वार्षिक प्रतिवेदन
Annual Report
2018-19

भाकृअनुप
ICAR

भाकृअनुप–केन्द्रीय उपोष्ण बागवानी संस्थान
रहमानखेड़ा, लखनऊ
ICAR-Central Institute for Subtropical Horticulture
Rehmankhera, Lucknow

केन्द्रीय उपोष्ण बागवानी संस्थान
CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE

ISO : 9001-2015

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

Annual Report
2018-19

ICAR-Central Institute for Subtropical Horticulture
Rehmankhera, P.O. Kakori, Lucknow - 226 101
Tel : (0522) 2841022-24, 2841026, Fax : (0522) 2841025
E-mail : cish.lucknow@gmail.com, Phone-in-live : 0522-2841082
Website : www.cish.res.in

भाकृअनुप
ICAR

ISO : 9001-2015

Correct Citation
ICAR-CISH Annual Report, 2018-19
Lucknow, India

ISO 9001 : 2015

Published by
Dr. S. Rajan
Director
ICAR-Central Institute for Subtropical Horticulture
Rehmankhera, Lucknow - 226 101 (U.P.), INDIA

Editors
P.K. Shukla
Abha Singh
Muthukumar M.
Nidhi Kumari
Dhiraj Sharma
Prananath Barman
Israr Ahmad
Pawan Singh Gurjar
Priti Sharma
Dinesh Kumar
Shailendra Rajan

Cover Illustration

30 June, 2019

Front Cover


Mango cv. CISH-Arunika


Mango cv. CISH-Ambika


Guava cv. CISH-Lalit


Jamun cv. CISH-Jamwant

Back Cover


H-4065


H-4104


H-4133

Printing
Army Printing Press, 33 Nehru Road, Sadar Cantt, Lucknow - 226 001, Ph 2481164, 8604565333

Preface

The ICAR-CISH, a premier Institute located amidst the mango belt of Lucknow region not merely contributed remarkably in research on subtropical horticulture but also improved livelihood of small and marginal farmers through technological interventions. With remarkable progress in production of fruit crops in India, there is a need to explore the possibility for bioavailability and bioprospecting of bioactive compounds and utilization of gene pool for development of novel and superior varieties/cultivars/hybrids of mandated crops. Research initiatives on profiling the phytochemicals and nutraceutical compounds in mango indicated wide variations in content of bioactive compounds among the varieties.

In subtropics, pests and diseases are major challenges in mango and guava production. Reduction in guava production due to incidence of root-knot nematode, *Meloidogyne enterolobii* in orchards during last 4-5 years is a matter of concern. This nematode created havoc by killing the seedlings in nurseries and also resulted sudden death of young trees (1-4 years old). Successful management efforts were made to manage mango thrips, presently, a serious threat in quality fruit production in north India. Attempts were made to explore possibility of off-season vegetable production under protected cultivation and resource management through hydroponics. Research experiments on container gardening, vertical gardening, crop diversification and introduction of temperate fruits in subtropics were successfully demonstrated for pomegranate, guava and strawberry. Among vegetables, hybrids between different ecotypes of pointed gourd showed potential for consumer preferences and adaptability. In the series of development of products from fruit waste, raw mango peel based soup powder was developed. Emphasis was given on horti-entrepreneurship development by extending the technologies like value addition, fruit crop nursery raising, growing tissue culture plants, green house fruit and vegetable cultivation and mushroom diversity adaption for round the year cultivation.

Area expansion of fruits crops in north-eastern states through capacity building of stakeholders and by supply of core planting materials were successful initiatives by the institute. Horticulture sector has the potential to provide enormous entrepreneurship and employment opportunities to unemployed youth in rural as well as urban areas. ICAR-CISH, Lucknow has helped scores of farmers, rural women and unemployed youth in capacity building in niche areas of horticultural technologies. ASCI sponsored Gardener's training led to capacity building of hundreds of youth. MANAGE sponsored training programme on "Certified Farm Advisor of Fruits", Model training course on entrepreneurship, Agri-Clinic and Agri-Business trainings. Three horti-entrepreneurship seminars were organized which were attended by a large number of youth. Institute has also developed entrepreneurship in mango based poultry farming, tissue culture, nursery and mushroom production. Institute worked closely with tribal farmers through 'Bhagidari' and 'Jagriti' a community based organization for empowerment of tribal rural women and through Tribal Nutri Smart Village. ICAR-CISH, Lucknow, a Student Ready Organization, has extended training to 313 students from four different institutions.

I am exceedingly grateful to Dr. T. Mohapatra, Hon'ble Secretary & Director General, Indian Council of Agriculture Research, New Delhi and Dr. A.K. Singh, Deputy Director General (Horticulture Science Division), New Delhi for their guidance and support in the overall development of the institute. Sincere thanks to all the scientists and members of publication committee for their industriousness compilation of this report.

Place : Lucknow

Date: 30-06-2019

(Shailendra Rajan)
Director

Contents

1 Executive Summary

Crop Improvement and Biotechnology

Twenty five mango germplasm accessions with traits *viz*., attractive peel colour, adaptability and shelf life were collected from Bihar, Maharashtra, Karnataka, Uttar Pradesh and West Bengal during 2018-19. A total of 772 mango accessions are being maintained in field gene bank. Profiling of nutraceuticals such as total antioxidants, total phenols, total flavonoids and total carotenoids was done in the pulp of 30 mango hybrids. Evaluation of 322 accessions indicated wide variability for various fruit physical parameters and around 55 per cent of accessions exhibited fruit weights in the desirable range of 200-400 g. During 2019, 50040 flowers were crossed on 11475 panicles using 12 cross combinations. A total of 43 seeds of mango hybrids were obtained from crosses made during 2017-2018 and 32 stones were germinated. One hundred and thirty two seedlings raised from hybrid combinations were planted in field for evaluation. Evaluation of 1312 hybrids for various physical parameters exhibited wide range of variability among hybrids. Five hundred SSR regions were mined from FBD transcriptome data and by computational analysis for SSR co-localized within functional DEGs actually associated with flowering. Gene expression analysis of hybrids such as CISH-Arunika, Hybrid 1084, 1054, 949 and 1739 derived from parental crosses *viz*., Amrapali×Vanraj, Amrapali×Janardhan Pasand and Neelam×Tommy Atkins was carried out to understand the molecular basis of peel color. Metabolite profiling of flavor and aroma volatiles carried out in mango hybrids, CISH-Ambika and CISH-Arunika along with their parents Amrapali, Janardhan Pasand, Vanraj through GC-MS analysis identified lactones as a major class of aroma volatiles. RNASeqMiner: a CDS retrieval tool (software) was developed for mining coding sequences from RNA-sequencing data. RNA-Sequencing data analysis and genomic annotation of the coding sequences of floral and vegetative buds indicated significant differentially expressed genes related to callose deposition in plasmodesmata and breakdown in conjunction with interplay with auxins and ABA at shoot apical meristem. Small RNA sequencing of floral (FBD) and vegetative buds (VBD) by Illumina platform and data analysis revealed 1615 DE miRNAs. Four transcriptome data sets of salinity stress imposed leaf and root samples of mango cv. 13-1 and control (non-stressed) was analyzed and eleven genes were found to have significant role in conferring salinity tolerance in mango cv. 13-1. Proteome analysis in mango pulp revealed proteins related to sugar metabolism, protein turnover, photosynthesis, cell wall metabolism and secondary metabolism were differentially regulated.

Fifteen trait-specific guava germplasm for traits such as fruit firmness, attractiveness, TSS, size and seed hardiness were collected from Uttar Pradesh, Karnataka, Chhattisgarh, Uttarakhand and West Bengal. Total antioxidants, total phenols, total flavonoids, lycopene and ascorbic acid were analyzed in 30 guava varieties. Evaluation of guava germplasm for fruit characteristics indicated wider variability for above traits. Evaluation of guava hybrid seedlings for fruit characteristics revealed highest variability for fruit weight followed by TSS and seed hardness. Attempts were made for standardizing genetic transformation protocol of mango. A marker free truncated hairpin loop coat protein gene was mobilized into somatic embryos of papaya for conferring PRSV resistance. Rewa, Satna and Chitrakoot of MP were explored and 10 superior aonla genotypes were collected. Accessions T_4, T_6, and T_8 were found promising ones. Out of 21 aonla accessions present in FGB, 11 accessions came into bearing during 2018-19. Two accessions *i.e.*, CISH A-31 and CISH A-33 were found promising. District Jaunpur and adjoining areas of UP were surveyed and 10 bael accessions were collected. Three bael accessions *i.e.* T_6, T_9, and T_{10} were found promising. Out of 36 vegetatively multiplied bael accessions maintained in FGB, 12 accessions came into bearing during 2018-19. Evaluation of these 12 accessions identified T_3 as superior accession with respect to yield, TSS, seed weight, shell thickness and weight. From 143 seedlings raised from promising bael accessions planted during 2003, 20 seedlings which came into bearing during 2018-19 were evaluated for their growth and fruit characteristics. Seedling No-31 and seedling No-57 were found to be most promising. Twelve trait-specific jamun germplasm accessions were collected from Gonda, Barabanki and Faizabad districts of U.P. with respect to good keeping quality as well as early bearing/maturity and their fruit qualities were evaluated. Maximum fruit weight was recorded in CISH J-60 accession collected from Faizabad with maximum TSS (14.5°Brix.). Maximum fruit yield was recorded in CISH J - 37 (75.50 kg/plant) while the minimum fruit yield was recorded in CISH J - 42 (12.83 kg/plant) on 11 year old tree. Pruning was imposed during mid October month to maintain different systems of trailing *i.e.* Open centre system and Palmette system. Flowering started after 2nd week of

March in both systems on one year old shoots. Open system of canopy recorded maximum fruit yield (85.73 kg/ plant). GA @ 60 ppm treatment for improving fruit size was attempted in CISH J-42 which increased fruit weight and TSS.

Crop Production

Effect of canopy modifications in mango cv. Dashehari after four years of planting was assessed and observations on stem diameter, girth, tree spread, light interception, flowering and fruiting were recorded. With the pursuit of refining the existing mango rejuvenation technology developed by ICAR-CISH in response to the farmer's feedback, experiments were initiated during 2015-16. Flowering was observed in the headed back trees. In an another experiment, different crops were evaluated as filler crops which includes guava cvs. CISH-Shweta and CISH-Dhaval; custard apple cvs. Arka Sahan, Balanagar, Atemoya x Balanagar; ber cv. Gola; apple ber and pomegranate cv. Bhagwa. Fifty per cent rejuvenated mango trees produced flowers during third year and 15 per cent mortality of headed back trees was also recorded due to severe infestation of stem borer.

Microbial and bio-chemical analysis of various on farm produced bio-enhancers were carried out during 2018-19 in panchagavya, cowpat pit, vermiwash, Jeevamrita and Bheejamrita. Ten bael cultivars (CISH B-1, CISH B-2, NB-5, NB-9, NB-16, NB-17, Pant Aparna, Pant Shivani, Pant Sujata and Pant Urvashi) were evaluated for fruit drop and low temperature/ frost. Irrespective of cultivars, maximum fruit drop (40%) was during January and minimum during September-October (5%). In jamun var. CISH J-37, under different pruning systems (control, open and palmate) morpho-physiological parameters and nutrient status were assessed. An experiment was conducted to optimize the nutrient dose and schedule for growth, yield and quality of banana cv. Grand Naine. Planting time of banana at monthly intervals revealed increased total functional leaf area, LAI, bunch weight and TSS (App. 20 ^{o}Brix) in banana planted during 15th of June and 15th of July. Mango, guava, citrus, pomegranate and papaya have been planted in different size of containers using different proportion of media (soil, FYM, sand and vermi-compost). All the plants have exhibited good vegetative growth. The citrus cv. Kagazi lime (SGN Lime 1), Arakta, Super Bhagwa of pomegranate, CISH-Lalit and CISH-Shweta of guava have started bearing within a year. A total of 8 peach varieties were evaluated for growth and fruiting under subtropical conditions. Earliest fruit maturity was recorded in Flordaprince (15-25 April). Different varieties of high value vegetable crops *viz.*, tomato, cucumber, capsicum, lettuce, broccoli, chinese cabbage, pointed gourd and dolichos bean were evaluated for developing cropping sequences for off season production. Twenty genotypes of dolichos bean collected from different parts of country were evaluated under subtropical conditions. Under PFDC, validation, refinement and technology dissemination of micro-irrigation, plastic mulching, greenhouse technology and canopy management in horticultural crops was done. Differential level of irrigation with drip and fertigation was given to the Dashehari trees based on 60 per cent OPE replenishment basis. The efficacy of black polyethylene mulching on cauliflower cv. Girija, cabbage cv. Green flash, red cabbage ("FIOM" and viswadeep), broccoli (Fiesta), parthenocarpic cucumber cv. Rucha was evaluated and increased yield with better quality of cole crops was obtained under polyethylene mulching as compared to control. Cucumber performed better under black mulch. Six varieties of tomato *viz.*, Cherry tomato, Heemsona, Heemshikhar, NS-1218, Sampurna, Laksh were assessed for their performance under protected cultivation conditions. Heemsona performed better in terms of yield, shelf life and recovery of lycopene. The potato cv. Kufri Chipsona was assessed for their performance under different irrigation levels and polyethylene mulching. During rainy season, maximum bulb weight (334g) and yield (28.8t/ha) of onion cv. ADR were recorded in drip irrigation coupled with polyethylene mulch. Inter cropping of turmeric cv. Rajendra Sonia was grown as intercrop in aonla orchards to evaluate the effects of black polyethylene mulching (100 µ) on the growth, yield and recovery of curcumin content and compared with control (unmulched). Turmeric yield were highest (1.0 kg per plant) with mulching as well as recovery of curcumin content was more (5.9%).

Crop Protection

Population dynamics of mango insect pests was recorded for fruit flies, hoppers, leaf webbers, fruit borers, blossom midges and semiloopers. The peak fruit fly population in trap was recorded in 29th SMW (second fortnight of July 2018) with 891.1 fruit flies/ trap/week. Mango hopper population was observed throughout the year in Rehmankhera farm. First peak population of hopper was recorded during 20th SMW (second week of May) with 12.02 hoppers/sweep. Second peak was recorded in 25th SMW (last week of June) with 36.36 hoppers/ sweep. Leaf Webber incidence was observed throughout the year. The peak incidence of leaf webber was recorded during 6th and 45th SMW with 4.45 and 3.74 webs/tree respectively. Peak incidence of mango fruit borer, *Dudua aprobola* was recorded during 20th SMW with 43.58 per cent incidence. Severe incidence of mango blossom midge, *Procantarinia mangiferae* was recorded at Kunwarpur (Sitapur) with an average incidence

of 3.2 infested blossoms/panicle. Peak incidence of semilooper, *Hyposidra talaca* was recorded during the 23rd SMW with 6.5 larvae/twig. Semiloopers were able to completely defoliate the new flushes on infested twigs. Similarly, disease dynamics mango diseases like anthracnose, powdery mildew and blossom blight were recorded during 2018-19. Maximum anthracnose incidence (37.45%) and severity (25.48 PDI) were recorded in the end of October, 2018. Powdery mildew disease appeared late during March, 2019. Moderate to severe incidence of the blossom blight was recorded in Malihabad, Mall and Kakori blocks of Lucknow; Mazar, Barabanki; Kunwarpur, Sitapur; Behat and Igari, Saharanpur. Field efficacy of newer insecticides was tested against mango hopper and thrips. Thiacloprid, fipronil, neem oil and profenophos were found effective in reducing the hopper population 21 days after spray. Spraying of neem oil, fipronil and thiamethoxam significantly reduced the thrips incidence. Highest yield (83.87 kg/tree) was recorded in treatment with fipronil spray. In order to develop eco-friendly management practices for bio-management of leaf webber, effect of neem oil and entomopathogenic fungus (*Beuveria bassiana*) were evaluated through laboratory bioassays. Neem oil @ 3 ml per litre of water along with sticker caused 100 per cent mortality of third instar larvae within a day. *B. bassiana* (2×10^8 spores/ml) @ 5 ml/ litre caused mortality up to 80 per cent 5 days after the treatment.

Guava fruit fly population was observed throughout the year using methyl eugenol based para pheromone trap. The peak fruit fly population was recorded in 33rd SMW (second fortnight of August 2018) with 548.8 fruit flies/trap/week. *Meloidogyne enterolobii* was identified as a severe constraint in guava production after thorough surveys in Andhra Pradesh, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh and Rajasthan states. Institute has recommended soil application of *Trichoderma harzianum* or *T. virens* enriched 5 kg compost with 250 g neem cake or 50 g carbofuran per pit at 7 days before transplantation of grafts in nematode infested areas for guava wilt management. Two treatments neem cake @ 50g/ 2 kg soil and ICAR-CISH-Biopesticide @ 50g/ 2 kg soil significantly reduced root-knot index and increased growth of guava plants under pot conditions. An experiment was also carried out at experimental orchard of N.D. University of Agriculture and Technology, Kumarganj, Ayodhya during 2018-19 and spray of Boron 20% @ 2 g/l and tebuconazole 25.9 EC @ 0.5 g/l followed by hexaconazole 5SC @ 1.0 ml/l was found effective for management of fruit drop in bael. Peak incidence (2.3 larva/tree) of jamun defoliator, *Carea angulata* was recorded during 31st SMW (First week of August). Peak incidence of ash weevil was recorded during 25th SMW (Last week of August) with 7.6 weevils/twig. The testing and refinement of computer softwares "Quick Leaf_LW v.1.02" and "Quick Leaf Area" was also done.

Post Harvest Management

A direct passive type solar dehydrator of 118×67×40 cm dimensions was developed for drying turmeric rhizomes. Mango cv. Dashehari treated with 0.01 per cent methyl jasmonate along with hot-water (45 °C) stored at temperature (12±2°C and R.H. 85-90%) exhibited decreased polygalacturonase and superoxide dismutase activities after 21 days of storage. Mango cv. Dashehari was treated with *Lactobacillus* @ 10^8 cells/ ml plus 2 per cent guar gum for 10 minutes and stored under ambient conditions exhibited extended shelf life. Fruits of guava cv. CISH-Lalit were sprayed with hexanol (2%) and harvested after 25 days had a shelf life for 9 days under ambient conditions.

Gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid and ellagic acid were quantified in unripe and ripe peel and pulp of five north Indian commercial mango cultivars (Dashehari, Langra, Amrapali, Mallika and Chausa). Three coumarins (marmelosin, psoralen and aurapten) were estimated in four selections of bael (Bael 637, Bael 20, Bael 34 and Bael I-1) at ripening stage (harvested at 325 days after fruit set). Total chlorophyll, total carotenoids and total antioxidants analysis in two varieties of lettuce (Black Rose and Grishma) grown under aeroponics and open conditions were carried out. Seven phenolic compounds like gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid, ellagic acid and *p*-coumaric acid were identified and quantified in 7 peach cultivars (Florida Prince, Shan-e-Punjab, Sarbati, Early Grandy, Saharanpur Prabhat, Pratap and Pant Peach-1).

Storage and quality studies of aonla juice at room temperature (8 months) with different concentrations of oxalic acid and L-cysteine as anti-browning agents were performed. Ethanol content was determined in 13 sugar beet lines in which SB1 was found best with average 8.0 per cent ethanol. Instant raw mango peel based soup powder was developed using certain additives. A herbal tea preparation was formulated using different plant leaves *viz*., jamun, bael, mango, guava, papaya and moringa. Raw mango candy of commercial cultivars *viz*., Totapuri, Mallika and Dasheheri was developed during the mango season and evaluated at 3 and 6 month's interval. Squashes were prepared from medicinally important herbs like brahmi (*Bacopa monnieri*) and ashwagandha (*Withenia somnifera*). A brahmi enriched aonla juice and dill flavoured squash was developed. Similarly, ashwagandha and brahmi-ashwagandha squashes were developed. A process was standardized for preparation of raw bael fruit dried flakes for making

bael tea. An integrated protocol for production of strawberry based probiotic drink and value added by-products like candy, squash, jelly and wine was developed. Three independent probiotic drinks using peach, bottle gourd and bitter gourd were prepared. Potassium metabisulphite (0.1%) was found effective in preservation of dried jamun powder without mixing. Similarly, sugarcane juice was blended with aonla juice and flavored with lemon, ginger and cumin and stored in PET bottles. Liquid feed enzyme was prepared from banana pseudostem and cabbage contained cellulase, pectinase and amylase activity. Probiotic liquid animal feed was prepared from mango stone with cellulase, pectinase and amylase activities besides *Lactobacillus* count of 5.66 x 10^7 CFU/ml after 30 days of preparation. A process was standardized for preparation of woodapple fruit powder which involves removal of fruit rind, cutting and slicing of fruit followed by drying and grinding of dried slices. A new method was developed for processing of turmeric by washing whole rhizome, slicing followed by drying and grinding which reduced the whole processing time by 50 per cent. Guava and jamun leaf based mouth paints were developed. A guava powder based face scrub was also developed which contained 26.2 mg vitamin-C and 372 mg/100 g phenolics. The scrub was packed in polyethene pouches and plastic containers and can be stored up to 28 days. Storage study revealed that plastic containers were better than polythene pouches in respect of microbial load.

The harvest time residues of hexaconazole after spraying at 0.05 and 0.1 per cent doses to mango cv. Mallika, were calculated as 0.063 and 0.111 ppm in whole fruits and 0.061 and 0.062 ppm in pulp, respectively. The culture isolated from chlorpyriphos and imidachloprid treated soil were identified as *Pseudomonas aeruginosa* strain MTRI1 and *P. mosselii* strain L27, respectively on molecular basis.

A mobile app named as "Mango Harvesting Advisor" was developed which can be downloaded from National Mango Database. The app contains detailed information with photographs about maturity indices, safe harvesting and ripening methods, packaging and marketing of mango in Hindi language.

Research on management of *Fusarium* wilt of banana

The Fusarium wilt (Panama disease) of banana caused by *Fusarium oxysporum* f.sp. *cubense* Tropical Race 4 (*Foc* TR4) is a devastating disease particularly affecting the Grand Naine (G-9) banana variety which is widely being cultivated in India. The disease cause huge loss to the growers and spreads rapidly in soil and water. In June 2017, there was sudden epidemic of the *Fusarium* wilt disease in the Sohawal block of Ayodhya district. The Asian and Australian countries have incurred billion dollar loss due to the disease in the past and are striving hard to develop the management practices for the management of the disease. Transect survey conducted in Uttar Pradesh and Bihar, confirmed the presence of TR-4 from several locations. VCG testing established that the fungal isolates obtained from isolated samples were compatible with VCG 01213/16 confirming the presence of TR-4 in India. In continuation the isolates (CSR-F-1 and CSR-F-2) used for confirmation were analyzed for pathogenicity to fulfill Koch's postulates on 50-day-old healthy tissue culture plantlets of Grand Naine under polyhouse conditions. After 45 days of incubation both the isolates caused typical wilting and internal discoloration symptoms of Fusarium wilt. All the symptomatic plants inoculated with *Foc* TR4 showed amplification of the amplicon of 463bp in PCR analysis, confirming that Foc TR-4 /VCG 01213/16 was the causal agent. The confirmation of Foc TR-4 done by ICAR-CISH and ICAR-CSSRI, RRS, Lucknow is the first report from India. Field evaluation of the formulation at 40 sick fields of adopters and non-adopters from two states Bihar and Uttar Pradesh indicated that the bio-formulation ICAR-FUSICONT was effective in controlling the disease to about 93.92 per cent with the disease incidence of 6.08 per cent only in case of adopters while the incidence was severe up to 45.68 per cent with non-adopters. An average yield of 25.98 kg/plant was obtained by adopters compared to non-adopters (11.22 kg/plant). The yield difference was significantly higher in the ICAR-FUSICONT treated plots compared to the untreated plots.

Meetings

The 23rd RAC meeting of ICAR-CISH, Lucknow was held under the Chairmanship of Dr. B.S. Chundawat, Ex-Vice Chancellor, Sardarkrushinagar Dantiwada Agricultural University, Gujarat on June 26-27, 2018. The forty-first meeting of Institute Research Committee of ICAR-CISH, Lucknow was convened during May 21 to 25 and June 8, 12 to 14, 2018. The 28th IMC committee meeting of ICAR-CISH was held on August 10, 2018. The QRT meeting of All India Coordinated Research Project on Fruits was held at ICAR-CISH, Lucknow from April 11-13, 2018 under the Chairmanship of Padmashree Dr. K.L. Chadha, former DDG (Hort.), ICAR, New Delhi.

Awards and Recognitions

Institute's Rajbhasha Patrika 'Udyan Rashmi' bagged prestigious Ganesh Shanker Vidyarthi Hindi Patrika Puraskar Plan 2017-18 by ICAR, New Delhi. Division of Post Harvest Management was awarded with HACCP Certificate by Quality Council of India.

ICAR-CISH's Exhibition stall got consolation prize in the State level Farmers Fair & Agricultural Industry Exhibition organized by NDUA&T, Kumarganj, Ayodhya on April 5-6, 2018. ICAR-CISH's Exhibition stall got first prize in the State level Kisan Mela & Agricultural Industry Exhibition organized by NDUA&T, Kumarganj, Ayodhya on December 7-8, 2018. Scientists of the Institute received 16 awards from various scientific bodies. Institute bagged prestigious DST-AWSAR award for popularization of science by Ministry of Science Technology, Govt. of India. Nine research papers presented by ICAR-CISH scientists were awarded as best papers. Eighty-eight recognitions were achieved by the scientists of the Institute.

Linkages and Collaborations

The Institute has linkages with various National and International organizations such as DAC-NCPAH, Ministry of Agriculture, DBT, DST, PPV & FRA, UPCST, UPCAR, AMAAS, RKVY, MANAGE, MNCFC, National Bee Board, Organic India Pvt. Ltd., K.R. Food Industries, Avadh Aam Utpadak Evam Bagwani Samiti, MATEE Foundation and CropLife India.

The Institute has MoUs with Integral University, Lucknow; Sam Higginbottom University of Agriculture, Technology and Science, Allahabad; Amity University, Lucknow Campus, Lucknow; Banda University of Agriculture & Technology, Banda; Uttar Banga Krishi Vishwavidyalaya Pundibari, Cooch Behar (W.B.), University of Gour Banga, Mokdumpur, Malda (W.B.); Narendra Deva University of Agriculture and Technology, Ayodhya (U.P.); Shri Ramswaroop Memorial University, Lucknow, (U.P.); Bundelkhand University (U.P.) for pursuing research as part of M.Sc. and Ph.D. degrees of their students. The institute also has collaborations with entrepreneurs and farmers *viz.*, Dr. Punit Bharadwaj, Shri Deepak Shukla, Shri Abdul Gaffar, Shri Sachin Jain, Shri Iqbal Ansari, Shri Sanjay Kr. Srivastava and Shri Vishal Barnawal for technology transfer and dissemination.

Human Resource Development

Human Resource Development is the principal component of the Institute which makes the institution dynamic, vibrant and productive by keeping mankind updated with the latest technologies and technical know-how. During the period 2018-19, trainings were not only organized for students, farmers, officials but also for specific groups. Eight trainings were organized for different groups of government employees or according to special interest of people on our mandate wherein 201 participants were trained. Five trainings were organized for students wherein more than 100 students were trained. Thirteen trainings were organized for farmers which were attended by hundreds of farmers. Thirty-eight training cum exposure visits were organized for people from different walks of life. Three month training of 5 students from universities was also conducted under their divergent educational programmes. Scientists, technical and administrative staff of the institute undergone trainings from various institutions for betterment of their working ambience.

Mera Gaon Mera Gaurav

Forty five selected villages of Malihabad and Kakori blocks of Lucknow adopted under Mera Gaon Mera Gaurav (MGMG) programme were visited frequently by scientists. This year 2 trainings were organized on mango processing and value addition for additional income generation of rural women community at Kanar and Kakori with the participation of 80 school going children; 4 gosthies were also organized in various villages of Malihabad and Kakori with the participation of 105 farmers. Four Scientists-Farmers Interaction meets and sensitization programmes were also conducted in the selected villages wherein 145 farmers were apprised about the developed technological interventions. Seeds and seedlings of vegetables were distributed among 110 farmers to motivate them for kitchen gardening. Six demonstrations were laid out on crop protection, harvesting, post-harvest handling and vermi-compost preparation technologies. Swachata Bharat Abhiyan was also implemented in MGMG villages and 8 programmes were organized.

Other activities

ICAR-CISH organized 13 skill development training programs for farmers and 5 for students on various disciplines of horticulture during 2018-19. The institute organized 36 training-cum-exposure visits on 'Improved Cultivation of Subtropical Fruits' and 2 trainings on 'Processing of Subtropical Fruits' for students, teachers and farmers. The institute imparted guidance to a number of students in their dissertation work. The institute in collaboration with various National organizations, conducted 8 Trainer's Training program to enhance the institute's expertise. A number of our scientists attended advanced training courses in other institutes for professional development.

Revenue Generation

A total of Rupees 61.03 lakhs was generated by the Institute during the financial year 2018-19.

2 Institute

The ICAR-Central Institute for Subtropical Horticulture (CISH) was established as Central Mango Research Station on September 4, 1972 under the aegis of the ICAR-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, one located at Rehmankhera, approximately 25 km away from the city and another at Raebareli (R.B.) Road right in the Lucknow city. The experimental farm at Rehmankhera has an area of 132.5 hectare comprising of 4 blocks (block I – 15.5 ha, block II – 35.5 ha, block III – 37.42 ha and block IV – 44.08 ha). The Institute was shifted to its present laboratory-cum-administrative building at block-II at Rehmankhera during May, 1999. The Project Coordinator Cell of AICRP on Subtropical Fruits was situated in CISH during 1972 to 2014, which later merged into AICRP (Fruits). 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 at large scale and that of jamun, litchi, strawberry and vegetable crops at limited scale 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 were also put in place under Skill India programme. Recognizing the importance of capacity building and in harmony with ICAR focus *Student Ready,* the Institute has in place MOUs with Amity University, Lucknow; Integral University, Lucknow; Sam Higginbottom University 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. Institute is keenly pursuing the programmes towards doubling farmer's income. Mango based farming system technologies have been transferred in three villages of Malihabad block of Lucknow district to enhance profitability of farmers under Farmer FIRST project. The Institute has also contributed significantly in research and extension to resolve farmers' issues in fruit crops under National Initiative for Climate Resilient Agriculture (NICRA), Precision Farming Development Centre (PFDC) and other projects. 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 everyday from 10.00 am to 4.00 pm and phone-in-live programme (0522-2841082) on every Friday from 10.30 am to 4.00 pm, services on soil and nutrient constraints, pest and disease 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. The ICAR-CISH Regional Research Station along with KVK at Makdumpur, Malda (West Bengal) are catering to subtropical horticulture for Eastern India.

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

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of subtropical horticultural crops.
- Repository of subtropical horticultural crop genetic resources and scientific information.
- Transfer of technology, capacity building and impact assessment of technologies.

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 enhancement of 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

- Field gene bank of the Institute has conserved the germplasm (1296 nos.) of mango germplasm (772) including 20 exotic cultivars besides germplasm/ accessions of guava (152), aonla (35), bael (59) jamun (38), litchi (35), khirnee (17), mahua (25), tamarind (20), wood apple (17), custard apple (8), mulberry (10), jackfruit (28), strawberry (3), pepino (4), leafy green mustard (2), lettuce (10), dolichos bean (22), beans (4), lady finger (2), Chinese cabbage (3), cucumber (22), tomato (7), pointed gourd (28) etc.
- Developed two mango varieties *viz*., CISH-Ambika, a regular bearing hybrid (cross between Amrapali and Janaradhan Pasand) for export market and Arunika (cross between Amrapali x Vanraj) to overcome the problem of biennial bearing, four guava varieties *viz*., CISH-Lalit, CISH-Shweta, CISH-Dhawal and CISH-Lalima from open pollinated seedling selections, two bael varieties (CISH-B-1 and CISH-B-2) and identified two promising accessions of jamun (CISH J-37 and CISH J-42) and two nutraceutically rich aonla selection (CISH-A-31 and CISH-A-33). Currently around six varieties are in pipeline and ten varieties in the stage of identification.
- Identified two polyembryonic salt tolerant mango rootstocks (ML-6 and ML-2 comparable with 13-1).
- Developed inter-specific wilt resistant rootstock (*P. molle x P. guajava*) of guava tolerant to even sodic soil conditions and its clonal multiplication technique.
- Genetic transformation system has been developed in guava and papaya for biotic resistance through *Agrobacterium* mediated genetic transformation system.

Crop Production

- 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) yielding 6.0 tonnes/ha.
- Crown thinning in mango resulted in higher yield (80 kg/plant) in Mallika in the following year as compared to 55 kg in control.
- Techniques for high density planting system and canopy management in guava were developed and popularized.
- Rejuvenation techniques for old and unproductive mango and guava trees continued to be demonstrated at farmers' fields.
- 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 yield. Trench application of fertilizers around the tree in July was found efficient in nutrient use.

Crop Protection

- Cost effective IPM modules based on crop phenology and weather for mango insect pests and diseases have been developed, refined and standardized.
- Entomogenous fungus *Verticillium lecanii*, egg parasites *Agrostocetus* sp., *Gomatocerus* sp., *Polynema* 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.
- *Ceratocystis fimbriata* was identified as the cause of mango wilt and decline. The decline was managed by trunk injection @ 10 per cent and soil drench @ 0.1 per cent of thiophanate methyl and spray with 0.1 per cent propiconazole. Zero tillage is advocated in affected orchards to avoid damage to roots and further infection.
- Bagging of fruits or spray of tree oil @ 1.0 per cent or difenoconazole @ 0.1 per cent were found effective in management of shoulder browning disease of mango fruits.
- Post-harvest diseases of mango, *viz.* anthracnose and stem end rot could be controlled by dipping of the fruits in hot water (52±1 °C) for 10 minutes.
- *Fusarium oxysporum* f.sp. *psidii* was found frequently associated with and potent in inciting the epidemics of guava wilt disease. Association of root-knot nematode (*Meloidogyne enterolobii*) was frequently found with wilt problems in Uttar Pradesh, Madhya Pradesh, Rajasthan, Andhra Pradesh, Maharashtra, Gujarat and Himachal Pradesh which is being critically investigated.

Post Harvest Management

- Maturity indices for commercial mango cvs. Dashehari, Langra, Mallika, Amrapali and Chausa were optimized.
- 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.
- Guava fruits cv. Allahabad Safeda could be stored for 28 days at 10 °C in 0.25 per cent ventilated LDPE bags.
- Pre-harvest sprays of calcium chloride di-hydrate (2%) at 10 days interval were found effective to reduce the jelly seed formation in mango.
- 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.
- The techniques for preparation of sweetened and brined (salted) aonla segments were optimized.
- Protocols for the preparation of mahua, mango and mulberry wine were developed.
- Protocols for the preparation of aonla, guava, bael and raw mango cider were developed.
- Mango peel could be utilized to produce compost, fiber, pectin, vinegar, and pectinase and cellulase enzymes.
- The Institute has developed vinegars from mango, aonla, bael, grape and jamun through acetic acid fermentation using immobilization technique.
- Low cost mango, guava and bael harvesters have been fabricated and the old mango harvester developed by the Institute was revisited, refined and parameterized. Destoning machine has been fabricated and evaluated for aonla.
- A low cost foldable ripening chamber has been designed and developed. Evaluation for different parameters is under progress.
- 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.
- Successful commercialization of two technologies, *viz*. Aonla Tea and Aonla Biscuit to the Centre for Technology and Entrepreneurship Development (CTED), Amethi, U.P has been accomplished.
- Food safety advisories on insecticide and fungicide residues are being provided to the mango growers.

Agriculture Knowledge Management Unit

The Institute has developed its own software for tracking the documents in the office. The system works through barcode readers and has the facility to have input of the barcodes manually. This on-line file tracking system not only allows the indenters to know the status of process but also location of the document by mere a click. This software also gives details that for how long the document was lying with staff member dealing with it in the chain. Several modules have been developed to get tailor made reports related to the outstanding documents with individual document processed and submitted by outstanding and disposed ones. It has been hosted on the web server and being utilized by all the staff members. This software is handy for the persons who are not able to type fast on computers and they can easily use barcode reader for log in the information which includes receiving/sending of documents.

The Institute has developed its own barcode label printing system as well as other requirements have been customized for this tracking system. It took about six months for developing this software and customizing it as per the document flow in the ICAR system. The Institute is also complying with MIS/ FMS system which monitors all employees' data like pay roll, leave processing stage/records, e-service book/record, establishment records and as such there is utter transparency in recording system. The Institute staff is now regularly using it even for applying leave.

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 as per MOU. It is well equipped with books, research journals and periodicals, reports, reprints and CD ROMs pertaining to different aspects of horticulture crops along with computer, internet and reprographic facilities. All the library reading materials has been automated through LSEASE software and search through OPAC (Online Public Access Catalogues). The institute library's existing collection of scientific and technical books (3887) has further enriched. The institute is accessing various journals through CeRA platform. Library has maintained the bibliography for research papers published by institute's scientists during 1972-2018. Institute's library has also collected the soft copies of research articles and also uploaded the same in ICAR software Krishi Kosh. Our institute's library has collection of e-pamphlets, e-newsletters, e-news papers clippings and other reading materials as repository. More than 98 annual reports and other magazines have been received from ICAR Institutes, State Agricultural Universities and International Institutes on exchange information basis. The library is also indulged in sending various reprints as per the 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 (Crop Improvement and Biotechnology, Crop Protection and Post Harvest Management) at headquarters Lucknow and one Regional Research Station and one KVK at Malda (W.B.). A proposal for creation of new Division of Crop Production is under consideration at Council. A Precision Farming Development Centre (PFDC) for promoting aspects of hi-tech horticulture is also located at the Institute. Set-up of the Institute is as below.

Staff Position (as on 31.03.2019)

Sl. No.	Category	Sanctioned	In Position	Vacant
1.	RMP	01	01	-
2.	Scientific	48	39	09
3.	Technical	44	31	13
4.	Administrative	24	18	06
5.	Skilled Support Staff	44	36	08
	Total	**161**	**125**	**36**

Details of Institute Government Grant expenditure for the year 2018-19

S.No.	Head	Total Allocation 2018-19	Expenditure (Govt.Grant) 2018-19				Total Expenditure 2018-19
			NEH	TSP	SCSP	Main	
1	Works						
	A. Land	0	0			0	0
	B. Building						0.00
	i. Office building	10977960	0			10977960	10977960
	ii. Residential building	0	0				0
	iii. Minor Works	0	0				0
2	Equipments	4712264	0		499190	4211946	4711136
3	Information Technology	686000	0			685734	685734
4	Library Books and Journals	1023776	0			1023776	1023776

5	Vehicles & Vessels	712000	0			711604	711604
6	Livestock	0	0				0
7	Furniture & fixtures	459000	0			458995	458995
8	Others	0	0				0
	Total – CAPITAL	18571000	0	0	499190	18070015	18569205
1	Establishment Expenses(Salaries)						
	i. Establishment Charges	172086000	0			172085140	172085140
	ii. Wages	1038000	0			1037057	1037057
	iii. Overtime Allowance	0	0				0
	Establishment Expenses	173124000	0	0	0	173122197	173122197
1	Pension & Other Retirement Benefits	64500000	0			64499462	64499462
2	T.A.						
	A. Domestic/Transfer TA	2593000	0			2592675	2592675
	Total – Traveling Allowance	2593000	0	0		2592675	2592675
3	Research & Operatinal Expenses						
	A. Research Expenses	14498500	494000	2724383	3665977	4380498	11264858
	B. Operational Expenses	13443500	0	1321755	1278400	9465282	12065437
	Res. & Oper. Expenses	27942000	494000	4046138	4944377	13845780	23330295
4	Administrative Expenses						
	A. Infrastructure	18579000	0			18578753	18578753
	B. Communication	183500	0			183496	183496
	C.Repair & Maintenance	0	0				0
	i. Equipments,Vehicles	1735500	0			1735500	1735500
	ii. Office building	652500	0			652497	652497
	iii.Residential building	54500	0			54471	54471
	iv. Minor Works	105500	0			105200	105200
	D. Others (excluding TA)	6959000	0			6958729	6958729
	Administrative Expenses	28269500	0	0	0	28268646	28268646
5	Miscellaneous Expenses						
	A. HRD	194000	0			193986	193986
	B. Other Items (Fellowships, Scholarships etc.)	0	0				0
	C. Publicity & Exhibitions	140000	0			139994	139994
	D. Guest House – Main.	264500	0			264500	264500
	E. Other Miscellaneous	596000	0			595996	595996
	Miscellaneous Expenses	1194500	0	0	0	1194476	1194476
	Grants in Aid - General	124499000	494000	4046138	4944377	110401039	119885554
	Grand Total	316194000	494000	4046138	5443567	301593251	311576956
6	Loans and Advances	0	0				0

Revenue Receipts for the Year 2018-19

Rs. in lakhs

S. No.	Realization of Revenue Receipts	Target	Achieved
1.	Income from sales / services	54.21	60.1
2.	Income from fees	0.00	0.34
3.	Income from Royalty / Publication	0.63	0.59
	Total	54.84	61.03

Joining

Scientist

1. Dr. Govind Kumar, Scientist (Agril. Microbiology) joined the Institute on October 06, 2018 after completing the training at ICAR-NAARM, Hyderabad.
2. Dr. Nidhi Kumari, Scientist (Plant Pathology) joined the Institute on October 9, 2018 after completing the training at ICAR-NAARM, Hyderabad.
3. Dr. Raj Kumar, Scientist-SS (Fruit Science) joined the Institute on March 01, 2019 after transfer from ICAR-CSSRI, Karnal.

Administration

1. Ms. Shreya Srivastava joined the Institute as Junior Clerk on November 22, 2018.
2. Shri Surendra joined the Institute as Junior Clerk on December 17, 2018.

Technical

1. Miss Jyoti Meena joined the Institute on selection as Technical Assistant (T-3) on June 13, 2018.
2. Dr. Sumit Kumar Soni joined the Institute on selection as Technical Assistant (T-3) on June 19, 2018.
3. Mohd. Riyaz joined the Institute on selection as Technical Assistant (T-1) on October 25, 2018
4. Shri Hemant Kumar Pandey joined the Institute on selection as Technical Assistant (T-1) on November 20, 2018.
5. Shri Alok Shukla joined the Institute on selection as Technical Assistant (T-1) on November 24, 2018.
6. Shri Arvind Kumar Singh joined the Institute on selection as Technical Assistant (T-1) on November 27, 2018.
7. Smt. Monika Singh joined the Institute on selection as Technical Assistant (T-1) on December 01, 2018.
8. Shri Satyendra Singh joined the Institute on selection as Technical Assistant (T-1) on December 01, 2018.
9. Km. Neetu Soni, joined the Institute on selection as Technical Assistant (T-1 Farm) on February 04, 2019.

