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वार्षिक प्रतिवेदन
Annual Report
2022

भाकृअनुप–केन्द्रीय उपोष्ण बागवानी संस्थान
रहमानखेड़ा, लखनऊ

ICAR-Central Institute for Subtropical Horticulture
Rehmankhera, Lucknow

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

वार्षिक प्रतिवेदन
Annual Report
2022

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ICAR-Central Institute for Subtropical Horticulture

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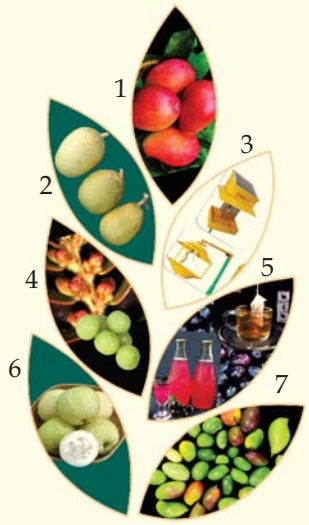

July, 2023

Preface

The fruit production in the subtropics especially in the Northern Plains of India has witnessed a sharp growth in the past. The region is known for its dominance of fruits like mango, guava, jamun and aonla. Uttar Pradesh alone accounts for 23.58% of the total mango production of the country. The integrated efforts of the farmers, state missionary and the scientists of ICAR- Central Institute for Subtropical Horticulture (ICAR-CISH) has been the cause for the substantial increase in the mango production and productivity in the subtropics covering the states of Uttarakhand, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and North Eastern Region. ICAR-CISH has played a lead role in acting as one of the custodians of mango research in the country. The institute holds the pride of serving as the world's largest *in-situ* mango germplasm collections, numbering to 775 and more than 3000 hybrids under evaluation. With the global fruit production in subtropics being challenged by constraints of climate change, outbreak of new species of pests and diseases, nutritional security, we are proud to share our achievements in this annual report of ICAR-CISH which provides insight on the research accomplishments that are addressing the above constraints in a holistic manner. During the past five decades, the institute has identified more than 10 promising cultivars in mandated crops like mango, guava, bael and aonla and more than 22 technologies addressing the production, protection and post-harvest aspects.

During this period the institute has carried out 63 research projects on various aspects of fruit improvement, production, protection, and post harvest under various flagship/externally funded and Institute based projects. Seventy eight mango hybrids were screened for yield and quality among which, 11 promising hybrids were identified and were profiled for nutraceuticals viz., mangiferin, lupeol and β-carotene content. Around 176 genotypes were genotyped and total of 945210 SNV were identified using Alphonso as reference genome. Mango cv. Mallika exhibited moderate tolerance to *Colletotrichum gloeosporioides* and was used for identification of potent antagonistic endophyte. In guava, six accessions were collected from Badaun and four from Farrukhabad based on quality attributes. A total of 62 hybrid progenies of L x PG mapping population was genotyped using the 28 discriminatory markers for identification of QTLs/major genes. In bael, seedling genotype S-31 were found to be promising having optimum yield, fruit traits and phenol content. The scientist team of the institute was successful in designing a indigenous bioreactor and standardized the cost effective protocol for micropropagation of banana tissue culture plantlets.

Rejuvenation and canopy management in old mango orchards with heading back of two branches/year to complete the process in three years gave the best tree shape and fruit yield of 24.68 kg/tree/year in the 3rd year of pruning. Studies conducted in jelly seed management showed positive control with the use of polyamine (2µM) as foliar spray along with the bagging of the fruits at pea stage in cv. Dashehari. Systematic trials on the natural farming depicts an average yield of 62-80 kg/tree in Dashehari suggesting the validation for more number of years to predict conclusive results.

The population dynamics of the hoppers and thrips were standardized with the period of intensive invasion for formulating effective timely control measures. Use of CISH-Glue traps, solar operated light traps developed by the institute showed significant decrease in the pest dynamics of the mango. Methyl eugenol embedded CISH-glue trap attracted more male fruit flies during the 4th to 23rd SMW. Under molecular diagnostics *Lasiodiplodia* specific primers targeting RPB2 gene and

Ceratocystis fimbriata specific primers was done using RT- PCR was developed. Fruit microbiome isolations resulted in identification of six antagonists for the *Colletrotrichum gloeosporides* and *Lasiodiplodia.* Institute also devised new tools devices and methodologies for pest management *viz*., CISH- blower trap, self perpetuating field parasite cage for effective management of mango pests.

CISH-fruit ripener was developed by using the ethrel (39%) and NaOH (1N) for enabling uniform ripening of mangoes. Economic analysis on mango production in the region revealed that Rs. 16.70 per kg is being incurred in the production of 1 kg of Dashehari mango in Uttar Pradesh and with the proper adoption of Good Agricultural Practices developed by the institute, the key challenges faced by the producers include fluctuating insect pest dynamics, huge post-harvest losses are minimized.

There is a need for the adoption of crop insurance policy for enabling the farmers to meet the challenges of climate change. The Regional Research Station of Malda has significantly contributed in the collection of mango germplasm, establishment of clean planting material production nursery and empowerment of more than 7000 tribal women through establishment of FPO like *Jagriti* and *Agrani*. State of art of honey and fruit processing for enabling tribal women to entrepreneurship has been developed at the centre. The institute is significantly contributing in the production of more than 2.5 lakh clean planting materials of mango, guava, aonla, bael, jamun, banana and papaya for the farmers and nurserymen of the country.

Institute also carried out skill up-gradation of primary stakeholders that includes farmers/ orchardists, state government officials, line departments of various states through trainings, demonstrations, field visits, exposure visits, meetings, goshthis, awareness programmes, showcasing technologies in exhibitions etc. CISH-ABI through technology mentoring sessions, entrepreneur incubation meet, inter-institutional meetings, participation of start-ups in national programmes has created 15 startups during this period. ITMU facilitated registration of 8 farmer's varieties in PPVFRA, 12 MoUs signed, one copyright and two patents have been received.

Due acknowledgments and congratulations for all the scientists, technical, supporting and administrative staffs of the institute for bringing out such significant research accomplishments for the promotion of production of subtropical fruits in the region.

I sincerely, thank our Honorable' Director General, Dr. Himanshu Pathak for providing us support and guidance to implement the various research and development programs of the institute. I place my gratitude to our Deputy Director General, Dr. A. K. Singh for supporting us in all programs of the institute. I thank our Asst. Directors General, Dr. V. B. Patel and Dr. Sudhakar Pandey along with scientific SMD staffs at Horticulture Division for their support to the institute.

Place: Lucknow
Date : July, 2023

(T. Damodaran)
Director

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कार्यकारी सारांश / Executive Summary

प्रतिवेदन की अवधि में संस्थान में 29 संस्थान–पोषित एवं 34 वाह्यवित्त–पोषित अनुसंधान परियोजनाएं संचालित की गई। वर्ष 2022 में आम की 7 प्रजातियों/संकरों का संकलन कर उन्हें प्रक्षेत्र जीन बैंक में संरक्षित किया गया। फलों के न्यूट्रास्यूटिकल (मैंजीफेरीन, ल्यूपियाल एवं बीटा कैरोटिन) विश्लेषण के आधार पर 'हाइब्रिड एच–1042' को आम के आशाजनक संकर के रुप में चिन्हित किया गया। इसी प्रकार आम के 78 संकरों में कुल फिनोल्स, फ्लैवानायड्स, एण्टी–आक्सीडेण्ट्स एवं कैरोटिनायड्स का मात्रात्मक विश्लेषण किया गया। आम के अवग्लूकोज रक्तकारक (हाइपोग्लाइसिमिक) संकरों को चिन्हित करने हेतु 38 संकरों में शर्करा का विश्लेषण किया गया। 226 प्रविष्टियों एवं 258 संकरों के मूल्यांकन के आधार पर फल रूपात्मक एवं जैव–रासायनिक गुणों में प्रचुर विविधता देखी गई। अधिकांश प्रविष्टियों एवं संकरों में गूदे की मात्रा 60–70 प्रतिशत थी। आम के 33 संकरों में औसत फल वजन 400 ग्राम से अधिक था जो अधिक फल वजन वाले संकरों के चयन की संभावना दर्शाता है। विभिन्न क्रास संयोजनों का प्रयोग कर 487 संकर फलों का विकास किया गया जिसमें से 284 में अंकुरण हुआ।

अल्फांसो को संदर्भ जीनोम के रूप में प्रयोग कर आम की 176 प्रजातियों में कुल 945210 एसएनपी मार्कर्स चिन्हित किए गए। फलों के रूपात्मक लक्षणों के दृश्य प्ररूपण के आधार पर फल भार (230.31) एवं गूदा भार (181.03) में प्रचुर आनुवांशिक विविधता देखी गई। आम की प्रजाति 'मल्लिका' कोलिटोट्राइकम ग्लूस्पोरायड्स के प्रति मध्यम सहिष्णु थी जिसका प्रयोग अन्तः पादपी परजीवियों के पृथक्करण हेतु किया गया। कुछ ऐसे प्रभावी सूक्ष्मजीवी चिन्हित किए गए जिनमें तुड़ाई–उपरांत एंथ्रेक्नोज प्रतिरोधी एवं एसीसी डीएमिनेज क्रियाशीलता के गुण विद्यमान थे। एकान्तर एवं नियमित फल देने वाली प्रजातियों के पुष्पीय एवं वानस्पतिक उतको का मेटाबोलिक विश्लेषण किया गया। एचपीएलसी विश्लेषण के आधार पर वानस्पतिक एवं पुष्पीय प्रतिदर्शों में फीनोलीक पदार्थों जैसे गैलिक एसिड, क्लोरोजेनिक एसिड, कैफिक एसिड, फेरूलिक एसिड एवं क्वरसीटीन

During the report period, 29 in house and 34 externally funded projects were executed in the institute. In the year 2022, seven mango varieties/hybrids have been collected and planted in the field gene bank for further evaluation. The present holding is 775 mango accessions in the field gene bank. Profiling of major nutraceuticals viz., Mangiferin, lupeol and β carotene content of 11 promising mango hybrids was assessed and H-1042 was found to be the best. Further, 78 mango hybrids was analysed for total phenols, flavonoids, antioxidants and carotenoids content. Efforts were made to identify hypoglycemic (low sugar) mango hybrids, sugar profiling of 38 mango hybrids was carried out. Evaluation data of 226 accessions and 258 hybrids indicated the wide variability in various fruit morphological and biochemical parameters with majority of accessions containing 60-70 percent pulp. Among hybrids, 33 had fruit weight >400 g indicating possible selection of hybrids with higher fruit weight.New hybrids of 17 different cross combinations, utilizing 46305 flowers on 9220 panicles were crossed yielding 487 mango hybrids fruits of which 284 germinated.

Around 176 genotypes were genotyped using GBS technology and total of 945210 SNV were identified using Alphonso as reference genome. Phenotyping for component traits (fruit) was done and high estimate of genetic advance was recorded for fruit weight(230.31) and pulp weight (181.03). Mango cv. Mallika exhibited moderate tolerance to *Colletotrichum gloeosporioides* and was used to exploit isolation of endophytes though peel metagenome and culturing techniques. Certain potent microbes harboring post harvest anthracnose antagonism and ACC deaminase activity were identified that needs to be validated. Metabolomic insights in floral and vegetative SAM in alternate and regular bearing varieties was done and HPLC analysis showed variation for phenolic compounds namely gallic acid, chlorogenic acid, caffeic acid, p-coumaric acid, ferulic acid, quercetin and

आदि में प्रचुर विविधता देखी गयी। आम की दशहरी एवं लंगड़ा प्रजातियों में नैनो–फारमुलेशन्स के प्रयोग द्वारा अनुपचारित वृक्षों की तुलना में एक पखवाड़े पूर्व ही पुष्पीय परिवर्तन देखा गया और साथ ही, पुष्पगुच्छ लक्षण जैसे–पुष्पगुच्छ आकार, फूलों की संख्या आदि भी बेहतर पायें गये हैं। तदोपरांत आम के सामान्य गूदे की तुलना में जैली सीड प्रभावित गूदे मे कैलशियम अभिगमन एवम संकेतन सम्बंधी जीन एक्सप्रेशन कम था।

उत्तर प्रदेश के बदायूँ एवं फरुखाबाद जिलों में सर्वेक्षण कर अमरुद की 10 प्रविष्टियाँ संकलित की गयी। अमरूद के 181 संकरों में फलों के रूपात्मक लक्षणों जैसे फल वजन, बीज दृढ़ता एवं कुल घुलनशील पदार्थ आदि के लिए प्रचुर विविधता पायी गई। अधिक फल वजन, कुल घुलनशील ठोस प्रदार्थ, फलों की अच्छी वाह्यकृति एवं स्वाद के आधार पर दो आशाजनक संकरण को चिन्हित किया गया। अमरूद की की 19 प्रजातियों एवं 8 जातियों में 40 नये एसएसआर चिन्हक विकसित एवम् पुष्ट किये गये। ललित एवं पर्पल ग्वावा के संयोजन से विकसित 62 संकर संततियों का 28 विभेदात्मक चिन्हको के प्रयोग द्वारा जोनोटाइपिंग की गयी। फलों एवं जड़ों में एक्सप्रेशन पैटर्न के आधार पर एमवाईबी जीन्स को गूदे के रंग एवं फलों व जड़ों के विकास से संबंधित पाया गया।

उत्तर प्रदेश के गोण्डा एवं बहराइच जिलों में सर्वेक्षण कर बेल की 10 प्रविष्टियां एकत्र की गयीं। फल गुणों के आधार पर एक प्रविष्ट (टी–10) आशाजनक पायी गयी। 22 प्रविष्टियों एवं 38 बीजू वृक्षों के एक प्रविष्ट (टी–37) एवं एक बीजू वृक्ष (एस–31) आशाजनक पाये गये। ट्रान्सक्रिप्टोम संसाधनों का प्रयोग कर 11 एस एस आर चिन्हकों का विकास कर उन्हें बेल की 8 प्रविष्टियों में पुष्ट किया।

मध्य प्रदेश में सर्वेक्षण कर आँवला की 24 प्रविष्टियाँ संकलित की गयीं। प्रक्षेत्र जीन बैंक में संरक्षित प्रविष्टियों के मूल्यांकन के आधार पर आँवला की सीआईएसएच–ए–10 प्रविष्टि आशाजनक पायी गयी। उत्तर प्रदेश के विभिन्न जिलों का सर्वेक्षण कर जामुन

kaempferol with specific retention times in the vegetative and floral bud samples. Manipulation of flowering using nanoformulation in mango cvs Dashehari and Langra was successful which displayed early floral transition atleast a fortnight prior to control and with better panicle characteristics including panicle size, number of flowers, and long anthesis period. Biochemical and gene expression in mango reveal that Ca^{2+} transporting and signalling genes expression was low in pulp affected with jelly compared to non-jelly affected pulp.

Under germplasm collection activity in guava, 6 guava accessions were collected and characterized using fruit quality attributes. Variations were recorded for fruit size, weight, seed hardiness and TSS in 181 guava hybrids. Two promising hybrids of Lalit and Purple guava parentage have been identified based on fruit weight, total soluble solids, fruit appearance and taste. 40 novel SSR markers were developed and validated in 19 guava germplasm and 8 *Psidium* species. 62 hybrid progenies of L × PG mapping population was genotyped using the 28 discriminatory markers for identification of QTLs/major genes. 16 morphological quantitative traits and 35 DUS descriptors were used for phenotyping of component fruit traits. MYB genes were found involved in pulp colour as well as fruit and root development, as per expression patterns seen in fruit and roots.

Survey in the parts of Gonda and Bahraich districts were done and 10 accessions were collected in Bael. One accession (T-10) was found to be promising, and grafts will be planted in coming season. Evaluation of clonally multiplied 22 accessions and 38 seedling accessions based on physico-chemical parameters was done, and T37 and seedling genotype S-31 were found to be promising having optimum yield, fruit traits and phenol content. 11 SSR markers were developed from transcriptome resources and validated in 8 Bael germplasm.

Aonla genetic resources have been augmented with 24 accessions from MP. Evaluation of 10 field germpalsm collection has also revealed superiority of CISH-A-10. Lucknow, Ayodhya and Siddharthnagar districts of Uttar Pradesh

की 23 प्रविष्टियाँ की गयीं एवं प्रारंभिक मूल्यांकन के आधार पर प्रविष्टि सिद्धार्थनगर–7 आशाजनक पायी गयी। जामुन की 2 ट्रान्सक्रिप्टोम अनुक्रमण लाइब्रेरी का प्रयोग कर एसएसआर चिन्हक विकसित किये गये। इसी प्रकार अमरूद में विकसित 10 एसएसआर चिन्हक भी जामुन में प्रयोग किये गये। स्कैनिंग इलेक्ट्रॉन माइक्रोस्कोपी के प्रयोग द्वारा जामुन–42 के फलों में क्षीण एपिकार्प एवं मिजोकार्प देखे गये जो कि अनियमित पेरेन्काईमेट्स कोशिकाओं से बने थे जबकि जामुन–37 के फलों में पेरेन्काईमा नियमित थी। संस्थान ने एक नवीन बायोरिएक्टर विकसित किया है जो कि परम्परागत इमर्जन बायोरिएक्टर की तुलना में केले के बायोइमूनाइज़्ड पौधों के सूक्ष प्रवर्धन में कहीं अधिक दक्ष है।

फल उपज एवं फल आकार के आधार पर आम के नये वृक्षों में छत्रक प्रबंधन हेतु क्रमशः टी–1 एवं टी–2 उपचार सर्वोत्तम पाये गये। आम की सघन बागवानी में फल उत्पादकता एवं गुणवत्ता बढ़ाने हेतु टपकदार सिंचाई एवं उर्वरक नियोजन हेतु प्रयोग किये गये। आम के पुनर्युवनित वृक्षों एवं पूरक फसलों के प्रदर्षन में आशाजनक परिणाम देखे गये। आम के पुराने बागों में पुनर्युवन एवं छत्रक प्रबंधन द्वारा इष्टतम् पुष्पन देखा गया एवं प्रति वृक्ष औसत उपज 6.7–24.68 कि.ग्रा. पायी गयी। प्रतिवर्ष दो शाखाओं की शीर्ष छंटाई कर पूरी प्रक्रिया तीन वर्षों में पूर्ण करने पर सबसे अच्छा वृक्ष आकार एवं फल उपज प्राप्त हुई। पुनर्युवनित एवं अनुपचारित वृक्षों की पत्तियों में प्रकाश संश्लेषण कर दर क्रमशः 7.56 एवं 14.67 µmol $CO_2/m^2/s$ दशहरी प्रजाति के पुनर्युवनित बागों में विभिन्न चारा फसलों का पूरक फसलों के रूप में मूल्यांकन किया गया। आम में सूखा तनाव में वृद्धि हेतु सैलिसिलिक एसिड (20 उड) का प्रयोग किया गया।

आम की लंगड़ा, लखनऊ सफेदा, बाम्बे ग्रीन, दशहरी, मल्लिका एवं आम्रपाली प्रजातियों की विभिन्न फिनोलॉजिकल अवस्थाओं जैसे कली विकास, पत्ती विकास, शाखा विकास, पुष्पन एवं फल विकास आदि के दौरान वृक्षों के नीचे प्रकाश उपलब्धता एवं प्रकाश संश्लेषण संबंधी लक्षणों में प्रचुर विविधता देखी गयी। बागों के पुनर्युवन के 6 वर्ष पश्चात मार्बल

were surveyed and 23 Jamun accessions were collected. Based on overall assessment, accession Siddharthnagar-7 was found promising, and was multiplied for further evaluation. Two Jamun transcriptome sequencing libraries were used for mining SSR containing contigs and marker development, besides using 10 SSR markers developed for guava in jamun. SEM of seedless fruits revealed thin epicarp and mesocarp (50 micron), made of irregular parenchyma ranging from 10-20 micron in size as compared to uniform parenchyma in J-37. Institute designed and developed novel bioreactor for enhanced efficiency of tissue culture system of G-9 banana that showed significant improvement under temporary immersion bioreactor in comparison to conventional tissue culture. TIS mediated plants registered better physiological characteristics.

Canopy architecture management in young mango plants for higher productivity recorded best results in T1 and T3, respectively in terms of fruit yield and fruit size. Drip irrigation and fertilizer scheduling for productivity and quality of HDP mango was standardized and maximum fruit growth (41.68, 39.59 and 42.14 %) was observed in mid may in cv. Amrapali under HDP. Performance of rejuvenated mango trees and filler cops has given some preliminary results. Rejuvenation and canopy management in old mango orchards exhibited optimal flowering and average fruit yield varied from 6.7 kg to 24.68 kg/tree. The treatment with heading back of two branches/ year to complete the process in three years gave the best tree shape and fruit yield. Net assimilation rate was 7.56 and 14.67 µmol $CO_2/m^2/s$ in the leaves of non-rejuvenated and rejuvenated trees respectively. Evaluation of different forage crops as fillers in rejuvenated orchard of mango cv. Dashehari has been done. Salicylic acid application @ 2.0 mM was evaluated for moisture stress tolerance in mango.

Considerable variation in light availability (direct and diffuse) beneath the tree and gas exchange parameters was recorded during different phenological stages (viz., bud development, leaf development, shoot development, inflorescence emergence, flowering, fruit development, maturity of fruit) of mango cvs. Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and

स्टेज में प्रत्यक्ष प्रकाश उपलब्धता 38–55 प्रतिशत थी। इसी प्रकार प्रकाश संश्लेषण, रंध्रवणता एवं वेपर प्रेशर डिफिसिट में भी प्रचुर विविधता देखी गयी। जीर्णोद्धार तकनीकी एवं आम की सघन बागवानी द्वारा उपज एवं फल गुणवत्ता बढ़ाने हेतु किसानों के खेतों पर भी प्रदर्शन संचालित किये गये। जैव–रासायनिक मूल्यांकन के आधार पर टी–5 उपचार को बेहतर पाया गया। आम की दशहरी प्रजाति के सामान्य फलों के गूदे की तुलना में जैली सीड प्रभावित गूदों में अल्फा अमाइलेज, सेलूलोज एवं पालीफिनाल आक्सीडेज की क्रियाशीलता अधिक थी। इसी प्रकार सामान्य गूदे में प्रति जैवकारक क्षमता जैली सीड प्रभावित गूदे की तुलना में अधिक थी। जेली सीड प्रभावित गूदों में सामान्य फलों की तुलना में कैल्शियम एवं पोटैशियम की मात्रा कम थी जो कि पेक्टिन मैट्रिक्स की विकृति के लिये उत्तरदायी हो सकते हैं। यह देखा गया कि मल्चिंग+कैल्शियम क्लोराइड डाइहाइड्रेट (2 प्रतिशत)+बैगिंग और मल्चिंग + पालीएमीन (2μM) + बैगिंग उपचारों में जेली सीड की समस्या में काफी कमी देखी गयी।

मृदा जैविक कार्बन, उपलब्ध फासफोरस, जिंक, कापर, मैंगनीज एवं लोहे के आधार पर आम के 9 बागों का मूल्यांकन किया गया। यह पाया गया कि इन बागों की कम उत्पादकता (<15.0 टन/हे.) का मुख्य कारण जैविक कार्बन एवं पोषक तत्वों की कमी हो सकती है। जिसके लिए किसानों द्वारा उन्नत प्रबंधन तरीकों का अंगीकरण आवश्यक है। आम की फल उत्पादकता के मूल्यांकन हेतु एक मानकीकृत वर्षण सूचकांक विकसित किया गया। दशहरी प्रजाति की उष्मा प्रयोग दक्षता नापी गई। आम की दशहरी प्रजाति के विभिन्न फिनोफेजेज में उष्मीय सूचकाकों में हुये परिवर्तन इसके फलन व्यवहार को प्रभावित कर रहें हैं। आम्रपाली प्रजाति में वाष्पोत्सर्जन एवं जल उत्पादकता संबंधी प्रयोगों से इंगित किया कि इसकी जल उत्पादकता 0.31–0.74 ग्रा०/मिमी थी। प्रति वृक्ष <200 ली. जल का प्रयोग करने पर आम्रपाली की फल उत्पादकता अच्छी होती है।

प्राकृतिक खेती की विभिन्न विधियों जैसे–आच्छादन, मृदा पर जीवामृत का छिड़काव, वृक्षों पर गौ मूत्र, अमृत पानी,

Amrapali. Six year after rejuvenation direct light availability at marble stage, photosynthesis rate, stomatal conductance and vapour pressure deficit during different phenological stages displayed wide variation. Maximum value of gas exchange parameters was found in T5. Farmer field trials were also laid out for Rejuvenation technology and testing cum demonstration of HDP mango for improved yield and quality. Glutathione reductase activity, total ascorbate content and ascorbate peroxidase activity were also found to be significantly differ. Analysis of healthy and 'Jelly-seed' affected Dashehari pulp revealed higher activity of α-amylase, cellulase and polyphenol oxidase in 'Jelly-seed' affected pulp as compared to healthy pulp. The content of calcium Ca^{++} and K^{+} were lesser in jelly seed fruits pulp as compared to healthy fruits, indicating the distortion of pectin matrix. Low level of calcium in pulp and higher activity of PME and PG led to the disintegration of pulp tissue leading to tissue softening. Further, among treatments combinations the mulch + foliar application of Calcium chloride dihydrate (2%) + bagging (T3) and mulch + polyamine (2μM) as foliar spray + bagging (T6) were found significantly effective in management of jelly seed in cv. Dashehari.

Characterization of mango orchards based on soil indicators was appraised in orchards of nine villages adjoining institute. Most of the mango orchards have lower productivity (<15 t ha^{-1}), with the low nutrient distribution pattern might account for it and recommendation of adoption of advanced orchard management practices for better yields is given. Standardized precipitation index was developed for characterizing mango fruit productivity. Porosity, bulk density and particle density were also worked out. Recent changes in thermal indices in phenophases of mango cv. Dashehari reveal impact of climatic indicators on the dynamic change in thermal indices at each critical phases impacting on fruiting behaviour. Dynamics of evapotranspiration and water productivity in cv. Amrapali estimated water productivity of 0.31 to 0.74 g/mm .Water use of <200 l/tree was observed successful to produce better productivity in Amrapali.

Natural farming practices of mulching, spraying jeevamrit on soil, cow urine, amrit pani and

वर्मी वाष, एवं नीम तेल का छिड़काव व गैर–रासायनिक एकीकृत कीट प्रबंधन का सुव्यवस्थित मूल्यांकन किया गया। इन पद्धतियों के प्रयोग से दशहरी प्रजाति की फल उपज 92–147 किग्रा./वृक्ष एवं लखनऊ सफेदा प्रजाति की फल उपज 56–90 किग्रा./वृक्ष थी। आम की फल उत्पादकता एवं गुणवत्ता बढ़ाने हेतु किये गये प्रयोग से यह ज्ञान हुआ कि नैनो फारमुलेशन्स डी.ए.पी. –कापर–जिंक का इसी क्रम में छिड़काव फल आकार एवं वजन (285.5 ग्रा./फल) बेहतर था। आम, अमरूद, जामुन एवं अन्य स्रोतों से 47 जीवाणु पृथक्कित किये गये जिनमें 18 ग्राम पॉजीटिव एवं 29 ग्राम निगेटिव थे। पृथक्कित किये गये आइसोलेट्स के पौध विकास गुणों को जानने हेतु किये गये परीक्षणों से ज्ञात हुआ कि विभिन्न आइसोलेट्स साइडरोफोर उत्पादन (29), फास्फेट वलयीकरण (17), पोटैषियम वलयीकरण (20), जिंक वलयीकरण (20) एवं एचसीएन उत्पादन (12) में दक्ष थे।

कंटाई–छंटाई के समय और गहनता का अमरूद के शीत ऋतु में फलोत्पादन एवं गुणवत्ता पर अच्छा प्रभाव देखा गया। अमरूद की ललित प्रजाति की सघन बागवानी हेतु इस्पैलियर पद्धति सर्वोत्तम पायी गयी। बेल की एन.बी.–16 एवं सीआईएसएच–बी–1 के वृक्षो पर पाले का न्यूनतम (5 प्रतिषत) प्रभाव देखा गया। जबकि सीआईएसएच–बी–2 में यह सबसे अधिक (40 प्रतिशत) था। जिससे बहुत अधिक फल गिरे। केला की प्रजाति ग्रांड–नैन में उर्वरकों की अनुशांसित मात्रा का 100 प्रतिशत अकार्बनिक स्रोतों से पूरा करने पर पेड़ी फसल में सर्वाधिक उत्पादक दक्षता प्राप्त हुई। टमाटर की प्रजातियों यू.एस.–2853 एवं एन.एस.–4266 में अधिक उत्पादकता हेतु न्यूट्रिएंट फिल्म तकनीकी एवं ड्रिप हाइड्रोपोनिक पद्धति का मानकीकरण किया गया।

संस्थान द्वारा उत्तर प्रदेश राज्य में अमरूद के उकठा और क्षय के वितरण और गतिशीलता का आंकलन करने के लिए सर्वेक्षण किया गया। जड़ ग्रंथि रोग की उपस्थिति 53.57 प्रतिशत बगीचों में पाई गई, जिसके कारण क्षय रोग (25.58%) की अधिकता रही। उकठा रोग 7.31% बागों में पाया गया। पत्ती एन्थ्रेक्नोज और जीवाणु पत्ती केंकर का प्रकोप चौसा किस्म पर अधिक पाया गया। मालफॉर्मेशन और काली फफूंद का प्रकोप

vermiwash, neem oil on trees, use of non-chemical IPM tools for pest management etc. were performed systematically. Yield variability of 62 to 147 kg/tree in Dashehari and 56 to 90 kg/tree in Lucknow Safeda was observed. Soil fertility was also assessed. Evaluation of nano formulations for enhancing productivity and quality of mango showed that sequence of DAP-Cu-Zn was better in terms of fruit size and weight (285.5 g/ fruit). Total 47 bacteria (18 Gram +ve & 29 Gram –ve) were isolated from different rhizosphere of mango, guava, jamun, and other sources. Further all selected isolates were screened for plant growth promotion properties and found to poseess siderophore production (29), phosphate solubilization (17), Potassium solubilization (20), zinc solubilization (17) and HCN production(12).

Approaches to maximize winter season guava production through pruning time and pruning intensity was standardized and had remarkable effect on yield and quality attributes. Enhancing guava productivity through espalier architecture under HDP was found best for cv. Lalit. Enhanced input use efficiency under HDP was ensured. Canopy of NB-16 and CISH-B1 was found to be least affected by cold stress (5% approx) whereas maximum in CISH B-2 (40% approx) leading to high fruit drop. Maximum productivity efficiency was recorded in ratoon crop of banana cv. Grand Naine, wherein 100% recommended dose of fertilizer applied through inorganic source followed by 100% NP and K supplied by organo-minerals and treatment of 50% RDF and 50% ICAR-Fusicont. Standardization of nutrient film technique and drip hydroponic system in tomato varieties US-2853 and NS- 4266 for high productivity has been done, wherein NS- 4266 performed best.

Roving survey for recording of the distribution and dynamics of guava wilt and decline was carried out by the institute in different districts of UP. The presence of root-knot nematode was found in 53.57 percent orchards, corroborating high incidence of wilt (7.31%) and decline (25.58%). Incidence of leaf anthracnose, bacterial leaf lesion incidence was observed high on cv. Chausa in 80 percent orchards. Floral malformation

भी कुछ बागों में गंभीर पाया गया। आम के पुष्प गुच्छों पर खर्रा फफूंदी और झुलसा रोग का प्रकोप कम दर्ज किया गया। लैंटाना के पौधों से थ्रिप्स आबादी का प्रवासन 11वें मानक सप्ताह से आम के पौधों की ओर शुरू हुआ। मैंगो हॉपर की संख्या गतिषीलता ने 26वें और 34वें मानक सप्ताह में दो उच्च षिखर दिखाए, जबकि थ्रिप्स के लिए यह 9वें और 14वें मानक सप्ताह के दौरान था।

हालाँकि सीआईएसएच ग्लू ट्रैप आधारित निगरानी से 15वें मानक सप्ताह के दौरान निचले तने (262.50/ट्रैप) पर भुनगा की सबसे अधिक आबादी पायी गयी। 19वें मानक सप्ताह के दौरान 6.9 लार्वा/टहनी के साथ लीफ वेबर की घटना सबसे अधिक थी। अमरूद पर महत्वपूर्ण कीटों की संख्या की गतिशीलता मिली और अमरूद फल छेदक का प्रकोप अधिकतम 4.20 प्रतिशत तक 36वें मानक सप्ताह में पाया गया। शूट बोरर के लिए, चरम 47वें मानक सप्ताह पर 33 प्रतिशत संक्रमित कलियों/पेड़ों के साथ दर्ज किया गया था, और सेमीलूपर 21वें मानक सप्ताह के दौरान 0.14 लार्वा/शूट के साथ दर्ज किया गया था। आम के बगीचे की मिट्टी में थ्रिप्स का चरम उद्भव अप्रैल के दूसरे सप्ताह के दौरान 29.6 औसत संख्या/700 ग्राम मिट्टी के साथ दर्ज किया गया था। मिथाइल यूजेनॉल एंबेडेड सीआईएसएच–गोंद जाल ने चौथी से 23वीं मानक सप्ताह के दौरान अधिक नर फल मक्खियों को आकर्षित किया।

आम के उकठा रोग के करक *सेराटोसिस्टिस फिम्ब्रिएटा* के लिए उच्च संवेदनशीलता वाली विशिष्ट आणविक पहचान परख का विकास राइजोस्फेरिक मिट्टी से किया गया। आरपीबी2 जीन और *सेराटोसिस्टिस फिम्ब्रिएटा* विशिष्ट प्राइमरों को लक्षित करने वाले *लैसियोडिप्लोडिया* विशिष्ट प्राइमरों का विकास आरटी–पीसीआर का उपयोग करके किया गया। *सिकेनस क्रोसेओविटैटस* को माइटोकॉन्ड्रियल जीन (सीओआई) का उपयोग करके चित्रित किया गया। आईटीएस और β–ट्यूबुलिन संयुक्त जीन डेटासेट 21–MW बिजनौर को *लै. थियोब्रोमी* पृथक के रूप में पहचान सकते हैं। आम की जड़ों से अलग किए गए चार एंडोफाइटिक बैक्टीरिया का इस कवक के खिलाफ प्रतिरोध के लिए दो आईएसओ–सी और ई ने सबसे अच्छा प्रदर्शन किया। आम की तुड़ाई के बाद की बीमारियों के प्रबंधन के लिए फलों के माइक्रोबायोम की खोज की गई, और छह जीवाणु क्षैतिज और साथ ही ऊर्ध्वाधर दोहरी संस्कृति परख में सी. ग्लियोस्पोरियोइड्स के खिलाफ सफल पाए गए।

and sooty mould were also reported severe. The incidence of powdery mildew and blossom blight were recorded low on mango panicles. Thrips population migration from Lantana host started from 11th SMW towards the mango plants. The population dynamics of the mango hopper showed two high peaks in 26th and 34th SMW, while for thrips it was during 9th and 14th SMW.

However, CISH-glue trap based monitoring revealed highest population of hoppers on lower trunk (262.50/trap) during 15th SMW. The leaf webber incidence was highest during the 19th SMW with 6.9 larvae/twig. Similarly, population dynamics of important insect pests on guava was also worked out and incidence of guava fruit borer peaked at 36th SMW with 4.20 percent incidence. For shoot borer, peak was recorded on 47th SMW with 33 percent infested buds/trees, semilooper during 21st SMW with 0.14 larvae / shoot. The peak emergence of thrips from mango orchard soil was recorded during the second week of April with 29.6 mean population thrips/ 700 g of soil. Methyl eugenol embedded CISH - glue trap attracted more male fruit flies during the 4th to 23rd SMW.

Development of *Ceratocystis fimbriata* specific molecular detection assay for mango wilt has been done from rhizospheric soil with high sensitivity. Development of *Lasiodiplodia* specific primers targeting RPB2 gene and *C. fimbriata* specific primers was done using RT-PCR. Reduvid predator, *Sycanus croceovittatus* was characterized using mitochondrial gene (*COI*). ITS and β-tubulin combined gene dataset could identify isolate 21-MW-Bijnor as that of *Lasiodiplodia theobromae*. Four endophytic bacteria isolated from the mango roots were tested for antagonism against this fungus and two Iso-C and E performed best. Fruit microbiome was explored for management of post-harvest diseases of mango, and six were found to show antagonism against *C. gloeosporioides* in horizontal as well as vertical dual culture assay.

संस्थान ने कीट प्रबंधन के लिए नए उपकरण और पद्धतियां भी तैयार कीं, जैसे सीआईएसएच– ब्लोअर ट्रैप, सेल्फ पर्चुएटिंग फील्ड परजीवी केज, पेस्टीकी ट्रॉली, बी. रूफोमैकुलाटा पर कीटनाषकों की प्रभावकारिता के लिए परीक्षण पद्धति, मैंगो थ्रिप्स प्रबंधन के लिए पानी में घुलनशील गोंद। हॉपर, मिली बग, मैंगो थ्रिप्स, फल मक्खियाँ, तना छेदक और चूसने वाले कीट कॉम्प्लेक्स जैसे लक्षित कीटों के लिए आईपीएम शेड्यूल के विकास और शोधन का भी प्रयास किया गया है।

आम के फलो की शेल्फ–लाइफ बढ़ाने के लिए मल्लिका प्रजाति के फलों को 0.02% हेक्सानल के साथ उपचारित किया गया और परिवेशीय परिस्थितियों में भंडारित करने पर उनकी शेल्फ लाइफ 12 दिन पायी गयी जबकि बिना उपचारित फलों की 8 दिन। इसी प्रकार आम की मल्लिका प्रजाति के फलो को 10 मिनट के लिए *लैक्टोबैसिलस प्लांटारम* और ग्वार गम से उपचार द्वारा शेल्फ–लाइफ 12 दिन पायी गयी। आम की मल्लिका प्रजाति को नैनो–सिल्वर और गोल्ड कणों से उपचारित करके नैनो सिल्वर कणों का उपचार 12वें दिन तक फलों की गुणवत्ता एवं शेल्फ–लाइफ बढ़ाने में प्रभावी था। चौसा प्रजाति के आम के फलो की शेल्फ–लाइफ के बढ़ाने के लिए दो उपचार लगाए गए (नियंत्रण और फल को 100 पीपीएम एथिलीन से उपचारित), पाया गया कि कोल्ड स्टोरेज में 15 दिन + पकने के लिए कमरे के तापमान पर तीन दिन (कुल 18 दिन) के बाद, एथिलीन से उपचारित फलों में उच्च टीएसएस, कम अम्लता और एक समान पीला रंग पाया गया। इथरेल (39%) और NaOH (1N) का उपयोग करके सीआई एस एच फ्रूट रइपेनर का विकास किया गया। मार्कोव श्रृंखला दृष्टिकोण का उपयोग करके व्यापार मैट्रिक्स का अनुमान लगाया गया जिसमे यह पाया गया कि भारतीय आम के प्रमुख आयातकों में ओमान सबसे स्थिर बाजारों में से एक है। उत्तर प्रदेश में दशहरी आम की खेती की लागत की गणना करने पर लगत रु 16.70 प्रति किग्रा पायी गयी। आम उत्पादकों के सामने आने वाली प्रमुख चुनौतियों में कीट–पतंगों की गतिशीलता में उतार–चढ़ाव, तुड़ाई उपरांत भारी नुकसान, फसल बीमा योजना की कमी शामिल है।

ललित प्रजाति के अमरूद फलों को हेक्सानल/ 0.1 पी पी एम से उपचारित किया गया, भंडारण के 12वें दिन टी एस एस अम्लता अनुपात 28.50 और एस्कॉर्बिक

Institute also devised new devices and methodologies for pest management viz., CISH-blower trap, self perpetuating field parasite cage, Pesticky trolley, testing methodology for efficacy of insecticides on the *B. rufomaculata*, water soluble gums for mango thrips management. Development and refining of IPM schedules for the targeted pests like hoppers, mealy bug, mango thrips, fruit flies, stem borer and sucking pest complex have also been attempted.

For enhancing the shelf-life of mango fruits of cv. Mallika were treated with 0.02% hexanal and under ambient conditions, shelf-life of 12 days was recorded compared to control (8 days). Similarly, mango fruits of cv. Mallika treated with *Lactobacillus plantarum* cell free extract plus guar gum for 10 min and stored under ambient conditions recorded a shelf-life of 12 days under ambient conditions. Post harvest treatment of nano-silver and nano-gold to mango fruits of cv. Mallika, revealed that nano-silver was effective in enhancing the quality of fruits up to 12th day of storage under ambient conditions. Chausa fruits treated with 100 ppm ethylene (T_2) after 15 days in cold storage + three days at room temperature for ripening (total 18 days) was reported to have high TSS, low acidity and uniform yellow colour. CISH-fruit ripener was developed by using the ethrel (39%) and NaOH (1N) which releases ethylene slowly and helps in uniform ripening of mangoes. The trade matrices (transitional probability matrix) were estimated using Markov chain approach which indicated that Oman is one of the most stable markets among the major importers of Indian mangoes. The cost of cultivation of mango cv. Dashehari in Uttar Pradesh was was calculated to be Rs. 16.70 per kg. Key challenges faced by the producers include fluctuating insect pest dynamics, huge post-harvest loss, lack of crop insurance scheme.

Guava fruits cv. Lalit were treated with hexanal @ 0.1, ppm hexanal had TSS: titratable acidity ratio of 28.50 and 108.13 mg 100 g^{-1} of ascorbic acid content on the 12th day of storage. In a study

एसिड 108.13 मिलीग्राम 100 ग्राम–1 था। श्वेता प्रजाति के अमरूद के फलो को सिल्वर, गोल्ड, जिंक एवं कॉपर नैनो कणों से उपचारित करके परिवेशी परिस्थितियों में भंडारित किया गया। नैनो–सिल्वर कणों से उपचारित फलों की शेल्फ–लाइफ 12 दिनों पायी गयी। अमरूद की सात किस्मों, इलाहाबाद सफेदा, श्वेता, एल–49, ललित, जी–1, जी–6 और जी–31 का पकने की अवस्था में जैव रासायनिक और एंटीऑक्सीडेंट गुणों के लिए मूल्यांकन किया गया। फ्राप विधि द्वारा अनुमानित एंटीऑक्सीडेंट श्वेता में अधिकतम और जी–31 में न्यूनतम थे। अमरूद की ललित प्रजाति में मेलाटोनिन और चिटोसन के डिप उपचार देकर तुड़ाई के 12 दिन बाद कम सांद्रता में मेलाटोनिन डिप उपचार फलों के क्षय को रोकने, कम वजन घटने फलों की देरी से पकने में उल्लेखनीय रूप से प्रभावी पाया गया। चिटोसन कोटिंग की कम सांद्रता कोशिका झिल्ली क्षति में कमी और कोशिका दीवार को ढीला करने वाले एंजाइमों द्वारा मध्यस्थता हो सकती है। भारत के प्रमुख उत्पादक राज्यों में अमरूद के क्षेत्र, उत्पादन और उत्पादकता की प्रवृत्ति का विश्लेषण करने के लिए चक्रवृद्धि वार्षिक वृद्धि दर (सीएजीआर) का उपयोग किया गया था। क्षेत्र और उत्पादन दोनों में महत्वपूर्ण सकारात्मक वृद्धि हुई लेकिन उत्पादकता में वृद्धि महत्वपूर्ण नहीं पायी गयी।

चकैया और एनए–7 प्रजाति के आँवला के फलो को 5 मिनट तक मेलाटोनिन, चिटोसन और सोडियम एल्जीनेट से उपचारित करके कमरे के तापमान पर भंडारित किया गया। भण्डारण के 15 दिन बाद पाया गया कि सोडियम एल्गिनेट/1.0%, चिटोसन/100 पीपीएम और मेलाटोनिन/100 पीपीएम रंग, दिखावट और बनावट के आधार पर अन्य उपचारों की तुलना में बेहतर पाए गए। आँवला जूस को 1 मिलीलीटर लीटर–1 वाणिज्यिक पेक्टिनेज एंजाइम से उपचार करके रेफ्रिजरेटर में, कमरे के तापमान पर और 35°सी पर भंडारित किया गया। जूस में शुरू में 414 एम जी/100 एमएल विटामिन–सी और 2.83% कुल फिनोलिक्स था। भण्डारण के 120 दिन बाद, जूस में कैटेचिन सबसे प्रचुर तथा पी–कौमरिक एसिड सबसे कम फेनोलिक यौगिक था।

प्रारंभिक अवस्था से छह महीने भंडारण तक आवला कैंडी में विटामिन–सी और फिनोल के स्तर का आकलन करने के लिए चकैया, ए–31 और ए–33 की कैंडी

of guava fruits of cv. Shweta treated with Ag, Au, Zn and Cu nano-particles and stored under ambient conditions, the nano-Ag treatment was found better with a shelf-life of 12 days compared to control (8 days). Seven varieties of guava, namely, Allahabad Safeda, Shweta, L-49, Lalit, G-1, G-6 and G-31 were assessed for biochemical and antioxidant properties at edible ripe stage. The antioxidants estimated by FRAP was maximum in Shweta and minimum in G-31. Edible coatings/ dip treatments of melatonin and chitosan were applied in guava cv. Lalit and physiological changes at room temperature were recorded till 12 days after harvest. Melatonin dip treatment in low concentration was found to be notably effective in reducing decay and weight loss of fruit and delayed senescence of fruit. Low concentration of coating may be mediated by decrease in cell membrane damage and cell wall loosening enzymes. Compound Annual Growth Rate (CAGR) was used to analyze the trend in the area, production and productivity of guava in major producing states of India. Both area and production had significant positive growth but the growth in productivity was not significant.

Fresh harvested aonla fruits of cvs. Chakaiya and NA-7 were treated with dip treatments of melatonin, chitosan and sodium alginate solutions for 5 minutes and stored at room temperature. After 15 days sodium alginate @ 1.0%, chitosan @ 100 ppm and melatonin @ 100 ppm were found to be better treatments as compared to other treatments in terms of colour, appearance and texture. Aonla juice was clarified using commercial pectinase enzyme treatment at 1ml L^{-1} for 1 h at room temperature and stored in refrigerator, at room temperature and at 35°C. The juice initially contained 414 mg 100 ml^{-1} vitamin-C and 2.83% total phenolics. After 120 days, Catechin was the most abundant phenolic compound while p-coumaric acid was least.

Candy of aonla varieties Chakaiya, A-31 and A-33 was developed to assess the retention of Vitamin-C and phenols from initial stage to six months of storage. The total soluble solids,

बनाई गई। भंडारण के दौरान कैंडी में कुल घुलनशील ठोस पदार्थ, अम्लता और रेड्युसिंग शर्करा में वृद्धि हुई जबकि एस्कॉर्बिक एसिड और एंटीऑक्सीडेंट में कमी आई। लीची शहद को मिलाकर आंवला प्रिजर्व बनाया गया, जिसकी शेल्फ–जीवन छह महीने पायी गयी। बेल और आँवला के लाभकारी यौगिकों को मिलाने के उद्देश्य से, बेल–आँवला मिश्रित प्राश तैयार किया गया। शहद आधारित बेल स्क्वैश को मानकीकृत किया गया जहां चीनी की जगह शहद का उपयोग किया गया। बिना किसी प्रिजर्वेटिव और बिना किसी अतिरिक्त रंग के बेल की सभी पोषण गुणों से युक्त इंस्टेंट बेल ड्रिंक विकसित किया गया, शुगर रोगियों के लिए शुगर फ्री बेल पेय विकसित किया गया। सब्जी में प्रयोग के लिए कटहल के निर्जलित क्यूब्स विकसित किए गए, जिनमे 1% नमक के साथ भाप ब्लांचिंग उपयुक्त पाया गया। कृत्रिम स्वीटनर (सुक्रालोज़ और स्टीविया) की अनुशंसित मात्रा का उपयोग करके बिना चीनी के स्ट्रॉबेरी आरटीएस का प्रोटोकॉल विकसित किया गया। शहद आधारित स्ट्रॉबेरी स्प्रेड विकसित किया गया; उत्पाद की शेल्फ लाइफ छह महीने पायी गयी।

विस्तार गतिविधियों के तहत संस्थान ने प्राथमिक हितधारकों का कौशल उन्नयन किया, जिसमें किसान/बागवान, राज्य सरकार के अधिकारी, विभिन्न राज्यों के लाइन विभाग शामिल हैं, जो प्रशिक्षण, प्रदर्शन, क्षेत्र दौरे, एक्सपोजर विजिट, बैठकें, गोष्ठी, जागरूकता कार्यक्रम, प्रौद्योगिकियों के प्रदर्शन के माध्यम से किया गया। सीआईएसएच–एबीआई द्वारा प्रौद्योगिकी परामर्श सत्र, उद्यमी ऊष्मायन बैठक, अंतर–संस्थागत बैठकें, राष्ट्रीय कार्यक्रमों में स्टार्ट–अप की भागीदारी आदि के माध्यम से कई गतिविधियाँ की गईं। आईटीएमयू ने पीपीवीएफआरए में 8 किसानों की किस्मों के पंजीकरण की सुविधा प्रदान की, 12 समझौता ज्ञापनों पर हस्ताक्षर किए गए, एक कॉपीराइट और दो पेटेंट प्राप्त हुए।

acidity, and reducing sugars increased while ascorbic acid and antioxidants decreased during the storage. Aonla preserve was prepared by incorporating litchi honey. The shelf-life of the product was six months. With the aim to combine beneficial compounds of bael and aonla, bael-aonla blended prash was prepared. A honey based bael squash was standardized where sugar was completely replaced by honey. Instant bael drink is developed with all the nutritional quality of bael with no preservative and no added colour. The sugar free bael drink was developed for sugar patient. Dehydrated cubes of jackfruit for vegetable purpose were developed, in which steam blanching with 1% salt was found to be suitable. The protocol for sugar free strawberry RTS was developed using the recommended dose of artificial sweetener i.e. sucralose and Stevia. Honey-based strawberry spread was developed with the shelf-life recorded upto six months.

Under extension activities Institute carried out skill up gradation of primary stakeholders that includes farmers/ orchardists, state government officials, line departments of various states was done through trainings, demonstrations, field visits, exposure visits, meetings, goshthis, awareness programmes, showcasing technologies in exhibitions etc. Several activities were under taken by CISH-ABI through technology mentoring sessions, entrepreneur incubation meet, inter-institutional meetings, participation of strat-ups in national programmes and so on. ITMU facilitated registration of 8 farmer's varieties in PPVFRA, 12 MoUs signed, one copyright and two patents have been received.

Introduction

Brief History

The ICAR-Central Institute for Subtropical Horticulture (CISH) was started 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 an independent Institute which was named Central Institute of Horticulture for Northern Plains in June 1984. The Institute was later rechristened as Central Institute for Subtropical Horticulture in June 1995, and the present laboratory-cum-administrative building came up at block-II at Rehmankhera during May, 1999. It is serving the nation by working on basic, strategic and applied research to enhance sustainable productivity, quality and utilization of subtropical horticultural crops. It is world renowned repository of subtropical horticultural crop genetic resources and is NAGS for mango. The Institute has two experimental farms, one located at Rehmankhera, approximately 25 km away from the city and another at Telibagh, Raebareli (R.B.) Road. The experimental farm at Rehmankhera has an area of 132.5 hectare comprising of 4 blocks in which nursery block, world mango germplasm, Indian mango collections, mango hybrids, clones and germplasm of other mandated fruit species have been planted. 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. It has strived to upgrade the infrastructure facilities during various five year plans so that assets like state-of-art tissue culture facility, molecular biology and genomics laboratory, microbiology laboratory, processing pilot plant and biocontrol laboratory are being used

to work in niche areas of horticultural research. The well established modern scientific nursery unit of the Institute is supported by mother blocks, polyhouses, shade net houses, mist chamber, sterilization chamber etc. Large amounts of quality planting material have been produced in mango, guava, aonla, bael, jamun, litchi, strawberry and vegetable crops with traceability and these are being supplied as core/genuine planting material to the farming communities. The institute also supports human resource development through Skill India Programme and various government and other sponsored schemes. Recognizing the importance of capacity building in harmony with ICAR focus of Student Ready, the Institute has in place MOUs with many universities of the state for supporting research activities leading to the award of M.Sc. and Ph.D. degrees. The Institute has also been recognized by IGNOU, New Delhi as one of its study centres 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 the farmers' income, wherein mango based farming system technologies have been integrated to enhance profitability of farmers under Farmer FIRST, SCSP and other extension projects. The Institute also renders other quality services to the growers, viz., responding to queries on orchard related problems through Kisan Call Centre and phone-in-live programme, services on soil and nutrient constraints, agro-advisory services, pest and disease problems, on-farm visits, production and supply of bio-control agents, hand holding of KVKs and other agriculture/horticulture universities with emphasis on North Eastern states 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 the needs of subtropical horticulture for Eastern India through infrastructure development for fruit and vegetable nursery production, bee keeping and honey processing and bottling unit, water conservation ponds and allied activities.

Objectives

1. Management of genetic resources of mandated fruit crops.
2. Crop improvement through breeding and genetic engineering.
3. 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.
4. Reduction in post-harvest losses and enhancement of profitability through integrated pre and post-harvest management practices, value addition and product diversification.
5. Human resource development, transfer of technology, capacity building and evaluation of its socio-economic impact.

Nursery

The institute has established a world class nursery facility (located at state highway -25 at Rehmankhera, Kakori, Lucknow) that is recognized by National Horticultural Board (NHB) with 3/3-star rating. The area of nursery spans over 15.5 ha. and houses mother block, poly-house, shade-net house and other utility structures needed for scientific nursery production. The nursery produces genetically pure and disease-free quality planting material of different varieties of horticultural crops viz., mango, guava, aonla, bael, litchi, lemon, jamun, grape and banana for the farmers, general public, private and public organizations.

Table. Planting material produced during 2022

S.No.	Crop	No. of Plants
1.	Mango	65,208
2.	Guava	67,797
3.	Banana	30,000
4.	Bael	12,159
5.	Jamun	5,879
6.	Papaya	5,202
7.	Apple Ber	4,100
8.	Litchi	1,643
9.	Aonla	1,507
	Total	193,495

Agricultural Knowledge Management Unit

The Agricultural Knowledge Management Unit (AKMU) is entrusted with responsibility of managing computational facilities, maintaining the Institute's network, the website and managing the video calling and conferencing facilities. The Institute is also complying with MISFMS 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.

Library and Information Centre

The Institute has a well established Library and Information Centre which caters to the requirements of scientists, scholars, traders, entrepreneurs and extension functionaries. All the library reading materials have been automated through LSEASE software and search through OPAC (Online Public Access Catalogues). At present the existing collection is 3977 of scientific and technical books which is continuously enhanced. Library and Information Centre is also maintaining the bibliography of publications from institute faculty in various Scientific Journals (1972-2021) that have been uploaded on Krishi Kosh (ICAR). The Institute Library and Information Centre is grid of e-pamphlets, e-newsletters, e-news papers clippings and others reading materials. More than 229 annual reports and other magazines are being received from ICAR Institutes, State Agricultural Universities and Institutes on exchange information basis. Institute Library and Information Centre in also supplying reprints of research papers to indenting Scientists/Officers as well as entrepreneurs through CeRA platform.

Organizational Set-up

The Institute research staff functioning is organized through four Divisions (Crop Improvement and Biotechnology, Crop Production, Crop Protection and Post Harvest Management) at headquarters Lucknow; one Regional Research Station and KVK at Malda (W.B.) respectively. The Precision Farming Development Centre (PFDC) was established by NCPAH to promote Precision Farming & Plasticulture Applications in horticulture. The institute also promotes vertical farming and soilless culture for vegetables through facilities developed by support of Rashtrya Krishi Vikas Yojna (RKVY). The institute is taking forward its organic research through Paramparagat Krishi Vikas Yojna (PKVY) a sub-component of Soil Health Management (SHM) scheme. The institute has recently been entrusted with the responsibility to promote and support the entrepreneurship ecosystem in horticulture through setting up of Agri-Business Incubator (ABI) Centre.

