</tr>
<tr>
<td>10.</td>
<td>Patents filed</td>
<td>Ideas and technologies developed would be reflected in patents filed and usable technology and methodology developed</td>
<td>Development of innovations</td>
<td>Number</td>
</tr>
<tr>
<td>11.</td>
<td>Human resource development (HRD) and transfer of technology</td>
<td>Capacity building programmes related to production, protection and post harvest management knowledge and skill improvement/development programmes would be conducted for end-users (farmers, rural youth and extension personnel)</td>
<td>End-users would be made aware of new skills/technologies generated in mandate crops through lectures, demonstrations, field visits etc.</td>
<td>Number</td>
</tr>
</tbody>
</table>
### Section 5: Specific Performance Requirements from other Departments

<table>
<thead>
<tr>
<th>Location Type</th>
<th>State</th>
<th>Organization Type</th>
<th>Organization Name</th>
<th>Relevant Success Indicator</th>
<th>What is your requirement from this organization</th>
<th>Justification for this requirement</th>
<th>Please quantify your requirement from this organization</th>
<th>What happens if your requirement is not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
</tr>
</tbody>
</table>

### Section 6: Outcome / Impact of activities of organization

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Outcome / Impact of organization / RCs</th>
<th>Jointly responsible for influencing this outcome / impact with the following organization(s)</th>
<th>Success Indicators</th>
<th>Unit 2011-12 2012-13 2013-14 2014-15 2015-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Central Institute for Subtropical Horticulture Orchardists of respective crops / State Horticulture Department</td>
<td>● Increase in supply of quality planting materials of improved varieties of guava (cvs Lalit and Shweta) and yield increase (25-30 % approx.) with local/conventional varieties leading to an income about Rs. 220 million. ● An increase of about 10000 ha area under high yielding varieties in Bihar, M.P., Maharashtra, Rajasthan, U.P. and Uttarakhand.</td>
<td>No. 82345 100000 94500 115000 125000</td>
<td></td>
</tr>
</tbody>
</table>
The agrometeorological observations recorded at the Institute’s meteorological observatory during the year 2014-15 revealed highest mean monthly $T_{\text{max}}$ of 39.8°C in the month of June and lowest of 17.2°C in January 2015. The mean monthly $T_{\text{min}}$ of 6.2°C was recorded in the month of December, 2014, which was lower than the last year’s average of 6.5°C. The location received a cumulative rainfall of 732.3 mm during 2014-15, which indicates a deficit of around 300 mm. The cumulative rainfall was found lower as compared to the previous two year’s (2013-14 and 2012-13) rainfall of 1004.1 and 1084.0 mm, respectively. The period, however, documented wide variations in the pattern of rainfall distribution. Season’s highest rainfall (231.4 mm) was received during September followed by 178.1 and 109.2 mm during July and August, respectively. Unseasonal rains occurred during December to March, which severely impacted the flowering as well as the fruit set. Higher mean monthly minimum temperatures (13.3°C) during the month of March 2015 as compared to last season (12.2°C) was observed, but low temperature during pollination period resulted in poor fruit set.

Higher pan evaporation values (11.0 and 11.4 mm per day) were recorded during May and June of 2014 as compared to the 2013-14 reproductive phases (9.0 and 5.6 mm per day). Such higher evaporation virtually resulted in the prevalence of relatively dry environment and in absence of rains in the month of May 2014, resulting in severe fruit drop was observed.

Based on the weather data, advisories along with the control measures of pests and diseases were issued to the growers during the season.
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