New Joining after court order

1. Shri Govind Prasad, S.S.S. April 04, 2018
2. Shri Ram Khelawan, S.S.S. April 04, 2018
3. Shri Raja Ram, S.S.S. April 04, 2018
4. Shri Bholanath, S.S.S. April 04, 2018
5. Shri Ram Lakhan, S.S.S. April 04, 2018
6. Shri Ram Swaroop, S.S.S. April 04, 2018
7. Shri Devi Deen, S.S.S. April 04, 2018
8. Shri Ram Bali, S.S.S. April 04, 2018
9. Shri Nankau, S.S.S. April 04, 2018
10. Shri Ram Pratap, S.S.S. April 04, 2018
11. Shri Shatrohan Lal, S.S.S. April 04, 2018

Promotion

Scientific

1. Dr. P.K. Shukla, Sr. Scientist was promoted to the post of Principal Scientist, w.e.f. August 19, 2015.
2. Dr. H.C. Verma, Scientist-SS (Computer Application) was promoted to the post of Scientist-SG (Computer Application) w.e.f. December 10, 2013.
3. Dr. Bharti Killadi, Scientist (Horticulture) was promoted to the post of Senior Scientist in grade pay of 9000/- w.e.f. July 12, 2010.
4. Dr. H. C. Verma, Scientist (Computer Application) was promoted to the post of Senior Scientist in the grade pay of Rs. 9000/- w.e.f. December 10, 2013.
5. Dr. Muthukumar M., Scientist (Bitechnology Plant Science) was promoted to the post of Senior Scientist in the grade pay of Rs. 8000/- w.e.f. January 07, 2018.
6. Dr. Gundappa, Scientist (Agril. Entomology) was promoted to the next grade pay of Rs. 7000/- w.e.f. July 02, 2016.

7. Dr. Prannath Barman, Scientist (Fruit Science) was promoted to the next grade of Rs. 7000/- w.e.f. January 01, 2017.
8. Dr. Pawan Singh Gurjar, Scientist (Fruit Science) was promoted to the grade pay of Rs 7000/- w.e.f. July 01, 2018.

Technical

1. Shri Dhruv Kumar, Senior Technician (T-2) got merit promotion to the next higher grade of T-3 Technical Assistant w.e.f. December 12, 2016.
2. Shri Vijay Kumar Verma, Technical Assistant (T-3) got merit promotion to the next higher grade of Senior Technical Assistant (T-4) w.e.f. June 29, 2017.

Administrative

1. Shri Vidyasagar, Senior Clerk was promoted to the post of Assistant w.e.f. January 21, 2019.
2. Shri Vijendra Singh, Senior Clerk was promoted to the post of Assistant w.e.f. January 21, 2019.
3. Smt. Annapurna Gupta, Junior Clerk was promoted to the post of Senior Clerk w.e.f. January 22, 2019.
4. Shri Mahendra Kumar, Junior Clerk was promoted to the post of Senior Clerk w.e.f. January 22, 2019.

Retirement

Scientist

1. Dr. R. M. Khan, Pr. Scientist retired from the Council's service after attaining the age of superannuation on June 30, 2018.
2. Dr. V. K. Singh, Pr. Scientist retired from the Council's service after attaining the age of superannuation on March 31, 2019.

Technical

1. Shri Ganga Sharan, Technical Officer (T-5) retired from Council's service after attaining the age of superannuation on October 31, 2018.
2. Dr. Raghuvir Singh, Chief Technical Officer (T-9) retired from Council's service after attaining the age of superannuation on April 30, 2018.
3. Shri Chandrabhal, Senior Technical Officer (T-6) retired from Council's service after attaining the age of superannuation on April 30, 2018.
4. Er. Ramendra Tiwari, Senior Technical Officer (T-6) retired from Council's service after attaining the age of superannuation on January 31, 2019.
5. Smt. Rekha Chaurasia, Assistant Chief Technical Officer (T-7-8) retired from Council's service after attaining the age of superannuation on February 28, 2019.

Administrative

1. Shri Vidyasagar, Assistant took voluntary retirement from the Institute w.e.f. February 18, 2019.

Skilled Support Staff

1. Shri Mahabeer, S.S.S. retired from Council's service on June 30, 2018.
2. Shri Shriram S/o Shri Dalla, S.S.S. retired from Council's service on June 30, 2018.
3. Shri Atique Ahmad, S.S.S. retired from Council's service on June 30, 2018.
4. Shri Roopchand, S.S.S. retired from Council's service on August 31, 2018.
5. Shri Ram Kumar, S.S.S. retired from Council's service on November 30, 2018.
6. Shri Shripal, S.S.S. retired from Council's service on December 31, 2018.
7. Shri Rajaram, S/o Shri Shukhdeen, S.S.S. retired from Council's service on January 31, 2019.

OBITURY

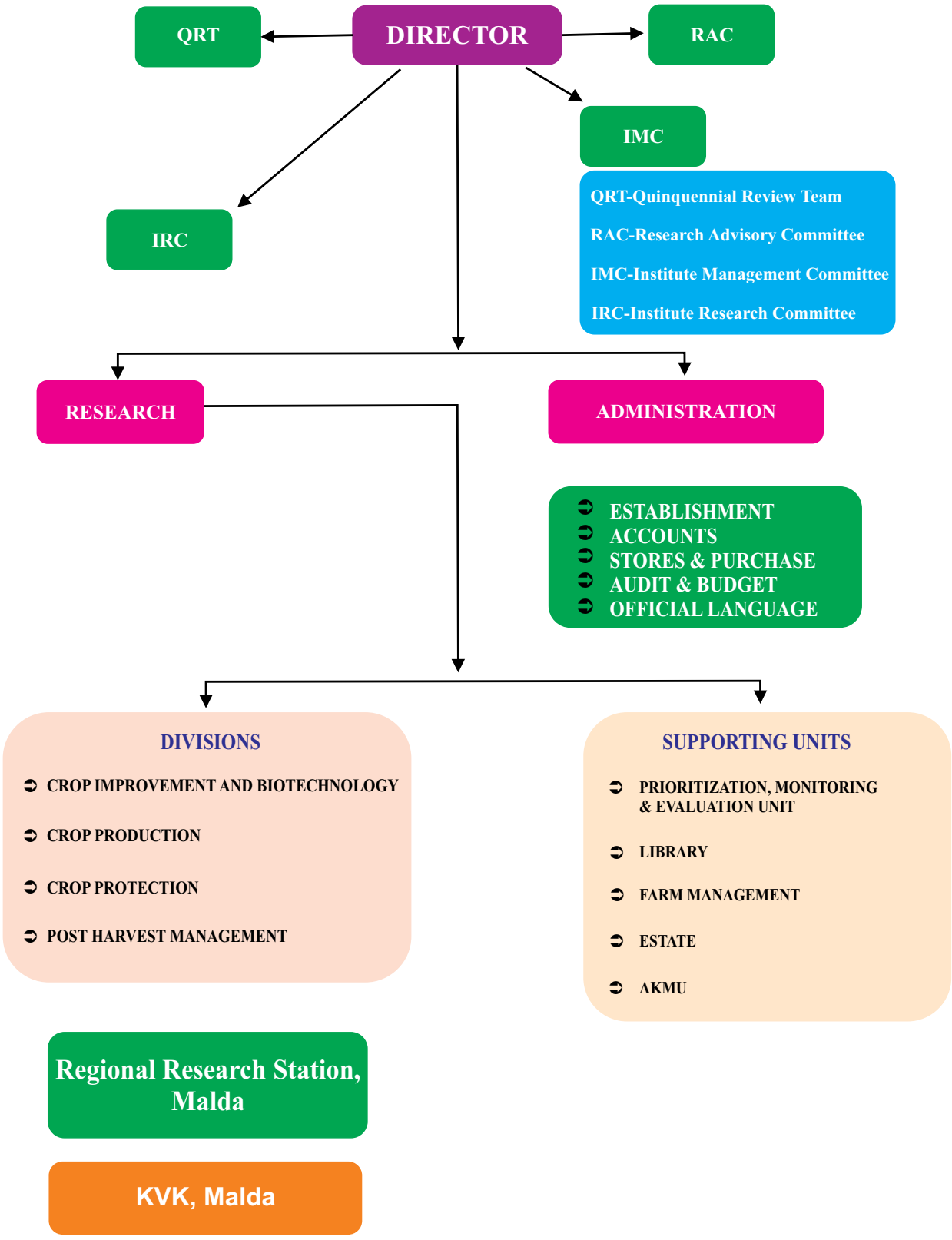
Administrative

1. Shri Amit Singh, Junior Clerk passed away on October 19, 2018.

Skilled Support Staff

2. Shri Ram Ashrey, SSS passed away on November 17, 2018.

Organogram


QRT
DIRECTOR
RAC
IMC
IRC
QRT-Quinquennial Review Team
RAC-Research Advisory Committee
IMC-Institute Management Committee
IRC-Institute Research Committee
RESEARCH
ADMINISTRATION
ESTABLISHMENT
ACCOUNTS
STORES & PURCHASE
AUDIT & BUDGET
OFFICIAL LANGUAGE
DIVISIONS
CROP IMPROVEMENT AND BIOTECHNOLOGY
CROP PRODUCTION
CROP PROTECTION
POST HARVEST MANAGEMENT
SUPPORTING UNITS
PRIORITIZATION, MONITORING & EVALUATION UNIT
LIBRARY
FARM MANAGEMENT
ESTATE
AKMU
Regional Research Station, Malda
KVK, Malda

Research Achievements

3 Crop Improvement and Biotechnology

Mango (*Mangifera indica* L.)

Germplasm Collection

Twenty-five mango germplasm accessions with traits *viz*., attractive peel colour, adaptability and shelf-life were collected from BAU, Sabour, Bihar; Malihabad, U.P.; Rahuri, Maharasthra; Karnataka and Murshidabad, West Bengal during 2018-19.

Field Gene bank planting

Total 772 mango accessions are being maintained in the field gene bank. Gaps were filled by multiplying thirty-nine accessions.

Germplasm Characterization

Profiling of major nutraceuticals

The pulp of thirty mango hybrids was analyzed for total antioxidants, total phenols, total flavonoids and total carotenoids. The total antioxidants, phenols, flavonoids and carotenoids content were recorded in the range of 0.32-0.88 µmol Trolox/100g, 24.86-79.72 mg gallic acid equivalent/100g, 11.33- 32.67 mg quercetin equivalent/100g and 2.40- 12.49 mg/100g, respectively. The lowest carotenoid (2.40 mg/100 g) content was recorded in H-705, while the highest carotenoid was recorded in hybrid H-973 (12.49 mg/100 g).

Documentation of germplasm

Evaluation

Evaluation data of 322 accessions indicated the wide variability for various fruit physical parameters. Around 55 per cent accessions evaluated exhibited fruit weights in the desirable range of 200-400 g, whereas, 15.47 per cent accessions recorded fruit weights in the range of 400-600 g. Pulp weight and TSS exhibited wide variability ranged from 15.66 g (Angoordana) to 1277 g (Hemlet) and 8 °B to 28 °B (Balkandpuri), respectively.

Hybridization and establishment

During 2019, using 12 cross combinations, 50040 flowers were crossed on 11475 panicles (Table 1). A total of 43 seeds of mango hybrids were obtained from the crosses made during 2017-2018 and 32 stones germinated. However, fruits could not be obtained from three of the cross combinations (Table 2). One hundred and thirty-two seedlings raised from hybrid combinations were planted in field for evaluation of F_1 progeny of mango hybrids with an objective to improve various fruit and quality parameters.

Evaluation of hybrids

During the year 2018-19, record 1312 number of hybrids were evaluated for physical parameters *viz*., fruit weight, fruit length, peel weight, stone weight, pulp weight, stone length, stone width and stone thickness. The hybrids exhibited wide range of variability for various fruit physical parameters including fruit colour as indicated by wide CIE L*a*b* values. The pulp weight ranged from 5 g (H-2682) to 992.17 g (H-730) among the hybrids while, the TSS varied between 7.2 °B to 28 °B (H-1740) with a mean of 19.48 °B. There is an ample scope for identifying hybrid with desirable fruit weight because among the hybrids evaluated, around 58.29 per cent hybrids exhibited fruit weight between 200-400 g (Fig. 1-3).

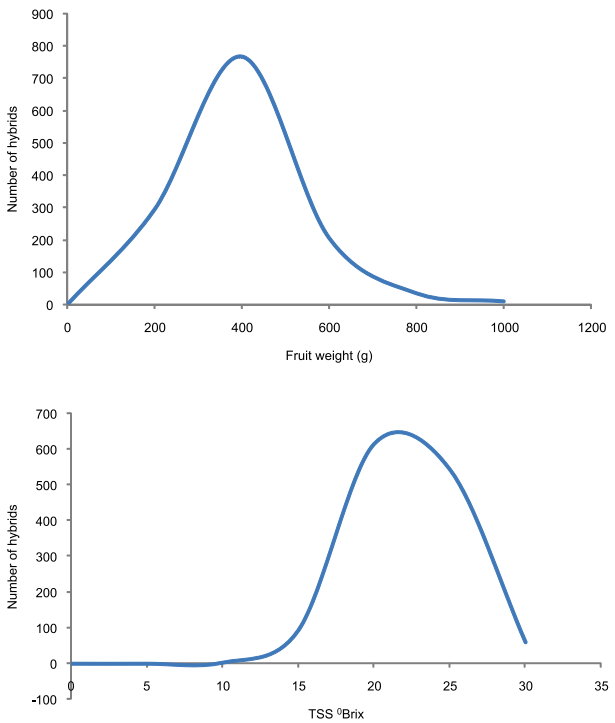


Fig. 1. Number of mango hybrids in fruit weight and TSS range

H-4065 H-4104 H-4133

Fig. 2. Promising hybrids selected in mango during 2018-19

Table 1. Hybridization carried out during 2018-19

S.N.	Cross combination	Panicles used for hybridization	Number of flowers
1	CISH-Ambika × Tommy Atkins	500	1828
2	CISH-Ambika × Sensation	400	1575
3	CISH-Arunika × Tommy Atkins	1150	2855
4	CISH-Arunika × Dashehari	1200	4447
5	Amrapali × Tommy Atkins	450	4281
6	Amrapali × Sensation	1550	6535
7	Amrapali × Vanraj	1250	5915
8	Dashehari × Tommy Atkins	2350	9792
9	Dashehari × Vanraj	500	2388
10	Dashehari × Sensation	1250	6713
11	Neelum × Tommy Atkins	850	3636
12	13-1 × ML-6	25	75
	Total	**11475**	**50040**

Table 2. Hybrid seedlings from hybridization during 2017-18

S.N.	Cross combination	Panicles used for hybridization	Number of flowers	No. of fruits harvested	No. of stone germinated
1	CISH-Ambika × Tommy Atkins	650	2049	-	-
2	Amrapali × Tommy Atkins	3050	11927	15	13
3	Amrapali × Vanraj	400	1586	-	-
4	Amrapali × Sensation	1400	5509	12	10
5	CISH-Arunika × Tommy Atkins	700	2453	2	-
6	Dashehari × Sensation	2400	8596	2	2
7	Dashehari × Tommy Atkins	3000	11288	5	2
8	Dashehari × Vanraj	2250	9516	2	1
9	Neelum × Tommy Atkins	1200	4270	5	4
10	13-1 × ML-2	75	120	-	-
	Total	15125	57314	43	32

Table 3. Basis for selection of cross combinations during 2018-19

S.N.	Cross combination	Q+C	RB	WA	AB
1	CISH-Ambika × Tommy Atkins	+	+	+	
2	CISH-Ambika × Sensation	+	+	+	
3	CISH-Arunika × Tommy Atkins	+	+	+	
4	CISH-Arunika × Dashehari	+	+	+	
5	Amrapali × Tommy Atkins	+	+	+	
6	Amrapali × Sensation	+	+	+	
7	Amrapali × Vanraj	+	+	+	
8	Dashehari × Tommy Atkins	+	+	+	
9	Dashehari × Vanraj	+	+	+	
10	Dashehari × Sensation	+		+	
11	Neelum × Tommy Atkins	+	+		
12	13-1 × ML-6				+

Q+C = Quality and Color of Fruits, RB= Regular Bearing, AB= Abiotic Stress, WA= Wider Adaptability

Development of genomic resources (SSR markers)

Five hundred SSR regions were mined from FBD transcriptome data and by computational analysis SSR co-localized within functional DEGs actually associated with flowering were identified. Three SSR regions in coding sequences for genes encoding TPR repeat containing Thioredoxin and endoglucanse were identified, *viz*. *MiSSR-TTL1* (tri-nucleotide repeats), *MiSSR-EnG3* (di-nucleotide repeats) and *MiSSR-EnG6* (tri-nucleotide repeats). Flanking primers were designed for these SSR regions using WEBSAT. Primers for *TTL1* and *EnG3* microsatellite regions yielded products of 181 and 170 bp, respectively, through *in silico* analysis and these primers were validated by standard PCR assay for developing functional markers.

Molecular basis of peel color in mango hybrids

Gene expression analysis of hybrids such as CISH-Arunika, Hybrid 1084, 1054, 949 and 1739 derived from parental crosses involving Amrapali x Vanraj, Amrapali x Janardhan Pasand and Neelam x Tommy Atkins were carried out to understand the molecular basis of peel color. Real time analysis of 3 key genes (*CHS2*, *F3H* and *DFR*) involved in anthocyanin biosynthetic pathway revealed high upregulation of these genes in hybrids with colored peel, indicating the anthocyanin accumulation for conferring characteristic purplish red peel color. A representative gene expression profile for *DFR* gene in different mango hybrids/cvs is shown in Fig. 3.

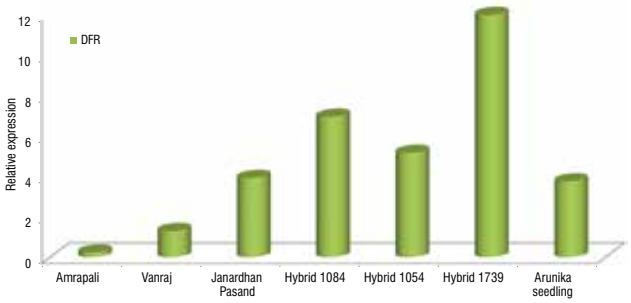


Fig. 3. Gene expression profiling of DFR gene in the peels of different mango hybrids/cultivars

Identification of flavor and aroma volatiles in mango cultivars/hybrids (pulp)

Metabolite profiling of flavor and aroma volatiles were carried out in mango hybrids CISH-Ambika and CISH-Arunika along with their parents such as Amrapali, Janardhan Pasand and Vanraj through Gas Chromatography-Mass spectrometry (GC-MS) analysis. Chromatograms obtained in the parents and hybrids showed spectral peaks matching with specific metabolites being inherited from either male or female parents confirming their hybridity. Library search analysis of the GC-MS data with NIST library identified metabolites belonging to quinones, coumarins and flavonoids that were characteristic for conferring flavor and aroma. Lactones, a subclass of benzopyrene class of Coumarins, a fragrant colorless compound were identified to be the major class of aroma volatiles. Three structural analogs of lactones were found in Vanraj and two structural analogs in Amrapali. Fluromethyl coumarin was unique in Vanraj. A structural analog called Furo-coumarin was common in CISH-Arunika and its parents, *viz*., Amrapali and Vanraj. Different structural analogs of dimethoxy-flavones (obtained from permethylation of flavonoids) were identified in Ambika and its female parent, Amrapali but it was not evident in its male parent, Janardhan Pasand.

Bioinformatics and computational analysis of genomics data

A software was developed for mining coding sequences from transcriptome assembled data/unigenes that facilitates accurate data retrieval for bioinformatics analysis. This software is named as RNASeqMiner: a CDS retrieval tool (software), since it is used for mining coding sequences from RNA-sequencing data. This tool was developed using base information of floral bud data sets of mango cv. Dashehari. This tool has the options of using either CDS, unigene or transcript ids for retrieving sequences from unigene or assembled sequence files for using them for prediction of alternate splice variants and phylogenetic analysis. This tool was used for sequence retrieval for CDS of 14 transcription factor gene families, *viz*., *RAV*, *DBB*, *Whirly*, *AGL26*, *COL*, *CO7*, *CO9*, *AP2-AIL6*, *LFY*, *ERF-RAP2-7*, *WRKY53*, *NAC*, *TFIID*, *TF-RF2a*, and *TCP13* from both floral (FBD) and vegetative buds (VBD) transcriptome data sets. In this software, processing took place within 5-10 minutes and results were obtained in 10-15 minutes. Consequently, it drastically reduced the time spent on CDS retrieval manually.

Small RNA sequencing and identification of miRNAs associated with flowering

Small RNA sequencing of floral (FBD) and vegetative buds (VBD) by Illumina platform and data analysis revealed 1615 DE miRNAs. About 2803 and 1641 miRNAs were identified as known miRNAs in FBD

and VBD, respectively. About 50 and 8 were novel miRNAs in FBD and VBD, respectively. Among the known miRNAs identified in FBD, some were well characterized and implicated in vegetative to floral transition (V-R) as indicated in Table 4. Eight miRNAs of *miR167* group were significantly upregulated and 112 (*miR399*, *miR159*, *miR156*, *miR408*, *miR160*, *miR159*, *miR171*, *miR166*, *miR396*, *miR482*, *miR1509*, *miR2111*) were significantly downregulated. Unique miRNAs were identified such as 26 miRNAs unique to VBD and 1162 unique to FBD. Novel miRNAs in both FBD and VBD were identified with targets for GRAS family, SPL2, 7, 9, ARF15/16 regulating flowering.

Table 4. Flowering related known miRNAs identified in the RNA-Seq data of flower bud

Known miRNAs	Gene Target	Counts	Significance and function
miR156	*SPL*	301	Phase transition V-R, promotes flowering
miR157	*SPL*	12	Phase transition V-R, promotes flowering
miR172	*AP2*	97	Repressor in photoperiod induction
miR159	*MYB*	91	Promotes flowering
miR171	*SCL/LM*	207	Promotes/ delays flowering
miR319	*TCP*	72	Promotes flowering
miR390	*tasi RNA*	81	Promotes juvenility
miR393	*TIR*	40	Repressor
miR399	*PHT2*	165	Temperature, phosphate starvation responsive, repressor
miR5200	*FT*	Nil	Photoperiod induction and promotes flowering
miR169	*NF-Y*	35	Repress/induce flowering in response to abiotic stress
miR824	*AGL*	Nil	Repressor based on environment/genetic background

Proteome analysis in mango ripe pulp and jelly seed pulp

Proteome analysis in mango pulp revealed proteins related to sugar metabolism (glyceraldehyde-3-phosphate dehydrogenase, sucrose-phosphate synthase, glycolate oxidase, ATP synthase CF1 beta subunit), protein turnover (polyubiquitin, Ubiquitin-40S ribosomal protein S27a, RNA polymerase β-subunit, ribosomal protein S3), photosynthesis (chloroplast chlorophyll A/B binding protein, light-harvesting complex), cell wall metabolism (β-galactosidase, lipoxygenase) and secondary metabolism (p-coumaroyl ester 3'-hydroxylases, palmitoyl-acyl carrier protein thioesterase, polyphenol oxidase, phenylalanine ammonia lyase) were differentially regulated.

Expression analysis of ripening genes during fruit development and ripening in mango

Expression analysis (RT-PCR) of four different *ACS* (*ACS*1, 2, 10, 12), two different *ACO* (*ACO*1, 4), *ERF* 21, 39 and *AUX* genes (*AUX*1, 2) were analyzed at different fruit development and ripening stages *i.e.* 0 dpa (1), 10 dpa (2), 20 dpa (3), unripe immature fruit pulp (4), ripe fruit pulp (5) and jelly seed pulp (6) in mango cv Dashehari. *ACS*2 play very important role during mango fruit development only while *ACS*10 and *ACS* 12 were involved in developmental and ripening. Expression of both the ERFs (Fig. 4) was found to be up-regulated during fruit development, ripening and jelly seed pulp as compared to 0 dpa suggests *ERF*21 and *ERF*39 plays important during normal fruit development as well as mango ripening and jelly seed formation. *AUX*1 played very important role during mango fruit development and ripening, however, *AUX*2 has no role in normal fruit development and ripening.

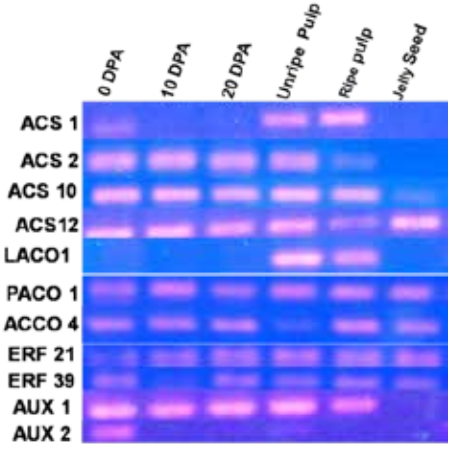


Fig. 4. Semi quantitative RT-PCR based expression profiling of ripening related gene

Expression of ethylene forming enzyme and ERF genes under salt stress in mango

Expression analysis (RT-PCR) of ethylene forming enzyme (*ACO-1, ACO-4, ACS2* and *ACS-10*), six ethylene responsive TFs genes (*ERF4, ERF105, ERF119, RAP2-3, RAP2-4*) and *AUX1* under salt stress (200mM NaCl, 1 hour) in mango cv. 13-1 revealed up-regulation of these genes.

Guava (*Psidium guajava* L.)

Characterization

During the year 2018-19, fifteen guava accessions were studied for their fruit firmness, attractiveness, TSS, size and seed hardiness from Uttar Pradesh, Karnataka, Chhattisgarh, Uttarakhand and West Bengal.

Profiling of major nutraceuticals

Biochemical components such as total antioxidants, total phenols, total flavonoids, lycopene and ascorbic acid were analyzed in 30 varieties and 30 hybrids of guava. Among all the analyzed varieties and hybrids, the total phenol content ranged from 120 - 675 mg/100g GAE; the total flavonoids varied from 10 - 249 mg/100g; total antioxidants varied from 0.32 - 4.19 µmol Trolax/100g and the lycopene content ranged from 1.10 – 5.5 mg/100g. The cultivar CISH-Shweta recorded the highest total antioxidant (4.19 µmol Trolox/100g) and highest total phenol (675.00 mg GAE/100g). Out of 30 hybrids, 8 were found to be rich source of lycopene content which ranged from 3.3 to 5.68 mg/100g. The cultivar Sardar recorded the highest total flavonoid (259 mg QE/100g). The highest vitamin-C was noticed in the cultivar Spear acid (336 mg/100g) and high TSS was recorded in cv. PHSG 10-4 (15.40 ^{o}B). The number of seeds was also one of the important traits low in hybrid line LR2P20. It recorded comparatively less number of seeds with 211mg/100g of vitamin C content and 14 ^{o}B TSS.

Evaluation of guava germplasm

Evaluation of guava germplasm for fruit characteristics indicated wide variability for fruit weight, fruit length, fruit width, seed hardiness and TSS. The fruit weight in the germplasm ranged from 44 g to 351 g (Baratan) with an average of 161.62 g, while, the TSS ranged from 7.2 ^{o}B to 15.40 ^{o}B (PHSG-10-4). Ascorbic acid ranged from 168 mg/100 to 336 mg/100g (Spear Acid) with a mean of 227.17 mg/100 g. Fruit weight exhibited maximum variability while seed hardiness exhibited minimum variability.

Evaluation of guava hybrids and half-sib population

Evaluation of hybrid seedlings for fruit characteristics revealed that highest variability was recorded for fruit weight followed by TSS and seed hardiness (Fig. 5). The fruit weight ranged from 47 g to 215.5 g (LR2P20) and Vitamin C content varied from 148.8 mg/100 g to 243.6 mg/100 g (LR10P105) while, TSS varied between 10.17 and 15.55 °B. The wide variability recorded for fruit weight and seed hardiness indicates the ample scope for identifying superior hybrids (Fig. 5) from the available population.

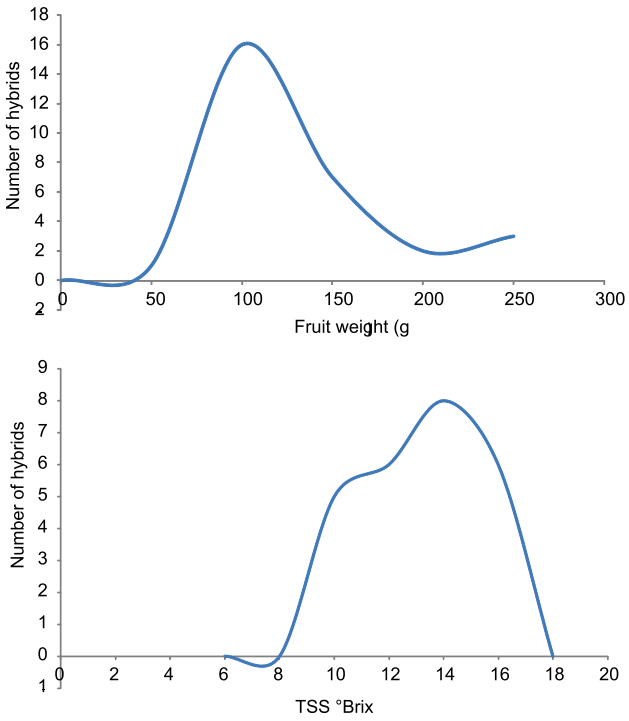


Fig. 5. Number of guava hybrids in fruit weight (A) and TSS range (B)

In vitro regeneration of wilt resistant guava rootstock

Size of explants is a crucial factor in determining its response *in vitro*. The explant size of 1.5 cm^2 was found to be optimum for callus induction (21.27%), high survival (41.23%) of explant and low necrosis (21.67%). Smaller explants tend to necrose quickly. However, larger explants showed high degree of fungal contamination. The media containing 2ip 0.5mg/l+NAA 0.5mg/l showed a significantly high survival rate of explant (63.43%), high regeneration frequency (32.12%) and required least number of days for callusing (12.7 days). Five different media (MS, WPM, Juglans, Date, Banana) formulated for fruit crops were utilized as basal media). Maximum explants induced callus from midrib in MS medium (48.20%) in 12.7 days followed by Juglans medium (42.5%) in 21.5 days. Highest number of shoots per callus (10.7) was also obtained in MS medium. WPM, Banana and Date medium formulations did not affect caulogenesis in guava due to subsequent necrosis. Both *in vitro* and *ex vitro* leaves were used as explants for callus induction. Minimum time taken for callus induction from *in vitro* leaf was observed to be 10.22 days while *ex vitro* leaf callused in 12.4 days in MS medium. Initially, the callus was observed at the cut end of the leaf. It was predominant at midrib on abaxial surface of *ex vitro* leaf. The entire *in vitro* leaf converted into callus in 3 weeks while *ex vitro* leaf

converted in 35 days. The calli from both types of explants were proliferated in the same media. After 3-4 weeks, green friable callus transformed into shoot like structures which were maintained under *in vitro* condition. However, the calli from *in vitro* leaf were smaller and shoots regenerated from them after one week while the ones from *ex vitro* leaves survived stably and proliferated.

Papaya (*Carica papaya* L.)

Development and generation advancement of transgenic papaya

A marker free truncated hairpin loop coat protein gene was mobilized into somatic embryos of papaya for conferring PRSV resistance. An optical density (OD 600 nm) of 1.0 of bacterial colony favours survival of embryos. Only 2.3 per cent embryos died after a week with 1.0 OD. *Agrobacterium* infection for 45 minutes was found optimum for efficient gene integration. A maximum of 6.39 per cent putative transformed embryos were recorded when explants infected for 45 minutes. Infected embryos were co-cultivated for 72 hours produced significantly higher putative transgenic embryos (8.8%). Acetosyringone (100 µM) augmented the process of transformation leading to production of higher putative transformants (11.20%). Spermidine at 100 µM concentration used as pre-conditioner increased the recovery of transformants. The best control of *Agro*-infection (8.80%) was observed when the co-cultivated explants were washed by MS salt solution supplemented with 100 mg L^{-1} cefotaxime. A total number of 8 plants were positive for *cp* gene after repeated PCR using *cp* specific primers. Transformants showed presence of *cp* gene. Out of 8 plants confirmed through PCR and dot blot hybridisation, only three exhibited positive results in real-time PCR analysis. These stable transformants were acclimatized for evaluation.

Aonla (*Emblica officinalis* Gaertn.)

Collection

Rewa, Satna and Chitrakoot of M.P. were explored for collection of superior aonla genotypes in terms of fruit size, yield, vitamin-C and phenol content. A total of 10 accessions were collected whose fruit weight ranged from 17.77 to 35.97 g, fruit length 2.53 to 3.30 cm, fruit breadth 2.80 to 3.77 cm and stone weight 0.85 to 1.89 g. Among the different accessions collected, ascorbic acid content ranged from 333.30 to 555.50 mg/100 g pulp and total phenol content 1.72 to 3.69 mg/100 g pulp, TSS 8.00 to 11.83 ^{o}B and total sugar 6.28 to 9.65 per cent. On the basis of overall assessment, three accessions *i.e.* T_4, T_6 and T_8 were found promising ones. The scion shoots of these 3 promising accessions were collected and plants multiplied in the nursery for planting in during next year in monsoon season (Fig. 6).

Fig.6. Elite germplasm accessions of aonla selected based on physical and biochemical attributes from collections

Evaluation

Out of twenty-one accessions of aonla, germplasm accessions of M.P. planted in the field along with 4 check varieties *viz*., NA6, NA7, Kanchan and Krishna during 2007, accessions came into bearing during 2018-19. These accessions were evaluated for different yields and quality parameters. Maximum fruit yield (55.10 kg/tree) was recorded in accession CISH A-33 followed by CISH-A-31 (40.10 kg/tree) and CISH A-3 (40.10 kg/tree each). The fruit weight varied from 23.53-44.30 g among the different accessions being maximum recorded in cv. Krishna. Ascorbic acid content ranged from 311.25 to 490.13 mg/100g pulp among the different accessions evaluated. Polyphenol content ranged between 0.67 and 1.71 TAE g/100g, with maximum polyphenol content (1.71 TAE g/100g) recorded in accession CISH-A-33 followed by CISH-A-31. On the basis of overall assessment, two accessions *i.e.,* CISH A-31 and CISH A-33 were found promising in terms of high nutraceutical properties (Fig. 7).

Fig. 7. Two superior aonla germplasm accessions selected based on evaluation during last 3 years.

Bael (*Aegle marmelos Correa*.)

Collection

District Jaunpur and adjoining areas of U.P. were surveyed wherein 10 accessions were marked and their passport data recorded. Fruits were analysed for various physical and biochemical parameters. The fruit weight (0.77-1.41 kg), fruit length (8.23-13.83 cm), fruit diameter (27.83-53.33 cm), number of seed sac (13.66-19.66), shell weight (0.133- 0.610 kg), number of seeds/fruit (78.00-115.00), TSS (32.20-37.33 ^{0}B), acidity (0.31-0.62%), ascorbic acid (9.62-19.23 mg/100g pulp), total sugar (15.51-22.27%), reducing sugars (6.62-8.44%), total phenol (1.65-2.46%) among the different accessions varied significantly. On the basis of overall performance, 3 accessions *i.e.* T_6, T_9 and T_{10} were found promising. The scion shoots of these 3 promising accessions were collected, their plants were multiplied in the nursery for planting them during the next year.

Evaluation

Clonally multiplied germplasm

Out of 36 vegetatively multiplied bael accessions planted in the field gene bank for evaluation, 12 accessions came into bearing and these accessions were analysed for physico-chemical parameters. The fruit weight (0.82-2.20 kg), shape (round to oblong), fruit length (12.50-15.97 cm), fruit circumference (33.67-49.52cm), number of seeds (68.22-111.65), shell weight (0.27-0.56 kg), shell thickness (1.97-3.00 mm), number of seeds sac (11.02-15.32), seed weight (6.13-13.32 g), fruit yield (15.54-50.42 kg/plant), TSS (32.20-37.63 ^{o}B), acidity (0.32-0.64%), ascorbic acid (8.85-16.17 mg/100g pulp), total sugar (15.51-22.27%) and tannins (1.65-2.46%) among the different accessions varied signifcantly. On the basis of overall assessment accession, T_3 was found promising with respect to yield (50.42 kg/tree), TSS (37.50 ^{o}B), less seed weight (11.56 g/fruit), less shell thickness (2.28 mm) and less shell weight (280 g/fruit).

Seedling germplasm

A total of 143 seedlings raised from promising bael accessions planted during 2003, which came to bearing during 2018-19 were evaluated for their growth and fruit characteristics. Plant height varied from 4.15-11.50 m, girth from 17.15-70.10 cm, plant spread 2.21-9.25 m (E-W) and 1.91-8.40 m (N-S) and fruit yield varied from 24.50-70.50 kg/tree. The fruit weight varied from 0.85-2.98 kg, fruit length (6.21-15.36 cm) and fruit circumference (26.5-45.43 cm) among the different seedling germplasm evaluated. Biochemical parameters *viz*., TSS (34.20-40.4 ^{o}B), total sugar (12.40-19.10%), reducing sugar (6.28-9.40%), tannin (1.35-2.35%) and vitamin 'C' content (12.56-18.17 mg/100g pulp) among the different seedling germplasm evaluated. On the basis of overall assessment, two seedling germplasm accessions *i.e*., seedling No-31 having fruit weight (950.50 g), fruit yield (64.50 kg/tree), seed weight (9.41 g), TSS 42 ^{o}B, acidity (0.48%), vitamin-C (25.64 mg/100g pulp) and seedling No-57 having fruit weight (1189 g) fruit yield (60.57 kg/tree) seed weight (16.94 g), shell weight (167 g), TSS (34 ^{o}B), acidity (0.48%), vitamin 'C' (25.64 mg/100g pulp) were found the most promising (Fig. 8).

Fig. 8. Elite Bael (T-3: Clonally multiplied, Seedling-31 and 57: Seedling germplasm) accessions selected by evaluation during 2018-19

Jamun (*Syzygium cumini* Skeels)

Collection

Twelve trait specific germplasm accessions were collected with reference to good keeping quality. Early bearing/maturity were collected surveying three districts *i.e*., Gonda, Barabanki and Faizabad of U.P. and their physico chemical properties were evaluated. Maximum fruit weight was recorded in CISH J-60 accession collected from Ayodhya, U.P. with maximum TSS 14.5 ^{o}B. These accessions showed early fruit ripening which started 10-12 days earlier *i.e.* during the first week of June than the other accessions available in our field gene bank.

Evaluation

Germplasm evaluation was done based on observations on flowering, fruiting behaviour and yield, quality parameters. The tree height was estimated in the range of 6.92 to 13.00 m. Maximum fruit weight varied 5.46 to 20.93 g and was recorded in CISH J-37 (20.93 g) followed by CISH J-15 (16.22 g) while the lowest in CISH J-45 (5.46.00 g). The fruit sizes ranged from 3.22 to 10.92 cm while the length: breadth ratio in the range of 1.31 to 1.88 cm among different accessions. A wide variation was also observed in seed weight as for an ideal variety, lower weight and small size of seed is desirable character. The seedless accessions CISH J-42 showed highest pulp content (97.07 %). The

maximum TSS was recorded in Gokak-1 (16.10 °B) followed by Gokak-III (15.90 °B). The maximum fruit yield was estimated CISH J - 37 (75.50 kg/plant) while the minimum fruit yield recorded in CISH J-42 (12.83 kg/plant) on 11th year old tree.

Canopy management of accessions CISH J-37 for enhanced productivity

Pruning was imposed to maintain different systems of trailing *i.e.* open centre system and palmette system. Tree branches were pruned during mid-October with both systems of canopy. Flowering started in open and palmate system on current season having one year old shoots after 2nd week of March. Initiation of flowering periods varied 2-3 days only, however, fruit setting periods were recorded 5 - 7 days intervals. East and south direction of shoot recorded one week early fruit setting and maturity. Fruit maturity also differed with directions of branches *i.e.* one week early maturity in east direction of tree. Maximum fruit yield/plant, TSS, average fruit weight were recorded in open system in east direction of tree. Open system of canopy recorded maximum fruit yield (85.73 kg/ plant) compared with control (72.70 kg/plant). Not much difference in average fruit weight was observed. The maximum number of fruit set was recorded in open and palmate system (46 and 35) on current year shoot (4 month old shoot), however, minimum number of fruit set was in open and palmate system on one year old shoot (25 and 23).

Use of GA_3 for fruit size improvement in CISH J-42

GA treatment for improving fruit size was attempted in CISH J-42. GA_3 treatments started on pea stage wherein the fruit bunches dipped in different concentrations of GA_3 after fruit set to assess the improvement in fruit size. The maximum fruit weight and TSS were recorded (8.6 g and 16 °B) in 60 ppm GA_3 compared to control fruit weight (6.45) and TSS (9.5 °B).

Crop Production

Canopy re-orientation of mango cv. Dashehari under high density plantation

Canopy reorientation program was carried out in overcrowded and unproductive orchards of mango cv. Dashehari involving three pruning heights (P), mulching (M) and two spacing (S). Maximum tree spread between row (2.30 m) was recorded in $S_1P_1M_1$ (2.5×2.5 m, 1.5 m height pruning with organic mulch), while primary shoot length was 13.61 per cent higher in S_2 (2.5×5.0 m) compared to S_1 (2.5×2.5 m). Overall average light interception was more in trees pruned at 1.5 m height. Maximum number of trees (78.33 %) experienced flowering in $S_1 P_3 M_2$ (spacing 2.5×2.5 m, pruning height 1.5 m without mulch). Overall, higher flowering and fruiting was recorded in trees pruned at 2.5 m height at 3 years of pruning (Fig. 9).

Fig. 9. Flowering in mango pruning height 1.5 m (2.5×5.0 m) spacing

Canopy management in old, unproductive and senile mango orchards

An experiment was initiated in 2015-16 with a view of refining the existing mango rejuvenation technology developed by ICAR-CISH in response to farmer's feedback. Old and relatively unproductive trees are subjected to various degrees of pruning to encourage the safe and healthy canopy development at the earliest in order to ensure farmer's income at an early date and to avoid/minimize the infestation of stem borer. The treatments included heading back of primary branches to varying heights. Besides, consecutive cutting one or two branches per year was also resorted. During third year of experimentation, the treatment wherein two branches were removed every year indicated maximum canopy development in terms of height and spread of plants (Fig. 10). Canopy development was slower in trees wherein one branch was removed every year (Fig. 11) when compared with two branches heading back per year. Fruit yield varying from 50 to 150 kg was recorded from the remaining branches which avoided complete loss of income for the farmers. Fruit yield from remaining branches was higher in treatment wherein one branch was headed back every year to complete the process in five years. In these two treatments, the incidence of stem borer was minimum and no mortality was recorded. As regards other treatments where all the branches were removed in first year, mortality to the tune of 15-25 per cent was noticed. However, during third year, flowering was observed in most of the plants headed back completely.

Fig. 10. Tree canopy after cutting 2 branches /year

Fig. 11. Tree canopy development in case of cutting of one branch/year

Physiological studies in rejuvenated and non-rejuvenated mango orchard

In rejuvenated orchard, total light availability beneath the canopy was found to vary from 44.67 to 53.33 per cent during April–September. Net photosynthesis rate and stomatal conductance ranged between 2.77 and 4.33 µmol CO_2 $m^{-2}s^{-1}$ and 57-117 mol H_2O

$m^{-2}s^{-1}$, respectively. During October-March, total light availability beneath the tree varied between 41.33 and 48.67 per cent, net photosynthesis rate and stomatal conductance was 7.44-16.67 µmol CO_2 $m^{-2}s^{-1}$ and 87-162 mol H_2O $m^{-2}s^{-1}$, in mature leaves of rejuvenated trees. Fruits were of better quality in trees where sequential rejuvenation of selected branches was done during three consecutive years followed by one time rejuvenation of trees as compared to control. Branch angle of newly developed secondary branches (laterals) was in the range of 45-60°.

Fourty-year-old mango trees of cultivars Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali, planted at 10×10 m spacing exhibited significant variability in light relations. During April to September, availability of total light was 28.87-32.67 per cent and membrane stability index (MSI) of different cultivars varied from 63.57 to 83.33. Carotenoids content of ripe fruits ranged between 190.6 to 366.3 µg 100 g^{-1}. During October to March light was more in Mallika (30.67%) while leaf area index of this cultivar was minimum (1.42). At flowering stage, rate of net photosynthesis of different cultivars varied from 5.66 to 10.82 µmol CO_2 $m^{-2}s^{-1}$ and membrane stability index varied from 72.33 to 87.67. In addition to genetic variability in different cultivars, light relations are critical for canopy management, optimal production and quality of fruits.