Staff Position

Overall Staff position for the institute including RRS Malda as on 31.12.2022 is given below

क्र.सं. S.N.	वर्ग Category	संस्वीकृत पद Sanctioned	भरा In Position	रिक्त Vacant
1	आर.एम.पी. (निदेशक) RMP	01	00	01
2	वैज्ञानिक Scientific	51	35	16
3	तकनीकी Technical	39	22	17
4	प्रशासनिक Administrative	26	15	11
5	कुशल सपोर्ट स्टॉफ Skilled Support Staff	39	05	34
	योग Total	**156**	**77**	**79**

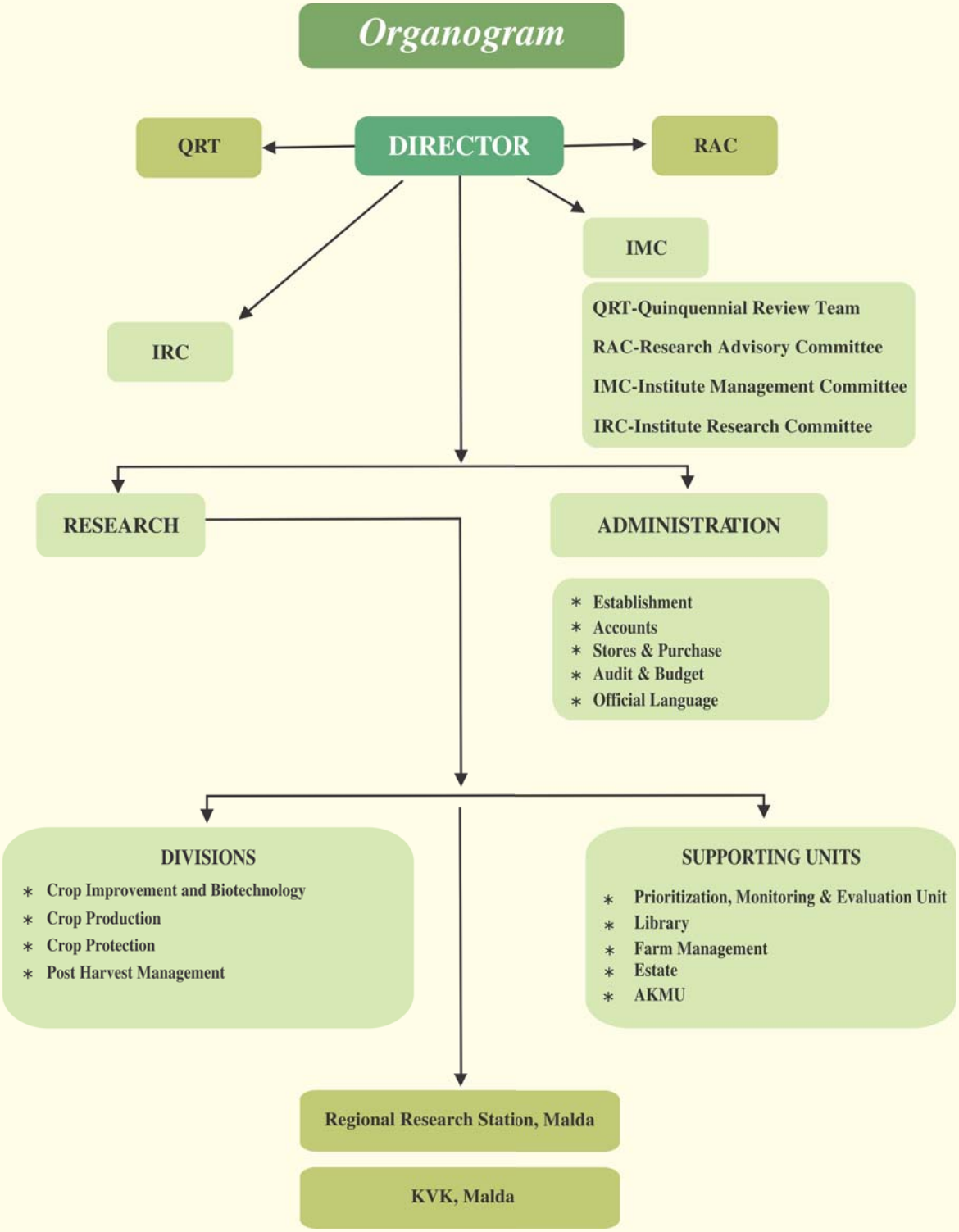
KVK Malda (as on 31.12.2022)

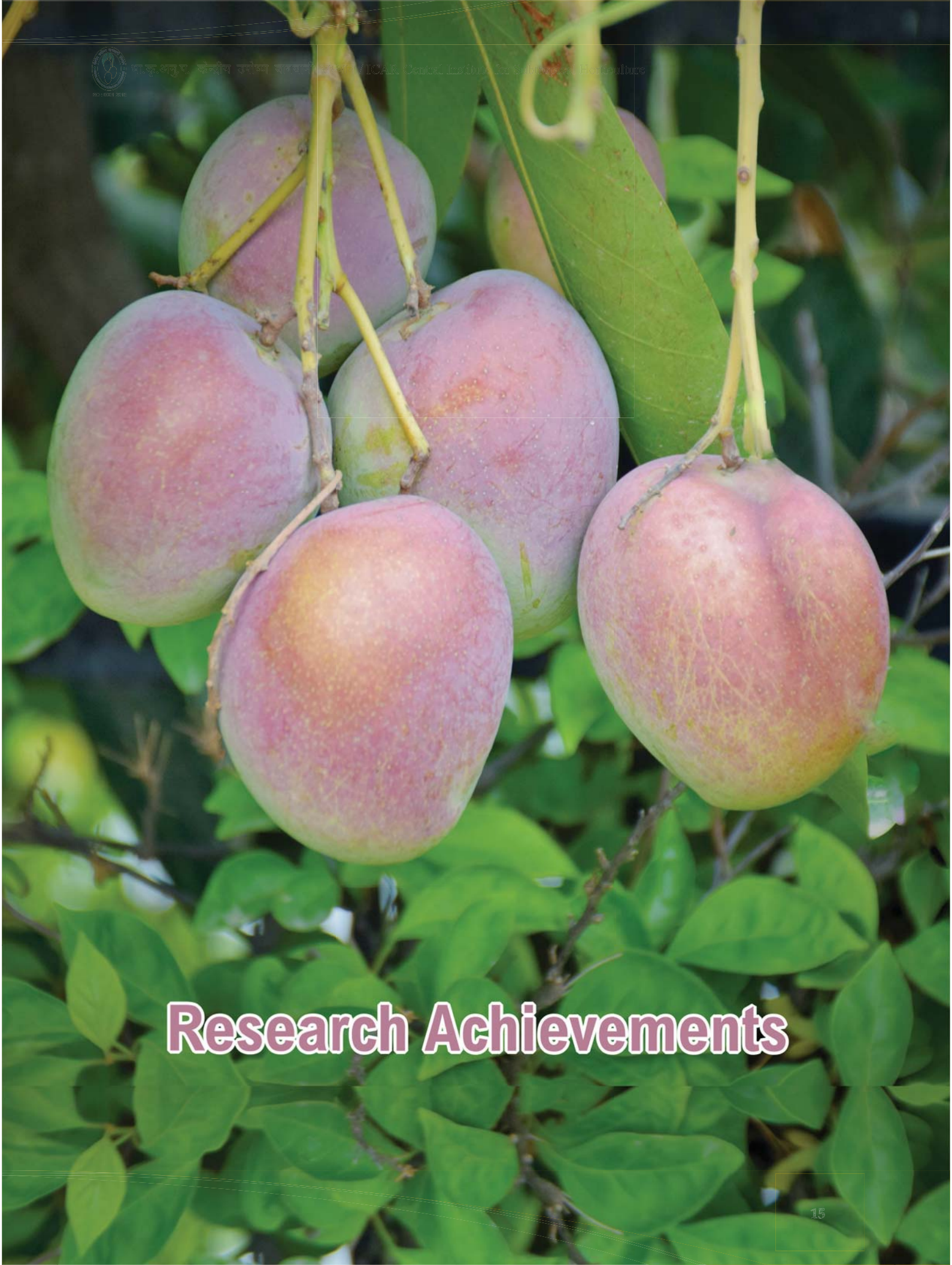
Sl. No.	Category	Sanctioned	In Position	Vacant
1.	Scientific	01	-	01
2.	Technical	05	01	04
	SMS/T-6	06	01	05
3.	Administrative	02	-	02
4.	Skilled Support Staff	02	-	02
	Total	**16**	**02**	**14**

प्राप्तियां (2022–23) Revenue Receipts (2022-23) **Rs. in lakh**

क्र.सं. S.No.	राजस्व प्राप्ति की वसूली Realization of Revenue Receipts	लक्ष्य Target	उपलब्धि Achievements
1	बिक्री और सेवाओं से आय Income from sales / services	55.53	34.40
2	फीस से होने वाली आय Income from fees/Sub.		00.50
3	रॉयल्टी और प्रकाशन से आय Income from Royalty / Publication		00.01
	कुल Total		34.91

Organogram


DIRECTOR
QRT
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

Division of Crop Improvement and Biotechnology

Mango (*Mangifera indica* L.)

Collection of mango germplasm

Collection:

During 2022, seven mango varieties/hybrids were collected and planted in the field gene bank for further evaluation.

Field gene bank planting

A total of 775 mango accessions are being maintained in the field gene bank. Gaps in the field gene bank were filled, and 67 accessions were multiplied for planting in the germplasm bank.

***Characterization*:**

Profiling of major nutraceuticals in mango hybrids

Mangiferin, lupeol and β carotene contents of 11 promising mango hybrids were assessed. Highest mangiferin (8.41 µ/g) and lupeol content (7.69 µ/g) were recorded in H-1042. Maximum β-carotene content (76.66 µ/g) was observed in H-4509 (Fig. 1). A total of 78 mango hybrids were analysed for total phenols, flavonoids, antioxidants and carotenoids content. Total phenol content varied from 37.36 mg/100g in H-620 to 93.06 mg/100g gallic acid equivalent in H-4309. Total flavonoid content varied from 17.9 mg/100g in H-3865 to 21.7 mg/100g quercetin equivalent in H-4000. The highest total antioxidants were recorded in H-3996 (1.41µmol Trolox/100g), and the lowest (0.22µmol Trolox/100g) in H-3550 (Fig. 2). The total carotenoids content ranged from 1.14-7.54 mg/100g. The lowest carotenoids (1.14 mg/100g) content was recorded in H-1761 while the hybrid H-4252 had the highest carotenoids (7.54 mg/100g) (Fig. 3).The ascorbic acid content was recorded in 51 hybrids which ranged from 6.4-252.8 mg/100 g. The lowest ascorbic acid

content (6.4 mg/100 g) content was recorded in H-3865 while hybrid H-4309 had the highest ascorbic acid content (252.8 mg/100 g) (Fig. 4).

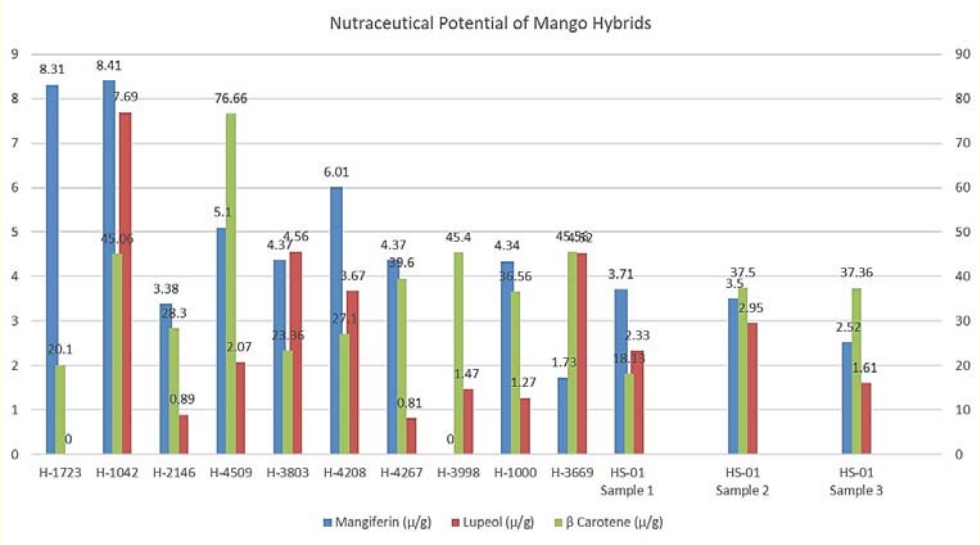


Fig. 1: Nutraceutical potential of mango hybrids

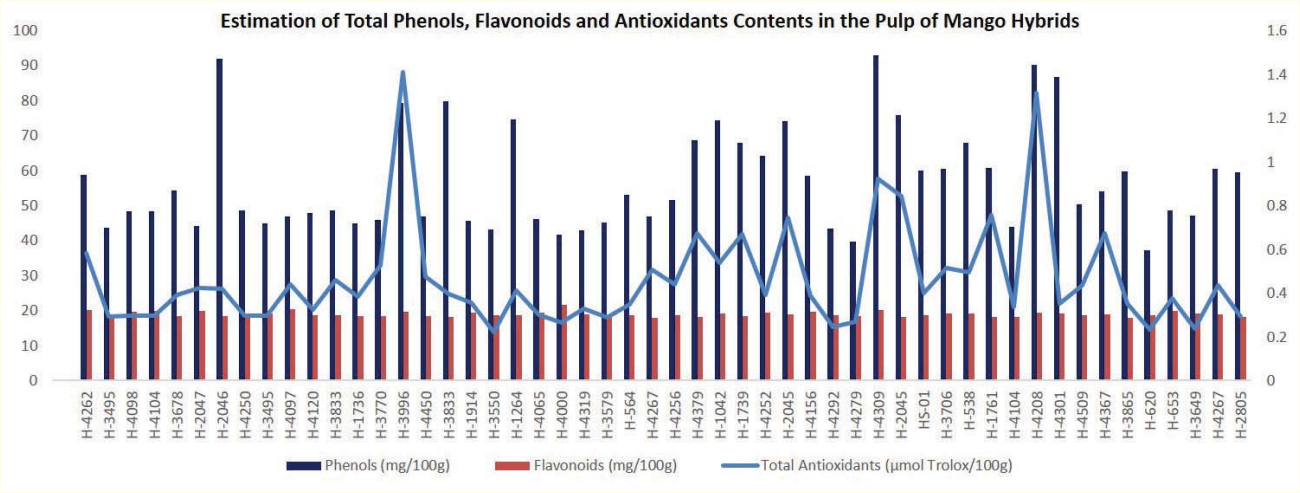


Fig. 2: Total phenols, flavonoids and antioxidants content in the pulp of mango hybrids

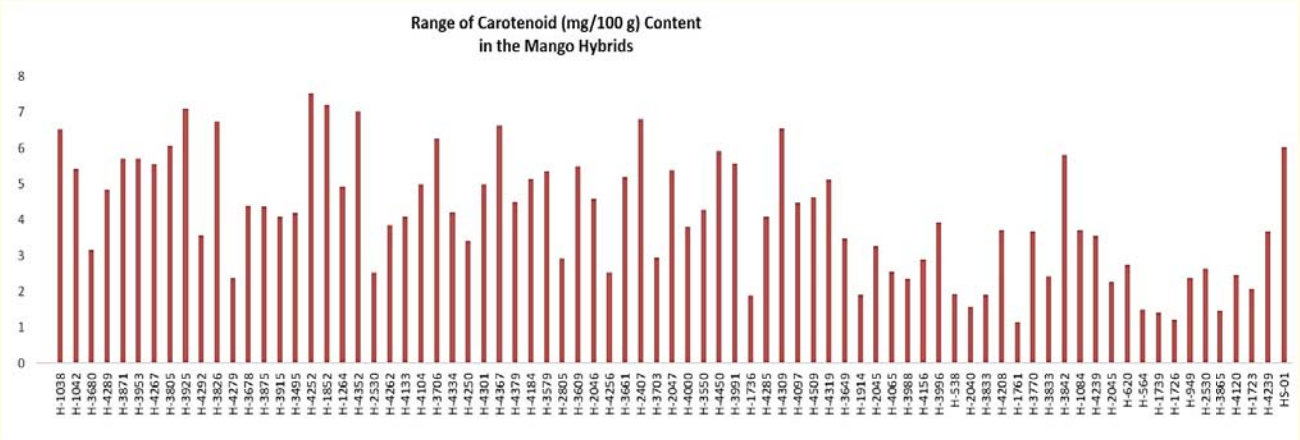


Fig. 3: Total carotenoid content in the pulp of mango hybrids

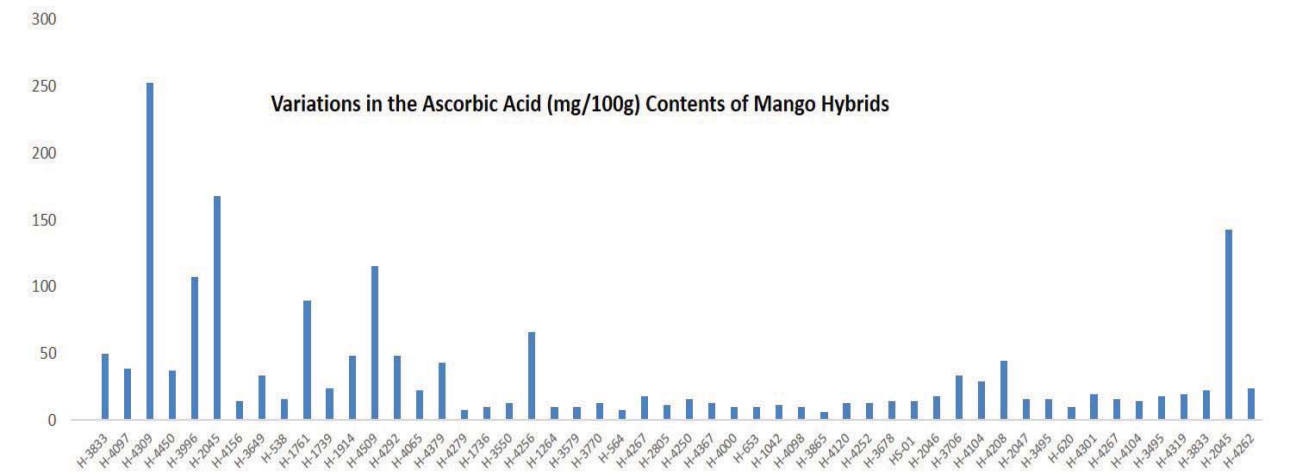


Fig. 4: Ascorbic acid content in the pulp of mango hybrids

Leaf nutraceutical profiling of mango hybrids

Leaf nutraceutical profiling of 11 promising mango hybrids was carried out. Total phenol content varied from 184.17 mg/100 g in H-3925 to 329.58 mg/100 g gallic acid equivalent in H-1084. Total flavonoid content varied from 26.0 mg/100 g in H-3925 to 61.8 mg/100 g quercetin equivalent in HS-01. The lowest carotenoids (6.14 mg/100 g) content was recorded in H-4309 while hybrid H-1739 had the highest carotenoids (9.99 mg/100 g).The highest total antioxidants were recorded in H-4065 (2.28 µmol Trolox/100 g), and the lowest (0.99 µmol Trolox/100 g) in H-4367. The lowest ascorbic acid content (33.6 mg/100 g) content was recorded in H-4065 while the hybrid H-4309 had the highest ascorbic acid content (251.2 mg/100 g) (Fig. 5)

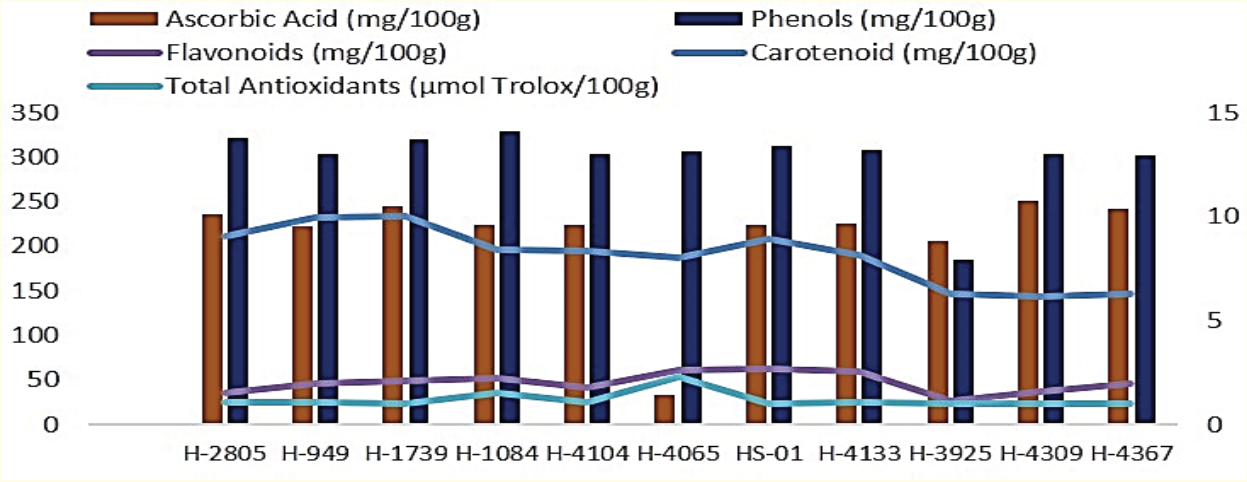


Fig. 5: Leaf nutraceutical profiling of promising mango hybrids

Sugars and Total Chlorophyll Profiling of mango hybrids

In order to identify hypoglycaemic (low sugar) mango hybrids, sugar profiling of 38 mango hybrids was carried out. Total sugar content varied from 9.94% in H-3495 to 13.22% in H-3649. The lowest reducing sugar content (3.13%) was recorded in H-1914 while the hybrid H-3495 recorded the meximum reducing sugar content (3.88%). Non reducing sugar content varied from 6.06% in H-3495 to 10.0% in H-3649 (Fig. 6). Total chlorophyll content profiling in the leaf of 41 mango hybrids was carried out. Total chlorophyll content varied from 2.26 mg/g in H-3432 to 4.24 mg/g in H-1729 (Fig. 7).

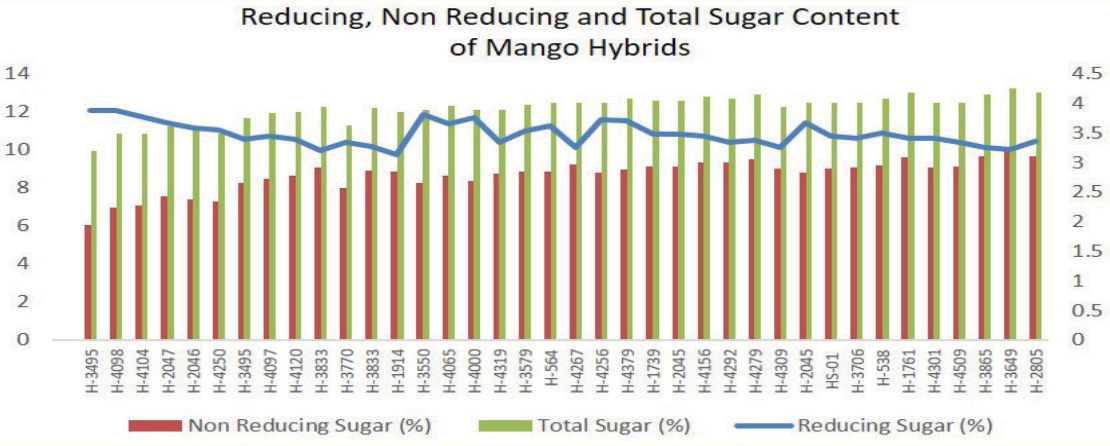


Fig. 6: Reducing, non reducing and total sugar content in the pulp of mango hybrids

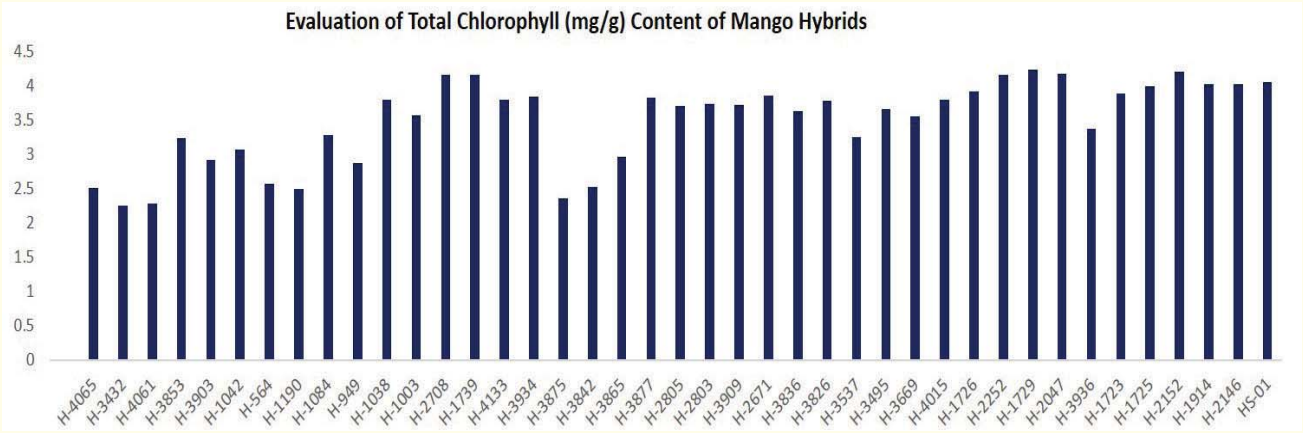
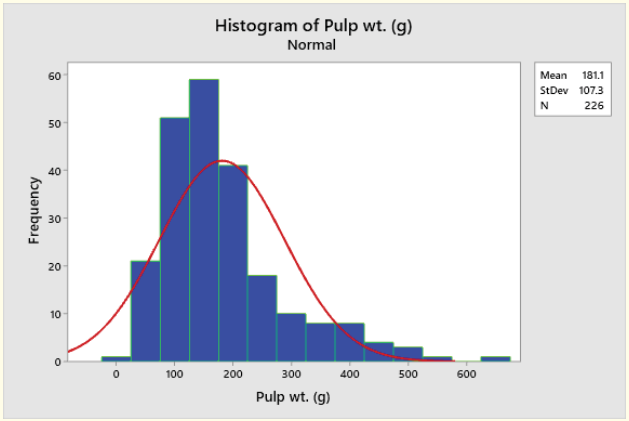
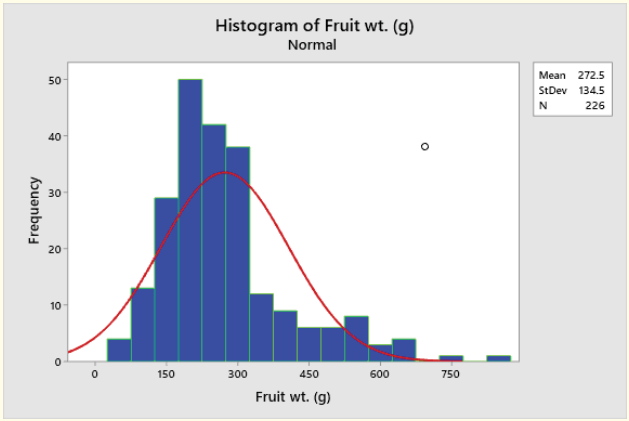


Fig. 7: Total chlorophyll content in the leaf of mango hybrids

Documentation of germplasm evaluation

Evaluation data of 226 accessions indicated the wide variability in various parameters such as fruit weight, fruit length, fruit breadth, stone weight, TSS, and pulp per cent. The weight of fruit differed significantly. The fruit weight ranged from 64.33g to 825 g, with a mean of 272.5 g. Fruit weight in most of the accessions ranged from 200 g to 300 g (Fig. 8). TSS was found to be in the range from 8.4°B to 29.50 °B. TSS of 15-21°B was found in the majority of accessions, but some had more than 22°B (Fig. 8). The pulp per cent ranged from 17.89 per cent to 79.68 per cent with a mean of 63.71 per cent. The majority of accessions had 60-70 per cent pulp.





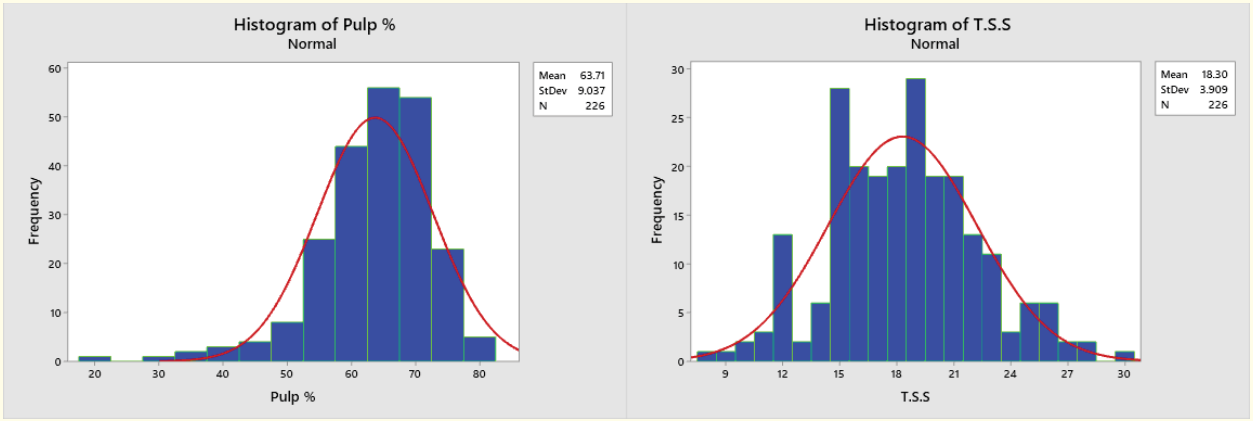


Fig. 8: Fruit weight, pulp weight, pulp percentage and TSS in mango accessions

Evaluation of exotic mango varieties

Sixteen exotic mango varieties were evaluated for fruit weight, fruit length, fruit breadth, stone weight, TSS, and pulp per cent. The fruit weight ranged from 80.33 g (Kent) to 550.33 g (Cowsaji Patel). TSS was found to be in the range from 13.2 °B (Eldon) to 23.6 °B (Maya). The pulp per cent ranged from 44.56% (Kent) to 77.42 per cent (Osteen) (Fig. 9)

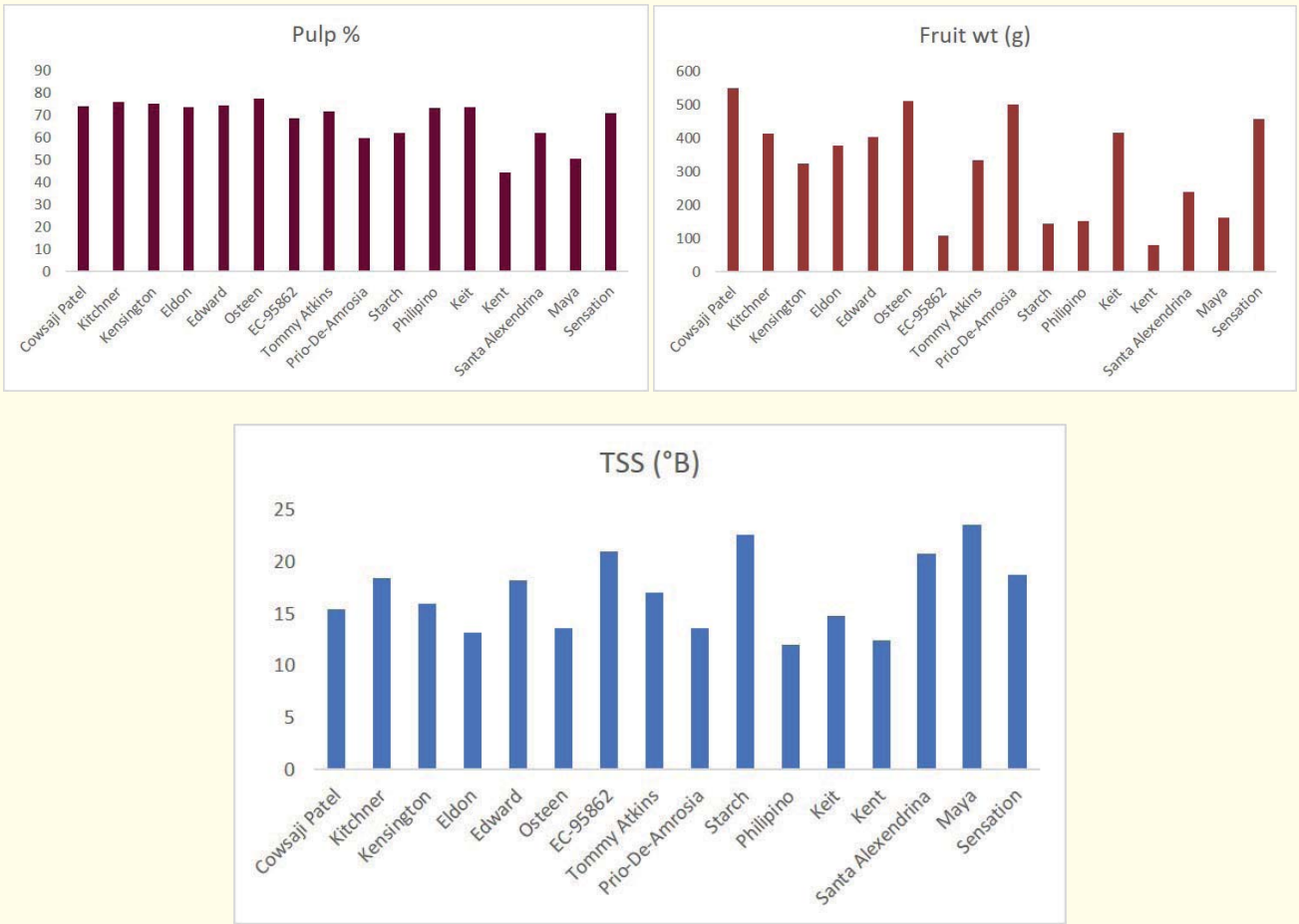


Fig. 9 : Fruit weight, TSS and pulp percentage of exotic mango varieties

Evaluation of hybrids

During 2022, a total of 258 hybrids were evaluated for fruit weight, fruit length, fruit breadth, stone weight, stone length, stone breadth, stone thickness, TSS and pulp per cent. For fruit physical parameters, the hybrids showed a wide range of variability. Out of the total number of hybrids evaluated, fruit weight in 40 hybrids ranged from 150 g to 200 g, from 200 g to 400 g in 183 hybrids and >400 g in 33 hybrids with a maximum weight of 727.0 g (Fig. 10). The majority of the hybrids had fruit weight ranging from 200 to 400 g, indicating the possibility of selecting hybrids with higher fruit weight. The TSS ranged from 9.40°B to 30.0°B. TSS of 15 to 22°B was found in the majority of hybrids, but some hybrids had TSS of >24°B (Fig. 10). The pulp percentage was found to be an important parameter, ranging from 36.40 percent to 79.54 per cent. Most of the hybrids had 65-75 per cent pulp.

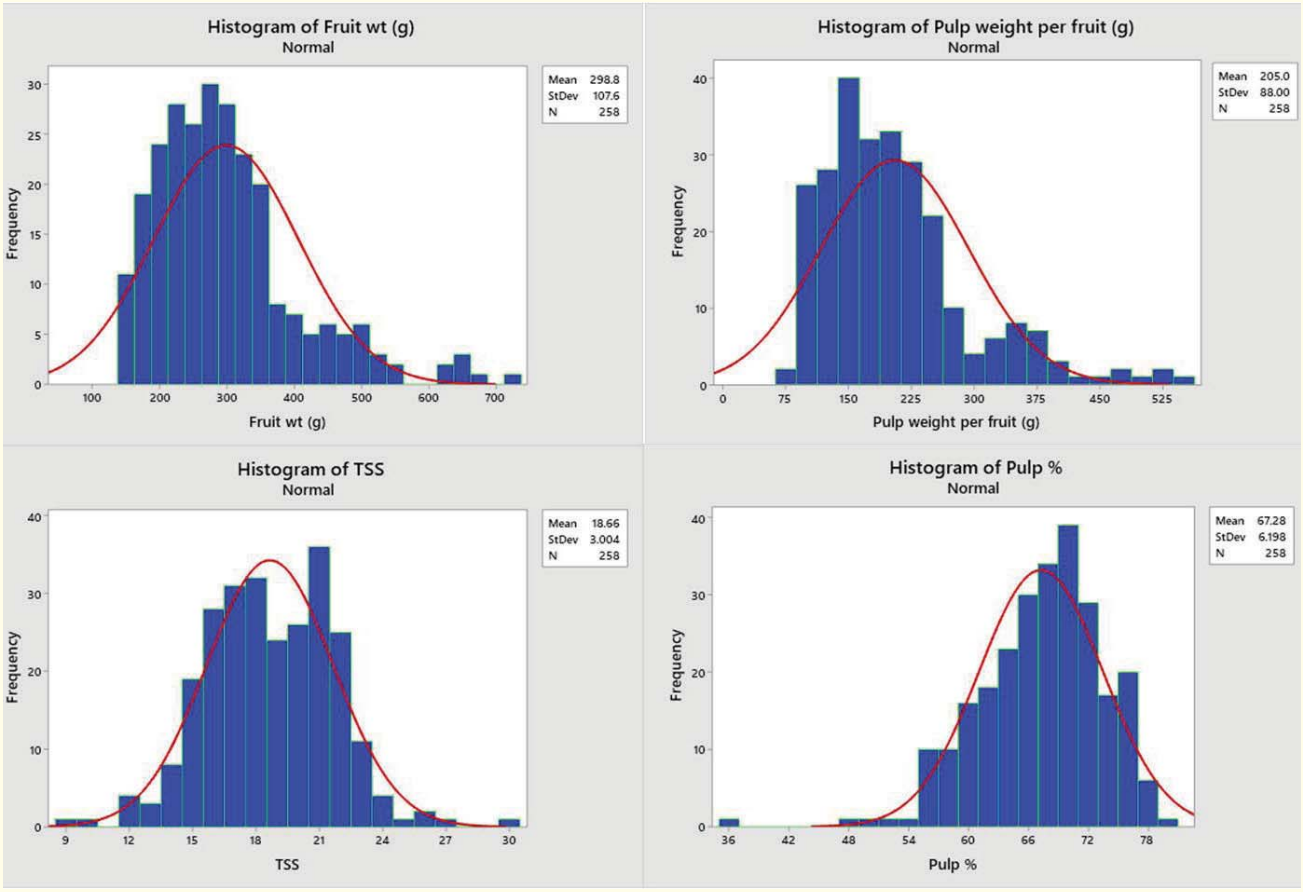


Fig. 10: Fruit weight, pulp weight, TSS and pulp percentage in different mango hybrids

Hybridization and establishment

During 2022, using 17 different cross combinations, 46305 flowers were crossed on 9220 panicles (Table 1). As a result, 487 mango hybrids fruits were obtained from the crosses made during 2021-2022, however, 284 stones germinated (Table 1). The basis for selection of cross combination during 2021-22 is given in Table 2. In 2020-21, 168 seedlings were raised from hybrid combinations to test the F1 progeny of mango hybrids.

Table 1. Hybrid seedlings from hybridization during 2021-22

S. No.	Cross combinations	Panicles used for hybridization	Number of flowers	Number of fruits set (on May 1, 2022)	Number of fruits harvested	No. of stone sown	No. of stone germinated
1	Amrapali × Vanraj	750	3163	8	7	7	2
2	Amrapali × H-1739	1100	5672	20	17	17	9
3	Amrapali × Tommy Atkins	1200	5893	379	288	288	200
4	Arunika × Mallika	1200	4660	14	14	14	5
5	Dashehari × H-1739	150	886	1	1	1	-
6	Dashehari × Tommy Atkins	950	5679	48	28	28	18
7	Mallika × Tommy Atkins	1820	11076	161	80	80	35
8	Osteen × Chausa	450	2368	18	7	7	-
9	Sensation × Chausa	50	779	15	8	8	1
10	Tommy Atkins × Chausa	450	1826	38	12	12	4
11	Kurukkan × H-13-1	150	685	12	5	5	4
12	H-13-1 × Kurukkan	250	910	14	8	8	1
13	Vellaikolumban × H-13-1	200	473	14	8	8	1
14	Kurukkan × Vellaikolumban	150	694	3	3	3	3
15	Vellaikolumban × Kurukkan	200	945	1	1	1	1
16	Vellaikolumban × Olour	137	497	1	-	-	-
17	Olour × Vellaikolumban	13	99	-	-	-	-
	TOTAL	**9220**	**46305**	**747**	**487**	**487**	**284**

Table 2. Basis for selection of cross combinations during 2021-22

S.N.	Cross combination	Q+C	RB	WA	AB
1	Amrapali × Vanraj	+	+		
2	Amrapali × H-1739	+	+		
3	Amrapali × Tommy Atkins	+	+	+	
4	Arunika × Mallika	+	+		
5	Dashehari × H-1739	+	+		
6	Dashehari × Tommy Atkins	+	+	+	
7	Mallika × Tommy Atkins	+	+	+	
8	Osteen × Chausa	+	+	+	
9	Sensation × Chausa	+	+	+	
10	Tommy Atkins × Chausa	+	+	+	
11	Kurukkan × H-13-1		+	+	+
12	H-13-1 × Kurukkan		+	+	+
13	Vellaikolumban × H-13-1		+	+	+
14	Vellaikolumban × Olour		+		+
15	Kurukkan × Vellaikolumban		+		+
16	Olour × Vellaikolumban		+		+
17	Vellaikolumban × Kurukkan		+		+

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

Augmenting genetic and genomic resources for mapping

Around 200 mango genotypes including mango germplasm, important parents used in breeding program, commercial hybrids and new mapping populations developed for enhanced peel characteristics and regular bearing habit (Amrapali × Sensation and Amrapali × Tommy Atkins) were used for DNA isolation and genotyping using GBS technology.

Genotyping for GWAS (SNP and SSR)

Around 176 genotypes were genotyped and total of 945210 SNV were identified using Alphonso as reference genome. Maximum variants were recorded in Chr 1 (76652) and least in Chr 20. Maximum SNVs were recorded in upstream (33.449%) and downstream genes (30.577%), indicating variations in cis acting regulatory elements which are crucial for gene expression. This opens up scope for identification of regions suited for gene editing and development of functional markers. The SNVs were used for exposing relationships among genotypes and NJ tree was drawn generated by Tassel (v.5.2.10) (Fig. 11).

Fig. 11: Kinship tree (NJ) based on GBS data

Phenotyping for component traits

Sixteen component traits of leaf and fruit was generated for the mapping population and subjected to multivariate analysis in which hierarchical clustering was carried out to find the pattern of Jaccard similarity coefficient using DARwin 5.0.128 software among the all cultivars and these matrix utilized for the construction of UPGMA based dendrogram. Principal Component Analysis was also performed. The high estimate of genetic advance was noticed for weight of fruit (230.31) and pulp weight (181.03). The correlation of leaf area was found to be significant and only positive with petiole length (0.652), weight of fruit (0.260), fruit width (0.238), fruit thickness (0.237), stone thickness (0.272) and pulp weight (0.268).

Identification of genes/proteins responsible for anthracnose resistance and shelf-life enhancement in mango

Transcriptome studies have revealed mechanism of the host pathogen-resistance and several genes are known to modulate this reaction related to JA, SA, NBS-LRR, ERF and other TFs. Further transcriptome has also identified anthracnose resistance induction by mango endophytic microbes. In a preliminary screening mango cv. Mallika exhibited moderate tolerance to *Colletotrichum gloeosporioides* and was used to exploit isolation of endophytes though peel metagenome and culturing techniques (Fig. 12). Certain potent microbes harboring post harvest anthracnose antagonism and ACC deaminase activity were identified and further validated under controlled conditions. Mango genotypes exhibiting enhanced ACC deaminase activity in peel will be tested and validated in the coming season.

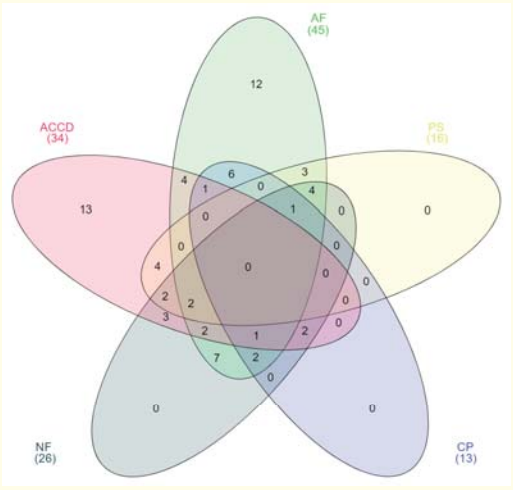


Fig. 12: Venn diagram showing the PGP characteristic of isolated endophytes

Metabolomic insights in floral and vegetative SAM in alternate and regular bearing varieties of mango

Flowering is a complex trait governed by several environmental cues, physiological and biochemical changes in the shoot apical meristem, and their molecular interplay which is also influenced by tree age and shoot maturity. It is one of the major pre-determining factors that contribute to alternate bearing besides affecting yield and production. Among physio-biochemical factors, endogenous hormones (auxins and gibberellins), phenols, carbohydrates, plant pigments and many other unknown factors have been implicated. We have utilized the HPLC analyses for floral and vegetative tissue of alternate and regular bearer mango. HPLC analysis showed variation for phenolic compounds namely gallic acid, chlorogenic acid, caffeic acid, p-coumaric acid, Ferulic acid, quercetin and kaempferol with specific retention times in the vegetative and floral bud samples (Fig. 13).

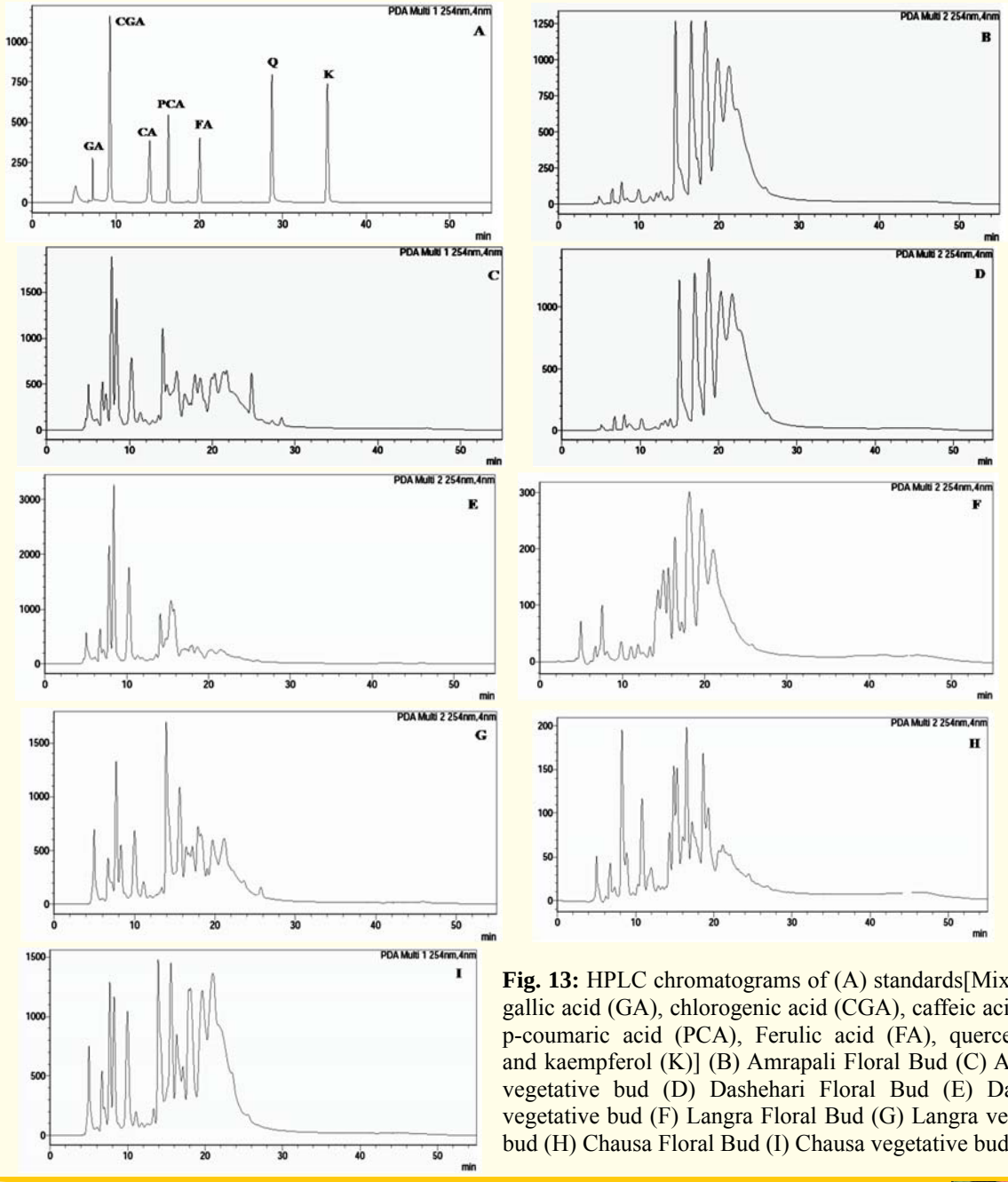


Fig. 13: HPLC chromatograms of (A) standards[Mixtures of gallic acid (GA), chlorogenic acid (CGA), caffeic acid (CA), p-coumaric acid (PCA), Ferulic acid (FA), quercetin (Q) and kaempferol (K)] (B) Amrapali Floral Bud (C) Amrapali vegetative bud (D) Dashehari Floral Bud (E) Dashehari vegetative bud (F) Langra Floral Bud (G) Langra vegetative bud (H) Chausa Floral Bud (I) Chausa vegetative bud

Manipulation of flowering using nanoformulation and its field evaluation

Nanoformulation was bioconjugated with AgNps using mango leaf extract for enhanced uptake of molecule which was done by basal application. Both cvs. Dashehari and Langra displayed early floral transition at least a fortnight prior to control. This was accompanied by better panicle characteristics including panicle size, number of flowers, and long anthesis period in comparison to control. Early and higher fruit set followed by better fruit size and weight were recorded. Incidence of Jhumka was also reduced in Dashehari due to early fruit set and avoidance of stenospermocarpy (Fig. 14).

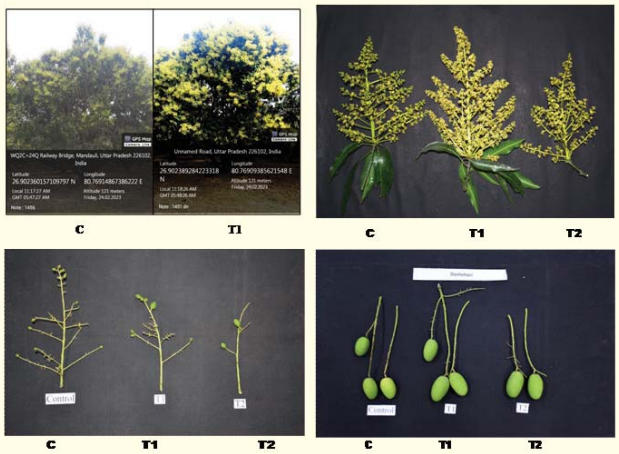


Fig. 14: Impact of Nano-formulation on early flowering, panicle growth characteristics, fruit set and fruit growth in cv.Dashehari

Biochemical and gene expression in mango during ripening

Mango bears two types of fruits (a) large stones with well developed cotyledon, radicle, and plumule and (b) Flat stones (parthenocarpic or separ) having an ill-developed cotyledon, radicle and plumule. Low-high temperatures during the flowering lead to production of parthenocarpic fruits, by reducing pollen viability and pollen tube growth in various mango genotype. We have observed reduction in shelf-life due to incidence of jelly seed disorder in mango fruits having normal stones (23%) and parthenocarpic ones (19%). Further, in normal stoned fruits, the cotyledon size increased with the size of the stone, while in parthenocarpic fruits the cotyledon size was significantly not altered. This shows that irrespective of stone size, the cotyledon size remains unaltered, although sufficient space is available for cotyledon and embryo to expand. Fully matured 'Dashehari' mangos when harvested in the first week of June, generally have more firmness and shelf-life due to lower jelly seed incidence than those harvested during last week of June. This shows that seed germination is not a requirement or cause of jelly seed disorder, as the symptom occurs in parthenocarpic mangoes that lack an embryo. The Ca^{2+} content in jelly pulp was lower than over ripe pulp. Our data is in accordance with data of previous workers that mango pulp without jelly symptom has more Ca^{2+} than jelly pulp. Moreover, during the study calcium deficiency symptoms were not manifested by the plants. This indicates that Ca^{2+} exclusively could not be the only factor that leads to this physiological malady. Ca^{2+} transporting and signaling genes expression was low in pulp affected with jelly compared to non-jelly affected pulp, that suggest Ca^{2+} content and Ca^{2+} associated gene are the major players that govern the shelf-life of mango fruit (Fig. 15).

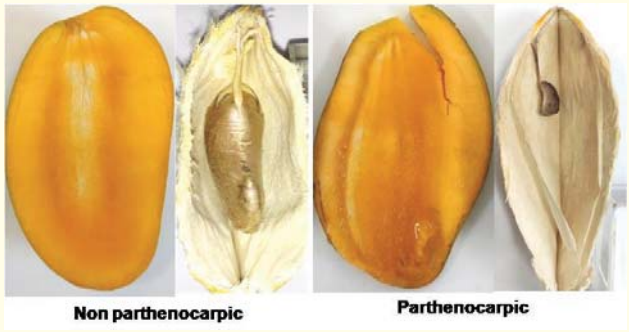


Fig. 15: Ripe Dashehari mango fruit without jelly seed with normal stone, cotyledon and parthenocarpic mango with jelly seed

Characterisation of ERFs, Pathogen responsive (PR), Calcium responsive and secondary metabolite genes under biotic stress

In transcriptome data of mango jelly seed several CDS associated with Pathogen responsive (PR), ERFs and secondary metabolites have

been recorded. Through RT-PCR analysis characterisation of ERF2, ERF39, RAP2-2, ERF3, CaATPase, PR3, PR5, PR7 and PR8, ANS, F^3H, C^4H, Peroxidase, MYC and MYB 5 was done in Amarpali leaf tissue subjected to 0 min, 5 min., 1 hr and 24 hr wounds. Study revealed that peroxidise, CaATPase, PR1 were act as early wound responsive genes, while calmodulin, ANS, F^3H, C^4H, PR2, PR3, PR8 RAP2-3 as mid responsive. MYC, MYB5, PR-5, PR7, ERF 3 and ERF 39 act as late responsive genes. Some of the genes were switched on during early phase, activate other TFs and further got down regulated (Fig. 16).

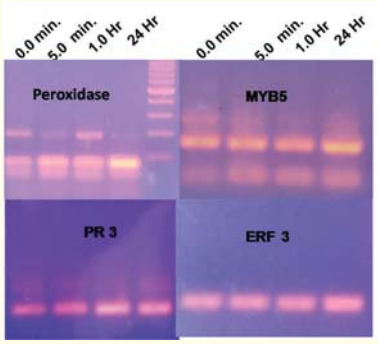


Fig. 16: Expression of different genes at different duration of biotic stress.

Guava (*Psidium guajava* L.)

Germplasm collection

The guava growing areas of Badaun and Farrukhabad districts of Uttar Pradesh were surveyed six guava accessions from Badaun and 4 from Farrukhabad were collected and characterized using fruit quality attributes. The fruit length varied from 5.92 cm (Ashraf Pink) to 7.12 cm (Kakrala). The fruit diameter ranged between 6.02 cm (Ashraf White) and 7.18 cm (Kakrala). The average fruit weight was the maximum (227.80 g) in Kakrala, and the minimum (134.75 g) in Baghar accessions. The fruit TSS was the minimum (9.40ºB) in Baghar and the maximum (11.34ºB) in Sakhanu accessions. The seed hardness varied between 12.46 kg/cm^2 (Ashraf White) and 13.69 kg/cm^2 (Saiyad Sakhanu). This reflects the good scope for selecting superior guava cultivars from the guava growing areas of Uttar Pradesh.

Field gene bank

Presently, about 160 different accessions of guava including 7 *Psidium* species are being maintained in the field gene bank. A total of 52 accessions were vegetatively multiplied in 2022 for gap filling in the field gene bank.

Evaluation of guava germplasm

A total of 40 guava accessions were evaluated using fruit quality attributes which revealed considerable genetic variability for traits of interests such as fruit weight, TSS and seed hardness. The fruit length ranged from 3.32 cm (*P. chinensis*) to 10.0 cm (Waiakea), fruit diameter from 2.66 cm (*P. chinensis*) to 7.94 cm (Behat Coconut), and fruit weight from 15.20 g (*P. chinensis*) to 315.0 g (5A Gangapur). The TSS varied from 8.0 °Brix (Spear Acid) to 12.62° Brix (Pear Shaped). Seed hardiness was the minimum (11.69 kg/cm^2) in Dhawal and the maximum (21.27 kg/cm^2) in Red Fleshed Gangapur.

Evaluation of guava hybrids and half-sib population

A total of 181 hybrid progenies were characterized using the fruit quality traits. The fruit length ranged between 4.76 cm (R24-P488) and 8.36 cm (HGL-610), and fruit diameter between 5.0 cm (R24-P488) and 8.82 cm (A23-P468). Similarly, the fruit weight varied between 73.48 g (R24-P488) and 403.80 g (A23-P468) with an average of 168.30 g. The pulp TSS ranged between 8.40ºBrix (R16-P320) and 14.68ºBrix (A6-P106) with an average of 11.41ºBrix. The seed hardness varied between 9.98 kg/cm^2 (R37-P1954) and 18.16 kg/cm^2 (R15-P314). This indicates good scope for developing superior guava cultivars by selection from the half-sib population.

Promising hybrids identified

Evaluation of half-sib population revealed that some red pulp hybrids were promising in terms of fruit weight, total soluble solids, fruit appearance and taste. Amongst the tested hybrids, HGL-610 (Purple Guava × Lalit) had average fruit

weight of about 325 g, TSS of about 11 ºBrix, attractive peel and pulp color, and excellent taste. Likewise, hybrid R13-P269 (Lalit x Purple Guava) had average fruit weight of about 240 g, TSS of about 12 ºBrix, attractive fruit appearance and good taste (Fig. 17).

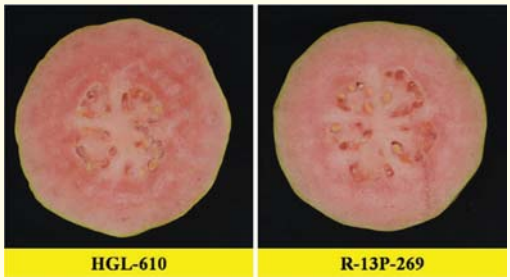


Fig. 17: Promising guava hybrids

Augmenting mapping population and developing genomic resource:

A mapping population of Lalit (L) × Purple guava (PG) was developed earlier by using Lalit as a female parent and Purple guava as the male parent. This cross combination was attempted for deriving segregating population for traits such as colored pulp and soft seededness as well as for developing new varieties towards accomplishing the breeding objective of pink pulp and soft seeded guava. Around 62 progenies in this mapping population maintained in the field gene bank were tagged and used for genotyping and phenotyping towards identification of QTLs. For developing novel genomic resources, 40 novel SSR markers were discovered and developed and validated in 19 guava germplasm, which included 11 commercially important cultivars/varieties and 8 *Psidium* species. Among them, 14 were highly polymorphic and able to discriminate all the accessions. The average heterozygosity index (Hi) was found to be highest for *mPg*SSR26 (0.4211). Polymorphic Information Content (PIC) ranged from 0.365 to 0.487 with an average of 0.410, while the resolving power (Rp) was found to vary between 0.211 (*mPg*SSR26-1) and 2.105 (*mPg*SSR37).

Genotyping for identification of QTLs/major genes:

Genomic DNA of 62 hybrid progenies (considered equivalent to F_2 generation) of L x PG mapping population was isolated from leaf samples and their quality was checked by 0.8% agarose gel electrophoresis. Parental polymorphism survey of Lalit and Purple guava was done using 80 SSR markers from which 28 markers were selected to be discriminatory markers for the parents. Genotyping of the F_2 progenies of the L x PG mapping population was performed using the 28 discriminatory markers and the progenies were scored for the presence of AA, BB or AB alleles per SSR marker. The genotyping data was analyzed statistically which indicated that maximum progenies (> 90%) have inherited B allele of purple guava also confirming the hybridity. Cluster Analysis and Principal Component Analysis also confirmed the hybridity as well as indicated the level of the genetic relatedness of the hybrid progenies with the parents (Fig. 18 and 19).

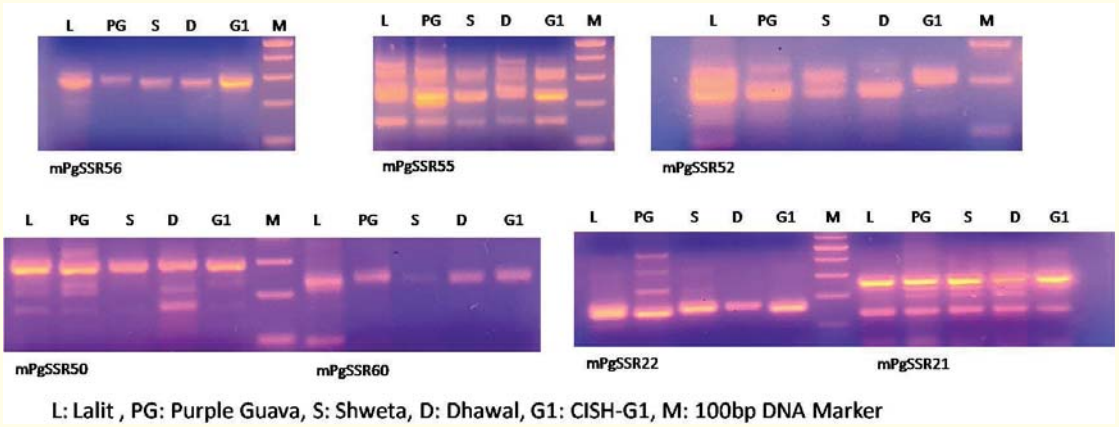


Fig. 18: Parental polymorphism survey of SSR markers for identification of discriminatory SSR markers for the parents to be used for genotyping

Phenotyping for component traits (fruit)

Phenotyping of 62 progenies of a mapping population generated from a cross involving Lalit x Purple guava was performed for 16 morphological quantitative traits and 35 DUS descriptors during 2022-23. Fruit weight had positive and strong correlation with fruit length and fruit width. Moderate and lesser correlation were observed for other traits.Both phenotype and genotype data would be used for QTL detection.

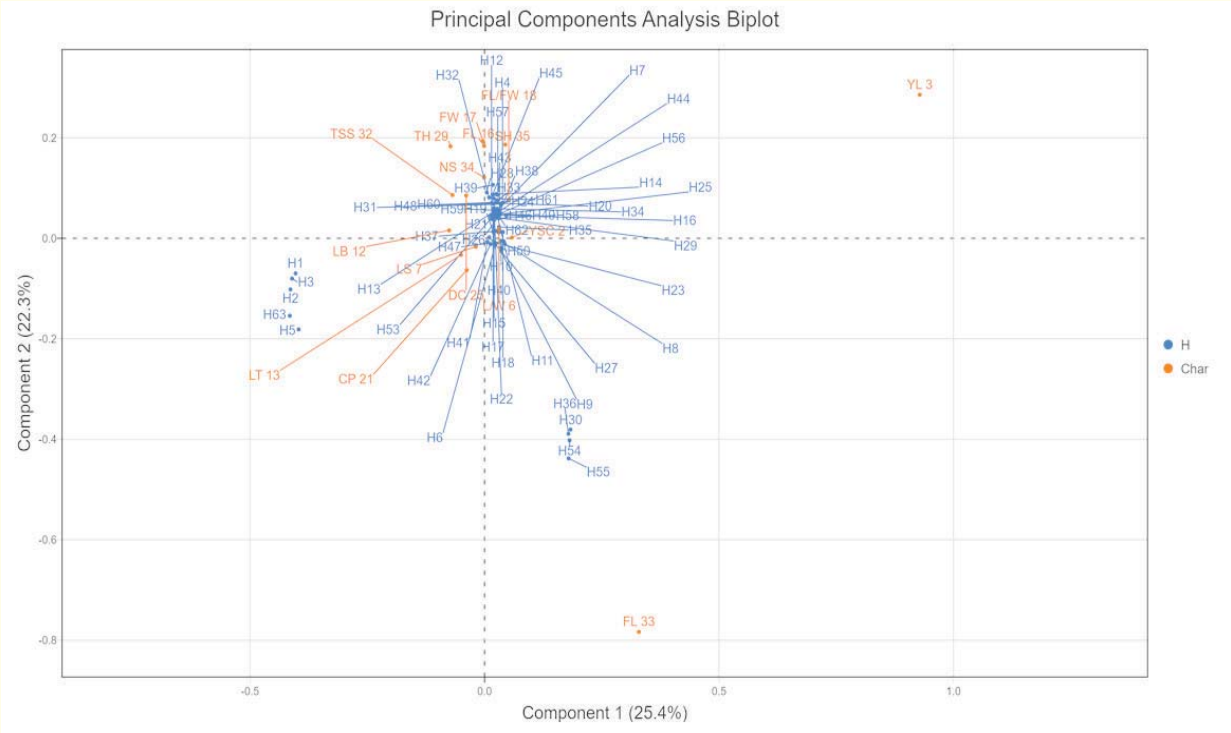


Fig. 19: PCoA analysis of morphological traits in the 62 hybrid progenies of Lalit x Purple Guava mapping population

Transcriptome analysis in guava

We have mined 15 distinct MYB transcription factor genes/transcripts viz *PgMYB3*, *PgMYB4*, *PgMYB23*, *PgMYB86*, *PgMYB90*, *PgMYB308*, *PgMYB5*, *PgMYB82*, *PgMYB3114*, *PgMYB6*, *PgMYB305*, *PgMYB44*, *PgMYB51*, *PgMYB46* and *PgMYB330*. On analysis, it was found that R2-MYB and R3-MYB domains are conserved in all known guava MYB proteins. The expression of six different MYB TFs was examined using semi-quantitative RT-PCR in Shweta pulp, Lalit pulp, Lalit root, and Lalit seed. Data revealed that MYB genes have functions in both development and ripening. MYB genes may be involved in pulp colour as well as fruit and root development, according to the expression patterns seen in fruit and roots (Fig. 20).

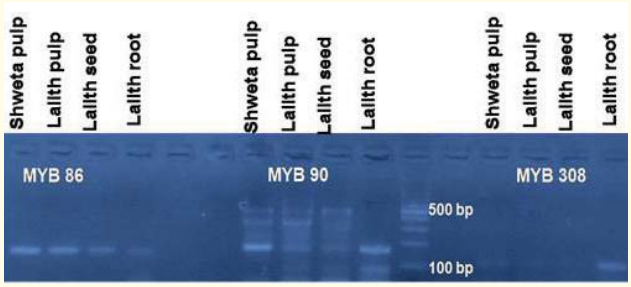


Fig. 20: Expression of MYB TFs in different tissue of guava

Bael (*Aegle marmelos* Corr.)

Germplasm collection

Surveys in the parts of district Gonda and Bahraich (U.P.) were carried out and 10 accessions were collected and passport data were recorded. Fruit samples were analysed for various physical and biochemical parameters. The fruit weight

ranged from 234.33-1033.67 g, fruit length from 14-18 cm, fruit diameter from 26.00-39.33 cm, shell weight from 38.23-100.20 g, no. of seeds/fruit from 90.67-182.00, TSS from 34.58-38.73^{0}B, acidity from 0.33-0.63%, total sugar from 16.46-20.07%, reducing sugars from 7.93-9.43% and total phenols from 1.90-2.81% among different accessions. On the basis of preliminary evaluation, one accession (T-10) was found promising. The scion shoots were collected and grafts prepared for planting in coming monsoon (Fig. 21).

Fig. 21: Bael accession (T-10)

Clonally multiplied germplasm evaluation

Forty three vegetative multiplied bael accessions are maintained in the field gene bank for evaluation. During 2022, twenty two accessions were analysed for physico-chemical parameters. The fruit weight ranged from 855.67-2280.00 g, fruit length from 14-21.86 cm, fruit circumference from 38.43-53.17 cm, no. of seeds/fruit from 62.00-191.00, shell weight from 132.55-248.36 g, shell thickness from 2.13-3.47 mm, no. of seed sacs/fruit from 12.00-18.00, seed weight/fruit from 8.03-25.77 g and fruit yield from 16.47-61.27 kg/plant among the different accession. With regard to chemical evaluation,TSS ranged from 33.97-40.98°B, acidity from 0.32-0.64%, vitamin C from 12.97-25.64 mg/100 g pulp and total sugars from 16.80-22.12% among the different accessions. On the basis of overall assessment the accessions T_{37} having higher fruit weight (1187.00 g/fruit), fruit yield (55.67 kg/plant), TSS (38.85°B), less seed percentage (0.72%), shell thickness (2.47 mm), high vitamin C (13.17 mg/100g pulp) and total phenols content (2.19%) was found to be the most promising at the age of fourteen years (Fig. 22).

Fig. 22: Elite bael germplasm line selection (T-37) A, B, C

Seedling germplasm

One hundred thirty eight seedlings raised from promising bael genotypes collected from different parts of U.P, Bihar and M.P. were planted during the year 2003. Among them 23 seedling genotypes were evaluated for their physico-chemical parameters during the year 2022. The fruit weight varied from 971.67-1847.33 g), fruit length from 11.32-22.36 cm, fruit circumference from 36.92-48.52 cm, no. of seeds/fruit from 66.00-190.00, no. of seed sacs/fruit from 13.00-16.00, shell weight from 116.40-270.33 g, shell thickness from 2.20-3.66 mm, pulp percentage from 82.28-89.01% and fruit yield from 15.47-48.67 kg/tree among different accessions. With respect to chemical parameters, TSS varied from 36.27- 42.94°B, acidity from 0.33-0.63%, vitamin C content from 18.62-26.34 mg/100 g, total phenol content from 1.66-2.84% and total sugars from 17.94-22.81%. On the basis of overall assessment, one seedling genotype *i.e.* S-31 having higher fruit weight (1117.0 g), fruit yield (48.67 kg/tree), TSS (42.94 °B), seed weight (9.37 g), less shell thickness (2.45 mm), high vitamin C content (25.46 mg/ 100 g pulp) and total phenol content (2.66 %) was found to be most promising (Fig. 23).

Fig. 23: Bael seedling genotype S-31

Genomic Resources

Around 11 SSR markers were developed from transcriptome resources and validated in 8 bael germplasm lines. These polymorphic markers would be used for fingerprinting of bael germplasm.

Aonla (*Emblica officinalis* Gaertn)

Germplasm collection

Rewa, Satna and Shahdol districts of Madhya Pradesh were surveyed, 24 accessions were collected and passport data were recorded. Fruit samples were analysed for various physical and biochemical parameters. The fruit weight varied from 7.4-42.5 g, fruit length from 24.2-45.3 mm, fruit diameter from 20.6-37.6 mm, stone weight from 0.6-2.7 g, TSS from 6-13°B, vitamin C from 312.5-675 mg/100 g pulp, acidity from 0.89-2.17% and total phenols from 0.91-2.6% among different accessions. Based on these parameters accessions i.e; A-6, A-17 and A-20 were found superior. The scion shoots of these accessions have been collected and grafted plants are being maintained in nursery (Fig. 24).

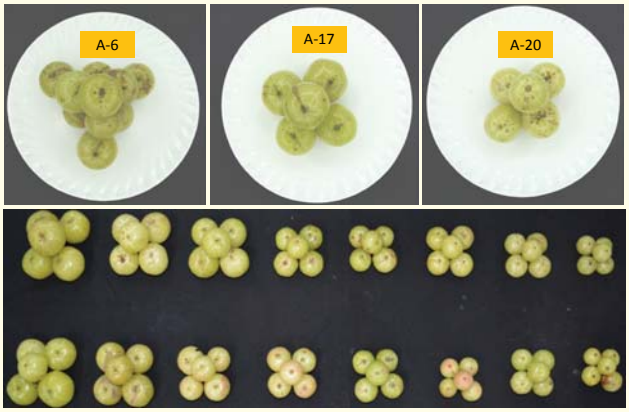


Fig. 24: Aonla accessions A-6, A-17 and A-20

Evaluation of germplasm

Ten aonla accessions, being maintained in field gene bank, were evaluated for physico-chemical properties. The fruit weight varied from 23.53-34.50 g), fruit length from 25.0-37.13 mm, fruit width from 30.46-43.9 mm, TSS from 8.4-9.8°B, acidity from 2.12-3.12%, vitamin C from 311.25-490.13 mg/100 g pulp and total phenols from 0.67-1.76% among the evaluated germplasm. CISH-A-10 has shown the maximum quality attributes *i.e.*, vitamin C content (409.12 mg/100 g pulp), total phenols (1.76%), TSS (9.4°B), acidity (2.61 %), with fruit weight of (33.41 g). followed by CISH-A-8 *i.e.*, vitamin C content (397.07 mg/100 g pulp), total phenols (1.20 %), TSS (9.3°B), acidity (2.54%), with fruit weight of 33.41 g (Fig. 25).

Fig. 25: Aonla accession CISH-A-10

Jamun (*Syzizium cuminii* Skeel)

Collection and characterization of germplasm

The variability in jamun from road side areas of Lucknow, Ayodhya and Siddharthnagar districts of Uttar Pradesh was surveyed during the 2022 fruiting season. A total of 10 accessions from Lucknow, 6 from Ayodhya and 7 from Siddharthnagar were characterized using the leaf descriptors and fruits quality traits. The average fruit length varied between 1.01 cm (Siddharthnagar-4) and 3.77 cm (Siddharnagar-7). Fruit diameter ranged between 0.85 (Lucknow-4) and 2.84 (Siddharnagar-7). The seed length ranged between 0.74 cm (Siddharthnagar-4) and 2.26 cm (Siddharthnagar-5), and seed diameter between 0.41 (Siddharthnagar-4) and 1.53 cm (Ayodhya-4). The maximum average fruit weight of 17.66 g and pulp content of 91.07% were recorded in Siddharnagar-7 (Fig. 26). Its fruits had an average TSS of 15.10 ºBrix. Based on overall assessment, accession Siddharthnagar-7 was found promising, and was multiplied for further evaluation.

Fig. 26: Fruits of jamun accession Siddharthnagr-7

Characterization of accessions

A total of 25 jamun accessions, being maintained in the field gene bank, were characterized using fruit quality attributes. The average fruit length was the maximum (3.46 cm) in J-15 and the minimum (1.03 cm) in J-43. The fruit diameter varied between 0.86 cm (J-43) and 2.48 cm (CISH Jamwant). Only two accessions *viz*. CISH Jamwant and J-15 had average fruit weight of about 15 g, while it was mostly below 10 g in other accessions. The seed length was the minimum (0.75 cm) in J-43 and the maximum (2.18 cm) in Konkan Bahadoli. The seed diameter varied between 0.23 cm (CISH J-42) and 1.24 cm (Gokak-2). The seed weight was the minimum (0.69 g) in CISH J-42, and the maximum (2.27 g) in Konkan Bahadoli. The TSS ranged between 11.73 ºBrix (Gokak-1) and 19.49 ºBrix (J-576). Accession J-15 had very high pulp content (>90.0 %). Based on the higher mean fruit weight (14.98 g), pulp content (92.55%), and TSS (16.76 ºBrix), accession J-15 was found to be promising.

Genomic resources

Two Jamun transcriptome sequencing libraries were used for mining SSR containing contigs. More than four thousand SSR containing contigs were identified and they have been used for developing primers for simple and compound SSR which will be validated in Jamun genomic DNA for DNA fingerprinting and diversity analysis. Around 10 SSR markers developed for guava were used for Jamun (Family Myrtaceae) SSR marker development as well (Fig. 27).

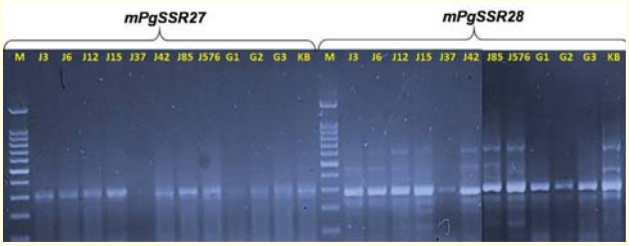


Fig. 27: Development of m*Pg*SSR markers and its PCR validation in Jamun germplasm.

Seedlessness in Jamun

The fruit development studies of CISH J-42 and CISH J- 37 (Jamwant) revealed embryo and endocarp disintegration in CISH J-42 and growth retardation 25 days after anthesis. Scanning electron microscopy revealed thin epicarp and mesocarp (50 micron) made up of irregularly formed parenchymatous cells ranging from 10-20 micron in size as compared to uniform parenchyma in J-37. Abnormal endocarp and absence of seedcoat are other characteristics of the seedless fruits. Further, there is distinct morphological variation in seed embryo also, indicating anomaly in seed morphogenesis and disintegration of embryonic mass. These characteristics indicate operation of late acting incompatibility (Fig. 28).

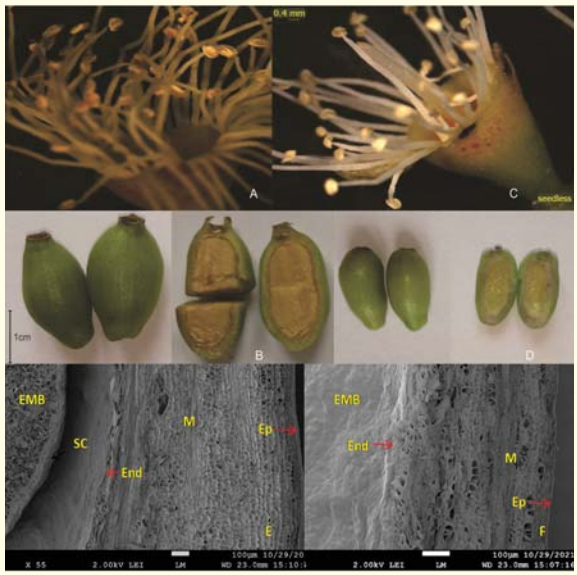


Fig. 28: Seedlessness mechanism explored in Jamun J-42**.** A) Flowers of CISH-J-37 (Jamwant) and CISH-J-42. B) Fruits whole and longitudinal sections of CISH-J-37 (Jamwant) and CISH-J-42. C) SEM image of CISH-J-37 (Jamwant) and CISH-J-42.

Banana (*Musa paradisiaca*)

Design and development of a novel bioreactor

The bioreactor consists of polycarbonate body which is transparent and can withstand heating up to 121^{0}C. The double Decker bioreactor is self illuminated with detachable media reservoir. The gases are passed through 0.2 micron sterile filters connected by silicon tubes to the inlets/outlet. The middle filter is connected by a silicon tube to the lower chamber. The bottom of the upper chamber has five nipples out of which one nipple goes through upper chamber to lower chamber with 10 mm on upper side and 10 mm in lower side. Other

four nipples open in the lower chamber only. These four nipples transfer nutrient medium from lower chamber to upper chamber while twin side nipples transfer sterile air to the lower chamber, It is designed in a way to allow nutrients to rise efficiently when pressure is applied. The system is connected with two pneumatic pumps and a solenoid valve for pushing the nutrient medium to the upper chamber. The system is connected with two timers.

Bioreactor mediated micropropagation of bio-immunized banana cv. G-9

Temporary Immersion Bioreactor System developed by CISH was compared with solid phase tissue culture system for micropropagation of bio-immunized plants of banana variety G-9. The medium and culture conditions were kept the same. Bioreactor medium did not contain agar as a gelling agent. The immersion frequency of 3 minutes at 6 hour interval was kept for TIS bioreactor whereas constant exposure to medium was maintained in Solid Phase Tissue Culture system. Both the systems were studied for various morphological characters. It is evident from table 3 that plant height, fresh weight of plant, shoot diameter, no. of roots and root biomass were got significantly improved under temporary immersion bioreactor compared to conventional tissue culture (Table 3).

Table 3. Evaluation of TIS vs. Solid Phase TC of banana cv. G-9

TC systems	SC Cycle	FW of plants (mg)	DW of plants (mg)	Shootheight (cm)	No. of leaves	Shoot Diameter	No. of roots	Length of roots (cm)	FW of roots (mg)	DW of roots (mg)
TIS	I	1015.67^{b}	69.33^{d}	6.57^{bc}	4.00^{ns}	3.21^{cd}	6.00^{b}	3.03^{d}	346.33^{c}	159.67^{b}
	II	1093.00^{a}	85.67^{b}	7.40^{ab}	5.00	3.80^{ab}	8.00^{a}	3.87^{c}	439.33^{a}	168.67^{a}
	II	1116.67^{a}	91.00^{a}	7.93^{a}	5.00	3.96^{a}	8.00^{a}	5.80^{a}	434.67^{a}	171.67^{a}
SPTC	I	950.00^{bc}	79.67^{c}	6.23^{c}	4.00	2.87^{d}	5.00^{b}	3.33^{d}	302.33^{d}	152.67^{c}
	II	932.33^{c}	80.67^{c}	6.50^{bc}	5.00	2.88^{d}	6.00^{b}	3.30^{d}	405.00^{ab}	155.00^{bc}
	II	1000.33^{b}	86.67^{b}	6.77^{bc}	5.00	3.51^{bc}	7.00^{a}	4.80^{b}	372.33^{bc}	154.33^{bc}
CD		0.9964	3.77	0.84	1.23	0.395	0.996	0.506	40.275	6.151

The plants developed through TIS had higher shoot and root biomass with higher girth of the shoot. However, number of leaves remain unaffected in both kinds of tissue culture system. The height of *in vitro* plants remained at par in first sub culture cycle. However, from 2nd sub culture cycle, plant height registered significant enhancement under TIS as compare to conventional tissue culture system. Shoot biomass is one of the indicators for higher growth rate in tissue culture studies. Higher shoot biomass also indicated better survival of plants during acclimatization phase. It is clearly indicated from Fig. 29 (i) that 30% higher shoot biomass was achieved by plants kept in bioreactor as compared to traditional tissue culture system. Shoot/Root biomass is another strong indicator for higher survival of plants during primary and secondary stage. The data clearly suggested (Fig. 29 (ii)) TIS mediated plants registered higher shoot to root ratio than in conventional system.

Fig. 29: (i) Shoot biomass as affected by type of tissue culture system **(ii)** Shoot/Root biomass in TIS and SSP tissue culture system

A higher regeneration frequency was observed in TIS system in banana cv. G-9 up to three subculture cycle. In 3 weeks time 86% regeneration frequency was observed in TIS where as only 64% in conventional system. A total of 18% enhancement in regeneration of shoots was observed in TIS system owing to better uptake of liquid medium, availability

of larger explants surface for absorption of medium and lack of hyper-hydricity due to gaseous exchange.

Primary hardening is one of the most crucial stages in the micropropagation of any crop. TIB generated tissue cultured plants were taller (20.3 cm), thicker at base (5.94 cm) with significantly higher biomass which leads to higher survival of primary hardened plantlets. Other parameters such as number of leaves, no. of roots, length of roots etc were statistically non significant (Table 4).

Table 4. Effect of TIS bioreactor on primary hardening of TC plants of banana

TC systems	FW of plants (mg)	DW of plants (mg)	Plant height (cm)	No. of leaves	Plant width	No. of roots	Length of roots (cm)	FW of roots (mg)
TIS	3698 ^{ns}	942.333^{a}	20.30^{a}	5.333 ^{ns}	5.94^{a}	18.00 ^{ns}	11.067 ^{ns}	364.333 ^{ns}
SPTC	2054 ^{ns}	664.333^{b}	14.367^{b}	4.667 ^{ns}	3.897^{b}	14.00 ^{ns}	9.733 ^{ns}	244.667 ^{ns}
CD	NS	193.138	2.363	NS	1.375	NS	NS	NS

Physiological status of TIS *vs* Solid phase tissue culture regenerated plantlets of banana

The plants being multiplied in TIS bioreactor and solid phase tissue culture system of similar age during *in vitro* multiplication phase were subjected to different physiological parameters such as chlorophyll a, chlorophyll b, total chlorophyll, chlorophyll ratio a/b and caretenoids. It is evident from the data that cholorophyll and caretenoid were higher in TIS. However, the data was non significant for all the variable except chl b. Although a very interesting scenario was observed when plants were analyzed during primary hardening stage. TIS regenerated leaves of plants registered significantly higher chlorophyll a, chlorophyll b, total chlorophyll, chlorophyll ratio a/b and caretenoid as compared to solid phase tissue cultured plants (Table 5).

Table 5. Effect of TIS and SSTC on chlorophyll and carotenoid during *in vitro* stage

	Chl a	Chl b	Total Chl	a/b	Carotenoid
TIS	5.377^{a}	0.197 ^{a}	5.577 ^{a}	27.34 ^{a}	1.397 ^{a}
SSP	4.777^{b}	0.153 ^{b}	4.933 ^{b}	31.093 ^{b}	1.09 ^{b}
CD	0.4	0.026	0.406	NS	0.224

Division of Crop Production

Mango (*Mangifera indica* L)

Canopy architecture management in young plants for higher productivity in mango

The experiment comprised of T_1 (3 Primary branches and 2 secondary branches), T_2 (4 Primary branches and 2 secondary branches), T_3 (3 Primary branches and 3 secondary branches), T_4 (4 Primary branches and 3 secondary branches) and T_5 (without canopy management as control).

At seven years after plantation, canopy spread (within the row and between the rows) were respectively increased by 91.16 and 57.65 per cent in T_1 which was statistically at par with T_3 for canopy spread between the rows (49.94%), as compared to T_5 (control). Primary branch girth was significantly higher in T_1 and T_3 by 25.04 and 10.07 per cent, respectively, as compared to control. The same treatments also had maximum trunk cross-sectional area and secondary branch diameter, although found statistically non-significant.

Fruits were harvested during the month of June, 2022 and grouped based on different grades, viz. Grade A ($\geq$ 250 g), Grade B (200-250 g), Grade C (150-200 g) and Grade D ($\leq$ 150 g). The T_1 and T_3 had maximum number of 'A' grade fruits (44.42 and 22.53% more than control, respectively) and control had highest number of 'C' grade fruits, whereas fruits of 'B' and 'D' grades were non-significant among the treatments. There existed non-significant difference among the treatments with respect to number of fruits per tree, however average individual fruit weight was 46.43 and 45.77 per cent more in T_1 and T_3, respectively, as compared to control. Fruit yield was significantly increased by 46.14 and 33.89 per cent in T_3 and T_1 over control, respectively and the same treatments also exhibited higher yield efficiency (39.42 and 13.20% more than control, respectively).

Evaluation of various rejuvenation methods

Treatments included heading back of primary branches to varying heights and in different training systems. The treatments were compared with performance of mango trees under old ICAR-CISH rejuvenation technology (T1-Control) wherein trees are headed back to 2.5-3.5 m height in one go. In case of T-2, central leader was kept higher (4-4.5 m) with side branches headed back to 2.5-3 m height while in T-3 central leader was restricted to 2.5-3 m with side branches upto 1.5-2 m height. In case of treatment T-4, open vase system was aimed with central leader restricted to 2.5-3 m height with side branches headed back to 4-4.5 m height. In case of T-5 and T-6, after thinning out of central leader, two branches/year and one branch/year were headed back to complete the process in 3 and 5 years, respectively

Trees exhibited vigorous growth in all the directions. This was relatively off year but partial to full flowering was observed in all the trees and average fruit yield varied from 6.7 kg to 24.68 kg/tree among different treatments. Treatments included different cutting/heading back intensities to rejuvenate the trees. The treatment with heading back of two branches/year to complete the process in three years gave the best tree shape and fruit yield. Individual fruit size among different treatments varied from 303 to 338 g/fruit. Enhanced fruit size was due to relatively vanation in TSS because of canopy management reduced fruiting this year. Total soluble solids varied from 16-19°B while ascorbic acid contents varied from 22.9 to 31.25 mg/100 g.

Physiological studies in refinement of rejuvenation technology in mango

Six year after rejuvenation direct light availability at marble stage ranged from 38-55 per cent, photosynthesis rate, stomatal conductance and vapour pressure deficit during different phenological stages ranged from 6.22-13.17 µmol $CO_2/m^2/s$, 61 to 183 mol $H_2O/m^2/s$ and 1.03 to 3.61 kPa respectively. Maximum value of gas exchange parameters was found in T5. In addition total glutathione and ascorbate were also the maximum in T5 i.e., 316.27 µmol/g fresh weight and 12.63 mmol/g fresh weight respectively. Rejuvenation of old and senile of mango orchards as in T5 may be a suitable strategy (Fig. 1-2).

Fig. 1: Centre opening by two branch thinning

Fig. 2: Fruiting in cetnrally opened mango trees cv Dashehari

Centre opening in mid-age mango orchard cv Dashehari

This was fourth year of experiment. The experiment was started with a view to giving proper shape to over-grown trees of mango Dashehari to facilitate light penetration, improve yield and quality of fruits through centre opening. The treatments comprised removal of one, two, three centrally located branches, crown thinning and control (no pruning). Pruning was done in January 2019 with partial thinning every year in December. During the period under report, fruit yield varied from 14 to 37 kg/tree being relatively off year. Highest fruit yield was recorded in two branch cutting from the centre followed by three branch cutting (34 kg/tree). Fruit size varied from

249 g to 314 g/fruit. Total soluble solids ranged between 16-18^{0}B while acidity and ascorbic acid contents of fruit varied from 0.17-0.23% and 33.3 to 43.8 mg/100g. As a result of centre opening, significant reduction in tree height was recorded. Tree height in T-2 (2 branch cutting) ranged in between 5.1-7.9 m while it was 11.7 to 12.2 m in case of control (no pruning). This facilitated various horticultural operations like spraying and also reduced incidence of hoppers and thrips as compared to dense canopied trees.

Physiological studies

Low light is a subtle abiotic stress in old mango orchards. To regulate the light availability in approximately 39 year old orchard, one center branch removal, two center branch removal, three center branch removal and 50% crown reduction were imposed in January 2019. Three years after center opening direct light availability beneath the trees increased from 22-55%, leaf chlorophyll content ranged from 5.98-7.69 mg/g fresh weight, net assimilation rate from 6.12-10.33 µmol CO_2/m^2/s, stomatal conductance 131.37-178.44 mol H_2O/m^2/s and vapour pressure deficit 1.95-3.06 kPa. In addition, membrane lipid peroxidation varied from 2.77- 6.33 n mol MDA formed. mg^{-1} protein. hr^{-1} was recorded. Light is an important environmental factor for vital functions in plants. Regulation of light through center opening is crucial to improve productivity.

Canopy reorientation in overcrowded and unproductive mango orchard var 'Dashehari'

The sub-project is being concluded during 2023 High density planting system of mango var. Dashehari planted in 1993-94 at 2.5 × 2.5 and 2.5 × 5.0 m spacing was unproductive after 13-15 years, due to no proper canopy management practices. The orchard was put under severe pruning at different heights with organic mulching for maintaining moisture. The findings revealed that 1.5-2.0 m pruning height is best. The flowering started 2 year after pruning in the trees which were pruned at 2.5 m pruning height. The trees pruned at 1.5 m height registered fruiting after 3 to 4 years. The trees pruned at 1.5 m height had low yields and those with 2-2.5 m pruning heights had initially high yield but as the trees advances in age the yield in 1.5 m pruning height increased and in 25 m pruning heights declined. Maximum average yield per tree (8-12 kg/tree) recorded in P1 & P2 pruning heights. However, the projected average yield recorded 8-9 t/ha in HDP mango orchard planted (800 trees/ha) after scientific interventions. Overall, yield and other cultural operations point of view 2.5 × 5.0 m spacing is best in HDP mango. The treatment combination S2P2M1 (2.5 × 5.0 m, 2.0 m pruning height, with mulching basin recorded maximum (84.08%) fruits of 'A' grade (Fig. 3-4).

Fig. 3: Bearing in 2.5×5.0 m spacing, pruning height 1.5 m after 6 years in HDP Dashehari

Fig. 4: Pruing in 2.5×5.0 m spacing after 6 years severe pruning treatment in HDP Dashehari

Drip irrigation and fertilizer scheduling for productivity and quality of HDP mango

Drip/fertigation scheduling based on canopy skirt area as influenced the growth, yield and quality of mango cv. Amrapali under HDP. The observations on fruit growth at periodical intervals (16th April, to 30th June, 2022) indicated that maximum fruit growth (42.22, 38.63 and 42.4%) were recorded during 16th May 2022 in drip irrigation treatments (Fig. 5).

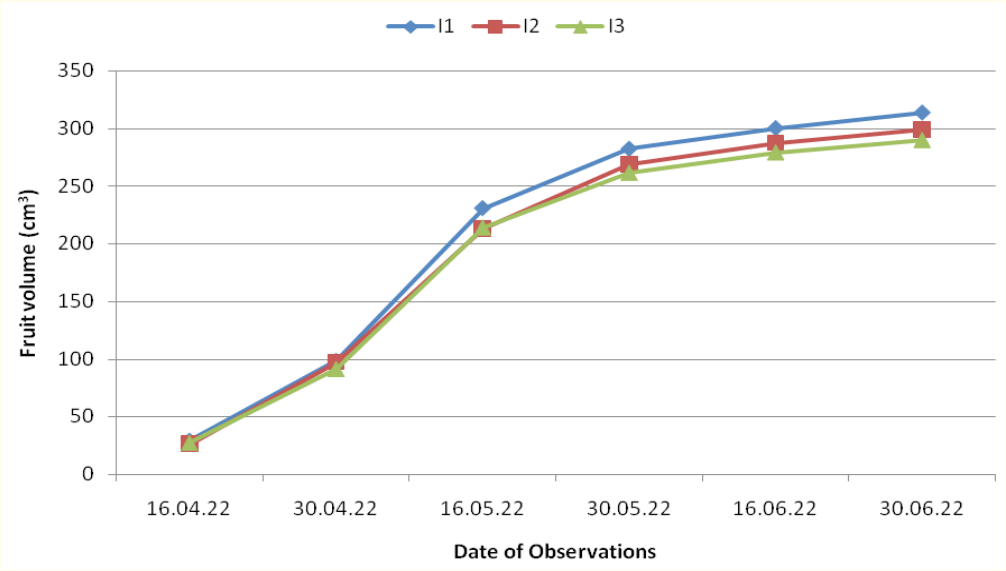


Fig. 5: Drip and fertilizer scheduling impacting fruit productivity

Similar fruit growth observations recorded in second factor i.e., fertigation scheduling treatment indicated that maximum fruit growth (41.68, 39.59 and 42.14%) was observed during 16th May 2022 in Amrapali mango under HDP.

Evaluation of filler crops for enhanced profitabity of rejuvenated mango orchard

Tree height of rejuvenated mango trees varied from 5.0 m to 7.9 m. Canopy spread in east-west direction was 5 to 9 m while it was 5.5 to 8.3 m in north-south direction. Trees exhibited vigorous growth in all the directions. This was relatively off year but partial to full flowering was observed in all the trees and average fruit yield varied from 14.65 kg to 35.33 kg/tree. Individual fruit size varied from 321.6 to 361 g/fruit. Enhanced fruit size was due to relatively reduced fruiting this year.

Physiological studies in rejuvenated mango orchard

Six years after rejuvenation, at marble stage of fruiting availability of diffuse light beneath the non rejuvenated and rejuvenated trees was 73.11 per cent and 35.79 per cent respectively. Net assimilation rate was 7.56 and 14.67 µmol $CO_2/m^2/s$ in the leaves of non-rejuvenated and rejuvenated trees respectively. Likewise, stomatal conductance was 112.67 and 221.48 mol $H_2O/m^2/s$ in non-rejuvenated and rejuvenated trees respectively. Vapour pressure deficit was more in rejuvenated trees (3.53 kPa) as compared to non-rejuvenated trees (1.44 kPa). Leaf chlorophyll content was higher in rejuvenated trees (7.86 mg/g FW) than in non-rejuvenated trees (5.07 mg/g FW). In rejuvenated trees, total and reduced glutathione were found to be more i.e., 293.67 µmol/g fresh weight and 2567.24 µmol/g fresh weight respectively whereas in non rejuvenated trees it was 153.67 59 µmol/g fresh weight and 115.78 59 µmol/g fresh weight. In non rejuvenated trees, epicuticular wax content was 0.29 mg/cm² leaf area whereas in rejuvenated trees it was 0.61 mg/cm² leaf area. Leaves of rejuvenated trees are more exposed to direct sun light and are better customized for variable environmental conditions.

Performance of filler crops

Different short statured fruit crops were grown as filler crops such as guava cv CISH-Shweta, CISH-Lalit and CISH-Dhawal, custard apple cv. Atemoya x Balanagar and Arka Sahan, ber cv. Apple Ber and pomegranate cv. Bhagwa and dragon fruit (*Hylocereus costarecensis*). Growth parameters were recorded during the period under report. Plant height of guava cv. CISH-Shweta and CISH-Lalit varied from 2.65 m to 4.3 m and 1.27m to 3.0 m, respectively. Custard apple cv Balanagar and Arka Sahan x Balanagar (AxB) attained plant height from 1.9 m to 3.5 m. Plant height in pomegranate cv. Bhagwa varied from 1.52 to 2.1 m. Plant spread (E-W) in guava and custard apple varied from 2.7 m to 3.6 m and 1.8 m to 3.10 m, respectively. Plant spread in north-west direction in guava and custard apple varied from 1.5 m to 3.9 m, respectively. Maximum plant height was observed in guava cv. CISH-Shweta while spread was maximum in guava cv. CISH-Lalit. Height of dragon fruit varied from 1.3 m to 2.4 m. Damage was caused to fruit plants by browsing by blue bulls and monkeys. Fruit yield in guava was obtained from 16.2 to 22.3 kg/tree but fruits/trees were damaged by monkeys.

Evaluation of forage crops for intercropping in mango orchard

The experiment was initiated in 2022 with introduction of different forage crops. Panicum grass var BG-1, Panicum grass var BG-2, perennial sorghum and cow pea. Panicum grass was found the best performing forage in mid age mango orchards. It gave 7-8 cuts in a year when compared with perennial sorghum which gave hardly 3-4 cuts. Green forage yield in Panicum grass BG-1 varied from 60-86 tonnes/year while it was 36-54 tonnes/year in case of Panicum BG-2. Perennial sorghum gave green forage yield of 21-25 tonnes. Besides, it was susceptible to waterlogging during rainy season. Heavy mortality was recorded during rainy season while growth was adversely affected during winter months. These forage grasses are also being evaluated on farmers' field in collaboration with ICAR-IGFRI, Jhansi.

Evaluation of salicylic acid application for moisture stress tolerance in mango

Moisture stress in plants lead to the over production of reactive oxygen species (ROS) causing stress in plants. Reactive oxygen species such as hydrogen peroxide and superoxide anion radicals cause decrease in gas exchange, lipid peroxidation and change in oxidation-reduction state of antioxidants resulting in oxidative stress. To adapt to water stress, plants have evolved acclimation mechanisms, including antioxidant defense systems, which enhances their capacity to grow and develop under moisture stress conditions. Plants adjust stress condition by maintaining non enzymatic antioxidants such as glutathione, ascorbate in reduced stste. ROS scavenging enzymatic antioxidants, such as catalase (CAT), peroxidase (POD), superoxide dismutase (SOD), glutathione reductase (GR) and ascorbate peroxidase (APX) becomes more active to clear these excessive ROS.

Three foliar sprays of salicylic acid @ 0.5, 1.0, 2.0 and 5.0 mM were applied at three phenological stages (fruit set, pea and marble stage) in twenty five year old mango trees. To compare with irrigation, a set of trees was given 3 irrigations and un-irrigated trees were sprayed with water to maintain as negative control. It has been observed that the new flush was more affected by moisture stress as compared to old leaves. Total chlorophyll content in mature leaves of un-irrigated trees was 6.68 mg/g as compared to 12.78 mg/g fresh weight in leaves of salicylic acid @ 2.0 mM treated trees. Activities of catalase, peroxidase, superoxidase dismutase, glutathione reductase and ascorbate peroxidase in leaves varied from 29.66 µmol/min/mg protein, 0.587 µmol/min/mg, 794.77 U/mg, 9.18 µmol/min/mg and 4.53 mmolsubstrate/min^{-1}. mg^{-1} protein in trees treated with salicylic acid @ 2.0 mM to 74.38 µmol/min/mg protein, 1.043 µmol/min/mg, 987.33 U/mg, 14.176 µmol/min/mg and 6.84 mmolsubstrate/min^{-1}.mg^{-1} protein in un-irrigated trees. Total glutathione varied from 112.67- 407.78 mmol.g^{-1} FW and total ascorbate was found to vary, 5.88 -10.65 m mol.g^{-1} FW

in the leaves of un-treated and salicylic acid (2.0 mM) treated trees. Reduced glutathione and reduced ascorbate percent was found to be more (93.23% and 87.78%) in salicylic acid (@ 2.0 mM) treated trees as compared to untreated (76.33% and 72.22%). A key difference was found in the yield of 'A' grade fruits (fruit weight ≥ 250g) in salicylic acid treated trees (@ 2.0 mM) (31%) and negative control plants (un-irrigated) (17%). In the irrigated and salicylic acid treated plants difference in activities of these enzymes was found to be non-significant.

Physiological traits during different phenological stages in mango

Light interception and gas exchange is vital for flowering and fruiting in mango. Crowded canopy in mango orchards cause decrease in light interception which in turn affects flowering, fruiting and productivity. Properties of direct light and diffused light differ and affect growth and development differently. Considerable variation in light availability (direct and diffuse) beneath the tree and gas exchange parameters was found during different phenological stages (viz., bud development, leaf development, shoot development, inflorescence emergence, flowering, fruit development, maturity of fruit) of mango cvs. Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali. Diffuse light beneath thev tree ranged from 37.85-53.45 percent durin bud development stage to 55.67-65.33 percent during maturity. Photo synthesis, stomatal conductance and vapour pressure deficit ranged from 9.42-14.76 µmol CO_2/m^2/s, 83-148 mol H_2O/m^2/s and 2007-3.88 kPa respectively. Total chlorophyll and carotenoids content in leaves varied from 6.29 to 8.12 mg/g fresh weight and from 0.617 to 0.853 mg/g fresh weight, respectively.

Significant variations in availability of light (direct and diffuse) and gas exchange parameters were found during different phenological stages (viz., bud development, leaf development, shoot development, inflorescence emergence, flowering, fruit development, maturity of fruit) of mango cvs. Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali. Diffuse light during bud development stage ranged from 39.63 to 51.67 per cent, during maturity of fruits 57.33 to 68.44 per cent. A decrease in photosynthesis rate was recorded during inflorescence emergence and flowering stage. However, a gradual increase in photosynthesis rate was found during fruit development stage which ranged from 10.33-14.47 µmol CO_2/m^2/s stomatal conductance ranged from 78 to 139 mol H_2O/m^2/s and vapour pressure deficit from 1.87 to 3.23 kPa. Total chlorophyll and carotenoid content in fresh leaves varied from 5.33 to 7.78 mg/g and from 0.533 to 0.737 mg/g fresh weight, respectively.

Enzymatic and non enzymatic antioxidants are important for environmental stress tolerance and resilience of cultivars to variable climatic conditions. Glutathione, a non enzymatic antioxidant, content in leaves at flowering stage ranged from 147.87 to 259.55 µmol/g fresh weight. Reduced glutathione content varied from 121.73 to 1996.38 µmol/g fresh weight. Glutathione reductase activity varied from 0.7687 to 2.4765 mmol substrate/$min^{-1}mg^{-1}$ protein. Total ascorbate content ranged from 6.51 to 10.89 mmol/g fresh weight, ascorbate peroxidase activity varied from 3.11 to 8.98 mmol substrate/$min^{-1}mg^{-1}$ protein.

In mango 'Jelly-seed is an important physiological disorder which affects fruit quality attributes (viz., colour, taste, after taste, texture and appearance of pulp) without any external symptoms. Prevalence of this disorder is considerable in mango cv. Dashehari. Analysis of healthy and 'Jelly-seed' affected fruits of Dashehari pulp revealed higher activity of α-amylase, cellulase and polyphenol oxidase in 'Jelly-seed' affected pulp (1.62 g kg^{-1} h^{-1} maltose liberated, 0.083 Ug^{-1} and 0.0221 Ug^{-1}, respectively) as compared to healthy pulp (0.77 g kg_{-1} h^{-1} maltose liberated, 0.028 Ug^{-1} and 0.0069 Ug^{-1}, respectively). Total antioxidant capacity was found to be more in healthy pulp (687.37 mmol kg^{-1} Trolox) as compared to 'Jelly-seed' affected pulp (468.42 mmol kg^{-1} Trolox).

Jelly seed in 'Dashehari' mango

An experiment was conducted on Dashehari mango in order to identify the jelly seed incidence level, causal factors and its management options. Seven treatment combinations were used to manage this disorder. In this study, mango fruits were harvested at weekly interval starting from 1st week of June to 1st week of July. Manual (cut with sharp knife) and non- destructive method (X-ray) were used in order to detect the jelly seed incidence in mango. The higher incidence of JS was noticed in the fruits that harvested after 3rd week of June or after. Further, the incidence was higher in tree ripened fruits as compared to artificially ripened fruits. The content of sugar was higher in JS fruits as compared to healthy fruits which may be attributed to rapid breakdown or conversion of starch to sugars and accumulation of sugars in jelly-seed pulp and due to the conversion of ascorbic acid into sugars. Further the content of calcium (Ca^{++}) and K^{+} were lesser in jelly seed fruits pulp as compared to healthy fruits, indicating the distortion of pectin matrix. Low level of calcium in pulp and higher activity of PME and PG led to the disintegration of pulp tissue that lead to the excessive tissue softening. Pre-germination event play a significant role in the development of jelly seed in mango. Study revealed that the level of endogenous hormone GA_3 and IAA were also increased in jelly seed kernal, indicating the activation of embryo for germination. Higher level of endogenous hormone GA_3 and conversion of starch into sugar in jelly seed kernel as compared to healthy kernel gave indication about higher metabolic activity in jelly seed. Further, among treatment combinations the mulch + foliar application of Calcium chloride dihydrate (2%) + bagging (T3) and mulch + polyamine (2µM) as foliar spray + bagging (T6) were found significantly effective in management of jelly seed. Overall, the study portrayed the comprehensive understanding of jelly seed formation in mango and also provides the management options (Fig. 6).

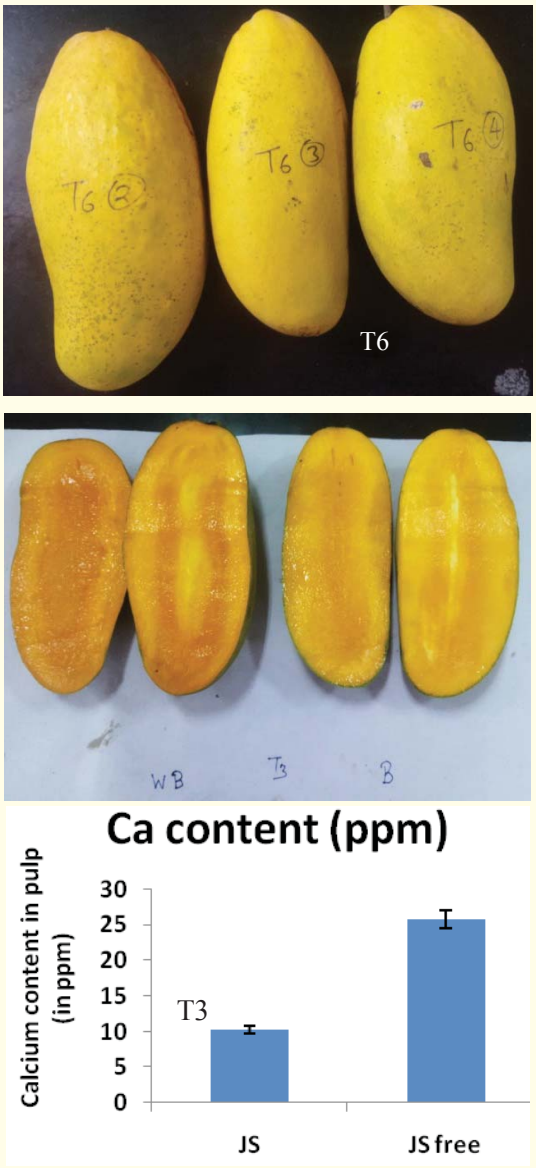


Fig. 6: Effect of Mulch+ $CaCl_2$ dihydate spray (2%) + bagging (T3) and Mulch+ putricine spray (2 uM) + bagging (T6) for control of jelly seed

Temperature response for flower production and fruit set in mango

An experiment was conducted to study the effect of temperature variation on the flowering behavior of Dashehari mango. Phenological data of flowering were recorded as per BBCH scale. Beginning of flower bud swelling (511) took place in 2nd week of January onwards, while first floral primordial emerged in 3rd week of January (513). From first flower open to fruit set takes

around 15 days (619). Further, it was observed that in 16.5 cm long panicle inflorescence (average of 10 inflorescence) the number of staminate flower was 321; hermaphrodite flower was 148, while total number of flower was 469. Sex ratio was 0.46. Floral surface temperature (31 & 35 ^{0}C) during 100% flowering was slightly higher as compared to leaf surface temperature (30.6 & 34.94 ^{0}C) as recorded on 15.03.2022 and 22.03.2022, respectively while atmospheric temperature in March was 33.9 ^{0}C (Tmax). The chlorophyll content (mg/g) and membrane integrity (MSI) were also influenced by high temperature (Fig. 7-8).

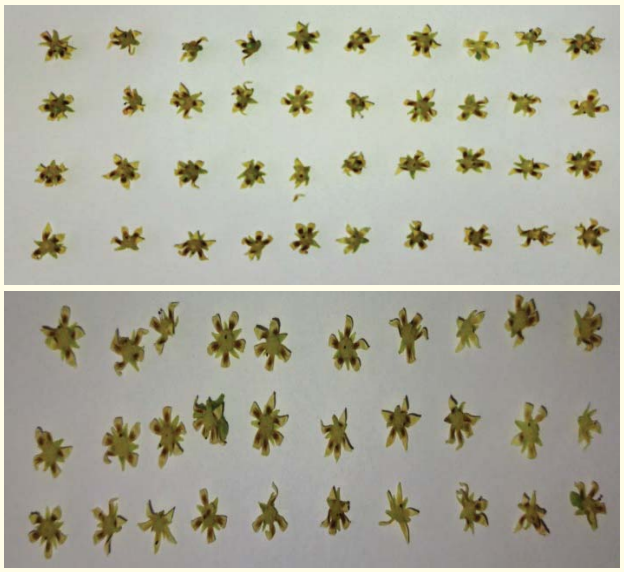


Fig. 7: Visual observations on hermaphrodite and staminate flowers in Dashehari Mango Inflorescence

Fig. 8: Leaves and inflorescence surface temperature recording with IR thermometer

Scientific characterization of mango orchards through soil indicators

Characterization of mango orchards based on soil indicators was appraised in orchards of nine villages viz., Ramnagar, Etauli, Jagtapur, Sarayya, Lagota Khera, Pitauna, Bhalakpur, Kharsara and Bhadwana. Mango orchards of Ramnagar and Jagtapur villages indicated 28, 31, 42 and 47, 41, 12 percentages of soil organic carbon in low, medium and high categories respectively. Available phosphorus varied in the range of 100, 82 and 56 percentages as low in Etauli, Jagtapur and Bhadwana. It was observed that samples of available zinc were also in low (72, 94, 95 and 81 per cents) and medium (28, 6, 5 and 19 per cents) in mango orchards of Ramnagar, Sarayya, Pitauna and Bhadwana villages. It was inferred from the data that 100 percent samples falls in low for copper and medium for Mn and Fe in subtropical mango villages. Productivity of <20 t ha^{-1} was noted. The implications of such scientific analysis enabled us to gain knowledge of the nutrient distribution in the existing mango orchards. Such analysis would definitely help farmers to adopt advance orchard management practices for better yields.

Scientific analysis of soil indicators vis-à-vis orchard productivity

Scientific analysis of mango orchards indicated lower productivity across mango growing villages (<15 t ha^{-1}). In this condition, maintenance of soil fertility plays dominant role to improve fruiting and yield per orchard. It is interesting to record that widespread variation in percentages of each nutrients in each mango orchard villages falls as different category ratings. Mango orchards of Kakori villages indicated 9, 39 and 52 percentages of soil organic carbon in low, medium and high categories respectively. The percentages of samples falls in the low and medium as 65 and 35, 65 and 35 with 78, 17 and 4 in low, medium and high for soil available phosphorus, potassium and zinc. It was observed that hundred percentages of available copper, manganese and iron noted in low, medium and medium category. The samples collected from

Rasulpur mango orchards indicated 72, 18, 9 percentages in low, medium and high ratings for soil organic carbon while for zinc, it was observed in the range of 64 and 36 percentages as low and medium. It was found that 100 percent samples falls in low for P in contrast, 9 and 91 percentages K as low and medium. It was inferred from the data that available K and Zn was in 44.4 and 56 percent in low and medium ratings in Salamigadi village. Soil organic carbon of 44, 44 and 12 percents falls in low, medium and high. Soil biological health in terms of dehydrogenase and fluorescence diacetate activity indicates the 0.01 to 2.48 (0.52±0.51) and 146.55 to 464.56 (262.57±78.96) respectively. The implications of such scientific analysis enabled us to gain knowledge of the nutrient distribution in the existing mango orchards. Farmers must be aware about the nutrient status of their mango orchards. Such analysis would definitely help farmers to adopt advance orchard management practices for better yields.

Developing standardized precipitation index for characterizing mango productivity

Standardized precipitation index was developed for characterizing mango fruit productivity. Statistical analysis of standardized precipitation index in the mango growing belts of Lucknow, UP had showed highly variable and dynamic. in nature over the years. From the univariate statistical analysis of SPI dataset, it was found that the whole dataset had skewness value of 0.101 and kurtosis value of 0.317. The maximum SPI value of 2.22 and minimum value of -2.21 was noted. Rainfall water use efficiency lies in 18.8 to 31.3 kg/mm and 13.4 to 20.1 kg/mm of rainfall water in Dashehari and Mallika mango in subtropics. The present study emphasized the need for precision soil and water management for maintaining moisture vis-à-vis greater productivity in subtropical zone.

Estimating soil indicators in mango germplasms for enhancing sustainability

The importance of soil health plays pivotal role in supporting the ecological systems of mango diversity of Lucknow. Latest information of water holding capacity, the most important index of physical soil health, falls in the class intervals of 12 to 13 per cent in the frequency levels of 7 per cent. Porosity had maximum and minimum class contents of 30 to 35 and 20 to 25 per cent in the distribution levels of 7 and 4 per cent, respectively. Lowest bulk density and particle density had an allocation of 2 and 3 per cent in class pattern of 1.5 to 1.6 and 2.3 to 2.4 g/cc, respectively. All these histographic distribution suggested the need for management option to improve the soil physicals and nutritional characters and in turn soil health condition. Histographic distribution showed leaf P had highest and lowest frequency distribution (91 and 1 per cent) in the class intervals of 0.1 to 0.2 and 0.2 to 0.3 percent. Potassium which is an important indicator had maximum frequency (>56 percent) in 0.8 to 1.0 per cent class levels followed by 1.0 to 1.2 per cent intervals (43 per cent). Statistical distribution of zinc showed frequency distribution (19% in the range of 10 to 16 ppm and 81% in the class intervals of 16 to 22 ppm respectively). For Boron maximum (89%) distribution in the range of 19.2 to 32.4 ppm was recorded. The Cu content had highest frequency level of 30 per cent in the class intervals of 16.8 to 22.2 ppm followed by 11.4 to 16.8 ppm in 27 per cent frequency. In case of Fe and Mn, highest and lowest frequency levels of 52, 42 and 41, 36 per cent was noted in the class intervals of 140 to 180; 100 to 140 ppm and 160 to 190; 190 to 220 ppm respectively. Such scientific analysis and distribution actually suggested the ranges of nutrients content dominating in which frequency levels. Higher nutrient contents showed in either lower or middle ranges indicating the need for soil and tree management for enriching nutrients.

Soil information system based on scientific ratings

Soil information system in mango orchards was developed for gaining knowledge and further improving the present soil health condition. The productivity distribution pattern showed orchards vary widely in terms of productivity level with only 63.6 per cent in between 8.01 to 12 t/ha

while 36.4 per cent orchard shad below 8 t/ha. The soil physical indicators like bulk density had a lower range of 1.28 to 1.32 to a higher range of 1.66 to 1.71g/cc across soil depths in twenty two mango orchards while particle density showed 2.19 to 2.25 and 2.61 to 2.65 g/cc. Minimum and maximum water holding capacity of 17.22 to 17.30 and 23.14 to 24.02 per cent whereas porosity of 29.22 to 30.18 and 46.69 to 49.81 per cent across mango orchards was estimated. Histographic distribution suggested frequency level (>25%) was in 0.4 to 0.53 class interval of soil organic carbon while >50 per cent frequency level in 97.6 to 122.5 mg/kg content level of nitrogen. For phosphorus, maximum frequency (30%) in 33.1 to 38.2 content level, followed by >20% in 27.9 to 33.0 mg/kg content level. In case of potassium, almost 30% frequency level had 136.05 to 165.73 class interval followed by >20% in 106.38 to 136.05 mg/kg class interval. Micronutrient distribution varied from higher frequency to lower frequency level. Available Zn had highest frequency (>60%) in 0.34 to 0.92 followed by 20% frequency level in 0.93 to 1.51 mg/kg. For available Cu, 0.38 to 1.32 mg/kg was in almost 50% frequency level. The histographic distribution level in Mn and Fe was widely distributed. Maximum frequency (>40%) was in 4.16 to 6.53, followed by 25% in 6.54 to 8.91 and lowest was in % (11.3 to 13.67conettn levels). Similarly, for Fe, highest and lowest frequency was in 60 and 5% in the ranges of 2.16 to 4.15 and 8.16 to 10.15 mg/kg respectively. Histographic distribution was ascertained to understand the distribution pattern of key soil information system and suggested to improve the distribution from lower to higher frequency level with greater contents. It was inferred from the analysis that there is a serious challenge to enhance the soil condition in terms of its indicators.