Evaluation of filler crops for enhancing profitability of rejuvenated orchard of mango cv. Dashehari

Different filler crops viz., guava (cv. CISH-Shweta), bael (cv. NB-5), custard apple (cv. Atemoya×Balanagar), ber (cv. Gola), Apple Ber and pomegranate (cv. Bhagwa) were planted in rejuvenated orchards or mango cv. Dashehari. Plant height of different filler crops varied from 0.3 to 1.11 m, while plant spread in east-west and north south direction ranged from 0.31 to 1.28 m and 0.36 to 1.15 m. Plant height and spread were maximum in guava cv. CISH-Shweta while it was minimum in pomegranate. During the period, custard apple cv. Arka Sahan and Balanagar, guava cv. CISH-Dhawal were also added as treatments. As regards performance of rejuvenated mango trees, around 50 per cent of rejuvenated trees produced flowers while mortality in around 15 per cent of total number of trees headed back for rejuvenation was recorded. Increase in growth of tree canopy in terms of height and spread was recorded. Rejuvenated trees gave a fruit yield of 1.2 to 14.5 kg/tree with average fruit size of around 250 g/fruit. Trees varied from 4-6.5 m in spread and 2.5-5.3 m in height. The mortality of plants was caused due to severe infestation of stem borer.

Physiological evaluation of bael cultivars for fruit drop

Ten bael cultivars (CISH B-1, CISH B-2, NB-5, NB-9, NB-16, NB-17, Pant Aparna, Pant Shivani, Pant Sujata and Pant Urvashi) were evaluated for fruit drop and low temperature/ frost damage. Irrespective of cultivars, maximum fruit drop (40%) was observed during January and minimum during September-October (5%). Fruit drop was more in cultivars in which canopy was more affected by low temperature. Low temperature damage to canopy ranged 5 per cent in NB-16 and CISH-B1 up to 40 per cent in CISH B-2 followed by 35 per cent in Pant Shivani and NB-17.

Light relations, gas exchange and associated physiological study in jamun orchard for canopy management

In jamun accession CISH J-37, under different pruning systems (control, open and palmate) total light availability was found varying between 31.33 per cent (in control) and 53.55 per cent (in open system) in south direction while only 24.55 per cent (in control) to 47.21 per cent (open system) light was available in the north direction. Similarly, net photosynthesis rate ranged 6.69-12.63 µmol $CO_2m^{-2}s^{-1}$ in south and 4.47-10.36 µmol $CO_2m^{-2}s^{-1}$ in north in control and open system, respectively. More light availability and gas exchange was found in open system of pruning as compared to palmate and control.

Enhancing guava productivity through espalier architecture under HDP

Preliminary data revealed that trunk girth was found maximum in CISH-Lalit (3.0 cm), the diameter of the primary scaffolds successively increased from 1st tier (basal tier) to 4th tier. Similarly light interception was maximum on 4th tier (78-93%), however, over all light availability was high in espalier architecture as compared to traditional training system (Fig. 12).

Fig. 12. Newly planted guava in espalier architecture system of training

Input use efficiency in HDP guava

Results revealed that maximum trunk girth (8.3 cm), primary branch girth (5.14 cm) and secondry branch girth (3.43 cm), yield (40.63 kg tree^{-1}) and yield efficiency (2.66 kg/m^3) were recorded in T_1 [raised bed+drip irrigation at 80 per cent ER at all stages + fertigation (75% RDF) + 100 microm black polythene mulch along with micronutirent spray (zinc sulphate and boric acid spray @ 0.2 %]. Maximum water use per day was noted in control (21.87 l/day). No significant differences with respect to plant height, canopy volume, pulp seed ratio and shelf life were noted.

Standardization of nutrients requirement through fertigation in banana cv. Grand Naine

The experiment was initiated during August 2016 with an objective to optimize the nutrient dose and schedule for growth, yield and quality of banana cv. Grand Naine. The total treatment combinations were thirteen replicated thrice under randomized block design. Maximum cumulative fruit yield (94.60 t/ha) was recorded in the treatment of 100 per cent RDF applied N:K (40:25, 30:35, 30:25, 0:15) at vegetative growth, pre-flowering, flowering and fruit development stage closely followed by 80 per cent RDF applied N:K (40:25, 30:35, 30:25, 0:15) at vegetative growth, pre-flowering, flowering and fruit development stage (93.02t/ha). Nutrient use efficiency was higher in 60 per cent RDF applied N:K (40:25, 30:35, 30:25, 0:15) at vegetative growth, pre-flowering, flowering and fruit development stage in banana cv. Grand Naine of plant crop and ratoon crop, respectively.

Phenological manipulation through planting time for higher yield and better quality in banana

Planting time of banana at monthly intervals revealed that total functional leaf area (8.14 and 9.76 m^2), LAI (3.01 and 3.61), bunch weight (19.5 and 20.2 kg/plant) and TSS (21.4 and 20.8 °Brix) were recorded in banana cv. Grand Naine planted during 15th of June and 15th of July. The total growing degree days from planting to shooting (5560 and 5531) were recorded in banana planted during 15th of June and 15th of July (Fig. 13).

Fig. 13. Bunch development in banana planted on (a) 15th June and (b) 15th July

Standardization of container gardening of fruits

Mango, guava, citrus, pomegranate and papaya have been planted in different size of containers using different proportion of media (soil, FYM, sand and vermi-compost). All the plants exhibited good vegetative growth. The citrus cv. Kagazi lime (SGN Lime 1), Arakta and Super Bhagwa of pomegranate, CISH-Lalit and CISH-Shweta of guava came into bearing during 1st year.

Improving fruit size and quality of peach under subtropical condition

Eight varieties under subtropical conditions were evaluated for fruit size and quality and it was found that earliest fruit maturity was recorded in Flordaprince (15-25 April) and Saharanpur Prabhat and late in Pant Peach-1 and Pratap (5-23 May), while, maximum yield per tree and yield efficiency were recorded in Flordaprince and Pant Peach cultivars. The fruit weight was registered maximum (50 g to 80.17 g/fruit) in Pant Peach-1, Pratap and Flordaprince, and TSS (15.17 °Brix) was maximum in Sharbati Surkha and Saharanpur Prabhat. The antioxidant properties revealed that Sharbati Surkha pulp contains maximum ascorbic acid, chlorogenic acid, catechin, epicatechin while gallic acid, caffic acid and p-caumaric acid were recorded maximum in Flordaprince (Fig. 14).

Fig. 14. Peach variety Pratap and Flordaprince laden with fruits

Development of techniques for off season vegetable production in peri urban areas

Different varieties of high value vegetable crops, *viz* tomato, cucumber, capsicum, lettuce, broccoli, chinese cabbage, pointed gourd and dolichos bean were evaluated for developing the cropping sequences for off season production.

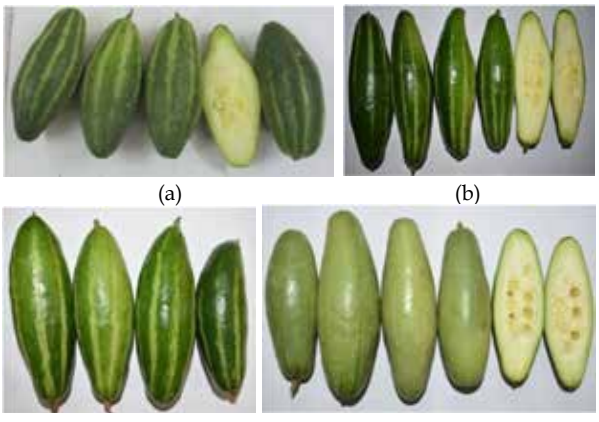
1. Dolichos Bean

Twenty genotypes of dolichos bean collected from different part of country were evaluated under subtropical condition (Fig. 15). Large variations were noticed in first harvesting date (100-258 days); genotype CISH-DC-1 had taken minimum days (100 days) for the first harvesting and CISH-DC-16 took maximum (258 days) for first harvesting. The genotype CISH-DC-12 recorded highest yield (9.59 kg/plant) closely followed by CISH-DC-15 (9.45 kg), CISH-DC-7 (9.18 kg) and CISH-DC-6 (9.10 kg), respectively. The lowest pod yield was recorded in genotype CISH-DC-3 (2.2 kg/plant).

Fig. 15. Promising genotypes of Dolichos bean

2. Pointed gourd

Twenty one genotypes were collected from Malda and Murshidabad districts of West Bengal for evaluation under subtropical conditions. The genotype CISH-PG-19 recorded highest fruit yield (4.10 kg/plant) followed by CISH-PG-20 (3.5 kg/plant), CISH-PG-5 (3.40 kg/plant), CISH-PG-3 (3.2 kg/plant) and CISH-PG-7 (3.2 kg/plant) which were better than National check Kashi Alankar (2.7 kg). The fruit weight ranged from 16 g to 81 g in different genotypes, where genotype CISH-PG-19 recorded highest fruit weight (81 g) followed by CISH-PG-20 (66 g) and CISH-PG-5 (66 g), and as smallest fruit size was oberved in genotype CISH-PG-12 (16 g) (Fig. 16).



(a) (b)

(c) (d)

Fig. 16. Promising genotypes of pointed gourd (a) CISH-PG-5 (b) CISH-PG-19 (c) CISH-PG-20 (d) Kashi Alankar

Effect of flower regulation on runner production in strawberry

Modified row cover was designed for strawberry production which started with covering of plants from April to June with 50 per cent shade net followed by side ventilated polythene row cover from July to September at a height of 3.5-4.0 m above ground level. Early runner production during the first week of April was observed in polythene row cover conditions. Higher temperature favoured early runner formation. Non removal of flower throughout fruiting season resulted in less number (32) of transplant while complete removal of the flowers resulted in maximum number (250) of runner formation in modified row cover.

Variations in modified growing conditions on survival of strawberry were evaluated. Modified row cover (cover with 75 per cent net from April-June followed by cover with ventilated Plastic row cover from July-September) exhibited maximum survival whereas complete mortality of plants was observed under open conditions in the first week of May followed by first week of July under 75 per cent shade net row cover. Modified row cover protected plants from intense sunlight from April-June and ventilated plastic cover from direct contact of rainfall to plants resulting in two times runner formation (Ist stage in the month of April and 2nd stage in the month of July) resulting in higher number of transplants production under subtropical conditions.

Seasonal variation and growing conditions on vegetative propagation of pepino (*Solanum muricatum*)

Semi hardwood cuttings of pepino were subjected to different growing conditions from August onwards under subtropical conditions. It was observed that open and 75 per cent shade net row cover was not effective during the month of August and September because of rainfall. Whereas, it exhibited maximum survival under 75 per cent shade net row cover followed by open conditions (80%) during the month of October. Plastic row cover during the month of August and September was effective for the survival of cuttings by avoiding direct contact with rainfall to the cuttings (Fig. 17).

Fig. 17. Pepino cutting for transplant Profuse rooting of cutting

Comparative microbiome analysis of mango

Microbiome profile of mango orchard (rhizosphere) was analyzed using culturable and unculturable (metagenomics) approaches. Rhizospheric soil samples one from mango orchard treated with organic preparations (G1) over past 20 years and another from one treated with inorganics/pesticides (G2) were used in this analysis. In culturable approach, total 56 bacteria (37 from organic and 19 from inorganic systems) were isolated from different management systems at CISH, Lucknow, India. Four common bacterial isolates (2, 3, 4 & 8) from organic treatments were found positive or siderophore production, P, Zn and K solubilisation while 2 bacterial isolates (I1 & I8) from inorganic treatments were found positive for above properties. Based on PGPR properties, 20 best isolates (13 from organic and 7 from inorganic system) were tested for acetylene reduction assay under aerobic and microaerophilic conditions. Metagenomics analysis of both these samples was targeted through the hypervariable (V3 & V4) regions of 16SrDNA. Results showed that phylum proteobacteria are more in abundance in organic treatment while phylum acidobacteria are more in abundance in inorganic treatment. In enzymatic study, organic system showed better dehydrogenase activity (0.784 µg TPF formed/ g of soil/hour) as compared to inorganic system (0.053µg TPF formed/ g of soil/hour). The alkaline phosphatase showed almost similar activity for both samples at pH level 11 while its activity was better in inorganic system at pH level 6.5. Based on these findings, test isolates showing PGPR properties can be used for reclamation of soil and environment in sustainable manner.

Crop Protection

MANGO (*Mangifera indica* L.)

Population dynamics of mango insect pests

Fruit flies

Mango fruit fly population was observed during the fruiting period by using methyl eugenol based para pheromone trap. The peak fruit fly population in trap was recorded during the 29th SMW (Second fortnight of July 2018) with 891.1 fruit flies/trap/week (Fig. 18). The trap catch of mango fruit fly was positively influenced by minimum relative humidity (r = 0.66**) and rainfall (r = 50**). Fruit fly catch was negatively correlated with maximum temperature (r = - 0.63**).

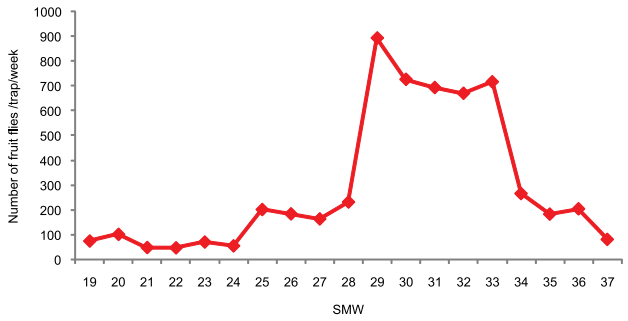


Fig. 18. Fruit fly population dynamics in mango orchards

Hopper

Mango hopper population was observed throughout the year in the ICAR-CISH Rehmankhera farm. First peak population of hopper was recorded during the 20th SMW (second week of May) with 12.02 hoppers/ sweep. Second peak was recorded during the 25th SMW (last week of June) with 36.36 hoppers/ sweep (Fig. 19). Hopper population was found positively correlated with minimum temperature and maximum relative humidity.

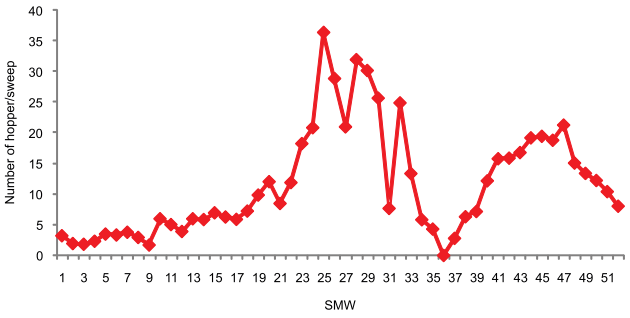


Fig. 19. Hopper population dynamics in mango orchards

Leaf Webber

Mango leaf Webber incidence was observed throughout the year. The peak incidence of the pest was recorded during the 6th and 45th SMW with 4.45 and 3.74 webs/ tree, respectively (Fig. 20). Leaf Webber incidence was found negatively correlated with minimum temperature (r = -0.683) and maximum relative humidity (r = -0.645).

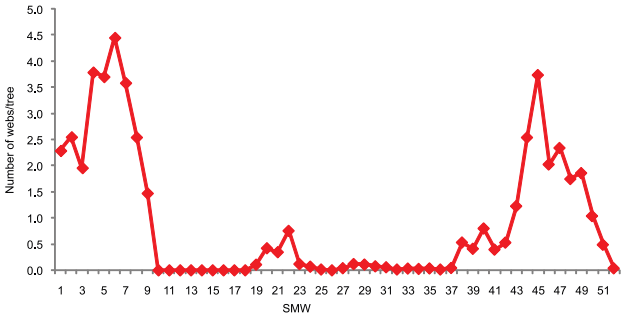


Fig. 20. Leaf web dynamics in mango orchards

Thrips

Peak incidence of thrips was recorded during the 15th SMW (second week of April) with 15.53 thrips/tap (Fig. 21). The incidence was found positively correlated with evaporation (r = 0.580*)

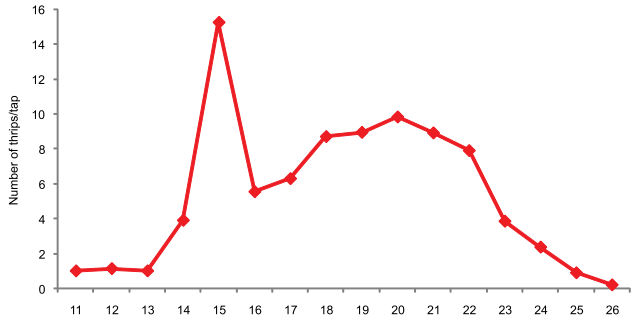


Fig. 21. Thrips population dynamics in mango orchards

Fruit borer

Peak incidence of mango fruit borer, *Dudua aprobola* (Tortricidae) was recorded during 20th SMW with 43.58 per cent incidence (Fig. 22).

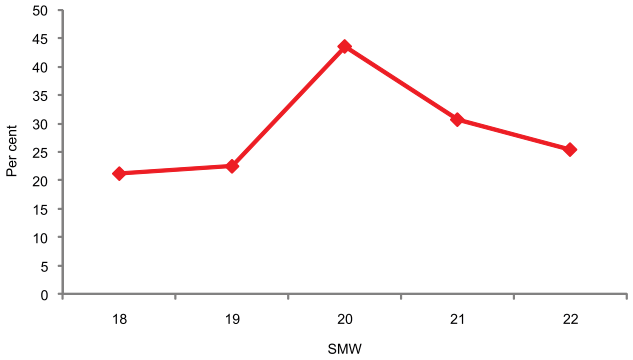


Fig. 22. Fruit borer population dynamics in mango orchards

Blossom midge

Severe incidence of mango blossom midge, *Procantarinia mangiferae* (Cicidomyiidae : Diptera) was recorded at Kunwarpur (Sitapur) with an average incidence of 3.2 infested blossoms/panicle.

Semilooper

Peak incidence of semilooper, *Hyposidra talaca* was recorded during the 23rd SMW with 6.5 larvae/twig. Semiloopers were able to completely defoliate the new flushes on infested twigs.

Disease dynamics of mango

Blossom blight

Due to intermittent rains during February and March, 2019, moderate to severe incidence of the disease was recorded in fixed orchards located in Malihabad, Mall and Kakori blocks of Lucknow; Mazar, Barabanki; Kunwarpur, Sitapur; Behat and Igari, Saharanpur; and through roving survey in mango orchards located in different parts of Uttar Pradesh. Disease progressed till mid of March and then decreased due to dry weather and shedding of infected flowers (Fig. 23).

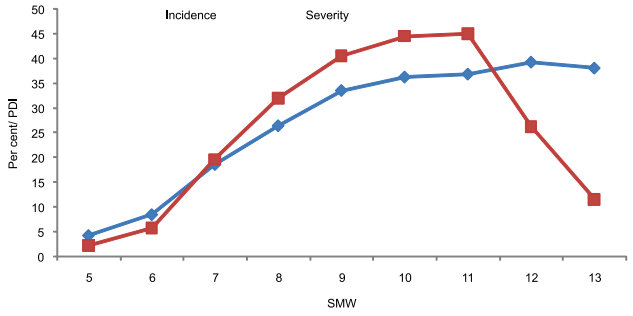


Fig. 23. Blossom blight disease dynamics in mango orchards

Powdery mildew

The disease appeared late during March, 2019. Data recorded in fixed orchards located in Malihabad, Mall and Kakori blocks of Lucknow; Mazar, Barabanki; Kunwarpur, Sitapur; Behat and Igari, Saharanpur; and through roving survey in mango orchards indicated moderate to severe incidence and severity. During the last seven years, severity of powdery mildew in fixed plots at Lucknow was recorded above economic threshold during 2013, 2014 and 2016 (Fig. 24).

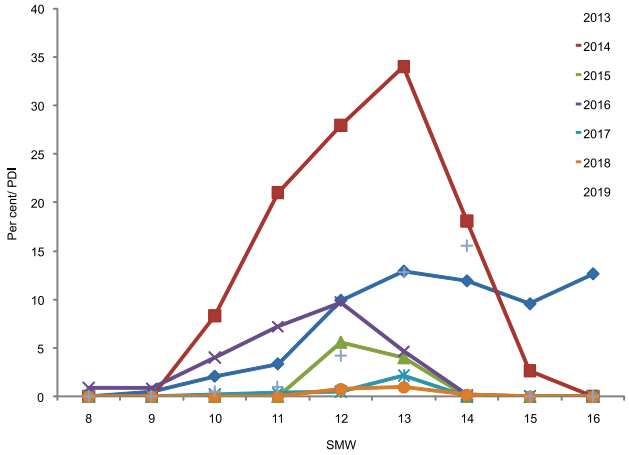


Fig. 24. Powdery mildew disease dynamics in mango orchards

Anthracnose

Data on disease incidence was recorded in fixed mango orchards round the year. Maximum incidence (37.45%) and severity (25.48 PDI) were recorded in the end of October, 2018 (Fig. 25). The range of disease was found in range as compared to the last seven year data.

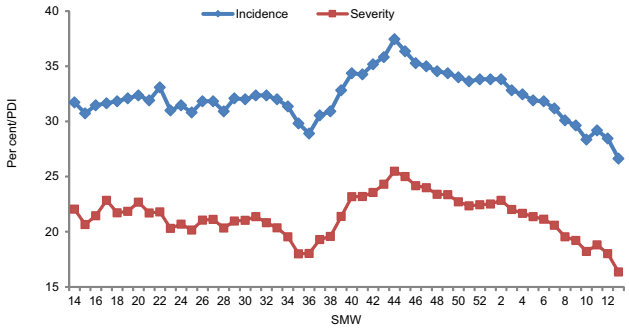


Fig. 25. Anthracnose disease dynamics in mango orchards

Management of mango hopper using newer insecticides

Field efficacy of newer insecticides was tested against mango hopper (Table 5). The significant difference was observed among the treatments with respect to the reduction in the hopper population at 3 days after spraying (DAS) ($F = 7.60$; $p<0.00$), 7 DAS ($F = 5.27$; $p<0.00$) and 21 DAS ($F = 8.54$; $p<0.00$). Among all the treatments thiacloprid, fipronil, neem oil and profenophos were found effective in reducing the hopper population 21 days after spray. Spraying with fipronil registered highest yield with 86.53 kg/tree as compared to control (38.73 kg/tree).

Table 5. Bio-efficacy of different insecticides against mango hoppers during the year 2018

Treatments	Number of hoppers/panicle					Yield (Kg/tree)
	Pre-treatment	3 DAS	7 DAS	14 DAS	21 DAS	
Imidacloprid 17.6 SL (0.3 ml/L)	14.40 (4.24)	13.40^{a} (3.86)	4.20^{ab} (2.50)	8.40^{b} (3.26)	7.00^{bc} (2.99)	64.60^{ab} (8.47)
Thiamethoxam 25 WG (0.3 ml/L)	14.13 (4.23)	9.07^{a} (3.33)	6.73^{ab} (3.02)	6.33^{ab} (2.88)	8.13^{c} (2.84)	60.73^{ab} (8.28)
Thiacloprid 21.7 SC (1 ml/L)	21.47 (5.10)	8.07^{a} (3.26)	11.87^{c} (3.91)	4.67^{ab} (2.51)	2.87^{a} (1.98)	65.73^{ab} (8.58)
Quinalphos 25 SC (2 ml/L)	20.40 (4.89)	5.60^{a} (2.63)	11.20^{c} (3.78)	5.00^{ab} (2.43)	4.00^{ab} (2.40)	65.67^{ab} (8.52)
Fipronil 5 SC (0.5 ml/L)	22.40 (5.07)	8.80^{a} (3.27)	4.80^{ab} (2.60)	5.13^{ab} (2.69)	2.53^{a} (1.83)	86.53^{b} (9.80)
Neem oil (3 ml/L)	18.40 (4.75)	6.20^{a} (2.90)	3.33^{a} (1.99)	3.00^{a} (1.56)	1.80^{a} (1.34)	45.40^{a} (7.19)
Profenophos 50 EC (2 ml/L)	17.80 (4.61)	7.13^{a} (3.02)	8.00^{bc} (3.16)	8.60^{b} (3.33)	2.67^{a} (2.01)	58.93^{ab} (8.14)
Control	20.07 (4.81)	21.40^{b} (5.09)	16.87^{d} (4.57)	7.33^{ab} (3.03)	9.07^{c} (3.47)	38.73^{a} (6.72)
F	NS	7.60	21.05	3.05	8.54	2.913
LSD (0.01)	0.157	0.144	0.077	0.086	0.075	1.64

Evaluation of newer insecticides against mango thrips

Field efficacy of newer insecticides was tested against mango thrips (Table 6). Significant differences were observed among the treatments with respect to the reduction in the thrips population at 3 days after spraying (DAS) ($F = 26.77$; $p<0.00$), 7 DAS ($F = 15.13$; $p<0.00$), 14 DAS ($F = 15.86$; $p<0.00$) and 21 DAS ($F = 3.93$; $p<0.00$). Among all the treatments, neem oil was found superior followed by fipronil 5 SC and thiamethoxam 25WG, found at par with each other. Spraying of neem oil, fipronil and thiamethoxam significantly reduced the thrips incidence. Highest yield (83.87 kg/tree) was recorded in treatment with fipronil spray.

Table 6. Bio-efficacy of different insecticides against mango thrips during the year 2018

Treatments	Number of thrips /tap					Yield (Kg/tree)
	Pre-treatment	3 DAS	7 DAS	14 DAS	21 DAS	
Imidacloprid (0.3ml/L)	23.33 (5.25)	13.^{13bc} (4.01)	15.40^{cd} (4.40)	6.00^{c} (2.87)	28.33^{ab} (5.69)	56.60^{b} (8.02)
Thiamethoxam (0.3 g/L)	27.53 (5.73)	9.47^{ab} (3.51)	9.00^{ab} (3.35)	2.33^{ab} (1.70)	25.33^{a} (5.28)	74.27^{bc} (9.12)
Thiacloprid (1ml/L)	26.93 (5.68)	18.00^{c} (4.57)	20.27^{de} (4.96)	4.27^{bc} (2.25)	30.67^{ab} (5.97)	55.33^{b} (7.94)
Fipronil (0.5 ml/L)	40.80 (6.77)	5.20 ^{a} (2.60)	5.67^{a} (2.75)	1.53^{ab} (1.37)	32.33^{ab} (6.02)	83.87^{c} (9.65)
Neem (3ml/L)	29.60 (5.84)	16.13^{bc} (4.39)	13.80^{bc} (4.11)	0.87^{a} (1.05)	17.67^{a} (4.64)	75.53^{bc} (9.13)
Control	30.93 (6.00)	33.40^{d} (6.21)	21.93^{e} (5.06)	8.60^{d} (3.36)	43.33^{b} (6.68)	32.73^{a} (6.21)
'F' value	4.91	26.77	15.13	15.86	3.93	11.31
LSD (0.01)	0.27	0.19	0.17	0.08	0.44	1.51

Bio-management of mango leaf Webber

Initially caterpillars feed on leaf surface by scrapping,. Later they make web of tender shoots and leaves together and feed within it. Mechanical removal of leaf webs and two need based sprays commencing from last week of July with lambda-cyhalothrin have been in practiced for management of this pest. In order to develop eco-friendly management practices for the pest effect of neem oil and entomopathogenic fungus (*Beuveria bassiana*) were evaluated through laboratory bioassays. Neem oil @ 3 ml of per litre of water along with sticker caused 100 per cent mortality of the third instar larvae within a day. *B. bassiana* (2×10^8 spores/ml) @ 5 g/litre caused mortality up to 80 per cent 5 days after the treatment. Since, both the treatments are compatible, can be applied together for long lasting management of leaf Webber.

GUAVA (*Psidium guajava* L.)

Population dynamics of guava fruit flies

Guava fruit fly population was observed throughout the year by using methyl eugenol based para pheromone trap. The peak fruit fly population was recorded during the 33rd SMW (Second fortnight of August 2018) with 548.8 fruit flies/trap/week (Fig. 26). The trap catch of guava fruit fly was positively influenced by minimum temperature (r = 0.61**), minimum relative humidity (r = 0.67**) and Rainfall (r = 52**).

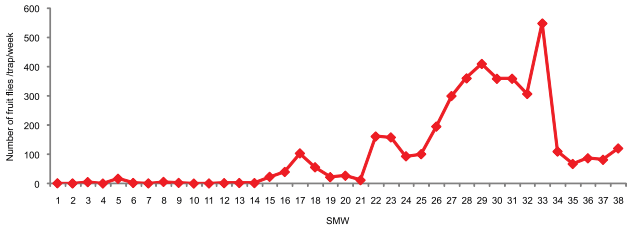


Fig. 26. Population dynamics of guava fruit flies at Rehmankhera Lucknow during the year 2018.

Evaluation of various treatments on guava root-knot disease

Seeds of guava cv. Allahabad Safeda were raised in sterilized soil : FYM (7:3) mixture. Thirty day old seedlings were transplanted in sterilized soil FYM (9:1) mixture. Treatments were applied at 7 days before transplantation and inoculation of nematodes (J2 = 1000/ pot). Observations regarding plant growth parameters and galling on roots were recorded at 120 days after inoculation. Data indicated that two treatments neem cake @ 50 g/ 2 kg soil and ICAR-CISH-Biopesticide @ 50 g/ 2 kg soil were superior treatments, which significantly reduced root-knot index and increased plant growth as compared to controls. Carbofuran applied @ 50 mg/ 2 kg soil was found ineffective (Table 7).

BAEL (*Aegle marmelos* Correa)

Management of fruit drop of bael

The experiment was carried out at experimental orchard of N.D. University of Agriculture and Technology, Kumarganj during 2018-19. The treatments were: 1. Napthyl Acetic Acid 4.5 SL @ 2 ml/l, 2. Boron 20% @ 2 g/l, 3. carbendazim 12% + mancozeb 63%WP @ 2 g/l, 4. tebuconazole 25.9% EC @ 0.5 g/l and hexaconazole 5SC @ 1 ml/l, 5. T1 + T3, 6. T2 + T3 and 7. untreated control under RBD with three replications. The treatments were applied on July 22, 2018 and August 25, 2018. Number of fruits, retained on trees till March, 2019, were recorded presented in Fig. 27 indicated that

Table 7: Efficacy of bio-agents against root-knot nematode in guava

Treatments	Shoot Length (cm)	Root Length (cm)	Shoot weight (g)	Root weight (g)	Root-Knot Index (0-4 scale)
Untreated uninoculated	10.72^{cd} (3.77)	17.24^{b} (4.63)	0.70^{d} (1.34)	0.30^{ab} (1.05)	0.00^{a} (0.50)
Untreated inoculated	4.88^{a} (2.69)	10.36^{a} (3.70)	0.16^{a} (0.90)	0.20^{a} (0.94)	3.55^{c} (2.38)
Carbofuran inoculated	6.34^{a} (3.01)	11.04^{a} (3.75)	0.24^{ab} (0.99)	0.30^{ab} (1.04)	3.20^{c} (2.29)
Neem cake inoculated	12.42^{d} (4.02)	16.88^{b} (4.59)	1.42^{f} (1.69)	0.82^{d} (1.41)	0.65^{b} (1.24)
ICAR-CISH-Bioagent inoculated	8.20^{b} (3.36)	9.80^{a} (3.61)	0.40^{bc} (1.13)	0.40^{bc} (1.13)	3.20^{c} (2.29)
ICAR-CISH-Biopesticide inoculated	9.82^{bc} (3.63)	12.28^{ab} (4.00)	1.02^{e} (1.51)	0.54^{c} (1.23)	0.25^{ab} (0.94)
LSD (0.01)	1.019	8.425	0.012	0.006	0.090

Values in the parenthesis are square root transformed √x+0.5

T2 and T4 were most effective in the management of fruit drop.

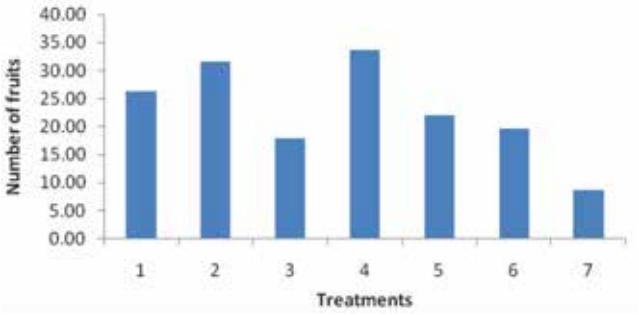


Fig. 27. Effect of different treatments on retention of bael fruits

JAMUN (*Syzizium cumini* Skeels)

Peak incidence (2.3 larva/tree) of jamun defoliator, *Carea angulata* (Fabricius) (Nolidae) was recorded during the 31st SMW (first week of August).

PEACH [*Prunus persica* (L.) Batsch]

Peak incidence of ash weevil was recorded during the 25th SMW (last week of August) with 7.6 weevils/twig.

Development and testing of computer software for fast and automatic measurement of leaf length, width and aspect ratio

A Software - 'QuickLeaf_LW v.1.02'', which was developed during previous years, has been refined to make it colour tolerant especially tolerant for red colour and its variants. The software is modified for batch processing of the images, so that it works fast and processes several images in batch mode. During execution, it needs minimum user interaction; thereby it is very fast and work in automatic mode. It can be used to measure length, width and aspect ratio, *i.e.* ratio of length to width.

The leaf area measurement software ''QuickLeafArea'' developed during previous years has been refined and tested. It was refined to make the software colour tolerant especially tolerance for red colour and its variants. During thorough testing using of leaves of different colors, it was found that for red colour leaves, the area measured less than actual area. For correcting this problem the software code was revised and image filtering was introduced. The software was tested using 15 numbers of different types of leaves including, red colour leaves, deep and light red leaves of coleus and yellow coloured over matured leaves of hibiscus. It was found that the error rate in leaf area is 0.784 and R^2 is 0.998. Therefore, the error rate is less than 1.0 and Pearson correlation coefficient is around 1.0. For the software, a user manual has also been developed for providing help in preparation of leaf images and storing, it in designated folder and executing the software, providing input and finding the output.

The software for quantitative assessment of damage caused by leaf spot diseases was also modified for batch processing of the images, so it works fast & processes several images in batch mode. During execution, it needs minimum user interaction; thereby it is very fast and works in automatic mode. It is further modified to produce the output result in spreadsheet, which further makes compilation and/or presentation of result more convenient.

Post Harvest Management

Machinery Developed

Development and testing of a solar dehydrator for drying of turmeric slices

A direct passive type solar dehydrator (Dimensions: 118×67×40 cm) was developed for drying turmeric rhizomes. The predominant parts of solar dehydrator are covering glass, aluminium trays, two shutters and a M.S. frame to hold it and the main body is made of tin sheet. The external and internal parts are insulated with foam so that heat flow between surface and internal parts can be restricted. The inner surface of dehydrator is painted with black colour to absorb maximum solar radiation. The dehydrator was successfully tested in drying of turmeric slices.

Mango (*Mangifera indica* L.)

Enzymatic changes during cold storage of methyl jasmonate treated mango cv. Dashehari

Mango cv. Dashehari treated with 0.01 per cent methyl jasmonate (Mej) along with hot-water (45 °C) including control was stored at low temperature (12±2 °C and R.H. 85-90%). These fruits were found to exhibit polygalacturonase (PG) activity of 0.100 units/g and superoxide dismutase activity (SOD) of 585.97 unit/g FW on the day of harvest. After 21 days of storage, PG activity observed in control was 1.89 units/g. In Mej+ hot-water treated fruits 1.52 units/g. Superoxide was 569.51 units/g FW in control and slightly lower (532.80 units/g FW) in Mej+hot-water treated fruits. Treatment was useful in the extension of shelf-life of mango cv. Dashehari. The low activity of PG and SOD in treated fruits reflect that the fruits are retaining membrane integrity thereby increasing the shelf-life of fruits.

Quality maintenance of mango cv. Dashehari

Mango cv. 'Dashehari' was treated with *Lactobacillus curvatus* 10^8 cells/ml plus 2 per cent guar gum for 10 minutes and stored under ambient conditions. The treated fruits reported cumulative physiological loss in weight (CPLW) of 16.72 per cent and firmness of 0.78 kg/cm^2, on the 10th day of storage while the control fruits exhibited CPLW of 16.82 per cent and firmness of 0.47 kg/cm^2. These fruits were also assessed for other quality parameters such as TSS, acidity, total carotenoids and antioxidants. Overall the treatment of *L. curvatus* @ 10^8 cells/ml plus 2 per cent guar gum had a shelf-life of 10 days under ambient conditions compared to 8 days in control.

Characterization of phenolic compounds in mango peel and pulp

Gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid and ellagic acid were quantified in unripe and ripe-peel and pulp of five north Indian commercial mango cultivars (Dashehari, Langra, Amrapali, Mallika and Chausa). Ellagic acid was the most dominant phenolic compound in peel of mango cultivars followed by epicatechin, catechin and gallic acid. However in pulp, catechin, epicatechin, ellagic acid and gallic acid were the most prevalent ones. Phenolic compounds were recorded maximum in unripe peel samples, seconded by ripe peel samples and were minimum in ripe pulp samples. Ripe peel of Mallika contained maximum amount of ellagic acid (562.80 mg/100 g), caffeic acid (805.97 mg/100 g) and catechin (118.42 mg/100 g). Ripe peel of Langra possessed maximum amount of gallic acid (306.78 mg/100 g), chlorogenic acid was maximum (169.28 mg/100 g) in Mallika unripe peel and epicatechin was maximum in Langra unripe peel (214.38 mg/100 g).

Development of raw mango peel based soup

Instant raw mango peel based soup powder was developed using certain additives. The product contained 52.6 mg vitamin-C and 944 mg phenolics per 100 g of soup powder. The soup prepared from powder exhibited good consistency and acceptable flavor and taste. The product could be stored for six months without any loss in its nutraceutical value as well as organoleptic quality (Fig. 28).

Fig. 28. Development of raw mango peel based soup

Development of jamun, bael, mango, guava, papaya and moringa based herbal tea infusion

A herbal tea preparation was formulated using different plant leaves, *viz.* jamun, bael, mango, guava, papaya and moringa. The prepared tea contained 58 mg anti-oxidants (as phenolics), 168 mg protein and 115 mg sugar per 100 ml of prepared tea. The calorie value was calculated to be 1.1 calorie per 100 ml of prepared tea (Fig. 29).

Fig. 29. Herbal tea infusion

Development of raw mango candy

Raw mango candy of commercial varieties, *viz.* Totapuri, Mallika and Dashehari was developed during the mango season and evaluated at three and six months' interval (Fig. 30). Organoleptic evaluation of the product was assessed by using nine point hedonic scales. The total soluble solids (TSS), acidity and reducing sugar increased while ascorbic acid and antioxidant decreased during the storage. Organoleptically Dashehari mango candy received the highest score (8.5 out of 9) while Mallika scored the lowest (7.8 out of 9). The highest TSS was recorded in Dashehari mango candy (73.5 ^{o}B) and lowest in Mallika (66.5 ^{o}B). Similarly, vitamin C content was high in Dasheheri and Mallika, *i.e.* 98.0 mg/100g and lowest in Totapuri 70.0 mg/100g. Acidity was highest in Mallika (0.81%) and lowest in Totapuri (0.33%).

Fig. 30. Raw mango candy from Dashehari (left) and Totapuri (Right)

Residue analysis of hexaconazole

The harvest time residues of hexaconazole, after spraying at 0.05 and 0.1 per cent doses to mango cv. Mallika, were calculated as 0.063 and 0.111 ppm in whole fruits and 0.061 and 0.062 ppm in pulp from single and double doses, respectively. The MRL (maximum residual limit) value (tolerance limit) of hexaconazole for EU (European Union) was 0.02 ppm and Japan 0.5 ppm. Harvest time residue in fruits was well below MRL as prescribed by Japan, but above the MRL value according to EU.

Molecular identification of pesticide degrading microbes

Molecular identification of pesticide degrading isolates revealed that the culture isolated from Chlorpyriphos treated soil (labeled as 7) showed similarity with that of *Pseudomonas plecoglossicida* strain PSG1. The culture isolated from Chlorpyriphos treated soil (labelled as 5) displayed similarity with that of *Pseudomonas aeruginosa* strain MTRI1. The culture isolated from Imidachloprid treated soil (labeled as 2) showed similarity with that of *Pseudomonas mosselii* strain L27. The culture labeled as Carbobact 1 showed similarity with that of *Pseudomonas aeruginosa.*

Mobile apps developed

A mobile app named as 'Mango Harvesting Advisor' was developed which can be downloaded from National Mango Database. The app contains detailed information including visuals with photographs about maturity indices, safe harvesting, ripening methods, packaging and marketing of mango in Hindi.

Two mobile apps, one each for raw and ripe mango products were developed in English language. These apps have easy recipes for the preparation of raw mango products, *viz.* amchoor, achar, pana, *etc.* and ripe mango products including pulp, jam, squash, leather, etc. The apps have recipe calculation facility for the users. The apps are freely available in Google Play Store. A mobile app on mango orchard based poltry farming was also developed and launched on mango data base.

Comparative analysis of marketing channels of mango in domestic markets

To enhance net profit of mango growers, interventions were made in marketing of fruits. Most of the mango farmers sold their orchards to pre harvest contractors and a few farmers sold fruits in local market (Fig. 31). The number of intermediaries in traditional marketing channel (channel 1) was more and farmers share in consumers' price is considerably lesser. Therefore, it is vital to trim down the number of intermediaries in marketing chain and explore new and distant markets to get rid of the glut prevalent in the local market. Marketing linkages were developed in local as well

as distant markets like Hyderabad and Bengaluru. In Hyderabad, an agreement was signed with NEML, a prominent firm in the area of marketing of fresh fruits and vegetables in metro cities. Dashehari mango was procured in bulk amount from farmers by NEML (channel 3) and transported through railway wagons. In another marketing channel fruits were delivered directly to consumers in local urban area of Lucknow district through mobile vans.

Fig. 31. Traditional and new marketing channels for mango

The highest net price per kg mango (Rs. 58.4) was realized in distant marketing (channel 3) followed by direct marketing to local consumer (Rs. 32.43) in urban areas (channel 2) whereas the lowest net price per kg mango (Rs. 20) was received in the traditional marketing (channel 1) (Fig. 32). However, the cost of marketing in channel 2 and 3 enhanced slightly due to investment in packaging, transport and branding as compared to traditional marketing channel but little expenditure has greatly augmented the sale price of mango.

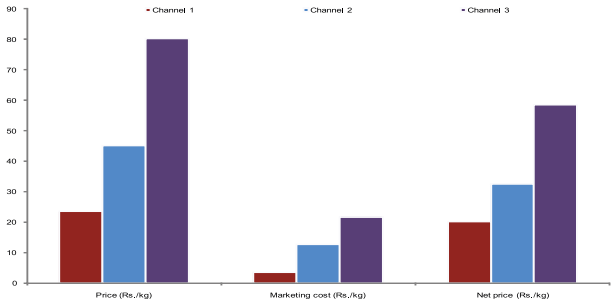


Fig. 32. Mango price obtained per kg fruits and marketing cost in different marketing channels

Guava (*Psidium guajava* L.)

Quality maintenance of guava during storage by use of *Lactobacillus*

Fruits of guava cv. CISH-Shweta were treated with *Lactobacillus* + guar gum (2%) which had a shelf life for 9 days under ambient conditions with 7.84 per cent weight loss compared to those treated singly with *Lactobacillus* (9.20%) 2 per cent guar gum (8.06%) and control (10.96% CPLW). The result indicated that *Lactobacillus* + guar gum (2%) treated fruits had low evapo-transpiration from fruit surface thereby increasing the shelf-life of fruits of 9 days in comparison to 7 days in control.