Estimating the variability of heat use efficiency in Dashehari mango

Critical analysis of weather indicators across the mango growing season is an urgent requirement to understand the variability occurring during phenophases vis-à-vis its impact on fruit production. Analysis of climatic indicators was performed scientifically and showed wider variability over mango production seasons. The variability of T_{max} and T_{min} during fruit set to development was noted as 30.21±3.25 to 38.79±4.96 and 11.93±1.55 to 24.38±0.58°C. The corresponding RH values lies at 90.05±6.75 to 83.33±16.30 and 68.52±4.93 to 49.57±13.69 per cent. Interestingly, high pan evaporation of 6.08±1.51 to 7.75±1.92 mm/day and BSS of 7.62±0.87 to 7.89±0.99 h were recorded. Mean weekly rainfall of 1.00 to 8.63 mm were also observed. The heat use efficiency varied between 1.87 to 3.74 $g/m^2/°Cd$ and considering the heliothermal values, variability of 0.23 to 0.46 $g/m^2/°Cdh$ was recorded. The estimated heat use efficiency in Dashehari mango had ranges of 0.14 to 0.28 $g/m^2/°Cdh$ involving photothermal values. Variability of such heat use efficiency acted as a function of tree-weather interactions at subtropical Lucknow zone.

Recent changes in thermal indices in phenophases of mango cv Dashehari

Recent observation showed that initially at the vegetative stages, the thermal indices particularly growing degree days (GDD), heliothermal (HTU) and photothermal units (PTU) were lower. At the flowering stage, GDD varied between 850.89 to 917.16°Cd, HTU and PTU of 8922.40 to 9538.69°Cdh and 9232.03 to 9615.38°Cdh, respectively. During the fruit set period, 883.04 to 1100.29°Cd GDD accumulation were noted while HTU of 6913.37 to 9825.93°Cdh. PTU were recorded as 10514.68 to 13335.6°Cdh. At the marble stages of Dashehari growth 1187.79 to 1606.44°Cd; it was inferred from the study that 10346.20 to 14075.55°Cdh HTU and 14618.09 to 20893.17°Cdh PTU were existed. At the maturity stage, PTU of 22588.16 to 35498.52°Cdh units were recorded. Histographic distribution indicated widespread distribution pattern of GDD, HTU and PTU. Interestingly, it was noted that GDD at vegetative stage 900 to 1000 class intervals with 30 per cent frequency level. At the flowering stage, 850 to 860°Cd with

20 per cent followed by 910 to 920°Cd in 13 per cent frequency level. Similarly in peanut stage, variable GDD at different class intervals with frequency levels was observed. It was found that at marble stage, 1600 to 1700°Cd class intervals at <2 per cent. At the maturity period, the changes of GDD was also noticed; 2600 to 2800°Cd at 5 per cent frequency level. The dynamic changes in climatic indicators do impacted on the dynamic change in thermal indices at each critical phases impacting on fruiting behaviour. Lower fruit production of 6 to 8 t ha^{-1} was accorded due to severe atmospheric aberration. Results suggested the impact of environmental factors on tree performances and thus resource conservation practices needs to be followed rigorously to attain optimum yield of mango at subtropics.

Estimation of critical climatic factors during Amrapali production

The dynamics of incoming shortwave radiation and outgoing long wave radiations had created radiation regimes. This radiation regime is important for the physiological changes in tree species. The ambient temperature and relative humidity dynamics significantly affect the reproductive cycles in fruit bearing trees. The incoming net shortwave radiation varied from 7.84 to 19.43 MJ/m^2/day. Mean values of net shortwave radiation stands at 15.15±3.75 MJ/m^2/day. Likewise, net long wave radiation has dynamics of 0.78 to 4.80 MJ/m^2/day with seasonal average of 3.34±0.93 MJ/m^2/day was recorded. In this scientific analysis, the most important component of net radiation during Amrapali production seasons was estimated and it was inferred that 5.10 to 15.94 MJ/m^2/day. During flowering season, 9.11±0.09 to 12.39±0.12 MJ/m^2/day were estimated while at peanut stage, 12.93±0.010 to 15.13±0.38 MJ/m^2/day were recorded. It was found that net radiations of 14.99±1.63 to 16.07±1.82 were at marble stages of Amrapali production. The seasonal variability of net radiations at vegetative and reproductive stages were also noted and it was found that 9.07 to 12.43 MJ/m^2/day was received at flowering stage. In peanut stage, the corresponding values were 12.84 to 14.72 MJ/m^2/day whereas net radiation dynamics of 13.99 to 15.67 MJ/m^2/day at marble stage. At the maturity stage, average values lies between 12.78±3.16 to 14.55±1.44 MJ/m^2/day.

Dynamics of evapotranspiration and water productivity in Amrapali

It is very much essential to estimate the ET_0 at the time of vegetative and reproductive stages in Amrapali production under subtropical climate. The dynamics of ET_0 showed variability in the ranges of 1.38 to 6.37 mm/day. The seasonal average of standard weekly data suggested values of 4.24±1.66 mm/day. It was inferred that ET_0 of 1.38 to 2.08 mm/day during vegetative stage; variability of ET_0 at flowering and peanut stage was of 2.60 to 4.45 and 4.97 to 5.78 mm/day respectively. At marble stage and over the period of maturity, 5.40 to 6.12 and 3 2.96 to 6.16 mm/day were recorded, respectively. All these values indicated the variability actually existed over the critical phenophases to influence the growth pattern and fruit load in Amrapali. Water application was thus very crucial in the drier months coinciding with the reproductive stages. In this experimentation, 10, 20 and 30 L water per tree was applied to the root zone basin of Amrapali mango to meet out the peak atmospheric demands. This condition coincides with the pea and marble stages of fruit development. During the entire period of fruit set at development, total of 150 to 190 l water/tree of Amrapali was applied in tree basins. The water productivity of 0.31 to 0.74 g/mm was estimated. Water use of <200 l/tree was observed to produce considerable amount of Amrapali fruits under subtropical climate for benefit of farmers.

Assessing thermal regimes vis-à-vis heat use efficiency in mango cv Amrapali at subtropical condition

Response of fruit trees to existing thermal regime is to be assessed to gather knowledge on climatic effects on trees. Under subtropical climate, thermal

regimes undergo dynamics changes in vegetative and reproductive phases of fruit production. It was thus necessary to quantify the actual values of thermal vis-à-vis phenophases changes. In this direction, BBCH scale based phenophases in mango cv Amrapali was used to quantify the thermal regimes. Thermal regimes significantly influence the pattern of flowering, fruit set and development in mango cv Amrapali at subtropical condition. Based on recent information, thermal heat accumulation in flowering (BBCH scale 510 to 627) was 804.34±37.9 to 883.48±37.3°Cd, pea phase having 1108.36±155.0 to 1274.26±186.1, marble phase attained a range of 1643.90±165 to 1930.1±188.9°Cd and finally at the maturity (BBCH scale 810, 819 to 829), the values varied from 2218.98±166.8 to 2611.94± 191.0°Cd in mango cv Amrapali. The estimated heat use efficiency varied between 2.39 and 5.77 g/m^2/°Cd. It was observed that the heliothermal regimes existed at vegetative phase (BBCH scale of 011 to 319) of 2938.14 to 7539.89°Cd h to maturity 12422 to 14587.32°Cd while photothermal regime indicated variability from 7146.66 to 7539.89 and 30225.72 to 35599.15°Cd h respectively. Scientific analysis clearly showed the affects of climate on the BBCH scale based thermal regimes in Amrapali production phases. The present study was thus indicative of climate vis-à-vis tree responses under varying thermal regimes of subtropical Indian condition.

Assessment of histographic distribution vis-à-vis heat use efficiency in Amrapali at subtropical condition

The detailed analysis of thermal regimes in vegetative phase showed variability of mean GDD at 701.27°Cd, heliothermal regimes at 4047.17°Cd h and photothermal regimes of 7539.89°Cd. Similarly, flowering phase had 883.48°Cd GDD; 6556.41°Cd h heliothermal and 9985.32°Cd h photothermal regimes. It was inferred that from pea to marble phase, average values 1108.36 to 1643.90°Cd. Interestingly, average values of GDD at maturity were noted as 2218.98°Cd. Heliothermal regimes of 8810.17 to 14485.44°Cd h and photothermal regimes of 13899.88 to 22051.96°Cd h were recorded. The histographic distribution of all three thermal regimes at each critical phase showed wider variability. It was noted that maximum frequency levels fall in the GDD ranges of 800 to 900, 850 to 875, 1000 to 1300, 1800 to 1900 and 2200 to 2400°Cd at vegetative, flowering, pea, marble and maturity phase in Amrapali mango. The highest frequency level of heliothermal regime of 5000 to 6000 (>100 per cent), 6000 to 7000 (48 per cent), 8000 to 10000 (42 per cent), 15000 to 17500 (35 per cent) and 20000 to 25000°Cd h (31 per cent) were observed. The frequency distribution clearly exhibited the distribution of heliothermal regimes across variable rate of classes. The pattern of such variability is indicative of higher or lower regimes exited across scale. In case of photothermal regimes and its histographic distribution, it was found that 9000 to 10000 (175 per cent), 9000 to 9500 (36 per cent), 12000 to 14000 (35 per cent), 24000 to 26000 (25 per cent) and 32000 to 34000°Cd h (26 per cent) had its maximum values. The average heat use efficiency of 4.01 g/m^2/°Cd was estimated. The corresponding values for heliothermal regimes was 0.72 g/m^2/°Cd h and photothermal regimes of 0.29 g/m^2/°Cd h respectively. Such wider variability may be because of the fact that differential thermal regimes impacted on the fruit yield of Amrapali under subtropical condition.

Assessing soil fertility vis-à-vis yield in mango cvs Dashehari and Lucknow Safeda under Natural Farming

Developing advanced technologies through natural farming is of national importance. Keeping this in view, natural farming technologies for producing mango cvs Dashehari and Lucknow Safeda was initiated at R B Road campus, Telibagh, Lucknow, UP. Soil fertility i.e. soil organic carbon, DTPA extractable Zn, Cu, Fe, soil available P, K, Ca at 0 to 30 and 30 to 60 cm soil depth was assessed. Data suggested that status of soil organic carbon was 0.53±0.14 and 0.47±0.13 per cent in Dashehari orchard while in Lucknow

Safeda, values of 0.56±0.02 and 0.51±0.04 per cent were recorded at 0 to 30 and 30 to 60 cm soil depths. Soil available P and K was 22.20±7.66, 21.10±2.03; 24.75±4.83, 21.25±5.25 ppm and 122.50±13.30, 122.14±11.37; 176.14±14.49, 172.61±27.17 ppm respectively at 0-30 and 30-60 cm depths. Soil Zn, Cu and Fe contents were found in sufficient ranges; 0.76±0.28, 0.72±0.26; 1.02±0.24, 0.84±0.26 ppm Zn; 3.40±1.44, 3.37±0.92; 5.08±1.59, 3.88±2.57 ppm Cu and 4.71±4.17, 3.41±2.13; 4.49±0.81, 3.29±1.43 ppm Fe in Dashehari and Lucknow Safeda orchard soils at upper and lower soil depth were recorded , respectively. Natural farming practices of mulching, spraying jeevamrit on soil, cow urine, amrit pani and vermiwash, neem oil on trees, use of non-chemical IPM tools for pest management etc. were performed systematically. Yield variability of 62 to 147 kg/tree in Dashehari and 56 to 90 kg/tree in Lucknow Safeda was observed. Results were encouraging to improve the yield harvesting in mango orchards under natural farming practices.

Evaluation of nano formulations for enhancing productivity and quality of mango

Nano formulations (Nano DAP, Nano Zn and Nano Cu) developed by Indian Farmers Fertilizer Cooperative were done on mango crop during 2022. Three sprays were conducted during pea to marble stage with different sequences of nano formulations. Sequence of DAP-Cu-Zn was better in terms of fruit size and weight (285.5 g/ fruit) than other sequences such as Cu-Zn-DAP (224.5 g/fruit) or Zn-Cu-DAP (243.5 g/ fruit) and control (203.0 g/fruit). There was no significant effect of nano formulations on TSS content of fruits.

Rhizo-phytomicrobiome for plant growth regularory attributes from subtropical fruit crops

Total 47 bacteria (18 Gram positive & 29 Gram negative) were isolated from different rhizosphere of mango, guava, jamun, and other sources. Further, all selected isolates were screened for plant growth promotion properties and it was found that siderophore production (29), phosphate solubilization (17), potassium solubilization (20), zinc solubilization (17), and HCN production (12). On the basic of PGP screening (Fig. 9) only 8 isolates were finalized for further study such as biosurfactants production, antifungal activity and nanoparticle (nanochitosan) interaction.

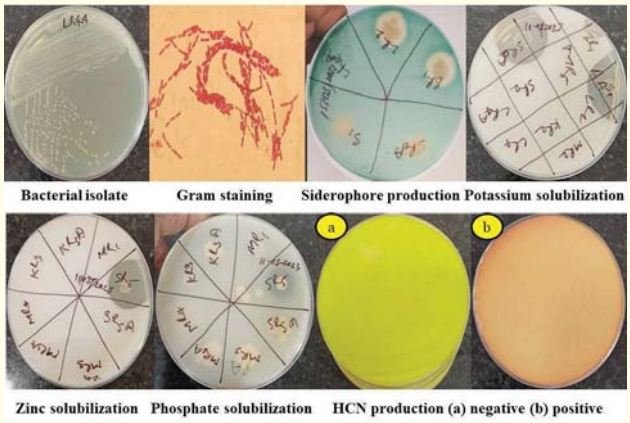


Fig. 9: Plant growth promontory attributes of isolated microbes

On farm trail

Rejuvenation technology in mango

On farm trial on rejuvenation technology was laid out at farmers field in village Hannikhera, Mall block, Lucknow. Objective of this trial was to compare old rejuvenation technology with refined technology. Trees of mango cv Dashehari were given treatments during January 2021. Treatments were Old CISH Rejuvenation technology (T1), Refined CISH Rejuvenation technology (T2), Heading back by maintaining one nurse branch (T3) and untreated control (T4). Each treatment was replicated on twenty-five trees. Recommended package of practices were followed for uniform management of all the trees in orchard.

There was profuse flowering in treated trees during February 2022 except in T1 (Old CISH rejuvenation technology). There was significant effect of treatments on tree height reduction, which continued during second year also. There was 55% reduction in height of tree canopy in

T2 followed by 43.5 % in T3 as compared to control. Among all treatments, fruit yield was recorded during June 2022 and it was concluded that during second year, yield of 55.5 kg/plant was recorded from T2, and 43.5 kg/plant from T3 while it was about 50 kg/plant in control. Fruit quality is a more important factor and it was observed that there were more than 50 percent fruits under A grade in T2 and T3 while they were only 12 percent in T4. There was no mortality of any tree due to pest incidence or any disease.

Physiological studies

At the marble stage of the fruit set, availability of direct light was 51.49 percent in T2 and only 30.63 percent in control. Similarly, chlorophyll content ranged from 4.55 mg/g FW in T4 to 8.11 mg/g FW in T2. Photosynthesis rate varied from 6.88 µmol $CO_2/m^2/s$ in T4 to 11.67 µmol $CO_2/m^2/s$ in T2. Somatal conductance was found to vary from 181.27 mol $H_2O/m^2/s$ and 233.75 mol $H_2O/m^2/s$ and vapour pressure deficit was 1.87 kPa and 2.88 kPa in T4 and T2, respectively.

Testing-cum-demonstration on HDP mango for improved yield and quality

The testing cum demonstration was initiated during 2020-21 at Phoolpur, Mishrikh of Sitapur, Uttar Pradesh. 'Chausa', 'Langra', 'Amrapali', 'Arunika', 'Ambika' at 5x5 m distance involving 400 plants per hectare in 10-12 hectare were planted in 2020-21. The inter space was planted with guava variety 'Thai Pink' and 'Thai White'. The canopy management, training system, drip and fertigation was adopted as recommended by CISH, Lucknow. The guava bearing started in 2nd year. Langra variety showed maximum trunk diameter (57.50 mm), tree height (164.17 cm), plant height with canopy spread 130-132 cm in north-south and east-west directions, However, Amrapali showed least trunk diameter, tree spread (122.33, 117 cm), and plant height (130.67 cm). Amrapali started fruiting from 3rd year.

At Hardaurpur, Bakshi-ka-talab, Lucknow, 'Amrapali, 'Mallika', 'Arunika' and 'Dashehari' were planted with the technological interventions of ICAR-CISH, Lucknow during 2017. At the age of 5 years, maximum fruiting (53.33/tree) was recorded in Dashehari, followed by Amrapali (32.17/tree). 'Amrapali' recorded maximum yield (13.72 t/ha).

Guava (*Psidium guajava* L.)

Approaches to maximize winter season guava production

To standardize pruning time and intensity and to maximize guava production during winter season the pruning was initiated from 15th April to 30th June in 7 year old guava variety Lalit. Irrespective of pruning intensity maximum fruits (240.50) were noted in D5 (15th June pruning), while lowest (145.25) on 30th April pruning. The full bloom to days taken for maturity was maximum (109.08 days), in D1 (15th April). Though maximum fruit weight (176.08 g) was recorded in D2 (30th April), it was non-significant. Due to fruit load maximum branch breaking incidence (2.97) noted in D1 (15th April) while minimum branch breaking (1.97) on D5 (15th June).

Irrespective of pruning time, pruning intensity also had remarkable effect on yield and quality attributes. Maximum fruit number (231.20) was noted in P1 (20 %) pruning intensity. Days required for fruit maturity, first noted in P3 (100 days), which was non-significant. Branch breaking was the maximum (3.0) in P1 and P2 pruning intensity, while minimum (1.70) in P3. Similarly yield was noted maximum (36.65 kg/tree) in P1 and lowest in P2 (24.20 Kg/tree). Maximum fruit numbers (359.25) per tree recorded in D4 P3 while was minimum (78.25) in D4 P2. Maximum days to maturity (115.25 days) were noted in D1P1 while minimum D5 P2, D5 P3 (91.75 days). Incidence of branch breaking was the maximum (4.5) in D2P1, while it was minimum (1.25) in D5P3. Maximum per tree yield (49.74 kg/tree) were recorded in D4P3 which was on par with D5P1 (48.41 kg/tree). Lowest yield (13.38 kg/tree) was in D4P2 (Fig. 10-13).

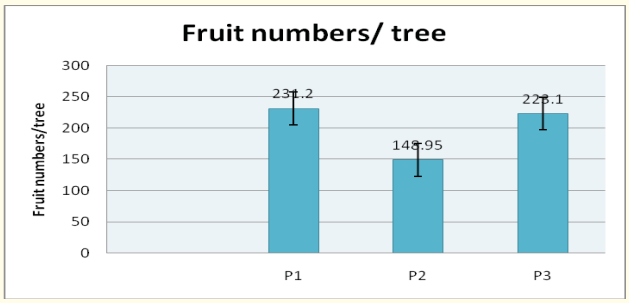


Fig. 10: Effect of pruning intensity fruit numbers of guava

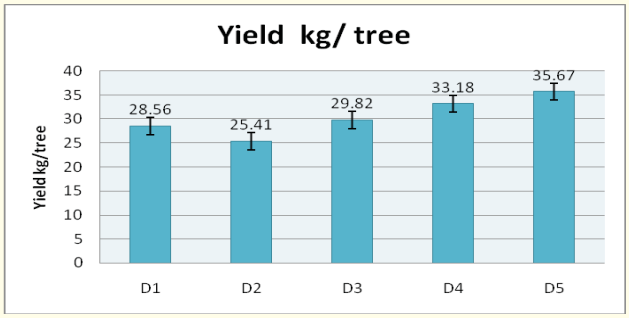


Fig. 11: Effect of pruning time on yield per tree in guava

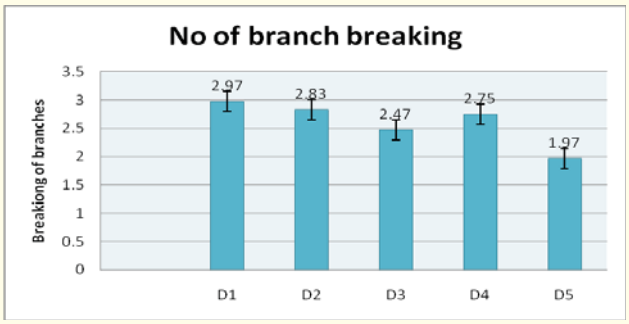


Fig. 12: Effect of pruning time on branch breaking due to crop load

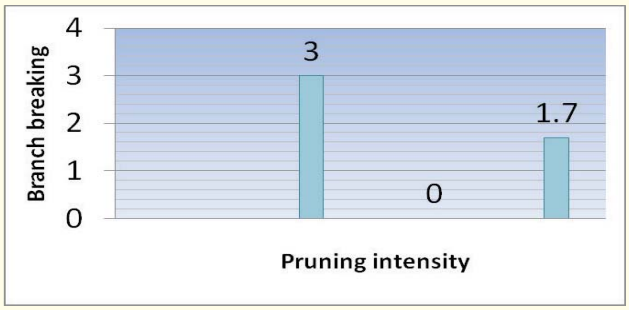


Fig. 13: Effect of pruning intensity on branch breaking due to crop load

Enhancing guava productivity through espalier architecture under HDP

Irrespective of tree architecture the maximum fruits per tree were recorded in CISH-Lalit (233) while minimum in CISH-Lalima (148.62). Significantly maximum yield (41.35 kg/tree) were noted in CISH-Lalit and minimum in CISH-Lalima (29.99 kg./tree). Yield per hectare were the maximum in CISH-Lalit (70 t/ha) and minimum in CISH-Shweta and CISH-Lalima. The total soluble solids, acidity and ascorbic acid content recorded non-significant, different among cultivars. Significant variation was recorded for trunk diameter and trunk cross sectional area. It was maximum (8.25 cm and 5.44 cm^2 respectively) in Shweta, while it has lowest in Lalima and Lalit cultivars. The effect of tree architecture on fruit number was non-significant. (Fig. 14-16) The maximum fruit weight (201.67 g/fruit) was recorded in espalier architecture while the lowest average fruit

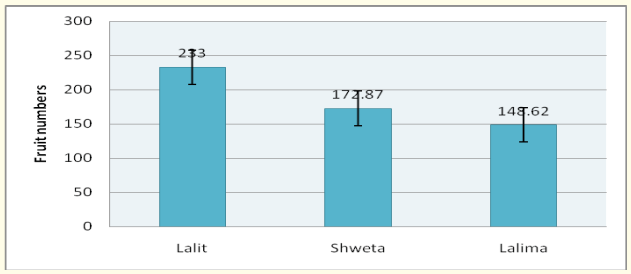


Fig. 14: Effect of variety on fruit numbers per tree planted in espalier architecture

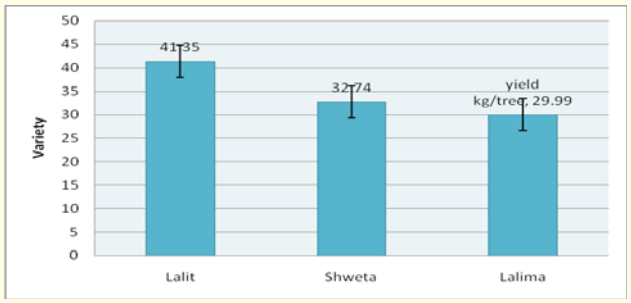


Fig. 15: Effect of variety on yield kg/tree per tree planted in espalier architecture

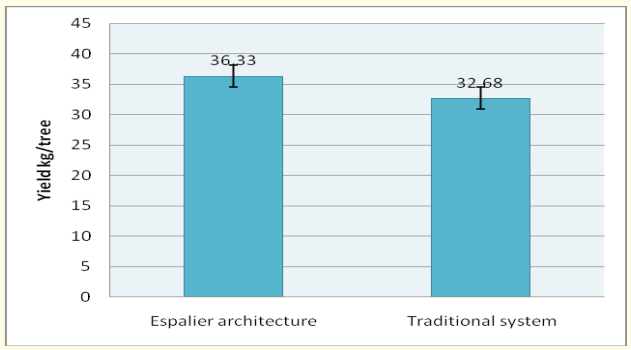


Fig. 16: Effect of tree architecture on yield kg/tree

weight (173.83 g/fruit) was in traditional tree architecture. Significantly maximum yield (75.51 t/ha was recorded in espalier architecture while lowest (37.5 t/ha) recorded in traditional tree architecture. Similarly, maximum 'A' grade fruits (44.5%) were recorded in espalier architecture and the minimum (34.585%) in traditional tree architecture. The interactions of varieties with training system were non-found significant.

Enhancing the input use efficiency in guava under HDP

The trial was started during 2015-16 under AICRP(F). The results indicated that maximum plant spread was recorded in T4 (3.08) and canopy height (2.89 m) in T5 (Control). The maximum stem girth (14.91 cm), fruit yield per tree, yield (t/ha) and yield efficiency, fruit weight, fruit numbers per tree were noted in T1 which were on par with T2. The status of soil analysis showed that pH value and organic Carbon were improved after 5 years. calcium and phosphorus content in leaves were non-significant. The nutrient contents in leaves with regard to K, Cu, Zn were no-significant. The Fe content was increased both in soil and leaves over the years (Fig. 17).

Fig. 17: Guava under HDP (3×3 m)

Bael (*Aegle marmelos* L. Correa)

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 cold stress tolerance. In cultivars having more fruit drop during winter, canopy was found to be more damaged due to cold stress. Canopy of NB-16 and CISH-B1 was found to be least affected by cold stress (5% approx) whereas in CISH B-2 (40% approx) maximum effect was recorded followed by Pant Shivani and NB-17 (35% approx). Electrolyte leakage in different cultivars was found to vary from 8.55%-31.58%, lipid peroxidation varied from 5.53-13.23 nmol MDA formed/mg protein/hr. Considerable variation in the activity of catalase (203.67 to 579.81 mmol hydrogen peroxide decomposed/min./mg protein), peroxidase (3.14 to 6.97 m mol substrate/min./mg protein) and superoxide dismutase (1637 to 2349 enzyme U/mg protein) was found in different cultivars. In north India, during winter season, winter fruit drop in bael is a major bottle neck in improving production and productivity. In cultivars having more leaf damage due to cold stress, fruit drop is also more. This might be due to source limitation and/or channel resistance. It seems that unavailability of threshold level of photosynthate production or translocation to the sink might be a probable reason.

Other fruits

Banana

Organo-formulation and fertilizer effects on fruit yield and quality

Experimental results of ratoon crop of banana cv. Grand Naine indicated that productivie efficiency varied from 0.083-0.135 kg/cm^2 PCSA (Pseudostem cross sectional area-PCSA). Maximum productivity efficiency (0.135 kg/cm^2 PCSA) was recorded in 100% recommended dose of fertilizer applied through inorganic source followed by 100% NP and potassium supplied by organominerals and treatment of 50% RDF and 50% Fusicont (0.120 kg/cm^2 PCSA) (Fig. 18).

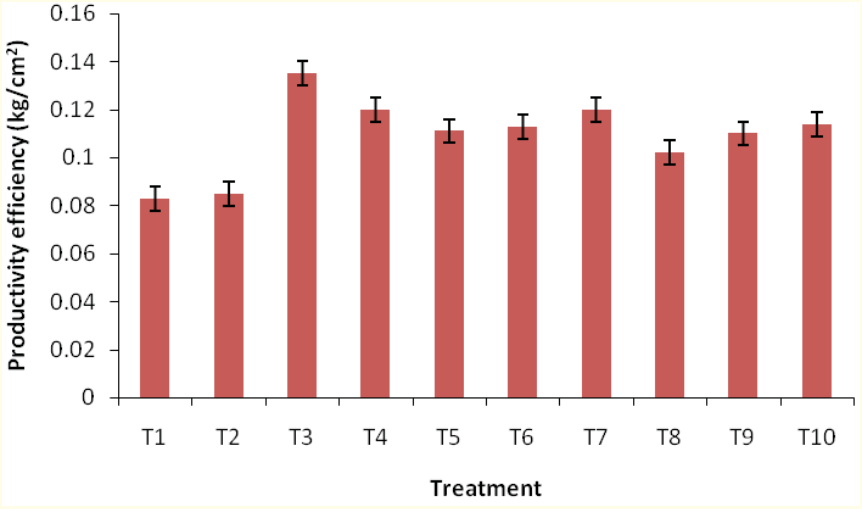


Fig. 18: Effect of organoformulations and fertilizers on productivity efficiency of banana

Soil sample were collected from 0-30 cm depth for nutrient analysis of ratoon crop of banana. The soil nitrogen, phosphorus and potassium content (225.42:8.68 :127.39 kg/ha) was analysed in 100 % RDF through organic source of fertilizer in banana cv. Grand Naine (Fig. 19).

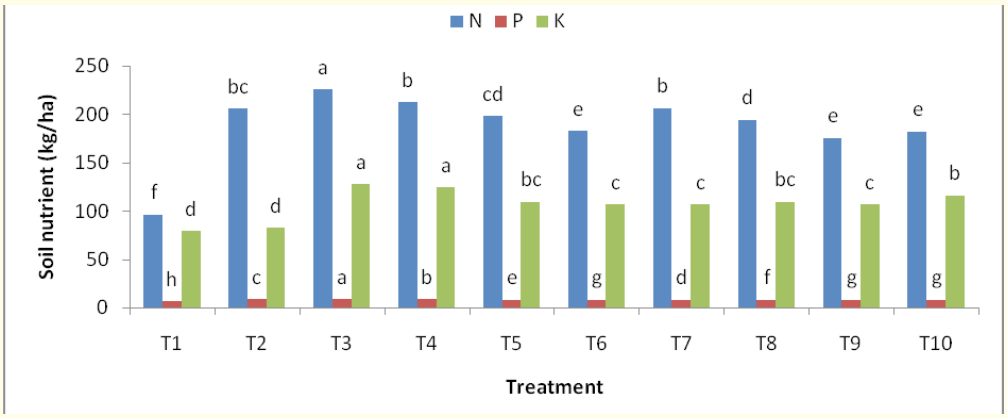


Fig. 19: Effect of organoformulations and fertilizers on soil NPK content of banana

Vegetables

Standardization hydroponic systems and varieties of tomato for high productivity

To find out best water and nutrient efficient hydroponic system and suitable variety of hydroponic tomatoes, two hydroponic growing systems i.e. Nutrient Film Technique and Drip Hydroponic System and two indeterminate varieties of hydroponic tomato i.e. US-2853 and NS- 4266 were evaluated with three replications in randomized block design. A and B, CISH-Hydroponic Nutrient Solution for solanacious vegetables was used for crop growing keeping the EC of solution between 1.8-2.0 mS/cm, pH between 5.5 - 6.5 and temperature of circulating medium between 18-24°C with use of EC, pH and temperature sensors . Drip hydroponics recorded early flowering,(48 days), highest number of fruits /plant (86.0), higher fruit yield/ plant (4660 g), maximum number of pickings (13.50), maximum yield kg/100 m^2, maximum water use efficiency (24.49 l/kg fruit) and the highest nutrient use efficiency (11.27 kg fruit/ lt. solution) whereas, nutrient film techniques of hydroponics recorded highest average fruit weight (64.50g) and largest fruit shelf-life (31 days) under ambient storage conditions. Variety NS-4246 recorded early flowering and fruit set, highest number of fruit /plant (76) fruit yield / plant (4.29 kg), maximum number of pickings

(13.5), and maximum yield quintal/100 m^2 (3.72), high water (28.17 l/water/kg fruit) and nutrient use efficiency (10.25 kg fruit/l nutrient solution) whereas variety, US -2859 recorded the highest fruit weight (62 g), fruit length (47.49 mm) fruit width (49.10mm) and the highest shelf-life (26 days) under ambient storage conditions. Variety NS-4266 recorded the highest yield with high water and nutrient use efficiency, may be adopted for commercial production in sub tropics (Fig. 20-22).

Table 1. Interaction effect of hydroponic systems and varieties of tomato for yield quality, water and nutrient use efficiency.

Traits	Drip Hydroponic System		Nutrient Film Techniques System	
	US-2853	NS- 4266	US-2853	NS- 4266
Days taken to first flowering	53.00	43.00	56.00	50.00
Days taken to first fruit set	66.00	66.00	66.00	59.00
Number of fruits /plant	62.00	110.00	54.00	42.00
Average fruit weight (g)	60.00	52.00	64.00	65.00
Fruit yield/plant (g)	3600.00	5720.00	3456.00	2730.00
Av. fruit length (mm)	48.25	44.48	47.53	49.00
Av. fruit width (mm)	45.77	48.53	52.42	45.00
Number of picking	12.00	15.00	10.00	12.00
Yield (kg/100m^2)	320.00	418.00	316.00	328.00
Shelf life (under ambient storage)	20.00	21.00	32.00	30.00
Water use efficiency (l/kg fruit)	27.44	21.53	34.38	34.81
Nutrient use efficiency (kg fruit/l. solution)	10.93	11.61	8.87	8.88

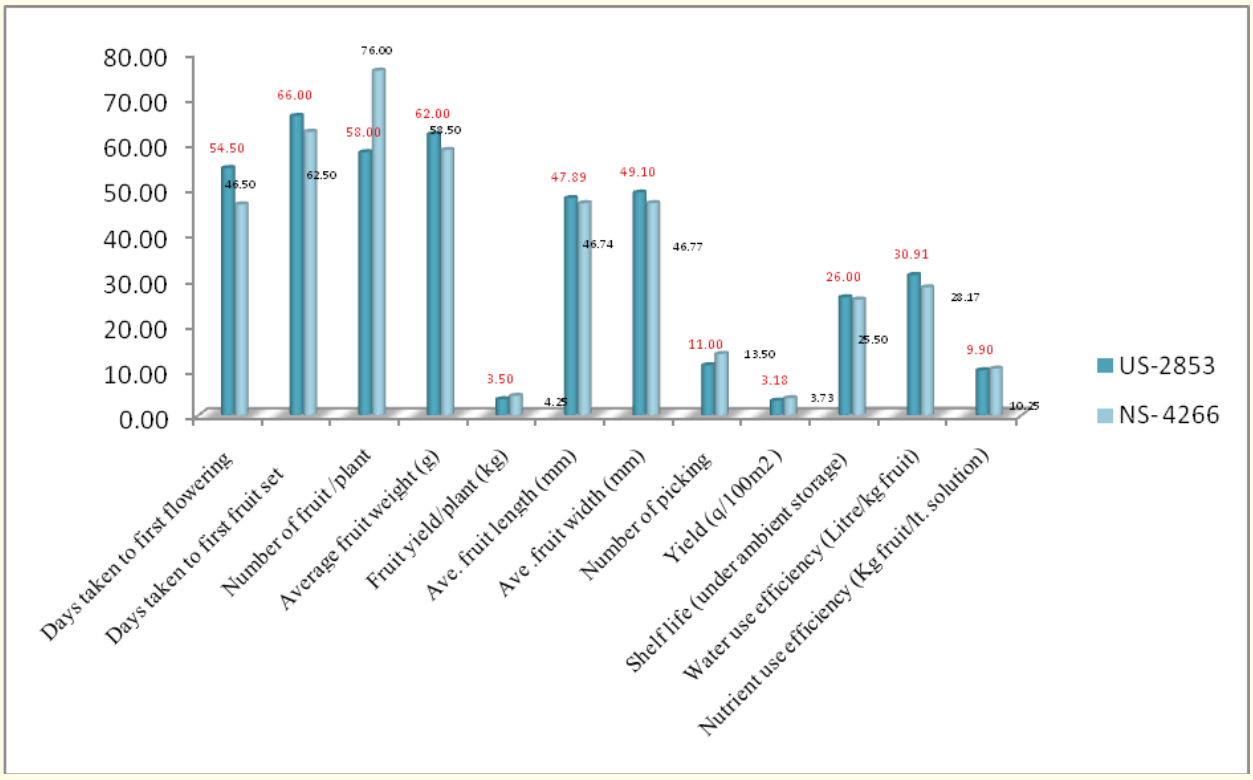


Fig. 20: Performance of tomato varieties under hydroponics in sub tropics

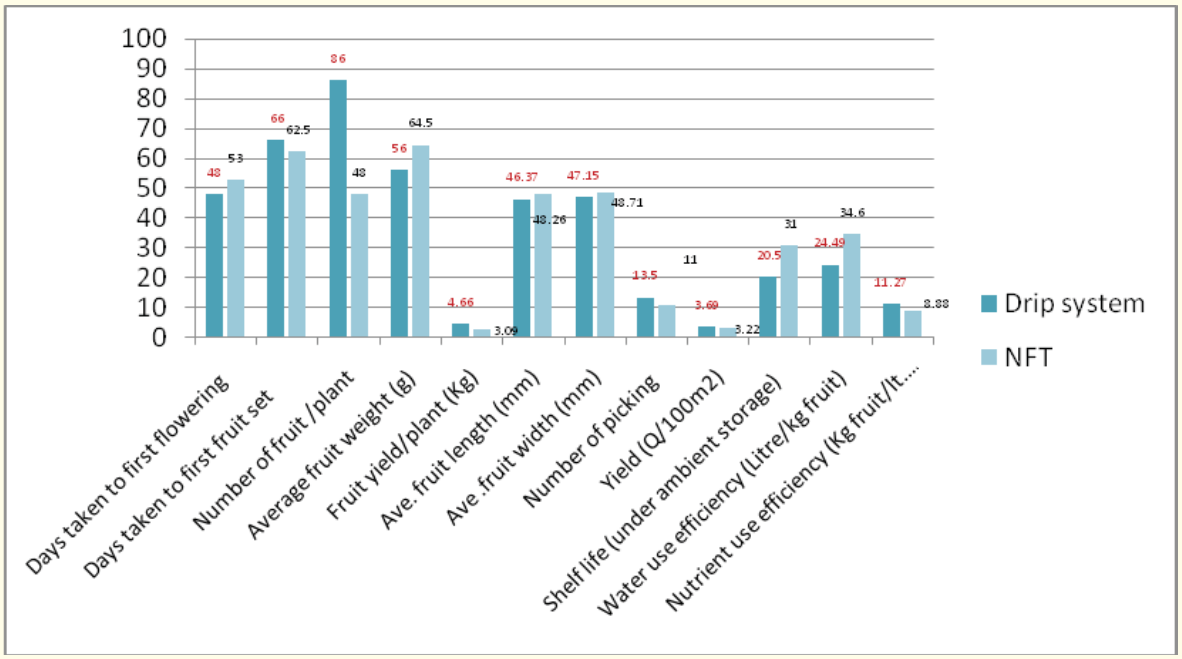


Fig. 21: Effect dydroponic system on yield, quality and input use efficiency in tomato production

Fig. 22: NFT system Drip hydroponic System in tomato

Improving knowledge & skill of stakeholders for enhancing production of subtropical fruits

The knowledge & skill of stakeholders including farmers, state government officials, the officers of line departments of various states were enhanced on production and post harvest management of subtropical horticultural crops through trainings, demonstrations, field visits, exposure visits, meetings, goshthies, awareness programmes, showcasing technologies in exhibitions, and Mera Gaon Mera Gaurav programme. The details are given hereunder.

Exhibitions

Institute participated in various State as well as National level exhibitions and displayed Institute's developed technologies . Exhibitions were highly effective in communicating the knowledge of technologies developed by the institute on subtropical horticultural crops among visitors.

Sl.	Event/Occasion	Place	Organizer	Date
1.	Vigyan Sarvatra Pujyate	NBRI, Lucknow	CISH-NBRI, Lucknow	February 22-28, 2022
2	State Level Fruit, Vegetable and Flower Show	Raj Bhawan, Lucknow	Deptt. of Horticulture and Food processing , Govt of U.P.	March 4-6, 2022
3	National Farmers Day	Integral University, Kursi Road, Lucknow	Integral University, Kursi Road, Lucknow	March 12, 2022
4	Workshop on Cultivation of aromatic & medicinal plants in U.P	State Agriculture Management Institute, Rehamnkhera	State Agriculture Management Institute, Rehamnkhera	March 22-23, 2022
5	Krishi Unnat Mela Evam Udhyan Mahotsav	Motihari, Bihar	KVK, Peeprakathi, Motihari, Bihar	April 15-17, 2022
6	Mango Diversity Fair	ICAR-CISH, Lucknow	ICAR- CISH, Lucknow	June 28, 2022
7.	Indo- Uzbek meet	Integral University, Lucknow	Department of bioengineering and co organized by Tashkent chemical Technological institute Tashkent Uzbekistan	November 24-25, 2022

Training-Cum-Exposure Visit

Sl.	Topic	Sponsored by	Duration	Participants
1.	Production Methods of Subtropical Fruits and Preparation of Commercial Products of Guava	Deputy Director Agriculture and ex- officio Project Deputy Director, ATMA, Sawai Madhopur, Rajasthan	March 22-28, 2022	Eleven farmers from Sawai Madhopur district of Rajasthan
2.	Technologies for Subtropical Fruits	Department of Horticulture, district Gopalganj, Bihar.	February 15, 2022	56 farmers from Kateya, Panchdewari, Vijayipur, Bhorey, Phulwariya, Uchkagaon, Kuchaikote, Gopalganj, Thawe, Baikunthpur, Sidhwaliya, Manjha, Barauli and Hathua blocks of Gopalganj district of Bihar
3.	Technologies for Subtropical Fruits	ATMA, Gaya, Bihar.	February 16, 2022	26 farmers and two officials from 24 blocks i.e. Neemchak Bathani, Manpur, Nagar, Bodh Gaya, Belaganj, Tankuppa, Atri,, Mohra,, Tekari, Konch, Guraru, Gurua, Mohanpur, Dobhi, Sherghati, Barachatti, Amas, Imamganj, Dumariya, Paraiya, Wazirganj and Fatehpur of Gaya district of Bihar
4.	Technologies for Subtropical Fruits	ATMA, Rohtas, Biahr	March 9 .2022	A group of 30 farmers including an official
5.	Technologies for Subtropical Fruits	Department of Agriculture, Uttar Pradesh.	March 15, 2022	A group of 19 Assistant Statistical Officers newly selected by Public Service Commission Uttar Pradesh
6.	Technologies for Subtropical Fruits	Department of Agriculture, Patna Bihar	March 23, 2022	A group of 44 farmers including two Assistant Technology Managers from 23 blocks of Patna district of Bihar.

7.	Technologies for Subtropical Fruits	Department of Agriculture, Bihar	March 26, 2022	A group of 37 farmers from Chhapra district of Bihar.
8.	Technologies for Subtropical Fruits	ATMA, Siwan, Bihar ATMA, Katni, M.P.	March 30, 2022	30 farmers and 3 officials from Siwan district of Bihar 21 farmers including 2 officials from Katni district of Madhya Pradesh
9.	Technologies for Subtropical Fruits	Janta College Bakewar, Etawah, Uttar Pradesh	May 05,2022	106 students of B. Sc. (Ag) VIII Semester and five faculty members of Janta College, Bakewar, Etawah Uttar Pradesh
10.	Technologies for Subtropical Fruits	ATMA Saran, Bihar in collaboration with Indira Gandhi Institute of Cooperative Management, Lucknow	December 8, 2022.	A group of 34 farmers including 5 women from Saran district of Bihar
11.	Technologies for Fruit Processing and Subtropical Fruits	Department of Horticulture, Gopalganj district of Bihar in collaboration with Indira Gandhi Institute of Cooperative Management, Rajajipuram, Lucknow	December 14, 2022	A group of 36 farmers from Gopalganj district, Bihar
12	Technologies for Subtropical Fruits	Indo- German Cooperation on Agricultural Market Development Project, jointly with Directorate of Agricultural Marketing and Foreign Trade, GoUP, and National Institute of Plant Health Management (NIPHM) Department of Agriculture, Uttar Pradesh in association with Directorate of Marketing and Inspection, Regional office, Lucknow	December 22, 2022	A group of 30 members of Farmers Producer Organization and two officers from the different districts of Uttar Pradesh
13	Technologies for Subtropical Fruits	Government Girls Inter College, Malihabad, Lucknow.	December 26 & 27, 2022	300 students of class IX to XII along with six teaching staffs from Government Girls Inter College, Malihabad, Lucknow Uttar Pradesh
14	Technologies for Subtropical Fruits	Rajkiya High School Amethiya Salempur, Kakori, Government High School Sadrauna Sarojini nagar Lucknow, Government Girls Inter college Malihabad and Rajkiya High School Haluapur, Kakori	December 22-30, 2022.	577 students of class of 9th to 12th standards from various school including Rajkiya High School, Amethiya Salempur, Kakori, Government High School Sadrauna Sarijini nagar Lucknow, Government Girls Intercollege Malihabad and Rajkiya High School, Haluapur, Kakori

Demonstrations on nutrient management in mango

It has been observed that most of the farmers are producing mango without managing major as well as micronutrients, resulting in lower yields (30- 40%) as compared to well managed crops. So, we organized two trainings cum demonstration on nutrient management in mango at Amethiya Salempur and Kanar villages. It has been observed that farmers applied fertilizers one or two times resulting maximum fertilizer wastage due to rain and plants are unable to take the nutrients as par their requirement. In this regard, we also demonstrated judicious application i.e. methods, time and application of fertilizers in splits so that plants are able to utilize proper amounts of fertilizers for their growth, production and quality of fruits. Awareness and knowledge skill were imparted among villagers on importance of nutrition of fruits and vegetables and establishment of nutri gardens and entrepreneurship development through secondary horticulture. We also advised the farmers to include legume vegetables in their farming system to reduce cost of fertilizers and improving soil fertility.

Farmers/Students/Extension Functionaries Exposure Visit

Fifteen hundred (1500) visitors including farmers from Uttar Pradesh, Bihar, Madhya Pradesh and Rajasthan, 70 rural women and 950 students, 88 dealers of pesticides, 37 Diploma in Agriculture Extension services for input dealers, 30 Farmers Producer Organization, 19 Assistant Statistical Officers visited Institute's Experimental field and Laboratory during January to December, 2022. During these visit, farmers were apprised about Institute's developed technologies like high density planting of mango and guava, improved varieties of mango, guava, bael, aonla and jamun, polyhouse vegetables production, organic farming, modern nursery, drip irrigation, integrated management of insect & diseases of mango, espalier and container gardening of guava, crop diversification, land management and preparing squash/juices and other value added products from various fruits like mango, guava, bael, aonla and importance of fruits and vegetables in human health.

Face to face farmers counselling

About 200 farmers from UP, Bihar, Punjab, MP, Haryana, Rajasthan and Maharastra visited the Institute and they were counseled about the doubts they faced during implementing production and plant protection activities in their fields.

Postal queries/email quaries

Grower's queries related to various aspects of subtropical fruits were attended through correspondence. Extension folders and bulletins related to scientific cultivation of mango, aonla, guava and papaya were provided to the orchardists. Avalability, planting time for improved varieties were replied through emails.

Farmer's Helpline

Two hundred seventy seven calls were received from farmers from different states regarding availability of planting materials (27.45%), insect-pest management (23.21%), disease control (22.73%), physiological disorders (10.81%), and other production aspects & processing of fruit crops (9.90%) and planting time and method (5.84%).

Whatsapp group of mango farming community-A group comprising 88 farmers of mostly mango and guava created 2 years ago was attended, all queries of the farmers regarding, planting, pruning, tree canopy management, disease, pest and water management are being addressed by ICAR-CISH experts.

Mera Gaon Mera Gaurav

S. No	Programme	Name of village	Date	Participants	Name of scientist
			Visit		
1	After care for mango orchards	Kanar	April 20, 2022	20	Naresh Babu & Arvind Kumar
2	Weeding and fertilizer application in kinnow plants and management and fungicide application in rejuvenated mango plants	Kanar	September 18, 2022	16	Naresh Babu & Arvind Kumar,
3	Organized awareness campaign on cleanliness and sanitation drive .	Kanar and Naijabhari	October16 , 2022	40 villagers including women and children	Naresh Babu and Arvind Kumar
4	Doubling farmers income through high value vegetables production	Amethiya/ Salempur	December, 6, 2022	15	Naresh Babu and Arvind Kumar
5	Integrated management of insects and diseases in kinnow and mandarin plants at farmers field	Amethiya/ Salempur	December, 15, 2022	20	Naresh Babu and Arvind Kumar
6.	Organized awareness campaign on cleanliness and sanitation	Sanyasibag village	December 18, 2022	40 villagers including women and children	Naresh Babu and Arvind Kumar
7.	Organized Sanitation Campaign	Mau	December 24, 2022	40 farmers including women and village youths	Naresh Babu and Arvind Kumar
			Stakeholders Meeting/ goshties		
8	Micro nutrient management and crop production, protection and post harvest management	Tiknatkheda Malihabad	August 18, 2022	40	Dushyant Misra, Tarun Adak, Bharati Killadi, Naresh Babu & Arvind Kumar
9	Farmer scientist interaction cum Kisan Goshthi	Naibasti, Dhaneva Malihabad	August 20, 2022	40	Dushyant Misra, Tarun Adak, Bharati Killadi, Naresh Babu & Arvind Kumar

Awareness / Sensitization					
10	Organic farming for enhancing the quality production and profitability of the farmers	Budhadia	February, 2022	30	Naresh Babu, & Arvind Kumar
11	Integrated insect pest and disease management in mango	6 villages of Kakori and Malihabad blocks	March,2022	40	Naresh Babu, & Arvind Kumar
12.	Created awareness among villagers regarding application of planofix for control of fruit drop and subsequent irrigation management.	Amethiya and Salempur	April, 2022	50	Naresh Babu, & Arvind Kumar
13	Use of pheromone trap for management of fruit fly in mango orchards.	Nejabari	May, 2022	30	Naresh Babu & Arvind Kumar
14	Creating awareness about need for safe harvesting and post harvest handling of mango fruits	Rasoolpur	June , 2022	40	Naresh Babu, & Arvind Kumar
15	Farmers were sensitized about organic cultivation and advers effect on increasing pesticide load on microorganisms in soil	Kushmora villages	July,2022	25	Naresh Babu, & Arvind Kumar
16	Importance of mulching and canopy management in mango	Habibpur	August , 2022	20	Naresh Babu, & Arvind Kumar
17	Awareness about the importance of nutrition of fruits and vegetables and encouraging farmers for development of nutrigarden	Kanar	September 18,2022	30	Naresh Babu, & Arvind Kumar
18	Organized awareness campaign on doubling farmers income through high value vegetables cultivation	Amethiya/ Salempur	December 6, 2022	15	Naresh Babu, & Arvind Kumar

Swachh Bharat Abhiyan					
19	Organized awareness campaign on cleanliness and sanitation drive	Kanar village in Malihabad block of Luck now district	December 19, 2022	40 villagers including women and children	Naresh Babu, and Arvind Kumar
20	Organized a Sanitation Campaign on Swachhta Awareness	Junior High School and Madhuapur village	December 23, 2022	150 students along with teaching staff of Junior High School Madhuapur and 40 villagers including women	Naresh Babu, Tarun Adak, V. Dayal and Arvind Kumar,
Organized Farmers' Fair					
21	Organized Kisan Gosthi during celebration of Institute Foundation Day	10 villages in Malihabad and Kakori blocks	June 1, 2022	300	All scientists
22	Mango Diversity Show	10 villages in Malihabad and Kakori blocks	June 28, 2022	350	All scientists

Division of Crop Protection

Distribution and dynamics of guava wilt and decline

Roving survey for recording of the distribution and dynamics of guava wilt and decline was carried out in Auraiya, Gonda, Basti, Bareilly, Budaun, Bijnor, Bulandshahar, Farukhabad, Hathras, Lucknow, Moradabad, Mujaffarnagar, Saharanpur and Shahjahanpur districts. Results indicated that the average age of guava orchards in surveyed areas was 6.1 year with average root-knot index of 1.03. The occurence of root-knot nematode was recorded in 53.57 percent orchards. Overall incidence of wilt was recorded 7.31 percent and decline, 25.58 percent. Maximum nematode infection was observed in Budaun and Shajahanpur districts and minimum in Bulandshahar, Hathras and Saharanpur districts.

Dynamics of diseases of mango

Roving survey: Incidence of diseases of mango was recorded in Amethi, Auraiya, Ayodhya, Basti, Bareilly, Budaun, Bijnor, Bulandshahar, Farukhabad, Gonda, Hathras, Lucknow, Moradabad, Muzaffarnagar, Saharanpur, Shahjahanpur, Sitapur, Sultanpur and Unnao districts. Data recorded from 92 orchards indicated that the average age of mango orchards in surveyed areas was 37.03 year and most severe new emerging issue is the twig drying disease. Maximum incidence of twig drying was observed in Bulandshahar district and at least on a few trees in each of districts surveyed. Increase in incidence and severity of Loranthus was also recorded. Incidence of wilt/decline was also recorded widespread with the maximum incidence in Bijnor and Saharanpur districts. Decline has become a common issue even in well maintained healthy orchards, where few to several tree becomes symptomatic. Incidence of leaf anthracnose was found in every orchard but had varying degree of severity. Bacterial leaf lesion and blight incidence was observed high on *cv*. Chausa in comparison to others cultivars and

in about 80 percent orchards. Floral malformation was observed upto 121 malformed panicles per tree and several orchards were found completely free from it. Severity of sooty moulds was high during the months of April and May; and was very low during October in western U.P.

Seasonal Incidence in fixed orchards of mango

Powdery mildew

The incidence of powdery mildew was initiated in the beginning of March after late emergence of panicles, however, the maximum temperature crossed 35°C on March 18, 2022, the critical limit for disease development and no further disease progress was noted. Maximum incidence was although recorded upto 50 per cent but severity (1.32%) was too low to be detected on the panicles.

Blossom blight

The incidence of blossom blight was initiated in the beginning of March after late emergence of panicles, however, the maximum temperature crossed 35°C on March 18, 2022, and no further disease progress was noted. Maximum incidence was although recorded upto 70 percent but severity (4.20%) was too low to cause any damage to panicles.

Anthracnose

Emergence of new flushes was observed in the end of February 2022 along with the panicles. The development of leaves took place during the month of March; when low night temperature with dew was suitable for infection of fungus in leaves. Incidence of leaf anthracnose was recorded from 6.6 to 64.9 percent and the severity from 2.10 to 10.92 percent during the months of March and April 2022.

Pest population dynamics on fruit crops

Population dynamics of insect pests on mango: The population dynamics of the mango hopper was recorded throughout the year. The hopper population was observed in two peaks, the first peak of the hopper population was recorded during the 26th SMW (Last week of June) with 17.25 hoppers/tap and the second peak was observed during the 34th SMW (Fourth week of August) with 5.95 hoppers/tap during the year 2022.

Thrips population on mango was observed between the 7th to 43rd SMW during 2022. The population was observed in two peaks, the first peak was recorded during the 9th SMW (Last week of February) with 14.25 thrips/tap and the second peak was observed during the 14th SMW (First week of April) with 61.55 thrips/tap.

The leaf webber incidence was observed between 20 to 49th SMW during 2022. The peak incidence of the leaf webber was recorded during the 47th SMW with 0.35 webs/tree.

The incidence of *Hyposidra talaca* was observed between the 1st to 46th SMW during 2022. The peak incidence of the pest was recorded during the 19th SMW with 6.9 larvae/twig with severe damage on new leaves, cut peduncles and the spots on the fruits by nibbling.

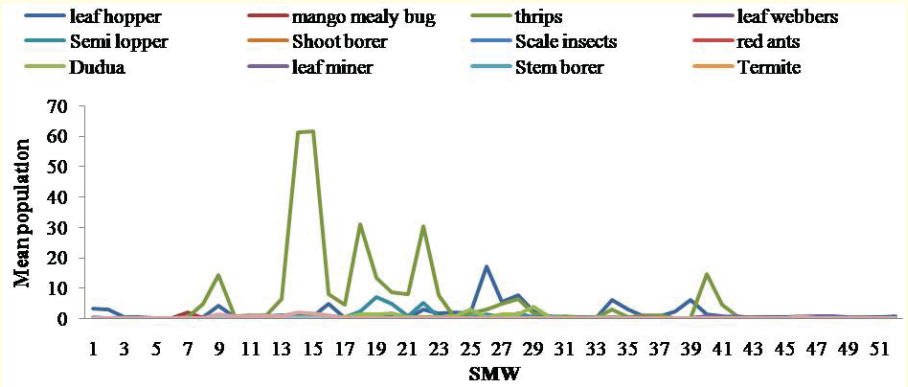


Fig.1: Insect pest population on mango

Population dynamics of insect pests on guava: Incidence of fruit flies was observed in 20th to 48th SMW. The peak incidence of the pest was recorded during 37th SMW with 33.95 percent incidence. Incidence of guava fruit borer was observed during 15th to 50th SMW. The peak incidence of the pest was recorded during 36th SMW with 4.20 percent incidence.

The incidence of shoot borer was observed around the year. The peak incidence of the pest was recorded during 47th SMW with 33% infested buds/trees. Semilooper incidence was observed during 2nd to 37th SMW. Peak incidence was observed 21st SMW with 0.14 larvae / shoot. Thrips population on guava was observed between the 15th to 31st SMW during 2022. For the thrips population, peak was recorded during the 20th SMW (Third week of May) with 15.65 thrips/tap causing severe damage on fruits (Fig. 2).

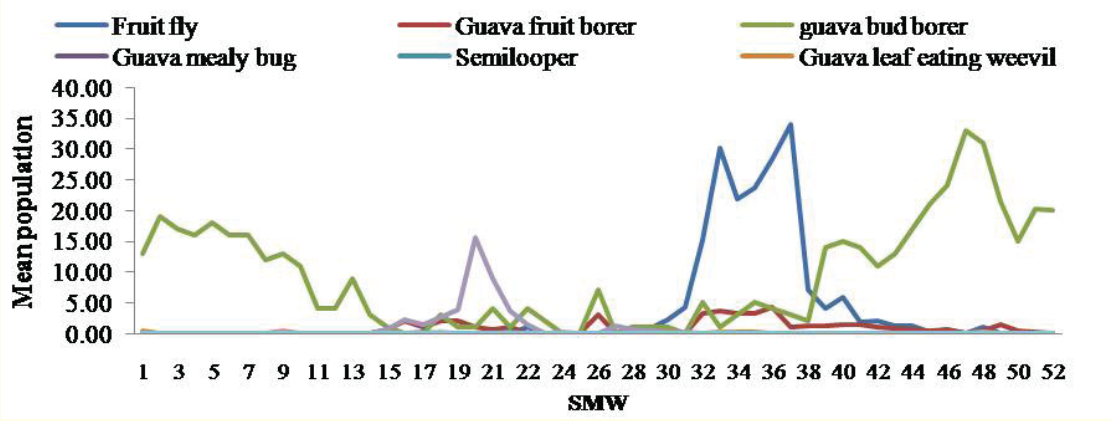


Fig. 2: insect pest population on guava

Thrips/ other arthropod emergence from the mango orchard soil: Monitoring of mango thrips emergence was done by collecting 700 g of soil from below the canopy of mango trees. Thrips emergence was recorded, the first emergence of thrips was observed during the second week of March. The peak emergence of thrips was recorded during the second week of April with 29.6 mean population thrips/ 700 g of soil (Fig. 3).

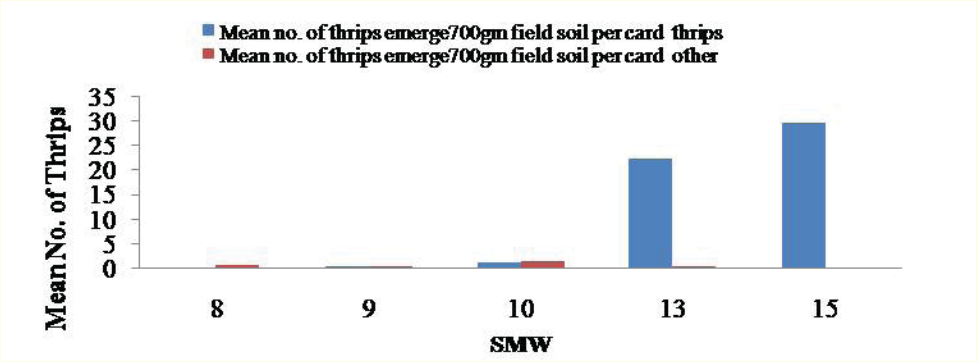


Fig. 3: Mango thrips emergence from soil

Thrips migration from lantana host in mango orchards: Mango thrips migration from its weed host *Lantana camara* to mango was monitored using CISH-glue trap. For the purpose, the yellow sticky trap was placed below the mango tree canopy at 10 m, 20 m, and 30 m distance from lantana host on orchard pheripheri. From 2nd to 14th SMW, it was found that thrips migrate from weed host to main crop. Initially high population of thrips was recorded in sticky traps at 10 m distance from *Lantana*. After 11th SMW thrips population started migration towards the inner plants that is at 20 m and 30 m distance (Fig. 4).

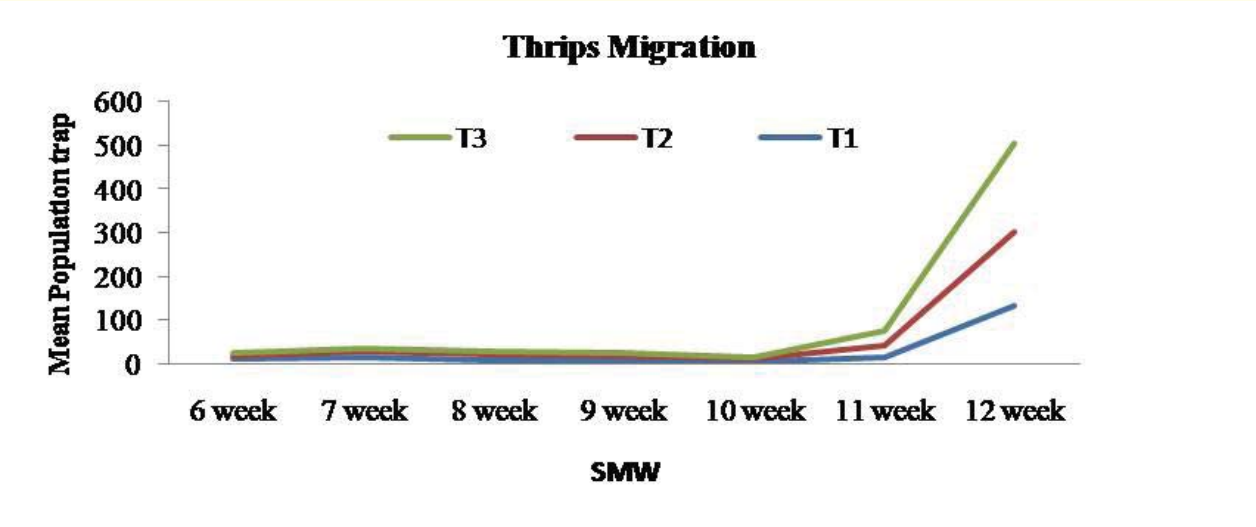


Fig. 4: Mango thrips migration from its weed host *Lantana camara* to mango

Monitoring of hopper present in different locations in mango canopy: Hoppers were monitored from 7th to 17th SMW by placing CISH-glue traps at different places in the mango tree trunk and canopy *viz.* LTH – Lower trunk hopper, MTH- middle trunk hopper, UTH – upper trunk hopper, NTCH – near trunk canopy hopper, MTCH – Middle trunk canopy hopper, OTCH - Outer trunk canopy hopper. Highest number of hoppers (262.50/trap) were observed at the lower trunk region during 15th SMW (Fig. 5).

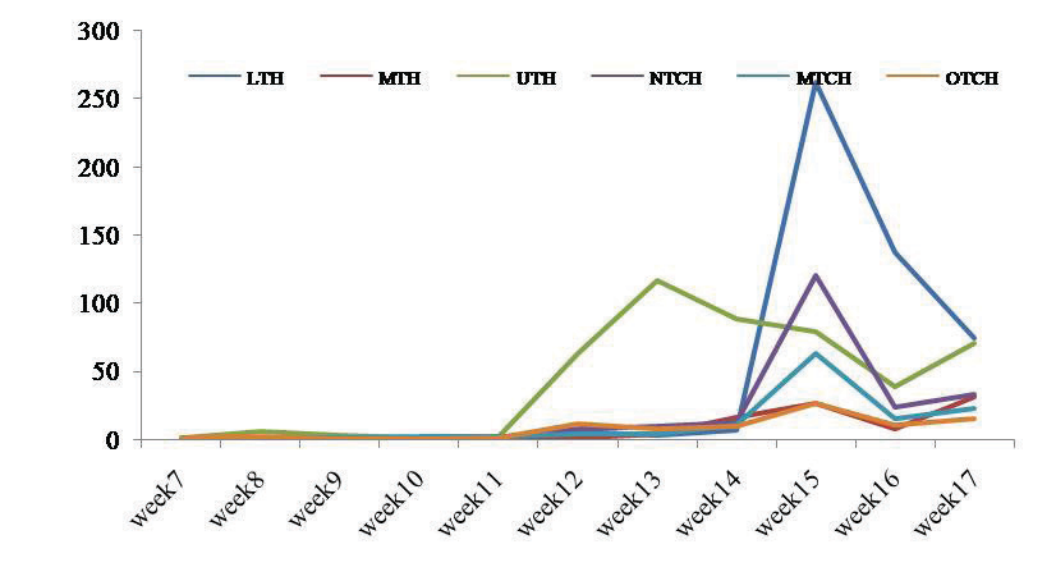


Fig. 5: Mango hopper population in different places of mango canopy

Evaluation of glue trap with different type of lure for male fruit fly attraction: Attraction of fruit flies to the CISH-glue trap with different substrates (Ammonium acetate, methyl eugenol, Cue-lure) was studied in the mango orchards. Each material was placed on glue trap with the help of 6 mm wool block. The population of attracted flies in each treatment was monitored from 4th to 23rd SMW. It was found that Methyl eugenol attracted more male fruit flies in the CISH - glue trap (Fig. 6).

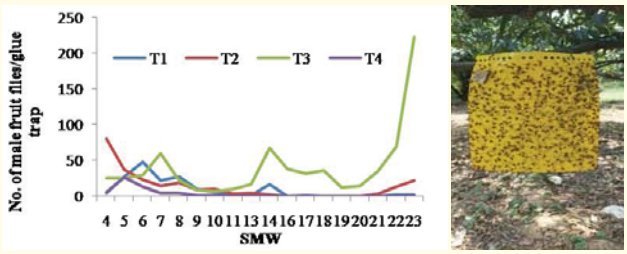


Fig. 6: Attraction of male fruit fly different lure in glue trap

Development of detection assay for mango wilt/MSD

Ceratocystis fimbriata specific primers (CF-F-5'-TAGTGAGATGAATGCTGTT TTGGTG-3'; CF-R1-5' CAAAAGTTGAGCGG GTTTAGCGGC-3') were used to detect the pathogen from rhizospheric soil of wilted mango trees collected from different orchards of Uttar Pradesh. The pathogen was successfully detected from the soil of completely wilted mango trees as well as trees that were in the initial phase of wilting. However, we did not obtain any amplification in the case of DNA isolated from the rhizospheric soil of banana, guava, and vegetable crops (Fig. 7). We could not detect the pathogen from the DNA isolated from trunk wood samples of wilted mango trees through PCR using the primers developed. The sensitivity of detection of *C. fimbriata* was 0.1 pg DNA in 25 µl PCR rection volume both from the pure fungal culture and rhizospheric soil. The amplification of expected size i.e. ~470 bp and ~350 bp band was obtained in only the samples with sufficient DNA concentration related to sensitivity parameter.

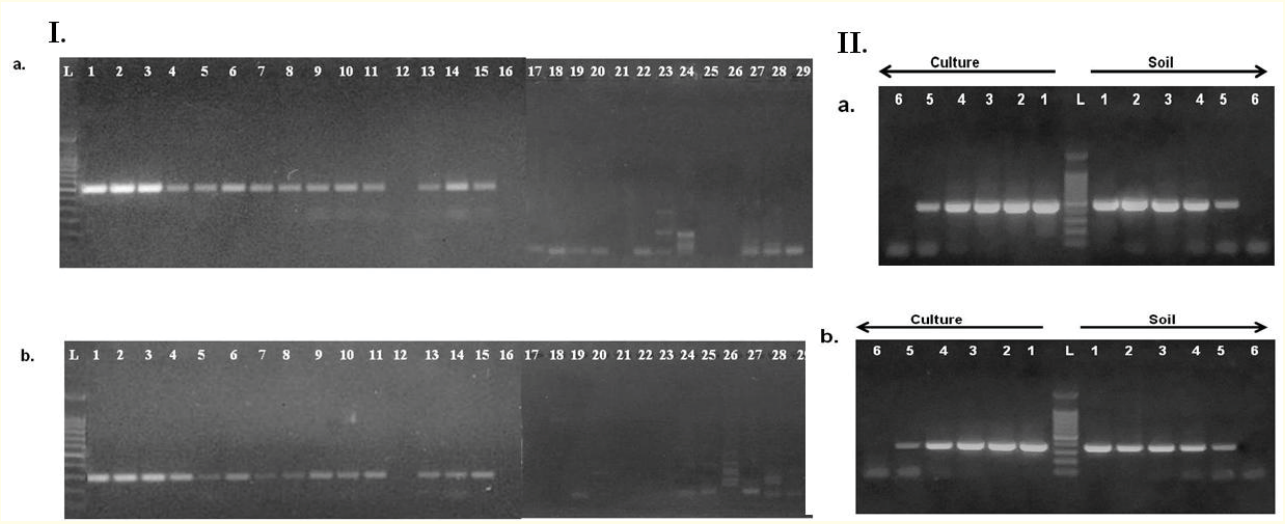


Fig. 7: I.: Detection of *Ceratocystis fimbriata* from soil samples (Lane 1-15: rhizospheric soil samples of partially and completely wilted mango trees, 16: healthy mango tree, 17-20: guava rhizospheric soil, 21-24; Banana rhizospheric soil, 25-28: Vegetable rhizospheric soil, 29: sterilized soil); II.: Sensitivity assay of primers using different concentration of DNA isolated from *Ceratocystis fimbriata* culture and soil sample (Lane 1: Stock DNA, 2: 1000 pg, 3: 100 pg, 4: 10 pg, 5: 0.1 pg, 6: nuclease free water).

Development of *Lasiodiplodia* and *Ceratocystis* specific primers

Two pathogens *viz.*, *Lasiodiplodia theobromae* and *Ceratocystis fimbriata* are the major causal agents of mango wilt/sudden decline. Primer pairs for specific detection of *L. theobromae* and *C. fimbriata* through real time PCR were developed. For developing *L. theobromae* primers, (RNA polymerase II second largest subunit RPB2 gene) was targeted. One forward (LT-F-5'-CGACGATCCATTCAGCCC GAACAAGGG-3') and two reverse primers (LT-R1-5'-CCATATCTCTTTTCTTGCCTCTCCTC ATC-3' and LT-R2-5'-TGCAATAATCCCTGCC AGCCATATCTC-3') were designed for specific detection of *L. theobroame* with expected product size of ~130 bp. Likewise primer pair (CF-2022-F-5'-CTTGGCGTTGGAGGTCCTGTTCTC-3' and CF-2022-R-5'-CAAAAGTTGAGCGGGT TTAGCGGC-3') for specific detection of *C. fimbriata* through real time PCR was designed

by targeting the ITS region. The sensitivity and specificity of these primer pairs were evaluated through conventional as well as real time PCR.

Molecular identification of Predatory bug

Reduviid predator *Sycanus croceovittatus* is a potential biological control agent feed on the larvae and pupae of Lepidoptera, Coleoptera and Diptera. Adult bugs were collected and morphological identification and molecular characterization was carried out. The sequence of the species was characterized using mitochondrial gene (COI) and submitted in NCBI GenBank (MW450669).

Isolation and pathogenicity test of *Botryosphaeriaceae* fungi

The pathogenicity of fungus which has regularly been isolated from the bark and wood tissues of twig drying and branch wilt affected mango trees was established in 2 years old mango seedlings (21-MW-Bijnor Isolate). The inoculations were done by removing the bark of stem (1 × 1 cm) and placing the 5 mm mycelial disk and covering it with plastic parafilm. Fungus-free PDA disk was placed in case of control plants. Symptoms were observed in inoculated plants (Fig. 8), and control plants remained free from any symptoms. The fungus did not sporulate on PDA as well as pine needle media. Therefore, the fungus was subjected to molecular identification.

Fig. 8: Symptoms produced of inoculated mango plants

Identification of isolate 21-MW-Bijnor

Lasiodiplodia species level identification was done through sequence characterization using ITS and β-tubulin gene is not possible only on the basis ITS gene. DNA of 21-MW-Bijnor was isolated and ITS and β-tubulin genes were amplified using primer pairs ITS1/4 and Btub-2a/2b, respectively. The purified PCR products were sequenced from Eurofins Pvt. Ltd. The concatenated sequenced of ITS and Btub gene using software Sequence Matrix 1.7.8 and most parsimonious tree was generated using software PAUP 4.0 version (Fig. 9). Based on BLAST analysis, the isolate was identified as *Lasiodiplodia theobromae*.

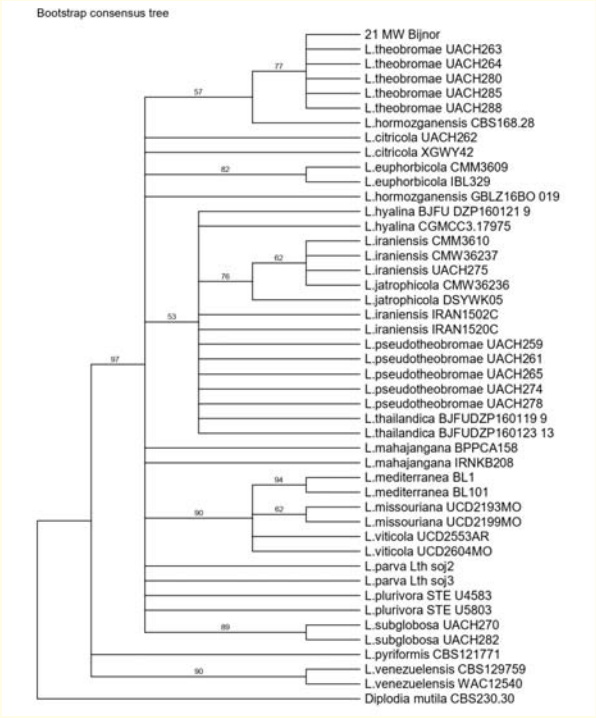


Fig. 9: Most parsimonious tree generated by maximum parsimony implemented in PAUP* 4.0 based on the combined ITS and B-tub gene dataset Bootstrap values (replication=1000) indicated above the nodes

Identification and molecular characterization of pathogens causing fruit spot in mango

We have observed fruit spots in the unripe green mangoes at Rehmankhera farm of CISH as well as farmer's orchards during surveys (Fig. 10).

Fig. 10: Symptoms on naturally infected mango fruits

In order to characterize the fungi responsible for causing fruit spots in unripe green mangoes, *cv*. Dashehari were collected during 2019-2022 and fungi associated with these symptoms were isolated followed by pathogenicity tests (Fig. 11).

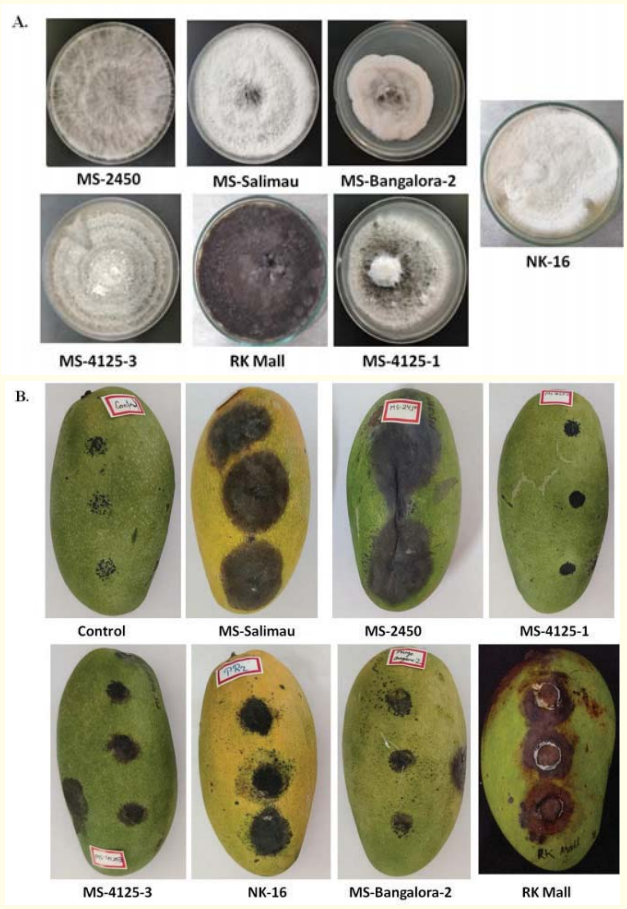


Fig. 11: Mycelial growth of pathogenic fungal isolates on PDA (A) and their pathogenicity tests on detached mango fruits cv. Dashehri (B)

Refinement in mango wilt/ decline management technology

Refinement of mango wilt/ decline disease management technology by incorporation of bio-control agents as a eco-friendly approach was investigated. *Lasiodiplodia theobromae* has been found associated with decline and branch drying. Four endophytic bacteria isolated from the mango roots were tested for antagonism against the pathogen. The antagonism against *L. theobromae* was tested in three ways, during direct interaction of bacterial isolates and pathogenic fungi in horizontal dual assay, and bacteria's volatile and non-volatile emissions (Fig. 12). Two isolates *viz*., Iso-C and E performed best and resulted in more than 70% mycelial inhibition through their non-volatile emissions (Fig. 13).

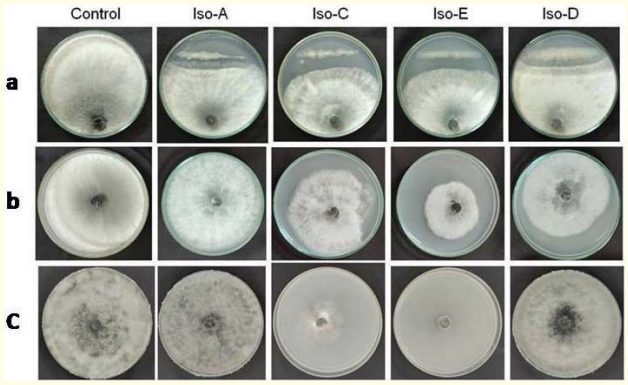


Fig. 12: Evaluation of antagonistic potential of bacterial endophytes against *Lasiodiplodia theobromae* through direct interaction (a), their volatile compounds through vertical dual culture assay (b) and using bacterial cell free supernatant (c)

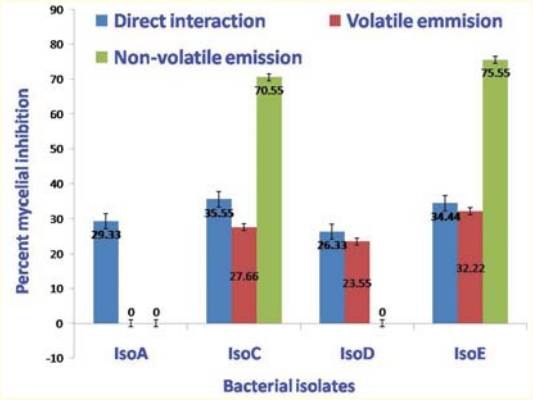


Fig. 13: Percent mycelial inhibition of *Lasiodiplodia theobromae* by bacterial endophytes during direct interaction (a), through their volatile compounds emission in vertical dual culture assay (b) and through non-volatile compounds emission (c)

Exploration of fruit microbiome for management of post-harvest diseases of mango

Bacterial strains were isolated from different fruits (mango, papaya, muskmelon, and malta), vegetables (cucurbits, tomato) and dairy products (tofu, milk, curd, and butter milk) on nutrient agar (NA), YPD agar media, and MRS agar media to select bacterial strains having antagonism against *Colletotrichum gloeosporioides* and *Botryopshaeria dothidea.* Forty five bacterial

strains were purified from single colonies and pure cultures were maintained on NA media. Preliminary horizontal dual cultures using these bacteria were performed with *C. gloeosporioides* to identify the antagonistic isolates (Fig. 14). Seventeen isolates were selected in the preliminary assays, among which only 6 (YPaB-3, MTofB-3 MMuB-1, Iso-F1, MCuB-3, and YMiB-4) isolates had shown antagonism consistently against *C. gloeosporioides* in horizontal as well as vertical dual culture assay (Fig. 14, 15).

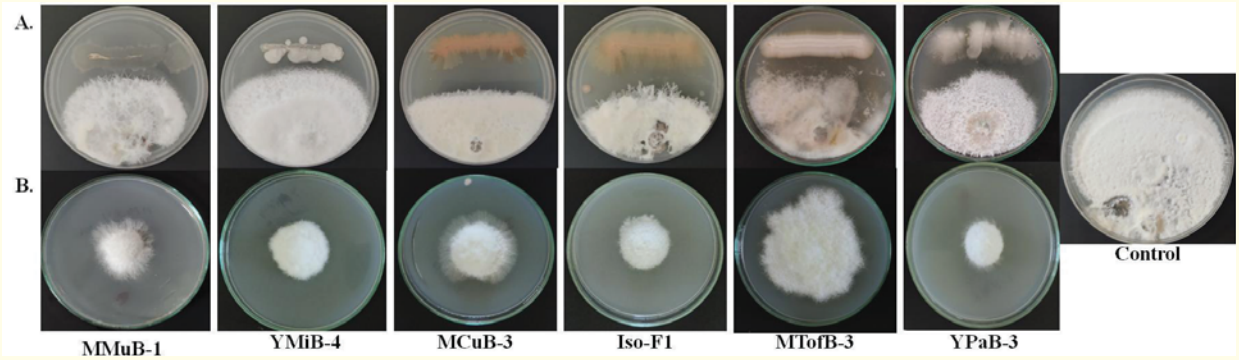


Fig. 14: Evaluation of antagonistic potential against *Colletotrichum gloeosporioides* through horizontal (A) and vertical dual culture assay (B)

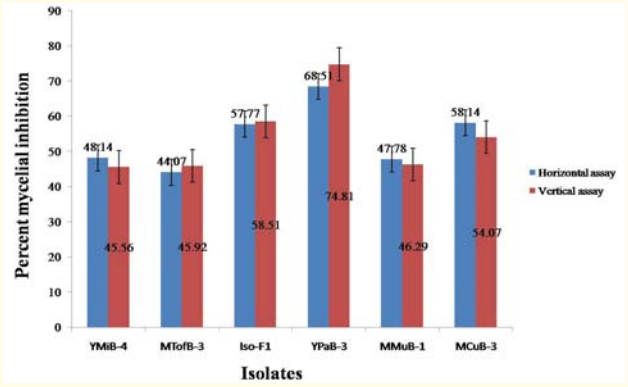


Fig. 15: Percent mycelial inhibition of *Colletotrichum gloeosporoides* by bacterial isolates

Developing new tools and devices for pest management.

Development of CISH- blower trap: To manage insects effectively by collection and destruction, CISH – blower trap was designed and prototype was developed and tested in field conditions. CISH - blower trap having components of light source, blower device and insect collection mechanism. This is the unique design and some modifications are underway to fully ready for use.

Development of CISH- self perpetuating field parasite cage (SPFPC): The self perpetuating cages were developed with objective to mass multiplication of host insect and parasitoid together in field conditions. This cage was tested for parasite emergence at different densities of host eggs wherein, the highest emergence of parasite (3003) was recorded in 0.5 cc host eggas.

The average parasitization of leaf webber by said parasite under field condition was 62.5%.

The highest parasitization of leaf webber was recorded at 1 meter and 2-meter distance with 90 and 70 percent parasitization, respectively. *Maruca vitrata* (Crambidae: Lepidoptera) infestation under field conditions (25.16 to 12.96 percent) was reduced upto 50 percent after the two weeks of the introduction of the larval parasitoid in the cages.

Killing efficiency of parasite under investigation revealed that it killed and survived on 14 species. Contrarily, it killed but not survived on 2 species of Leopidopteran insect pests. Under lab conditions 488.68 adult parasites emerged per day for 32 days from one cage under field conditions,

whereas 126.09 parasite adults emerged per day for 42 days in field conditions.

Water soluble polymer on sticky surface for catching the white flies: To manage Hemipateran insects effectively by collection and destruction, CISH - Pesticky trolley was designed and prototype was developed and tested in field conditions. CISH - Pesticky trolley having water soluble polymer killed significant number of whiteflies in single operation in its first trial.

New methodology to test the efficacy of pesticides against trunk borer: CISH developed methodology for testing the efficacy of insecticides by infesting the *B. rufomaculata* larvae in the moringa and mango logs. It was found that moringa log based testing methodology was found ideal for testing the efficacy of insecticides on the *B. rufomaculata.*

Evaluation of water soluble gums for mango thrips management: Water soluble gums were diluted at different concentrations and sprayed on the mango canopy wherever thrips population was high. It was found that gums are arresting the free movement of the thrips there by its controlling the population. There was no phytotoxic effect on the sprayed area.

Develop and refining the IPM schedules for the targeted pests

Mango mealy bug management technology: Modified banding technology was standardized against the mango mealy bug.

Evaluation newer insecticide for their bio-efficacy against mango thrips : Abamectin and Emamectin benzoate were found superior among 11 insecticides tested against thrips. Combi insecticides were also evaluated separately against mango thrips. Among the treatments tested Beta-cyfluthrin + imidacloprid (8.49+19.81 ww) and Sinetorum 11.7 SC were found very effective in reducing the thrips population.

Evaluation of attractants for female fruit flies: Different attractants were evaluated for trapping of female fruit flies. The treatments were found significantly different with respect to female fruit fly ($F_{3, 40} = 4.334$; $p = 0.010$) catches. Ammonium acetate was found very effective in attracting female fruit flies with 33 female fruit fly catches within 12 days. Different doses of ammonium acetate were also evaluated for fruit fly trapping ammonium acetate at 4 % attracted the highest number of female fruit flies.

Evaluation of different botanical formulations for management of sucking pest complex in mango: Evaluation of different botanical formulations for management of sucking pest complex in mango, revealed that after 7 days of last spray lowest thrips population was recorded on Azadirachtin 10,000 ppm (3 ml/l) followed by Neem soap (IIHR product) at 10g/l followed by Pongamia soap (IIHR product) at 10g/l followed by Botanical formulation "AAVYA" (4 g/l)

Effect of different concentrations of ammonium acetate (AA) on fruit fly attraction: Different concentration of ammonium acetate was evaluated for the attraction of fruit flies. Among the treatments of ammonium acetate, 3% were found very efficient in attracting male fruit flies, whereas the highest female fruit flies were attracted in 4% ammonium acetate.

Evaluation of botanical extracts for fruit fly attraction: Plant extracts were evaluated for attraction to fruit flies. Among treatments, the highest number of male fruit flies was attracted in botanical extract A (code), which was followed by extract B (code).

Bio-efficacy of insecticides and bio-agents against mango stem borer: Biocontrol agents and insecticides were evaluated against mango stem borer *Batocera rufomaculata.* Among the treatments tested highest mortality of the grub was recorded in treatment with Chlorpyriphos followed by Malathion. Among the bio-agents tested the highest mortality of the grubs observed in *Beuveria bassiana*.

Bio-efficacy of *Beuveria bassiana* against mango mealybug *Drosicha mangiferae:* In modified banding technology for mango mealy bugs, new instar mealy bugs congregate at the

base of the band some population reverse migrate and move to the alternate host. In order to kill this population, bio-efficacy of entomopathogenic fungi *B. bassiana* was evaluated. It was found that within 3 days of the spray *B. bassiana* kills the first instar nymphs of mealy bug.

Suitable pesticide for trunk borer control: Monocrotophos 36SL @ 2ml/lit Chlorpyriphos @ 2ml/lit. Cypermethrin 25EC @2ml/lit. Emamectin benzoat 1.9EC @1ml/lit Carbosulfan 25EC @ 2ml/lit Lamda cyhalothrin @1ml/lit, Spinetoram 11.7SC @0.2ml/lit. Chloropirifose 50EC, Water and untreated control, Bio-control agents and insecticides were evaluated against mango stem borer, *Batocera rufomaculata*. Among the treatments tested, highest mortality of the grub was recorded in the treatment with Chlorpyriphos followed by Malathion.

Management of mango hoppers and thrips on mango by oil-based formulation of *Metarhizium anisopliae*: *M. anisopliae* (oil-based formulation @ 0.5ml/ l) was found effective in reducing the thrips population (37.5/ tap) after the 9 days of last spray. For hoppers, *M. anisopliae* (oil-based formulation) was effective @ 1ml/ l.

Division of Post Harvest Management

Mango (*Mangifera indica* L.)

Shelf-life enhancement of mango cv. Mallika by use of hexanal

Mango fruits of cv. Mallika were treated with 0.02% hexanal for enhancing the shelf-life under ambient conditions. These fruits were analyzed for different physicochemical parameters at regular intervals of storage. The fruits treated with 0.02% hexanal had a shelf life of 12 days compared to control which had 8 days of shelf life.

Quality maintenance of mango fruits during storage by use *of Lactobacillus plantarum*

Mango fruits of cv. Mallika were treated with *Lactobacillus plantarum* @10^8 cells ml^{-1}, *Lactobacillus plantarum* @10^8 cells ml^{-1} plus 2% guar gum for 10 minutes and stored under ambient conditions. The treated fruits reported Cumulative Physiological Loss in Weight (CPLW) of 8.88 % and firmness of 1.15 Kg cm^{-2}, on 12^{th} day of storage while the control fruits exhibited CPLW of 18.77 % and firmness of 0.61 Kg cm^{-2}. These fruits were also assessed for other quality parameters such as TSS, acidity, total carotenoids and antioxidants. Overall the *L. plantarum* @10^8cells ml^{-1} plus 2% gual gum had a shelf-life of 12 days under ambient conditions.

Effect of nano silver and nano gold particles on the shelf life of mango cv Mallika.

Nano-silver and nano-gold were applied to Mallika mango fruits and assessed for physico-chemical attributes at regular intervals during storage. Nano-silver particles were effective in enhancing the quality of fruits in terms of high TSS (29.1°B), titratble acidity (0.13 per cent) and total carotenoids (6.74 mg^{-1}/100 g) on the 12^{th} day of storage under ambient conditions.

Development of protocol for export of mango cv. Chausa through sea route

Experiment was designed for extension of shelf-life of mango cv. Chausa. Two treatments were imposed i.e. control (T_1) and fruit treated with 100 ppm ethylene (T_2). Mandatory quarantine with hot water treatment at 46.8°C for 1 hour was common for both the treatments. Fruits were withdrawn at three different time intervals i.e. after 6, 12, and 15 days of storage. The quality parameters were analyzed immediately after withdrawal and after three days of ripening at room temperature with ripening sachet in CFB boxes. After 15 days of storage, TSS, acidity, firmness and PLW (%) of both the treatments were analyzed and it was found that after 12 days of cold storage, there were no significant changes noticed in TSS, acidity, firmness and PLW (%) as compared to the previous withdrawal (12 days), hence it was continued and after 15 days in cold storage + three days at room temperature for ripening (total 18 days), it was found that fruits treated with ethylene reported high TSS, low acidity and uniform yellow colour. Disease incidence was lower with less number of spoiled fruits as compared to control.

Protocol for development of ripening sachet for mango

In the market, the ethylene ripening sachets are available. However, the release of ethylene gas is very fast which is not good for the uniform ripening of the mango fruits. In this regard plant based CISH-fruit ripener was developed by using the ethrel (39%) and NaOH (1N) which releases ethylene slowly and helps in uniform ripening of mangoes. The hourly ethylene generation was estimated and it was found that up to 15-18 hours 101 ppm ethylene gas was released and in 24 hours total ethylyne released was131 ppm (Fig. 1). In raw mango, peel contains highest amount of phenolic compounds followed by pulp. After ripening chlorogenic acid increases in pulp where as other phenolic compounds significantly decreased in pulp.

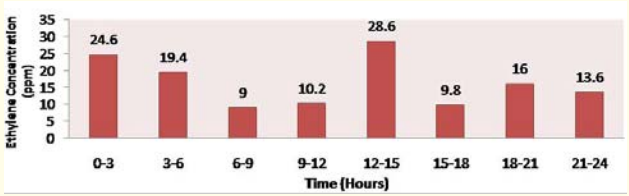


Fig. 1: Ethylene generation from the sachet

Table 1. Effect of ripening sachet on phenolic compounds in mango

Phenolic Compound	Control (raw mango)		Mango ripened using CISH ripening sachet	
	Peel	Pulp	Peel	Pulp
Gallic Acid	819.52 ± 8.930^a	95.197 ± 2.564^b	723.373 ± 6.083^c	73.187 ± 4.113^d
Chlorogenic Acid	456.21 ± 7.888^b	524.93 ± 9.077^a	379.1 ± 3.032^d	410.63 ± 2.470^c
Catechin	2776.68 ± 27.202^a	322.367 ± 3.706^c	2274.897 ± 17.497^b	268.223 ± 7.539^d
Epicatechin	209.63 ± 3.712^b	58.58 ± 3.020^c	239.363 ± 3.272^a	60.057 ± 3.011^c
Caffeic Acid	0.82 ± 0.066^a	0.543 ± 0.031^c	0.653 ± 0.025^b	0.32 ± 0.036^d
Paracoumeric Acid	2419.08 ± 16.364^a	30.037 ± 1.822^c	2241.257 ± 6.386^b	20.303 ± 0.893^c

The TSS, acidity, fruit firmness was found significantly superior in CISH- Fruit ripener than the market ripening sachet and PLW (%) was found minimum (Fig 2).

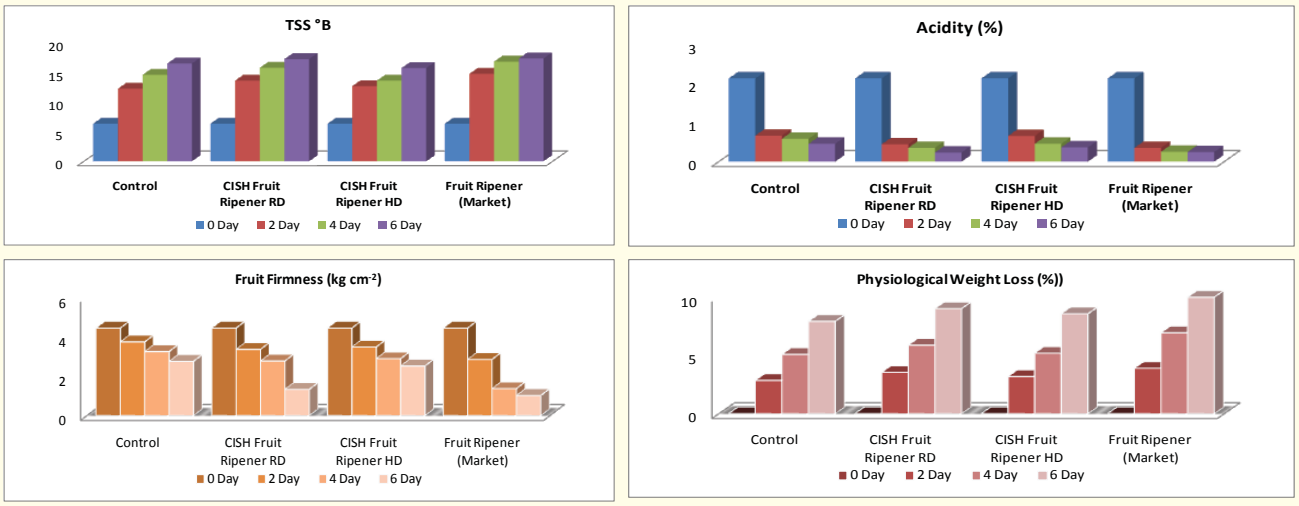


Fig. 2: Effect on TSS, acidity, fruit firmness and physiological weight loss of mango ripened through ripening sachet.

Stability analysis of fresh mango export from India

The Trade matrices (transitional probability matrix) were estimated using Markov chain approach (Table 2). Annual export data for period 2009-10 to 2018-19 were used to analyze the direction of trade and changing pattern of Indian mango exports. The columns element indicates the probability of gains in volume of trade from other competing countries and the diagonal element indicates probability of retention of the previous year's trade volume by the respective country. Oman was one of the most stable markets among the major importers of Indian mango. The probability of retention was 0.696, 0.681 and 0.680 for Bangladesh, United Arab Emirates and United Kingdom, respectively.

Table 2. Transitional Probability Matrix for quantity of fresh mango export from India

Country	UAE	UK	Oman	Qatar	USA	Bangladesh	Kuwait	Saudi Arab	Nepal	Others
UAE	**0.681**	0.050	0.000	0.000	0.000	0.000	0.026	0.064	0.101	0.079
UK	0.000	**0.680**	0.040	0.066	0.039	0.000	0.000	0.175	0.000	0.000
Oman	0.000	0.000	**0.915**	0.000	0.000	0.000	0.000	0.000	0.085	0.000
Qatar	0.000	0.230	0.153	**0.000**	0.000	0.000	0.199	0.000	0.033	0.384
USA	0.000	0.000	0.000	1.000	**0.000**	0.000	0.000	0.000	0.000	0.000
Bangladesh	0.304	0.000	0.000	0.000	0.000	**0.696**	0.000	0.000	0.000	0.000
Kuwait	1.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000
Saudi Arab	0.237	0.000	0.000	0.204	0.000	0.000	0.000	**0.000**	0.285	0.274
Nepal	0.117	0.000	0.010	0.126	0.073	0.031	0.006	0.013	**0.504**	0.118
Others	0.799	0.000	0.000	0.000	0.015	0.186	0.000	0.000	0.000	**0.000**

Cost of cultivation of Dashehari mango

The cost of cultivation of mango cv. Dashehari in Uttar Pradesh was Rs. 1,68,418.00 ha^{-1}. Variable costs comprise 50.1 % of the total cost of cultivation. Expenditure on plant protection chemicals and man power contributed to 62% of the total variable cost (Fig. 3). An average yield of 102 q/ha^{-1} was obtained. The average cost of producing mango was Rs. 16.70 per kg. Key challenges faced by the producers include fluctuating insect pest dynamics, lack of knowledge on quality insecticides/pesticides, huge post-harvest loss, low price of mango due to market oversupply, and a lack of crop insurance scheme.

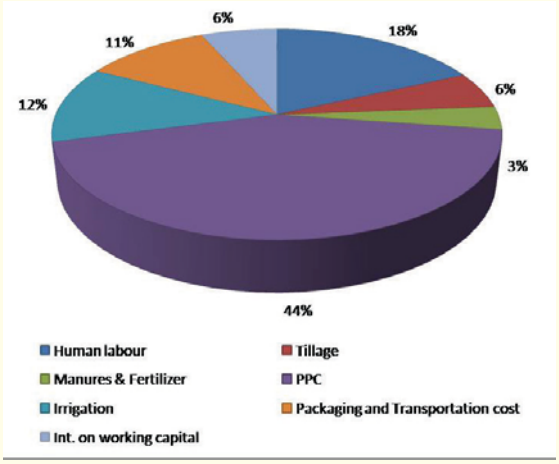


Fig. 3: Share of different components of variable costs in mango production

Guava (*Psidium guajava* L.)

Shelf-life enhancement of guava cv. Lalit by use of hexanal.

Guava fruits cv. Lalit were treated with hexanal @ 0.1, 0.075, 0.05, 0.150 ppm and control fruits without any treatment for prolonging the shelf-life under ambient conditions. These fruits were analyzed for different physico-chemical parameters at regular interval of 0, 4, 6, 8, 10 and 12 days of storage. The fruits treated with 0.1 ppm hexanal had TSS: titratable acidity ratio of 28.50 and 108.13 mg 100 g^{-1} of ascorbic acid content on the 12th day of storage.

Effect of nano-particles on the shelf-life of guava

Guava fruits of cv. Shweta were treated with nano- particles such as silver gold, Zn, Cu and control without any treatments. The fruits were packed and stored under ambient conditions. These fruits were analyzed for different storage parameters at regular intervals. The fruits treated with nano-silver had a shelf-life of 12 days compared to control which had a shelf-life of 8 days.

Antioxidants content in guava at the edible ripe stage

Seven varieties of guava, namely, Allahabad Safeda, Shweta, L-49, Lalit, G-1, G-6 and G-31 were assessed for its biochemical and antioxidant properties at edible ripe stage. The fruit pulp was extracted in different solvents and assessed by Expand FRAP (Feric Reducing Antioxidant Power) and DPPH (2, 2-Diphenyl-1-Picrylhydrazyl) methods for its antioxidants. The antioxidants estimated by FRAP in acetone extract was maximum (6.97µ moles TE g^{-1}) in Shweta and minimum (2.12µ moles TE g^{-1}) in G-31. The variety G-31 and Shweta followed the same trend in ethanol and methanol extract. Maximum inhibition per cent as determined by DPPH was 92.97 % in ethanol extract in G-31 followed by Lalit and Shweta in acetone and methanol extract, respectively. Minimum inhibition per cent was in L-49 (70.74%).

Effect of melatonin and chitosan dip treatments on post-harvest physiology of guava

Post harvest physiological and biochemical activities of fruit affect the quality of guava. Ripening and senescence during handling, retailing and storage affects the external and internal qualities of fruits and determine the transportability and storability as well. Loss in visual appearance and textural quality considerably reduces the consumer acceptance and marketability of fruit. Physiological and biochemical functions are fundamental for post harvest management of fruits. Post-harvest physiological changes in fruits can be manipulated by application of edible barrier materials (coatings). Edible coatings of melatonin and chitosan were applied in guava cv. Lalit and physiological changes at room temperature were recorded till 12 days after harvest. Exogenous application of melatonin (@ 50, 100 and 150 ppm) was found to remove excess reactive oxygen species from fruits by increasing antioxidant enzymes, non-enzymatic antioxidants. Coating/ dip treatment in low concentration was found to be notably effective in reducing decay and weight loss of fruit and delayed senescence of fruit (Fig. 4 - 11).

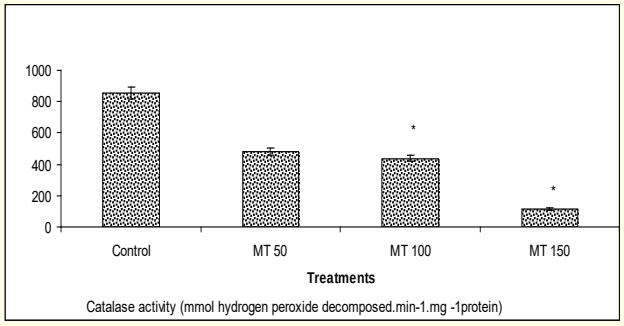


Fig. 4: Catalase activity in guava Pulp

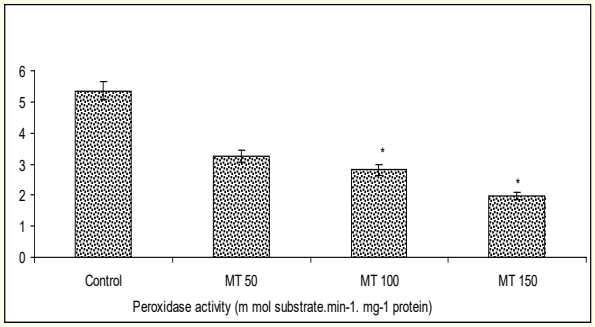


Fig. 5: Peroxidase activity in guava Pulp

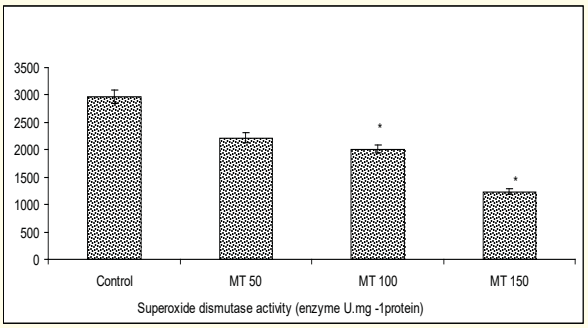


Fig. 6: Superoxide dismutase activity in guava Pulp

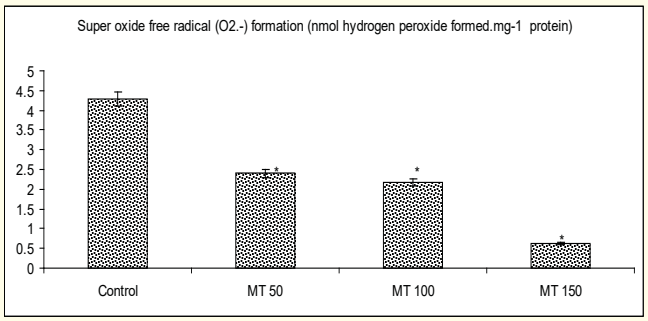


Fig. 7: Super oxide Free Radical Formation in guava Pulp

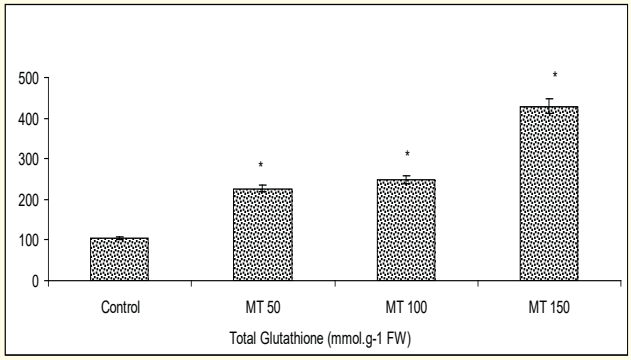


Fig. 8: Total Glutathione Content in guava Pulp

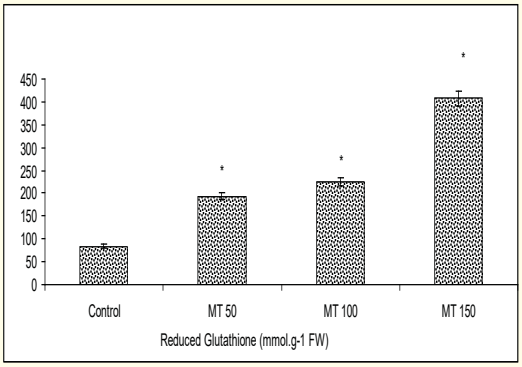


Fig. 9: Reduced Glutathione Content in guava Pulp

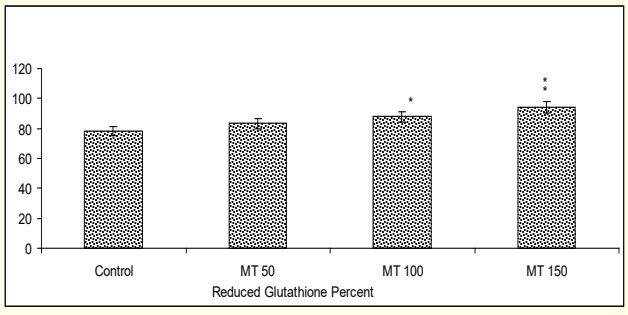


Fig. 10: Reduced Glutathione Percent in guava Pulp

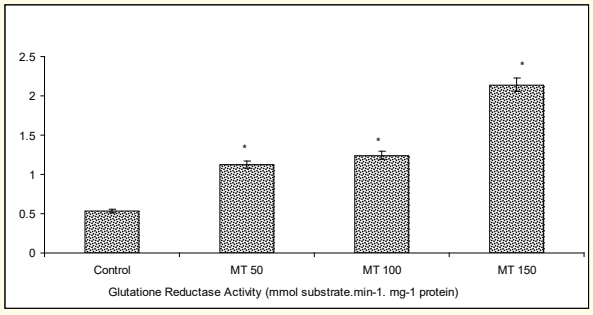
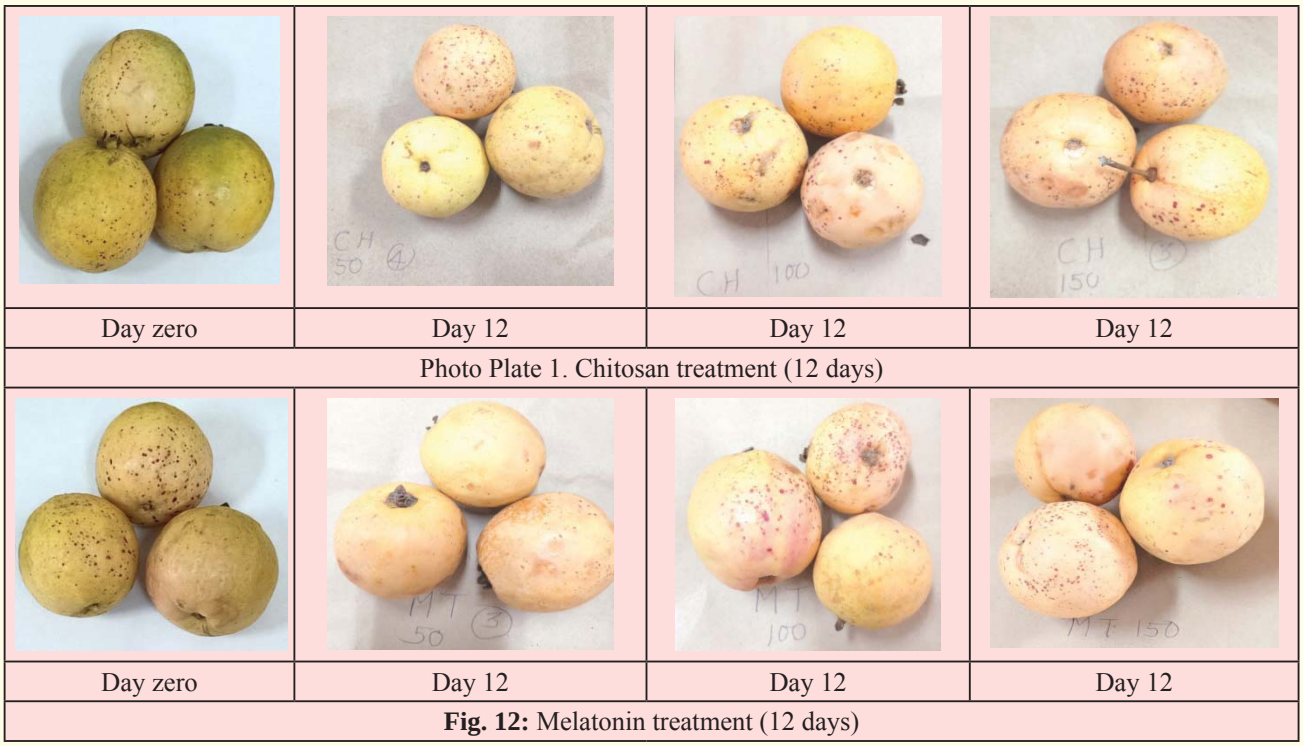


Fig. 11: Glutatione Reductase Activity in guava Pulp

Figure 4-11

Similarly, fruits of guava cv. Lalit were treated with chitosan (@ 50, 100 and 150 ppm) and stored at room temperature. At day 12, catalase activity ranged from 815 mmol hydrogen peroxide decomposed $min^{-1}mg^{-1}$ protein in control to 248.78 mmol hydrogen peroxide decomposed

min^{-1}mg^{-1} protein in CH 100. Peroxidase activity varied from 5.61 m mol substrate min^{-1}. mg^{-1} protein in control to 2.23 m mol substrate min^{-1} mg^{-1} protein in CH 100. Maximun superoxide dismutase activity 2756 enzyme U mg^{-1} protein was found in control and minimum 1638.49 enzyme U mg^{-1} protein in CH 100. Super oxide free radical (O2.-) formation was 4.23 in control to 2,22 nmol hydrogen peroxide formed mg^{-1} protein in CH 100 treated fruits. Antioxidant glutathione was also more in CH 100 treated fruits (265.12 mmol.g^{-1} FW) as compared to control (111.15 mmol.g^{-1} FW). Moreover, in treated fruits glutathione was more in reduced form i.e., in CH 100 treated fruits 83.96 % and in control 72.90 %. Glutathione reductase activity was also in accordance with this (0.64 mmol substrate.min^{-1}. mg^{-1} protein in control and 1.35 mmol substrate min^{-1}. mg^{-1} protein in CH 100 treated fruits). Low concentration of coating may be mediated by decrease in cell membrane damage and cell wall loosening enzymes (Fig. 12).



Day zero	Day 12	Day 12	Day 12
Photo Plate 1. Chitosan treatment (12 days)			
Day zero	Day 12	Day 12	Day 12

Fig. 12: Melatonin treatment (12 days)

Trend and instability in guava area, production and productivity

Compound Annual Growth Rate (CAGR) was used to analyze the trend in the area, production and productivity of guava in major producing states of India. The period of analysis was 2010-11 to 2021-22. The area, production and productivity of guava in India increased at a rate of 3.56, 5.79 and 2.17 per cent annually, respectively. Uttar Pradesh is the major guava producing state in the country having 52.25 thousand ha of area and produces around 20 per cent of total production. Both area and production had significant positive growth but the growth in productivity was not significant. Though, there is significant decrease in the productivity of guava in Madhya Pradesh, production increased significantly due to the increase in area. In Bihar, there is decrease in area but it is not significant. Cuddy Della Valle Index was worked out to study the instability in area, production and productivity of guava. Both area and production of guava in Uttar Pradesh had high level of instability. This instability can be attributed to guava wilt disease. Production and productivity is highly instable in Madhya Pradesh. However, there was no higher instability in guava production in Bihar and India.

Table 3. Trend and instability in the area, production, and productivity of Guava in UP and India

State/Country	Particulars	CAGR (%)	Instability
Uttar Pradesh	Area	13.00***	23.06
	Production	14.45***	21.85
	Productivity	1.30^{NS}	8.13
Madhya Pradesh	Area	13.17***	11.94
	Production	8.00***	26.37
	Productivity	-4.56*	30.26
Bihar	Area	-0.05^{NS}	2.30
	Production	5.47***	11.39
	Productivity	5.53***	11.81
India	Area	3.56***	4.25
	Production	5.79***	8.16
	Productivity	2.17***	7.40

Note: *** and * indicates significance at 1 and 10 per cent, respectively and NS- Non-significant

Aonla

Effect of dip treatments on the storage-life of aonla fruits

Fresh eg harvested aonla fruits of cvs. Chakaiya and NA-7 were treated with dip treatments of melatonin (@ 50, 100 and 150 ppm), chitosan (@ 50, 100 and 150 ppm) and sodium alginate (@ 0.5, 1.0 and 1.5 %) solutions for 5 minutes. The fruits were surface dried at room temperature, packed in brown paper bags and stored at room temperature. Initially, Chakaiya fruits had 7.6°B TSS, 1.63 per cent acidity, 286 mg 100 g^{-1} vitamin-C and 1.86% total phenolics. Similarly, NA-7 fruits had 9.0°B TSS, 3.01% acidity, 286 mg 100 g^{-1} vitamin-C and 2.14 % total phenolics. After 15 days sodium alginate @ 1.0%, chitosan @ 100 ppm and melatonin @ 100 ppm were found to be better treatments as compared to other treatments in terms of colour, appearance and texture.