Shelf life of hexanol treated (at pre-harvest and post harvest stages) in guava cv. CISH-Lalit

Fruits of guava cv. CISH-Lalit were sprayed with hexanol (2%) and harvested after 25 days had a shelf-life for 9 days under ambient conditions as compared to the control. On the harvest day hexanol treated fruits had 12.33 kg/cm^2 firmness, 12.53 °Brix TSS, 0.5 per cent titratable acidity and 137.31 mg/100g ascorbic acid while the control fruits had 11.73 kg/cm^2 firmness, 12.8 °Brix TSS, 0.37 per cent titratable acidity and 127.13 mg/100 g ascorbic acid. After 9 days of shelf-life, hexanol treated fruits had 6.36 kg/cm^2 firmness, 15.3 °Brix TSS, 0.21 per cent titratable acidity and 112.39 mg/100 g ascorbic acid while control fruits were shrivelled and desiccated. The result indicated that pre-harvest application of hexanal increased the shelf life of guava for 9 day as compared to control fruits for 6 days under ambient conditions.

Development of guava and jamun leaf based mouth paint

Guava and jamun leaf based mouth paints were standardized. Two bacteria were isolated from mouth saliva, purified and grown on nutrient agar medium. Individual as well as combo samples of guava and jamun mouth paints exhibited anti-microbial activities against these two oral bacteria as evidenced by *in vitro* creation of 2.5-3.1 cm wide inhibition zone in plates.

Development of guava based skin scrub

A guava powder based face scrub was developed which contained 26.2 mg vitamin-C and 372 mg/100 g phenolics. External application of this powder resulted into removing dead skin giving smooth glossy appearance to skin. The scrub was packed in polyethene pouches and plastic containers and can be stored up to 28 days. Storage study revealed that plastic containers were better than polythene pouches in respect of microbial load.

Mobile app developed

A mobile app named as "Guava kitchen recipes" was developed in Hindi language, which can be downloaded freely from Google play store. The app describes the recipes for making processed guava products *viz.* pulp, jelly, squash, juice, powder, cheese, toffee, bar, supari, ketchup, etc. (Fig. 33).

Fig. 33. Guava receipes app

Aonla (*Emblica officinalis* Gaertn.)

Use of anti-browning agents during storage of aonla juice

After 8 months of storage of aonla juice at room temperature with different concentrations of oxalic acid and L-cysteine as anti-browning agents revealed that 0.75 per cent oxalic acid was able to check browning in aonla juice followed by combination of 0.25 per cent oxalic acid + 0.025 per cent L-cysteine. Retention of ascorbic acid was maximum in the combination of oxalic acid and L-cysteine (72%) and minimum non enzymatic browning (NEB) (124%) and polyphenols (44%) were recorded in juice with 0.75 per cent oxalic acid. Overall increase in total polyphenols content and NEB values and decrease in ascorbic acid content and acidity were noticed during storage.

Development of aonla based squashes from medicinally important herbs viz. brahmi [*Bacopa monnieri* (L.) Pennel] and ashwagandha [*Withenia somnifera* (L.) Dunal]

Squashes were prepared from medicinally important herbs like brahmi (*Bacopa monnieri*) and ashwagandha (*Withenia somnifera*). A brahmi enriched aonla juice and dill flavoured squash was developed (Fig. 34). The product contained as high as 87.7 mg/100 ml vitamin-C and 527.8 mg/100 ml phenolics. The product was stored for 6 months without any deterioration in the quality. Similarly, ashwagandha and brahmi-ashwagandha squashes were developed. Ashwagandha squash contained 52 °B TSS, 1.18 per cent acidity, 2.4 mg/100 ml vitamin-C and 19.2 mg/100 ml total phenolics. Blending with brahmi resulted into increase in phenolic content to 34.7 mg/100 ml.

Fig. 34. Aonla squash

Bael (*Aegle marmelos* Correa)

Estimation of coumarins in bael selections and bael powder

Three coumarins (marmelosin, psoralen and auraptene) were estimated in four selections of bael at ripening stage (harvested at 325 days after fruit set). CISH-637 was found the richest source of coumarin. In case of bael powder prepared from fruits of CISH B-1 harvested at different stages of maturity, decrease in marmelosin and psoralen content was observed during the maturity period (unripe to ripe).

Bael tea

A process was standardized for the preparation of dried flakes from raw bael fruit for making bael tea. Twenty gram of dried flakes was required to dip in hot water for making 200 ml tea. The moisture content in dried flakes is 6.4 per cent on dry weight basis. The bael tea is rich in antioxidants (12.8×10^3 µmol/ml in terms of FRAP) and phenolics (0.346 g/100 g equivalent tannic acid).

Jamun (*Syzizium cumini* Skeels)

Safe storage of jamun pomace powder

An experiment was conducted to assess the potassium metabisulphite for preserving jamun powder without mixing it in the powder. Maximum microcidal effect was observed after 14 days of storage. Bacterial load was $5.1x10^3$ CFU/g at zero time which reduced 2 times and 4.5 times after 28 days of storage in bottles and packets, respectively. The fungal load reduced from 6.0×10^3 CFU/g to nil in both packs and bottles. The study indicated that using potassium metabisulphite at 0.1 per cent concentration is effective in preservation without mixing it in dried jamun powder. It kills all the fungal and yeast load while, reduces bacterial load significantly.

Strawberry (*Fragaria* × *ananassa*)

Development of strawberry probiotic drink and value added by-products

An integrated protocol has been worked out for the development of strawberry based probiotic drink and value added by-products. The probiotic drink developed through lactic acid fermentation contained 37.1 mg/100 ml phenolics and 2.36 mg/100 ml anthocyanins. The leftover strawberry fruits after probiotic drink preparation was used for the preparation of candy (Fig. 35). The leftover syrup after candy preparation rich in anthocyanins was used for preparing of squash, jelly and wine.


Fig. 35. Strawberry probiotic drink and by-products

Peach (*Prunas persica* (L.) Batsch)

Profiling of nutraceuticals in peach cultivars

Seven phenolic compounds like gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid, ellagic acid and *p*-coumaric acid were identified and quantified in seven peach cultivars (Florda Prince, Shan-e-Punjab, Sarbati, Early Grandy, Saharanpur Prabhat, Pratap and Pant Peach-1). Epicatechin and gallic acid were most dominant phenolic compounds in peach followed by caffeic acid and catechin, while chlorogenic acid was least dominant (not detected in four cultivars). Three B-vitamins (riboflavin, thiamine and niacin) and seven organic acids (ascorbic acid, oxalic acid, citric acid, tartaric acid, malic acid, succinic acid and fumaric acid) were also identified and quantified in seven peach cultivars. Among the B-vitamins, niacin was the most prevalent one in peach followed by riboflavin and thiamine. Citric and malic acids are the most dominant organic acids whereas, ascorbic, oxalic and succinic acids the least dominant ones recorded in peach cultivars.

Development of peach probiotic drink and value added by-products

An integrated protocol was developed for the production of probiotic drink and value added by-products (Fig. 36). The probiotic drink was prepared through lactic acid fermentation of brine containing peach segments. After completion of fermentation, segments were used for preservation while the syrup was utilized for preparation of squash. Analysis of peach probiotic drink estimated of 1.6 mg/100 ml vitamin-C and 14.6 mg/100 ml total phenolics.

Fig. 36. Peach probiotic drink and by-products

Woodapple (*Feronia Limonia* L.)

A process was standardized for preparation of woodapple fruit powder. The process embodied removal of fruit rind, cutting and slicing of fruit, drying and grinding of dried slices. Peeled fruits were cut into 2 cm thick slices and sun dried for 18 hours (three days period). The powder yield was obtained as 28.45 per cent of fresh fruit and it contained 6.4 per cent moisture, 1.21 g/100 g (tannic acid equivalent) total phenols and 32.47×10^6 µmol/kg (in terms of FRAP) total antioxidants. Powder was stored in moisture proof containers and polythene bags for storage studies.

Turmeric (*Curcuma longa* L.)

Fast and low cost method for turmeric processing developed

The traditional method of turmeric processing involves curing, boiling, drying, polishing and grinding of whole rhizome, a lengthy process which requires 15 days. A low cost method was developed to reduce this processing time. The new method includes thorough washing of whole rhizome, slicing followed by drying and grinding. The ideal thickness of slices was standardized at 5-10 mm for fast drying of slices. The slices were dried for 16 hr in solar dryer where temperature varied from 42-61 ^{o}C while in sun drying required 27 hrs for drying of slices up to 7-8 per cent moisture content at 32-39 ^{o}C (Fig. 37). In traditional processing method; whole rhizome dried in 34 hrs and 72 hrs in solar dehydrator and Sun drying, respectively. Turmeric powder yield was obtained as 14.3 and 15.0 per cent in new method and traditional method, respectively. Slightly low yield in new processing method was due to loss of rhizome during slicing process. Processing time in new method was reduced to almost 50 per cents compared to traditional method.

Fig. 37. Turmeric powder

Lettuce (*Lectuca sativa* L.)

Nutritional and quality parameters estimation in lettuce

Biochemical parameters like total chlorophyll, total carotenoids and total antioxidants were estimated in two varieties of lettuce (Black Rose and Grishma) grown under aeroponics and open conditions. Black

Rose was found superior compared to Grishma in terms of total chlorophyll, carotenoids and antioxidants in both growing conditions. Total chlorophyll (2.43 µg/g FW) and carotenoids (0.612 µg/g FW) were estimated more in Black Rose grown under aeroponics compared to open growing condition where total chlorophyll and carotenoids were 1.07 and 0.216 µg/g FW, respectively. However, total antioxidants and phenols were observed significantly higher (21.35×10^6 µmol/kg) in both varieties grown in open condition as compared to aeroponics.

Bottle gourd (*Lagenaria siceraria* (Molina) Standl.) and Bitter gourd (*Momordica charantia* L.)

Development of bottle gourd and bitter gourd probiotic drinks

Probiotic drinks were prepared from bottle gourd or 'lauki' and bitter gourd or 'karela', vegetables having medicinal properties through application of *Lactobacillus* sp. bacteria. The drinks prepared from bottle gourd and bitter gourd contained 1.6 and 23.8 mg/100 ml of vitamin-C and 7.2 and 24.8 mg/100 ml of total phenolics, respectively.

Fruit and vegetable mandi waste

Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable *mandi* waste

Liquid feed enzyme prepared from banana pseudostem and cabbage contained cellulase, pectinase and amylase activity. Solid feed residues were dried and packed. Probiotic liquid animal feed prepared from mango stone were found to have cellulase (0.2100 µM/ml/min), pectinase (0.1830 µM/ml/min) and amylase (0.2580 µM/ml/min) activities besides *Lactobacillus* count of 5.66×10^7 CFU/ml after 30 days of preparation.

Sugar beet (*Beta vulgaris* L.)

Ethanol estimation in sugarbeet breeding lines under Inter Institutional collaboration with IISR, Lucknow)

Thirteen lines of sugar beet were evaluated for their ethanol content and SB1 was found best with (average 8.0%) ethanol content.

Sugarcane (*Saccharum officinarum* L.)

Preservation of flavoured sugarcane juice in PET bottles

Sugarcane juice as such and blended with aonla juice were flavored with lemon, ginger and cumin apart from control. The juice treatments were chemically preserved and packed in PET bottles to evaluate its nutritional, sensory and microbial qualities during storage. The juices were evaluated for various parameters (Fig. 38).

Fig. 38. Preserved sugarcane juice

4 Flagship & Externally Funded Projects

Flagship project: Survey, characterization and assessment of bio-efficacy of microbial formulations in the control of *Fusarium* wilt of banana (Inter-Institutional Collaboration; ICAR-CISH and ICAR-CSSRI, RS, Lucknow)

Name of the PI: T. Damodaran

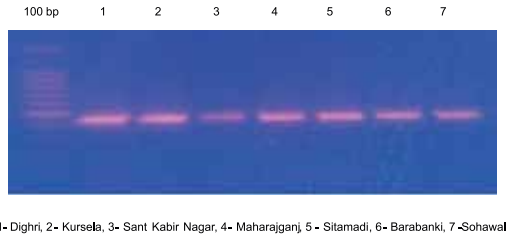
Name of the Co-PIs: S. Rajan, Manish Mishra, Dinesh Kumar, P.K. Shukla, Muthukumar M., Israr Ahmad, Nidhi Kumari, Dipak Nayak and Ashok Yadav

Survey and confirmation of banana Fusarium wilt (TR-4) disease

Fusarium wilt (Panama disease) of banana caused by *Fusarium oxysporum* f. sp. *cubense* Tropical Race 4 (Foc TR-4) is a devastating disease particularly affecting the Grand Naine (G-9) banana variety which is widely being cultivated in India. The disease cause huge losses to the growers and spreads rapidly in soil and water. In June 2017, there was sudden epidemic of the disease in Sohawal block of Ayodhya district. In the past, Asian and Australian countries have incurred billion dollars loss due to this disease and are still striving hard to develop management practices for controlling it. The pathogen Foc TR-4 was confirmed using morphological, molecular and vertical compatibility grouping experiments and first report from India was published by ICAR-Central Soil Salinity Research Institute (CSSRI), RRS, Lucknow and ICAR-Central Institute of Sub-tropical Horticulture (CISH). Transect survey conducted in Bihar from Katihaar to Hazipur, also confirmed the presence of TR-4 in Katihaar and Muzaffarpur districts.

Molecular confirmation of the occurrence of TR-4 in Bihar

Molecular confirmation of the Foc isolates from 7 locations using TR-4 specific primers (Foc-TR4-F:5´-CACGTTTAAGGTGCCATGAGAG-3´) and (*Foc*-TR4-R:5′-GCCAGGACTGCCTCGTGA-3′) amplified an amplicon of 463 bp (Fig. 39) specific to VCG 01213 (Foc TR-4) confirming the presence of TR-4 pathogen.



1- Dighri, 2- Kursela, 3- Sant Kabir Nagar, 4- Maharajganj, 5 - Sitamadi, 6- Barabanki, 7 -Sohawal

Fig. 39. Molecular confirmation of Foc TR-4 isolates from different locations

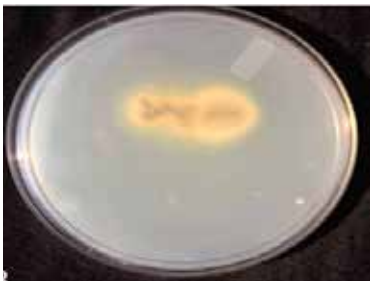


Fig. 40 .VCG testing for confirmation of Foc TR-4

VCG testing established that the fungal isolates obtained from isolated samples were compatible with VCG 01213/16 confirming the presence of TR-4 in India (Fig. 40). These isolates (CSR-F-1 and CSR-F-2) were analyzed for pathogenicity to fulfil Koch's postulates on 50 day old healthy tissue culture plantlets of Grand Naine under polyhouse conditions. After 45 days of incubation both isolates caused typical wilting and internal discoloration symptoms of Fusarium wilt. The Foc was re-isolated from the infected plants on ¼ strength of PDA medium. All the symptomatic plants inoculated with Foc TR-4 showed amplification of the diagnostic amplicon 463bp in PCR analysis, confirming that Foc TR-4 /VCG 01213/16 to be the causal agent.

Efficacy of ICAR-FUSICONT against FocTR-4 in sick fields of Ayodhya district

Field evaluation of the formulation at 40 sick fields of adopters and non-adopters from two states Bihar and Uttar Pradesh indicated that the bio-formulation ICAR-FUSICONT was effective in controlling the disease to about 93.92 per cent. It was found that only 6.08 per cent disease incidence with adopters of the technology while it was recorded severe with non-adopters (45.68%). An average yield of 25.98 kg/plant was obtained by adopters compared to non-adopters with an average yield of 11.22 kg / plant (Table 8). The yield of the plant was also significantly higher in the ICAR-FUSICONT treated plots compared to the untreated control. This suggests that the formulation can be commercialized as a candidate for the management of the disease.

Table 8. Combined impact of the ICAR-FUSICONT in the control of the Fusarium wilt disease of banana at the hotspots (n=40)

Community	Percent disease incidence	Yield / plant	Total income / acre	Expenditure/ acre	Net income/acre
Adopters	6.08 (7.74)	25.98 (3.63)	291330.70 (90987.04)	126086.40 (17321.18)	182949.40 (77450)
Non-adopters	45.68 (18.13)	11.12 (1.33)	132654.900 (51656.66)	92737.861 (10687.21)	39917.038 (13998.22)
t value	-12.04*	23.05*	9.09*	9.86*	9.63*

Values in the parentheses indicate the standard deviation of the replicates with the mean

Fig. 41. A, B, C - Loss of crop before adoption of technology and D, E, F - Status of crop at 10 months after adoption of technology

Flagship project: Resilience of mango (*Mangifera indica*) production to temperature, salt and moisture stresses

Name of PI: V.K. Singh

Name of Co-PIs: S. Rajan, Anju Bajpai, P.K. Shukla, Ashok Kumar, A.K. Trivedi, Tarun Adak, Gundappa, Muthukumar M., Israr Ahmad, Veena G.L.

Four transcriptome data sets of salinity stress imposed leaf and root samples of 13-1 and control (non-stressed) were analyzed for understanding the salinity stress responses and their differential gene regulation. Eleven genes were shortlisted based on their roles in salinity stress response from the DEGs predicted from the transcriptome data which includes; *OLP*, *ADH*, *APN*, *YABBY*, *FLP*, *DREB*, *DNaseI*, *WRKY72*, *LOX*, *T6PP* and *GT*. Primers were designed for real time analysis and used for gene expression analysis in the same RNA samples of 13-1 (control and salinity stress; leaf and root) samples. The comparative data analysis of real time PCR relative fold expression values showed similar trends of expressions at par with the patterns recorded in RNA Seq data (Log2FC) as evident from the heat maps (Fig. 42). Genes *viz*., *OLP*, *APN*, *FLP*, *DREB*, *DNaseI*, *WRKY72*, *LOX* and *T6PP* were found to be upregulated in the leaves under control conditions where as *GT* showed down-regulation upon salinity stress. Contrasting patterns was recorded in the roots where in these genes showed upregulation in the roots upon induction of stress (24 hrs after stress) indicating the role of aquaporins, stress related ROS scavengers, alternate sugar metabolism and transcription factors to be operating in stress signaling in response to salinity stress in mango cv. 13-1. This study paved way for elucidating salinity stress mechanism in mango polyembryonic root stocks.

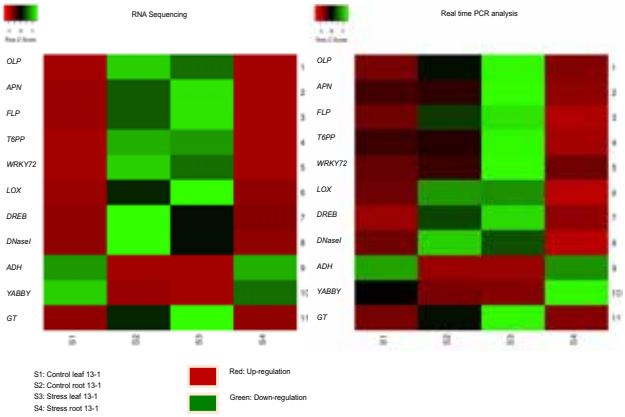


Fig. 42. Comparison of heat maps of DEGs from RNA-Seq data and real time PCR analysis

Flagship project: Profiling of biotic, edaphic and bioclimatic factors responsible for guava wilt and its management

Name of PI: P.K. Shukla

Name of Co-PIs: S. Rajan, Maneesh Mishra, A.K. Bhattacherjee, K.K. Srivastava, Tarun Adak, Israr Ahmad, Gundappa, Nidhi Kumari

Surveys were conducted in Himachal Pradesh, Andhra Pradesh, Gujarat, Maharashtra and Uttar Pradesh for prevalence of root-knot nematode in the guava orchards. It was not found in any orchard in Mandi, Bilaspur, Kullu districts of Himachal Pradesh and in Meerut, Mujaffarnagar, Saharanpur districts of Uttar Pradesh. In a nursery at Kullu all the guava graft kept for sale to farmers were found severely infected with nematode. In Prakasam district of Andhra Pradesh nematode infestation was recorded in 4 out of five orchards observed. In Navsari district of

Gujarat, nematode infestation was recorded in 3 out of four orchards. Orchards in Nasik districts of Maharashtra were also found infested (66.7%) with the nematode. Awareness efforts for management of *Meloidogyne enterolobii* made in nurseries at Malihabad has resulted decrease in number of infested nurseries and reduced level of infection in infested nurseries; but still several nurseries are severely infested.

ICAR-Farmer First project: Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules

Name of Nodal officer: Shailendra Rajan

Name of PI: Manish Mishra

Name of Co PIs: R.A. Ram, S.K. Shukla, S.R. Singh, P.K. Shukla, Ashok Kumar, Gundappa, A.K. Verman and P.S. Gurjar

Funded by: KVK Scheme of ICAR, New Delhi

Impact Assessment

Mango Orchard based Poultry Farming

Hundred Dashehari mango orchards from three villages of Malihabad block were integrated with rural poultry. Impact assessment of two years revealed that farmers realized a net income of Rs.168497 per acre by integrating rural poultry compared to non integrated orchards (Rs. 55311/acre). The BC ratio of mango orchard-based poultry farming was significantly higher (3.29) as compared to mono crop of mango production which registered low benefit cost ratio (2.88). Significant reduction in leaf Webber incidence in mango orchards integrated with poultry was demonstrated. During the pupation period, active feeding of poultry birds in the orchards affected next generation life cycle of pest and some of the strains like *Kadaknath* climbed on the upper canopy of the tree to feed on larvae of this pest. Mango orchard based rural poultry farming system significantly reduced the pest incidence in mango orchards. Those farmers which adopted this technology sprayed pesticides 3 times during the year and spent only Rs.7910/ acre as compared to those not adopted the technology and spent around Rs. 14080/acre on 6-7 pesticide sprays. A total reduction in input cost of 43.8 per cent was observed in mango orchards where poultry was integrated.

Adoption of Mango GAP, Exploitation of Geographical Indication and Linking Farmers to Market

A total of 30 farmers adopted CISH Mango-Good Agricultural Practices (CISH Mango-GAP), exploited Geographical Indication (GI) of Malihabadi Dashehari and linked to local and distant marketing channels through Mandi Parishad of Uttar Pradesh. The highest net price per kg mango (Rs. 58.4) was obtained in distant marketing followed by direct marketing to local consumer (Rs. 32.43) in urban area whereas lowest net price per kg mango (Rs. 20) was obtained in traditional marketing. GAP adoption and market linkages led to 93.08 per cent enhancement in farmer's income compared to traditional production, harvesting, post harvest practices and marketing. Fruit quality and consumer appeal for fruits were enhanced by good harvesting and post harvest handling practices, packaging, branding and market linkages which helped in getting lucrative prices of mango fruits.

Precision Farming Development Centre (PFDC)

Name of PI: V.K. Singh

Funded by: MA&FA, Govt. of India, New Delhi

The main activities of the centre include hi-tech horticulture and plasticulture technology

development, validation, refinement and technology dissemination, *viz*. micro-irrigation, plastic mulching, greenhouse technology and canopy management in horticultural crops, publication of extension literature and organizing workshop and trainings for state government officials and farmers.

Effect of fertigation schedules on growth and yield of different canopy shape of mango cv. Dashehari

Levels of drip irrigation and fertigation were arranged based on 60 per cent OPE replenishment basis.

Fig. 43. Flowering in different canopy of mango cv. Dashehari under fertigation and mulching

In general, non significant differences in the growth performance among the trees of different shapes were observed. But the trees receiving 100 per cent OPE replenishment of water indicated better flowering and fruit set. Maximum fruit set (55 kg/ha) was observed in centre open canopy shape (>50%). It was interesting to note that the trees having open canopy shape yielded more (41%) 'A' grade fruits than the other shape of canopy in Dashehari mango (Fig. 43).

Assessment of headed back winter season HDP guava cv. Lalit under drip irrigation and canopy management and mulching

The trees were pruned during April-May for development of proper canopy shape and flowering. Minimum fruit set to the tune of 20-25 per cent was recorded during winter season. Drip irrigation at 80 per cent PE and black polyethylene mulching resulted significantly higher yield (24.0 kg/tree) and fruit weight (188.2 g) as compared to control with minimum yield (14.6 kg/tree) and fruit weight (125.1 g) in trees (Fig. 44).

Fig. 44. Guava cv. Lalit under high density planting

Performance of cole crops and cucumber under polyethylene mulching

Cultivation of cauliflower cv. Girija, cabbage cv. Green Flash, Red Cabbage ("FIOM" and Viswadeep), broccoli (Fiesta), parthenocarpic cucumber cv. Rucha was undertaken to evaluate the efficacy of black polyethylene mulching (Fig. 45). An increased yield with better quality of cole crops, *i.e.*, higher curd/head weight was obtained under polyethylene mulching as compared to control. Among them, cucumber performed better in respect to yield (3-5 kg/plant) under black mulch as compared to control (1.8-2.5 kg/plant).

Cauliflower cv. Girija | Cabbage cv. Green Flash

Red Cabbage | Broccoli cv. Fiesta

Cucumber cv. Rucha

Fig. 45. Field performance of cole crops and cucumber under polyethylene mulching

Performance of tomato varieties under polyhouse condition

Six varieties of tomato, *viz*. Cherry tomato, Heemsona, Heemshikhar, NS-1218, Sampurna, Laksh were assessed for their performance under protected conditions. Heemsona performed better in terms of yield (16.8 kg/plant), shelf life and recovery of

lycopene in open conditions (5-7 kg/plant) and also recorded low lycopene and sugar content. However, in Heemshikhar fruit per cluster was maximum (6-11 fruits) and minimum in Laksh (Fig. 46).

Tomato cv. Heemshikhar

Tomato cv. Heemsona

Tomato cv. Sampurna

Fig. 46. Fruiting in tomato cultivars under polyhouse

Standardization of drip irrigation and polyethylene mulching in potato

The potato cv. Kufri Chipsona was assessed for their performance under different irrigation levels and polyethylene mulching (Fig. 47). Maximum yield (38.3 t/ha) was recorded in drip irrigation along with polyethylene mulch and minimum in control (29.7 t/ha). The starch content in potato was observed higher in 80 per cent drip irrigation with polyethylene mulch (20.9%) as compared to control (16.3%).

Fig. 47. Potato production under different irrigation levels and polyethylene mulching

Effect of drip irrigation on quality production in sugarcane cv. COPKO5191

Planting was done during 28th March, 2019 at a spacing of 90 cm row to row and sowing depth 30-45cm and germination was started in second week of April after planting (Fig. 48). Maximum plant height (4.90 m), girth (3.4 cm), cane weight (1.43 kg) was recorded in 80 per cent ET_0 of irrigation and minimum in control plot (4.20 m, 2.4 cm, 1.05 kg). Total Soluble Solids (19.4 °Brix) and sucrose in juice (17.21%) was found to be higher in 80 per cent ET_0 of drip irrigation as compared to control (18.0 °Brix and 15.30%) in sugarcane cultivar COPKO5191.

Fig. 48. Effect of drip irrigation on sugarcane crop

Standardization of fertigation and water requirement for year round production of onion

Onion cv. ADR rainy season crop performed best in terms of bulb weight (334 g) and yield (28.8 t/ha) were recorded in drip irrigation coupled with polyethylene mulch in onion (Fig. 49).

Fig. 49. Standardization of fertigation and water for onion

Intercropping of turmeric in aonla orchards

Turmeric cv. Rajendra Sonia was done as intercrop in aonla orchards to evaluate the effects of black polyethylene mulching (100 µ) on the growth, yield and recovery of curcumin content and compared with control (unmulched). Plant height increased

significantly with black polythene mulch but there was no effect on number of leaves and tillers. Maximum turmeric yield was 1.0 kg per plant with mulching while minimum in control. The recovery of the curcumin content was more (5.9%) in plants grown with polythene mulch treatment and low in control (without mulch). This indicates that black polyethylene mulching provides conducive environment and proper uptake of nutrient to enhance the quality yield of turmeric (Fig. 50).

Fig. 50. Turmeric intercrop in aonla plantation

Functional genomics in mango

Name of PI: Anju Bajpai

Name of Co-PIs: S. Rajan, Muthukumar M.

Funded by: ICAR-NNFGGM, New Delhi

RNA-Sequencing data sets of floral and vegetative bud of mango cv. Dashehari were critically analyzed for the differential gene expression patterns using logarithm 2 fold change (Log2FC) and p-value. In the floral bud, around 423 and 301 differentially expressed genes (DEGs) were observed to be significantly up-regulated genes and downregulated respectively. A representation of the differential expression analysis shown as heat map in Fig. 51, wherein red color indicates significantly up-regulated genes and green color indicates significantly down-regulated genes in flower bud. The genomic annotation of the coding sequences representing floral and vegetative buds in the differential gene analysis indicated that significant differentially expressed genes in vegetative and floral buds are related to callose deposition in

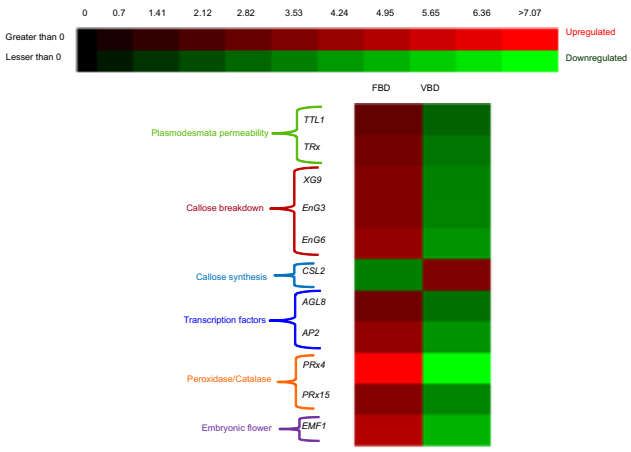


Fig. 51. Heat map depicting differential gene expression between floral (FBD) & vegetative buds (VBD)

plasmodesmata and breakdown, respectively in conjunction with interplay with auxins and ABA at shoot apical meristem. This indicated that these were the key genes that regulated flowering and therefore, provides molecular insights into floral transition phenomenon and flower bud differentiation.

Developing protocol for reduction of pesticide residues by microbial intervention in mango orchard soil

Name of PI: A. K. Bhattacherjee

Funded by: UPCST, Lucknow

Imidacloprid persisted up to 60 days in mango orchard soil when sprayed at 0.005 per cent on mango trees (cv. Dashehari) during panicle formation stage. Its residue dissipated from 0.76 µg/g at 0 day to 0.044 µg/g after 60 days of application with 94.21 per cent degradation.

Two bacteria (CISH Bac-2 and CISH Bac-5), having ability to degrade imidacloprid and chlorpyrifos, were identified as *Pseudomonas mosselii* strain L27 and *Pseudomonas aeruginosa* strain MTRI1 using 16S rDNA based molecular technique. CISH Bac-2 with straw degraded imidacloprid faster (from 0.606 µg/g in 0 day to 0.052 µg/g after 67 days of treatment – 91.42% degradation) in mango orchard soil as compared to CISH Bac-2 applied in nutrient broth (from 0.30 µg/g in 0 day to 0.043 µg/g after 67 days of treatment – 85.67% degradation) as well as control (from 0.216 µg/g in 0 day to 0.048 µg/g after 67 days of treatment – 77.78% degradation).

Two bacteria, CISH Bac-9 and CISH Bac-10, were isolated from carbosulfan containing mango orchard soil in the laboratory. These bacteria were found to be rod shaped and gram negative bacteria.

On farm production of bio-enhancers, isolation, characterization, molecular identification and development of beneficial microbial consortium for organic farming

Name of PI: R.A. Ram

Name of Co-PIs: Israr Ahmed and Govind Kumar

Funded by: UPCST, Lucknow

Various bio-enhancers were produced and isolation, characterization of known beneficial microbes was performed. The maximum number of bacterial colony (20.8 × 10^6 CFU ml^{-1}) were observed on the Jensen's agar medium (specific for *Azotobacter*) as compare to *Azospirillum* (9.6×10^6 CFU ml^{-1}), G^+ bacteria (8.0×10^6 CFU ml^{-1}), Actinomycetes (6.0 x10^6 CFU ml^{-1}), *Rhizobium* (6.0×10^6 CFU ml^{-1}), G^- bacteria (5.2 x 10^6 CFU ml^{-1}), *Pseudomonas* (4.8 × 10^6 CFU ml^{-1}), P-solubilizing bacteria (4.4×10^6 CFU ml^{-1}) and other

significant bacteria in panchagavya. The selected B2, B5 & B8 showed high activity for urease, nitrate reduction, citrate utilization, malonate utilization, esculin hydrolysis, different sugar (adonitol, melibiose, reffinose, trehalose) utilization and catalase test (+). All tested isolates showed negative results for indole, MR and phenylalanine deamination in biodynamic liquid pesticide. In CISH-bio-enhancer , maximum number of bacterial colony (18.5×10^6 CFU ml^{-1}) were observed on the actinomycetes isolation agar medium (specific for actinomycetes) as compared to *Azotobacter* (16.0×10^6 CFU ml^{-1}), P-solubilizing bacteria (13.2×10^6 CFU ml^{-1}), *Pseudomonas* (10.4×10^6 CFU ml^{-1}), *Rhizobium* (7.6×10^6 CFU ml^{-1}) and other significant bacteria.

Evaluation of Servo Agrospray Oil for bio-efficacy and residue analysis on Mango from CISH, Lucknow

Name of PI: P.K. Shukla

Name of Co-PIs: A.K. Bhattacharjee and Gundappa

Funded by: Indian Oil Corporation Limited, Faridabad

The trials were carried out at five geographically and climatically diverse locations in Barabanki, Lucknow, Saharanpur and Sitapur districts. The Servo Agrospray Oil was sprayed twice @ 2.0, 1.0, 0.5 and 0.25 per cent along with standard check (fungicides and insecticides at recommended doses) and untreated controls. Data regarding effect of treatments on hopper, scale, thrips, natural enemies of pests, powdery mildew, blossom blight, anthracnose and fruit yield has been recorded at suitable period intervals. Residue analysis in soil and fruits will also be done. The oil has better performed against diseases as compared to insects as the preliminary indications have been received from results.

All India Coordinated Research Project on Biological control of Crop Pests (AICRP, BCCP)

Name of PIs: Gundappa and P.K. Shukla

Funded by: ICAR, New Delhi

Predator and parasitoids population in relation to pest infestation was recorded in mango ecosystem during the flowering and fruiting period. Among the natural enemies spider population was high during 21st SMW with 2.3/tree. Coccienellids population was found high (4.2 adults/tree) during 20th SMW. Peak population of Hoverflies and Chrysopids was recorded during 18th and 16th SMW with 4.2 and 1.3 adults / tree respectively. Parasitoids parasitizing on the hairy caterpillars were collected from the mango ecosystem and identified as *Glyptapanteles* sp. (Braconidae) and *Tetrastichus* sp. (Eulophidae). Entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae* formulations were tested for its bio-efficacy against mango leaf webber. *B. bassiana* (CISH formulation) and *M. anisopliae* (NBAIR formulation) reduced the leaf Webber infestation significantly. In an experiment bio-management inputs against root-knot nematode in guava, treatments with neem cake @ 50g/2 kg soil and CISH-Biopesticide @ 50g/2 kg soil significantly reduced the root-knot formation and increased plant vigour.

Understanding the changes in host pest interactions and dynamics in mango under climate change scenario

Name of PIs: P.K. Shukla and Gundappa

Funded by: ICAR, New Delhi

Peak incidence of bacterial blight was recorded during 36th SMW with 22.00 per cent incidence. Incidence was increase extraordinarily during 32nd to 35th SMW. Such a great fluctuation in incidence of blight was observed for the first time since inception of NICRA project during 2012 and it was attributed to heavy and continuous rain during 27th to 37th SMW (total 953.9 mm in 77 days). Peak severity (25.47 PDI) of anthracnose on mango was recorded during 44th SMW and it was negatively correlated with maximum temperature (r = - 0.560); minimum temperature (r = - 0.782), maximum relative humidity (r = -0.652), rainfall (r= -0.502) and evaporation (r = - 0.530). Peak incidence (38.72%) and severity (23.78 PDI) of sooty mould was recorded during 29th and 30th SMW respectively. Incidence of sooty mould was positively correlated with the minimum temperature (r = 0.425) and minimum relative humidity (r = 0.375). Severity of sooty mould was negatively correlated with minimum relative humidity (r = -0.416).

The peak hopper population was recorded during 25th SMW with 36.3 hoppers /sweep. Hopper population was positively correlated with minimum temperature (r = 0.410) and maximum relative humidity (r = 0.380). Mango mealy bug incidence was observed during 6 to 20th SMW (2018). Peak scale insect incidence was recorded during 43rd SMW with 1.14 infested shoots/5 shoots. The incidence of scale insect in mango orchard was positively correlated with minimum temperature (r = 0.387), maximum relative humidity (r= 0.216) and evaporation (r= 0.213). The peak incidence of leaf Webber was recorded during 6th and 45th SMW with 4.45 and 3.74 webs/tree. Leaf Webber incidence was found negatively correlated with minimum temperature (r= -0.683) and maximum relative humidity (r = -0.645). Mango thrips incidence was observed from 11th SMW to 26th SMW during the year 2018. The peak incidence of the pest was recorded during 15th SMW with 15.23

thrips /tap. Thrips population was found positively correlated with the maximum relative humidity (r= 0.273) and evaporation (r= 0.588).

Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable mandi waste

Name of PI: Neelima Garg

Funded by: ICAR, New Delhi

Highest phytase activity was observed in crude enzyme extract of mixed fruit pomace (103 µmol/ml/min) followed by Bael waste and aonla pomace (100 and 99 µmol/ml/min, respectively). Highest pectinase activity was observed in crude enzyme extract of kinnow peel (3.887 µmol/ml/min) followed by bael waste (1.0883 µmol/ml/min). Highest cellulase activity was observed in crude enzyme extract of kinnow peel (1.406 µmol/ml/min) followed by bael waste (0.978 U µmol/ml/min). Highest amylase activity was observed in crude enzyme extract of kinnow peel (3.121 µmol/ml/min) followed by bael waste (1.150 µmol/ml/min). Since enzymes are proteins with a highly complex three-dimensional molecular structure and are heat sensitive, the activity decreased during storage at room temperature. Higher protein value and probiotic microbial load was observed in solid residues left after crude enzyme extraction. A microbial consortium of 20 bacterial and 12 fungal isolates, from degrading organic substrates and having high degradative enzyme activities, was used for composting of mango leaves. It took one month for complete composting. Metagenomic study analysis at species level of the mango leaf compost indicated that 3% of OTUs were assigned to unassigned species with in chitinophagaceae family.

Development of morphological descriptors and DUS test guidelines for Jamun (*Syzygium cuminii* Skeels)

Name of PI: A. K. Singh

Funded by: PPV & FRA, New Delhi

A total of 40 accessions/varieties of jamun are established in field gene bank of ICAR-CISH, Lucknow. This year, 20 accessions were characterized with physico-chemical characters and 10 accessions were characterized for growth habit, tree foliage, leaf characteristics, flowering characteristics, fruit characteristics and physico-chemical traits of fruits. The accessions were grouped on the basis of characters. The flowering characteristics of selected accessions were evaluated and the initiation of bloom and full bloom time period grouped the different accessions into two groups *i.e.* early (2nd week of February), medium (3rd and 4th week of February) and late (1st week March) for initiation of bloom. However, as far as full bloom was concerned it also grouped the accessions into groups as early (2nd week of April), medium (3rd and 4th week of April) and late (1st and 2nd week of May). The considerable differences in fruit shape were recorded among different accessions /varieties. According to fruit shape different accessions /varieties were grouped into 3 group. The shape of fruit was observed oblong in 5 accessions, ovoid in 2 accessions and round in 3 accessions. The observation on the fruit apex was recorded inflattened and depressed among different accessions/varieties and 8 accessions have inflattened fruit apex while, 2 accessions have depressed fruit apex. The observation on fruit base stalk end revealed flattened, depressed and nipple shape among different accessions/ varieties. Flattened fruit base stalk end was observed in 3 accessions, 2 accessions have nipple shape and 5 accessions were depressed at fruit base stalk end. The observation on fruit colour showed the grouping of accessions into 3 groups. The fruit colour purple black was recorded in 5 accessions and purple red fruit colour was found in 3 accessions however in 2 accessions the fruit colour was recorded deep purple. The data on physico-chemical characteristics of jamun fruits showed significant differences and wide range of variability among 40 accession/varieties. The maximum fruit yield 75.50 kg/plant was estimated in CISH Jamwant (J–37) while the minimum fruit yield was recorded in CISH J – 42 (12.83 kg/plant) on 11th years of age.

Collection, evaluation & conservation of jackfruit (*Artocarpus heterophyllus* L.) germplasm

Name of PI: Ghanshyam Pandey

Funded by: UP Council of Agriculture Research, Lucknow

A total of 13 exploration trips were carried out during 2015-17 and a total of 98 distinct jackfruit germplasm accessions were collected from diverse locations from 38 districts of Uttar Pradesh. Major hot spots areas of jackfruit variability were recorded in Basti, Kushinagar, Bahraich, Gonda, Jaunpur, Itaawa and Farukhabad. Out of 98, the 11 distinct accessions suitable for culinary types were identified. The important ones were CISH-Jack-6, CISH Jack-11, CISH-Jack-48, CISH-Jack- 52, CISH-Jack-56, CISH-Jack-57 and CISH-Jack-65. Amongst the collection, the most important accessions suitable for vegetables were from Basti (02), Lucknow (03) and 01 each from Kushinagar, Ambedkar Nagar, Unnao, Itaawa, Banda and Bahraich. Propagation of jackfruit through wedge grafting followed by capping with poly tubes between the last

weeks of January to 10 February was standardized with 76 per cent success. Two accessions were also identified for big size flakes suitable for table purposes. One accession was identified from Indo-Nepal border areas of Balrampur in being off-season producer based on farmer's feedback.

Development of national database on mango

Name of PI: S. Rajan

Funded by: D.B.T., New Delhi

Information collected from 10 mango growing districts on cultural practices, varieties, crop protection measures, mango uses etc. and updated in database. 10 custodian farmers details along with their varieties from Motihari (Bihar), Alirajpur (M.P.) and Barabaki (U.P.) districts were added. Characterization data of 100 mango accessions was compiled for uploading in database. Identification of duplicate accessions from different gene banks for removal is under progress. Detailed Information collected on mango diversity fairs conducted at Vengurla (Ratnagiri, Maharashtra), New Delhi (Janakpuri Dilli Haat, Delhi), Pinjore (Panchkula, Haryana) and Lucknow (Uttar Pradesh). Besides, details of mango food festival (Lucknow) conducted by U. P. Tourism department was collected and updated in database. Online software to compare test variety to reference variety was developed. Two mobile apps on "mango orchard based poultry farming" and "mango harvesting advisor" were developed. Update of database on mango processing units, accredited nurseries, fruit & pulp exporters and mango pack houses was undertaken.

Total number of hits on database was 3266104 during 2018 with 358.76 GB bandwidth use. Maximum numbers of visitors on database were from Indonesia (443440) followed by USA (394850) and India (432971).