Preservation of clarified aonla juice at different temperatures

Aonla juice was clarified using commercial pectinase enzyme treatment at 1ml $litre^{-1}$ for one hour at room temperature. The clarified juice, filled in glass bottles, was stored in refrigerator, at room temperature and at 35°C along with untreated (control) juice. The juice initially contained 414 mg100 ml^{-1} vitamin-C and 2.83% total phenolics. Observations up to four months of storage revealed decrease in vitamin-C in all treatments. Juice samples exhibited more browning at 35° C than at room temperature and least under refrigerated condition. After 120 days, HPLC analysis of aonla juice revealed presence of gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid, ellagic acid and p-coumaric acid as major phenolics. Catechin was the most abundant (7894 µg/ml) phenolic while p-coumaric acid was least (382 µg/ml) at zero day (Fig. 13-15).

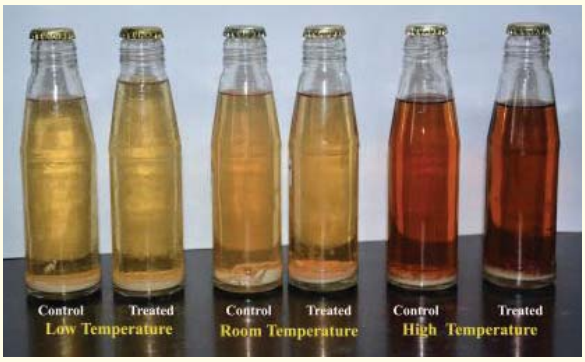


Fig. 13: Aonla juice storage at different temperatures

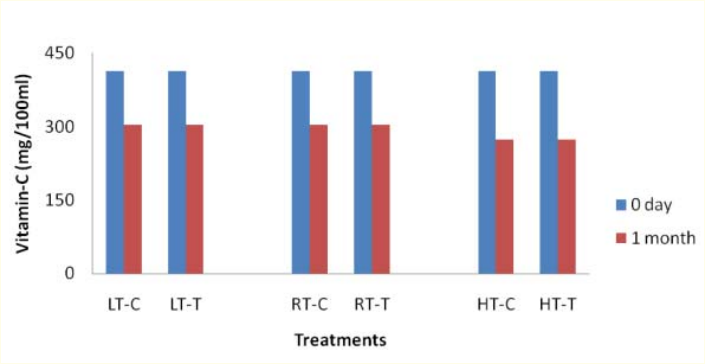


Fig. 14: Changes in vitamin-C content of aonla juice during storage

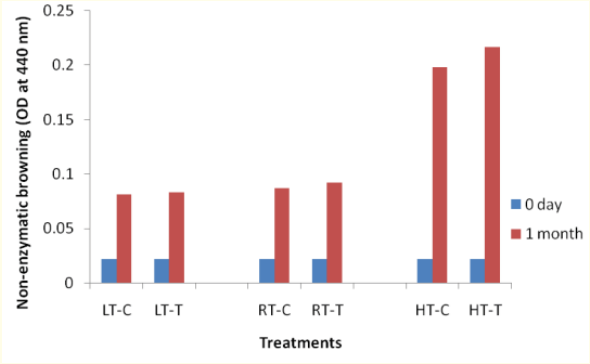


Fig. 15: Non-enzymatic browning of aonla juice during storage

Evaluation of Aonla candy for quality and storage studies

Candy of aonla varieties Chakaiya, A-31 and A-33 was developed to assess the retention of Vitamin-C and phenols from initial stage to six months of storage. The total soluble solids, acidity, and reducing sugars increased while ascorbic acid and antioxidants decreased during the storage. Higher TSS was recorded in A-31 candy and lower in A-33. Vitamin-C was higher in A-31 and lower in A-33. Acidity was higher in A-31 (0.98%) and lower in Chakaiya. During the storage, phenols in aonla candy ranged from 7.07 to 28.58 mg g^{-1}. The A-31 and A-33 are very rich in Vitamin-C and phenols and retention of nutrients is also high after six months of storage. Sensory evaluation of aonla candy was assessed by using nine point hedonic scale and it was found that A-33 have more hedonic scores followed by A-31 and Chakaiya for colour, texture, taste and overall acceptability (Fig. 16).

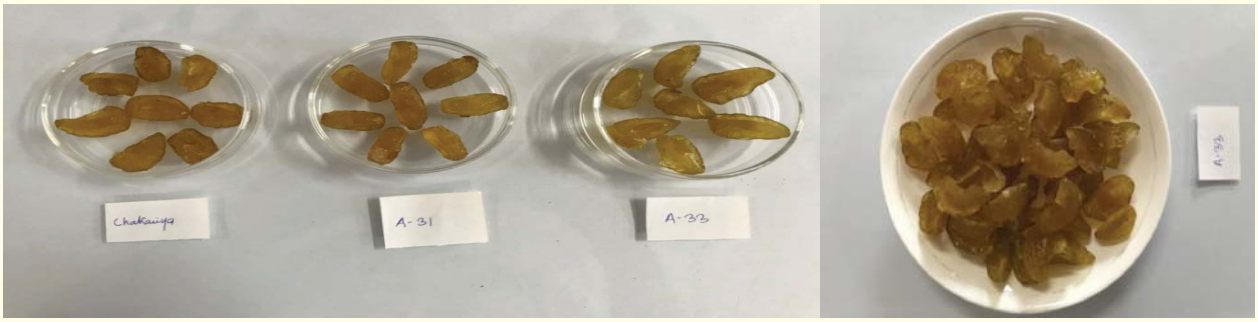


Fig. 16: Aonla Candy of different varieties

Aonla honey preserve

Aonla is the rich source of Vitamin C. The raw fruit, due to its high acidic nature and astringent taste is unacceptable to the consumers. Honey is a natural high energy sweetener with many medicinal values like antimicrobial, antiviral, antiparasitic, anti-inflammatory, antioxidant, antimutagenic and antitumor effects. Keeping in view the nutritional and therapeutic values of aonla fruit and honey, aonla preserve was prepared by incorporating litchi honey. The shelf-life of the product was six months, and had good amount of Vitamin C 196 mg 100 g^{-1}. TSS of the final product was recorded 68.7 °Brix with an acidity of 0.96% (Fig. 17).

Fig. 17: Aonla honey preserve

Beal

Preparation of bael-aonla blended prash

Bael and aonla both are medicinally important fruits having therapeutically important nutraceutical elements. Aonla contains rich amounts of fibre, vitamin-C and phenolics whereas bael is rich in fibre, phenolics and mucilagenous substance. Bael also contains medicinally important bioactive compounds such as marmelosin and psoralen. With the aim to combine beneficial compounds of bael and aonla, bael-aonla blended prash was prepared using pulp powder of both the fruits along with Indian herbs and spices. The product was found to contain 78 °B TSS, 2.2 per cent acidity, 41.4 mg 100 g^{-1} vitamin-C and 3.38 % total phenolics (Fig. 18).

Fig. 18: Bael - Aonla blended Prash

Development of honey-based bael squash

Sugar has become a major problem in several health complications including diabetes. Honey is a pro-health natural sweetener with wide utility. It is beneficial for a number of diseases. Hence, a honey based bael squash was standardized where sugar was completely replaced by honey. It is less sweet with all medicinal properties of bael and honey. The squash was found to contain 34 °B TSS, 0.5 % acidity, 7.1 mg 100 g^{-1} vitamin-C and 987 mg 100 g^{-1} total phenolics (Fig. 19).

Fig. 19: Honey-based bael squash

Standardization of instant bael drink

Bael fruit is rich source of various nutrients like beta-carotene, protein, riboflavin and vitamin-C. It is loaded with vitamins B1 and B2, thiamine, riboflavin, niacin, and carotene and possesses good amounts of minerals like calcium, potassium, fiber and good fats. Instant bael drink is developed with all the nutritional quality of bael with no preservative and no added colour. Organoleptic evaluation of instant bael drink of different treatments was done. Treatment T_2 was found to be highly acceptable with taste and colour of drink. The TSS was found 12-14 °B and acidity was 0.21%. The marmelosin and psoralen were quantified to be 0.171 and 0.003 mg g^{-1}, respectively (Fig. 20).

Fig. 20% Instant Bael Drink

Protocol for development of sugar free instant bael drink

Bael fruits are rich in minerals and vitamins. Bael powder can be stored for a longer time. The sugar free drink was developed for sugar patient. Stevia power was used to make the instant drink. The TSS was found 10-12 °B and acidity 0.23% with acceptable taste and favour. The marmelosin and psoralen were quantified to be 0.171 and 0.003 mg g^{-1}, respectively (Fig. 21).

Fig. 21: Sugar free instant bael drink

Other Crops

Development of dehydrated cubes of jackfruit for vegetable purpose

Ten treatments for developing dehydrated cubes of jackfruit for vegetable purpose were imposed with water blanching/steam blanching with salt or without salt. After two months of storage, vegetable curry was also prepared. Among all the tretments, based on rehydration, sensory evaluation of vegetable curry. The treatment steam blanching with 1% salt was found suitable (Fig. 22).

Fig. 22: Dehydrated Jackfruit Cubes

Development of sugar free strawberry RTS

Strawberries are rich in phenolics, vitamins and minerals. The sugar content in strawberry is quite low as compared to other fruits. Being rich in vitamins and minerals, it can be a suitable drink for the diabetic patients. The protocols were developed for RTS by using the recommended dose of artificial sweetener i.e. sucralose and stevia. The organoleptic taste and flavor were found acceptable in sucralose based RTS. The acidity of this drink was 0.23% and TSS was 10 °Brix (Fig. 23).

Fig. 23: Sugar free strawberry RTS

Honey-based strawberry spread

Strawberries are high in natural antioxidants and antioxidant enzymes, which protect the body from harmful free radicals and play an important role in human health. Honey-based strawberry spreads without artificial flavouring agents have a niche market among consumers who prefer fewer chemical additives. One of the most important aspects of preserving fruit pulp is the preparation of spread. The honey-based fruit spread will undoubtedly have national and international market potential. These exotic spreads can be used to make sandwiches and other similar breakfast foods more appealing and appetizing. The shelf-life of the product was recorded six months, and the TSS was 69.4 °B with an acidity of 1.15% (Fig. 24).

Fig. 24: Honey based strawberry spread

Externally Funded Projects

DBT Funded Project: Management of Fusarium wilt of NER Banana using ICAR-Fusicont Technology

PI: Dr. T. Damodaran

Co-PI: Dr. Maneesh Mishra & Dr. Ashish Yadav

Funding Agency: DBT, New Delhi

In vitro bioassay of bio-immune formulation against *Foc* TR4

Bio-immune formulation exhibited a significant antifungal potency ($p \leq 0.05$) against the *Foc* TR4 at different concentrations, compared with the control. The inhibition zone diameter ranged between 2.70cm – 6.03 cm in different concentrations. On 9th day after inoculation, the maximum radial growth (6.03 cm) was observed at concentration 0.5%, while minimum radial growth (0.47 cm) was recorded at 2.0% concentration. Whereas no radial growth was observed in *Foc* TR4 at a 2.5% concentration of the bio-immune formulation, the data showed that with the increase in the concentration of the bio-immune formulation the percent of inhibition of *Foc* TR4 significantly ($p \leq 0.05$) increases. The highest percent inhibition (100%) was observed at 2.5% concentration of bio-immune on 5th, 7th and 9th DAI followed by 96% on 7th DAI and 94% on 9th DAI at 2.0% concentration respectively.

Effect of bio-immunization on *in vitro* rhizogenesis, shoot proliferation and hardening stages of tissue culture banana plants of G-9 banana variety

The highest significant ($p \leq 0.05$) values (4.63 cm, 4.37, 7.67, 59.67 mg, and 12.67 mg) were observed in bio-engineered tissue culture banana plantlets for root length, number of leaves, roots, fresh root weight, and dried root weight respectively, compared to control 3.73 cm, 3.70, 5.00, 39.60 mg and 6.67 mg respectively. Similar to this, the results indicated that mean shoot proliferation rates of bio-engineered biomolecule were significantly ($p \leq 0.05$) higher after the basal cycle. The bio-engineered banana tissue culture plantlets showed significantly ($p \leq 0.05$) higher values (12.67, 3.43 cm, 2.03 mg, and 0.13 mg) for no. of shoots, average leaf length, fresh root weight, and shoot dry weight respectively compared to control 9.67, 5.43 cm, 3.70 mg, and 0.30 mg.

During the primary hardening, all observed vegetative growth metrics had better results which includes, plant height (12.53 cm), root length (10.07 cm), plant girth (2.47 cm), no. of primary roots (6.47), no. of leaves (6.27), and leaf area (125.40 cm^2) were significantly ($p \leq 0.05$) higher in bio-immunized banana transplants compared to control by 28.17 %, 6.65 %, 21.86 %, 14.99 %, 14.35 %, and 6.56 % respectively. Banana transplants that have been acclimated had a greater survival rate upto 97.57 % for the bio-immunized banana transplants compared to control (94.53 %) respectively. Similarly, during secondary hardening, bio-engineered biomolecule significantly ($p \leq 0.05$) enhanced all the vegetative growth parameters viz. plant height (19.66 %), root length (27.60 %), plant girth (22.91 %), no. of primary roots (7.28 %), no. of leaves (4.22 %), and leaf area (38.39 %), respectively, compared to control.

In vivo evaluation of bioimmunized plants under pot conditions against *Fusarium* wilt

The height and girth of immunized plants (TFBI) were measured to be 38.54 cm and 5.80 cm, respectively, higher than those of the ICAR-Fusicont-treated plants (TFTR) (34.78 cm and 5.22 cm), *Foc* TR4 treated control (TF) plants (31.34 cm and 3.74 cm), and untreated control (TC) plants (26.90 cm and 3.06 cm) respectively. Remarkably, Fusicont-treated plants showed a significant ($p \leq 0.05$) difference in percent increment in plant height and girth

(TFTR) (20.43 % and 28.46 %) followed by bio-immunized plants (TFBI) (18.92 % and 28.39%). With time, non-immunized plants inoculated with *Foc* TR4 (TF) exhibited mortality between 60 to 90 days. At 90th day after planting, the treatment TF showed a significant ($p \leq 0.05$) high mean disease severity index (DSI) of 3.45 whereas, the bio-immunized plants (TFBI) and plants treated with Fusicont (TFTR) showed significant ($p \leq 0.05$) lower DSI (0.20 and 1.00).

Analysis of defense-related enzymes and phenol content

Comparing bio-immunized plants with non-immunized plants, a significant increase in the production of all the analyzed enzymes, including phenylalanine ammonia lyase (PAL), β-1, 3-glucanase, polyphenol oxidase (PPO), peroxidase (POD), phenol, and chitinase was observed. However, compared to the *Foc* infected hybrids, the control (uninoculated) plants usually had reduced enzyme activity.

Multi-location trial and assesssement of performance of bioimmunized plants

Field trials were conducted for two consecutive years (2020-21 and 2021-22) in the field of susceptible soil at two locations Nirpur, Purnia district and Dighari, district Katihar (Bihar, India) (Table). It was observed that bio-immunized plants significantly enhanced the growth and yield compared to control (non-immunize) plants. At location 1, the maximum plant height and plant girth was recorded in TBITR (257.30 cm, 70.80 cm) followed by TBI (249.30 cm, 68.70 cm) and TTR (238.90 cm, 57.95 cm) compared to untreated control plants (TC) (222.65 cm, 53.65 cm), respectively. At location 1, the highest bunch weight (30.85 kg), and no. of hand/bunch (12.30) was observed in treatment TBITR whereas, maximum no. of fingers/ hand was found in TBI (17.50) significantly similar to TBITR (17.45) followed by TTR and TBI respectively. At location 2, the highest plant height was observed in TBITR (249.40 cm) and plant girth in TBI (66.45 cm) significantly ($p \leq 0.05$) higher than control (TC). The maximum no. of leaves/plant, 3rd leaf length (12.35 and 228.35 cm) was found in TBITR, while highest 3rd leaf breadth (82.60 cm) was recorded in TBI significantly ($p \leq 0.05$) higher than other treatments and control as indicated by DMRT. Similarly, the highest bunch weight (31.70 kg), no. of hand/bunch (12.40), was observed in TBITR inoculated plants, while maximum no. of finger/hand (18.95) was observed in TBI followed by TBITR, TTR and control (TC), respectively.

Effect of bio-immunization and ICAR-FUSICONT (*Trichoderma reesei* (CSR-T-3)) treatment on *Fusarium* wilt management and growth of banana plantlets under field experiment in sick fields

Treat.	Plant height (cm)	Plant Girth (cm)	No. of leaves/ Plant	3rd Leaf length (cm)	3rd Leaf Breath (cm)	Bunch wt. (kg)	No. of hand/ bunch	No. of finger/ hand
Location 1 : Nirpur, Purnia district, Bihar, India								
TBI	249.30c (±6.76)	68.70c (±3.18)	10.00b (±0.79)	222.40c (±5.71)	72.00c (±1.34)	28.25b (±1.59)	11.25b (±0.85)	17.50c (±1.05)
TTR	238.90b (±3.01)	57.95b (±5.17)	8.10a (±0.72)	200.40b (±6.12)	65.53b (±3.60)	28.70b (±1.13)	9.25a (±0.72)	15.20b (±0.83)
TBITR	257.30d (±5.41)	70.80d (±5.00)	11.15c (±0.88)	233.45d (±2.93)	73.65d (±1.35)	30.85c (±1.60)	12.30c (±0.66)	17.45c (±1.10)
TC	222.65a (±5.25)	53.65a (±1.50)	7.65a (±0.59)	186.65a (±4.76)	59.20a (±2.40)	16.19a (±1.11)	9.10a (±0.72)	14.60a (±1.10)
Location 2 : Dighari, Katihar district, Bihar, India								
TBI	230.05b (±9.27)	66.45c (±3.84)	10.55b (±1.10)	196.10b (±5.21)	82.60d (±4.26)	25.65b (±2.13)	11.30b (±1.17)	18.95d (±3.14)
TTR	238.75c (±12.27)	62.60b (±2.16)	10.45b (±2.70)	207.75c (±11.76)	73.55b (±7.76)	27.10c (±2.05)	11.10b (±1.21)	15.00b (±1.30)
TBITR	249.40d (±4.12)	63.80b (±2.48)	12.35c (±1.04)	228.35d (±5.24)	80.05c (±5.80)	31.70d (±2.47)	12.40c (±0.75)	17.15c (±1.50)
TC	187.55a (±6.35)	55.15a (±2.30)	7.65a (±0.59)	147.45a (±6.26)	53.45a (±1.23)	14.13a (±2.47)	9.10a (±0.72)	12.90a (±0.79)

TFBI: Treatment *Fusarium* and bio-immunized; TTR: Treatment *Trichoderma*; TBITR- Treatment bio-immunized and *Trichoderma*; TC: Treatment control (No inoculations)

Values are the means of ten replicates with the sample size n=5.

Means in the columns followed by the distinct letters are significantly different according to Duncan's multiple range test at P=0.05. The standard deviation of the mean is indicated by values in parentheses.

PPVFRA Project: National DUS centre for mango crop

PI: Dr. Ashish Yadav

Co-PI: Dr. Vishambhar Dayal

Funding Agency: PPV&FRA, New Delhi

Achievements

Mango reference varieties (410) are being maintained in the field gene bank of ICAR-CISH. Characterization of mango varieties in the field gene bank was carried out as per revised guidelines for the conduct of test for distinctiveness, uniformity and stability in mango. Fruit characterization of 97 varieties, leaf characterization of 31 varieties and inflorescence characterization of 23 mango varieties have been carried out in 2022 as per revised guidelines.

On-site DUS testing data for 2nd year and compiled data (1st year and 2nd year) of mango denomination 'Ambika' and 'Arunika' submitted to PPV&FRA. After completion of Onsite DUS Testing of farmers mango varieties; PPV&FRA issued 08 'Certificate of Registration' for mango denominations viz., August (REG/2014/775), Tukhmi Heera (REG/2014/776), Safeda Amin (REG/2014/777), Jamun (REG/2014/779), Matka Gola (REG/2014/780), Aamin (REG/2014/783), Munjjar Amin (REG/2014/784), and Deshi Gola (REG/2014/807).

PPVFRA Project: DUS characterization of guava

PI: Dr. Anshuman Singh

Co-PI: Dr. Visambhar Dayal

Funding Agency: PPV&FRA, New Delhi

Achievements

The guava accessions being maintained in the field gene bank are being characterized using the guidelines for the conduct of test for distinctiveness, uniformity and stability in guava. In 2022, 25 accessions were characterized using DUS descriptors for fruit traits. Similarly, 30 accessions were characterized using leaf descriptors. The process is underway for the registration of varieties released from the Institute viz., Lalit, Shweta and Dhawal from PPV&FRA, New Delhi.

PPVFRA Project: Development of morphological descriptors and DUS test guidelines for jamun (Syzygium cumini Skeels)

PI: Dr. Anshuman Singh

Co-PI: Dr. Anju Bajpai

Funded by: PPV & FRA, New Delhi

Achievements

A total of 40 varieties and accessions are being maintained in the field gene bank. In 2022, 18 accessions were characterized using the fruit quality descriptors. The fruit length was the minimum (1.03 cm) in J-43 and the maximum (3.04 cm) in J-33. The fruit diameter varied between 0.86 cm (J-43) and 2.33 cm (J-33). The fruit weight was the maximum (11.0 g) in J-33 and the minimum (4.35 g) in J-43. Seed length varied between 0.75 cm (J-43) and 2.18 cm (Konkan Bahadoli). Seed diameter ranged between 0.32 cm (J-33) and 1.24 cm (Gokak-2). The seed weight ranged between 0.85 g (J-576) and 2.27 g (Konkan Bahadoli). The pulp TSS was minimum (11.73 ºBrix) in Gokak-1 and maximum (19.43 ºBrix) in J-12. The pulp content varied between 71.85% (J-585) and 90.76% (J-576).

PPVFRA Project: Validation of DUS descriptors of bael (Aegle marmelos Correa)

Name of the PI: Dr. D. Pandey

Funding Agency: PPV & FRA, New Delhi

Achievements

Eight leading commercial varieties of Aonla viz., NA-6, NA-7, NA-10, Kanchan, Krishna, Banarsi, Chakaiya and Francis which are maintained in field gene bank were characterized during this period for different morphological and biochemical parameters as per DUS Guidelines.

PPVFRA Project: Characterization of aonla varieties for developing DUS test guidelines

Name of the PI: Dr. D. Pandey

Funding Agency: PPV & FRA, New Delhi

Achievements

Eleven varieties are commercially cultivated in different parts of the country viz., CISH-B-1, NB-5, Pant Aparna, NB-16, Pant Shivani, NB-9, Pant Sujata, CISH-B-2, NB-17, Pant Urvashi and NB-7 that are maintained at FGB in ICAR-CISH, Lucknow were characterized during 2022 for different morphological and biochemical parameters as per DUS Guidelines. Physical and biochemical attributes of 7 bael varieties registered at PPV &FRA viz., Barsati Bael, Ram Bael, Swati Bael, Jhulan Bael, Amar Bael and Bael were also characterized. Highest vitamin C content was recorded in Barsati Bael (19.3 mg/100g pulp). Highest phenol content was recorded in Amar Bael (2.0 %).

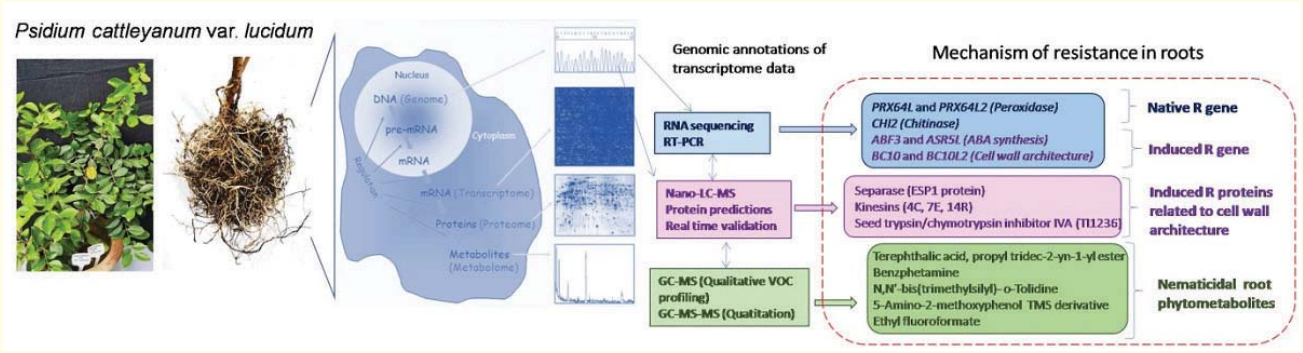
DST-SERB-EMEQ Project: Genomics assisted identification of resistance genes from wild relatives of guava against Meloidogyne enterolobii causing wilt

PI: Dr. Muthukumar. M.

Funding Agency: DST-SERB, New Delhi

Achievements

Screening 10 members of Myrtaceae family against root knot nematode (RKN, *Meloidogyne enterolobii*) infection causing guava decline, 3 species were recorded to have intact roots without gall formation and healthy rooting system viz., *P. cattleyanum* var. *lucidum* Sabine, *Syzygium cumini* (L.) Skeels and *S. zeylanicum* (L) DC. Total phenols, total tannins, and total auxin contents were recorded to be highest in the susceptible species, viz., *P. chinensis* followed by *P. guineense*. Contrarily in the resistant species, the auxin content reduced by 10-20% and GA3 content increased by 5-10% but upon RKN infection. Comparative analysis of these parameters was in correlation with the expression of major symptoms of wilting in both control and nematode infected. Root transcriptome (RNA-Seq), proteome (LC-MS) and metabolome (GC-MS) were performed with the same set of root samples of *P. guajava* (susceptible) and *P. cattleyanum* var. *lucidum* (resistant). Peroxidase encoding gene PRX4L, Abscisic acid pathway genes ABF3 and ASR5L, cell wall architecture related genes BC10 and BC10L2 were found to be upregulated in resistance species and susceptible species upon infection by RKN. PRX64L and PRX64L2 were found to be typically upregulated in only resistance species. Chitinase encoding CHI2 was upregulated in resistant species and contrastingly CHIAL was upregulated in susceptible species. Highly significant upregulation of proteins such as Separase (ESP1 protein), kinesins (4C, 7E, 14R) and seed trypsin/chymotrypsin inhibitor IVA (TI1236) were recorded. These protein encoding genes were shortlisted from the transcriptome data and validated using real time PCR. From comparative analysis of omics-data a mechanism of resistance has been postulated.



Mechanism of resistance in Psidium cattleyanum var. lucidum against Meloidogyne enterolobii

DST-SERB-CRG Project: Genome wide SNP markers associated with fruit traits for developing climate smart mango hybrids using genome selection

PI: Dr. Anju Bajpai

Co-PI: Dr. Muthukumar. M.

Funding Agency: DST-SERB, New Delhi

Achievements

GWAS for fruit traits using an association panel of 145 germplasm accessions was performed using TASSEL version 5.0. The panel was genotyped at an average density of 1 marker per 22.5 kb using GBS technology. LD in the panel was high (r^2>0.6, on average, for 20 kb mean distances between markers). The panel showed a moderate to high diversity for the observed traits. Association analyses were conducted using a mixed model involving both population structure and kinship to control the false positives. GWAS identified 163 markers significantly associated based on sorting with cut-off values r^2>0.2 and p <0.001 in GLM while only 1 SNP marker was identified associated with Fruit Length. Around 252 markers significantly associated with PW (pulp weight) were detected based on sorting with cut-off values r^2>0.2 and p <0.001 in GLM while no SNP marker was identified associated with ST (stone thickness). Around 2 markers significantly associated with PL (panicle length) which is an important attribute for fruit bearing and quality.

SCSP Project

PI: Dr. Vishambhar Dayal

Field demonstration of CISH Fasal Shakti

Field demonstration of CISH developed Fasal (micronutrient) was done in village in mall and Kakori blocks of Lucknow were 600 packets of Fasal Shakti (1 kgpack) were distributed to the farmers with hands on training and technical details.The performance of ICAR Fasal Shakti in vegetables crops was very good. By using CISH developed Fasal Shakti yield was increases upto 20 percent more in compare to without use.

Organic vegetable production through use of CISH-Bio-Enhancer

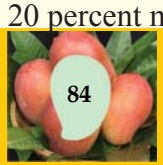
Field demonstration of organic vegetables cultivation through use of CISH Bio-enhance was carried out in Mal and Kakori blocks of Lucknow. About 50 kg bio-enhancer was distributed to the farmers with technical details. The performance of bio-enhancer was good in brinjal and chilli. It enhances the yield up to 15 percent.

Promotion of nutria-garden for improvement of nutritional status of schedule caste family

During the year of 2022-23 more than 400 farmers family were supported for improved nutritional status activities with input support of seed materials of vegetables crops (Carrot, Radish, Coriander, Beet Root, Palak, Soya Methi, etc.), planting materials of fruits (Red lady papaya, banana and guava etc.) and technical knowledge under kitchen garden. Availability of diverse vegetable and diverse fruit crops were found to improve nutritional security of farm family.

Distributed of Knapsack hand and battery operated spray machine.

Knapsack hand and battery operated spray machine (117 nos.) were distributed to the farmers of adopted village in Mall and Kakori



blocks of Lucknow. Before this intervention farmers were forced to hire machine for spray to carry out plant protection measures on custom hiring basis rupees @50/- per day. The activity was resulted in the income generation of Rs.1.88 lakhs to the beneficiary.

Demonstration and promotion of ICAR-CISH developed mango harvester under SCSP

Under SCSP programme mango harvester (200 nos.) was distributed to the scheduled cast mango growing farmers with proper training and technical details. Mango harvesting efficiency was enhanced by use of ICAR-CISH developed mango harvester.

National Networking: National Agricultural Innovation Fund (NAIF) Project

NAIF-Component I: Intellectual Property and Technology Management Unit (ITMU)

PI: Dr. Muthukumar. M. (w.e.f. March 2022)

Co-PI: Dr. S.C. Ravi

ITMU at CISH was started in 2008, and ITMU under NAIF component received an annual budget overlay of approximately 8 lakhs during 2022. Through ITMU, 8 farmer's varieties have been registered through PPVFRA. Around 12 MoUs have been signed during this period for technology commercialization. During 2022, one copyright and two patents have been received to Scientists of the Institute. Three contract research projects with collaborative work have been initiated with M/s Bayer Crop Sciences Ltd, Maharashtra in the areas of pest and disease management. CISH gluetrap and ICAR-FUSICONT have generated more than Rs. 50.0 lakh revenue. Around 5 new technologies have been recently identified in VTIC which are ready for commercialization.

NAIF-Component II: Agri-Business Incubation (ABI) Centre

PI: Dr. Maneesh Mishra

Co-PI: Dr. S.C. Ravi

CISH-ABI incubated M/s Amaka Food Industries, Lucknow for CISH-Aonla biscuit and Aonla herbal tea technology. Besides this, license was given to M/s Ranaji Biotech India Pvt. Ltd., Kanpur for CISH-Decomposer and M/s Newtraway LLP, Lucknow for CISH-Hot Water Dispersible Aonla-Herbal Tablet technology during 2022. CISH-ABI conducted 2 entrepreneurship development programmes and 2 collaborative meetings with reputed institutions for extending its programme. Furthermore, ICAR-CISH start-ups got recognition in Prime Minister Agri Startup Conclave & Kisan Sammelan and other national programmes this year. Spreading awareness about CISH-ABI, the centre also published technology flyers, articles, display at museum and website.

Participation of CISH-ABI start-ups in national programmes

ICAR-CISH start-ups have been recognized in national programmes and got opportunities to show case their technology and services for the benefit of society. Details of participation of start-ups in the events are as follows:

Krishi Mela at Barmer District, Rajasthan: ICAR-CISH, ABI incubated two startups M/s Parashar Agrotech Bio Pvt. Ltd., Varanasi, U.P. and M/s Farmers Family, Noida, who participated in the 'Krishi Mela' held on 1-3 April, 2022 at Barmer, District, conducted by ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan.

Participation of CISH-ABI start-up in PM Agri Startup Conclave & Kisan Sammelan at Pusa, N. Delhi: CISH-ABI startup, M/s Farmers Family, Noida, U.P. was selected to exhibit in the Honorable Prime Minister's programme, 'Agri Startup Conclave & Kisan Sammelan' held on October 17 & 18, 2022 at IARI Mela Ground, Pusa, New Delhi. Out of 300 selected startups, M/s Farmers Family, Noida showcased its business activities under the category, Supply Chain at the stall no. S13. A team of Ministers, Shri Narendra Singh Tomar, Minister of Agriculture & Farmers Welfare; Shri Kailash Choudhary, State Minister of Agriculture & Farmers Welfare and Sushri Shobha Karandlaje, MOS (Agriculture & Farmers Welfare) visited the Farmers Family startup stall (S13) to whom the Founders, Mr. Vikal and Mayank Kulshreshta explained them about their startup's operation, network, impact and connected farmers. Higher government officials and delegates Shri Ashok Thakur (Director, NAFED); Dr. Saravanan Raj, Director (Agricultural Extension), MANAGE; Capt. Vikas Gupta, Chairman, UP Council of Agricultural Research and Mr. Harsh Kapoor (GM Marketing, Krishi Jagran) also interacted with the startup at their booth.

Project: 'Geographical Indication for Langra, Chausa, Gaurjit and Rataul Mango'

PI: Dr. Ashish Yadav

Funded by: State Agricultural Produce Market Board, Uttar Pradesh

Duration: 2020-21 to 2022-23

Achievements

State Agricultural Produce Market Board, Uttar Pradesh has entrusted ICAR-CISH for the GI registration of Langra, Chausa, Gaurjeet and Rataul mango varieties of Uttar Pradesh for the benefit of the farmers.Accordingly, GI applications were filed in 2020 for Chausa and Gaurjeet mango varieties and GI Application No. 778, was allotted in respect of 'Gaurjeet Mango of Uttar Pradesh' and GI Application No. 779, in respect of 'U.P. Chausa Mango'. Reply for Formality Check Report has been prepared and submitted to the Mandi Parishad for finalization and onward submission to the Geographical Indication Registry, Chennai.

Projects: All India Coordinated Research Project on Fruits [AICRP(F)]

Project: Augmentation and evaluation of germplasm in mango

PI: Dr. Ashish Yadav

Achievements

Collected 05 Mango varieties viz.,Pusa Deepshikha, Pusa Manohari, Pusa Lalima, Arka Suprabhat and Arka Udaya for planting at Field Gene Bank of ICAR-CISH. Also received plants of mango variety Anand Rasraj (Gujarat Mango 1) for planting at NAGS.

Project: Scion breeding in Mango (Amrapali x Vanraj)

PI: Dr. Ashish Yadav

Achievements

A total of 3163 flowers were crossed on 750 panicles. A total of 08 hybrid mango fruits were

harvested and seeds sown for germination. 07 no. of hybrid mango seeds germinated and plants are growing well.

Project: Root stock breeding in Mango

PI: Dr. Ashish Yadav

Achievements

A total of 1167 flowers were crossed on 350 panicles using cross combinations Vellaikolumban x H-13-1 and Kurukkan x Vellaikolumban. A total of 16 hybrid mango fruits were harvested and seeds sown for germination. 11 no. of hybrid mango seeds germinated and plants are growing well.

Project: MLT-2 for mango hybrids

PI: Dr. Ashish Yadav

Achievements

Plants of Pusa Deepshikha, Pusa Manohari, Pusa Lalima collected from IARI and Arka Suprabhat, Arka Udaya collected from IIHR, Bangalore in 2022.

Project: AICRP Varietal Trial in Jamun

PI: Dr. Anshuman Singh

Co-PI: Dr. Vishambhar Dayal

Achievements

The four varieties viz. CISH-Jamwant (J-37), CISH J-42, Konkan Bahadoli and Goma Priyanka were evaluated using tree growth and fruit quality traits. The observations were recorded on eight year old plants. The tree height was the minimum (4.77 m) in Konkan Bahadoli and the maximum (6.03 m) in Goma Priyanka. Trunk circumference was the lowest (45.67 cm) in Konkan Bahadoli and the highest (81.33 cm) in CISH J-42. Canopy spread in the east-west direction was the lowest (3.27 m) in Konkan Bahadoli and the highest (5.07 m) in CISH Jamwant. Similarly, canopy spread in north-south direction was the minimum (2.93 m) in Konkan Bahadoli and the maximum (5.47 m) in CISH Jamwant. While CISH-Jamwant (J-37) had the highest average fruit weight (14.94 g), it was the lowest (5.65 g) in CISH J-42. The fruit length was the maximum (3.79 cm) in CISH-Jamwant (J-37) followed by 2.98 cm in Konkan Bahadoli. While the highest pulp content (96.22%) was noted in CISH J-42, it was the lowest (72.05%) in Konkan Bahadoli. Fruit TSS was the minimum (12.85 ºBrix) in Konkan Bahadoli and the maximum (14.34 ºBrix) in Goma Priyanka. Variety CISH-Jamwant (J-37) outperformed others in terms of fruit yield (22.72 kg/tree) while it was the lowest (6.23 kg/tree) in Goma Priyanka.

Transfer of Technology

Transfer of Technology

As part of institute mandate of extension activities for technology dissemination, its adoption, knowledge management, several programs were conducted for capacity development towards agri-based rural development. The skill up-gradation of primary stakeholders that includes farmers/orchardists, state government officials, line departments of various states was done through trainings, demonstrations, field visits, exposure visits, meetings, gosthies, awareness programmes, showcasing technologies in exhibitions etc. The details of the programmes are given below:

Exhibitions

Vegetable and Flower Show-2022

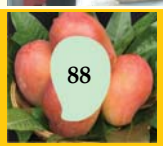
Directorate of Horticulture and Food Processing, Lucknow organized three days (March 4-6, 2022) Vegetable and Flower Show at Rajbhawan, Lucknow. Scientists and Technical Officer of ICAR-CISH participated and showcased the institute technologies. ICAR-CISH displayed various items in the show viz., hydroponic system for growing vegetables of tomato, lettuce and salad, guava varieties (Lalit, Lalima and Shweta), bael varieties (CISH B1 and CISH B2). Jamun (J-37 and J-42), processed fruit products, mang.0o harvester, mechanical device for removing leaf webber in mango and ready to fruit bag of oyster mushroom that were big attraction for visitors at the institute stall. More than 5000 visitors including officials from various departments, farmers, women, students, youths visited the stall and benefited from the information on advance technologies developed by the institute.

National Farmers Day

ICAR-CISH participated and displayed its technologies in the National Farmers Day organised by Integral University, Kursi Road, Lucknow at their campus on March 12, 2022. An exhibition was also arranged related to agricultural technologies during the occasion, which was inaugurated by Hon'ble Vice Chancellor of Rani Lakshmi Bai Central Agricultural University, Jhansi, Prof. Panjab Singh. Several dignitaries, students and farmers visited the stall and made aware about institute technologies. Improved varieties of bael (CISH B1 and CISH B2), grafted fruit plants, vermi compost, CPP, liquid manure of Neem, Jevamrit, Biozaper, Bioenhancer, fermented fruit products, processed fruit products like juices, squash, pickle, candies, pulp, vinegar, ciders, mango fiber, aonla herbal tea, fruit wines and mango harvester were the crowd pullers.

Regional Krishi Mela

ICAR-CISH Regional Research Station and Krishi Vigyan Kendra, Malda participated in the Regional Krishi Mela organized by Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur, Bihar during March 12-14, 2022. Different technologies and food products of Jagriti International FPO were displayed. During the mela many dignitaries visited the stall and the institute stall won second prize for display.



Kisan Mela

A *Kisan Mela* was organized jointly by Indian Oil Seeds and Produce Export Promotion Council, Mumbai, Ministry of Commerce, GoI, Indian Institute of Oil Seed Research, Hyderabad and ICAR-CISH-Krishi Vigyan Kendra, Malda with support from Agrani Neo Farmers Producer Company Ltd., Habibpur on March 12, 2022 at Malda, WB. In this Mela, about 1000 women farmers participated in the awareness programme. During the Kisan Mela, an awareness programme was organized on sesame cultivation and various prospects of sesame cultivation were discussed.

Workshop-cum-exhibition on 'Cultivation of aromatic & medicinal plants in Uttar Pradesh'

ICAR-CISH participated and displayed its technologies in two days workshop on "Cultivation of aromatic & medicinal plants in Uttar Pradesh" organised by State Agriculture Management Institute (SIMA) at its Rehmankhera campus during March 22-23, 2022. Workshop was inaugurated by Additional Chief Secretary (Agriculture) Dr. Devesh Chaturvedi through online. Dr. Pankaj Tripathi, Director, SIMA, Rehmankhera presided the function. Several dignitaries including Director SIMA, Rehmankhera, Ex Director and Dy. Directors of SIMA, farmers and entrepreneurs visited the institute's exhibition stall and showed interest in fruit based probiotic drinks, herbal tea tablets, mango fibres and improved varieties of bael.

Aam Mahotsav-2022

Institute participated and put its stall in Aam Mahotsav-2022 organized by Department of Horticulture and Food Processing, Government of Uttar Pradesh during July 4-7, 2022 at Awadh Shilpgram, Lucknow. Hon'ble Chief Minister, Government of Uttar Pradesh, Shri Yogi Adityanath ji inaugurated the Aam Mahotsav-2022 and visited ICAR-CISH stall. Hon'ble CM interacted with Director Dr. Neelima Garg and emphasized on the development of mango varieties having export potential and quick transfer of technologies to the mango farmers. ICAR-CISH displayed 211 mango varieties and hybrids during Aam Mahotsav-2022.

Media Mango Exhibitions

ICAR-CISH participated in 'Media Mango Exhibitions' organized by National Media Club at Moti Jheel, Kanpur on July 14, 2022 and at Western Court Annexe, Janpath Road, New Delhi on July 27, 2022. Kanpur 'Media Mango Exhibition' was inaugurated by Hon'ble Former Governor of Uttarakhand and Cabinet Minister, Baby Rani Maurya. During the exhibition, all the Hon'ble Ministers and various other dignitaries visited ICAR-CISH stall, where about 100 mango varieties and hybrids and 10 mango based products were displayed. New Delhi 'Media Mango Exhibition' was inaugurated by Parshottam Rupala, Hon'ble Union Cabinet Minister of Fisheries, Animal Husbandry and Dairying, Govt. of India. Various ministers, MPs and dignitaries visited the mango exhibition in which more than 200 mango varieties and hybrids and 15 mango based products were displayed.

Indo-Uzbek Meet & International Conference

ICAR-CISH participated and exhibited it's technologies showcasing exhibition stall in the Indo-Uzbek Meet & International Conference on Trends & Innovations in Food Technology from Farm to Fork TIFT-2022 organised by Department of Bioengineering, Integral University, Kursi Road, Lucknow and Co-organised by Tashkent Chemical-Technological Institute, Tashkent, Uzbekistan at the Campus of Integral University during November 24-25, 2022. ICAR-CISH exhibition stall was visited by many VIPs and other visitors including general public and students. Conference was concluded on November 25, 2022, where Dr. Rajendra Khimani, Vice Chancellor, Gujarat Vidyapith, Ahmdabad, Gujarat was the chief guest of closing ceremony, he appreciated the technologies developed by CISH during visiting the CISH's Exhibition stall.

Exposure Visit of Farmers/Students/Extension Functionaries

Training-cum-Exposure visit of Officers/ Farmers/ Students

Several training-cum-exposure visits were organized in the institute's research farms for state government officers and farmers from various districts of Bihar, Madhya Pradesh and Uttar Pradesh. It was aimed to popularize technologies like rejuvenation of unproductive mango orchards, high density planting of mango and guava, management of irregular bearing in mango, intercropping, espalier and container gardening of guava, integrated management of insect and diseases, improved varieties of mango and guava, grafting, planting methods, crop diversification, etc. The farmers' visits were sponsored by ATMA and coordinated by Dr. Naresh Babu, Principal Scientist and Shri. Arvind Kumar, ACTO. Students from Agriculture College also visited the institute as part of their course curriculum.

Skill Development Scheme

About 127 students from Rajkiya High School, Amethiya Salempur, Kakori, 100 students from Government High School, Sadrauna, Sarojni Nagar, Lucknow, 280 students from Government Girls Inter College, Malihabad and 70 students from Rajkiya High School, Haluapur, Kakori, Lucknow including 27 faculty members (teaching staff) visited the Institute during December 22 to 30, 2022 Under Skill Development Scheme derived by Department of Technical Education, Government of Uttar Pradesh, Students were made aware about the agro-technologies developed at the Institute.

S.N.	Date	Place	Sponsor	Number of Farmers/ officials/ students
1.	15.02.2022	Gopalganj district, Bihar	ATMA , Bihar	56 farmers and two officials
2.	16.02.2022	Gaya district, Bihar	ATMA , Bihar	26 farmers and two officials
3.	09.03.2022	Kochas, Nauhatta, Vikramganj, Chenari, Dinara, Nausa & Rohtas blocks of Rohtas district of Bihar	ATMA, Rohtas, Bihar	30 farmers including one official
4.	15.03.2022	State Agriculture Management Institute, Rehmankhera, Lucknow	Public Service Commission Uttar Pradesh	19 newly selected Assistant Statistical Officers
5.	23.03.2022	23 blocks of Patna district of Bihar	Indira Gandhi Institute of Cooperative Management, Lucknow	44 farmers and two Assistant Technology Managers
6.	26.03.2022	Chhapra district of Bihar	ATMA , Bihar	37 farmers
7.	30.03.2022	Siwan, Bihar and Katni, M.P.	ATMA, Siwan district of Bihar and ATMA, Katni Madhya Pradesh	30 farmers including 3 officials
8.	05.05.2022	Janta College Bakewar Etawah Uttar Pradesh	-	106 students of B.Sc. (Ag) VIII Semester and five faculty members
9.	10.05.2022	Bhagalpur	ATMA, Bhagalpur	9 Zardalu Mango farmers
10.	09.11.2022	College of Horticulture, Central University, Pondicherry	Pondicherry	B.Sc. (H) students
11.	26.12.2022-27.12.2022	Government Girls Inter College, Malihabad	Malihabad lucknow	300 students of class IX to XII

One day training-cum-workshop on 'Entrepreneurship Development in Oyster Mushroom Production'

ICAR-CISH, Lucknow organized one day training-cum-workshop on February 16, 2022 on 'Entrepreneurship Development in Oyster Mushroom Production' under Farmer's FIRST project. More than 15 farmers from adopted villages; Navipanah, Mohammad Nagar Talukdari and Meethenagar of Malihabad blocks participated in the programme. The main objective of this workshop was to build livelihood for rural youth through mushroom production. Principal Scientist, Dr. P.K. Shukla gave lectures on various aspects of ready-to-fruit mushroom bag production technology and marketing.

Scheduled Caste Sub Plan

Distribution of Marigold seed and its cultivation

Institute organized marigold seed distribution program on January 17, 2022 in which 60 farmers from neighboring villages of Ranimau, Bansigarhi and Kakrabad participated. Emphasis was given on profitable earning from marigold cultivation and through product diversification like incense sticks, extracts and beauty products. While addressing the farmers in the meeting, Nodal Officer reiterated that marigold being a popular flower, plays an important role in wedding ceremonies, social and religious functions for decoration. He trained the farmers about its cultivation, topics included suitable soil, climate, selection of marigold varieties, use of manure and fertilizers, sowing of seeds, plantation, irrigation and pest and weed control. Special emphasis was given to raising of nursery and good agronomic practices. Later Dr. Vishambhar Dayal (Nodal Officer, SCSP) made many other visits on field of farmers in the adopted village Karjhan, Kakori block, on June 13, 2022. Marigold flower seeds were distributed to more than 150 farmers under the plan.

Field demonstration of garlic farming

About 1000 kg of garlic seeds variety (G-282) were provided to 450 target farmers in Mal and Kakori blocks of Lucknow for field demonstration and income generation. The variation in yield and size of bulb was observed across the villages and time of planting. Bulblets were sown in second forth night of October gave higher yield and better quality as compare to the late planting. An area of about 20000 square meters was undertaken for demonstration of garlic. The activity was resulted in the income generation of Rs.22.50 lakhs to the beneficiary.

Field demonstration of rabi season onion farming

About 80 kg of onion seeds variety (NHRDF-Red, NHRDF-Red3, NHRDF-Red -4) were distributed to 413 farmers in Mal and Kakori blocks of Lucknow for field demonstration and income generation. The variation in yield and size of bulb was observed across the villages and time of planting. The nursery were prepared in month of November, gave higher yield and better quality as compare to the late sown. An area of about 8.0 hectare was undertaken for demonstration of onion. The activity was resulted in the income generation of Rs.21.60 lakhs to the beneficiary.

Distribution of grafted mango plants and Red lady papaya plants

More than 2823 plants of mango varieties (Amrapali, Mallika, Dashehari, Langra, Chausa, Arunika and Ambika) were distributed to the farmers of 37 villages in Mal and Kakori blocks of Lucknow. The farmers were provided technical assistance for better establishment of orchards. More than 32000 plants of Red lady papaya seedling plants were distributed to the farmers (200) of 37 villages in Mal and Kakori block of Lucknow.

Field demonstration of CISH Fasal Shakti

Field demonstration of ICAR-CISH developed Fasal Shakti (micronutrient) was done in adopted villages and 600 packets of Fasal Shakti (1 kg pack) were distributed to the farmers with hands on training and technical details. The performance of CISH Fasal Shakti in vegetables crops was good with 20 percent enhanced yield in comparison to control.

Organic vegetable production through use of CISH-Bio-Enhancer

Field demonstration of organic vegetables cultivation through use of CISH Bio-enhancer was carried out and 50 kg Bio-enhancer was distributed to the farmers. The performance of bio-enhancer was good in brinjal and chilli with enhanced yield up to 15 percent.

Promotion of nutri-garden for improvement of nutritional status of scheduled caste family

More than 400 farmers and their family members were supported for improved nutritional status with input support of seed materials of vegetables crops (carrot, radish, coriander, beet root, palak, soya methi, etc.), planting materials of fruits (Red lady papaya, banana and guava etc.) and technical knowledge for establishing year round kitchen garden. Under the scheme, about 18000 plants of strawberry variety Camarosa were provided to 18 farmers in an area of 0.4 hectare for field demonstration and income generation. Tissue cultured plants were planted in month of November and started fruiting in second fortnight of January leading to income generation of Rs.7.20 lakhs to the beneficiary. Beneficiary farmers (20) of the target group from villages of Mal and Kakori block in Lucknow were selected for distribution of cucumber seeds of variety 'Arka Veera' (500 g) for commercial cultivation. An area of about 1.0 hectare was under taken for the demonstration and cultivation, income generation of Rs.1.50 lakhs to the beneficiary could be realized. Coriander seeds variety 'Arka Isha' (30 kg) were provided to 350 farmers in an area of about 3.0 hectare yielding green coriander and grain yield (6.0 tons per hectare) and income (Rs.2.59 lakhs). Tomato seeds 'Arka Rakshak' and 'Arka Samrat' (1.3 kg) were provided to 350 farmers in an area of about 8.66 hectare with income generation of Rs. 21.00 lakhs. Furthermore, cole crops vegetables seeds (cauliflower, cabbage and broccoli) were distributed to the farmers of adopted village in Mal and Kakori blocks of Lucknow. The growth and yield performance of cole crops vegetables were observed in the farmers' fields. An area of about 12.00 hectare was under taken for the demonstration and cultivation that benefited the farmers (Rs. 4.0 lakhs). 1000kg seeds of pea variety (AP-3) were distributed to the adopted farmers (172 nos.) and performance of growth and yield was monitored. An area of about 10.0 hectare was under taken for the cultivation leading to earning of Rs.12.0 lakhs, besides ensuring enhanced nutrition availability

Distributed of knapsack hand and battery operated spray machine.

Knapsack hand and battery operated spray machine (117 nos.) were distributed to the farmers of adopted villages. By using spray machines the farmers are able to save money spent on hiring and purchase of the spray machines. The activity was resulted in the income generation of Rs.1.88 lakhs to the beneficiary.

Demonstration and promotion of ICAR-CISH developed mango harvester

Under SCSP mango harvesters (200 nos.) were distributed to (200 nos.) the schedule cast mango growing farmers with proper training and technical details. Mango harvesting efficiency was enhanced by using of ICAR-CISH developed mango harvester.

Participation of farming communities in various programs

S.N.	Name of training/ Field day/ meeting	Venue	Date	No of participants
1	Celebration of institute foundation day	ICAR-CISH, Rehmankhera, Lucknow	01.06.2022	56
2	Aam ki surakshit tudai evam vikaro ki pehchan	Saidapur	18.06.2022	60
3	Training on improved production technology for horticultural crops	ICAR-CISH, Rehmankhera, Lucknow	10.08.2022	40
4	Pradhan mantri kisan sammelan	ICAR-CISH, Rehmankhera, Lucknow	17.10.2022	264
5	Celebration of soil day	Kakrabaad	05.12.2022	54
6	Shree ann par prashikshan sah jagrukta karykram	Gopalpur	29.03.2023	102

Trainings-cum-Farmer-Scientist Interaction

Farmers Scientist Interaction Meeting on 'Fresh Water Aquaculture- Diversified source of Income'

ICAR, CISH, Lucknow organized a webinar-cum-Farmers-Scientist Interaction Meeting on 'Fresh Water Aquaculture-diversified source of income' on February 5, 2022, aimed to create mass awareness among farmers and stakeholders about importance of fresh water aquaculture for generating the income throughout year and improving the nutritional requirement through fresh water agriculture. Dr. Sharad Kumar Singh, Principal Scientist, ICAR-National Bureau of Fish Genetic Resources, Lucknow presented the keynote address on "Fresh water Aquaculture-Diversified source of income". He elaborated the present status of fish farming in India and emphasized on the availability of essential

nutrient in fishes. During his deliberation he explained the farmers about sustainable carp farming and rearing of fingerling. The queries of farmers related to fish farming was replied by guest speaker. A total of 50 participants including CISH Staff, researchers and farmers from Lucknow associated with the Farmer's First Project participated. The webinar was coordinated by Dr. R. A. Ram and Dr. Karma Beer.

Training on 'Propagation methods of sub tropical fruits and preparation of commercial products of guava'

ICAR-CISH, Lucknow organized seven days training programme on ''Propagation methods of subtropical fruits and preparation of commercial products of guava'' during March 22-28, 2022 sponsored by ATMA Sawai Madhopur, Rajasthan. Eleven farmers from Sawai Madhopur district of Rajasthan were present. The subjects covered in training were: establishment of orchards, production technology, important varieties of guava and mango and its cultivation methods, organic fruit production, high density planting and canopy management, important insect pest and diseases of guava and their integrated management, processing and value addition of fruit crops, identification of maturity standards of mango and guava, etc. Dr. Naresh Babu, Principal Scientist, Dr. Vishambhar Dayal, Scientist and Sri Arvind Kumar, ACTO coordinated the programme.

'Kisan Bhagidari, Prathmikta Hamari' Campaign

ICAR-CISH, Lucknow and its Krishi Vigyan Kendra, Malda (West Bengal) organized a programme on 'Kisan Bhagidari, Prathmikta Hamari' Campaign on April 26 and 28, 2022. This programme was aimed to create mass awareness about importance of mechanization in production and processing of fruits and vegetables. Er. Anil Kumar Verma, Senior Scientist, delivered a talk on importance of mechanization in production and processing of fruits and vegetables. He also demonstrated mango fruit bagging technique and discussed its benefits to the farmers. The programme was organized in hybrid mode in which 80 participants were present. The programme was coordinated by Dr. Karma Beer.

Training-cum-interface meeting 'Safe Mango Harvesting and post harvest Management'

ICAR-CISH, Lucknow organized a training-cum-interface meeting programme on 'Safe Mango Harvesting and post harvest Management' on June 18, 2022. Being the mango harvesting season, this programme also aimed to train the mango growers for safe mango harvesting, ripening and management of jelly seed. Dr. Bharati Killadi, Principal Scientist told the farmers about jelly seed and its effective management. Dr. Karma Beer, Scientist highlighted about mango harvesting, safe ripening, packaging and export of mango to various European and Gulf countries. He also demonstrated the CISH Mango ripener sachet and operation of Mango Harvester for safe harvesting of mangoes. During the programme Dr. Sharad Kumar Dwivedi, Scientist and Dr. Vishambhar Dayal, Scientist attended the queries of the farmers related to mango cultivation.

In total, 65 farmers participated including women shelf help group, progressive farmers and youth.

Kisan gosthi on 'Problems of low productivity in mango orchards'

A kisan gosthi was organized at the village Tiknakhera, Malihabad, Lucknow, U.P. on August 18, 2022. Dr. Dushyant Mishra, Dr. Naresh Babu, Dr. Bharati Killadi, Dr. Tarun Adak and Mr. Arvind Kumar participated in the programme. Interaction with the farmers was held and problems of low productivity in mango orchards, wilting of mango trees, lack of water availability, leaf webber and other pest control emerged as serious challenge for growers. Farmers were encouraged to work in groups and also to adopt FPO for more benefit. CISH-bioenhancer was distributed to sensitize growers to encourage organic cultivation. Farmers were encouraged to add moringa and aonla in their land holding for improving nutrition of rural family. The gosthi was coordinated by Dr. Tarun Adak.

Farmer-Scientist Interaction-cum-Kisan Gosthi

A farmer-scientist interaction-cum-kisan gosthi was organized at the village Naibasti Dhaneva, Malihabad, Lucknow, UP on August 20, 2022. Interaction with the farmers was held and problems of thrips in mango orchards and its control appeared as serious challenge was discussed. Scientists advised measures on the insects and disease management, nutrient practices, rejuvenation of orchards for getting better quality fruits. The role of fruit diversification like cultivation of apple ber was discussed for enhancing farmers income. Farmers and farm women's showed interest in growing of turmeric and ginger as intercrops in the interspaces of mango orchards. Women have shown interest in post-harvest training. About 40 young girls and boys, old women and men took part in the gosthi. CISH-bioenhancer was distributed to sensitize growers to encourage organic cultivation.

Farmer-Scientist Interaction meeting on 'Maintaining soil health for sustainable fruit production'

Institute organized a Farmer-Scientist meeting on the topic 'Maintaining soil health for sustainable fruit production' on August 26, 2022. On this occasion, Dr. N. P. Singh, Hon'ble Vice Chancellor, Banda University of Agriculture and Technology, Banda, Uttar Pradesh was the Chief Guest. Dr. Singh emphasized on the role of better soil health, balanced fertilizer use, and integrated nutrient management for the higher production of fruits and other horticultural crops while addressing the farmers and CISH staff. This program was attended by 120 participants including 80 SCSP beneficiary farmers who were also provided the grafted plants of Arunika mango variety for planting in their kitchen gardens. The program was coordinated by Dr. Karma Beer, Dr. Anshuman Singh and Dr. Vishambhar Dayal.