5 Technology Assessment and Transfer

Technology Assessment

Scientist-farmers interaction-cum-participatory assessment of banana *Fusarium* wilt (TR-4) management technology

Assessment of the bio-formulation "ICAR-FUSICONT" was undertaken in the areas affected with Panama wilt of banana caused by *Fusarium oxysporum* f. sp. *cubense* tropical race 4, which has been a major problem for banana growers. A team of ICAR-CISH and ICAR-CSSRI scientists formulated a unique combination of fungi and bacteria and also developed the process suitable for its application in the field level. This new bio-formulation was applied in more than 48 acres of Panama affected areas and approximately 95 per cent success was achieved in disease suppression. In order to create awareness regarding successful proliferation of the technology, management of disease was done in the wilt affected areas of Uttar Pradesh and Bihar. MoU was signed with Uttar Pradesh Banana Producers Association, Sohawal, Ayodhya for community based dissemination of ICAR-FUSICONT technology.

Assessment of mango wilt disease management technology

The mango wilt disease management technology was assessed at Aligarh, Faizabad, Sitapur, Pratapgarh and Unnao districts of Uttar Pradesh. The treatments were applied during 2017 and 2018 and data was recorded during 2018-19. One hundred and forty-two mango trees of 18-80 years age showing initial symptoms of wilt or decline were treated as soil drenching with thiophanate methyl @ 75-150 g in 300-500 litre of water/tree. The success rate was recorded around 93 per cent. However, none of the mango trees suffering from severe symptoms of sudden wilt could be saved during this period.

Transfer of Technology

Mango Festival

Institute participated and displayed around 200 mango collections including institute's developed varieties, indigenous collections and exotic varieties at 30th Delhi mango festival held at Dilli Haat, Janakpuri, N. Delhi from July 6-9, 2018. The festival was inaugurated by Deputy Chief Minister Delhi and Chairmas, DTTDC, Shri Manish Sissodia, Shri Shurbir Singh, MD & CEO Delhi Tourism, Shri Arvind Chandra, GM, DTTDC and other dignitaries. All the dignitaries visited institute's exhibition stall and appreciated institute's released hybrids Ambika and Arunika. Our exhibition stall displaying diverse mango collections was the major attraction among common visitors, farmers, government officials and media persons. Our institute's developed hybrids which are under the pipeline for release were the major attraction among the crowd for their attractive color and size.

Scientist-farmers interaction meet on livelihood options for schedule castes farmers through horticulture based ventures

An interaction meet with 30 scheduled castes farmers of Malihabad block was held on 05 February, 2019, under the Scheduled Caste Sub Plan of the Indian Council Agricultural Research. The principal aim of the meeting was to deliberate on the livelihood options of the poor and landless farmers belonging to scheduled castes community through various horticulture-based ventures. Interaction focused on the issues, ways and

means of upliftment of living standard of landless, below poverty line scheduled castes farmers through demonstration and training of advanced techniques of pig farming, vermi-composting, mushroom production, nutri-garden, contract farming and on-farm value addition of raw mango. The institute helped them to convert agricultural waste into pig fodder. During the meeting, the farmers agreed to set up a self-help group of farmers belonging to scheduled caste community.

Scientist-farmers interaction meet on aonla production

An interaction meeting with the farmers in Chilabila block of Pratapgarh district was organized by District Horticulture Officer (DHO) to discuss the issues related to propagation of aonla cultivation, proper pricing and marketing problems on February 2, 2019. During the interaction, suggestions were made on remedial measures to address the problems of the local farmers regarding aonla production, protection and management against insects and diseases as well as options for facilitating proper marketing. Farmers were also exhorted diversify their aonla orchards with crops like ber, apple, guava, bael, legumes, pulses and oilseeds to enhance their profitability. Scientists also suggested them to form aonla growers association in their respective districts for getting higher price *via* linking it directly with e-markets.

Kisan Gosthi on minimizing the post harvest losses

A Kisan Gosthi was organized on Institute's 35th Foundation Day on June 01, 2018. On this occasion, scientists briefed the farmers about improving their income by minimizing post harvest losses and also resolved their technical problems. In scientist-farmers interaction programme, major issues of harvesting, de-sapping, ripening, packaging and transport were deliberated wherein more than 100 mango growers from nearby areas participated.

Agro-biodiversity exhibition

The Institute showcased diversity of mango, guava, jamun bael, sem (Dolichos bean) and aonla varieties maintained at its Rehmankhera premises. Institute's mechanism to protect farmers' varieties with the help of communities were deliberated. More than 400 farmers visited the stall during the exhibition.

TOT under Precision Farming Development Centre

It was observed that most of the farmers of Malihabad are harvesting mango using traditional methods and selling their fruits without cleaning, washing, grading and even proper packaging resulting huge losses (30- 40%) at farm level. To increase the harvesting efficiency and to minimize the fruit losses, demonstrations on mango harvester developed by institute and packaging of fruits using CFB Boxes for increasing harvesting efficiency, reducing losses of fruits, enhancing shelf-life and quality of fruits at Mandauli and Saidapur villages of Kakori and Malihabad blocks were given. Apart from these scientific advisory to the farmers about harvesting method and time, cleaning, washing and grading of fruits which help to minimize the losses of fruits at farm level were also given. Awareness knowledge and skill were imparted on nutrition gardens and entrepreneurship development through secondary horticulture. The interface was organized to sensitize the farmers about the plan to undertake research and extension activities and for capacity building among the farmers on the subtropical horticulture technologies. Capacity building of farmers was done on scientific method of high value vegetable and flowers *viz.*, marigold and gladiolus cultivation at Amethiya, Salempur and Kanar villages in Kakori and Malihabad blocks increase productivity and income. Further, critical inputs such as seedlings of improved varieties of tomato, brinjal, cabbage and cauliflower were also distributed to all the farmers of three villages. During the program, scientists also visited the farmer's field and provided advisory to solve their problems. People were also made aware to clean their surroundings.

Face to Face Farmers Counselling

About 30 farmers from Uttar Pradesh, Bihar, Punjab, Madhya Pradesh, Haryana and Uttarakhand visited the institute were suggested remedies and management strategies regarding horticultural issues encountered by them.




Postal Queries

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

Farmers' Helpline

Farmer's queries (375 Calls) pertaining to insect pests (25.33%), disease control (23.73%), physiological disorders (15.73%), fruit plantation & plantation timing (2.93%), availability of grafted plants of fruits (25.33%), processing of fruit crops (6.93) were attended and their solution were provided through telephone of the Kisan Call Centre.

WhatsApp groups

Mobile technology for ready advisory to farmers was utilized through WhatsApp groups like Mango Crop Health Care, Guava Crop Care, Mushroom

growers, RTFB mushroom growers, CISHLKO Nursery group, ICAR-FUSICONT, etc. Over 1000 farmers, news-media persons, scientists interact regularly with group members. Farmers asking queries, send the photographs of diseases, insects and other symptoms on crops and advisories are issued on the same day.

Institute Participation in Exhibitions/Kisan Melas

S.N.	Event/Occasion	Place	Organizer	Date
1.	State Level Farmers Fair & Agricultural Industry Exhibition	NDUA&T, Campus Kumarganj, Ayodhya, U.P	NDUA&T, Kumarganj, Ayodhya	April 5-6, 2018
2.	State Level Agriculture Fair	Zila School Ground, Motihari, Bihar	ICAR-RCER, Patna	April 13-15, 2018
3.	22nd Sabri Urs Mela	Village Sabri, Musandi, Kalukhera, Maurawan, Unnao	Sabri Foundation Trust, Mumbai	May 7-10, 2018
4.	UP Aam Mahotsav	Indira Gandhi Pratisthan, Gomtinagar, Lucknow	Government of Uttar Pradesh, Lucknow	June 23-24, 2018
5.	Agriculture Exhibition & Kisan Sangosthi	Deen Dayal Dham, Fareh, Mathura	ICAR-DKMU in collaboration with Ministry of Agriculture & Farmers Welfare, New Delhi	October 6-8, 2018
6.	Krishi Kumbh - 2019	ICAR-IISR, Telibagh, Lucknow	Ministry of Agriculture & Farmers Welfare, New Delhi in collaboration with Govt. of Uttar Pradesh	October 26-28, 2018.
7.	State Level Kisan Mela & Agricultural Industry Exhibition	NDUA&T, Campus Kumarganj, Ayodhya, U.P	NDUA&T, Kumarganj, Ayodhya, U.P.	December 7-8, 2018
8.	National Horticultural Fair - 2019	ICAR-IIHR, Hessarghatta, Bengaluru, Karnataka	ICAR-IIHR, Hessarghatta, Bengaluru, Karnataka	January 23-25, 2019
9.	Kisan Mela	CSIR-CIMAP, Lucknow	CSIR-CIMAP, Picnic Spot, Kukrail, Lucknow	January 31, 2019
10.	Krishi Kumbh	Gandhi Maidan, Motihari, Bihar	ICAR-RCER, Patna in collaboration with NHB & Ministry of Agriculture & Farmers Welfare, New Delhi	February 9-11, 2019
11.	State Fruit, Flower & Vegetable Show	Rajbhawan, Lucknow	Directorate of Horticulture & Food Processing, Lucknow	February 16-17, 2019
12.	9th Science Expo	RSC, Aliganj, Lucknow	RSC, Aliganj, Lucknow	February 18-20, 2019
13.	Agro & Food Technology Industrial Exhibition	IIA Bhawan, Vibhutikhand, Gomti Nagar, Lucknow	Indian Industrial Association & supported by Deptt. of Horticulture, Govt. of U.P.	February 22-24, 2019
14.	Agricultural Technology Showcasing Exhibition & Gosthi for Farmers of SC/ST	ICAR-CISH, Rehmankhera, Lucknow	ICAR-CISH, Lucknow	February 28, 2019
15.	Pusa Krishi Vigyan Mela	ICAR-IARI, New Delhi	ICAR-IARI, New Delhi	March 5-7, 2019

6 Human Resource Development

Human resource development (HRD) is a sine-qua-non for any research institute that helps it to become dynamic, vibrant and production oriented. The HRD is a perennial process to keep mankind update with the latest technologies and technical know-how over and above motivating them. Human resource has unlimited potential which tries to create a climate under which humans provide their maximum. The conducive climate continuously identifies, nurtures and uses the capabilities of people. The ICAR-CISH has developed several HRD techniques in the yesteryears by which farmers, orchardists, students, entrepreneurs, officials, etc. were trained to perform in the best by which their can not merely augment fruit production but simultaneously improve their livelihood also. Detailed account of the trainings conducted by ICAR-CISH during 2018-19 are given below.

Training Organized

1. Trainings of specific groups

S. No.	Topic of Training	Sponsoring Agency	Duration	No. of Trainees
1.	Production, Protection and Post harvest management of mango and guava	Commissioner, Agricultural Horticulture and Field Forestry, New Delhi	06.08.2018 to 10.08.2018	18
2.	MTC on Entrepreneurship Development through market driven production and processing of horticultural crops	DOE-MAFW, New Delhi	10.09.2018 to 17.09.2018	15
3.	Organic farming in horticultural crops	CPWD, Lucknow	03.10.2018 to 08.10.2018	30
4.	Refresher program on opportunities for value addition in horticulture for established agripreneurs	MANAGE, Hyderabad	22.10.2018 to 25.10.2018	14
5.	MTC on Food and Nutritional security of farm women through horticulture based interventions	DOE-MAFW, New Delhi	13.11.2018 to 20.11.2018	20
6.	Training-cum-Workshop Programme under Pradhanmantri Sinchai Yojna on Per drop more crop (Microirrigation)	PFDC, ICAR-CISH, Lucknow	09.01.2019 to 10.01.2019	50
7.	MTC on Scientific bee-keeping for alternative livelihood & higher yield of crop plants through efficient pollination	DOE-MAFW, New Delhi	01.02.2019 to 08.02.2019	18
8.	Training programme on Ready to fruit bags mushroom cultivation	Self Financed Training	20.03.2019	36



2. Training for Students

S.No.	Topic of Training	Sponsoring Agency	Duration	No. of Trainees
1.	Horticulture crop production under subtropics	Mewar University, Government of Rajasthan	01.06.2018 to 30.06 2018	26
2.	Horticulture crop production under subtropics	BHU, Varanasi	04.06.2018 to 10.06.2018	20
3.	Certified farm advisor (Fruits)	MANAGE, Hyderabad	03.10.2018 to 17.10.2018	11
4.	Horticulture crop production under subtropics	BHU, Varanasi	26.12.2018 to 03.01.2019	15
5.	Residential training under Agri Clinic & Agri Business Centre	MANAGE, Hyderabad	08.01.2019 to 07.03.2019	32


Residential training under Agri Clinic & Agri Business Centre

Students of BHU, Varansi (left) and from MANAGE, Hydarabad (right)

3. Trainings for Farmers

S.No.	Topic of Training	Sponsoring Agency	Place	Date	Beneficiary
1.	Gardener Training	Agriculture Skill Council of India (ASCI)	ICAR-CISH Rehmenkhera	15.03.2018 to 19.04.2018	100

2.	Gardener Training	Agriculture Skill Council of India	ICAR-CISH Rehmenkhera	15.04.2018 to16.05.2018	100
3.	Demonstration and training on mango based poultry	Farmer FIRST Project-ICAR	Kasmandikalan, Lucknow	18.04.2018	14
4.	Demonstration and training on mango based poultry	Farmer FIRST Project-ICAR	Kasmandikalan, Lucknow	25.05.2018	12
5.	Gardener training	Agriculture Skill Council of India	ICAR-CISH Rehmenkhera	25.05.2018 to 26.6.2018	95
6.	Demonstration and training on nutri garden	Farmer FIRST Project-ICAR	Kasmandikalan, Lucknow	22.07.2018	35
7.	Demonstration and training on mango based poultry	Farmer FIRST Project-ICAR	Kasmandikalan, Lucknow	24.07.2018	8
8.	Demonstration and training on intercropping of *Panicum* grass	Farmer FIRST Project-ICAR	Mohd. Nagar, Lucknow	14.08.2018	9
9.	Training on scientific bee keeping and awareness program under tribal sub-plan	Self Financed Training	ICAR-CISH, Malda	12.12.2018 to 13.12.2018	50
10.	Training on nursery management of horticultural crops	Self Financed Training	ICAR-CISH, Rehmenkhera	27.12.2018 to 29.12.2018	114
11.	Training on high density planting of subtropical fruits	ATMA, Begusarai, Bihar	ICAR-CISH Rehmenkhera	06.02.2019 to 08.02.2019	21
12.	Training on integrated management of mango & guava	Horticulture Department, Mandi	ICAR-CISH Rehmenkhera	12.03.2019 to 18.03.2019	22
13.	Training programme for Scheduled Caste farmers on mushroom cultivation through ready to fruit bags	Self Financed Training	ICAR-CISH Rehmenkhera	13.03.2019	26

Self financed training programme on nursery management of horticultural crops

Training of SC farmers on ready to fruit bags mushroom cultivation

Training on scientific bee keeping under tribal sub-plan

4. Training-cum-Exposure Visit

S.No.	Topic	Sponsoring agencies	Dates	Participants
1.	Improved cultivation of subtropical fruits	Government of Puducherry	02.04.2018	25 Farmers & officials
2.	Improved cultivation of subtropical fruits	Banda University of Agriculture and Technology, Banda	21.04.2018	25 Students
3.	Improved cultivation of subtropical fruits	City Montessori School, Lucknow	08.05.2018	55 Students & teachers
4.	Improved cultivation of subtropical fruits	Mewar University, Government of Rajasthan	01.06.2018	26 Students & teachers
5.	Improved cultivation of subtropical fruits	BHU, Varanasi	04.06.2018	17 Students & teachers
6.	Improved cultivation of subtropical fruits	NDUA&T, Ayodhya	04.06.2018	40 Farmers
7.	Processing of STF	Vidyasthali, Kanar, Lucknow	07.07.2018	34 Students (12th class)
8.	Processing of STF	Triloki Singh Inter College, Kakori, Lucknow	17.07.2018	43 Students (10, 11 & 12th classes)
9.	Improved cultivation of subtropical fruits	Dept. of Agriculture, Fatehpur	17.07. 2018	50 Farmers of Fatehpur district
10.	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	09.08.2018	46 ATM & BTMs from Hardoi, Raebareilly, Sitapur & Allahabad districts of U.P.
11.	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	07.09.2018	39 Rural women of Hamirpur & Sidharth Nagar, U.P.
12.	Improved cultivation of subtropical fruits	CEDMAP, Muraina, M.P.	07.09.2018	10 Farmers of Muraina district, M.P.
13.	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	07.09.2018	45 ATM & BTMs of Devipatan Mandal , U.P.
14.	Improved cultivation of subtropical fruits	SHE&T, Malihabad, Lucknow	10.09. 2018	43 Farmers
15.	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	20.09.2018	46 ATM, BTMs of Sitapur, Bulandshahar, Meerut & Unnao
16.	Improved cultivation of subtropical fruits	Sri Ram Institute of Management, BKT, Lucknow	27.09.2018	48 Students of B.Tech. (Ag)
17.	Improved cultivation of subtropical fruits	*Jan Jyoti Vikas Seva Sansthan*, Fatehpur	12.10.2018	17 Farmers of Fatehpur district
18.	Improved cultivation of subtropical fruits	SHE & T, Malihabad, Lucknow	24.10.2018	60 farmers (trainees of gardening) from various districts
19.	Improved cultivation of subtropical fruits	Bhal Chandra Institute of Education & Management, Dubagga, Lucknow	31.10.2018	17 Students of B.Sc. (Ag.).
20.	Improved cultivation of subtropical fruits	SIMA, Rehmankhera, Lucknow	01.11.2018	59 ATM, BTMs including rural women from Rampur, Sambhal, Kanpur, Jalaun & Lalitpur districts
21.	Improved cultivation of subtropical fruits	SHIATS, Naini, Allahabad	11.11.2018	120 Students of B.Sc.(Ag.).
22.	Improved cultivation of subtropical fruits	SHE & T, Malihabad	06.12.2018	45 Farmers (Trainees of gardening) from Lucknow

23.	Improved cultivation of subtropical fruits	BHU, Varanasi	26.12.2018	15 Students & teachers
24.	Improved cultivation of subtropical fruits	NDUAT, Kumarganj, Ayodhya Faizabad	03.01.2019	53 Students & teachers
25.	Improved cultivation of subtropical fruits	State Agricultural Management Institute, Rahmankhera, Lucknow	03.01.2019	47 ATM/BTM
26.	Improved cultivation of subtropical fruits	State Agricultural Management Institute, Rahmankhera, Lucknow	04.01.2019	44 Farmers
27.	Improved cultivation of subtropical fruits	ATMA, Dholpur, Rajasthan	04.01.2019	56 Farmers & officials
28.	Improved cultivation of subtropical fruits	Banda University of Agriculture and Technology, Banda	08.01.2019	49 Students & Assistant Professors
29.	Improved cultivation of subtropical fruits	Bakshi-Ka-Talab, Lucknow	11.01.2019	60 Farmers
30.	Improved cultivation of subtropical fruits	Government High-School, Goshalalpur, Kakori, Lucknow	11.01.2019	62 Students & teachers
31.	Improved cultivation of subtropical fruits	State Agricultural Management Institute, Rehmankhera, Lucknow	30.01.2019	38 Trainees
32.	Improved cultivation of subtropical fruits	ATMA, Begusarai, Bihar	12.02.2019	27 Farmers & officials
33.	Improved cultivation of subtropical fruits	C.S. Azad University of Agriculture and Technology, Kanpur	16.02.2019	54 Students & teachers
34.	Improved cultivation of subtropical fruits	Krishi Vigyan Kendra, Dhaura, Unnao	20.02.2019	40 Farmers & officials
35.	Improved cultivation of subtropical fruits	Sugarcane Farmers Institute Training Centre (SFITC), Pipraich, Gorakhpur	21.02.2019	45 Farmers
36.	Improved cultivation of subtropical fruits	Farmer Welfare and Agriculture Development (FWAD) scheme, Bhind, Madhya Pradesh	22.02.2019	22 Farmers
37.	Improved cultivation of subtropical fruits	Farmer Welfare and Agriculture Development (FWAD) scheme, Bhind and Ashok Nagar Madhya Pradesh	23.02.2019	40 Farmers
38.	Improved cultivation of subtropical fruits	Zila Parishad Krishi Mahavidhyalaya, Banda	18.3.2019	25 Students of B.Sc.(Ag.) and teachers

Students Guided

S.No.	Name of Student	Name of Guide	Duration	Title
1	Nirmal Yadav from DUVASU, Mathura	Muthukumar. M	April-June, 2018	Molecular basis of vegetative bud formation and floral transition in mango (*Mangifera indica* L.)
2	Pankaj Maurya from DUVASU, Mathura	Israr Ahmad	April-June, 2018	Characterization of ripening genes during fruit development, ripening and jelly seed in mango
3	Jaynarayan Talan from DUVASU, Mathura	Anju Bajpai	April-June, 2018	Molecular and physiological basis of salinity tolerance in mango (*Mangifera indica* L.)
4	Sumit Tomar from DUVASU, Mathura	Anju Bajpai	April-June, 2018	Molecular analysis of transcription factors controlling flowering in mango
5	Ayushi Rastogi from SHIATS, Allahabad	Anju Bajpai	March-May 2018	Molecular analysis of *CO*, *AP2* and *AGL26* in mango using bioinformatics tools

Training Attended

S.No.	Topic	Place	Duration	Name of the person
1.	Climate Smart Governance	Indian Institute of Public Administration, New Delhi	25.06.2018 to 06.07.2018	Trivedi, A. K.
2.	DST-SERB School on Chemical Ecology	Indian Institute of Science, Bengaluru	08.07.2018 to 22.07.2018	Gundappa
3.	IP valuation and technology management	ICAR-NAARM, Hyderabad	24.08.2018 to 29.08.2018	Neelima Garg
4.	Human resource development for agricultural research	ICAR-NBFGR, Lucknow	04.12.2018 to 06.12.2018	P. Barman
5.	Work ethics for development professionals	SIMA, Rehmankhera, Lucknow	26.03.2019 to 28.03.2019	Bharti Killari
6.	Work ethics for development professionals	SIMA, Rehmankhera, Lucknow	26.03.2019 to 28.03.2019	P. Barman
7.	Next generation sequencing: An overview	Biotech Park, Lucknow	27.03.2019 to 29.03.2019	Muthukumar M. and Israr Ahmad

7 Awards and Recognitions

Awards

Institute/ Division Awarded

- Institute's Rajbhasha Patrika 'Udyan Rashmi' has been selected for the prestigious Ganesh Shanker Vidyarthi Hindi Patrika Puraskar Plan 2017-18 by ICAR, New Delhi.
- Division of Post Harvest Management was awarded with HACCP Certificate by Quality Council of India.
- ICAR-CISHs Exhibition stall got the consolation prize in the State level Farmers Fair & Agricultural Industry Exhibition organized by NDUA&T, Kumarganj, Ayodhya on April 5-6, 2018.
- ICAR-CISH's Exhibition stall got the first prize in the State level Kisan Mela & Agricultural Industry Exhibition organized by NDUA&T, Kumarganj, Ayodhya on December 7-8, 2018.
- Institute was awarded trophy for displaying maximum number of mango varieties/hybrids during 30th Delhi Mango Festival held at Dilli Haat, Janakpuri, New Delhi from July 6-9th, 2018.
- Institute was awarded certificate of appreciation for excellent exhibition stall during U.P. Mango Festival 2018 held at Indira Gandhi Prathisthan, Gomti Nagar, Lucknow from June 23-24, 2018

Individuals Awarded

- Bajpai, A. was awarded 'Aufau International Best Scientist Award 2019' by Chemical Sciences and Reviews Letters during the conference held on February 9-10, 2019.
- Barman, P. was awarded 'Best Young Scientist Award 2018' in 7th International Conference on Agriculture, Horticulture and Plant Sciences, held at Shimla, Himachal Pradesh, organized by the Society of Tropical Agriculture, New Delhi on June 28-29, 2018.
- Barman, P. was awarded with 'Young Scientist Award' in the field of Science & Allied in World Environment Day, held at BBA University, Lucknow, organized by Samgra Vikas Welfare Society, Lucknow on June 5, 2018.
- Gundappa was bestowed with 'Best Scientist award' on the occasion of ICAR- CISH, foundation day on June 1, 2018.
- Gundappa received 'Young Scientist Award' from *Doctor's Krishi Evam Bagwani Vikas Sanstha* in International Conference on Sustainable Organic Agri-Horti System held at Bagidari Bhavan, Lucknow, during November 28-30, 2018.
- Gurjar, P.S. received 'Rajendra Prasad Young Scientist Award' from Society for Development of Subtropical Horticulture, Lucknow on June 22, 2018.
- Muthukumar, M. was awarded 'Aufau International Young Scientist Award 2019' by Chemical Sciences and Reviews Letters during the conference held on February 9-10, 2019.
- Rajan, S. received 'Life Time Achievement Award' from farmers' society *Awadh Aam Utpadak Evam Bagwani Samiti*, Nabi Panah, Lucknow for excellent contribution in the field of augmenting livelihood of mango farmers in Malihabad, Uttar Pradesh on March 5, 2019.
- Ram, R.A., Mishra, M., Singh, S.R., Shukla, P.K., Verma, A.K., Gundappa and Gurjar P.S. received 'Best Scientist Award' from farmers' society *Awadh Aam Utpadak Evam Bagwani Samiti*, Nabi Panah, Lucknow for their excellent contribution in the field of augmenting livelihood of mango farmers in Malihabad, Uttar Pradesh on March 5, 2019.
- Shukla, P.K. imparted 'Life Time Achievement Award' in National Symposium on Sustainable Management of Pests and Diseases in Augmenting Food and National Security held at NAU, Navsari, Gujarat during January 22-24, 2019.
- Shukla, P.K. received 'Recognition Award' of Doctor's *Krishi Evam Bagwani Vikas Sanstha* in International Conference on Sustainable Agri-Horti Systems held at Bhagidari Bhavan, Lucknow during November 28-30, 2018.
- Trivedi, A.K. was awarded 'Reviewer Excellence Award' as reviewer of 'Agricultural Reviews'.
- Trivedi, A.K. was awarded 'Scientist of the Year Award 2018' for his outstanding contribution in the field of Plant Physiology by Society for Science & Nature during International Seminar on Recent Trends and Experimental Approaches in Science Technology, Nature & Management held at Jodhpur during December 23-24, 2018.
- Trivedi, A.K. was awarded certificate of outstanding contribution in reviewing from Ecotoxicology and Environmental Safety.
- Trivedi, A.K. was awarded first in Simulation Exercise Group Presentation of two weeks Faculty Development Program on 'Climate

Smart Governance' at Indian Institute of Public Administration, New Delhi during June 25 – July 06, 2018.

- Verma Swati, Research Scholar of ICAR-CISH, Lucknow bagged DST-AWSAR (Augmenting Writing Skills for Articulating Research) award for her article titled 'Tailoring Papaya For Viral Resistance' with prize money of Rs. 10,000/- by DST on February 28, 2019.

Best Paper/Poster Award

- Adak, T., Pandey G., Garg N., Kumar, R., Singh, S.R., Chandra, S. and Kumar, A. were awarded with 3rd prize for e-poster presentation entitled as 'Scientist–farmers interaction for enhancing farmer's income through nutrient management, crop diversification, value addition and other horticultural technologies' in National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics during June 21-22, 2018.
- Garg, N., Vaish, S., Singh, B., Kumar, S. and Shukla, P. K. were awarded 2nd prize for e-poster presentation entitled 'Bael waste as potential substrate for probiotic animal feed supplement and feed enzymes' during National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics during June 21-22, 2018.
- Killadi, B., Chaurasia, R. and Shukla, D.K. were awarded 2nd prize for poster presentation entitled 'Effect of methyl jasmonate and methyl salicylic acid on the shelf-life of mango cv. 'Dashehari' under ambient conditions' during two-day conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21- 22, 2018.
- Kumar, D. was awarded best paper award, for paper entitled 'Fruit production and carbon sequestration potential of rainfed apple (*Malus × domestica* Borkh) under various moisture conservation techniques' by Indian Association of Soil and Water Conservationist, Dehradun *Indian Journal of Soil Conservation*, 46(1): 109-117.
- Pandey, D., Singh, S., Giri, D. and Nehal, N. were awarded with Best Poster entitled 'Variability in biochemical traits of aonla cultivar at different maturity stages' during the National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21-22, 2018.
- Shukla, P.K., Fatima T., Ahmad, I. and Khan, R.M. received best paper award for oral paper presentation on 'Incidence of *Meloidogyne enterolobii* in nurseries and orchards of Guava' in National Symposium on Sustainable Management of Pests and Diseases in Augmenting Food and Nutritional Security held at NAU, Navsari, Gujarat during January 22-24, 2019.
- Vaish S., Garg, N. and Ahmad I. Z. were awarded 1st prize for poster presentation entitled 'Enzymatic and siderophore production behavior of fungal isolates from various biodynamic preparations' during the International Conference on Sustainable Organic Agri-Horti Systems, held at Bhagidari Bhawan, Lucknow during November 28-30, 2018.
- Verma, H.C. conferred with the best paper award for paper entitled 'An expert system for advisories on mango (*Mangifera indica* L.)' presented during International Conference on Rural Livelihood Improvement by Enhancing Farmers' Income Through Sustainable Innovative Agri and Allied Sector *(RLISAAe-2018)* at Birla Institute of Technology, Patna during October 30 to November 1, 2018.
- Yadav, A. received the best poster award on poster entitled 'Transcriptome analysis of flowering genes in mango (*Mangifera indica* L) in relation to floral malformation at International Mango conference held at Regional Fruit Research Station, Vengurle, Maharashtra during May 8-11, 2018.

Recognitions

- Bajpai, A. acted as an expert of DNA Fingerprinting Core Group at ICAR-NBPGR, New Delhi in 2018.
- Bajpai, A. and Muthukumar, M. presented lead lecture on 'Advances in genomics for fruit improvement' during the International Conference on Sustainable Organic Agri-Horti Systems, Lucknow during November 28 -30, 2018.
- Bajpai, A. delivered talk on 'Newer insights into identification of incitants of mango malformation through 18s amplicon sequencing and metabolite analysis' in International Conference on Sustainable Organic Agri-Horti Systems at *Doctor's Krishi Evam Bagwani Vikas Sanstha*, Lucknow during November 28-30, 2018.
- Bajpai, A. presented lead lecture on 'Coordinated cross-talk of transcription factors regulating floral transition in mango' during International Mango Conference at Vengurle during May 8-10, 2018.
- Bajpai, A.and Muthukumar, M. presented lead lecture on 'Recent advancements in genomics approaches for molecular breeding in fruits'

during National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics, held at ICAR-CISH, Lucknow during June 21-22, 2018.

- Barman, P. nominated as member of the Editorial Board in SCIREA Journal of Agriculture during October, 2018.
- Barman, P. recognized as evaluator of manuscript entitled 'Influence of environmental factors and cropping practices on passion fruit productivity in Eastern Africa (Burundi, Kenya and Rwanda): A review and synthesis of recent research' in the Fruits Journal during January, 2019.
- Barman, P. recognized as evaluator of Ph.D. Thesis and External Examiner for final viva voce examination at University of Horticultural Sciences, Bagalkot, Karnataka on March 21, 2019.
- Bhattacherjee, A.K. acted as rapporteur in Technical Session on 'Integrated Pest Management' during International Conference on Sustainable Organic Agri-Horti Systems held at Bhagidari Bhawan, Lucknow during November, 28-30, 2018.
- Garg, N., Singh V.K., Shukla P.K. and Rajan S. acted as a judge for processed products and mango stalls at *Aam Mahotsav* on June 24, 2018.
- Garg, N. acted as a member of Institute Management Committee, ICAR- IIHR, Bangalore during 2018-19.
- Garg, N. delivered a lead lecture entitled 'Business Opportunities in processing of fruits and vegetable crops' during the conference on Horti-Entrepreneurship Workshop on Nursery, Protected cultivation, Value addition, Organic farming and Tissue culture at ICAR-CISH, Rehmankhera, Lucknow on August 18, 2018.
- Garg, N. delivered lead lecture on 'Entrepreneurship development, employment generation and environment protection through horticultural waste management in National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics during June 21-22, 2018.
- Garg, N. delivered lead lecture on 'Microbial characterization of organic preparations' in International Conference on Sustainable Organic Agri-Horti Systems, held at Bhagidari Bhawan Lucknow during November 28-30, 2018.
- Garg, N. served as a member of the decisive team for testing fruit conservation product exhibitions in 'Regional Fruit Shak Bhaji and Flower Exhibition' on February 16, 2019.
- Garg, N. acted as Chairman for session 'Microbial for sustainable Agri- horti system' in International Conference on Sustainable Organic Agri-Horti Systems, held at Bhagidari Bhawan, Lucknow during November 28-30, 2018.
- Garg, N. served as chairperson and delivered lecture on the importance of microorganisms on World Soil Day at ICAR-CISH, Lucknow on December 5, 2018.
- Garg, N. acted as chairperson for session 'Microbial for sustainable Agri- horti system' in International Conference on Sustainable Organic Agri-Horti Systems, held at Bhagidari Bhawan Lucknow on November 29, 2018.
- Gundappa acted as a rapporteur for the session on 'Status and Policy Regulations in Pest Management' in International Conference on Sustainable Organic Agri-Horti Systems at Bhagidari Bhavan, Lucknow during November 28 -30, 2018.
- Gundappa was elected Life Time Fellow of The Entomological Society of India on December 31, 2018.
- Gurjar, P.S. acted as a rapporteur for the session on 'Hi-tech Horticulture for Income Generation' in National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics held at ICAR-CISH, Lucknow during June 21-22, 2018.
- Killadi, B. served as a rapporteur during the conference on Strategies and Challenges in Doubling Farmer's Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21-22, 2018.
- Killadi, B., Garg, N. and Chaurasia, R. presented an oral presentation on 'Post harvest dip-treatment of *Bacillus subtilis* for maintaining quality and shelf life of guava cv. Allahabad Safeda' during the International Conference on Sustainable Organic Agri-Horti Systems at Bhagidari Bhavan, Gomati Nagar, Lucknow on November 28-29, 2018.
- Kumar, A. presented a lead lecture on 'Resource use efficient strawberry production for enhancing farmers' income in subtropics' in National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21-22, 2018.
- Kumar, A. acted as nodal officer for Agri-Clinics and Agri-Business Centres (AC&ABC) Scheme.
- Kumar, D. acted as rapporteur for Plenary Session of National Conference on Strategies and Challanges in Doubling Farmers Income through Horticultural Technologies in Subtropics, ICAR-CISH, Lucknow during June 21-22, 2018.

- Kumar, D. acted as a rapporteur for Technical Session-7 of National Conference on Farmer First for Conserving Soil and Water Resources in Eastern Region at ICAR-IISWC Research Centre, Koraput, Odisha during February 6-8, 2019.
- Mishra, M. acted as member of expert committee in agriculture & allied sciences, UPCST, Government of U.P. during 2016-18.
- Mishra, M. acted as a member of Institute Management Committee, ICAR-NRC, Litchi during 2018-19.
- Mishra, M. delivered a lead lecture during the International Conference on sustainable Development Strategies and Emerging Trends organized at NSBPG College, Lucknow during November 16-17, 2018.
- Mishra, M. delivered a lead lecture in National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics organized at ICAR-CISH, Lucknow during June 21-22, 2018.
- Mishra, M. acted as Secretary, SDSH, Lucknow during 2018-19.
- Muthukumar, M. acted as rapporteur in Technical Session on Biotechnology for Better Tomorrow in National Conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21-22, 2018.
- Nayak, D. acted as an expert member for promotion of tourism in Malda district of West Bengal during 2018.
- Nayak, D. delivered a key note lecture on 'Prospects & Strategies for Promotion of Food Processing & Value Addition of Agri-Horticultural Crops in Malda & Adjoining Districts' in Food Processing Conclave at Malda on May 25, 2018.
- Nayak, D. delivered a lead lecture on Integrated Farming System in National Conference on 'Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics' organized at ICAR-CISH, Lucknow, June 21-22, 2018.
- Nayak, D. served as Coordinator in recruitment of various staffs under ATMA scheme of office of the Deputy Director of Agriculture (Admn.) at Malda during 2018.
- Nayak, D. served as Judge in Bengal Mango Utsav Malda, W.B. during June 8-9, 2018.
- Pandey G., Shukla, S.K., Tewari, J.N., Trivedi, A.K., Adak, T. and Kumar, S. delivered lead lecture entitled 'Jackfruit-A new option to organic window for doubling farmer's income' in International Conference on Sustainable Agri-Horti Systems organized by *Doctor's Krishi Evam Bagwani Vikas Sanstha*, Lucknow on November 28-29, 2018.
- Pandey, D. acted as a convener in the session on 'Innovation in Horticultural Crop Management' and also acted as member of organizing committee in the National Conference on Strategies & Challenges in Doubling Farmers Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21-22, 2018.
- Pandey, D. presented a lead lecture on 'Transforming Salt Affected Soil in Subtropical through Fruit crops' in the National conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics during June 21-22, 2018 at ICAR-CISH, Lucknow.
- Rajan, S. acted as member of committee constituted by ICAR for evaluation of SAUs during 2018-19.
- Rajan, S. acted as member of Committee on Impact of industries near Kanpur constituted by ICAR for Green Tribunal, New Delhi during 2018.
- Rajan, S. acted as member of Global Agriculture & Food Summit, Ranchi, Jharkhand on November 29, 2018.
- Rajan, S. acted as member of Judging Committee for B.P. Pal Award on January 30, 2019.
- Rajan, S. acted as member of Regional Advisory Group, NABARD, Lucknow on September 10, 2018.
- Rajan, S. acted as member of Scientific Advisory Committee, VKS, KVK, Unnao on March 15, 2019.
- Rajan, S. delivered a lead lecture in Brainstorming programme on innovations and entrepreneurship for rural prosperity at ICAR-IARI, New Delhi on November 2, 2018.
- Rajan, S. delivered a lead lecture in International Conference on Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Enterprises (RLISAAe) during October 30-November 1, 2018.
- Rajan, S. delivered a lead lecture in International Mango Conference at Regional Fruit Research Station, Vengurle during May 8-9, 2018.
- Rajan, S. delivered a lead lecture in National conference on Strategies and Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics at ICAR-CISH, Lucknow during June 21-22, 2018.
- Rajan, S. delivered a lead lecture on the 8th Indian Horticulture Congress-2018 at IGKV Raipur, Chattisgarh during October 29- November 2, 2018.

- Rajan, S. served as editor for Journal of Applied Horticulture and Journal of Innovative Horticulture during 2016-19.
- Rajan, S. served as President of Society SDSH, Lucknow during 2016-19.
- Rajan, S. visited Ulavapadu Mango Cluster in Prakasam District in Andhra Pradesh as member of expert team to identify the problems of mango farmers and to prepare a road map to harness the potential by addressing their problems during July 29-August 5, 2018.
- Shukla, P.K. acted as a member of mango exhibition Judging committee at Aam Mahotsav on June 24, 2018.
- Shukla, P.K. acted as Chairman in second scientific session of International Conference on 'Integrated Management of Crop Diseases: A Biotechnological Approach' held at J.P. College, Narayanpur and T.N.B. College, Bhagalpur during September 19-21, 2018.
- Shukla, P.K. acted as Co-chairman in Second Scientific Session of National Symposium on 'Recent challenges and opportunities in sustainable plant health management' held at BHU, Varanasi during February 26-28, 2019.
- Shukla, P.K. acted as evaluator in Second and Third Scientific Sessions of poster presentation in National Symposium on 'Recent challenges and opportunities in sustainable plant health management' held at BHU, Varanasi during February 26-28, 2019.
- Shukla, P.K. acted as rapporteur in Session II: Keynote Lectures of Doctor's Krishi Evam Bagwani Vikas Sanstha organized International Conference on Sustainable Organic Agri-Horti Systems held at Bhagidari Bhavan, Lucknow during November 28-30, 2018.
- Shukla, P.K. and Gundappa served as coordinator for the abstract souvenir and proceedings preparation committee of International Conference on Sustainable Organic Agri-Horti System held at Bagidari Bhawan, Lucknow, during November 28-30, 2018.
- Shukla, P.K. delivered lead lecture on 'Efficacy of secondary metabolites of *Trichoderma harzianum* Rifai against mango wilt pathogen, *Ceratocystis fimbriata* Ellis and Halst' in DKEBKS International Conference on Sustainable Agri-Horti Systems held at Bhagidari Bhavan, Lucknow during November 28-29, 2018.
- Shukla, P.K. delivered lead lecture on 'Guava decline disease is caused by root-knot nematode alone or with wilt fungus' in International Conference on Integrated Management of Crop Diseases: A Biotechnological Approach held at J.P. College, Narayanpur and T.N.B. College, Bhagalpur during September 19-21, 2018 .
- Shukla, P.K. delivered lead lecture on 'Newly emerged wilt, decline and branch blight diseases are big challenge to mango industry' in ISMPP 39th Annual Conference & National Symposium on Plant and Soil Health Management: New Challenges and Opportunities, held at I.I.P.R., Kanpur during November 16-18, 2018.
- Shukla, P.K. delivered lecture on 'Integrated disease management technology in mango orchards' to the farmers participating in U.P. Aam Mahotsava organized by Uttar Pradesh Horticulture and Food Processing Ministry at Indira Gandhi Pratisthan, Gomtinagar, Lucknow on June 23, 2018.
- Shukla, P.K. delivered special lecture on 'Doubling farmers' income through mushroom cultivation' in International Conference on Integrated management of crop diseases: A Biotechnological Approach held at J.P. College, Narayanpur and T.N.B. College, Bhagalpur during September 19-21, 2018.
- Shukla, P.K. visited Ulavapadu Mango Cluster in Prakasam District in Andhra Pradesh during July 29- August 5, 2018 as member of expert team to identify the problems of mango farmers and to prepare a road map to harness the potential by addressing their problems.
- Shukla, S.K., Adak, T. and Singh, V.K. delivered lead lecture on 'Improvement in yield and quality of mango cv. Mallika through soil and foliar nutrition of zinc supplements' in International Conference on Sustainable Agri-Horti Systems organized by Doctor's Krishi Evam Bagwani Vikas Sanstha, Lucknow on November 28 -30, 2018.
- Singh, A.K. and Bajpai, A. presented lead lecture on 'Evaluation of jamun (*Syzygium cuminii*) germplasm for growth and yield behavior' in International Conference on Sustainable Organic Agri-Horti Systems, Lucknow during November 28-30, 2018.
- Singh, A.K. and Shukla, P.K. nominated as observers by ASRB New Delhi for conducting the examination of technician (T-1) on July 1, 2018.
- Singh, A.K. delivered a talk in Kisan Mela & Kisan Gosti for *'Ekikrit Baghwani Vikash Mission (Jila Aoudhanik Mission)'* at Raibareli on July 24, 2108.
- Singh, A.K. delivered a lead lecture in the International Conference on Sustainable Organic Agri-Horti Systems organized by Doctor's Krishi

evam Bagwani Vikas Sanstha, Lucknow (UP) on November 28, 2018.