Kisan Gosthi on the occasion of release of 12th instalment of PM Kisan Samman Nidhi by PM during PM Kisan Samman Sammelan

Institute organized a Kisan Gosthi on October 17, 2022 the occasion of release of 12th instalment of PM Kisan Samman Nidhi by PM during PM Kisan Samman Sammelan. The topic of Kisan Gosthi was 'Winter operations in mango orchards'. Ahead of Diwali, Hon'ble PM Narendra Modi released the 12th instalment of the Pradhan Mantri Kisan Samman Nidhi (PM Kisan) to more than 8 lakh farmer families by e-transfer. PM Modi distributed Rs.16,000 crore to the PM Kisan beneficiaries via Direct Benefit Transfer. On the occasion, PM highlighted the natural farming, One District One Product Scheme, One Nation-one Fertiliser, International Year of Millet-2023 and use of latest agricultural technologies like drone in agriculture. More than one crore farmers participated in the event virtually. Speaking on the occasion, Dr. Neelima Garg, Director, ICAR-CISH announced that

small processing unit will be established in the village itself for the use by scheduled caste farmers under SC project. Dr. S.K. Shukla, Principal Scientist explained the benefits of natural farming and exhorted to adopt at least one indigenous cow and prepare various cow based inputs. More than 250 farmers participated in the event.

Training on 'Horticulture, cow based natural farming, post harvest handling and value addition technologies'

Training of 12 UP Diversified Agricultural Support Project (DASP) officers was organized by the ICAR-CISH, Lucknow during November 14-18, 2022. During the training, lectures and practical classes were arranged in various fields of horticulture viz. variety development, production, protection and post harvest technologies of subtropical fruits besides natural farming and practical exposure to rejuvenation sites, espalier system of guava training, CISH-Mango museum, processing laboratory and natural farming complex, etc. The feedback was also recorded from various participants. The training was coordinated by Dr. S. K. Shukla, Principal Scientist of the Institute.



Kisan Diwas

Kisan Diwas (Farmer's Day) was celebrated on December 23, 2022 by inviting farmers and stakeholders of Farmers FIRST project. Smt. Jaya Devi, MLA from Malihabad was the chief guest of the function. Director of ICAR-CISH, Dr. D. Pandey welcomed the chief guest and Dr. P.L. Saroj introduced about the institute activities. Around 30 farmers participated in the event. The farmers shared their experiences regarding technical knowhow and inputs that were given by the FF team and its leader Dr Manish Mishra. Selected 6 farmers were felicitated for their good agriculture practices. The chief guest interacted with the farmers and was keen for their upliftment. The dignitaries paid their respect to Late Shri Chowdhary Charan Singh ji on his birth anniversary. The institute participated in KISAN DIWAS celebrations chaired by Agriculture Minister and organized by Secretary DARE and DG ICAR at New Delhi through virtual mode.

Technology Commercialization and Entrepreneurship Development

The Institute is managing the intellectual properties developed through research as per the new IP regimes set out by the Council. To accelerate the dissemination of the technologies developed, Institute has commercialized various technologies to private firms across the country. Institute is also aiming towards Atma Nirbhar Bharat through entrepreneurship development.

Technology commercialization

1. ICAR-CISH, Lucknow signed a Memorandum of Understanding (MoU) with M/s NEWTRAWAY LLP, Lucknow on February 25, 2022 for commercialization of 'CISH-Hot Water Dispersible Aonla Herbal Tablet'.

2. ICAR-CISH, Lucknow signed a Memorandum of Understanding (MoU) with M/s GT-Biosciences Limited, Nagpur on June 30, 2022 for commercialization of CISH-Trap-1 (Automated colour changing solar light insect trap with CFL having restrictor with regulated crop area illumination), CISH-Trap-2 (Solar operated dual UV light automated agricultural insect trap with restrictor having regulated crop area illumination), CISH-Trap-3 (Automatic electrical UV light source trap with restrictor having regulated crop area illumination) and CISH- Rain-proof and long lasting fruit fly traps technology for fruit (CISH-OMAT) and vegetable (CISH-VMAT) crops.

3. ICAR-CISH, Lucknow signed a Memorandum of Understanding (MoU) with M/s Ranaji Biotech India Private Limited, Kanpur on July 02, 2022 for commercialization of 'CISH- Decomposer'.

4. ICAR-CISH, Lucknow signed a Memorandum of Understanding (MoU) with M/s SUPA Biotech Private Limited, Nainital on June 30, 2022 for commercialization of CISH-Bio Enhancer.

Other MoU's signed

S.No.	Name of MOU	Date	Period	Name of partner
1.	MoU for facilitating dtudents' Training/ Postgraduate research	08-03-2022	3 Years	Mahatma Jyotiba Phule Rohilkhand University, Bareilly
2.	MoU for facilitating dtudents' training/ Postgraduate research	22-03-2022	3 Years	Dr. Y.S.R. Horticulture University, Andhra Pradesh
3.	Enhancing the productivity in mango and other subtropical crops fruits	28-03-2022	5 Years	ITC Limited, Kolkata
4.	Capacity Building of Master trainees in mango	12-04-2022	5 Years	M/s Bayer Cop Sciences Limited, Maharashtra
5.	MoU for facilitating students' training/ postgraduate research	18-05-2022	5 Years	Nehru College of Engineering & Research Centre
6.	Development of technology related to management of diseases of bael	25-04-2022	1 Year	Mr. Vinay Sanan (Farmer)
7.	Development of technology related to management of diseases of bael	19-05-2022	1 Year	Mr. Prakash Naryan Mishra (Farmer)
8.	MoU for facilitating students' training/ postgraduate research	26-08-2022	5 years	Banda University of Agriculture and technology, Banda
9.	MoU for providing planting materials	16-09-2022	1 Year	Virendra Kumar
10.	MoU for providing planting materials	16-09-2022	1 Year	Anupam Rawat
11.	MoU for field trial mango crop contract service	16-12-2022	2 Season	M/s Ju Agrisciences ltd
12.	MoU for field trial mango crop contract service	16-12-2022	2 Season	Bayer crop sciences

IP Protection Patent Granted

A patent has been granted for the invention 'UV light source trap with restrictor having regulated crop area illumination (CISH Trap-3)'for a period of 20 years from September 09, 2020. The date of grant of patent is November 01, 2022. (Patent No- 410667), Patentee- Indian council of Agriculture Research and Palvi Industries.

Patents filed

The institute has filed two patents during 2021, viz., 'CISH-Glue Trap (Multi-layered, white oil glue based long-lasting insect sticky trap for agriculture use) and a process of operating thereof (Application No. 2202111005138 dated February 06, 2021)' and 'Bio immunized tissue culture technology for banana and a process of operating thereof (Application No. 202111003761, dated January 28, 2021)'.

Technology Commercialization and MoUs

The CISH-ABI centre facilitated the commercialization of two technologies viz. CISH-Hot Water Dispersible Aonla-Herbal Tablet and CISH-Decomposer. The institute signed the MoUs with M/s Newtraway LLP, Lucknow and M/s Ranaji Biotech India Pvt. Ltd., Kanpur, U.P., respectively for the same.




Spreading awareness about horti-entrepreneurship

CISH-ABI published articles, technology flyers, ICAR-CISH annual report, display at museum and website for awareness generation of entrepreneurship development in youth.

Technology Mentoring session on "Entrepreneurship Development through Value Addition and Processing of Fruit and Vegetable Crops"

Institute organized one day Webinar on 25th January, 2022 to deliberate opportunities in value addition and processing of fruit and vegetables. Expert Dr. R.B. Tiwari, Principal Scientist of Indian Institute of Horticultural Research, Bangalore presented the details of PH technologies developed by IIHR, Bangalore. He also showed the commercial enterprises/ startups working on ICAR-PHT technologies. He emphasized the importance of dehydration, osmotic dehydration and freezing dehydration for value addition of fruit and vegetables. Dr. Neelima Garg (Acting Director) made presentation of technologies such as cidar, wines, probiotic drinks, fiber enriched biscuit, aonla prash and herbal chew etc. Fruit and vegetable post harvest losses are huge and therefore there exist great opportunity for technology led entrepreneurship. The programme was co-ordinated by Dr. Maneesh Mishra, Principal Scientist, Agri-Business Incubation Centre of CISH Lucknow. A total number of 83 students, industry partners, scientists and entrepreneurs participated in the program through virtual mode.

Entrepreneur's Incubation Meet

An Entrepreneur's Incubation Meet was organized on 23rd March, 2022 by the Agri-Business Incubation Centre of the institute. Dr. Maneesh Mishra, P.I. of the project appraised about the current scenario of horticulture startups in India including process & procedure pertaining to incubation at ABI. Acting Director, Dr. Neelima Garg interacted with each participant and encouraged them to come forward for entrepreneurship development in horticulture. A total 27 entrepreneurs proposed various horticultural startup ideas from seven different states viz. Bihar, Haryana, Jharkhand, Kerala, Madhya Pradesh, Uttarakhand and Uttar Pradesh. Out of which five startup ideas were accepted for the incubation after detailed discussion and review by the scientists, mentors and experts. The event was conducted in hybrid mode.

EDP on "Funding Opportunities for Entrepreneurs through BIRAC under BIG Scheme" in association with Startup Incubation and Innovation Centre (SIIC), IIT Kanpur

Institute organized a capacity building programme for entrepreneurs on "Funding Opportunities for Entrepreneurs through BIRAC under BIG

Scheme" in association with Startup Incubation and Innovation Centre (SIIC), IIT Kanpur on 25th July, 2022. Through this webinar, entrepreneurs came to know about the Biotechnology Ignition Grant (BIG) Scheme of Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology (DBT), Government of India. The event was introduced by Dr. Maneesh Mishra, Principal Scientist and Principal Investigator, ABI Centre. He remarked on the current status and progressive scenario of entrepreneurship in India. Dr. Mishra spelt out that a good funding plays a crucial role in the success of any startup. The director of institute, Dr. Neelima Garg, advocated for supporting and strengthening the horti-entrepreneurship ecosystem at ground level. Ms. Rohini Chawla, Manager, Bio-Programs, key speaker from SIIC, IIT Kanpur, detailed about the Biotechnology Ignition Grant (BIG) Scheme of BIRAC. She told that it is a very good source of funding for eligible startups, scholars, innovators, scientists, faculty members and technical staffs through which they can get the benefit of funding up to Rs. 50 lakhs. Moreover, SIIC, IIT Kanpur team is ready to assist interested applicants for applying in the scheme. A total of 34 participants attended the webinar in hybrid mode (online and offline). The programme was co-ordinated by Dr. Sharad Verma, ABI, CISH, Lucknow and Ms. Manaswita Pandey from SIIC, IIT Kanpur.

Inter-Institutional Meeting with CIPET

An Inter Institutional Meet between ICAR-CISH, Lucknow and CIPET, Lucknow was held on 17th August 2022 in CIPET, Lucknow regarding the development of prototype of bioreactor and guava harvester. Development of vegan leather was also discussed.

Inter-Institutional meeting with SIIC, IIT Kanpur: Inter-institutal meeting between ICAR-CISH-ABI, Lucknow and Foundation for Innovation & Research in Science & Technology (FIRST) of Start-up Innovation & Incubation Centre (SIIC), IIT Kanpur was held on 03rd October, 2022 in the institute under the chairmanship of Dr. N. Garg, Director (Acting) of the institute.

Points of collaboration of MoU were discussed in detail between both the institutions in the meeting. The outcome of this MoU will be beneficial in developing and strengthening the start-up / entrepreneurial ecosystem. Both the institutes agreed for co-incubation of agri-startups registered in respective incubation centres. Scientists / Professor of each institute will contribute their expertise as per the requirements and TOR mentioned in the MoU.

Copyrights filed

- Copyright application was submitted for the mobile app ripe mango products (in Hindi) [Diary No. 28093/2021-CO/L] on November 22, 2021.
- Copyright application was submitted for the mobile app ripe mango products (in English) [Diary No. 28094/2021-CO/L] on November 22, 2021.
- Copyright application was submitted for the mobile app Raw mango products (in Hindi) [Diary No. 28091/2021-CO/L] filed on November 22, 2021.
- Copyright application was submitted for the mobile app Raw mango products (in English) [Diary No. 28087/2021-CO/L] on November 22, 2021.
- Copyright application was submitted for the mobile app aonla processed products

(in Hindi) [Diary No.28779/2021-CO/L] on November 30, 2021.

- Copyright application was submitted for the mobile app aonla (Indian Gooseberry) Products (in English) [Diary No. 28785/2021-CO/L] on November 30, 2021.
- Copyright application was submitted for the mobile app guava processed products (in English) [Diary No. 28790/2021-CO/L] on November 30, 2021.
- Copyright application was submitted for the mobile app guava kitchen recipes [Diary No. 28801/2021-CO/L] on November 30, 2021.

Human Resource Development

Institute has followed HRM Policy of ICAR for continuous skill up-gradation of its manpower in various categories. Regular technical and managerial development through periodic trainings was encouraged by preparing an Annual training plan as per identification of competency gaps among the employees, and its implementation to enhance efficiency and productivity of the employees.

Trainings Attended

Name of participant	Training	Date
Scientific		
Dr. A. K. Trivedi	Online Training Programme on "Intellectual Property Rights in Agricultural Research" organized by ICAR-CISH, Lucknow	January 10-15, 2022
Dr. Abha Singh	Online Training Programme on "Intellectual Property Rights in Agricultural Research" organized by ICAR-CISH, Lucknow	January 10-15, 2022
Dr. Karma Beer	Online Training Programme on "Intellectual Property Rights in Agricultural Research" organized by ICAR-CISH, Lucknow	January 10-15, 2022
Dr. Alok Kumar Gupta	Online Training Programme on "Intellectual Property Rights in Agricultural Research" organized by ICAR-CISH, Lucknow	January 10-15, 2022
Dr. Anju Bajpai	Attended a Virtual Training Programme on "QTL analysis and genome-wide association studies" organized by IASRI, New Delhi	February 15-24, 2022
Dr. Anju Bajpai	Attended Competency Enhancement programme for "Effective Implementation of Training Functions by HRD Nodal Officer's of ICAR"	February21-23, 2022
Dr. Muthukumar. M.	Attended a Virtual Training Programme on "Genome-wide association studies and its application in Agriculture" organized by IASRI, New Delhi	March 15-24, 2022
Dr. Ravi, S. C.	Training programme on "Analytical Techniques for Impact Evaluation Methods" jointly organized by Institute of Agricultural Sciences, Banaras Hindu University (BHU) and International Food Policy Research Institute.	April 25 - 30 2022
Dr. Muthukumar, M.	Attended Virtual Hindi Karyashala organized by Kendriya Hindi Prasheekshan Sanstan, New Delhi	July 4-7, 2022
Dr. Sanjay Kumar Singh	Training programme on "Processing Techniques of Horticultural and Arable crops" organized at ZTM & BPD unit and Division of Food Science & Post Harvest Technology, ICAR-IARI, New Delhi	August 22-27, 2022
Dr. Alok Kumar Gupta	Training programme on "Processing Techniques of Horticultural and Arable crops" organized at ZTM & BPD unit and Division of Food Science & Post Harvest Technology, ICAR-IARI, New Delhi	August 22-27, 2022

Dr. Abha Singh	Training programme on "Science Administration and Research Management" organized by Administrative Staff College of India	September 05 – 16, 2022.
Dr. Anju Bajpai	Training programme on "Science Administration and Research Management" organized by Administrative Staff College of India	September 05 – 16, 2022.
Dr. Ravi, S. C.	Online training programme on "Application of R-Software for Social Sciences" organized by Department of Agricultural Economics, Agricultural College Bapatla, Acharya N G Ranga Agricultural University, Hyderabad.	November 14th – 20th, 2022
Dr. Karma Beer	Training on "Agri-startups and Entrepreneurial Ecosystem- An Indian Prospective" organized by ICAR- National Academy of Agricultural Research And Management, Hyderabad	November 14-19, 2022
Dr. Ningthoujam Samarendra Singh	Training programme on "Pesticide Residue Analysis (PRA)" organized by Pesticide Management Division of National Institute of Plant Health Management (NIPHM), Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmer Welfare, Government of India in Hyderabad	November 2-22, 2022.
Dr. K.K. Srivastava	Attended and expressed expert opinion on "Different weather based factors on guava, aonla and banana" at Directorate of Horticulture and Food Processing, Lucknow	November 02, 2022
Technical		
Dr. Sumit K. Soni	Attended training programme on "Hierarchical clustering & RNA-seq data analysis in linux"	December 14-20, 2022
Sh. Virendra Kumar Yadav	Attended training programme on Automobile Maintenance, Road Safety and Behavioral Skills organized by ICAR-CIAE, Bhopal	September 26 – October 01, 2022
Administrative		
Sh. Rahul Bhat, AAO	Online Training Programme on Pension & Retirement Benefits conducted by ICAR-NRRI, Cuttack.	January 12-14, 2022
Km. Shreya Srivastava, LDC	Online Training Programme on Pension & Retirement Benefits conducted by ICAR-NRRI, Cuttack.	January 12-14, 2022
Sh. S.L. Gautam, AAO	Online Training Programme on Pension & Retirement Benefits conducted by ICAR-NRRI, Cuttack.	January 12-14, 2022
Mrs. Kalpana Singh, LDC	Online Training Programme on Pension Retirement & Benefits at ICAR-NRRI, Cuttack.	April 18-20, 2022
Sh. Nitesh Kumar, Stenographer	Online Training Programme on Pension Retirement & Benefits conducted by ICAR-NRRI, Cuttack.	April 18-20, 2022
Sh. Mahendra Kumar, UDC	Smart governance in office system & office procedure at ICAR-NBAIM, Mau.	October 10-12, 2022
Sh. S.L. Gautam, AAO	Residential Training Programme on MDP on Public Procurement (Basic) at AJNIFM, Faridabad	October 10-15, 2022

International/ National - Seminars/ Symposia/ Conferences/ Webinars attended

1. Dr. Tarun Adak attended the National Seminar on Agrophysics for Smart Agriculture during February 22-23, 2022.
2. Dr. Tarun Adak attended and in National Webinar on "Sustainable interventions Towards Resource Conservation and Natural Farming" organized online during April 22-23, 2022.
3. Dr. Tarun Adak attended the National Webinar on "Groundwater Management for Sustainable Development" organized by ANRCM, Lucknow on March 22, 2022.
4. Dr. S.K. Dwivedi attended webinar on "*Phal utpadan aum phal prasanskaran ki naveentam taknikey*" on May 6, 2022 at ICAR-CISH, Lucknow.
5. Dr. Tarun Adak participated in IIHR, Bengaluru's National webinar on "Healthy soil, water and atmosphere for healthy environment under climate change conditions" on June 6, 2022.
6. All the Scientists of the Institute attended National Webinar on "Disaster Management in Horticultural Crops", ICAR-CISH, Lucknow (Online mode) on July 26, 2022.
7. Dr. S.K. Dwivedi attended online webinar on Evaluation of Plant structure and function. Plantae, on September 16, 2022, American Society for Plant Biologist.
8. Dr. Tarun Adak attended On-line training on "Cocoponics/Soilless Culture - A New Method of Growing Vegetables & Medicinal Herbs in Terrace/Roof Top" organized by IIHR, Bengaluru on September 24, 2022.
9. Dr. Tarun Adak participated in the National Webinar on "Estimating water and solute balances with Lysimeters for conducting drought experiments" delivered by Prof. Naftali Lazarovitch, Director, French Associates Institute for Agriculture and Biotechnology of Drylands, The Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Israel and organized by ICAR-IIMR, Hyderabad on September 28, 2022.
10. Dr. Tarun Adak participated in International Webinar on "Enhancing global consumption and trade of passion fruit" delivered by experts from Malaysia, Vietnam, China and Indonesia on September 29, 2022 and organized by International Tropical Fruits Network.

Workshops and Meetings attended

1. All the Scientists of the Institute participated in the Kisan gosthi and Farmer Scientist Interface meeting on "*Aam ke bagho mey saamyik karya*" with 200 farmer participants on January 1, 2022 at ICAR CISH auditorium.
2. All the Scientists of the Institute attended a Scientist Farmers interaction program on the theme "High-tech horticulture for higher productivity and income" under *Azadi ka Amrut Mahotsav* on January 7, 2022 at ICAR-CISH, Lucknow.
3. Dr. Tarun Adak participated in **"**Drones for Boosting Agricultural Productivity" delivered by Mr. Aaakash Sinha, Founder and CEO, Omnipresent Robotics Technology, on February 4, 2022 and organized by ICAR-CPCRI, Kasaragod, Kerala.
4. Dr. Tarun Adak participated in 50th year's celebration of ICRISAT Event by Hon'ble Prime Minister on Saturday, February 5, 2022.
5. Dr. S.K. Dwivedi attended a capacity development program on the theme "Empowering women farmers with skill and knowledge" under *Azadi ka Amrut Mahotsav* and International Women Day celebration on March 8, 2022 at ICAR-CISH, Lucknow.
6. Dr. Dushyant Mishra participated in Kharif Meeting 2022 organized by UP State Department of Agriculture on March 15, 2022 at Krishi Bhavan, Lucknow.

7. All the Scientists of the Insitute participated in Farmer Scientist Interaction meeting on April 28, 2022 organized at ICAR CISH, Lucknow.
8. All the Scientists of the Institute attended a Scientist Farmers interaction program on the theme "One district One Product- Local to Global" under *Azadi ka Amrut Mahotsav* on May 21, 2022 at ICAR-CISH, Lucknow.
9. All the Scientists of the Institute attended a lecture on "*Phasal utpadan mej jaivik kheti ki upyogita*" during Hindi Workshop on June 23, 2022 at ICAR-CISH, Lucknow.
10. Dr. Dushyant Mishra participated in Innovative farmers meet on "Mango based agro-forestry models for better returns and input use efficiency" on June 13, 2022 organized at ICAR CISH, Lucknow.
11. Dr. Tarun Adak attended National talk on "Food-Energy-Water (FEW) Nexus" by Prof. Vijay P. Singh, Distinguished Professor, Texas, USA on July 6, 2022 and organized by ICAR-IISWC, Dehradun.
12. Dr. Tarun Adak attended the National talk on "Protected Cultivation: The experience of Western Sydney University, Australia" on July 22, 2022 and organized by ICAR-CTCRI, Kerala.
13. All the Scientists of the Institute attended the Workshop on "Strengthening of Export Potential of Honey", VAMNICOM, Pune (Online mode) during August 30, 2022.
14. Dr. Tarun Adak attended the Virtual Workshop on "Global food and nutritional security, and sustainable development through major and minor pulses" on October 14, 2022 organized by National Academy of Agricultural Sciences (NAAS), NASC Complex, New Delhi.
15. Dr. Anshuman Singh, Dr. Devendra Pandey, Dr. P.K. Shukla, Dr. Ashish Yadav, Dr. H. S. Singh and Dr. K K Srivastava attended meeting for "QRT of AICRP-Fruits for Mango and Guava" during November 24-25, 2022 at ICAR-CISH, Lucknow.
16. Dr. D. Pandey and Dr. Anju Bajpai attended the meeting on "Bridging the Climate Change Research and Policy Gap for Enhanced Local Climate Action in Uttar Pradesh" during December 29, 2022 organized by Directorate of Environment, UP, Lucknow.

Awards and Recognitions

Individual Awards

1. Dr. A. K. Trivedi was awarded as Fellow, Indian Society of Horticultural Research and Development during 2022.

Recognitions

1. Dr. K.K. Srivastava acted as Raporteur in the Technical session-V of 1st International Conference (Virtual Mode) on 'Recent advances for managing sustainable soil health and crop production', during February18-20, 2022 organized by GKV Society, Agra, India.
2. Dr. Tarun Adak acted as Convener in the session "Conservation of natural resources for food security and environmental safety through organic and natural farming" in National Webinar on "Sustainable interventions towards resource conservation and natural farming" during April 22, 2022 organized by ANRCM, Lucknow, UP.
3. Dr. Abha Singh was the Member Expert of Scientific Advisory Committee Meeting held on December 6, 2022 at KVK, Kaushambi, Uttar Pradesh.
4. Dr. K.K. Srivastava Evaluated "Project proposal of Uttar Pradesh Council of Science and technology, Lucknow on "To sensitize, educate and train the farmers in commercial cultivation and propagation of gladiolus and tuberose for socio-economic up heaval development and doubling farmer's income, on March 9, 2022 for UPCST, Lucknow.
5. Dr. Sanjay K. Singh was appointed as external observer for UPCATET-22 (M.Sc. and Ph.D. Programme) by Registrar, BUA & T, Banda, UP on June 17, 2022.
6. Dr. Ravi, S. C. attended as expert in the Industry-Academia Brainstorming session organized by Amity University on June 21, 2022.
7. Dr. Ravi, S. C. acted as Rapporteur for Technical Session-I in the National Seminar on "Challenges and Prospects of Horticulture in India" on October 31, 2022 organized by Babasaheb Bhimrao Ambedkar University, Lucknow.
8. Dr. Ravi, S. C. delivered a TV talk on "Farmer Producer Organizations" at Doordarshan, Lucknow on November 9, 2022.
9. Dr. Sanjay K. Singh received the FSSAI registration for 37 products for sale of value added products on behalf of Fruit Processing Unit, ICAR-CISH, Lucknow.
10. Dr. Muthukumar. M was invited as Co-Chairman of the technical session-3 on "Food Innovation Technology and Waste Valorization" November 25. 2022, in the two day Indo-Uzbek Meet and International Conference on "Trends and Innovations in Food Technology from Farm to Fork" held at Integral University, Lucknow.
11. Dr. Tarun Adak acted as Convener in technical session-IV: Biodiversity conservation and soil health in the 3rd International Web-Conference on "Natural resource management for global food security and sustainable development Goals" organized during December 2 to 3, 2022.
12. Dr Anju Bajpai and Dr. Muthukumar. M. were nominated for providing inputs to the vision document on UP Biotech Policy, during December 15, 2022 for coordinating with UPCST, Lucknow.
13. Dr. A. K. Trivedi was appointed as member, Board of Studies, Department of Plant Physiology, Institute of Agricultural sciences, Banaras Hindu University, Varanasi.
14. Dr. S. K. Dwivedi became Associate Editor of Journal "Plant Physiology Reports" published by Springer (ISSN: 2662-2548).
15. Dr. S. K. Dwivedi become topic editor in "Frontier in Agronomy" (ISSN: 2673-3218).

16. Dr. S.K. Dwivedi became Advisory board member of Journal "Heliyon" published BY Cell press (ISSN: 2405-8440.
17. Dr. Sanjay Kumar Singh was appointed as External Examiner by Registrar, RPCAU, Pusa, Samastipur to conduct Written Comprehensive Examination 2022 for M.Sc. (Horticulture-Fruit Science) students of College of Agriculture.

External Examiner

1. Dr. A. K. Trivedi evaluated a Ph. D. thesis entitled "Transcriptome Dynamics and Regulation of Gene Expression in Relation to Starch Biosynthesis and Grain Filling in Contrasting Recombinant Inbred Lines (RIL) of Rice" from School of Life Sciences, Sambalpur University, Odisha.
2. Dr. A. K. Trivedi evaluated a Ph. D. thesis entitled "Mitigating Effect of Brassinosteroid on Salinity Stress in *Stevia rebaudiana* Bertoni under *in vitro* condition with special reference to Morphological and Biochemical changes" from Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
3. Dr Anju Bajpai was appointed as external examiner at IT Girls PG College, Lucknow University for BSc- I practical examination on March 28, 2022.
4. Dr. Muthukumar. M. Acted as External Examiner for conducting Viva Voce examination of final year project dissertations of B. Tech (Biotechnology) IV Year/VIII Semester at Department of Bioengineering, Integral University, Lucknow, on July 18, 2022.
5. Dr. K.K. Srivastava evaluated the M.Sc (Ag) Horticulture thesis of Department of Horticulture and Fruit Technology, BAU, Sabour, Bhagalpur and conducted viva-voce examination.
6. Dr. Karma Beer appointed as question paper setter for B. Sc. (Ag.) on "Fundamentals of Horticulture" from Banda University of Agriculture & Technology, Banda Uttar Pradesh.
7. Dr. Karma Beer appointed as question paper setter for M. Sc. (Ag.) on "Breeding of Fruit Crops" from Banda University of Agriculture & Technology, Banda Uttar Pradesh.
8. Dr. A. K. Trivedi, conducted Online viva voce examination of Ph. D. Thesis of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi on December 05, 2022.

Lecture Delivered

Name of scientist	Topic of lecture	Date
Dr. Dinesh Kumar	अमरुद में जल एवं पोषण प्रबंधन to the progressive farmers sponsored by Bhawana Seva Sadan, Thakurganj, Lucknow at, ICAR-CISH, Lucknow	January 12, 2022
Dr. Tarun Adak	Delivered an oral presentation on "Jackfruit conservation under natural farming for quality food and micronutrient nutrition" National Webinar on "Sustainable interventions Towards Resource Conservation and Natural Farming" organized online mode	April 22-23, 2022.
Dr. Ravi, S. C.	Activities and Achievements of ICAR-CISH, Lucknow to the final year B.Sc. Hons. (Horti.) students of Adhiparasakthi Horticultural College, Ranipet, Tamil Nadu	April 24, 2022
Dr. A. K. Trivedi	Delivered an oral presentation entitled "Moisture Stress Management in Mango (*Mangifera indica* L.) in Subtropical Region" in the "2nd Indian Horticulture Summit - 2022 On Horticulture for Prosperity and Health Security, Navsari Agricultural University, Navsari, Gujarat, India.	April 27-29, 2022

Dr. Dushyant Mishra	Rejuvenation of senile mango orchards through canopy management in webinar on "Recent techniques in fruit production and processing" organized at ICAR-CISH, Lucknow	May 6, 2022
Dr. Abha Singh	Delivered a talk in National Hindi Seminar on "Possibilities of health benefits of rural women through fruits and vegetables"	May 6,2022
Dr. Dushyant Mishra	Bonsai Making to students of Dharava High School, Jaipur through digital media	May 26, 2022
Dr. Muthukumar. M.	Delivered a talk on Biotechnology and its industrial applications during the training to UG student of SHUATS at ICAR-CISH, Lucknow	June 2, 2022
Dr. Anju Bajpai	Delivered a talk on Biotechnology and its agricultural applications during the training to UG student of SHUATS at ICAR-CISH, Lucknow	June 3, 2022
Dr. S. K. Dwivedi	Genetically modified crops and its implications" during the training to UG student of SHUATS at ICAR-CISH, Lucknow	June 4, 2022
Dr. Abha Singh	Delivered an oral presentation on "Osmotic dehydration of guava varieties Lalit and Shewta" in 5th International Conference on Advances in Agricultural Technology and Allied Sciences (ICAATAS 2022)	June 4-5, 2022
Dr. Dushyant Mishra	Improving productivity of subtropical fruit crops in training program for students of SHUATS, Prayagraj at ICAR-CISH, Lucknow	June 9, 2022
Dr. Dushyant Mishra	Use of nano fertilizers in fruit production at ICAR-CISH, Lucknow	June 21, 2022
Dr. Dinesh Kumar	संतुलित उर्वरक उपयोग में मृदा परिक्षण का महत्व एवं टपक सिंचाई के लाभ to the progressive farmers at ICAR-CISH, Rehmankhera, Lucknow.	June 21, 2022
Dr. Ningthoujam Samarendra Singh	Delivered a talk on "Application of HPLC in fruit crop research" during the training to UG student of SHUATS at ICAR-CISH, Lucknow	June 22, 2022
Dr. Ravi, S. C.	Economic feasibility of perennial crops: Methods and issues" in one month training (June 01st – 30th) of Undergraduate students of SHU&TS, Prayagraj	June 23, 2022
Dr A. K. Trivedi	Disaster Risks and Challenges to Subtropical Fruits: Some Mitigation Options' in the 'National Webinar on Disaster Management in Horticultural Crops' organized by ICAR-Central Institute for Subtropical Horticulture (CISH), Lucknow in collaboration with National Institute of Disaster Management (NIDM), Delhi	July 26, 2022
Dr A. K. Trivedi	Management of Subtropical Fruit Crops in Climate Change Perspective in the Training Program on "Climate Smart Horticulture" for the state officials of Haryana at National Institute of Agricultural Extension Management (MANAGE), Hyderabad	July 26, 2022
Dr. Tarun Adak	Delivered a lead talk on "Horticultural Resource Utilization for Nutritional Security" in the Academy of Natural Resource Conservation and Management (ANRCM) foundation Day via on-line mode.	August 16, 2022

Dr. Ravi, S. C.	Delivered an online oral presentation on "Good Agriculture Practices for Sustainable Agriculture: A case of Mango in Malihabad region of Uttar Pardesh" in the International Conference on "Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS-2022) organized at University of Agricultural Sciences, Bangalore.	August 22-24, 2022
Dr. Dinesh Kumar	''उत्तम मृदा स्वास्थ्य के लिए एकीकृत पोषण प्रबंधन'' पर सतत फलोत्पादन हेतु मृदा पोषण प्रबंधन का आज़ादी का अमृत महोत्सव के तहत at ICAR-CISH, Rehmankhera, Lucknow.	August 26, 2022
Dr. Sanjay Singh	Integrated Orchard Nutrition through litchi and mango based IFS Model' during 15 days Residential Training Programme on INM at Krishi Vigyan Kendra (RPCAU, Pusa, Samastipur), Muzaffarpur	September 19, 2022
Dr. Sanjay Singh	आम, अमरुद एवं निम्बू के बाग में सम–सामयिक कार्य, (सजीव प्रसारण, हेल्लो किसान, 20 सितम्बर 2022 सायं 5.30 बजे) डी. डी. बिहार, दूरदर्शन केंद्र, पटना	September 20, 2022
Dr. Sanjay Singh	फलदार पौधों का रोपण, संवर्धन एवं संरक्षण' (खेत खलिहान, 3 अक्टूबर 2022, दोपहर 14.00 बजे प्रसारित) डी.डी. बिहार, दूरदर्शन केंद्र, पटना	October 3, 2022
Dr. S. K. Dwivedi	Delivered a talk during the training of UG students from Gopal Narayan Singh University, Sasaram, Bihar at ICAR-CISH, Lucknow	October 6, 2022
Dr. Abha Singh	Bio-fortification for improved nutrition to the students of B.Sc. Ag of Sasaram University, Bihar	October 11, 2022
Dr. Dushyant Mishra	Improving productivity of existing fruit orchards and field visit to students from GNS University, Sasaram, Bihar	October 13, 2022
Dr. Dushyant Mishra	Canopy management and rejuvenation of mango orchards and field visit / practical demonstration at R B road Campus during training program of farmers from different districts of UP	October 14, 2022
Dr. Ravi, S. C.	Minimum Support Price and its implications" in the 21 days traininig (October 06th – 26th, 2022) of Undergraduate students of Gopal Narayan Singh University (GNSU) Jamuhar, Sasaram, Bihar	October 24, 2022
Dr. Ningthoujam Samarendra Singh	Delivered a talk on "Analysis of bio-molecules in fruits" in 21 days training of undergraduate students of Gopal Narayan Singh University (GNSU) Jamuhar, Saram, Bihar	October 06-26, 2022
Dr. Ravi, S. C.	Delivered an oral presentation on "Transforming mango value chain for sustainable livelihood" in the National Seminar on Challenges and Prospects of Horticulture in India held at Babasaheb Bhimrao Ambedkar University, Lucknow	October 31, 2022
Dr. Dinesh Kumar	"केला उत्पादन की नवीन तकनीकी" केला उत्पादन प्रौद्योगिकी विषय पर दो दिवसीय प्रशिक्षण कार्यक्रम, ग्राम पंचायत भवन चक पृथ्वीपुर, बक्शी का तालाब, लखनऊ	November 1, 2022
Dr. Sanjay Singh	Recent advances on Production Technology of Guava and its Processing" during Technical Session on Horticulture during three days Farmer's Fair and Agricultural Exhibition-2022 (11-13th November, 2022) at Dr. Bhimrao Stadium, Morena, MP.	November 12, 2022
Dr. Karma Beer	Gaon me vividh mulya vardhit fal evam anya utpadon dwara poshkiye unnayan for UP-DASP official at ICAR-CISH, Lucknow	November 14, 2022

Dr. Ravi, S. C.	"Horticultral Economy" in a training programme on "Horticulture, Cow based Natural Farming, Post Harvest Management and Value Addition Technology" held during November 14th – 18th, 2022 at ICAR-CISH, Lucknow	November 2022	14,
Dr K.K. Srivastava	Growing guava on espalier architecture under high density planting system to the District Coordinator/Technical officers of UPDASP officials at ICAR-CISH, Lucknow	November 2022	14,
Dr. Dinesh Kumar	आम एवं अमरुद के बागो में सिंचाई एवं पोषकीय प्रबंधन" पर व्याख्यान उत्तर प्रदेश कृषि विविधीकरण परियोजना के जिला परियोजना समन्वयक एवं तकनीक सहायक का प्रशिक्षण at ICAR-CISH, Lucknow	November 2022	15,
Dr. Dushyant Mishra	"IFS for Sustainable Agriculture" to trainees (District Project Coordinators) from different district of UP, sponsored by UPDASP at ICAR-CISH, Lucknow	November 2022	16,
Dr. S. K. Dwivedi	Aam, Amrud aur Aonla ki kiryatamak bimariya aum unka prabandhan during training on the theme "Baghwani, gau aadharit prakritik kheti, turai uprant prabandhan aum mulya samwardhan prodhikiya" for UP-DASP official at ICAR-CISH, Lucknow	November 2022	18,
Dr K.K. Srivastava	Growing banana under improvised package of practices at Food and Agriculture Foundation (Lucknow Chapter), Amity University Uttar Pradesh, Lucknow	November 2022	23,
Dr. Dushyant Mishra	Orchard floor management through mulching in a program on World soil day at village Kakarabad, Lucknow	December 2022	5,
Dr. Ningthoujam Samarendra Singh	Encouraging organic cultivation of vegetables and fruits and sensitized about adverse effects of increasing pesticide load on microbial community in soil" in World Soil Day program at Kaakrabad village of Lucknow, U.P	December 2022	5,
Dr. Dinesh Kumar	Delievered a talk on "Guava Nutrition and Water Management" on Guava Day at ICAR-CISH, Lucknow	December 2022	27,
Dr. Anju Bajpai	Presented an oral talk on "Impact of Climate Change in Subtropical Horticulture" in the meeting on "Bridging the Climate Change Research and Policy Gap for Enhanced Local Climate Action in Uttar Pradesh" organized by , Lucknow.	December 2022	29,

Linkages and Collaborations

Institute have linkages with the following organizations/ universities/ agencies/ societies/ entrepreneurs during 2022

1. Department of Biotechnology, 6th-8th Floor, Block 2, CGO Complex, Lodhi Road, New Delhi for research funding.
2. Department of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi for research funding.
3. Protection of Plant Varieties and Farmers' Rights Authority (PPV & FRA), Government of India, Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Co-operation & Farmers Welfare, NASC Complex, DPS Marg, Opposite Todapur Village, New Delhi 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 for research funding.
5. UP Council of Agricultural Research (UPCAR), 8th Floor, Kisan Mandi Bhawan, Vibhuti Khand, Gomtinagar, Lucknow, Uttar Pradesh for research in priority areas established with special reference to Uttar Pradesh.
6. National Bee Board, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India "B" Wing, II Floor, Janpath Bhawan, Janpath, New Delhi for project on 'Integrated Bee Development Centre'.
7. Mission for Integrated Development of Horticulture (MIDH)-National Horticulture Mission, NHM 248A, Krishi Bhawan, Dr. Rajendra Prasad Road, New Delhi for development of Hi-Tech Nursery for Public Sector.
8. M/s Bayer Crop Science Limited, Khasra No.563, Amar Shaheed Path, Lucknow, Uttar Pradesh for contract research on 'Evaluation of bio-efficacy and phytotoxicity of Flupyram and Trifloxystrobin against anthracnose, powdery mildew and leaf spot and Tebuconazole against anthracnose, powdery mildew and post harvest diseases in mango'.
9. Agriculture Skill Council of India (ASCI) 6th Floor, GNG Building, Plot No. 10, Sector - 44, Gurugram, Haryana for providing the farmers centric training.
10. M/s Palvi Industries, Sangli, Maharashtra C/o Sudarshan Agro Engineering, Plot No - H/18-1, Behind Latthye Polytechnic College, Sangli, Maharashtra signed MoU for five years w.e.f January 01, 2020 for 'Prototype development of solar light based insect traps having electrified killing mechanism and other associated prototype development works'.
11. National Bank for Agriculture and Rural Development (NABARD), Plot C-24, G Block, Bandra Kurla Complex, BKC Road, Bandra East, Mumbai, Maharashtra for technology interventions for quality mango production for doubling income of mango growers in Malda Districts, West Bengal.
12. National Institute of Agricultural Extension Management (MANAGE), Rajendranagar Hyderabad, Telangana signed MoU for three years w.e.f. 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.
13. M/s Crop Life India, 2nd Floor, Ansal Chambers II 6 Bhikaji Cama Place, New Delhi signed MoU for three years w.e.f. March 27, 2019 for providing training on organic cultivation.

14. Bundelkhand University, Kanpur Road, Jhansi, Uttar Pradesh signed MoU for three years w.e.f. March 12, 2019 for facilitating student training/ post graduate dissertation/ research work.
15. M/s Green Care Hydroponics Private Limited, Lucknow signed MoU for three years w.e.f. April 06, 2019 for crop specific hydroponics nutrient management technology.
16. Rama University, Kanpur signed MoU for three years w.e.f. April 18, 2019 for facilitating students' training/postgraduate research.
17. *Awadh Aam Utpadak Evam Bagwani Samiti,* Malihabad, Lucknow signed MoU for three years w.e.f. April 22, 2019 for sustainable development and extension of mango orchard-based poultry farming.
18. M/s Agrarian Development Consultant Private Limited, 441.L-IV/08 Purana Topkhana, Bari Road Balaganj, Lucknow signed MoU for three years w.e.f. June 10, 2019 for carrying out the technical support/ guidance towards export of mango.
19. SRIJAN, 4, Community Shopping Centre, Saidullajab, New Delhi signed MoU for three years w.e.f. June 27, 2019 for betterment of farmers and knowledge sharing.
20. M/s Satvik Biotech Kela Utpadak Nursery, Lucknow signed MoU for three years w.e.f. July 04, 2019 for technology transfer of ICAR- Fusicont to control *Fusarium* wilt.
21. G.L.A. University, Mathura signed MoU for three years w.e.f. November 20, 2019 for promotion of Inter-institutional research collaboration, staff and students' training/ post graduate research.
22. M/s Parashar Agrotech Bio Pvt. Ltd., Varanasi signed MoU for five years w.e.f. November 11, 2020 for licensing CISH Trap container.
23. ICAR-Directorate of poultry Research, Rajendra nagar, Hyderabad, signed MoU for two years w.e.f. November 17, 2020; for 'Introduction/ evaluation of suitable backyard poultry farming in the scheduled caste populated village/block/district of west Bengal'.
24. M/s Ranaji Biotech India Pvt. Ltd., Kanpur signed MoU for five years w.e.f. November 30, 2020 for licensing CISH glue trap.
25. M/s Garden King, Kannauj, U.P. signed MoU for three years w.e.f. January 01, 2021 for pulp processing (turmeric, ginger, garlic, onion paste).
26. M/s Scientia *in vitro* Agritech, Lucknow signed MoU for five years w.e.f. January 12, 2021 for 'Production and commercialization of *in vitro* immunization of tissue culture banana Technology'.
27. M/s Life Speaks, Atherv Elite flat no 205, Neminath Nagar, Maharashtra signed MoU for five years w.e.f. January 19, 2021 for licensing CISH-VMAT and OMAT.
28. M/s Saavi Industries Ltd, Sangli, Maharashtra signed MoU for five years w.e.f. January 19, 2021 for licensing CISH Pest Hammer.
29. G. H. Raisoni University, Chhindwara, MP signed MoU for five years w.e.f. February 04, 2021 for facilitating students training/ postgraduate research.
30. ICAR-NINFET, 12, Composite Housing Estate, Regent Park, Kolkata, West Bengal signed MoU for five years w.e.f. August 08, 2021 to promote and enhance research interests, sharing scientific knowledge, methodology.
31. Amity University, Lucknow signed MoU for five years w.e.f. August 09, 2021 for facilitating students training/postgraduate research.
32. Ch. Charan Singh Meerut University, Meerut signed MoU for five years w.e.f. September 08, 2021 for facilitating students training/ postgraduate research.
33. M/s Sai Enterprises, Lucknow, U.P. signed MoU for three years w.e.f. September 08, 2021 for marketing license of CISH-Glue Trap (multi-layered, white oil glue based long-lasting insect sticky trap for agriculture use).

34. M/s Balaji Agro Foods, Lucknow signed MoU for five years w.e.f. October 26, 2021 for mango based immunity booster products.
35. RML Avadh University, Ayodhya signed MoU for three years w.e.f. November 20, 2021 for facilitating students training/ postgraduate research.
36. M/s Atharv Biotech OPC Pvt. Ltd., Lucknow signed MoU for five years w.e.f. November 30, 2021 for production of bio-immune tissue cultured banana plants.
37. NABARD, Kolkata signed MoU for three years w.e.f. November 30, 2021 for promoting NABARD FPO.
38. M/s NEWTRAWAY LLP, Lucknow signed MoU on February 25, 2022 for commercialization of "CISH-Hot Water Dispersible Aonla Herbal Tablet".
39. Mahatma Jyotiba Phule Rohilkhand University, Bareilly signed MoU for three years w.e.f. March 8, 2022, for facilitating students training/postgraduate research..
40. Dr. Y.S.R. Horticulture University, Andhra Pradesh signed MoU for three years w.e.f. March 22, 2022, for facilitating students training/postgraduate research..
41. ITC Limited, Kolkata Pradesh signed MoU for five years w.e.f. March 28, 2022, for enhancing the productivity in mango and other subtropical crops fruits.
42. M/s GT-Biosciences Limited, Nagpur signed MoU on June 30, 2022 for commercialization of CISH-Trap-1, CISH-Trap-2, CISH-Trap-3 and CISH- Rain-proof and long lasting fruit fly traps technology for fruit (CISH-OMAT) and vegetable (CISH-VMAT) crops.
43. M/s SUPA Biotech Private Limited, Nainital signed MoU on June 30, 2022 for commercialization of CISH-Bio Enhancer.
44. M/s Ranaji Biotech India Private Limited, Kanpur signed MoU on July 02, 2022 for commercialization of CISH-Decomposer.
45. Banda University of Agriculture and technology, Banda signed MoU for five years w.e.f. August 26, 2022 for facilitating students training/postgraduate research.
46. M/s JU Agriscience Ltd, Noida signed MoU for five years w.e.f. December 12, 2022 for contract research on 'Testing bio-efficacy of Spirotetramat 11.01% + Imidacloprid 11.01% w/w SC" insecticide on Mango'.

Publications

Research Papers

1. Adak, T., Kumar, A., Pandey, G. and V. K. Singh (2022). Yield sustainability in mango (*Mangifera indica*) as influenced by different levels of foliar Zn sprays. *Indian Journal of Agricultural Sciences,* 92 (2): 222-225.
2. Adak, T., Kumar, K., Singh, V.K. and A.N. Ganeshamurthy. (2022). Response of Dashehari mango to different Zn levels on yield and pulp nutrient contents grown on sandy loam soils of Lucknow *Journal of Horticultural Sciences,* 17(1): 103-109.
3. Adak, T., Singh, V.K. and N. Babu. (2022). Optimizing the determinants of water use efficiency in mango. *Journal of Natural Resource Conservation and Management,* 3(1): 12-16.
4. Babu, N., Adak, T. and A. Kumar (2022). Horticulture intervention for improving productivity and profitability of small and marginal farmers. *Journal of Natural Resource Conservation and Management,* 3(1): 49-57.
5. Bindu, M.H., Maurya, M., Ravi, S.C. and A. Mishra. (2022). An economic analysis of cotton production in Bhadradri Kothagudem district of Telangana State. *Multilogic in Science,* XII (XXXXIII): 31-35.
6. Ganesan, S., Sahu, S., Kishore, K., Kumari, N., and G.C. Acharya. (2022). First report of pineapple leaf blight caused by *Lasiodiplodia theobromae* in India. *Journal of Plant Pathology*,104: 885.
7. Kumar, D., Kumar, G., Srivastava, K.K. and S.R. Singh. (2022). Phenological response through planting time for quality banana production under sub-tropics. *Krishi Science*, 03(01): 22-23.
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Agro-technological Options for Resource Conservation and Management (Sanjay Swami and Shubham Singh editors), p 135-150. ISBN 978-81-7622-516-8.

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2. Roy S S., P. Kashyap and T. Adak (2022). *Natural Resource Management in Horticultural Crops*. pp 326. Today and Tomorrow's Printers and Publishers, New Delhi, India, ISBN 9789391734336.
3. Singh, J., Beer, K., Lal, S., Saurav, S., Tiwari, A., and J. Rajesh. (2022). Smart Horticultural Technologies, Biotech Books, pp. 278.

E-Publications

1. Dwivedi S.K. (2022). Jelly seed formation in Mango, possible causes and its management. Krishisewa (e- publication).
2. Kumari, Nidhi, Shukla, P.K., Singh, Haripal (2022). *Bacillus amyloliquefaciens*. Accession number OM541330, date of submission: 07-02-2022.

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Abstracts in Seminar/Symposia/Conferences

1. Adak T. and N. Babu (2022). Assessing productivity gap analysis of fruit crops through soil indices for its sustainability and policy planning. *In:* Proceedings of National webinar on "Sustainable interventions Towards Resource Conservation and Natural Farming" organized online during April 22 to 23, 2022. p 1.18/37.
2. Adak T. and N. Babu (2022). Innovative approach for enhancing water productivity in Mango cv Amrapali. *In:* Proceedings of 3rd International Web-Conference on "Natural Resource Management for Global Food Security and Sustainable Development Goals" organized during December 2 to 3, 2022. p. 69-70.
3. Adak, T. (2022). Innovative approach for enhancing water productivity in Mango cv Amrapali. *In*: 3rd International Web-Conference on "Natural Resource Management for Global Food Security and Sustainable Development Goals" December 2-3, 2022.
4. Bajpai, Y., Prakhar, S., Kumar, S., Muthukumar M., Trivedi, M., and A. Bajpai. (2022). Floral Morphogenesis and Assessment patterns of quantitative gene expression in mango (*Mangifera indica* L.). *In*: International conference on recent advances in horticulture research (August 8-9, 2022 ICRAHOR-2022) Amity University Noida, Uttar Pradesh. (Oral presentation). p. 30.
5. Kumar, S., Bajpai, Y., Singh, A., Trivedi, M., Bajpai, A. and Muthukumar. M. (2022). Genome wide parental polymorphism survey and its validation for characterization of Lalit x Purple guava mapping population. *In*: International conference on recent advances in horticulture research (August 8-9, 2022 ICRAHOR-2022) Amity University Noida, Uttar Pradesh. (Oral presentation). p. 29.
6. Laxmi, Soni, S.K, Bajpai, Y., and A. Bajpai (2022). Uncovering candidate genes responsive to salt stress in mango (*Mangifera indica* L.). *In*: International conference on recent advances in horticulture research (August 8-9, 2022, ICRAHOR-2022) Amity University Noida, Uttar Pradesh. (Poster presentation).
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8. Srivastava, K.K., Kumar Dinesh, Singh, S.R. and Sharma, N.K. (2022). Container gardening of fruits for nutrition and income generation. *In*: National Seminar on fruit Production in Eastern Tropical Region of India. Challenges and opportunities, March 24-26, 2022 at CHES, ICAR-IIHR, Bhubaneswar.

Technical Bulletins

1. Singh, A.K., Singh, A., Bajpai, A., and Garg, N. (2022). *Jamun ki Unnat Bagwani* (in Hindi). ICAR- Central Institute for Subtropical Horticulture Technical Bulletin 2022/1. p. 28.
2. Singh, A., Dayal, V., Shukla, P.K., Mishra, D., Singh, S., Shukla, S.K. and Gundappa. (2022). *Aam Bagwanon ki Diary* (in Hindi). ICAR- Central Institute for Subtropical Horticulture Technical Bulletin 2022/2. p. 28.

Research Projects

In-House Research Projects

S.N.	Name of Project	PI	Co-PI
1.	Genetic resource management and improvement of mango	Dr. Ashish Yadav	Dr. Anshuman Singh, Dr. Vishambhar Dayal, Dr. Amar Kant Kushwaha, Dr. P.K. Shukla, Dr. Gundappa
2.	Genetic resource management and improvement of guava	Dr. Anshuman Singh	Dr. Ashish Yadav, Dr. Vishambhar Dayal, Mr. Amar Kant Kushwaha, Dr. Nidhi Kumari, Dr. Gundappa
3.	Genetic mapping and development of genomic tools to accelerate molecular breeding in fruits	Dr. Anju Bajpai	Dr. Muthukumar M, Dr. Israr Ahmad, Dr. H.C. Verma, Dr. Bharati Khilladi, Dr. Ashish Yadav, Dr. Devendra Pandey, Dr. Anshuman Singh, Dr. P. K. Shukla
4.	Improvement of aonla and bael for higher yield and nutraceutical value	Dr. D. Pandey	Dr. Anju Bajpai, Dr. A.K. Bhattacherjee, Mr. Amar Kant Kushwaha
5.	Genetic resource management and improvement of jamun	Dr. A.K. Singh/ Dr. Anshuman Singh	Dr. Anju Bajpai
6.	Development of tissue culture system of fruit crops though bioreactor	Dr. Maneesh Mishra	Er. Anil Kumar Verma
7.	Development of ICT based advisory and analytical tools for subtropical fruit crops	Dr. H.C. Verma	Dr. A.K. Trivedi, Dr. P.K. Shukla, Dr. Tarun Adak
8.	Impact of climatic variables on reproductive growth phases, yield and quality of mango genotypes under subtropics	Dr. Swosti Suvadarsini Das	Dr. Ashish Yadav, Dr. S.K. Dwivedi, Dr. Vishambhar Dayal
9.	Impact of microbial formulations in organic production system of mango (*Mangifera indica* L.) under Indian subtropics	Dr. P. L. Saroj	Dr. Dinesh Kumar, Dr. H.S. Singh, Dr. Dushyant Mishra, Dr. Govind Kumar, Dr. Muthukumar M, Dr. Ravi S.C.
10.	Canopy management for improving productivity in mango and guava	Dr. K.K. Srivastava	Dr. S.K. Shukla, Dr. D. Mishra, Dr. Dinesh Kumar, Dr. A.K. Trivedi, Dr. S.K. Dwivedi, Dr. P. Barman, Dr. Govind Kumar
11.	Enhancing input use efficiency for higher productivity of subtropical fruits	Dr. Dinesh Kumar	Dr. R.A. Ram, Dr. S.K. Shukla, Dr. K.K Srivastava, Dr. S.R. Singh, Dr. Naresh Babu, Dr. A.K. Verma, Dr. Tarun Adak, Dr. S.K. Dwivedi, Dr. P. Barman, Dr. Govind Kumar
12.	Crop diversification in fruit production system for enhanced productivity and farmer profitability	Dr. S.K. Shukla	Dr. D. Mishra, Dr. S.R. Singh, Dr. Naresh Babu, Dr. K.K. Srivastava, Dr. A.K. Trivedi, Dr. P. Barman, Dr. Israr Ahmad, Dr. Govind Kumar, Dr. Ravi S.C.
13.	Development and evaluation of nano formulations for enhancing productivity and quality of horticultural crops	Dr. Dushyant Mishra	Dr. A.K. Trivedi, Dr. S.K. Shukla, Dr. Dinesh Kumar, Dr. Israr Ahmad, Dr. Bharati Khilladi, Dr. P. Barman, Dr. Govind Kumar,
14.	Improving knowledge and skill of stakeholders for increasing production and productivity of subtropical horticultural crops	Dr. Naresh Babu	Dr. S.K. Shukla, Dr. K.K. Srivastava, Dr. S. R. Singh, Vishambhar Dayal, Dr. Ravi S.C.