- Singh, A.K. was nominated as a member of committee/expert group for DUS Monitoring of Sugarcane varieties at ICAR-IISR, Lucknow on February 18, 2019.
- Singh, A.K. was nominated as member of *Pradesik Phal, Shakbhaji evam Pusp Pradarsani Samiti*, Lucknow on January 16, 2019.
- Singh, A.K. was nominated as an external expert for the interview board for the post of Professor (CAS) and Assoc. Professor at S.K.N.A.U. Jobner, Jaipur (Rajasthan) during May 27-28, 2018.
- Singh, A.K. was nominated for screening committee for granting Senior Scale to Asstt. Professors CAS (Regulation 2010) - Horticulture at S.K.R.A.U. Bikaner, Rajasthan on September 29, 2018.
- Srivastava, K.K. acted as Convener for the session on Nutrition, Water Management and Orchard Management in the 6th Group Discussion of ICAR-AICRP-Fruits at Assam Agricultural University, Jorhat during February 14-16, 2019.
- Srivastava, K.K. acted as a panelist and rapporteur for the technical session during the International Seminar on Sustainable Development: Strategies & Emerging Trends at Netaji Subhash Chandra Bose Govt Girls PG College, Aliganj, Lucknow during November 16-17, 2018.
- Srivastava, K.K. acted as a rapporteur for the Centre wise Presentation-I Meeting QRT of AICRP-Fruits held at ICAR-CISH, Lucknow on mango, guava and litchi.
- Trivedi A.K. acted as Consulting Editor – Journal of Environmental Biology 2019.
- Trivedi A.K. acted as Editorial board member of the Academic Research Journal of Agricultural Science and Research 2019.
- Trivedi A.K. acted as Editorial board member of the Agricultural Reviews 2019.
- Trivedi A.K. evaluated Ph.D. Synopsis of Banasthali University, Rajasthan on Topic 'Ethanobotanical Significance and Phytochemical Analysis of Selected Quranic and Prophetic Plants'.
- Trivedi A.K. evaluated Ph.D. Thesis of Banaras Hindu University, Varanasi on Topic 'Physiological and Biochemical Significance of Brassinolide on Ameliorating Heat Stress in Wheat (*Triticum aestivum* L.)'.
- Trivedi A.K. evaluated Ph.D. Thesis of Banasthali University, Rajasthan on Topic 'Identification of Molecular Markers to Screen for Heat and Drought Tolerant Wheat (*Triticum* sp.) genotypes' and conducted Viva-Voce Examination.
- Trivedi, A.K. has delivered a Radio Talk at AIR, Lucknow on '*Padap Daihik vikaron ka aam ke fasal utpadan par prabhav*' (Recording date April 16, 2018; Broadcast date April 21, 2018).
- Verma, H. C. worked as national advisor for organizing International Conference on Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Sector (RLISAAe-2018) at Birla Institute of Technology, Patna during October 30- November 1, 2018.
- Verma, H.C. worked as a member of board of executive editors for the Journal of AgriSearch during the year 2018-19.





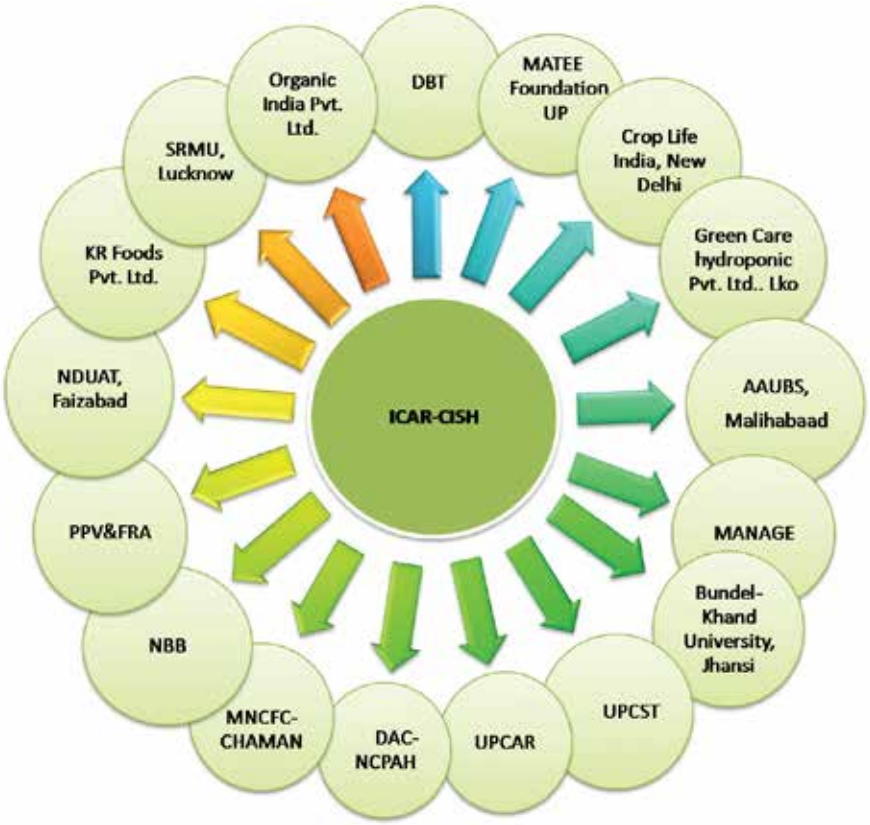

8 Linkages and Collaborations

Institute has established linkages with following organizations/ universities/ agencies/ societies/ entrepreneurs during the period:

1. National Committee on Plasticulture Applications in Horticulture (NCPAH), Department of Agriculture, Cooperation & Farmers Welfare (DAC&FW), 10th Floor, International Trade Tower, Nehru Place, New Delhi - 110 019 for Hi-tech horticulture for utilization of resources through precision farming under PFDC.
2. Department of Biotechnology, 6th-8th Floor, Block 2 CGO Complex, Lodhi Road, New Delhi-110003 for development of national database on mango.
3. Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), Govt. of India, Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Co-operation & Farmers Welfare, NASC Complex, DPS Marg, Opp-Todapur Village, New Delhi - 110 012 for development of morphological descriptors and DUS test guidelines for mango, guava, jamun, aonla and bael.
4. Council of Science and Technology U.P. (UPCST), Vigyan Bhawan, 9-Nabiullah Road, Lucknow, Uttar Pradesh - 226 018 for four projects *viz*. 1. Standardization of container gardening of fruits for catering the nutritional requirements of city dwellers; 2. Developing protocol for reduction of pesticide residues by microbial intervention in mango orchard soil; 3. On farm production of bio-enhancers, isolation, characterization, molecular identification and development of beneficial microbial consortium for organic farming; and 4. Mass multiplication of wilt resistant rootstock of guava through *in vitro* techniques.
5. UP Council of Agricultural Research (UPCAR), 8th Floor, Kisan Mandi Bhawan, Vibhuti Khand, Gomtinagar, Lucknow, Uttar Pradesh - 226 010 for project on Collection, evaluation and conservation of elite jackfruit (*Artocarpus heterophyllus* Lam.) germplasm.
6. Mahalanobis National Crop Forecast Centre, Department of Agriculture, Cooperation & Farmers Welfare, Near Krishi Vistar Sadan, Pusa Campus, New Delhi - 110 012; for project on 'Coordinated Horticulture Assessment and Management using Geoinformatics'.
7. National Bee Board, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India "B" Wing, IInd Floor, Janpath Bhawan, Janpath, New Delhi - 110 001; for project on 'Integrated Bee Development Centre (IBDC)'.
8. K.R. Food Industries, NM-16, Old DLF Colony, Sector-14, Gurugram, Haryana - 122 001 signed MoU on April 17, 2018; for transfer of CISH-Herbal Prash technology.
9. Shri Ramswaroop Memorial University, Village - Hadauri, Post - Tindola, Lucknow, Uttar Pradesh - 225 003 signed MoU on July 12, 2018; for facilitating student training/post graduate dissertation/ research work.
10. Dr. Punit Bharadwaj, Mohanlalganj (Entrepreneur), Lucknow signed MoU on August 16, 2019; for Strawberry and high value horticulture crops production technology.
11. Organic India Pvt. Ltd., Kamla Nehru Nagar, Shankar Puri, Chinhat, Lucknow, Uttar Pradesh - 226 010 signed MoU on September 03, 2018; for providing training on organic cultivation.
12. Narendra Dev University of Agriculture & Technology (NDUA&T), Kumarganj, Ayodhya, Uttar Pradesh - 224 229 signed MoU on November 15, 2018; for facilitating student training/post graduate dissertation/ research work.
13. Avadh Aam Utpadak Evam Bagwani Samiti (Reg. No.-1442), Nabi Panah, Malihabad, Lucknow, Uttar Pradesh signed MoU on December 04, 2018; for dissemination of technologies.
14. Shri Deepak Shukla (farmer), Sitapur, UP signed MoU on December 10, 2018; for rejuvenation of old and unproductive mango orchards.
15. Sh. Abdul Gaffar (farmer), Eegari, Saharanpur, UP signed MoU on January 10, 2019; to carry out the tests for the development of technology regarding management of mango pests.
16. Sh. Sachin Jain (farmer), Bhojpur, Behat, Saharanpur, UP signed MoU on January 10, 2019; to carry out the tests for the development of technology regarding management of mango pests.
17. National Institute of Agricultural Extension Management (MANAGE), Rajendranagar, Hyderabad, Telangana signed MoU on February

02, 2019; for providing support in training program (ACABC, Certified Farm Advisor Programme and Diploma in Agricultural Extension Services for Input Dealers (DAESI) at KVK, Malda by SAMETI & MANAGE.

18. Sh. Iqbal Ansari, (farmer) Biswan, Sitapur, UP signed MoU on February10, 2019; to carry out the tests for the development of technology regarding management of mango pests.
19. Bundelkhand University, Kanpur Road, Jhansi, Uttar Pradesh signed MoU on March 12, 2019; for facilitating student training/post graduate dissertation/ research work.
20. MATEE FOUNDATION, Parasurampur, Nathnagar, Sant Kabir Nagar, Uttar Pradesh signed MoU on March 18, 2019; for Technology transfer for control of *Fusarium* wilt in banana.
21. CropLife India, 2nd Floor, Ansal Chambers II. 6 Bhikaji Cama Place, New Delhi signed MoU on March 27, 2019; for providing training on organic cultivation.
22. Sh. Sanjay Kr. Srivastava, B-31 Kendriya Vihar, Jankipuram Extension, Lucknow signed MoU on March 29, 2019; for Ready to fruit bag mushroom cultivation technology.
23. Sh. Vishal Barnawal, H.N.-3 Ayush Vihar Colony, Phase 2, Near Kendriya Vihar, Jankipuram Extension, Lucknow signed MoU on March 29, 2019; for Ready to fruit bag mushroom cultivation technology.



9 List of Publications

Research papers

- Adak, T., K. Kumar, S.K. Shukla, V.K. Singh and S. Rajan (2018). Micronutrient status in leaf tissue of mango germplasm conserved under subtropical environment of Lucknow, Uttar Pradesh, India. *Tropical Plant Research*, **5**(1): 96-106.
- Ahmad, I., A. Bajpai and S. Rajan (2018). cpSSR marker based DNA fingerprinting and diversity assessment of mango genotypes. *Research Journal of Biotechnology*, **13**(12): 22-26.
- Ahmad, I., A. Bajpai, M. Muthukumar, U. Hudedamani and S. Rajan (2018). *In silico* identification of *mi-RNAs* from Mango (*Mangifera indica* L.) fruit transcriptome data. *Research Journal of Biotechnology*, **13**(10): 98-104.
- Yadav, A., K Usha and P.K. Jayaswal (2019). *In-silico* analysis of WRKY Transcription Factors gene family in healthy and malformed stages of mango (*Mangifera indica*). *Indian Journal of Agricultural Sciences,* **89**(1): 111–116.
- Bajpai, A., N. Sharma, N. Srivastava, S. Rajan and M. Muthukumar (2018). Intra-cultivar variability endorsed by SSR Markers in Mango. *Biosciences Biotechnology Research Asia*, **15**(1): 181-186.
- Bajpai, A., Y. Bajpai, M. Muthukumar and L. Rastogi (2019). Overview of cellular and molecular responses to abiotic stresses in fruit. *International Journal of Agriculture Sciences,* **11**(8): 8186-8189.
- Garg, N., A.K. Bhattacharjee and Jyotsna (2018). Bacterial degradation of imidacloprid and carbosulfan under *in-vitro* conditions in mango (*Mangifera indica*) – a preliminary study. *Current Horticulture*, **6**(2): 23-26.
- Garg, N., P. Yadav and S. Kumar (2019). Simultaneous extraction of pectin, fibre, anthocyanin and oil from mulberry pomace. *Indian Journal of Experimental Biology*, **57**(3): 218-220.
- Gundappa, B., D. Singh and M.M. Tripathi (2018). Efficacy of different management schedules against mango shoot gall psylla, *Apsylla cistellata* (Buckton) (Hemiptera: Psyllidae). *Pest Management in Horticulture Ecosystem*, **24**(2): 91-95.
- Gundappa, B., T. Adak and P.K. Shukla (2018). Application of growing degree day for hopper population dynamics in Lucknow (U.P). *Journal of Agrometeorology*, **20**(1): 50-52.
- Gundappa, B., T. Adak and P.K. Shukla (2018). Population dynamics of mango mealy bug (*Drosicha mangiferae*) (Margorididae: Hemiptera) and its relation with weather parameters in subtropical climatic conditions. *Indian Journal of Agricultural Sciences*, **88**(6): 865-70.
- Gurjar, P.S., A.K. Verma, S.C. Yadav, D.K. Shukla and M. Mishra (2018). Enhancing income of rural women through processing and value addition of raw mango fruits in Malihabad, UP: A case Study. *Asian Journal of Agricultural Extension, Economics & Sociology*, **28**(1): 1-6.
- Killadi, B., J. Lenka, R. Chaurasia and D.K. Shukla (2018). Effect of methyl jasmonate on physico-chemical properties of mango (*Magnifera indica*) fruits cv. Dashehari during cold storage. *Indian Journal of Agricultural Sciences*, **88** (11): 1779-1783.
- Killadi, B., R. Chaurasia and D.K. Shukla (2018). Pectin fraction in guava (*Psidium guajava* L.) Cultivars "Shweta" and "Lalit''. *International Journal of Chemical Studies*, **6**(5): 1114-1117.
- Killadi, B., R. Chaurasia, D.K. Shukla and A. Dikshit (2018). Physio-chemical properties and pigment changes in the pericarp of mango cultivar during storage and ripening. *Journal of Environmental Biology*, **39**: 373-378.
- Kumar, D. and D.B. Singh (2018). Effect of fertigation on growth, yield and quality of almond under Kashmir conditions. *Indian Journal of Horticulture*, **75**(2): 197-201.
- Kumar, D., K.K. Srivastava and D.B. Singh (2018). Effect of moisture conservation techniques on almond (*Prunus dulcis*) productivity under rainfed conditions. *Indian Journal of Agricultural Sciences*, **88**(3): 429-434.
- Kumar, D., K.K. Srivastava and S.R. Singh (2018). Morphological and horticultural diversity of plum varieties evaluated under Kashmir condition. *Tropical Plant Research*, **5**(1): 77-82.
- Kumar, D., K.K. Srivastava, S.R. Singh and A.C. Rathore (2018). Fruit production and carbon sequestration potential of rainfed apple (*Malus domestica* Borkh) under various moisture conservation techniques. *Indian Journal of Soil Conservation*, **46**(1): 109-117.
- Kumari, S., A. Sharma, V.K. Sharma, K.G. Rosin and D. Kumar (2018). Enhancement of apple (*Malus* × *domestica*) productivity and soil health through organic fertilization and bio-inoculants under north-western Himalayan region of India.

Indian Journal of Agricultural Sciences, **88**(9): 1463-1468.

- Kumari, S., M. Trivedi, A. Das and M. Mishra (2019). Effect of plating density, amino acid and osmoticum on transformation efficiency of papaya (*Carica papaya* L.). *Medicinal Plants*, **11**(1): 104-109.
- Kumari, S., M. Trivedi, N. Shukla and M. Mishra (2018). Polyamine mediated genotype independent somatic embryogenesis in papaya (*Carica papaya*). *Plant Archives*, **18**(1): 581-589.
- Lal, B., D. Mishra and P. Barman (2018). Harnessing potential yield of mango (*Mangifera indica* L.) cv. Dashehari by adopting efficient system of planting under Lucknow condition. *Agricultural Science Digest*, **38**(2): 152-154.
- Muralidhara, B.M., G.L. Veena, S. Rajan, A.K. Bhattacharjee and P.K. Malav (2018). Effect of post harvest ripening on bioactive secondary metabolites and antioxidant activity in mango cv. Amrapali. *Journal of Horticultural Sciences*, **13**(2): 23-29.
- Muralidhara, B.M., G.L. Veena, S. Rajan, A.K. Bhattacharjee and U. Hudedamani (2019). Profiling of major biochemical compounds for identification of nutritionally rich genotypes in mango. *Journal of Environmental Biology*, **40**(2): 177-182.
- Pandey, A.K., S. Pathak, P. Barman and D. Tiwari (2019). Influence of macro nutrients and plant growth regulators on biochemical traits and antioxidant production in strawberry. *Journal of Pharmacognosy and Phytochemistry*, **8**(2): 1352-1356.
- Pankaj, B., S. Gangola, P. Chaudhary, P. Khati, G. Kumar, A. Sharma and A. Srivastava (2019). Pesticide induced up-regulation of esterase and aldehyde dehydrogenase in indigenous *Bacillus* spp. *Bioremediation Journal*, **23**(1): 42-52.
- Ram, R.A. and A. Kumar (2019). Bio-Dynamic Agriculture: An Advance Stage of Organic Farming. *Journal of Eco-Friendly Agriculture*, **14**(1): 34-37.
- Ram, R.A., A. Singha and A. Kumar (2018). Microbial characterization of cow pat pit and other biodynamic preparations used in biodynamic agriculture. *Indian Journal of Agricultural Sciences,* **89**(2): 42-46.
- Sharma, M.R., S. Kumari and M. Mishra (2018). *In vitro* regeneration of wilt resistant root stock of guava. *Plant Archives*, **18**(1): 1170-1174.
- Sharma, N., N. Kumari, S.K. Sharma, B.A. Padder and P.N. Sharma (2019). Investigating the virulence and genetic diversity of *Colletotrichum lindemuthianum* populations distributed in the North Western Himalayan hill states. *Journal of Plant Pathology*, https://doi.org/10.1007/s42161-019-00269-8.
- Shukla, P.K., S. Varma, T. Fatima, R. Mishra, A.K. Misra, A. Bajpai, B. Gundappa and M. Muthukumar (2018). First report on wilt disease of mango caused by *Ceratocystis fimbriata* in Uttar Pradesh. *Indian Phytopathology*, **71**(1): 135-142.
- Singh, A.K., A. Bajpai, M. Muthukumar and K.K. Mishra (2018). Antidiabetic assays' based fractionation and characterization of Jamun (*Syzygium cumini* Skeels) fruits. *Journal of Pharmacognosy and Phytochemistry*, **7**(4): 3107-3111.
- Singh, S.R., A. Ahmed, K.K. Srivastava and P.A. Shagoo (2018). Studies on factors influencing the vegetative propagation of walnut (*J. regia*). *Journal of Horticultural Science,* **13**(1): 91-96.
- Singh, V.K., A.K. Srivastava and A.K. Bhattacherjee (2018). Profiling of bioactive phytonutrients associated with antioxidant activity at various growth stages of mango. *Agricultural Research Journal*, **55**(2): 230-235.
- Verma, H.C., S. Rajan and T. Ahmed (2019). A review on land cover classification techniques for major fruit crops in India - present scenario and future aspects. Electronic publication, Elsevier Digital Library (February 23, 2019). https://ssrn.com/abstract=3356502.
- Verma, H.C., T. Adak and K. Kumar (2019). An expert system for identification of nutrients deficiency/disorder and their management advisories in Mango (*Mangifera indica* L.). *Indian Journal of Agricultural Physics*, **18**(1): 74-81.
- Vishwakarma, M., A. Bajpai and C. Kole (2018). Crossability studies in mango (*Mangifera indica* L.) malformation in a subtropical climate. *International Journal Genetics,* **10**(10): 511-513.
- Vishwakarma, M.K., A. Bajpai and C. Kole (2019). Study of flowering behavior of malformed vs normal mango varieties in subtropical region of India. *International Journal of Agriculture Sciences*, **11**(6): 8134-8136.
- Yadav, P., N. Garg and S. Kumar (2017). Screening of mulberry accessions for wine preparation. *International Journal of Food Fermentation Technology*, **7**(1): 103-109.

Popular Articles

- Ahmad, I., M. Muthukumar, U. Hudedamani, D. Pandey and S. Rajan (2018). Jaivik tatha ajaivik tanav me ethylene ki bhagidari. *Udhyan rashmi*, **16**(2): 51-52.
- Bajpai, A., M. Muthukumar, Laxmi and Y. Bajpai (2018). Falon ke Aushadhiya aur Poshan Gun. Udyaan Rashmi, 17(1): 72-75.

- Bajpai, Y., Laxmi , M. Muthukumar and A. Bajpai (2019).Plastic Pradooshan: Samasyaa aur Nidaan. Udyaan Rashmi. 17(2): 58-60.
- Bhattacherjee, A.K. and P.K. Shukla (2018). Spirulina – bhabishya ka ek poustik bhojan. *Udyan Rashmi*, **16**(2): 33-36.
- Garg, N. (2019). Phal prasaskaran se naye utpaadon ka wikaas. *Phal Phool*, January-February, pp. 8-10.
- Garg, N. and H.C. Verma (2018). Aam prasanskaran ki jankaari le lo mobile app se. *Phal Phool*, September-October, p. 28.
- Garg, N. and S. Kumar (2018). Amrud ke phalon ka tudai upraant prabandhan. *Bagwani*, **17**: 8-22.
- Garg, N. and S. Kumar (2018). Fruit Vinegar: A Diversified Fruit Product. *Indian Horticulture,* **63**(6): 26-27.
- Garg, N. and S. Kumar (2018). Khadya prasanskaran aur swachchhata, *Udyan Rashmi*, **16**(2): 76-78.
- Gundappa, B., P.K. Shukla and H. Pal (2018). Thrips keet: Aam par Mahamari aur mahatva. *Udyan Rashmi*, **16**(2): 64-65.
- Gurjar, P.S., S.K. Shukla, A.K. Verma, G. Carpenter, M. Mishra and S. Rajan (2018). Aam ke bag se adhik munafaa. *Phal Phool,* **39**(4): 20-23.
- Kumar, D., K.K. Srivastava and D.B. Singh (2018). Conserving moisture helps enhance almond yield. *Indian Horticulture*, **63**(1): 12-14.
- Kumari, N. and P.N. Sharma (2018). Shimla mirch mein vishanu rogon ka khatra awam iski rokthaam. *Udyan Rashmi*, **17**(1): 42-43.
- Kumari, N., P.K. Shukla and Gundappa (2018). Papite ke mukya vishanu rog awam unka prabhandhan. *Udyan Rashmi*, **17**(1): 40-41.
- Kumawat, K.L., M.K. Verma, D. Kumar, A.A. Sofi, N. Ahmed, D.B. Singh, S. Lal and C. Lal (2018). Exploring promising almond cultivars for health and prosperity. *Indian Horticulture*, **63**(6): 15-17.
- Muralidhara, B.M., G.L. Veena and S. Rajan (2018). Fast track techniques for raising genuine rootstocks in polyembryonic varieties of Mango. *Vatika Independence*, Issue-II (July- December), p. 14.
- Pandey, D., A.K. Trivedi, S.K. Shukla, N. Nehal and D. Giri (2018). Bel ke phalon ka phatna aur aparipakva avastha men girna: samasya evam samadhan. *Udyan Rashmi*, **16**(2): 19-21.
- Pandey, D., G. Pandey, D. Giri and N. Nehal (2018). Swasthay avam samridhhi ke liye daiviy phal-aonla. *Udhyan rashmi*, **16**(2): 10-15.
- Rajan, S., A.K. Singh, P.K. Shukla, B. Gundappa and D. Sharma (2018). Lucknow janpad ke aam ke bagon me pure varsh ke dauran hone wali karshan kriyayon ka calander. *Udyan Rashmi*, **16**(2): 87-89.
- Shukla, P.K., B. Gundappa and T. Fatima (2018). Aam ke bagon me samekit prabandhan: Aavashyakta evam mahatv. *Udyan Rashmi*, **16**(2): 61-63.
- Shukla, S.K. (2018). Bel par Dohe. *Udyan Rashmi*, **16**(2): 81.
- Shukla, S.K. and G. Pandey (2018). Shobhakar vrikshon, jhadiyon evam aarohi lataon dwara saundaryikaran. *Udyan Rashmi*, **16**(2): 39-41.
- Shukla, S.K., G. Pandey and A.K. Trivedi (2018). Aamdani evam gunvatta hetu aam ke bagon men chhatra prabandhan. *Udyan Rashmi*, **17**(1): 15-16.
- Shukla, S.K., G. Pandey, D. Pandey and M. Mishra (2018). Badhal-ek upyogi phal vriksh aur iski vyavasayik keti ki sambhavanayen. *Udyan Rashmi*, **16**(2): 25-27.
- Shukla, S.K., R.A. Ram and S. Rajan (2018). Kachra prabandhan sabji utpadan ke liye vardan. *Udyan Rashmi*, **17**(1): 1-4.
- Singh, A.K. and G.S. Vishen (2018). Khirnee me poshak tatvo ka mahatva. *Udyan Rashmi*, **17**(1): 23.
- Srivastava, K.K., D.B. Singh, D. Kumar, S.R. Singh and J.I. Mir (2018). Saghan Bagh me paudh architectural taqnik. *Phal Phool*, **39**(1): 31-35.
- Srivastava, K.K., G. Pandey, D. Kumar, S.R. Singh and S. Pandey (2018). Uposhn aaru ki kheti ek labhkari upaya. *Udyan Rashmi*, **16**(2): 28-30.
- Trivedi, A.K., G. Pandey, D. Pandey and S.K. Shukla (2018). Uposhna phalon ke padap daihik vicar evam unka prabandhan. *Udyan Rashmi*, **17**(1): 46-50.
- Verma, A.K., S. Pandey, K.K. Srivastava, S. Rajan, D. Kumar and G. Pandey (2018). Espalier architecture for revolutionizing high quality guava production. *Indian Horticulture*, **63**(4): 18-20.
- Verma, H.C. (2018). Cyber surakshya, mahatwa ewan awashakta. *Udyan Rashmi*, **16**(2): 100-103.

Abstracts

- Adak, T., G. Pandey, D. Pandey, N. Garg, R. Kumar, S.R. Singh, S. Chandra and A. Kumar (2018). Scientist-farmers interaction for enhancing farmer's income through nutrient management, crop diversification, value addition and other horticultural technologies. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 115.
- Adak, T., P.K. Shukla and Gundappa (2018). Soil biological indicator as an index for assessing the mango orchard sustainability. *In*: Souvenir cum book of abstracts, national conference on strategies

& challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 133-134.

- Bajpai, A., M. Muthukumar, M. Kavinkumar, V.K. Singh and S. Rajan (2018). Coordinated cross-talk of transcription factors regulating floral transition in mango. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 21.
- Bajpai, A., M. Muthukumar, Y. Bajpai and A.K. Trivedi (2018). RNA-Seq analysis of salinity stress response in mango. *In:* National conference on arid horticulture for enhancing productivity and economic empowerment, October 27-29, Bikaner, p. 74.
- Bajpai, A., M. Muthukumar, Y. Bajpai, V.K. Singh and S. Rajan (2018). Modelling of regulatory networks governing vegetative and flower bud formation in mango. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 165.
- Bajpai, A., S. Rajan and M. Muthukumar (2018). Newer insights into identification of incitants of mango malformation through 18S amplicon sequencing and metabolite analysis. *In*: International Conference on Sustainable Organic Agri-Horti Systems, November 28-30, Bhagidari Bhawan, Lucknow, p. 61.
- Barman, P. and D. Kumar (2018). Canopy architecture management in young plants for higher productivity and quality in mango. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 132-133.
- Barman, P. and D. Kumar (2018). Efficient energy harvest through canopy modification in mango for quality fruit production. *In*: International conference on impact of climate change and abiotic stresses on agriculture and management strategies, November 17-18, Banaras Hindu University, Varanasi, p. 23.
- Bhattacherjee, A.K. and A. Dikshit (2018). Role of nutraceutically rich fruit varieties in enhancing farmers' income. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 117-118.
- Bhattacherjee, A.K., N. Garg, P.K. Shukla, B. Singh, S. Vaish and A. Dikshit (2018). Microbial degradation of imidacloprid in mango orchard soil. *In*: International conference on sustainable organic agri-horti systems, November 28-30, Bhagidari Bhawan, Lucknow, pp. 82-83.
- Fatima, T. and P.K. Shukla (2018). Testing for development of biopesticides to manage mango wilt pathogen, *Ceratocystis fimbriata*. *In:* International conference on integrated management of crop diseases: a biotechnological approach, September 19-21, TNB College, Bhagalpur and JP College, Narayanpur, p. 36.
- Fatima, T., P.K. Shukla and Gundappa (2018). Isolation and mass multiplication of entomopathogenic fungi from *Helicoverpa armigera*. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 145.
- Garg, N., A.K. Bhattacherjee, B. Singh, S. Vaish, P.K. Shukla, A. Dixit and S. Kumar (2018). Biological activities of *Pseudomonas* sp. isolated from chlorpyriphos applied mango orchard soil. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 157.
- Garg, N., S. Vaish, B. Singh, S. Kumar and P.K. Shukla (2018). Bael waste as potential substrate for probiotic animal feed supplement and feed enzymes. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 156.
- Garg, N., B. Singh, S. Vaish and S. Kumar (2018). Enzymatic analysis of lactic acid fermented animal feed prepared from different fruit and vegetable waste. *In:* International conference on emerging issues in agricultural, environmental & applied sciences for sustainable development, November 27-29, SHUATS, Prayagraj, p. 125.
- Garg, N., P.K. Shukla, S. Vaish, B. Singh and S. Kumar (2018). Safe use of potassium metabisulphite for preservation of dried jamun powder. *In:* International conference on emerging issues in agricultural, environmental & applied sciences for sustainable development, November 27-29, SHUATS, Prayagraj, p. 74.
- Gundappa, B. (2018). Impact of climate change on potential distribution of mango insect pests in India. *In:* International conference on sustainable organic agri-horti systems, November 28-30, Bagidari Bhavan, Lucknow, p. 53.
- Gundappa, B. and P.K. Shukla (2018). Efficacy of different management practices on the incidence of guava bark eating caterpillar, *Indarbela* sp. *In:*

International conference on sustainable agri-horti systems, November 28-30, Bhagidari Bhavan, Lucknow, p. 58.

- Gundappa, B. and P.K. Shukla (2018). Incidence of mango twig gall, *Oligotrophus mangiferae* (Cecidomyiidae: Diptera) in West Bengal and Bihar. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 122.
- Gundappa, B., B.M. Rajkumar and P.K. Shukla (2018). Survey and surveillance of natural enemies in mango ecosystem. *In:* International conference on biological control: approaches and applications, September 27-29, Bangalore, p. 20.
- Gundappa, B., P.K. Shukla, M. Mishra, P.S. Gurjar and A.K. Verma (2018). Need based application of pesticide in mango ecosystem: Approach for doubling farmer's income. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, Lucknow, p. 175.
- Killadi, B., N. Garg and R. Chaurasia (2018). Post harvest dip treatment of *Bacillus subtilis* for maintaining quality and shelf life of guava cv. Allahabad Safeda. *In:* International conference on sustainable organic agri-horti systems, November 28-30, Bhagidari Bhawan, Lucknow, p. 83.
- Kumar, D. (2019). Fruit yield and nutrient use efficiency as influenced by drip fertigation in banana under subtropics. *In:* National conference on farmers first for conserving soil and water resources in eastern region, February 6-8, ICAR-IISWC, Research Centre, Koraput, Odisha, p. 59.
- Kumar, D. and R. Kumar (2018). Response of N and K fertigation for yield and quality of banana under subtropics. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 121.
- Kumar, D., K.K. Srivastava and S.R. Singh (2019). Moisture conservation *in situ* for productivity and quality enhancement of almond under rainfed conditions of Kashmir Valley. *In:* National conference on farmers first for conserving soil and water resources in eastern region, February 6-8, ICAR-IISWC, Research Centre, Koraput, Odisha, p. 66.
- Mishra, M., R.A. Ram, A.K. Verma, P.S. Gurjar and S. Chandra (2018). Enhancing livelihood and profitability of farmers' through horti-enterprise modules. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 84.
- Muralidhara, B.M., G.L. Veena, S. Rajan, A.K. Bhattacharjee and U. Hudedamani (2018). Screening of mango hybrid population for developing nutritionally rich hybrids. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 32.
- Muthukumar, M., A. Bajpai, A. Gupta, M. Sivakumar and S. Rajan (2018). Functional validation of carotenoid biosynthetic genes for pulp coloration in mango. *In*: International mango conference, May 8-10, Vengurle, Maharashtra, p. 29.
- Muthukumar, M., A. Bajpai, Y. Bajpai, V.K. Singh and S. Rajan (2018). Differential gene expression responses induced by salinity stress in polyembryonic mango cultivars. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 161-162.
- Pandey, D. and D. Giri (2018). Evaluation of Indian gooseberry (*Embilica officinalis* Gaertn.) genotypes for yield and quality under Lucknow condition. *In:* International conference on sustainable organic agri-horti systems, November 28-30, Bhagidari Bhawan, Lucknow, pp. 97-98.
- Pandey, D., S. Singh, D. Giri and N. Nehal (2018). Variability in biochemical traits of aonla cultivar at different maturity stages. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 141.
- Pandey, D., S.K. Shukla and D. Giri (2018). Evaluation of Bael germplasm collected from Western Uttar Pradesh. *In:* National conference on arid horticulture for enhancing productivity & economic empowerment, October 27-29, ICAR-CIAH, Bikaner, p. 8.
- Pandey, D., S.K. Shukla and D. Giri (2018). Evaluation of bael germplasm collected from western Uttar Pradesh. *In:* National conference on arid horticulture for enhancing productivity and economic empowerment, October 27-29, ICAR-CIAH, Bikaner, p. 8.
- Pandey, G., J.N. Tewari, D. Pandey, S.K. Shukla, A.K. Trivedi and S. Kumar (2019). Collection and characterization of trait specific jackfruit germplasm from Uttar Pradesh. *In:* Souvenir cum lead and oral paper abstracts, Indian Horticulture Congress, January 17-21, IGKV, Raipur, p. 34.
- Pandey, G., J.N. Tewari, S.K. Shukla, A.K. Trivedi,

T. Adak and S. Kumar (2018). Possibilities of jackfruit in semi-arid region of India. *In:* National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment, October 27-29, ICAR-CIAH, Bikaner, p. 7.

- Pandey, G., S.K. Shukla, J.N. Tewari, A.K. Trivedi, T. Adak and S. Kumar (2018). Jackfruit-A new option to organic window for doubling farmer's income. *In:* Souvenir and abstracts, International Conference on Sustainable Agri-Horti Systems, November 28-30, Bhagidari Bhawan, Lucknow, p. 95.
- Pandey, S., K.K. Srivastava and M. Kumar (2018). Changes in fruiting behavior of ber (*Z. mauriatiana* Lamrk) fruits during growth and development. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 143.
- Rajan, S., U. Hudedamani, V. Singh, P. Sagar and S. Singh (2018). Evaluation of mango hybrid population for fruit quality parameters. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 164.
- Ram, R.A. (2018). Biodynamic agriculture: An advance stage of organic farming. *In:* International conference on sustainable organic agri-horti system, November 28-30, Bhagidari Bhawan, Lucknow, p. 86.
- Ram, R.A. (2018). Bio-enhancers: A potential tool to improve soil fertility and plant health in organic production of horticultural crops. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 172.
- Ram, R.A. (2018). Diversification of horticulture with sustainable and eco-friendly farming practices in subtropical and tropical regions of India. *In:* National conference on intensification and diversification in agriculture for livelihood and rural development, May 28-30, Samastipur, Bihar, p. 106.
- Ram, R.A. (2018). On farm production of quality inputs for organic production of horticultural crops in arid zones of India. *In:* National conference on arid horticulture for enhancing productivity and economic empowerment, October 27-29, ICAR-CIAH, Bikaner, pp. 112-117.
- Ram, R.A. and A.K. Verma (2018). Response of various organic amendments on yield, quality and economics of production in mango cv. Dashehari. *In:* International mango conference, May 8-11, Vengurle, Maharashtra, p. 173.
- Ram, R.A. and I. Ahmed (2018). Isolation and characterization of PGPRs from organic preparation. *In:* International conference on sustainable organic agri-horti system, November 28-30, Bhagidari Bhawan, Lucknow, p. 121.
- Ram, R.A. and R.K. Pathak (2018). Bio-enhancers for soil, plant health and insect pest management in organic production of horticultural crops. *In:* International conference on sustainable organic agri-horti system, November 28-30, Bhagidari Bhawan, Lucknow, p. 84.
- Ram, R.A., I. Ahmed, A. Singha, S. Vaish and A. Kumar (2018). Isolation and characterization of phosphate solubilizing bacteria from organic preparation. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 176.
- Ram, R.A., S. Rajan, M. Mishra, A.K. Verma and S. Yadav (2018). Enhancing livelihood and nutritional security of farmer's through mango based rural poultry. *In:* International Mango Conference, May 8-11, Vengurle, Maharashtra, pp. 57-58.
- Shukla, A.K., M.K. Soni, A. Yadav, A.K. Bhattacherjee and V.K. Singh (2018) Assessment of tomato (*Solanum lycopersicum* Mill.) varieties for quality production under protected cultivation in subtropics. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 128-129.
- Shukla, P.K. (2018). Lead Lecture: Newly emerged wilt, decline and branch blight diseases are big challenge to mango industry. *In:* Proc. ISMPP 39th Annual Conference & National Symposium on Plant and Soil Health Management: New Challenges and Opportunities, November 16-18, IIPR., Kanpur, p. 247.
- Shukla, P.K. and T. Fatima (2018). Suppressive effects of fungicides on growth of mango wilt pathogen. *In:* International Mango conference, May 8-10, Vengurle, Maharashtra, p.128.
- Shukla, P.K., R.M. Khan, S. Rajan and T. Fatima (2018). Guava decline disease is caused by root-knot nematode alone or with wilt fungus. *In:* International conference on integrated management of crop diseases: a biotechnological approach, September 19-21, TNB College, Bhagalpur and JP College, Narayanpur, p. 34.

- Shukla, P.K., R.M. Khan, T. Fatima and S. Rajan (2019). Current status of guava wilt and decline disease management. *In:* National symposium on recent challenges and opportunities in sustainable plant health management, February 26-28, BHU, Varanasi, pp. 70-71.
- Shukla, P.K., T. Fatima and Gundappa (2018). Efficacy of secondary metabolites of *Trichoderma harzianum* Rifai against mango wilt pathogen, *Ceratocystis fimbriata* Ellis and Halst". *In:* International conference on sustainable agri-horti systems, November 28-30, Bhagidari Bhavan, Lucknow, p. 71.
- Shukla, P.K., T. Fatima and Gundappa (2018). Mango wilt incidence in India. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 129.
- Shukla, P.K., T. Fatima and S.C. Yadav (2018). Strategies and challenges in doubling farmers through mushroom cultivation. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 113-114.
- Shukla, P.K., T. Fatima, I. Ahmad and R.M. Khan (2019). Incidence of *Meloidogyne enterolobii* in nurseries and orchards of Guava. *In:* National symposium on sustainable management of pests and diseases in augmenting food and national security, January 22-24, NAU, Navsari, Gujarat, pp. 34-38.
- Shukla, S.K., D. Pandey and G. Pandey (2018). Evaluation of custard Apple genotypes under Lucknow conditions. *In:* National conference on arid horticulture for enhancing productivity & economic empowerment, October 27-29, ICAR-CIAH, Bikaner, p. 25.
- Shukla, S.K., T. Adak and V.K. Singh (2018). Improvement in yield and quality of mango cv. Mallika through soil and foliar nutrition of zinc supplements. *In:* International conference on sustainable agri-horti systems, November 28-30, Bhagidari Bhawan, Lucknow, p. 86.
- Singh, A.K. and A. Bajpai (2018). Evaluation of jamun (*Syzygium cumini* Skeels) germplasm for growth and yield behaviour. *In:* International conference on sustainable organic agri-horti system, November 28-30, Bhagidari Bhawan, Lucknow, p. 139.
- Singh, A.K. and A. Bajpai (2018). Jamun (*Syzygium cumini* Skeels): Potential Fruit for Livelihood and Nutritional Support. *In:* National conference on intensification and diversification in agriculture for livelihood and rural development, May 28-31, Samastipur, Bihar, p. 17.
- Singh, A.K., A. Bajpai and K.K. Mishra (2018). Influence of canopy architecture on yield behaviour and quality of fruits in jamun (*Syzygium cuminii* Skeels). *In:* National conference on arid horticulture for enhancing productivity & economic empowerment, October 27-29, ICAR-CIAH, Bikaner, p. 31.
- Singh, S.R., K.K. Srivastava, A. Kumar, B.M. Murlidhara and G.L. Veena (2018). Evaluation of lettuce (*Lactuca sativa* L.) varieties under subtropics. *In:* Souvenir cum book of abstracts, national conference on strategies and challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 135.
- Srivastava, K.K., D. Kumar, S.R. Singh, G. Pandey, S. Pandey and P. Barman (2018). Growth pattern and phenological stages of peach trees under subtropics. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 142.
- Trivedi, A.K., A.K. Singh, A. Bajpai and K.K. Mishra (2018). Effect of training systems on light interception and gas exchange parameters in Jamun (*Syzigium cumini* L. Skeels). *In:* International conference on plants and environmental pollution (ICPEP6), November 28-30, CSIR-NBRI, Lucknow, pp. 22-23.
- Vaish, S., N. Garg and I.Z. Ahmad (2018). Enzymatic and siderophore production behavior of fungal islates from various biodynamic preparations. *In:* International conference on sustainable organic agri-horti system, November 28-30, Bhagidari Bhawan, Lucknow, p. 116.
- Veena, G.L., B.M. Muralidhara and S. Rajan (2018). Genotypic variability and correlation studies in mango cultivars for bioactive components. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 26.
- Veena, G.L., M.R. Dinesh, K.S. Shivashankar, K.V. Ravishankar and M. Sankaran (2018). Traditional wealth of aromatic pickle mango of India. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 143.
- Verma, A.K., P.S. Gurjar, Gundappa and M. Mishra (2018). GAP coupled with market linkage augmented farmers income in Malihabad, Uttar Pradesh. *In:* International mango conference, May 8-10, Vengurle, Maharashtra, p. 122.
- Verma, H.C. and N. Garg (2018). Applications of ICT for rural development with special reference

to mobile apps, *In:* International conference on sustainable organic agri-horti system, November 28 – 30, Bhagidari Bhawan, Lucknow, p. 108.

- Verma, H.C. and N. Garg (2018). Mobile apps-potential ICT tools to disseminate technologies on value addition of raw and ripe mango, *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, p. 155.
- Verma, H.C., B. Gundappa, P.K. Shukla and R. Kumar (2018). An expert system for advisories on mango (*Mangifera Indica L.*), *In:* International conference on rural livelihood improvement by enhancing farmers income through sustainable innovative agri and allied entrepreneurs, October 30 - November 01, Birla Institute of Technology, Patna, p. 139.

Proceedings

- Kumar, A. (2018). Resource use efficient strawberry production for enhancing farmers' income in subtropics. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 23-27.
- Shukla, P.K. (2018). Eco-friendly management of major diseases of mango and guava for sustainable productivity. *In:* Proceedings of national conference on strategies and challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 66-70.
- Shukla, P.K. (2019). Variations in expression of symptoms and extent of damage of mango lethal diseases in India (Lead Lecture). *In:* Proceedings of national symposium on sustainable management of pests and diseases in augmenting food and national security, January 22-24, NAU, Navsari, Gujarat, pp. 34-38.
- Singh, S.R. and A. Kumar (2018). Exotic vegetable production under protected cultivation for doubling the farmer income. *In*: Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH, pp. 93-98.
- Srivastava, K.K., D. Kumar, S.R. Singh and S. Pandey (2018). Growth pattern and phenological stages of peach varieties under northern plains of India. *In:* 8th Indian horticulture congress, IGKVV, Raipur, p. 268.

Edited book

- Bajpai, A., A. Singh, S.R. Singh, M. Muthukumar, and S. Rajan (2018). Training manual of model training course on food and nutritional security of farm women through horticulture based interventions, November 13-20, ICAR-CISH Publications, Lucknow, pgs. 132.
- Kumar, A., G.L. Veena and G. Carpenter (2018). Compendium of refresher training program on opportunities of value addition in horticultural produce for established AC&ABC Agripreneures, October 22-25, ICAR-CISH Publications, Lucknow, pgs. 60.
- Kumar, A., G.L. Veena, A. Singh and I. Ahmad (2019). Compendium of two months residential training on AC&ABC sponsored by MANAGE in collaboration with ICAR-CISH Lucknow, January 08 – March 08, ICAR-CISH Publications, Lucknow, pgs. 252.
- Kumar, A., I. Ahmad and G.L. Veena (2018). Compendium of training on certified farmer advisor (fruits), October 3-17, ICAR-CISH Publications, Lucknow, pgs. 209.
- Mishra, M., A.K. Bhatacharjee, R.A. Ram, P.K. Shukla, P.S. Gurjar and M. Muthukumar (2018). Souvenir cum book of abstracts, national conference on strategies & challenges in doubling farmers' income through horticultural technologies in subtropics, June 21-22, ICAR-CISH Publications, Lucknow, pgs. 186.

Extension Folders / Technical Bulletins

- Garg, N. (2018). Aam ki utpaad vividhta, mulya sanwardhan, apsisht upyog tatha khadya surakshya. *Smarika*, Uttar Pradesh Aam Mahotsav, pp. 60-65.
- Gundappa, B. and P.K. Shukla (2018). Mango Shoot Gall Psylla Management. Technical folder, ICAR-CISH, Lucknow
- Gundappa, B. and P.K. Shukla (2018). Mango Thrips Management. Technical folder, ICAR-CISH, Lucknow
- Mishra, M., R.A. Ram, B. Gundappa, S. Chandra and S. Rajan (2018). Doubling the farmers' income and improving the mango ecosystem through integration of new poultry production technology. Technical folder, ICAR-CISH, Lucknow.
- Shukla, P.K., S. Rajan and T. Fatima (2018). Amrud ka jad grinthi rog: pahchan aur prabandhan (Hindi).
- Shukla, P.K., S. Rajan and T. Fatima (2018). Root-knot disease of guava: Identification and management (Bilingual).

- Shukla, S.K., P.K. Shukla and S. Rajan (2018). Uttar Pradesh ke paridrishya men aam moolya shrinkhala kaa moolyaankan. *Smarika*, Uttar Pradesh Aam Mahotsav-2018, 23-24 June, Indira Gandhi Pratishthan, Lucknow, pp. 24-29.

Chapters in Books

- Bajpai, A. (2018). Food and nutritional improvement of farm women: An ICAR initiative. *In: Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions*, November 13-20, ICAR-CISH Publications, Lucknow, pp. 8-11.
- Bajpai, A. (2018). Nutrition and food policy initiatives in India. *In: Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions*, November 13-20, ICAR-CISH Publications, Lucknow, pp. 101-104.
- Bajpai, A. and M. Muthukumar (2018). Nutrition profiling of fruits. *In: Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions*, November 13-20, ICAR-CISH Publications, Lucknow, pp. 120-123.
- Garg, N., S. Kumar, P. Singh and K.K. Yadav (2018). Development of blended aonla squash. In: *Sustainable Horticulture*, Vol. 2, Food Health and Nutrition, Mandal, D., A.C. Shukla and M.W. Siddique (Eds.), Apple Academic Press, USA, pp. 79-85.
- Gundappa, B. (2018). Pests of fruit crops. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, p. 215.
- Gundappa, B., B.M. Rajkumar, S. Singh and S. Rajan (2018). Pests of guava. *In: Pests and their Management*, Omkar (Ed.), Springer, Singapore, pp. 491-516.
- Gundappa, B., H. Khader Khan and A.K. Chakravarthy (2018). Bioecology and management of fruit and shoot borer, *Conogethes punctiferalis* guenée (crambidae: lepidoptera) on fruit crops in central India. In: *The Black spotted, Yellow Borer, Conogethes punctiferalis Guenée and Allied Species*, Chakravarthy, A. (Ed.), Springer, Singapore, pp. 157-164.
- Hudedamani, U., G.L. Veena, I. Ahmad and S. Rajan (2018). Rootstock: foundation for biotic and abiotic stresses. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 121-126.
- Killadi, B. (2019). Guidelines for post-harvest and cool chain management of mango (*Mangifera indica*) for domestic and export trade. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 91-94.
- Killadi, B., N. Garg, R. Chaurasia, K.K. Yadav and D.K. Shukla (2018). *Saccharomyces cerevisiae* post harvest dip treatment for improving quality and storability of mango cv. Dashehari. In: *Sustainable Horticulture*, Vol. 2, Food Health and Nutrition, Mandal, D., A.C. Shukla and M.W. Siddique (Eds.), Apple Academic Press, USA, pp. 87-100.
- Kumar, A. (2018). Exotic fruit production under subtropics *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 175-180.
- Kumar, A. (2018). Low cost protected cover in fruit crop production *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 170-174.
- Kumar, A. (2018). Success of strawberry cultivation. *In: Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions*, November 13-20, ICAR-CISH Publications, Lucknow, pp. 51-54.
- Kumar, A. and G.L. Veena (2019). Exotic fruit production under sub tropics. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 156-162.
- Kumar, A. and G.L. Veena (2019). Low cost protected fruit crop production. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 150-155.
- Muthukumar, M. (2018). Strategies for upliftment of nutritional status of farm women and children. *In: Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions*, November 13-20, ICAR-CISH Publications, Lucknow, pp. 73-76.
- Pandey, D. (2019). Bael cultivation. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8- March 8, Kumar, A., G.L. Veena, A. Singh

and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 171-179.

- Pandey, D. (2019). Scientific cultivation of aonla. *In: Compendium on Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 180-188.
- Pandey, D., U. Hudedamani and M. Muthukumar (2018). Horticulture diversification for food and nutritional security. *In: Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions*, November 13-20, ICAR-CISH Publications, Lucknow, pp. 19-21.
- Pandey, G., A.K. Trivedi, K.K. Srivastava and S.K. Shukla (2018). Action plan for expansion of fruit crops in Arunachal Pradesh. *In: The Recommendations and Proceedings of the State Conclave on Perspective Planning for Resurgent Agriculture & Allied Sectors in Arunachal Pradesh*, May 18-19, Itanagar, pp. 90-92.
- Pandey, G., S.K. Shukla and A.K. Trivedi (2018). Production technology of jackfruit. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 72-79.
- Rajan, S., U. Hudedamani and G.L. Veena (2018). Breeding of sub-tropical fruits: strategies, achievements and future needs. *In: Shaping the Future of Horticulture*, Chadha, K.L., S.K. Singh, Jai Prakash and V.B. Patel (Eds.), Kruger Bent Publishers, New Delhi, pp. 94-100.
- Rajkumar, B.M., B. Gundappa, M.M. Tripathi and S. Rajan (2018). Pests of jackfruit. *In: Pests and their Management*, Omkar (Ed.), Springer, Singapore, pp. 415-440.
- Reddy, V.R.P., B. Gundappa, A.K. Chakravarthy (2018). Pests of mango. *In: Pests and their Management*, Omkar (Ed.), Springer, Singapore, pp. 587-602.
- Salwan, R., N. Kumari and V. Sharma (2019). Bioactive volatile metabolites of *Trichoderma*: an overview. *In: Secondary Metabolites of Plant Growth Promoting Rhizomicroorganisms*, Singh, H. *et al.* (Eds.), Springer, Singapore, pp. 87-111.
- Shukla, P.K. (2018). Entrepreneurship development in mushroon production. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 20-29.
- Shukla, P.K. (2018). Integrated disease management in subtropical fruit crops. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 44-56.
- Shukla, P.K. (2018). Management of diseases of subtropical fruit crops. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 197-209.
- Shukla, P.K. (2018). Nematodes management in subtropical fruit crops: an overview. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 194-196.
- Shukla, P.K. (2018). Survey in plant pathology: need, planning, preparation, period, procurements, precautions, sampling and efficiency. *In: Integrated Management of Crop Diseases*, Courasia, H.K. and S.K. Coudhary (Eds.), Today and Tommorrow's Printers and Publishers, New Delhi, pp. 125-135.
- Shukla, S.K. (2018). Shobhakar vrikshon, jhadiyon evam aarohii lataon dwara sundarikaran. *In: Compendium on Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 95-96.
- Shukla, S.K., G. Pandey and A.K. Trivedi (2018). Aam ke bagon men jeernoddhar evam chhatra prabandhan. *In: Compendium on Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 97-98.
- Shukla, S.K., G. Pandey and A.K. Trivedi (2019). Aam ke baagon mei jirnodhyar ebam chhatra prabandhan. In: Compendium on *Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 99-102.
- Shukla, S.K., G. Pandey, and A.K. Trivedi (2018). Fruit orchard rejuvenation. *In: Compendium on Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 85-97.
- Shukla, S.K., R.A. Ram, and S. Rajan (2018). Udyamita hetu gharelu kachra prabandhan evam

gharelu bagwani. *In: Compendium on Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 103-106.

- Singh, A.K. (2019). Production technology of Jamun. *In: Compendium on Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 57-63.
- Singh, P., N. Garg and S. Kumar (2018). Storage study of jamun-aonla blended ready-to-serve beverages. *In: Sustainable Horticulture*, Vol. 2, Food Health and Nutrition, Mandal, D., A.C. Shukla and M.W. Siddique (Eds.), Apple Academic Press, USA, pp. 69-77.
- Singh, V.K. (2019). Internal breakdown in mango (*Mangifera indica* L.) is an important physiological disorder - An overview. In: *Advances in Plant Physiology*, Vol. 18, Hemantaranjan, A. (ed.) Scientific Publishers (India), pp. 315-334.
- Trivedi, A.K., G. Pandey and S.K. Shukla (2018). Physiological disorders of fruit crops. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 82-84.
- Trivedi, A.K., G. Pandey, S.K. Shukla and P. Barman (2018). Implications of solar radiation for agri-horticultural production, *In: Advances in Plant Physiology*, Vol. 18, Hemantaranjan, A. (Ed.), Scientific Publishers (India), Jodhpur, pp. 295-313.
- Veena, G.L., I. Ahmad, A. Kumar and A. Singh (2019). Resource analysis and counselling. *In: Compendium Two Months Residential Training Programme on Agri-Clinic and Agri-Business Centre Scheme*, January 8 – March 8, Kumar, A., G.L. Veena, A. Singh and I. Ahmad (Eds.), ICAR-CISH Publications, Lucknow, pp. 162-166.
- Veena, G.L., U. Hudedamani, A. Kumar and S. Rajan (2018). Nutracuetical values of fruit crops. *In: Compendium of Training on Certified Farmer Advisor (Fruits)*, October 3-17, Kumar *et. al*. (Eds.), ICAR-CISH Publications, Lucknow, pp. 36-44.

E-publications

- Bajpai, A., A. Singh, S.R. Singh, M. Muthukumar and S. Rajan (2018). E-book of Training Manual of Model Training Course on Food and Nutritional Security of Farm Women through Horticulture Based Interventions, November 13-20, ICAR-CISH Publications, Lucknow, pgs. 132.
- Kumar, A., G.L. Veena and G. Carpenter (2018). Compendium of Refresher Training Program on Opportunities of Value Addition in Horticultural Produce for Established AC&ABC Agripreneures, October 22-25, ICAR-CISH Publications, Lucknow, pgs. 64.
- Kumar, A., G.L. Veena, A. Singh and I. Ahmad (2019). Compendium of Two Months Residential Training on AC-ABC sponsored by MANAGE in collaboration with ICAR-CISH, January 8 – March 8, ICAR-CISH Publications, Lucknow, pgs. 252.
- Kumar, A., I. Ahmad and G.L. Veena (2018). Compendium of Training on Certified Farmer Advisor (Fruits), October 3-17, ICAR-CISH Publications, Lucknow, pgs. 209.

10 Research Projects

Institute Projects

Title	Name of Scientists
Research Programme	
1. Conservation and utilization of genetic resources for improvement of subtropical fruits for higher productivity and quality	Dr. S. Rajan, Dr. A. K. Singh, Dr. D. Pandey, Dr. Maneesh Mishra, Dr. (Mrs.) Anju Bajpai, Dr. H.C. Verma, Dr. Muthukumar M., Dr. Israr Ahmad, Dr. Umesh Hudedamani, Dr. (Mrs.) Veena G.L., Miss. Antara Das (on study leave), Miss. S.S. Das (on study leave)
2. Integrated nutrient, water, space and canopy management for improving productivity of subtropical fruits	Dr. Ghanshyam Pandey, Dr. V. K. Singh, Dr. R.A. Ram, Dr. S.K. Shukla, Dr. Dinesh Kumar, Dr. S.R. Singh, Dr. A.K. Trivedi, Dr. K.K. Srivastava, Dr. Ashok Kumar, Dr. Tarun Adak, Dr. Raj Kumar, Dr. Govind Kumar, Dr. Prananath Barman.
3. Diagnosis of new and emerging biotic stresses, development of prediction models and devising integrated management schedules for higher productivity	Dr. R. M. Khan, Dr. P.K. Shukla, Dr. Gundappa, Shri H.C. Verma, Dr. (Miss) Nidhi Kumari
4. Devising technologies for minimizing postharvest losses, value added products and marketing of subtropical fruits	Dr. (Mrs.) Neelima Garg, Dr. A.K. Bhattacherjee, Dr. (Mrs.) Abha Singh, Er. A.K. Verma, Dr. (Mrs.) Bharati Killadi, Dr. P.S. Gurjar, Mrs. Jyotirmayee Lenka
5. Improving knowledge and skill of stakeholders for improving production of subtropical fruits	Dr. Naresh Babu, Shri Subhash Chandra, Dr. V.K. Singh, Dr. S.R. Singh, Dr. S.K. Shukla, Er. A.K. Verma
Flagship Projects	
6. Resilience of mango (*Mangifera indica*) production to temperature, salt and moisture stresses	Dr. V. K. Singh, Dr. S. Rajan, Dr. (Mrs.) Anju Bajpai, Dr. P.K. Shukla, Dr. Ashok Kumar, Dr. A.K. Trivedi, Dr. Tarun Adak, Dr. Gundappa, Dr. Muthukumar M., Dr. Israr Ahmad, Dr. (Mrs.) Veena G.L.
7. Profiling of biotic, edaphic and bioclimatic factors responsible for guava wilt and its management	Dr. R. M. Khan, Dr. S. Rajan, Dr. Manish Mishra, Dr. A.K. Bhattacherjee, Dr. K.K. Srivastava, Dr. P.K. Shukla, Dr. Tarun Adak, Dr. Israr Ahmad, Dr. Gundappa, Dr.(Miss) Nidhi Kumari
8. Survey, characterization and assessment of bio-efficacy of microbial formulations in the control of Fusarium wilt of banana	Dr. T. Damodaran, Dr. S. Rajan, Dr. Manish Mishra, Dr. Dinesh Kumar, Dr. P.K. Shukla, Dr. Muthukumar M., Dr. Israr Ahmad, Dr. (Miss) Nidhi Kumari, Dr. Dipak Nayak and Dr. Ashok Yadav

Externally Aided Projects

S.N.	Project Title	PI/Nodal Officer	Period
	DAC, NCPAH, Ministry of Agriculture, GOI		
1.	Hi-tech horticulture for efficient utilization of resource through precision farming (PFDC)	Dr. V.K. Singh/ Dr. S.R Singh	2002-2020
	AMAAS, MAU		
2.	Network project on Microorganisms in agriculture and allied sectors Sub-Project: Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable mandi waste	Dr. (Mrs.) Neelima Garg	2017-2020
	DBT		
3.	Development of national data base on mango	Dr. S. Rajan	2013-2020

	DST-SERB		
4.	Genomics assisted identification of resistance genes from wild relatives of guava against *Meloidogyne enterolobii* causing wilt	Dr. Muthukumar M.	2018-2022
	UPCST		
5.	Mass multiplication of wilt resistant root stock of guava through *in vitro* techniques	Dr. Maneesh Mishra	2016-2019
6.	Standardization of container gardening of fruits for catering the nutritional requirements of the city dwellers	Dr. K. K. Srivastava	2017-2020
7.	Developing protocol for reduction of pesticide residues by microbial intervention in mango orchard soil	Dr. A.K. Bhattacharjee	2017-2020
8.	On-farm production of bio-enhancers, isolation, characterization, molecular identification and development of beneficial microbial consortium for organic farming	Dr. R.A. Ram	2018-2021
	PPV & FRA		
9.	Developing national repository and facilities for DUS testing in guava (*Psidium guajava*) and litchi (*Litchi chinesis*)	Dr. S. Rajan	2012 -2019
10.	Characterization of aonla varieties for developing DUS test guidelines	Dr. Devendra Pandey	2012 -2019
11.	Validation of DUS descriptors of bael (*Aegle marmelos* Correa)	Dr. Devendra Pandey	2012 -2019
12.	Development of morphological descriptors and DUS test guidelines for jamun	Dr. A.K. Singh	2012 -2020
13.	National DUS centre for mango crop	Dr. S. Rajan	2012 -2019
	ICAR Networking Project		
14.	Network project on transgenics in crops (Functional genomics of mango)	Dr. (Mrs.) Anju Bajpai	April, 2015 – March, 2020
15.	National Agriculture Innovation Fund	Director/I/c PME	2008- 2020
	National Initiative on Climate Resilient Agriculture (NICRA)		
16.	Understanding the changes in host-pest interactions and dynamics in mango under climate change scenario	Dr. P.K. Shukla	2012-2020
	RKVY		
17.	Refinement and demonstration of hydroponic techniques for high value vegetable production in subtropical areas	Dr. S.R. Singh	2016-17 to 2019-2020
18.	Creation of commercial banana tissue culture facility using bio-priming technology	Dr. Maneesh Mishra	2018-2021
19.	Advance centre for establishment of value chain and food processing of agri-horticultural crops to empower rural youth, self-help groups and processing entrepreneurs	Dr. Dipak Nayak	2018-2020
	Farmer FIRST Programme of KVK scheme		
20.	Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules	Dr. Maneesh Mishra	2016-17 to 2019-2020
	CHAMAN Project (ICAR-CISH in collaboration with Mahalanobis National Crop Forecast Centre (MNCFC), New Delhi		
21.	Coordinated Horticulture Assessment and Management using Geoinformatics	Dr. S. Rajan	2018-2020

	Seed Hub Project		
22.	Seed Hub Project at KVK Malda	Dr. Dipak Nayak	2016-17 to 2019-2020
	National Bee Board, New Delhi		
23.	Integrated Bee Development Centre (IBDC)	Dr. Dipak Nayak	2018-2021
	Tribal Sub Plan		
24.	Tribal Sub Plan	Dr. Dipak Nayak	April 2018-19
	S.C. Sub Plan		
25.	S.C. Sub Plan	Dr. Ashok Kumar	April 2018 onwards

All India Coordinated Research Project-Fruits: On-going experiments

S.N.	Code No.	Title	Name of PI
1.	1.2.1. G	Augmentation and evaluation of germplasm in guava	S. Rajan
2.	1.2.5. G	Testing the performance of new promising hybrids and selections of guava (MLT-3)	S. Rajan
3.	3.2.4. G	Enhancing the input use efficiency in guava under HDP	K.K. Srivastava
4.	5.2.2. G	New and emerging insect pests in guava	Gundappa
5.	6.2.2. G	New and emerging diseases of guava	P.K. Shukla
6.	6.2.3. G	Integrated management of guava wilt	P.K. Shukla
7.	6.2.4. G	Management of guava anthracnose	P.K. Shukla
8.	1.1.1. M	Augmentation and evaluation of germplasm in mango	S. Rajan
9.	1.1.13. M	Improvement of mango through half-sibs	S. Rajan
10.	1.1.14. M	Scion breeding in mango	S. Rajan
11.	1.1.15. M	Root-stock breeding in mango	S. Rajan
12.	3.1.4. M	Development of organic package of practices for mango	R.A. Ram
13.	3.1.5. M	Fertilizer scheduling for high density planting in mango	D. Kumar
14.	3.1.6. M	Effect of micronutrients on yield and quality of mango	D. Kumar
15.	4.1.4. M	Assessing the effect of climatic variability on mango flowering and yield	V.K. Singh
16.	4.1.6. M	Assessment of post-harvest loss in mango	Anil Verma
17.	5.1.4. (a) M	Integrated pest management of hopper in mango	Gundappa
18.	5.1.7. M	Model based pest management in mango	Gundappa
19.	5.1.4. (b) M	Documentation and monitoring of population of pollinators	Gundappa
20.	5.1.5. M	Survey and surveillance of insect-pests and natural enemies in mango	Gundappa
21.	5.1.6. M	Management of mango hoppers and thrips using entamopathogens	Gundappa
22.	6.1.5. M	New and emerging diseases of mango	P.K. Shukla
23.	6.1.6. M	Cost effective management of post-harvest anthracnose of mango by pre and post-harvest treatments	P.K. Shukla
24.	6.1.9. M	Identification and characterization of pathogens associated with stem end rot in mango	P.K. Shukla
25.	New Exp.	Evaluation of different botanical formulations for management of sucking pest complex in mango	Gundappa

11 Consultancies, Patents and Commercialization of Technologies

Technology commercialized

CISH-Herbal Prash technology was commercialized to M/s K. R. Food Industries, NM-16, Old DLF Colony Sector-14 Gurugram, Haryana at an amount of Rs. 2,51,000.

Contract Research

Contract research was carried out on "Evaluation of spraying of Servo Agrospray oil against pests of mango crop" and taken up at an amount of Rs. 9,00,000 from Indian Oil Corporation R&D Centre, Faridabad, Haryana.

Contract Service

Contract service was provided to National Nursery, Malihabad, Lucknow for the analyses of nematode and DNA of guava plants for an amount of Rs. 5000.

Consultancies

Consultancy service was provided to Dr. Punit Bharadwaj, Mohanlalganj, Lucknow, Uttar Pradesh for large scale production and know-how of the high value crops including strawberry, vegetables and flowers production technologies. Shri Deepak Shukla, Sitapur, Uttar Pradesh for rejuvenation of old and unproductive mango orchards' technology.

Technologies dissemination for the benefit of young entrepreneurs

Institute shared technologies' details (value addition and agro processing) with Small Farmers Agribusiness Consortium, Department of Agriculture Development & Farmers, Government of Kerala, Thiruvananthapuram and Business Development Division, CSIR-National Chemical Laboratory, Pune, Maharashtra.

Agri-Clinic and Agri-Business Centre

Institute started Agri-Clinic and Agri-Business Centre to facilitate agriculture students with the intention to train them the basic concept of Agri-business management from January to March, 2019. The qualified trained agricultural professionals would be eligible to set up Agri-ventures that can deliver value-added extension advisory services to farmers. These professionals will be eligible for startup loans from nationalized banks and subsidy from National Bank for Agriculture and Rural Development (NABARD).

Horti-entrepreneurship workshop for rural youth

The need to create viable economic opportunities to engage educated unemployed youth is urgently needed. In response to the growing demand of employment opportunities in horticulture sector, institute regularly organized Horti-entrepreneurship workshops to improve the income of the rural youth and farmers through entrepreneurship. Several farmers, students and entrepreneurs from different parts of the country were benefitted from such sort of programs. In technical sessions, ways and means to increase the income of the farmers, the knowledge about e-national agriculture market (e-NAM), new agricultural technologies and its training for farming, various government schemes related with horticulture and agriculture were given by different subject matter experts.

12 QRT of AICRP-Fruits / RAC / IRC / IMC

Quinquenial Review Team (QRT) of AICRP-Fruits

The QRT meeting of All India Coordinated Research Project on Fruits was held at ICAR-CISH, Lucknow from April 11-13, 2018 under the Chairmanship of Padmashri Dr. K.L. Chadha, former DDG (Hort.), ICAR, New Delhi. Other distinguished members were Dr. S. Maiti, Dr. D.S. Khurdia, Dr. B.M.C. Reddy and Dr. V.S. Thakur. The objectives of the AICRP were testing and recommending locations and need based technologies depending on agro-climatic conditions. Project Coordinator, Dr. P. Patil, ICAR-IIHR, Bengaluru submitted the AICRP report at length. Nodal Officer, AICRP-Fruits of Lucknow, Dr. K.K. Srivastava, Principal Scientist apprised the august house that more than 45 scientists working on different aspects of mango, guava and litchi from different parts of India are participating to discuss the progress made in different experiments from 2011 to 2017 during the review meeting of QRT. A total of 80 experiments of mango, guava and litchi were discussed explicitly. Experts interacted with progressive farmers associated with cultivation of mango, guava, litchi and other fruits. Farmers expressed their concerns for low prices of Dashehari besides the onslaught of insects, pests and diseases of guava, mango, etc. Expert scientists also told methods to the farmers for increasing farm income through e-marketing. After thorough discussion, the committee offered the following recommendations:

Recommendations

- The Chairman of QRT, Dr. K.L. Chadha vehemently exhorted the farmers to use quality planting materials and some of the new promising varieties of fruits available at ICAR-CISH, Lucknow nursery.
- The farmers were advised to go for processing and pulp making of mango.
- The farmers were also counselled to adopt the HDP, drip irrigation and fertigation in fruit crops for higher productivity.
- The pre-cooling was also suggested to farmers for increasing the shelf-life of mango.
- The farmers must be made aware about the profitable marketing of produce through e-marketing.
- The QRT suggested that instead of individual experiment for each pest, integrated pest management experiment should be formulated by considering the major pests and diseases of the crop.
- Reconsideration for including 3 new varieties under MLT can be assured only if the centre provides sufficient data related to the performance of the said varieties.
- The centre must have a well designed AICRP program clearly differentiated from the institute's projects.

Research Advisory Committee (RAC)

The 23rd RAC meeting of ICAR-CISH was held during June 26-27, 2018. It was also attended by:

1.	Dr. B.S. Chundawat, Ex-Vice Chancellor, Sardarkrushinagar Dantiwada Agricultural Univer-sity, Gujarat	:	Chairman
2.	Dr. K.K. Jindal, Ex-ADG (Hort. Science) & Adjunct Professor, UGC	:	Member
3.	Dr. N.S. Pasricha, Ex-Director, Indian Potash Institute and Ex-Head, Deptt. of Soil Science, PAU, Ludhiana	:	Member
4.	Dr. C. Aswath, Ex-Head, Division of Biotechnology, ICAR-IIHR, Bengaluru	:	Member
5.	Dr. Prem Shankar Singh, Professor & Head, Deptt. of Entomology, BHU, Varanasi	:	Member
6.	Dr. W.S. Dhillon, ADG (Hort.-I), ICAR, New Delhi	:	ICAR Nominee
7.	Dr. S. Rajan, Director, ICAR-CISH, Lucknow	:	Member
8.	Dr. R.M. Khan, Chairman, PME	:	Member Secretary

Following members were not present owing to their pre-occupations

9.	Dr. Abhijit Kar, Pr. Scientist, Division of Post Harvest Technology, ICAR-IARI, New Delhi	:	Member
10.	Shri Suvrat Pathak, Mohalla Patkana Kannoj Non-Official member nominated by Hon'ble Agriculture Minister	:	Non-Official member

Following Chairman's remarks, committee members gave their observations and suggested requisite inputs during the presentations made by Heads/scientists with reference to the work carried out during the period.

Specific Recommendations of RAC

Division of Crop Improvement & Biotechnology

1. All breeding programs are required to have Marker Assisted Selection (MAS) as they improve efficiency. Mutation in guava may be tried with just regenerated explants instead of seeds. Highest priority might be given to develop micro-propagation in hybrid root-stock and micro cuttings in released varieties.
2. Lots of resources in biotechnology is going for basic studies of regulatory genes, which need to be diverted towards identifying 'trait specific' markers raise usefulness for breeders. Functional markers in skin colour are of no importance as they express during fruiting only.
3. Therapeutic values of seeds and fruits of jamun might get profiled from NRCG, Pune.
4. Data need to be compiled and action should be taken for the release of jamun varieties. If the variety under consideration for release is a collection from farmer's field, it should be released as farmer's variety following the PPV & FRA guidelines.

Division of Crop Production

5. Work is to be taken up on collection of geo-referenced grid soil samples (0-20, 20-40 cm depth) for establishing Diagnosis and Recommendation Integrated System for different nutrient expressions for computing DRIS Indices. DRIS ranges thus evolved could be divided in different zones for zone specific fertilizer management scheme and used for routine diagnostic and advisory services.
6. Component of weather vagaries is to be taken into account pertaining to canopy management.
7. Being a premier research institute on mango/guava, the programs should focus on standards of orchard establishment comprising of region/crop specific ideal plant densities, orchard soil management and kinds of crop specific root-stocks.

Division of Crop Protection

8. Mango wilt seems to be a problem of unmanaged orchards; hence a comparative data of well managed and unmanaged orchard is required to be compiled with reference to status of wilt across the country. Work on dissolution of wax coating, especially in mealy bug and termite a problem of unmanaged orchard and needs attention.
9. Work on GIS application with reference to distribution and prediction of pest and disease need to be attended instead of mobile app.

Division of Postharvest Management

10. Post harvest issues in guava need to be attended with precision. Use of nano-technology may be thought of through a collaborative programme with TNAU.

RRS, Malda

11. Malda Regional Station need to initiate work on mango based farming system, instead of spreading scarce resources thinly. Superior clone of 'Malda' variety need to be identified.
12. Farming system especially for supporting a family through homestead gardening needs to be developed especially for resource deficient tribal region.

Institute Research Committee (IRC)

The forty-first meeting of Institute Research Committee was convened during May 21 to 25 and June 8, 12 to 14, 2018. Presiding over the meeting, Director, ICAR-CISH deliberated, at length, about the current issues being faced by the farmers. The emerging problems being encountered and the efforts made by the Institute to address the problems of mandated horticultural crops. After introductory remark, Director asked the respective PIs/CoPIs of the institute projects to present the findings and made suggestions.

Significant decisions

1. Prepare electronic flip book by grouping varieties regions wise (South India, North India etc.)
2. Prepare strategic paper on carotenoid biosynthesis with special reference to mango.
3. Flowering transcriptome data should be documented.
4. Economics of hydroponics needs to be work out after standardization of technology
5. Espalier planting should be well documented.
6. Separate project on carbon sequestration for mango should be developed.
7. Work on optimization of nutrient dose, growth schedule, yield and quality of banana need more attention.
8. Sugarcane+aonla drink should be commercialized in consultation with Director, ICAR-IISR.

Institute Management Committee (IMC)

The 28th IMC meeting of ICAR-CISH was held on August 10, 2018. It was also attended by:

1.	Dr. S. Rajan, Director, ICAR-CISH, Lucknow	:	Chairman
2.	Dr. B.P. Ram, CHS, Govt. of U.P.	:	Member
3.	Dr. N. Garg, Head, Division of Post Harvest Management, ICAR-CISH, Lucknow	:	Member
4.	Dr. G. Pandey, Ic Head, Division of Crop Production, ICAR-CISH, Lucknow	:	Member
5.	Dr. P.K. Shukla, Ic Head, Division of Crop Protection, ICAR-CISH, Lucknow	:	Member (Invited)
6.	Sri A. Srivastava, F&AO, ICAR-CISH, Lucknow	:	Member (Invited)
7.	Sri R.N. Mallik, SAO, ICAR-CISH, Lucknow	:	Member Secretary

Five agenda items were discussed and approved during the meeting.

QRT meeting of AICRP-Fruits at ICAR-CISH, Lucknow

RAC meeting of ICAR-CISH at Rehmankhera, Lucknow

IRC meeting of ICAR-CISH at Rehmankhera, Lucknow

13 Participation in Seminars/Symposia/Conferences

Conferences/Congress

All the scientists of the institute participated in national conference on "Strategies & challenges in doubling farmers' income through horticultural technologies in subtropics" held at ICAR-CISH, Lucknow, June 21-22, 2018.

Bajpai, A., A.K. Bhattacharjee, A.K. Singh, B. Khilladi, Gundappa, H.C. Verma, K.K. Srivastava, N. Garg, P.K. Shukla, R.A. Ram, S.K. Shukla and S. Rajan attended international conference on "Sustainable organic agri-horti systems" held at Bhagidari Bhawan, Lucknow during November 28-30, 2018.

Bajpai, A., P.K. Shukla, S. Rajan, G.L. Veena and A. Yadav, attended international mango conference held at Regional Fruit Research Station, Vengurle (Maharashtra), May 8-10, 2018.

Barman, P. attended International conference on "Impact of climate change and abiotic stresses on agriculture and management strategies" held at institute of Science, Banaras Hindu University, Varanasi, November 17-18, 2018.

Gundappa attended international conference on "Biological control: approaches and applications" held at ICAR-NBAIR, Bengaluru, September 27-29, 2018.

Nayak, D. attended the Australian Native Bee Conference at Brisbane, Australia, July 1-2, 2018

Killadi, B. attended international conference on "Agriculture & horticulture" held at Puri, Odisha, November 26-28, 2018.

Pandey, D. and S.K. Shukla attended national conference on "Arid horticulture: enhancing productivity and economic empowerment" held at ICAR-CIAH, Bikaner, October 27-29, 2018.

Rajan, S. attended 'Adivasi kisan sammelan' at Gyanananda Sarasswati Ashram, Chenna, Bankura (WB) on February 11, 2019.

Shukla, P.K. attended international conference on "Integrated management of crop diseases: a biotechnological approach" held at TNB College, Bhagalpur and JP College, Narayanpur, September 19-21, 2018.

Shukla, P.K. attended ISMPP 39th annual conference & national symposium on "Plant and soil health management: new challenges and opportunities" held at ICAR-IIPR., Kanpur, November 16-18, 2018.

Singh, A. attended national conference on Intensification and diversification in agriculture for livelihood and rural development at DRPCAU, Pusa, Samastipur, Bihar, May 28-31, 2018.

Singh, A. attended seminar on Women in Agriculture organized by Government of Odisha in collaboration with Confederation of Indian Industry, Bhubaneswar, Odisha, January 17-19, 2019.

Srivastava, K.K. and S.K. Shukla attended Indian horticulture congress on "Shaping future of Indian horticulture" held at IGKV, Raipur, January 17-21, 2019.

Trivedi, A.K. attended international conference on "Plants and environmental pollution (ICPEP-6)" held at CSIR-NBRI, Lucknow, November 27-30, 2018.

Trivedi, A.K. attended international plant physiology congress at CSIR-NBRI, Lucknow, December 2-5, 2018.

Verma, H.C. attended international conference on "Rural livelihood improvement by enhancing farmers' income through sustainable innovative agri and allied enterprises (RLISAAE-2018)" held at BIT, Mesra, Patna, October 30– November 1, 2018.

Verma, H.C. attended international conference on "Sustainable computing SUSCOM- 2019" held at Amity University, Jaipur, February 26-28, 2019.

Seminars/Symposia

All the scientists of the institute participated in one day farmers' fair and seminar on "Empowerment of scheduled caste through agricultural technologies" held at ICAR-CISH, Lucknow, February 28, 2019.

Garg, N. attended seminar on *"Kisano ki aay doguni karne par charcha"* held at Nabi Panah, Malihabad, Lucknow, July 23, 2018.

Garg, N. attended seminar on *"Tudai uprant prabandhan evam khadya prasanskaran wishayak prashikshan"* held at SIMA, Rehmankhera, Lucknow, July 12, 2018.

Garg, N. attended seminar on *"Krishi raksha karyakram evam keet prabandhan vishayak prashikshan"* held at SIMA, Rehmankhera, Lucknow, July 19, 2018.

Garg, N. attended seminar on "Scaling up food fortification" held at Gomti Nagar, Lucknow, February 13, 2019.

Rajan, S. attended the District Level Seminar on Vegetable Seed Production at ICAR-CISH KVK, Malda (WB) on July 27, 2018.

Shukla, P.K. attended national symposium on "Recent challenges and opportunities in sustainable plant health management" held at BHU, Varanasi, February 26-28, 2019.

Shukla, P.K. attended national symposium on "Sustainable management of pests and diseases in augmenting food and national security" held at NAU, Navsari, Gujarat, 22-24 January, 2019.

Trivedi, A.K. attended international seminar on "Recent trends and experimental approaches in science technology, nature & management" held at Jodhpur, Rajasthan, December 23-24, 2018.

Workshops

Ahmad, I. and M. Muthukumar attended workshop on "Next generation sequencing: an overview" held at Biotech Park, Lucknow, March 26-29, 2019.

All the scientists of the Institute participated in one day workshop on "*Aam adharit kukkut palan*" at ICAR-CISH, Lucknow, August 09, 2018.

All the scientists of the Institute participated in one day workshop on "Waste management, value addition and air pollution" at ICAR-CISH, Lucknow, February 14, 2019.

All the scientists of the institute participated in one day workshop on "Per drop more crop" at ICAR-CISH, Lucknow, March 05, 2019.

Kumar, A. and N. Garg attended Horti-Entrepreneurship workshop on "Nursery, protected cultivation, value addition, organic farming and tissue culture" at ICAR-CISH, Lucknow, August 18, 2018.

Kumar, A. attended NHB workshop on "DPR preparation" in New Delhi, February 5-6, 2019.

Rajan, S. attended the National Workshop on 'Horti-produce transport in India-Present status and issues for reduction in post-harvest losses' at New Delhi on January 8, 2019.

Yadav, A. attended the workshop on "Review and convergence workshop of ATMA at SAMETI, Narendpur, Kolkata, W.B., September 11, 2018

Yadav, A. attended the "National workshop on Integrated farming system" organized by Dhanyaganga Krishi Vigyan Kendra, Sargachi, Murshidabad, in collaboration with RMA, ICAR-CISH RRS Malda, W.B., office of DDA (Admin.) and office of the Deputy Director Horticulture, Murshidabad, W.B., December 28-31, 2018

Nayak, D. attended National workshop on Integrated farming system in the capacity of Organizing Secretary on the occasion of *Krishi Samridhhi Mela* at RKMA, Sargachi, December 29-30, 2018

Yadav, A. attended the workshop on "Emerging issue of DAESI and STRY programme" at SAMETI, Narendpur, Kolkata, W. B., September 10-11, 2018.

Kumar, A. attended one-day workshop on "Impact assessment of farmers first project" at ICAR-CISH, R.B. Road Campus, Telibagh, Lucknow, March 25, 2019.

Kumar, A. attended workshop on "Reducing agriculture caused pollution" at ICAR-CISH, Lucknow, June 5, 2018.

Meetings

Garg, N. attended the 87th Institute management committee meeting of IIHR held at ICAR-IIHR, Bengaluru, April 21, 2018.

Garg, N. attended meeting on "India food processing and value addition programme" at IIA Bhawan, Lucknow, January 24, 2019.

Gundappa attended 'State level pest surveillance & advisory unit' meeting at Krishi Bhavan, Lucknow, December 21, 2018.

Nayak, D. attended ATMA management committee meeting at Krishi Bhavan, Malda, January 29-February 15, 2019.

Nayak, D. attended Governing body meeting at office of the District Magistrate, Malda, September 27, 2018.

Nayak, D. attended Review meeting of CISSA, Seed Hub and NICRA at ICAR-CISH Krishi Vigyan Kendra, Malda, December 21-22, 2018.

Rajan, S. attended meeting of U.P. Mango Festival 2018 at Auditorium of Commissioner, Lucknow Mandal, Lucknow on May 22, 2018.

Rajan, S. attended a meeting and presented before a panel of selection team for selection of Nodal Training Institution for CISH, Lucknow under ACABC Scheme at MANAGE, Hyderabad on July 4, 2018.

Rajan, S. attended the State Level Meet of Stakeholders at NABARD Regional Office, Gomti Nagar, Lucknow on November 15, 2018.

Rajan, S. attended meeting with Director Krishi Mandi Parishad at Gomti Nagar, Lucknow on December 3, 2018.

Yadav, A. attended the 24th Regional committee meeting of ICAR Region II held at Bhubaneswar, June 22-23, 2018.

Nayak, D. attended Annual Australia–India collaborative pollinator programme meeting in Brisbane, Australia organized by Western Sydney University, Australia, July 3, 2018.

Gundappa attended the 27th Annual group meet on "AICRP on Biological control of crop pests" held at KAU, Thrissur, May 17-18, 2018.

Gundappa attended Meeting of nodal officers of 'ICAR research data repository for knowledge management' held at NAAS complex Delhi, December 4-5, 2018.

Gundappa attended one-day national consultation meet on "Information communication technology in agriculture" at NAAS complex, New Delhi, March 6, 2019.

Gundappa attended State level review meeting on '*Gramin Krishi Mausam Sewa*' at Piccadaily Hotel Lucknow, December 20, 2018.

Rajan, S., R.A. Ram, K.K. Srivastava, P.K. Shukla, D. Kumar, Gundappa and A. Yadav attended 6th Group discussion of AICRP (fruits) at Assam Agriculture University, Jorhat, February 14-16, 2019.

Rajan, S., R.A. Ram, K.K. Srivastava, P.K. Shukla, D. Kumar and Gundappa attended quinquenial review team (QRT) meeting of AICRP Fruits on mango, guava and litchi held at ICAR-CISH, Lucknow, April 11-13, 2018.

Miscellaneous

Rajan, S. attended National Mango Festival-2018 organized by Department of Horticulture and Food Processing, Dehradun on July 16, 2018.

Rajan, S. attended the Mango Exhibition at Constitution Club, New Delhi on July 24, 2018.

Rajan, S. attended 76th CSIR Foundation Day at CSIR-NBRI, Lucknow and CSIR-CIMAP, Lucknow on September 26, 2018.

Rajan, S. attended the Global Agricultural Conclave during India International Science Festival-2018 held at Indira Gandhi Pratishthan, Gomti Nagar, Lucknow on October 5, 2018.

Rajan, S. attended meeting of Chapter of National Academy of Agricultural Sciences (NAAS), New Delhi in collaboration with ICAR-IISR, Lucknow

14 Seminars/Symposia/Workshops/Events organized

National Conference on Doubling Farmers' Income

A two-day National Conference on 'Strategies & Challenges in Doubling Farmers' Income through Horticultural Technologies in Subtropics' was jointly organized under the aegis of ICAR-Central Institute for Subtropical Horticulture, Lucknow and the Society for Development of Subtropical Horticulture, Lucknow during June 21-22, 2018. Delegates and farmers from 28 cities representing 10 states participated in the National Conference and presented their technologies developed on mango, guava, litchi, aonla, bael, strawberry, banana, citrus, grapes, jamun, forest trees, medicinal and aromatic crops, spices, vegetables and mushrooms. All aspects of horticulture crop production and protection were covered including improved cultivars, tree architecture management, post-harvest handling along with waste utilization. Dr. R.C. Srivastava, Vice Chancellor, RAU, Pusa was the chief guest, whereas Dr. W.S. Dhillon, ADG (Horti. Science) and Swami Vishwamayananda ji, Ram Krishan Ashram, Saragachi (W.B.) were the guests of honour during the program. Five eminent horticulturists of the country were conferred with SDSH fellow during the conference.

Farmer's Fair-cum-Seminar on Empowering Scheduled Castes Farmers

A farmers' fair-cum-seminar on 'Empowering scheduled castes farmers' was organized at ICAR-CISH, Rehmankhera, Lucknow on February 28, 2019. The fair was inaugurated by Mrs. Jai Devi Kaushal, Hon'ble MLA of Malihabad along with Dr. Shailendra Rajan, Director, ICAR-CISH, Rehmankhera, Lucknow. In farmers' fair, various government and non-government organizations showcased their products and technologies which were overviewed by more than 600 farmers. The farmers engaged with Farmer-First project also displayed their agricultural products such as vegetables, fruits, plants, flowers, hens, eggs, etc. The best exhibition awards in different categories were also given to farmers of both scheduled castes and general category. The agricultural techniques needed to improve the income of small and marginal scheduled caste farmers were discussed. In the seminar, lectures were given on suitable farming for marginal farmers, nutritionist, mushroom production, vermi-compost and low cost protected farming.

Workshop on poultry in mango orchard

ICAR-CISH, Lucknow organized one-day workshop on integration of rural poultry in mango orchard ecosystem on August 09, 2018. Director, ICAR-CISH, Lucknow informed that in order to enhance livelihood base of farmers, rural poultry under mango orchard. Within a year, this module has become so popular that it has spread to more than four villages in Malihabad. Due to active role played by media in spreading this technology, now this module is being adopted in other orchard ecosystems. Dr. R.B. Rai, renowned poultry expert and Ex-Director ICAR-CARI, Port Blair, A&N Islands interacted with farmers and exhorted that *Azolla* must be integrated in mango orchard as poultry feed.

Awareness programme on Scientific Bee Keeping

Two-day awareness programme on Scientific Bee Keeping was jointly organized by ICAR-CISH RRS, Malda, W.B. & AICRP Honey Bees and Pollination during August 13-14, 2018 at Malda and Sargachi, Murshidabad, respectively. The programme was inaugurated in the gracious presence of eminent scientists such as Dr. P.K. Chakraborty (ADG PP & B, ICAR, New Delhi), Dr. S. Rajan (Director, ICAR-CISH, Lucknow), Swami Viswamayananda Ji (Chairman, Dhanyaganga KVK, Sargachi) and Dr. Kumaranag (AICRP HB & P, New Delhi). Three hundred fifty bee keepers from Malda district were trained on August 13 , 2018 and 300 participants from Murshidabad district on August 14, 2018 on the latest bee keeping technologies.

Horti-Entrepreneurship Workshop

Horti-Entrepreneurship Workshop on nursery, protected cultivation, value addition, organic farming and tissue culture was organized at ICAR-CISH, Lucknow on August 18, 2018. A total of 68 participants (graduate to Ph.D.) and 7 well educated farmers representing 16 districts of 4 states (Bihar, Jammu & Kashmir, Rajasthan and Uttar Pradesh) participated in the workshop. A special session dedicated to entrepreneurship in nurseries of fruit, ornamental and vegetable crops was organized. Value addition attracts youth for establishing small scale industry or household level production of value added products. Business opportunities in processing of fruits and vegetable crops and scope of small scale pickle industry in U.P. were discussed. Protected cultivation of high value fruit and vegetable crops, entrepreneurship in organic farming and mushroom production were the important issues for discussion. With increasing demands of tissue culture banana plants, entrepreneurship in tissue culture and secondary hardening have attracted many graduates to earn money within few months. Dr. Maneesh Mishra, Principal Scientist coordinated the program as organizing secretary.

Workshop on Bio-waste management

ICAR-CISH organized a workshop on horticulture waste management which was attended by scientists of ICAR-CISH and ICAR-NBFGR, Lucknow on August 20, 2018 with an objective to brainstorm on different ways by which the horticulture produce residues from mandis, households, farmers' fields and processing factories can be converted into value-added products. Dr. Neelima Garg, Head, Division of Post Harvest Management delivered a talk on 'Horticultural waste management by microbial interventions'. She emphasized that these wastes were very rich in organic constituents like cellulose, starch, pectin, vitamins, minerals, etc. and posed serious health hazards due to high biological oxygen demand (BOD) and led to environmental pollution. On this occasion, Dr. Ram Awadh Ram, Principal Scientist also delivered a talk on 'Viable solutions to crop and municipal solid waste management in India' on this occasion.

Workshop on Nutrismart Tribal Village

ICAR-CISH-RRS, Malda organized a workshop on ''Nutrismart Tribal Village'' in collaboration with Shree Shree Gyanananda Saraswati Ashrama, Chatna, Bankura, West Bengal on October 13, 2018. The main aim of this workshop was to promote the concept of nutrismart tribal village and encourage local people to grow the improved fruit varieties of ICAR-CISH (Mango - Ambika and Arunika) and vegetable varieties of other institutes to fulfill the desired demand of resource poor villages. More than 210 farmers attended

the programme. The arrangement of the programme was made by Secretary, Dolpur Shree Gyanananda Saraswati Ashrama. Dignitaries like Mr. Subhasis Batabyal (Vice Chairperson, Bankura Zilla Parishad), Deputy Director of Agriculture (Admn.), Bankura, Project Director (ATMA), BLRDO, Chatna graced the workshop by sharing their experiences.

Workshop on Strawberry production in subtropics - challenges and strategies

ICAR-CISH, Lucknow organized a workshop on "Strawberry Production in Subtropics - Challenges and Strategies'' on October 29, 2018. A total of 16 farmers participated in this workshop. The main aim of this workshop was to promote the production of strawberry in subtropics area by mitigating the difficulties and training the local farmers for cultivation of strawberry. The programme was coordinated by Dr. Ashok Kumar, Principal Scientist.

Workshop on Waste to Wealth

A workshop on "Waste to Wealth" was organized on December 22, 2018 to educate and motivate staff member of ICAR-CISH for minimizing solid waste from households. In this activity, three lectures were delivered in which messages of minimizing food and urban waste by around 75 per cent and role of agriculture waste management in climate change were emphasized upon. Utilizing domestic solid waste for compost preparation and container gardening in terrace would also ensure chemical free vegetable availability in urban localities. Institute staff could become torch bearers in this activity by becoming role models.

Seminar on 'Per Drop More Crop' (Microirrigation)

A two-day seminar on 'Per Drop More Crop' (Microirrigation) was organized at ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, Uttar Pradesh during March 5-6, 2019 under Prime Minister Krishi Sichai Yojna.

Workshop on Horticulture Entrepreneurship

One-day workshop on Horticulture Entrepreneurship was organized under the auspices of Agriculture and Rural Development Centre (CARD), New Delhi in collaboration with ICAR-CISH, Lucknow and Horticulture and Food Processing Department, Uttar Pradesh at Udhyan Bhawan, Lucknow on March 7, 2019. The main objective of this workshop was to improve the income of the farmers by creating awareness amongst them on better market place available for their crops. Approximately, 200 farmers from different districts of Uttar Pradesh and government officials participated in this workshop.

35th Foundation Day celebration

The ICAR-CISH, Rehmankhera, Lucknow celebrated its 35th Foundation Day on June 01, 2018. Dr. K. K. Lal, Director, ICAR-NBFGR Lucknow was the chief guest of the function In his address, he exhorted the farmers to look into the possibilites of integrating fisheries with horticultural crops for enhancing their income. Appreciating the achievements of ICAR-CISH, Lucknow in the sphere of augmenting livelihood of mango growers, Dr. Lal firmly believed that, in future, both the Institutes would work in tandem to augment farmers' income. A gosthi was also organized, on this occasion, on the topic of improving the income through minimizing post harvest losses. Scientists of the Institute interacted with the farmers and resolved their problems. In scientist-farmers interaction programme, major issues of harvesting, de-sapping, ripening, packaging and transport were deliberated.

International Yoga Day

On the occasion of International Yoga Day, scientists, officers and employees of ICAR-CISH, Lucknow performed yoga at the Institute premises on June 21, 2018. Shri Dhiraj Sharma, Assistant Director (OL) led all the officers and employees in the practice with the chanting of mantra 'Om'. After that Padamasana, Vajrasan, Sukhasan and Siddhasan followed by Kapalbhati and Mandook Asana prior to Anulom Vilom pranayama were exercised by one and all present. Besides, Tadasan, Vrikshasana, Hast padasana and Ardh-chakrasan were also practiced. During the programme, Dr. Shailendra Rajan, Director delineated the significance of yoga for healthy body and mind. He summed up with a remark that yoga is a sublime method by which we could remain fit at body as well as mind levels. The programme ended with Hasyasana.

Vigilance Awareness Week

The employees of ICAR-CISH, Lucknow organized Vigilance Awareness Week from October 29, 2018 to November 03, 2018. On this occasion, oath was taken by staff of the institute on 29 October, 2018. Shri Dhirendra Kumar, Retired COA of CSIR-CIMAP delivered a lecture on vigilance on November 11, 2018.

National Unity Day Celebration

National Unity Day was celebrated on October , 2018 at ICAR-CISH, Lucknow on the occasion of birth anniversary of Ex. Home Minister, Sardar Vallabh Bhai Patel. The staff of the institute took oath on national unity and pledged that they would try their best to spread national integrity. Staff took part in national unity run inside the institute. On this occasion, contributions of Sardar Vallabh Bhai Patel was appreciated wholeheartedly by Director of the institute.

World Soil Day Celebration

ICAR-CISH, Lucknow organized World Soil Day on December 5, 2018 with the farmers of Farmer

First project. Dr. Neelima Garg, In-Charge Director, ICAR-CISH, Lucknow delivered a talk on role of microbes for improving soil health. Dr. Ram Awadh Ram, Principal Scientist deliberated on role of organic input for sustainable health of soil. Soil health cards were distributed to farmers of Mohammad Nagar Talukedari village. ICAR-CISH RRS, Malda also organized World Soil Day.

Rice Day Celebration

Rice Day was organized at Shyamdanga village of Habibpur block, Malda under Tribal Sub-Plan programme by ICAR-CISH Regional Research Station, Malda (W.B.) on October 10, 2018. The programme was organized to showcase the production potential of newly introduced short duration rice variety (Sahabhagi) grown for seed production in the field (4 acres). This short duration rice variety has tremendous potential in Habibpur block, where most of the rice fields are rainfed and upland type. Farmers were in huge crisis during this year due to long dry spell and Swarna paddy (long duration dominated variety) was affected severely. They were excited seeing the performance of Sahabhagi paddy and ready to accept the technology in the coming season. The programme was attended by more than 300 tribal farmers, majority of them were tribal women from 30 adopted tribal villages.

JAGRITI Empowerment of Rural Women

The ICAR-CISH, RRS, Malda organized a two-day (December 1-2, 2018) workshop on JAGRITI ''Empowerment of Tribal Women" with financial support from Tribal Sub Plan programme. The main objective of this workshop was to sensitize and motivate the tribal villagers to adopt new technologies for doubling their income and also empowering tribal women in different agriculture and allied sectors to improve their socio-economic status. The programme was inaugurated by Swami Viswamayananda Ji (Ramkrishan Mission Ashram, Sargachi) along with Dr. S. Rajan (Director, ICAR-CISH, Lucknow).

Bhagidari under TSP

The ICAR-CISH RRS, Malda (W.B.) inaugurated the new component 'Bhagidari' on December 21, 2018 under Tribal Sub-Plan programme as an initiative for promotion of micro-irrigation through community approaches by forming water user groups. Bhagidari has been conceptualized by observing severe water scarce situation and limited water sources at adopted tribal villages of Habibpur block, Malda. Under this component, five water user groups have been formed and memorandum has been signed between tribal water user groups and ICAR-CISH to provide sprinkler and rain gun-sprinkler facilities by using common water sources for irrigating their crop fields of 5 ha area at a time to have better yield and quality of crops.

Kisan Diwas Celebration

On the occasion of 119th Birth Anniversary of former Prime Minister Chaudhari Charan Singh, Kisan Diwas was celebrated at ICAR-CISH, Lucknow on December 23, 2018. The Director of the institute inspired the invited farmers from four villages of Malihabad block to form Self-Help Groups for their livelihood empowerment. He also highlighted the change in mind of villagers from Mohammad Nagar Talukedari towards open defecation by taking advantage of government funded cleanliness facilities (e.g. toilet). Scientists deliberated about the importance of nutri-gardens and preparation of organic manure and vermi compost at rural level for income generation. Some of the invited farmers were also honored for their meaningful contribution in farming and cleanliness drive by the Director through distribution of certificates.

Krishi Samriddhi Mela

Ramkrishna Mission Ashrama, Sargachi, Murshidabad and Dhanyaganga Krishi Vigyan Kendra, Sargachi with the help of ICAR-CISH RRS, Malda and

Agriculture Department, Govt. of West Bengal jointly organized a National Workshop on Krishi Samriddhi Mela-cum-Integrated Farming System at Ramkrishna Mission Ashrama, Sargachi during December 28-31, 2018. Dr. Ashish Banerjee, Hon'ble Minister of Agriculture, Govt. of West Bengal inaugurated the workshop as a chief guest in the presence of Dr. A.K. Singh, DDG (Agril. Extension), ICAR, New Delhi as special guest. Besides, Dr. P.K. Chakraborty, ADG (PP&B), ICAR, New Delhi, Dr. S. Rajan, Director, ICAR-CISH, Lucknow, Dr. S.S. Singh, Director, ICAR-ATARI, Kolkata and Shri Musharaf Hussain, Chairman, Murshidabad Zilla Parishad were also present during the workshop. Thousands of farmers participated in the mela and visited more than 60 stalls of various ICAR institutes, SAUs, KVKs, NGOs and Self-Help Groups. On this occasion, a number of experts from different parts of the country delivered lectures on integrated farming system and shared their experiences with farmers and other stakeholders.

National Productivity Week

The ICAR-CISH, Rehmankhera, Lucknow organized the National Productivity Week from February 12 to 18, 2019. The theme of the week was 'Circular Economy for Productivity and Sustainability'. On this occasion The Institute organized discussion, deliberation, painting and slogan competitions for technical officers, research associates, senior research fellows, etc. on the titles such as germplasm, soil pollution and its continuous degradation, waste management and impact on crop production. Lectures on various topics were also organized to create awareness among the staff members.

ICAR-CISH bid to empowers scheduled caste farmers

ICAR-CISH, Lucknow invited 30 scheduled cast farmers of Malihabad block for Scientist-farmer interaction meet on February 5, 2019. The main aim of this meeting was to discuss perking up the livelihood of the poor and landless farmers of scheduled castes community through various horticulture-based ventures. Dr. S. Rajan, Director-CISH interacted with invited farmers and told them that under the Scheduled Caste Sub Plan of the Indian Council Agricultural Research, CISH will help in upliftment of living standard of landless, living below the poverty line scheduled castes farmers through demonstration and training of advanced techniques of pig farming, vermi composting, mushroom production, nutri-garden, contract farming and on farm value addition of raw mango. The institute will also help to convert agricultural waste into pig fodder. During the meeting, the farmers agreed to set up a self-help group of scheduled castes farmers.

International Women's Day

International Women's day- 2019 was celebrated with great fanfare at the Institute on March 8, 2019. On this occasion, all staff members gathered in Institute's auditorium for live telecast of interaction of our Hon'ble Prime Minister, Shri Narendra Modi with Self Help Group (SHG) on women empowerment and wealth from waste. The live telecast of Hon'able Prime

Minister also organized at Raibareli road campus for the benefit of trainees attending Agri Clinic and Agri-business Centre. A talk on the role of women in different walks of life with an emphasis on scientific innovation and women empowerment and leadership roles were delivered by the women scientists.

Second phase of the programme was held at Mohammad Nagar village in Malihabad block. A team of scientists led by Director, ICAR-CISH interacted with rural women and scientists and delivered lecture on health and nutrition security of rural women. Rural women were also sensitized on the ways and means to generate income through processing and value addition of mango. Mango Apps were also demonstrated to develop mango products developed by ICAR-CISH.

Rajbhasha activities and Hindi Pakhwada 2018

The Institute Rajbhasha Implementation Committee of the ICAR-Central Institute for Subtropical Horticulture, Lucknow, in view of the annual target of the Rajbhasha Vibhag, Home Ministry, Government of India organized meeting of the committee in every quarter of the financial year 2018-19. Besides, Hindi workshops were also organized during each quarter of the year. Distinguished Hindi stalwarts like Dr. Vijay Narayan Tiwari, former Joint Director (Official Language), CSIR-CDRI, Lucknow, Dr. A.K. Mishra, former Project Coordinator (STF), ICAR-CISH, Lucknow, Dr. Kuldeep K. Lal, Director, ICAR-NBFGR, Lucknow, Dr. Jitendra Nath Dikshit, Hindi Laureate, etc. were invited to deliver talks on various Hindi aspects. Over and above, the Institute also organized Hindi Pakhwada from 14 September to 28 September, 2018. During Hindi Pakhwada 2018, several competitions, like Hindi Nibandh Pratiyogita, Hindi Debate, Hindi Kavya Paath, etc. were organized to proliferate Hindi amongst the officers and staff of the Institute. Apart from the above, a Kavi Sammelan was organized on September 26, 2019 wherein noted Hindi poets of Lucknow and adjoining areas enthralled the officers and staff with their satire, sarcasm, irony, poems, recitals, etc.

Keeping in view the Hindi related annual targets, quarterly reports were sent to ICAR, Regional Office of the Rajbhasha Vibhag. Besides, half yearly Hindi reports were also sent to the Town Official Language Implementation Committee II, Lucknow. To propagate science primarily agriculture science amongst farmers and orchardists, the Rajbhashaa Patrika "Udyan Rashmi 2018-19" was published. Udyan Rashmi's 2017-18 version have been adjudged the best Rajbhasha Patrika (Ganesh Shanker Vidyarthi Award) among all ICAR Institute's publications. The 2018-19 version of Udyan Rashmi has been declared the best Rajbhasha Patrika by the TOLIC, Lucknow.

Mera Gaon Mera Gaurav Initiatives

S.N.	Programme	Name of village	Date	Participants	Name of Scientists
		Field Visits			
1.	Field visit to advise management of mango orchard including thinning and pruning of insect and diseases affected branches.	Hasnapur	July, 18, 2018	20	Israr Ahmad, P. S. Gurjar, Naresh Babu, Subhash Chandra & Arvind Kumar
2.	Scientific cultivation of tomato, cauliflower, pea and gladiolus	Amethiya and Salempur	November 11, 2018	30	Naresh Babu & Arvind Kumar
3.	Demonstration on pinching technique in marigold for higher flower yield	Amethiya and Salempur	December 13, 2018	25	Naresh Babu & Subhash Chandra
4.	Management of marigold cultivation for higher flower yield	Kanar	January 01, 2019	25	Naresh Babu, Subhash Chandra & Arvind Kumar
5.	Discussion with farmers for distribution of improved breeds of goats for higher income in Malihabad area	Kanar, Mandauli, Meethenagar, Mohammad Nagar, Talukedari, Nezabari, Khalispur	March 3-10, 2019	150	Subhash Chandra, Naresh Babu & Arvind Kumar
		Trainings organized			
6.	Training on processing and value addition of mango	Vidyasthali School, Kanar	July 7, 2018	35	Neelima Garg, D.K. Shukla, Subhash Chandra, Naresh Babu & Arvind Kumar
7.	Training on preparing mango squash	Kakori Inter college	July 17, 2018	45	Neelima Garg, D.K. Shukla, Subhash Chandra, Naresh Babu & Arvind Kumar
		Gosthis/ Meeting			
8.	Scientific cultivation of high value vegetables like cucumber, green pea, onion, tomato cauliflower, cabbage and flower crops like marigold and gladiolus by scientific method	Amethiya and Salempur	November 28, 2018	30	Naresh Babu & Arvind Kumar
9.	Scientific cultivation of high value vegetables like cucumber, green pea, onion, tomato cauliflower, cabbage and flower crops like marigold and gladiolus	Amethiya and Salempur	December 13, 2018	25	Naresh Babu & Subhash Chandra
10.	Cultivation of winter vegetables for nutrition security	Kanar	January 01, 2019	25	Naresh Babu, Subhash Chandra & Arvind Kumar
11.	Insect pest and diseases and their management in mango and guava	Gulabkhera	March 4, 2019	25	Devendra Pandey, Muthukumar M. & Prananath Barman
		Awareness / Sensitization Programme			
12.	Improved horticulture technologies including intercropping in mango orchard for income enhancement	Mandauli	June 29, 2018	20	Naresh Babu, Subhash Chandra, Gopal Carpenter & Arvind Kumar
13.	Awareness programme on integrated management of thrips, hopper, leaf webber of mango orchard	Saidapur, Mall	July 6, 2018	20	Naresh Babu, Subhash Chandra, Gopal Carpenter & Arvind Kumar

14.	Awareness programme on harmful effects and eradication of *parthenium*	Dugauli, Tikaitganj and Rasoolpur	August 20, 2018	90	Neelima Garg, Dinesh Kumar & Arvind Kumar
15.	Awareness programme on harmful effects and eradication of *parthenium*: A part of observing *Parthenium* awareness week	Amethiya	August 21, 2018	15	Naresh Babu and Arvind Kumar
	Demonstrations				
16.	Demonstration of mango harvester and CFB boxes to reduce post-harvest losses of fruits	Mandauli	June 29, 2018	20	Naresh Babu, Subhash Chandra, Gopal Carpenter & Arvind Kumar
17.	Demonstration of mango harvester and CFB boxes for reducing post-harvest losses of fruits	Saidapur, Mall	July 6, 2018	20	Naresh Babu, Subhash Chandra, Gopal Carpentor & Arvind Kumar
18.	Demonstration of CFB box for packaging of mango	Haphizkhera	July 18, 2018	20	Israr Ahmad, Pawan Singh Gurjar, Naresh Babu, Subhash Chandra & Arvind Kumar
19.	On-farm demonstration of preparation of vermi-compost	Golakuan and Tikaitganj	September 22, 2018	10	R.A. Ram, Naresh Babu, Subhash Chandra and Arvind Kumar
20.	Demonstration and motivation for vermi-compost preparation	Rasoolpur	December 29, 2018	35	H.C. Verma, R.A. Ram, Abha Singh, Subhash Chandra & Arvind kumar
21.	Demonstration on eco-friendly management of mango mealy bug	Belgarha	January 10, 2019	10	G. Pandey, S.K. Shukla, Nraesh Babu, A.K. Trivedi & Subhash Chandra
	Distribution of planting material				
22.	Distribution of vegetable seeds for kitchen gardening to ensure nutritional security of rural women	Hafizkhera and Hasnapur	July 18, 2018	40	Israr Ahmad, P.S. Gurjar, Naresh Babu, Subhash Chandra & Arvind Kumar
23.	Seedlings of improved varieties of tomato (var. NS 285) and cauliflower (var. Subra) plants	Amethiya and Salempur	November 28, 2018	30	Naresh Babu & Arvind Kumar
24.	Seedlings of improved varieties of tomato (var. NS 285) and cauliflower (var. Subra) plants	Amethiya and Salempur	December 13, 2018	25	Naresh Babu & Subhash Chandra
25.	Seedlings of tomato (var. NS 285) and brinjal (var. Pusa Uttam) were distributed	Kanar	January01, 2019	25	Naresh Babu Subhash Chandra & Arvind Kumar
	Swachchha Bharat Abhiyan				
26.	Created awareness about the cleanliness at surroundings. Planted guava saplings in Angan wadi campus	Dugauli, Tikaitganj and Rasoolpur	August 20, 2018	90	Neelima Garg, Dinesh Kumar & Arvind Kumar
27.	Educated children and other residents of the village about cleanliness and sanitation.	Kithaipara	September 13, 2018	80	G. Pandey, D. Pandey, Naresh Babu, A.K. Trivedi, Subhash Chandra & Arvind Kumar
28.	Planted guava saplings in school premises and to make students aware about its importance in nutritional security.	Belgarha and Ladhausi	September 18, 2018	60	G. Pandey, Naresh Babu, A.K.Trivedi, Abha Singh Subhash Chandra & Arvind Kumar

29.	Waste collection and vermicompost preparation.	Golakuan and Tikaitgang	September 22, 2018	10	R.A. Ram Naresh Babu, Subhash Chandraa and Arvind Kumar
30.	Awareness on waste collection	Moiddipur and Saidpur	September 27, 2018	60	V.K. Singh, K.K. Srivasrava, A.K. Bhttacherjee, Naresh Babu, Subhash Chandra, Bharati Killadi & Arvind Kumar
31.	Awareness campaigns around better sanitation practices like using a toilet, hand washing, health and hygiene	Rasoolpur	September 28, 2018	50	H.C. Verma, Neelima Garg, Devendra Pandey, Dinesh Kumar, Subhash Chandra & Arvind Kumar
32.	Awareness about cleanliness among school children	Gulabkhera, Mujasa and Sanyasibagh	October 1, 2018	65	D. Pandey, Muthukumar M & Prananath Barman
33.	Awareness among farmers about cleanliness and sanitation activities like using kitchen waste water for irrigation of crops, street cleaning, drainage channels, cleaning and maintenance of ponds for irrigation of crops during lean period	Amethia Salempur, Moidinpur, Pahiazampur, Kushmora, Rahmankhera Amlauli and Kurasar	December 19 and 22, 2018	150	Naresh Babu, Subhash Chandra, K.K. Srivastava, Ashok Kumar & Arvind Kumar

Celebration of Gram Swaraj Abhiyan

S.N.	Programme	Name of village	Date	Participants	Name of Scientists
1.	Panchayati Raj Diwas	Amethia Salempur, Moidinpur and Nejabhari Khera	April 24, 2018	150	A.K. Singh, Anju Bajpai, Naresh Babu, Subhash Chandra & Tarun Adak.
2.	Gram Swaraj Diwas	Sanyasi Bagh and Kanar	April 28, 2018	25	Naresh Babu, Subhash Chandra & Arvind Kumar
3.	Kisan Kalyan Diwas	Saidpur	May 02, 2018	25	Naresh Babu, Subhash Chandra & Arvind Kumar
4.	Aajivika evam Kausal Vikas Diwas	Kakori Inter collage and Bari Garhi	May 05, 2018	90	Neelima Garg, G. Pandey, S.K. Shukla, Naresh Babu, Subhash Chandra and Arvind Kumar

15 Distinguished Visitors

1. Dr. R.R. Verma, Deputy Director Agriculture, U.P. Government, Basti (April 6, 2018).
2. Dr. Narendra Singh, Assistant Manager, HOFED, Lucknow (April 19, 2018).
3. Dr. E. Venkata Rao, Project Manager (AC & ABC), MANAGE, Hyderabad (April 20, 2018).
4. Dr. Sameer Sawant, Principal Scientist and Task Force member, NBRI, Lucknow (May 11, 2018).
5. Dr. V.N. Tiwari, Ex-Joint Director (OL), CSIR-CDRI, Lucknow (May 16, 2018).
6. Shri T.K. Shibu, IAS, Special Secretary, Rural Development, U.P. Government, Lucknow (May 19, 2018).
7. Dr. R.C. Srivastava, Vice-Chancellor, DRPCAU, Pusa, Samastipur, Bihar (June 21-22, 2018).
8. Dr. W.S. Dhillon ADG (HS-II), KAB-II, Pusa, New Delhi (June 21-22 and June 26-27, 2018).
9. Dr. M.R. Dinesh, Director, ICAR-IIHR, Bengaluru (June 21-22, 2018).
10. Dr. Vishal Nath, Director, ICAR-NRC on Litchi, Mushahri, Muzaffarpur, Bihar (June 21-22, 2018).
11. Dr. Indu Sawant, Principal Scientist, NRC Grapes, Pune, Maharashtra (June 21-22, 2018).
12. Dr. Mathura Rai, Ex-Director, ICAR-IIVR, Varanasi (June 21-22, July 25 and August 18, 2018).
13. Dr. Bengali Baboo, Ex-National Director, ICAR-NAIP, New Delhi (June 21-22, 2018).
14. Dr. D.K. Singh, Prof. & Head, GBPUA&T, Pantnagar (June 21-22, 2018).
15. Dr. U.W. Ambekar, Ex-Director, Agriculture, U.P. Government (June 21-22, 2018).
16. Dr. B.S. Chundawat, Ex-Vice-Chancellor, Navasari Agriculture University, Navsari, Gujarat (June 26-27, 2018).
17. Dr. K.K. Jindal, Ex-ADG (Hort. Science), ICAR, New Delhi (June 26-27, 2018).
18. Dr. C. Aswath, Ex-Head, Division of Biotechnology, ICAR-IIHR, Bengaluru (June 26-27, 2018).
19. Dr. N.S. Pasricha, Ex-Director, Indian Potash Institute and Former Head, Dept. of Soil Science, PAU, Ludhiana (June 26-27, 2018).
20. Dr. Prem Shankar Singh, Professor & Head, Dept. of Entomology, BHU, Varanasi (June 26-27, 2018).
21. Shri Rajan Agarwal, Director (DARE), ICAR, New Delhi (June 29, 2018).
22. Dr. Bhupindra Singh, Horticulture Divisional Officer, Nalagarh, Solan (July 2, 2018).
23. Shri Satish Kumar Singh, Manager Export cell, UP Mandi Parishad, Kisan Mandi Bhawan, Lucknow (July 6, 2018).
24. Shri Jaswant Singh, Member of Legislative Council (MLC, Aligarh-Hathras), Lucknow (July 10, 2018).
25. Dr. Pranab Chattopadhyay, Former Professor, BCKV, Bardhaman, West Bengal (July 10, 2018).
26. Shri Prem Prakash Maurya, Under Secretary, DARE, Krishi Bhawan, New Delhi (July 11, 2018).
27. Shri Atul Kumar Mishra, IFS, Additional Secretary, Horticulture and Food Processing, Government of M.P. (July 13, 2018).
28. Dr. Kuldeep Singh, Director, ICAR-NBPGR, New Delhi (July 13, 2018).
29. Dr. Jai C. Rana, National Coordinator, UNEP, GEF, Biodiversity International, NASC, New Delhi (July 13, 2018).
30. Dr. R.K. Pal (Ex-Director, NRCP Solapur) (July 20 & December 1, 2018).
31. Mr. Kaushik Bhattacharya, IAS, District Magistrate, Malda (July 20, 2018).
32. Mr. Pradeep Kumar Pattanaik, Regional Manager, National Seed Corporation (July 26, 2018).
33. Dr. A.K. Singh, Head, KVK, Dhaura, Unnao, U.P. (July 26, 2018).
34. Swami Viswamayananda Ji, Secretary, Ramakrishna Mission Ashrama, Sargachi (July 28, 2018).
35. Dr. Bhim Singh, Additional Chief Project Coordinator, Lupin Foundation, Lupin Human Welfare & Research Foundation, Bharatpur, Rajasthan (July 30, 2018).
36. Shri Rajeshwar Pratap Singh, Deputy RMO, Mathura, Uttar Pradesh (August 4, 2018).
37. Shri Kumar Pal Mehta, ICFRES, Ministry of Environment, Forest and Climate Change, New Delhi (August 8, 2018).
38. Dr. R.B. Rai, Ex-Director, CARI, Port Blair, Andaman Nicobar (August 9 and September 24, 2018).

39. Mr. Sekhar Varshney, Regristration and Regulatory Affairs, Syngenta India Ltd. (August 12, 2018).
40. Dr. P.K. Chakrabarty, Assistant Director General-Plant Protection & Biosafety, ICAR, New Delhi (August 12 & 14, 2018).
41. Prof. Harish Sharma, Professor, Dr. Y.S.P.U.H. & F, Nauni, Solan, Himachal Pradesh (August 13, 2018).
42. Dr. R.S. Singh, Dy. Director, SIMA, Rehmankhera, Lucknow (August 23, 2018).
43. Shri Surender Singh, Deputy Director, NHB, Lucknow (August 27 and October 10, 2018).
44. Dr. B.N. Srivastava, Deputy Director General, (Hort.), CPWD, New Delhi (September 5, 2018).
45. Dr. A.K. Mishra, Ex-Project Coordinator AICRP (STF), ICAR-CISH, Lucknow (September 14, 2018).
46. Dr. K.K. Lal, Director, ICAR-NBFGR, Lucknow (September 29, 2018).
47. Miss V.K.A.S.M. Wanasinghe, CESS Collection Office, Sugarcane Research Institute, Battara-mulla, Srilanka, (October 5, 2018).
48. Dr. Dinesh Badiyal, Dean, CCSKV, Palampur, Himachal Pradesh (October 15, 2018).
49. Shri Pratap Singh Chundawat, DIG, SSB, Lucknow, Uttar Pradesh (October 20, 2018).
50. Shri Dhirendra Kumar, Retd. Administrative Controller, CSIR-CIMAP, Lucknow (November 1, 2018).
51. Dr. Sant Lal, Head, Horticulture, GBPUA&T, Pantnagar (November 16, 2018).
52. Dr. Robert Spooner Hart, Professor Western Sydney University, Australia (December 11, 2018).
53. Dr. S.S. Singh, Director, ICAR-ATARI, Kolkata (December 21, 2018).
54. Shri Jitendra Nath Pandey, Prakhayat Sahityakar, Lucknow (December 22, 2018).
55. Shri Souhei Wada, Director, Vadalogistic, Japan (December 22, 2018).
56. Dr. Ravi Parkash, Registrar, PPV&FRA, New Delhi (December 26, 2018).
57. Shri V.K. Awasthi, D.R.P., NRLM, Lucknow (December 26, 2018).
58. Dr. Manoj Kumar, Joint Director, ICAR-CPRI, Modipuram, Meerut (January 15, 2019).
59. Shri Shigeo Sasaki, Deputy General Manager, Mizuho Information & Research Institute, Tokyo, Japan (January 29, 2019).
60. Shri Hiroki Nanba, Chief, Nouentai Co. Ltd., Japan (January 29, 2019).
61. Shiho Sabaguchi, Osaka, Japan (January 29, 2019).
62. Dr. Raj Kumar Thakur, Joint Director (Communication), Dr. YS Parmar University of Horticulture and Forestry, Solan Himachal Pradesh (January 31, 2019).
63. Dr. K.K. Kumar, Ex. Director, ICAR-NRCL, Mushahri, Muzaffarpur, Bihar (February 2, 2019).
64. Dr. M.R. Srinivasan, Professor, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (Febraury 3, 2019).
65. Dr. C.R. Satapathy, Former Professor Entomology, OUAT, Bhubaneswar (Febraury 5, 2019).
66. Dr. J.P. Tiwari, Ex. Dean, GBPUA&T, Pantnagar (February 20, 2019).
67. Mrs. Jai Devi Kaushal, Hon'ble MLA of Malihabad visited the Institute on February 28, 2019.
68. Shri Kaushal kishore, Hon'ble member of Parliament visited the Institute on March 5, 2019.
69. Dr. Vijay Shankar Pandey, Manager (Production), National Seeds Corporation Limited, New Delhi (March 7, 2019).
70. Dr. Brijendra Shukla, Head, Dept. of Biotechnology, Bhundelkhand University, Jhansi (March 12, 2019).

16 Personnel

Scientific

S. No.	Name of the officer	Degree	Designation
1.	Shailendra Rajan	Ph.D.	Director
Division of Crop Improvement and Biotechnology			
2.	Devendra Pandey	Ph.D.	Principal Scientist (Horticulture) & I/c Head
3.	Anand Kumar Singh	Ph.D.	Principal Scientist (Horticulture)
4.	Maneesh Mishra	Ph.D.	Principal Scientist (Horticulture)
5.	Anju Bajpai	Ph.D.	Principal Scientist (Genetics & Cytogenetics)
6.	Harish Chandra Verma	MCA	Scientist (SG) (Computer Application)
7.	Muthukumar M.	Ph.D.	Senior Scientist (Biotechnology)
8.	Israr Ahmad	Ph.D.	Scientist (SS) (Biotechnology)
9.	Umesh Hudedamani	Ph.D.	Scientist (Plant Breeding)
10.	Veena G.L.	Ph.D.	Scientist (Fruit Science)
11.	Antara Das	M.Sc.	Scientist (Biotechnology) (On study Leave)
12.	Swosti Suvardarsini Das	M.Sc.	Scientist (Fruit Science) (On study Leave)
Division of Crop Production			
13.	Ghanshyam Pandey	Ph.D.	Principal Scientist & I/C Head
14.	Vinod Kumar Singh	Ph.D.	Principal Scientist (Plant Physiology)
15.	Ram Awadh Ram	Ph.D.	Principal Scientist (Horticulture)
16.	Sushil Kumar Shukla	Ph.D.	Principal Scientist (Horticulture)
17.	Dinesh Kumar	Ph.D.	Principal Scientist (Horticulture - Fruit Science)
18.	Naresh Babu	Ph.D.	Principal Scientist (Horticulture)
19.	Kanchan Kumar Srivastava	Ph.D.	Principal Scientist (Horticulture- Fruit Science)
20.	Shyam Raj Singh	Ph.D.	Principal Scientist (Horticulture- Veg. Science)
21.	Ajaya Kumar Trivedi	Ph.D.	Principal Scientist (Plant Physiology)
22.	Ashok Kumar	Ph.D.	Principal Scientist (Environmental Science)
23.	Subhash Chandra	Ph.D.	Scientist (SG) (Agril. Extension)
24.	Tarun Adak	Ph.D.	Scientist (SS) (Soil Phy./Soil & Water Conservation)
25.	Prananath Barman	Ph.D.	Scientist (SS) (Horticulture-Fruit Science)
26.	Govind Kumar	Ph.D.	Scientist (Agricultural Microbiology) w.e.f. 06.10.2018
27.	Raj Kumar	Ph.D.	Scientist (SS) (Fruit Science) w.e.f. 01.03.2019
Division of Crop Protection			
28.	Rashid Masood Khan	Ph.D.	Principal Scientist (Nematology) & I/C Head (Retd. w.e.f. 30.06.2018)
29.	Prabhat Kumar Shukla	Ph.D.	Principal Scientist (Plant Pathology) & I/C Head (w.e.f. 01.07.2018)
30.	Gundappa	Ph.D.	Scientist (SS) (Agril. Entomology)
31.	Nidhi Kumari	Ph.D.	Scientist (Plant Pathology) (w.e.f. 09.10.2018)
Division of Post Harvest Management			
32.	Neelima Garg	Ph.D.	Principal Scientist and Head

33.	Anup Kumar Bhattacharjee	Ph.D.	Principal Scientist (Agril. Chemistry)
34.	Abha Singh	Ph.D	Principal Scientist (Food & Nutrition)
35.	Anil Kumar Verma	M.Tech.	Scientist (SG) (FM&P)
36.	Bharati Killadi	Ph.D.	Senior Scientist (Hort-Veg. Science)
37.	Pawan Singh Gurjar	Ph.D.	Scientist (SS) (Fruit Science)
38.	Jotirmayee Lenka	M.Sc.	Scientist (Fruit Science) (On study Leave)
39.	Gopal Carpenter	M.Tech.	Scientist (Farm Machinery & Power)
		R.R.S. Malda	
40.	Dipak Nayak	Ph.D.	Scientist SS (Fruit Science) & In-charge
41	Ashok Yadav	Ph.D.	Scientist (Fruit Science)

Technical

S. No.	Name of the officer	Degree	Designation
1.	Sudhir Kumar Singh Raghav	Ph.D.	CTO (FT) T-9
2.	Santosh Kumar	M.Sc (Ag.)	CTO (FT) T-9
3.	Raghubir Singh	Ph.D.	CTO (FT) T-9 (Retd. w.e.f. 30.04.2018)
4.	Sanjay Kumar	M.Sc.	CTO (LT) T-9
5.	Abhay Dixit	M.Sc.	CTO (LT) T-9
6.	Vinod Kumar Singh	Ph.D.	CTO(LT) T-9
7.	Rekha Chaurasia	M.Sc.	ACTO (LT) T-7-8 (Retd. . w.e.f. 28.02.2019)
8.	Anil Kumar Singh	M.Sc.	ACTO (LT) T-7-8
9.	Dharmendra Kumar Shukla	M. Tech.	ACTO (LT) T-7-8
10.	Bahadur Singh	Dip. (Refrig. & AC)	ACTO (WS) T-7-8
11.	Chandra Bhal	B.Sc.	ACTO (LT) T-7-8 (Retd. w.e.f. 30.04.2018)
12.	Om Prakash	Ph.D.	STO (LT) T-6
13.	Ramendra Tewari	B.Tech.	STO (WS) T-6 (Retd. w.e.f. 31.01.2019)
14.	Arvind Kumar	M.Sc. (Ag.)	STO (LT) T-6
15.	Priti Sharma	M.Sc., M. Phil.	STO (LT) T-6
16.	Brajendra Kumar Pushkar	M.Sc.(Hort.)	STO (FT) T-6
17.	Ganga Saran	M.A.	TO (LT) T-6 (Retd. w.e.f. 31.10.2018)
18.	R.K. Mishra	High School	TO (Arts) T-5

Administrative

S. No.	Name of the officer	Degree	Designation
1.	Rabindra Nath Mallik	B.Sc.	Senior Administrative Officer
2.	Dhiraj Sharma	M.A. (English)	Assistant Director (Official Language)
3.	Ashish Srivastava	B.Sc., L.L.B.	Finance & Accounts Officer
4.	Satya Deo Prasad Dixit	M.A.	Assistant Administrative Officer
5.	Gyani Prasad Mishra	Intermediate	Private Secretary

17 Meteorological Parameters

Month	Temperature (°C)		Humidity (%)		Bright Sunshine (h/day)	Wind speed (km/h)	Wind Direction (code)	Rainfall (mm)	Evaporation in 24 hour (mm)
	Max	Min	Max	Min					
April 2018	36.2	18.1	90.9	44.4	8.0	3.5	24.1	0.0	10.0
May 2018	38.5	22.7	91.2	42.1	7.5	3.9	25.1	4.0	11.5
June 2018	38.7	25.8	92.2	49.2	7.9	4.0	24.2	73.2	8.3
July 2018	33.4	25.5	94.4	73.5	4.3	3.7	21.9	324.4	8.6
August 2018	32.1	25.0	94.0	72.1	2.8	3.7	21.2	492.9	9.1
September 2018	32.5	23.6	90.5	70.5	5.6	3.0	23.5	241.6	6.9
October 2018	33.2	16.7	91.7	62.7	8.1	1.2	24.0	0.0	6.7
November 2018	28.3	9.8	89.4	70.3	6.6	1.1	20.8	0.0	6.5
December 2018	23.3	3.7	86.0	63.6	6.0	0.9	19.5	0.0	4.9
January 2019	22.3	4.6	87.5	66.3	5.1	1.7	21.3	0.0	3.9
February 2019	24.2	8.5	91.0	65.3	5.6	2.2	22.9	20.0	4.3
March 2019	30.2	11.1	92.9	49.7	8.0	2.4	22.4	0.0	6.1

Meteorological data recorded during the year 2018-19 at the Institute's observatory indicated the highest and lowest mean monthly maximum temperature of 38.7 °C and 22.3 °C which were recorded during the months of June and January, respectively. Similarly, the highest and lowest mean monthly minimum temperatures were recorded 25.8 °C and 3.7 °C during the months of June and December, respectively.

Maximum and minimum relative humidity varied between 86 to 94.4 per cent and 42.1 to 73.5 per cent, respectively. Average wind speed of 0.87 to 4.0 km/h and average bright sunshine hours of 2.8 to 8.0 h were also recorded. A range of 3.9 to 11.5 mm evaporation recorded in January and May months, respectively. Total rainfall of 1156.1 mm was received during 2018-19. The rainfall was restricted from June to September with highest precipitation of 492.9 mm recorded in the August month.

Based on weather data, agro-advisories were issued to the growers for effective orchard management during the season on weekly basis both in Hindi and English.

भाकृअनुप
ICAR

ICAR-Central Institute for Subtropical Horticulture

Rehmankhera, P.O. Kakori, Lucknow - 226 101

Tel : (0522) 2841022-24, 2841026, Fax : (0522) 2841025

E-mail : director@cish.res.in, Kisan Call Centre : 9415751200

Phone-in-live : 0522-2841082, Website : www.cishlko.res.in

केन्द्रीय उपोष्ण बागवानी संस्थान
CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE

ISO : 9001-2015