15.	Development of input efficient soilless culture technology for high value horticultural crops	Dr. S.R. Singh	Er. A.K. Verma, Dr. Ashok Kumar
16.	Exploring possibilities of non-traditional fruit crops for extended availability of fresh fruit in subtropics	Dr. Ashok Kumar	Dr. Naresh Babu, Dr. S.R. Singh
17.	Evaluation of soil, tree and climatic indicators in mango orchards	Dr. Tarun Adak	Dr. Naresh Babu, Dr. Ashok Kumar
18.	Development of natural farming system models for subtropical horticultural crops	Dr. S.K. Shukla	Dr. Dushyant Mishra, Dr. S.R. Singh, Dr. Dinesh Kumar, Dr. P.K. Shukla, Dr. Gundappa, Dr. Govind Kumar, Dr. Tarun Adak, Dr. A.K. Trivedi, Dr. Bharati Killadi, Dr. Ravi, S.C., Mr. Amar Kant Kushwaha
19.	Identification, dynamics, loss assessment and devising management tools and schedules for prevailing and emerging insect pests of subtropical fruit crops	Dr. H.S. Singh	Dr. Dinesh Kumar, Dr. S.K. Shukla, Dr. P.K. Shukla, Dr. Gundappa, Dr. S.K. Dwivedi, Dr. Govind Kumar
20.	Disease diagnosis, devising detection tools and management practices for diseases of subtropical fruit crops	Dr. P.K. Shukla	Dr. Nidhi Kumari
21.	Management of abiotic stress and physiological issues in subtropical fruit crops	Dr. A.K. Trivedi/ Dr. S.K. Dwivedi	Dr. S.K. Shukla, Dr. Dinesh Kumar, Dr. Dushyant Mishra, Dr. Israr Ahmad, Dr. P. Barman, Dr. Govind Kumar, Dr. Alok Kumar
22.	Developing protocols for value added products of fruits and vegetables	Dr. Abha Singh	Dr. Neelima Garg, Dr. Bharati Khilladi, Dr. A.K. Gupta, Dr. Karma Beer
23.	Development of protocol for shelf life extension of subtropical fruits and vegetables	Dr. Bharati Killadi	Dr. Alok Gupta, Dr. Neelima Garg, Dr. Abha Singh
24.	Minimization of post harvest losses, export promotion and export competitiveness of subtropical fruit crops	Dr. Karma Beer	Er. A.K. Verma, Ravi S.C.
25.	Identification of constraints and opportunities for improving efficiency of mango and guava value chain in subtropics	Dr. Ravi S.C.	Dr. Karma Beer, Er. A.K. Verma
26.	Rapid multiplication of guava through advanced propagation techniques	Dr. Alok Kumar Gupta	Dr. S.R. Singh, Dr. S.K. Dwivedi
27.	Study the influence of pesticide on and agrochemicals on subtropical fruit shelf-life and quality	Dr. N. Samrendra Singh	Dr. Bharati Khilladi, Dr. Amar Kant Kushwaha
28.	Genetic resource management and utilization of traditional mango Varieties from West Bengal	Dr. Dipak Nayak	Dr. Prannath Barman
29	Integrated orchard health management and crop diversification in mango orchard of Malda	Dr. Prannath Barman	Dr. Dipak Nayak, Dr. Govind Kumar

Externally Funded Projects

S.N.	Project Title	PI/Nodal Officer	Period
AMAAS, MAU			
1.	Network project on Micro organisms in agriculture and allied sectors Sub-Project: Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable mandi waste	Dr. Neelima Garg	2017-2022
DST-SERB			
2.	Genomics assisted identification of resistance genes from wild relatives of guava against *Meloidogyne enterolobii* causing wilt	Dr. Muthukumar M.	2018-2022
3.	Micro biome analysis and their application for pesticide biodegradation and plant growth promotion in subtropical horticultural crops	Dr. Govind Kumar	2019-2022
4.	Genome wide SNP markers associated with fruit traits for developing climate smart mango hybrids using genome selection	Dr. Anju Bajpai	2020-2023
DBT			
5.	Management of Fusarium wilt in NER banana using ICAR-FUSICONT Technology	Dr. T. Damodaran (Project Coordinator) Dr. Maneesh Mishra (Co-PI), Dr. Ashish Yadav (Co-PI)	2021-2024
UPCST			
6.	Development of integrated package for management of fruit drop of beal (*Aegle marmelos* Correa)	Dr. P.K. Shukla	2021-2024
7.	Biochemical and molecular dynamics of jelly seed disorder in mango (*Mangifera indica* L.)	Dr. Israr Ahmad	2022-2025
8.	Development of low cost vitamin A rich weaning mix (baby food mix) from locally available food materials for nutritional upliftment of infants.	Dr. Abha Singh	2022-2025
UPCAR			
9.	Design and development of ergonomically efficient fruit harvesters for mango, guava and bael	Er. Anil Verma	2020-2023
PPV & FRA			
10.	Developing national repository and facilities for DUS testing in guava (*Psidium guajava*) and litchi (*Litchi chinesis*)	Dr. Anshuman Singh	2012-2023
11.	Characterization of aonla varieties for developing DUS test guidelines	Dr. Devendra Pandey	2012-2023
12.	Validation of DUS descriptors of bael (*Aegle marmelos* Correa)	Dr. Devendra Pandey	2012-2023
13.	Development of morphological descriptors and DUS test guidelines for jamun	Dr. A.K. Singh/ Dr. Anshuman Singh	2012-2023
14.	National DUS centre for mango crop	Dr. Ashish Yadav	2012-2023
ICAR Networking Project			
15.	National Agriculture Innovation Fund: Component-I IP&TM	Dr. Ravi S.C./ Dr. Muthukumar M.	2008-2023
16.	National Agriculture Innovation Fund: Component-II ABI	Dr. Maneesh Mishra	2019-2023

ICAR (Emeritus Scientist Scheme)			
17.	Evolving safe paclobutrazol use technology for regular cropping and avoiding decline in mango orchards	Dr. V. K Singh	2020-2023
PKVY			
18.	Promotion of organic farming practices for improving livelihood security of small and marginal farmers in Uttar Pradesh	Dr. R.A. Ram	2020-2023
RKVY			
19.	Agri-Drone Project	Dr. P.K. Shukla	2022-2025
MIDH			
20.	Hi-Tech Nursery Public Sector (4 ha)	Dr. Dipak Nayak	2020-2023
Farmers FIRST Programme (KVK Scheme)			
21.	Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules	Dr. Maneesh Mishra	2016-2023
Mandi Parishad, U.P. (Contract Service)			
22.	Preparation of work plan and its implementation for GI patenting of Langra, Chausa and Rataul mango of U.P.	Dr. Ashish Yadav	2020-2022
Seed Hub Project			
23.	Seed Hub Project at KVK Malda	Dr. Dipak Nayak	2017-2022
National Bee Board, New Delhi			
24.	Integrated Bee Development Centre (IBDC)	Dr. Dipak Nayak	2018-2022
Crop Life India			
25.	Responsible use of Crop Protection products in mango and litchi for farmers safety, pollinators conservation and enhancing yield of the crops in West Bengal and Bihar under crop life	Dr. Dipak Nayak	2019-2022
NABARD			
26.	Technology interventions for quality mango production for doubling income of mango growers in Malda District, West Bengal	Dr. Dipak Nayak	2020-2023
Tribal Sub Plan			
27.	Tribal Sub Plan	Dr. Dipak Nayak/ Dr. S.K.Shukla	2018-2024
Scheduled Caste Sub Plan			
28.	S.C. Sub Plan	Dr. Vishambhar Dayal	2018-2024
Inter-Institutional Collaborative Project (ICAR-CISH and CSIR-NBRI, Lucknow)			
29.	Application of whitefly-trap-cum death sink cotton to protect vegetables and horticultural crops from whitefly vectored viral diseases in India	Dr. Maneesh Mishra (PI) Dr. Nidhi Kumari (Co-PI)	2021-2026
Bihar State Biodiversity Project (Collaborative Project)			
30.	Evaluation of diversity and decline of indigenous seedling mango of Bihar and study for its conservation strategy	Dr. D. Pandey (PI) Dr. Sanjay K. Singh (Co-PI)	2022-2024
Palvi Industries, Sangli, Maharashtra (Collaborative Research)			
31.	Prototype development of solar light based insect traps having electrified killing mechanism and other associated prototype development works.	Dr. H.S. Singh	2019-2023

JU Agriscience Ltd., Noida (Contract Research)			
32.	Bio-efficacy of "Spirotetramat 11.01% + Imidacloprid 11.01% w/w SC" Insecticide on Mango	Dr. H.S. Singh	2022-2024
Bayer Crop Science Ltd., Lucknow (Contract Research)			
33.	Evaluation of bio-efficacy and phytotoxicity of Flupyram 250 g/l + Trifloxystrobin 250 g/l (Luna sensation 500SC) against anthracnose, powdery mildow and leaf spot and Tebuconazole 430 SC (BUONOS) against anthracnose, powdery mildew and post harvest diseases in mango	Dr. P.K. Shukla	2021-2023
34.	Efficacy evaluation of Flubendiamide 90 g/l + Deltamethrin 60 g/l (Fenos quick) on mango" insecticide on Mango	Dr. H.S. Singh	2022-2024

AICRP-Fruits

S.No.	Experiment Code	Title of Experiment	Name of PI
1	1.2.1 G	Augmentation and evaluation of germplasm in guava (1.1.1.G.)	Dr. Anshuman Singh
2	1.2.5. G	Testing the performance of new promising hybrids and selections of guava (MLT-3)	Dr. Anshuman Singh
3	1.2.7.G	Testing the performance of promising hybrids of guava	Dr. Anshuman Singh
4	3.2.4. G	Enhancing the input use efficiency in guava under HDP	Dr. K.K. Srivastava
5	5.2.2. G	New and emerging insect pests in guava	Dr. Gundappa
6	6.2.2. G	Survey on disease dynamics in guava	Dr. P K Shukla
7	6.2.3. G	Integrated management of guava wilt	Dr. P K Shukla
8	1.1.1.M	Augmentation and evaluation of germplasm in mango	Dr. Ashish Yadav
9	1.1.14.M	Scion breeding in Mango	Dr. Ashish Yadav
10	1.15.M	Root stock breeding in Mango	Dr. Ashish Yadav
11	1.1.17.M	MLT-2 for mango hybrids	Dr. Ashish Yadav
12	3.1.5.M	Fertilizer scheduling for high density planting in mango	Dr. Dinesh Kumar
13	3.1.6.M	Effect of micro-nutrients on yield and quality of mango	Dr. Dinesh Kumar
14	4.1.4.M	Assessing the effect of climatic variability on mango flowering and yield	Dr. Dinesh Kumar
15	5.1.5 M	Survey for new and emerging insect-pests and their natural enemies of mango	Dr. H.S. Singh
16	5.1.6.M:	Management of mango hoppers and thrips by oil-based formulation of *Metarhizium anisopliae*	Dr. H.S. Singh
17	5.1.8.M	Evaluation of different botanical formulations for management of sucking pest complex in mango	Dr. H.S. Singh
18	5.1.9.M	Management of mango stem borer (*Batocera rufomaculata*) using 'Arka Borer Control'	Dr. H.S. Singh
19	5.1.10.M	Slow release of pheromone formulation for management of fruit fly in mango	Dr. H.S. Singh
20	5.1.7.M	Module based pest management in Mango	Dr. H.S. Singh
21	6.1.5.M	Survey on disease dynamics in mango	Dr. P.K. Shukla

AICRP- Biological Control

S.N.	Code No.	Title	Name of PI
1.	14.1	Survey, surveillance and collection of natural enemies of major pests infesting mango	Dr. Gundappa/ Dr. H.S. Singh
2.	14.2	Bio-efficacy of bio-pesticides for the management of mango hoppers	Dr. Gundappa/ Dr. H.S. Singh
3.	14.3	Bioefficacy of entomopathogenic fungi formulations in suppression of mango leaf webber	Dr. Gundappa/ Dr. H.S. Singh
4.	14.4	Habitat manipulation for conservation of bioagents for management of mango insect pests	Dr. Gundappa/ Dr. H.S. Singh
5.	14.5	Field evaluation of microbial biocontrol agents for the management of mango thrips	Dr. Gundappa/ Dr. H.S. Singh
6.	15.1	Evaluation of bio-agents against root-knot nematode and *Fusarium* wilt complex in guava under controlled conditions	Dr. P.K. Shukla

QRT/RAC/IMC/IRC Meetings

Quinquennial Review Team – AICRP (Fruits)

Quinquennial Review Team (QRT) for the AICRP-Fruits on mango and guava reviewed the AICRP programme going on in different ICAR Institutes as well as State Agriculture Universities at ICAR-CISH, Lucknow for the period 2017-18 to 2021-22 during 24th to 25th November, 2022. Dr V.A. Parthasarathy (Chairman), Dr. B.N. Hazarika (Member), Dr. Doddaballapur Balasimha (Member), Dr. V. Ravi (Member), Dr. A.K. Misra (Member), Dr. C. Aswath (Member Secretary), Dr. Sridhar Gutum (Member) and other scientists attended the meeting. Dr K.K. Srivastava, Nodal Officer and Organizing Secretary arranged the QRT meeting. The programme was started with the welcome address of Dr. Devendra Pandey, Director, ICAR-CISH after that Dr. Prakash Patil (Project Coordinator) presented the report virtually on mango and guava. During the two days deliberations, 23 centres working on mango and 17 centres working on guava presented their five years reports before the committee. The QRT also reviewed physically the on going experiments at ICAR-CISH, Lucknow.

Research Advisory Committee (RAC)

Twenty-sixth RAC meeting of ICAR-CISH was held during July 22 & 23, 2022 at ICAR-CISH, Lucknow. The following members attended the meeting :

i.	Dr. N. Kumar, Former Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore	:	Chairman
ii.	Dr. (Mrs.) Chandish Balal, Ex. Director, ICAR-NBAIR, Bengaluru	:	Member
iii.	Dr. A.N. Ganeshmurthy, Dean, College of Agriculture, Central Agricultural University, Imphal, Manipur & Former Principal Scientist and Head, Division of Soil Science & Agril. Chemistry, ICAR - IIHR, Bangalore	:	Member
iv.	Dr. Jai Singh, Ex. Director, ICAR-CIPHET, Ludhiana	:	Member
v.	Dr. (Mrs.) Ambika B Gaikwad, Principal Scientist, Division of Genomic Resources, Bio-Technology (Plant Science), ICAR-NBPGR, New Delhi	:	Member
vi.	Dr. Neelima Garg, Director, ICAR-CISH, Lucknow	:	Ex-Officio Member
vii.	Dr. Maneesh Mishra, Chairman, PME, ICAR-CISH, Lucknow	:	Member Secretary
viii.	All scientists of ICAR-CISH, RRS, Malda		

General Recommendations

- Leaf Area Software developed by the institute should be evaluated by ICAR-IIPR, Kanpur or any other ICAR institute.
- All CISH technologies should be uploaded on Institute website for its wider reach to stakeholders.
- Demonstration plots for CISH technologies should be established.

Technical Recommendations

Division of Crop Improvement & Biotechnology

- Exhaustive mango breeding program is carried at the institute. It is imperative to select parents taking into account phenotypic, biochemical and disease/pest resistance traits also instead of only phenotypic traits.
- Work on mango malformation has gone out of priority. There is need to hold a brain storming session on mango malformation inviting all experts who have experience of working on this issue and come out with a multidisciplinary project on tackling the problem of malformation.
- Mango database (www.mangifera.org) should become functional and to be operated by the Institute.

Division of Crop Production

- Grafting of guava on Myrtaceae family rootstocks have shown poor success. However, with advent of hi-tech nursery technology, this work should be attempted for mitigation of wilt disease.
- Melatonin spray technology may be taken to farmer's field for large scale demonstration to increase 'A' grade fruits percentage.
- The high density orchard yield in the institute is very low. We had a presentation on management of HDP in mango by Chairman, RAC. HDP in mango experiments of CISH may be revisited and planned accordingly.

Division of Crop Protection

- Till date management of thrips and fruit flies was focused on managing the pest on the crop canopy. But the real problem lies in the soil where both thrips and fruit flies pupate. Any management of these two insect pests may be focused on soil rather than canopy alone.
- It is important to identify the pests and natural enemies under study and report the scientific names of the same.
- In the population dynamics study, it is important to document the seasonal dynamics of natural enemies besides pests.
- Assessment losses due to the major pests to be quantified and documented.
- Attempts to be made to tackle the pests from the source population.
- The population of natural enemies (if any) caught in the pest traps to be documented.

Division of Post-Harvest Management

- CISH should work towards developing products using guava and aonla for mid day meal for enhancing bio-absorption of iron.
- There is need to strengthen post-harvest physiology research to address several challenges in post-harvest management.

Regional Research Station, Malda

- Research work should be focused more towards addressing research problems of mandated crops for Eastern India.
- RRS, Malda should focus on evaluation of technologies developed at ICAR-CISH.
- RRS, Malda should present the analyzed data of research outcomes in the next RAC.

Release of Annual Report, 2021 by the RAC Committee

Institute Research Committee (IRC)

46th Institute Research Committee Meeting

Forty-sixth meeting of Institute Research Committee was held on February 1, 2022. Dr. Neelima Garg, Director and Chairperson of Institute Research Committee discussed the

initiatives to be taken up for the promotion of Natural Farming as per the directives of Hon'ble PM. Dr. S.K. Shukla, Principal Scientist & PI presented the details of research activities of the project entitled "Development of natural farming system models for subtropical horticultural crops". All scientists of the Institute attended the meeting.

47th Institute Research Committee Meeting

The of 47th meeting of Institute Research Committee (IRC) of ICAR-CISH, Lucknow was held on 29th November, 2022 through hybrid mode for consideration of new research proposals submitted by Scientists. The 47th IRC comprised of the following members:

Table : Members of 47th IRC Committee

Name	Designation	Affiliation	Mode of Participation
Dr. Devendra Pandey	Chairman	Director (Acting) & I/c, Head, Division of Crop Improvement and Biotechnology	Physical
Dr. P. L. Saroj	Member	I/c, Head, Division of Crop Production	
Dr. H. S. Singh	Member	I/c, Head, Division of Crop Protection	
Dr. A. K. Trivedi	Member	I/c, Head, Division of Post Harvest Management	
All Principal Scientists, Senior Scientists and Scientists	Members	ICAR-CISH, Lucknow	
Dr. Deepak Nayak	Member	I/c, RRS, Malda, West Bengal	Virtual
Dr. P. Barman	Member	RRS, Malda (WB)	
Dr. Anju Bajpai	Member Secretary, PME Cell	ICAR-CISH, Lucknow	Physical

The Chairman remarked that the purpose of IRC is to refine research activities and consider new research project proposals keeping in view the research mandates of the Institute. He also reminded the house that with the slashing of fund under grant-in-aid (General) for the institute, the institute scientists' have added responsibility for getting funds through various externally funded projects. Following new proposals were approved after and discussion:

1. Impact of microbial formulations in organic production system of mango (*Mangifera indica* L.) under Indian subtropics. (PI-Dr. P. L. Saroj)
2. Organic production of dragon fruit in subtropical conditions. (PI-Dr. P. L. Saroj)
3. Rapid multiplication of guava through advanced propagation techniques (PI-Dr. Alok Kumar Gupta)
4. Impact of climatic variables on reproductive growth phases, yield and quality of mango genotypes under subtropics (PI-Dr. Swosti Suvadarsini Das)
5. Study the influence of pesticide and agrochemical on sub-tropical fruit shelf-life and quality. (PI-Dr. N. Samrendra Singh)
6. Genetic Resource Management and Utilization of Traditional Mango Varieties from West Bengal. (PI-Dr. Deepak Nayak, RRS, Malda)
7. Integrated orchard health management and crop diversification in mango orchard of Malda. (PI-Dr. Prannath Barman, RRS, Malda)

Institute Management Committee (IMC)

ICAR-CISH, Rehmankhera, Lucknow organized 31st meeting of Institute Management Committee (IMC) on July 19, 2022. The Director and Chairman of IMC, Dr. N. Garg in her introductory remarks expressed the necessity to convene the meeting of the IMC and recounted the progress made by Institute since last IMC meeting.

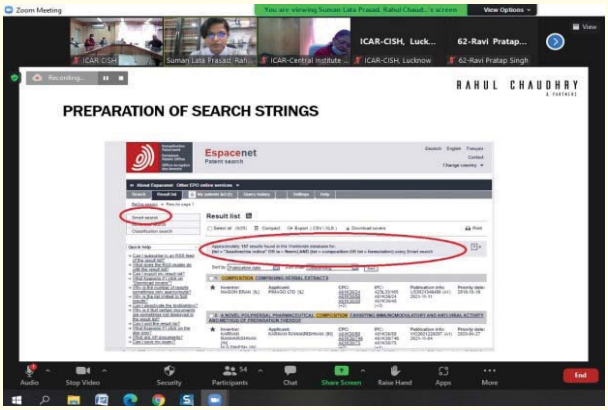
Webinars/Seminars/Symposia/Workshop/ Meetings/Programmes organized

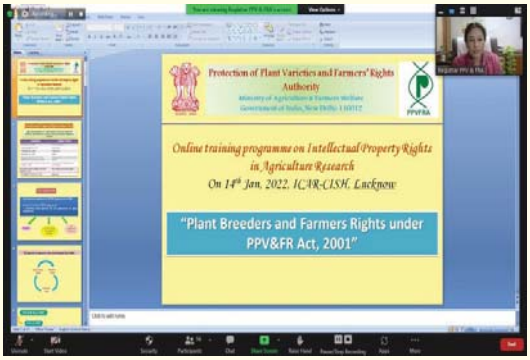
ICAR-CISH organized a number of webinars, interaction meetings, events and programmes of National and International importance such as International Women's Day, World Water Day, International Yoga Divas, Mahila Kisan Diwas, World Food Day, Vigilance Awareness Week, National Unity Day, Constitution Day, Agriculture Education Day, World Soil Day, National Farmers Day etc, and various events under *Amrut Bharat Mahotsav*. The Institute also organized various campaigns under Swacchta Mission and Rajbhasha Hindi.

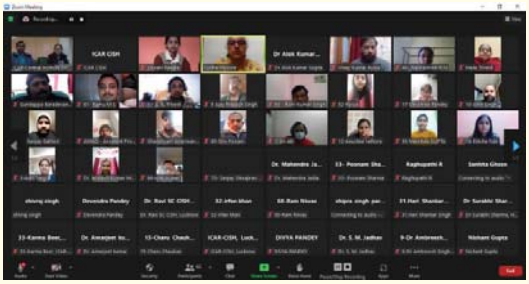
1. WEBINARS /SEMINARS ORGANIZED

Online webinar on "Intellectual Property Rights in Agriculture Research"

ICAR-CISH, Lucknow organized an online webinar on "Intellectual Property Rights in Agriculture Research" during January 10-15, 2022. About 90 participants attended the programme from various research institutes and universities across the country. During the webinar, the extensive knowledge were given about the importance of IPR, types of IPR & law governing them, hands on patent search, patent filing, Breeders and Farmers right under PPV&FR Act-2001, geographical indications, agribusiness incubation system, technology valuation, commercialization, etc. to the participants.







Webinar on "Latest techniques of fruit production and fruit processing"

ICAR-CISH, Lucknow organized a webinar on "Latest techniques of fruit production and fruit processing" on May 06, 2022. About 190 participants attended the programme from our institute, various other research institutes and universities across the country. Dr. Neelima Garg, Director, ICAR-CISH emphasized the future prospects of waste resource management and fruits and vegetable processing. During the webinar, the participants were benefited by the lectures delivered by the eminent scientists on various aspects of production, protection and post-harvest management of subtropical fruits.

National Webinar on "Soil Health Management in Horticultural Ecosystem"

A National webinar on 'Soil Health Management in Horticultural Ecosystem' was organized at ICAR-CISH, Lucknow on December 20, 2022. Dr. P.L. Saroj has focused on importance of conservation and management of natural resources. The programme was inaugurated by Dr. Devendra Pandey who emphasized the importance of natural resources management in sustaining productivity and profitability in horticultural ecosystem. The concern of food security and in order to achieve sustainable developmental goals, the role of soil and tree health management was given due focus and national importance to obtain orchard sustainability. Dr. Tarun Adak while welcoming the delegates emphasized the essentiality of health management and dissemination of farmers' friendly technologies for the benefits of growers' vis-à-vis national growth.

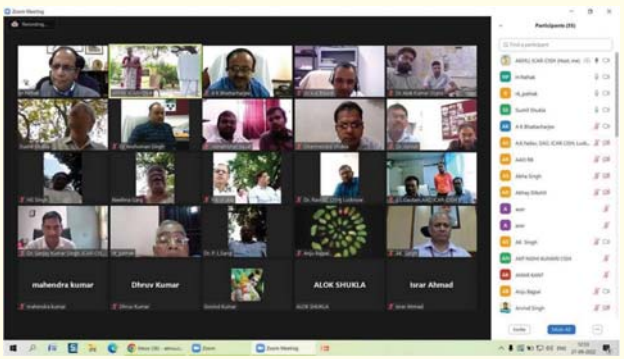
2. CELEBRATIONS

International Women Day

ICAR-CISH, Lucknow celebrated the International Women Day by organizing a capacity development program for the women farmers of Lucknow district on March 8, 2022. The theme of this capacity development program was 'Empowering women farmers with skill and knowledge'. On this occasion, Dr. Neelima Garg, Director exhorted the women farmers to increasingly harness value addition in fruits and vegetables for assured returns and nutritional security of their families. She informed the gathering that ICAR-CISH has developed several high-value processed products in fruits like mango, guava, aonla, bael and jamun, and all possible efforts are underway to commercialize such products in collaboration with women's Self Help Groups, Farmer Producer Organizations and other stakeholders. She assured the women farmers for all the technical support from the institute for their present and future endeavors. Dr. Anju Bajpai, Principal Scientist delivered a talk on the subject 'Nutri-genomics for women health'. On this occasion, 10 women beneficiary farmers under SCSP program were felicitated for their outstanding efforts in initiating and popularizing the commercial farming and kitchen gardening of horticultural crops. A total of 117 knapsack sprayers were distributed among the women and other farmers. The program was attended by 120 farmers including 60 women farmers.

Inauguration of "Natural Agriculture Complex" at the Rae Bareli Road campus of the ICAR-CISH by Dr. Himanshu Pathak, Secretary, DARE & DG, ICAR

'Natural Agriculture Complex' was inaugurated on Sept. 27, 2022 at the Rae Bareli Road campus of the ICAR-Central Institute of Subtropical Horticulture, on-line by Dr. Himanshu Pathak, Secretary, Department of Agricultural Research and Education, Government of India and Director General, Indian Council of Agricultural Research. All the scientists and employees of the institute were associated on this occasion. Dr. Ram Kripal Pathak, former director of the institute and scholar of cow-based farming, was also involved in this process. On this occasion, the chief guest thanked all the scientists and said that the benefits of natural farming has to be proven through scientific research based outputs for validating and promoting the technology. There is need for alternative to chemical farming but it should be scientifically proven and universally acceptable. The chief guest praised the work done by the institute. On this occasion, Dr. A.K. Singh, Deputy Director General (Horticulture), Indian Council of Agricultural Research, Delhi, congratulated the director and scientists of the institute and outlined the efforts made by the institute. The Director of the institute Dr. Neelima Garg discussed in detail the achievements of the institute in the field of natural farming and told that the institute also provides training to the farmers and other interested persons in this field. She told that the institute is developing an area of 13.2 ha as a full-fledged natural farming complex with about 10 ha available for farm and garden. The farm management is being done successfully without chemical fertilizer and insecticide use. Dr. Sushil Shukla, Principal Scientist and P.I. of natural farming narrated the benefits and income from the natural farming orchards.



Independence Day

On the occasion of the 75th anniversary of the country's independence, the Institute celebrated Independence Day on August 15, 2022, in which all the officers and employees of the institute participated. The Independence Day program started with the national anthem of the country, on this occasion the soldiers who were martyred

for the freedom of the country were remembered. The director of the institute, Dr. Neelima Garg detailed about the progress made in the research and development of the institute and the work done by the institute for the benefit of the farmers. Finally, the program was concluded by planting saplings.

Constitution Day

ICAR-CISH, Lucknow celebrated the Constitution Day (Samvidhan Diwas), also known as 'National Law Day' on November 26, 2022 at ICAR-CISH Raebareli Road Campus to commemorate the adoption of the Constitution of India by the Constituent Assembly on 26th November 1949 which came into effect on 26 January 1950. The event was organized by the institute and attended by all the staff of the institute through physical presence and virtual mode and online pledge was taken. The staff were also sensitized about the importance of our constitution and democracy by a talk given by Dr. S.R. Singh, Principal Scientist of the institute.

Guava Day

Institute celebrated Guava Day on December 27, 2022 to disseminate recently developed guava technologies to the farmers. Dr. D. Pandey, Director, ICAR-CISH, Lucknow briefed about recent developments made in canopy architecture management, bagging of fruits and resulting fruit quality. The Chief Guest of the programme, Dr. Sanjay Singh, Director General, U.P. Council of Agriculture Research, appreciated the efforts made by the institute in development of new varieties, new technologies and helping farmers to maintain guava productivity in the state. Director General also invited a mega project to extend the postharvest value addition technologies on guava with the involvement of start-ups for public health improvement. Dr. P.L. Saroj, Head I/c, Division of Crop Production elaborated overview of Guava Day programme and presented the scenario of guava cultivation in U.P. state. Dr. K.K. Srivastava, Principal Scientist explained about canopy architecture management and bagging of fruits, and shared its advantages for the rainy season and winter crops of guava. He also talked about enhancement in yield, individual fruit weight and fruit quality. Dr. P.K. Shukla, Principal Scientist explained about the integrated approach for the management of guava decline disease, which has been a major constraint in guava cultivation during the recent past. Dr. Dinesh Kumar, Principal Scientist explained about guava nutrition and Dr. A.K. Trivedi, Head I/c, Division of Postharvest Management focused on safe harvesting, post harvest handling and value addition. More than 150 farmers and students participated in the programme.

Har Ghar Tiranga programme on the occasion of 75th anniversary of Independence

On the occasion of the 75th anniversary of Independence, the Amrit Mahotsav program of Independence was celebrated in a dignified manner throughout the country. Under the Amrit Mahotsav of Independence, a special movement – 'Har Ghar Tiranga' was organised. 'Har Ghar Tiranga' is a campaign under the aegis of Azadi Ka Amrit Mahotsav to encourage people to hoist it, to bring the tricolor home and to mark India's 75th year of independence. Our relationship with the flag has always been more formal and institutional than personal. Collectively bringing home the flag as a nation in the 75th year of Independence thus becomes not only an act of personal connection to the Tricolor but also a symbol of our commitment to nation-building. The idea behind this initiative of the Prime Minister was to inculcate the spirit of patriotism in the hearts of people and to promote awareness about the Indian National Flag. On this occasion, ICAR-CISH, Lucknow organized the program 'Har Ghar Tiranga' on August 10, 2022, in which scientists, officers, employees and farmers of the institute participated. In this program, tricolor and saplings were distributed to more than 200 farmers of Farmer First Project and Scheduled Caste Sub-Scheme being run by the institute. During this 'Vande Mataram' song was presented by scholar and in the end everyone concluded the program by singing the national anthem.

3. PROGRAMMES ORGANIZED UNDER SWACHHTA CAMPAIGN

Swatchhta Pakhwada (December 16-31, 2022)

The Swatchhta Pakhwada was initiated at CISH as per directions of ICAR to spread the message of clean and green India given by Hon'ble Prime Minister. Swachh Bharat banner was displayed in main gates of the campuses and Swachhta pledge was given by the Director and Nodal Officer on December 16, 2022. Various activities were conducted with active participation of staff

which included Parthenium weed removal and its composting, organizing webinar on 'Waste to Wealth', auction of obsolete scrap, resonating Swachha Bharat call among villages, school and college students and other stakeholders. MLA and village Pradhan also participated in the institute events for the community involvement. Dr. U. Berck and Dr. R.K. Pathak participated in Agnihotra program for environment cleanliness. Adequate coverage of the events was done by involving press and electronic media.

4. PROGRAMMES ORGANIZED UNDER AMRUT BHARAT MAHATSAV

National Webinar on "Clean Milk Production for Better Health and Price"

ICAR-CISH, Lucknow organized a webinar on 'Clean Milk Production for Better Health and Price' on January 6, 2022, which aimed to create mass awareness on importance of hygiene and sanitary measures during procurement, processing as well as sale of milk and milk products for improving human health and financial upliftment. Dr. Neelima Garg, Director of the institute emphasized the importance of indigenous cow breeds for milk production and income generation of farmers and stakeholders. The keynote speaker of the programme, Dr. Latha Sabikhi, Principal Scientist, Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal gave a talk on 'Clean milk for better health and price'. Fifty farmers and other stakeholders including scientists, researchers and academicians from various ICAR institutes and universities of India participated in this programme. The webinar was coordinated by Dr. P. Barman and Dr. Karma Beer.

Interaction dialogue for promoting mango exports

ICAR-CISH, Lucknow organized a farmer-scientist interaction programme on May 21, 2022 involving progressive mango growers, scientists and APEDA officials for identifying and addressing the gaps stalling mango exports from Uttar Pradesh with focus on Dashehari mango. This program was organized on the theme 'Atmanirbhar Bharat: One District One Product-Local to Global'. On this occasion, Dr. Neelima Garg, Director, ICAR-CISH said that Dashehari mango produced in Lucknow and neighboring districts has a vast potential for export. She exhorted the farmers to adopt the best management practices to ensure that their Dashehari fruits meet the global export standards. Dr. C. B. Singh, Regional Head, APEDA discussed the role of various pre- and post-harvest practices in enhancing the cosmetic appeal of mango fruits that plays a crucial role in consumer acceptability of the indian mangoes abroad. He opined that proper harvesting, pre-cooling, grading and packaging were critical to

ensure competitiveness in mango exports. He urged the farmers to apply only recommended pesticides while maintaining pre-harvest interval and maximum residue limit standards. Citing the success story of Zardalu mango exports from Bihar, he expressed his views to take leads for Dashehari export using their model. He also encouraged Dashehari mango growers to collaborate with other stakeholders in the mango supply chain involving State Horticulture Department, APEDA, testing and certification agencies, pack-houses and exporters, etc. to harness the export potential. Er. A. K. Verma, Senior Scientist delivered a lecture on the topic 'Safe harvesting, ripening and storage practices for promoting mango exports' and described in detail various post-harvest operations for producing the best quality mangoes for export. Earlier, Dr. R. A. Ram, Head, Crop Production Division welcomed all the participants and informed them about the importance of Atmanirbhar Krishi. He also briefed about the use and benefits of CISH Bio-enhancer in horticultural crops. CISH Bio-enhancer was also provided to the farmers free-of-cost. Some of the farmers raised their queries including problems in Horti-net registration which were replied by the panel. This program was attended by about 50 participants including mango growers and CISH staff. The program was coordinated by Dr. Anshuman Singh, Senior Scientist.

39th Foundation Day of ICAR-CISH, Lucknow

On June 1, 2022, the institute celebrated its 39th foundation day with great enthusiasm and grandeur. Mango diversity exhibition, mango food festival, Ikka tour of the institute and mango eating competition were important attractions of the day. On this occasion, the Chief Guest, Minister of State (Independent Charge) for Horticulture, Shri Dinesh Pratap Singh inaugurated the CISH-Museum of the institute which also houses 'Aam Sangrahalaya'. He appreciated the technologies developed by the institute and suggested popularizing the technologies by printing letters or folders in simple Hindi language so that it reaches to the common people through village heads. The MLA of Malihabad region, Smt. Jai Devi was also present as a special guest. On this occasion, kits were distributed to the beneficiaries of SCSP. In this kit, farmers were provided with a mango harvester and packets of micronutrient mixture and bio-catalyst each. Dr. Neelima Garg, Director briefed about the achievements of the institute since its inception. A Kisan Goshthi was also organized on this occasion on the topic 'Manage after Harvesting Management'. On this occasion, Dr. Pankaj Tripathi, Director of State Institute of Agricultural Management, Dr. Vishal Nath, Er. Anil Verma addressed the farmers on various topics. In addition to the scientists, employees of the institute, about 200 farmers and 200 other visitors including school and college students participated in the programme.

National Webinar on Disaster Management in Horticultural Crops

Under the ongoing 'Azadi ka Amrut Mahotsav', ICAR-CISH, Lucknow in collaboration with National Institute of Disaster Management (NIDM), Delhi organized a 'National Webinar on Disaster Management in Horticultural Crops' on July 26, 2022 with the aim to sensitize the horticultural fraternity and other stakeholders about vulnerabilities and hazards facing Indian

horticulture industry due to natural disasters and the pathways to develop disaster resilient horticultural systems. Dr. Neelima Garg, Director, ICAR-CISH highlighted the different types of disasters that affects the subtropical fruits and mentioned the issues related to futuristic food security. Chief Guest of the webinar Dr. A. K. Singh, DDG (Horticulture) highlighted the risks of climate change and occurrence of cyclone and other natural disasters badly impact subtropical fruit crops. He suggested that focus must be on climate resilient crops so that they can adapt to the climatic disruption. Keynote speaker of the webinar Prof. Anil Kumar Gupta, Professor, NIDM, Delhi highlighted the global scenario of the disasters and briefed on current IPCC report. Dr. A. K. Trivedi, Principal Scientist, talked on risk and challenges of different subtropical fruits. Dr. Rocky Thokchom, Assistant Prof. FGI, Manipur highlighted issues in disaster management in horticultural crops, He also raised the concerns on disaster affected sectors whose activities are adversely affected by weather change that results the huge economic losses and disruption of livelihood security. The webinar was attended by 110 participants and programme was coordinated by Dr. Karma Beer, Scientist, ICAR-CISH, Lucknow and Dr. Shweta Baidya Consultant, ECDRM, NIDM, New Delhi.

Vigilance Awareness Week 2022

In light of the central vigilance commission's circular no. 14/07/2022 dated 28/07/2022, ICAR-CISH Lucknow has started a three month campaign (16-08-2022 to 15-11-2022) on preventive vigilance measures in all in-house activities, precursor to the Vigilance Awareness Week 2022. Director,Head of the divisions/ administration, scientists, technical and administrative staff of the institute attended various programmes. Dr. S.R. Singh, Vigilance Officer of the institute has apprised about preventive vigilance measures to be taken during three months campaign in the institute aimed at reducing lapses for better governance. The director emphasised detective and punitive action and also to complete the all six earmarked activities during the campaign period for deterring any lapses.

5. PROGRAMMES ORGANIZED UNDER RAJBHASHA HINDI

विश्व हिंदी दिवस

प्रथम विश्व हिंदी सम्मेलन की वर्षगांठ की स्मृति में भारतीय कृषि अनुसंधान परिषद दारा 10 जनवरी, 2022 को विश्व हिंदी दिवस का आयोजन किया गया। महानिदेशक, भारतीय कृषि अनुसंधान परिषद एवं सचिव डेयर, नई दिल्ली, डॉ. त्रिलोचन मोहपात्रा जी

ने कार्यक्रम की अध्यक्षता की और आनलाईन संबोधन प्रस्तुत किया। इस अवसर पर कार्यक्रम के मुख्य वक्ता महात्मा गाँधी अंतर्राष्ट्रीय हिंदी विश्वविद्यालय के पूर्व प्रति–कुलपति प्राध्यापक ए. अरविंदाक्षन ने कहा कि यदि हिंदी को संयुक्त राष्ट्र संघ में मंजूरी मिले तो हिंदी का प्रभाव बढ़ेगा। भा.कृ.अनु.प.–केन्द्रीय उपोष्ण बागवानी संस्थान में उपरोक्त कार्यक्रम हेतु संस्थान की निदेशक द्वारा नामित सदस्य सहित अन्य कर्मियों ने भी आनलाईन प्रतिभाग किया।

राजभाषा कार्यान्वयन समिति की बैठकें

संस्थान राजभाषा कार्यान्वयन समिति की उक्त अवधि में चार बैठकों का आयोजन कर संस्थान में राजभाषा को बढ़ावा देने पर बल दिया गया। संस्थान के नोटिस बोर्ड, मोहरें, प्रयोगशालाओं के दरवाजों पर नाम पट्टिकाओं को द्विभाषी करना, 'क' क्षेत्र में हिन्दी के पत्रों का प्रतिशत बढ़ाना, द्विभाशी पत्रों को बढ़ाना, हिन्दी की पुस्तकों को क्रय करना एवं हिन्दी पखवाड़ा का आयोजन करना आदि संबंधित निर्णयों के कार्यान्वयन हेतु चार बैठकों का आयोजन प्रत्येक तिमाही में किया गया। राजभाषा नियमावली 1976 के नियम 8(4) के अनुसार अपना समस्त कार्य हिंदी में करने के लिए संस्थान के 13 हिंदी में प्रवीणता/कार्यसाधक ज्ञान प्राप्त अधिकारियो एवं कर्मचारियों को अध्यक्ष राजभाषा कार्यान्वयन समिति द्वारा व्यक्तिशः आदेश जारी किए गए। नगर राजभाषा कार्यान्वयन समिति (नराकास) कार्यालय–2, भारतीय भूवैज्ञानिक सर्वेक्षण, लखनऊ द्वारा आयोजित प्रथम छमाही बैठक दिनांक 17.05.2022 एवं द्वितीय छमाही बैठक दिनांक 29.11.2022 में संस्थान ने प्रतिभाग किया तथा समीक्षित बिन्दुओं का पालन संस्थान में किया गया।

हिंदी कार्यशाला

संस्थान के निदेशक एवं राजभाषा कार्यान्वयन समिति के अध्यक्ष की अध्यक्षता में उक्त अवधि में पाँच हिंदी कार्यशालाओं का आयोजन किया गया। सभी कार्यशालाओं में संस्थान के वैज्ञानिक/अधिकारी एवं कर्मचारियों ने प्रतिभाग किया। संस्थान ने केन्द्रीय हिंदी प्रशिक्षण संस्थान, नई दिल्ली द्वारा आयोजित ऑनलाईन गहन हिंदी कार्यशालाओं में प्रतिभाग करने हेतु गैर हिंदी भाषी राज्यों के संस्थान में कार्यरत 6 वैज्ञानिकों को नामित किया जिससे उनके द्वारा हिंदी में उत्साहपूर्वक कार्य किया जा सके।

हिंदी दिवस समारोह एवं द्वितीय अखिल भारतीय राजभाषा सम्मेलन

राजभाषा विभाग, गृह मंत्रालय (भारत सरकार) द्वारा सूरत (गुजरात) में 14–15 सितंबर, 2022 को आयोजित हिंदी दिवस समारोह एवं द्वितीय अखिल भारतीय राजभाषा सम्मेलन में संस्थान में राजभाषा का कार्य कर रहे श्री अरविन्द कुमार, सहायक मुख्य तकनीकी अधिकारी एवं नोडल अधिकारी (राजभाषा) ने प्रतिभाग किया।

राजभाषा हिंदी पखवाड़ा–2022

राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद द्वारा जारी दिशा–निर्देशानुसार दिनांक 14–29 सितंबर, 2022 के दौरान संस्थान में हिंदी पखवाड़ा का आयोजन किया गया। इस अवधि में विभिन्न प्रतियोगिताओं जैसे– हिंदी निबंध लेखन, हिंदी काव्य–पाठ प्रतियोगिता, यूनिकोड में हिंदी टंकण प्रतियोगिता, हिंदी वाद–विवाद प्रतियोगिता तथा वर्ष में हिंदी भाषा में सर्वाधिक कार्य करने आदि का आयोजन किया गया। इस पखवाड़े में दिनांक 23 सितंबर, 2022 को एक कवि सम्मेलन का

भी आयोजन किया गया, जिसमें दिल्ली, बाराबंकी एवं लखनऊ से सम्मिलित कवियों ने अपनी विभिन्न रचनाओं को उपस्थित श्रोताओं के समक्ष प्रस्तुत किया। पखवाड़े का समापन दिनांक 29 सितंबर, 2022 को हुआ, इस अवसर पर वैज्ञानिक तथा तकनीकी शब्दावली आयोग द्वारा प्रकाशित प्रशासनिक शब्दावली पुस्तक से अंग्रेजी के शब्दों का हिंदी में अनुवाद किये गये शब्द पर आधारित एक प्रश्न–मंच प्रतियोगिता का भी आयोजन किया गया। उपरोक्त आयोजित विभिन्न प्रतियोगिताओं में संस्थान के 48 प्रतियोगियों ने सफलता प्राप्त की जिन्हें नियमानुसार कार्यक्रम के समापन समारोह में सम्मिलित मुख्य अतिथि संस्थान के सेवानिवृत पूर्व प्रधान वैज्ञानिक एवं फसल सुरक्षा विभाग के विभागाध्यक्ष डॉ. अशोक कुमार मिश्रा ने पुरस्कृत किया एवं संस्थान की निदेशक महोदया ने प्रमाण–पत्र प्रदान कर सम्मानित किया।

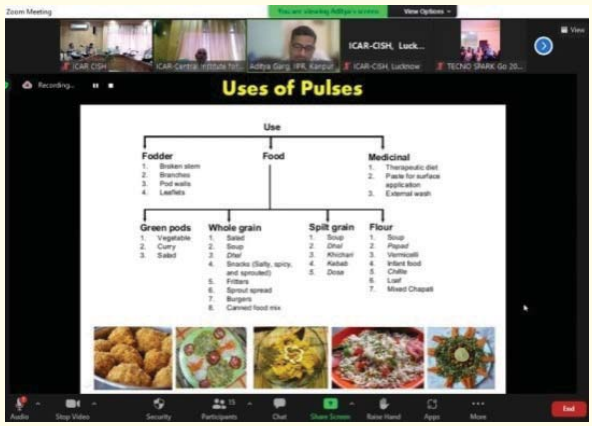
कवि सम्मेलन का आयेजन

हिंदी पखवाड़ा समापन समारोह

6. OTHER PROGRAMMES ORGANIZED

Webinar on 'Atmanirbhar Bharat – Harnessing potential of pulses for import substitution'

ICAR, CISH, Lucknow organized a webinar on *'Atmanirbhar Bharat* – Harnessing potential of pulses for import substitution' on April 8, 2022 under *'Azadi ka Amrit Mahotsav'*. The keynote speaker of the webinar, Dr. Aditya Pratap, Principal Scientist, Crop Improvement Division, ICAR-Indian Institute of Pulses Research, Kanpur highlighted the importance of pulses for health benefits, research achievements in field of pulses, high yielding and short duration varieties of pigeon pea, lentil, moong, pea, cow pea, gram and rajma. He also explained about the management practices involved for higher production of pulses by adopting the integrated pest management practices. During his deliberation he highlighted about the bio-fortified variety of lentil IPL-220. Fifty participants including scientists, researchers and academicians from institutes and farmers from Malihabad, Lucknow associated with the Farmer's First Project joined the programme.



Personnel

Institute Headquarters, Lucknow (Uttar Pradesh)

Scientific			
S. No.	**Name of the officer**	**Degree**	**Designation**
1.	Neelima Garg	Ph.D.	Director (Acting) (retired on 31.10.2022)
A. Division of Crop Improvement and Biotechnology.			
1.	Devendra Pandey	Ph.D.	Principal Scientist (Horticulture) & Director (Acting) (w.e.f. 01.11.2022)
2.	Anand Kumar Singh	Ph.D.	Principal Scientist (Horticulture) (retired on 31.03.2022)
3.	Maneesh Mishra	Ph.D.	Principal Scientist (Horticulture)
4.	Anju Bajpai	Ph.D.	Principal Scientist (Genetics & Cytogenetics)
5.	Ashish Yadav	Ph.D.	Principal Scientist (Horticulture)
6.	Harish Chandra Verma	MCA	Scientist (SG) (Computer Application)
7.	Sanjay Kumar Singh	Ph.D.	Senior Scientist (Horticulture)
8.	Muthukumar M.	Ph.D.	Senior Scientist (Biotechnology)
9.	Israr Ahmad	Ph.D.	Senior Scientist (Biotechnology)
10.	Anshuman Singh	Ph.D.	Senior Scientist (Horticulture)
12.	Vishambhar Dayal	Ph.D.	Scientist (Horticulture)
12.	Antara Das	Ph.D.	Scientist (Biotechnology) (Transferred to ICAR-IIPR, Kanpur on 17.09.2022)
13.	Swosti Suvardarsini Das	Ph.D.	Scientist (Horticulture)
14.	Amarkant Kushwaha	M.Sc.	Scientist (Genetic & Plant Breeding)
B. Division of Crop Production			
1.	P.L. Saroj	Ph.D.	Principal Scientist (Horticulture) & Head (I/c) (w.e.f. 01.08.2022)
2.	Ram Awadh Ram	Ph.D.	Principal Scientist (Horticulture) & Head (I/c) (retired on 31.07.2022)
3.	Sushil Kumar Shukla	Ph.D.	Principal Scientist (Horticulture)
4.	Dinesh Kumar	Ph.D.	Principal Scientist (Horticulture)
5.	Naresh Babu	Ph.D.	Principal Scientist (Horticulture)
6.	Kanchan Kumar Srivastava	Ph.D.	Principal Scientist (Horticulture- Fruit Science)
7.	Shyam Raj Singh	Ph.D.	Principal Scientist (Horticulture- Veg. Science)
8.	Dushyant Mishra	Ph.D.	Principal Scientist (Fruit Science)
9.	Ashok Kumar	Ph.D.	Principal Scientist (Environmental Science) (Transferred to ICAR-NRCO, Pakyong on 09.05.2022)
10.	Tarun Adak	Ph.D.	Senior Scientist (Soil Physics/Soil & Water Conservation)
11.	Sharad Kumar Dwivedi	Ph.D.	Senior Scientist (Plant Physiology)
12.	Govind Kumar	Ph.D.	Scientist (Agricultural Microbiology)
C. Division of Crop Protection			
1.	Hari Shankar Singh	Ph.D.	Principal Scientist (Agril. Entomology) & Head (I/c)
2.	Prabhat Kumar Shukla	Ph.D.	Principal Scientist (Plant Pathology)
3.	Gundappa	Ph.D.	Scientist (Agril. Entomology) (Transferred to ICAR-NBAIR, Bengaluru on 17.08.2022)
4.	Nidhi Kumari	Ph.D.	Scientist (Plant Pathology) (Transferred to ICAR-IIPR, RRS, Bhopal on 12.10.2022)

D. Division of Post Harvest Management			
1.	Neelima Garg	Ph.D.	Principal Scientist (Agril. Microbiology) & Head (I/c) (retired on 31.10.2022)
2.	Ajaya Kumar Trivedi	Ph.D.	Principal Scientist (Plant Physiology) & Head (I/c) (w.e.f. 01.11.2022)
3.	Abha Singh	Ph.D	Principal Scientist (Food & Nutrition)
4.	Bharati Killadi	Ph.D.	Principal Scientist (Hort-Veg. Science)
5.	Anil Kumar Verma	Ph.D	Scientist (SG) (FM&P)
6.	Alok Kumar Gupta	Ph.D	Scientist (Fruit Science)
7.	Karma Beer	Ph.D	Scientist (Fruit Science)
8.	Gopal Carpenter	M.Tech.	Scientist (Farm Machinery & Power)
9.	Ravi S.C.	Ph.D.	Scientist (Agricultural Economics)

Technical

S. No.	Name of the officer	Degree	Designation
1.	Sudhir Kumar Singh Raghav	Ph.D. (Agronomy)	Chief Technical Officer (Field/ Farm Tech.)
2.	Santosh Kumar	M.Sc. (Agronomy)	Chief Technical Officer (Field/ Farm Tech.) (retired on 31.07.2022)
3.	Sanjay Kumar	M.Sc. (Botany)	Chief Technical Officer (Lab. Tech.)
4.	Abhay Dixit	M.Sc. (Chemistry)	Chief Technical Officer (Lab. Tech.)
5.	Vinod Kumar Singh	Ph.D. (Botany)	Chief Technical Officer (Lab. Tech.)
6.	Anil Kumar Singh	M.Sc. (Ag.)	Chief Technical Officer (Lab. Tech.) (retired on 31.05.2022)
7.	Dharmendra Kumar Shukla	M. Tech. (Food Technology)	Chief Technical Officer (Lab. Tech.)
8.	Arvind Kumar	M.Sc. (Ag.)	Assistant Chief Technical Officer (Lab. Tech.)
9.	Brajendra Kumar	M.Sc. (Hort.)	Assistant Chief Technical Officer (Field/ Farm Tech.)
10.	Priti Sharma	M.Sc. (Botany), M. Phil.	Assistant Chief Technical Officer (Lab. Tech.)
11.	Md. Afroz Sultan	M.Sc. (Agronomy)	Technical Officer (Programme Assistant-Lab. Tech.)
12.	R.K. Mishra	High School, ITI	Technical Officer (Arts) (retired on 30.06.2022)
13.	N.C. Verma	Ph.D. (Library & Information Science)	Technical Officer (Library)
14.	Yamuna Prasad	8th	Technical Officer (Workshop-Driver) (retired on 30.06.2022)
15.	Virendra Pratap Singh	8th	Technical Officer (Workshop-Driver)
16.	Virendra Kumar Yadav	B.A.	Senior Technical Assistant (Workshop-Driver)
17.	Dhurva Kumar	B.A.	Senior Technical Assistant (Field/ Farm Tech.)
18.	Sumit Kumar Soni	Ph.D. (Biotechnology)	Technical Assistant (Lab. Technician)
19.	Mohd. Riyaz	B.Sc.	Technical Assistant (Lab. Technician)
20.	Radhey Lal	High School	Senior Technician (Field/ Farm Tech.) (retired on 31.12.2022)
21.	Satyendra Singh	B.A.	Technician (Field/ Farm Tech.)
22.	Alok Shukla	M. Sc. (Biochemistry)	Technician (Lab. Technician)
23.	Arvind Kumar Singh	M. Sc. (Biotechnology)	Technician (Lab. Technician)
24.	Monika Singh	B. Sc., M.C.A, B.Ed.	Technician (Lab. -Computer)
25.	Hemant Kumar Pandey	B.A., M.B.A.	Technician (Field/ Farm Tech.)

Administrative

S. No.	Name of the officer	Degree	Designation
1.	Sujeet Kumar Verma	M.Sc.	Senior Administrative Officer (Transferred to ICAR-IIPR, Kanpur on 08.09.2022)
2.	A. K. Yadav	LLB	Senior Administrative Officer

3.	Dhiraj Kumar Agnihottri	B.Com.	Senior Finance & Accounts Officer
4.	Rahul Bhat	B.Com., M.A. (Public Admin.)	Assistant Administrative Officer
5.	Sajeewan Lal Gautam	M.A.	Assistant Administrative Officer
6.	Gyani Prasad Mishra	Intermediate	Private Secretary
7.	Sulabh Singh Sengar	B.Tech. (Com. Sci. & Eng.)	Assistant
8.	Vijendra Singh	B.A.	Assistant
9.	Hardev Singh	B.A.	Assistant
10.	Ram Gopal	High School	Upper Division Clerk
11.	Mahendra Kumar	Intermediate	Upper Division Clerk
12.	Annapurna Gupta	B.A.	Upper Division Clerk
13.	Nitesh Kumar	B.Sc.	Stenographer Grade III
14.	Shreya Srivastava	B.Com.	Lower Division Clerk
15.	Surender	B.A.	Lower Division Clerk
16.	Kalpana Singh	B.A.	Lower Division Clerk

Skilled Supporting Staff

S. No.	Name	Designation
1.	Sanjay Kumar	Skilled Supporting Staff
2.	Maheshwari Devi	Skilled Supporting Staff
3.	Rajesh Kumar	Skilled Supporting Staff
4.	Gyan Wati	Skilled Supporting Staff
5.	Ram Bali	Skilled Supporting Staff (retired on 30.06.2022)
6.	Vishram	Skilled Supporting Staff (retired on 30.06.2022)
7.	Anand Gautam	Skilled Supporting Staff

Regional Research Station, Malda (West Bengal)

Scientific

S. No.	Name of the officer	Degree	Designation
1.	Dipak Nayak	Ph.D.	Senior Scientist (Fruit Science) & In-charge
2.	Prananath Barman	Ph.D.	Scientist (Horticulture-Fruit Science)

Technical

S. No.	Name of the officer	Degree	Designation
1.	Nabin Kumar Das	M.Sc. (Ag.)	Senior Technical Assistant (Field/ Farm Tech.)

Krishi Vigyan Kendra, Malda (West Bengal)

Scientific

S. No.	Name of the officer	Degree	Designation
1.	Dipak Nayak	Ph.D.	Senior Scientist (Fruit Science) & In-charge

Technical

S. No.	Name of the officer	Degree	Designation
1.	Shailesh Kumar	Ph.D.	Subject Matter Specialist (Fisheries)
2.	Varnayudh Vratdhari Diptikar	MCA	Senior Technical Officer (Computer)

Distinguished Visitors

1. Dr. A. D. Pathak, Director, ICAR-IISR, Lucknow, U.P. (April 05, 2022).
2. Mr. Anurag Pandey, Director, MPB Public School, Malihabad, Lucknow, U.P. (April 06, 2022).
3. Hon'ble Mr. Justice Het Singh Yadav, Allahabad High Court, U.P. (April 21, 2022).
4. Dr. Gaurav Rathore, Principal Scientist & Head, ICAR-NBFGR, Lucknow (May 10, 2022).
5. Mr. Suyash Sharma, Sr. Manager, Jagran Prakashan Ltd., Lucknow (May 19, 2022).
6. Mr. A.P. Singh, Ranaji Bio-tech Pvt. Ltd., Kanpur, U.P. (May 25, 2022).
7. Shri Ravindra Jaiswal, Hon'ble Rajya Mantri Swatantra Parbhar, U.P. (May 25, 2022).
8. Smt. Jai Devi, M.L.A. Malihabad, U.P. Lucknow, (June 01, 2022 & December 23, 2022).
9. Shri Dinesh Partap Singh, Hon'ble Minister of State (Independent Charge), Horticulture, Agricultural Marketing, Agricultural Foreign Trade and Agricultural Exports, U.P. (June 01, 2022 & June 28, 2022).
10. Padam Shri Kaleem Ullah Khan, Abdullah Nursery, Malihabad, Lucknow, (June 09, 2022 & June 27, 2022).
11. Mr. Sayar Mal Gurjar, State Coordinator-Rural Economy Partner in Prosperity, Enriching People, and Planet, New Delhi (June 13, 2022).
12. Dr. V.K. Vidyarthi, General Manager, Agricultural and Processed Food Products Export Development Authority (Ministry of Commerce & Industry, Govt. of India (June 15, 2022).
13. Mr. Mujib Mashal and Hari Kumar, South Asia Bureau Chief and Correspondent, New Delhi. (June 15, 2022).
14. Dr. R.B. Singh, Deputy Director of Agriculture, Lucknow, U.P. (June 15, 2022).
15. Dr. (Smt.). Anita Yadav, Senior Project Manager, Grameen Foundation India, Haryana (June 22, 2022).
16. Mr. Saurabh Shukla, Balaji Agro Food, Lucknow, U.P. (June 23, 2022).
17. Dr. Anitha Karun, Director, ICAR-CPCRI, Kerala (June 25, 2022).
18. Dr. Sanjay Kumar Singh, Director General, UPCAR, Lucknow, U.P. (June 28, 2022 & December 27, 2022)
19. Dr. R.B.Ram, Ex. Dean, BBAU, Lucknow. U.P. (July 05, 2022).
20. Dr. G.M Tirpathi, Ex. Principal Scientist, ICAR-IISR, Lucknow (July 05, 2022).
21. Shri. V.K. Verma, Director, MSME-Kanpur, Govt. Of India, Ministry of MSME, (July 07, 2022).
22. Dr. K.K. Tipapthi, BAIF, Lucknow, U.P. (July 08, 2022)
23. Mr. Vilas Shinde, Retd. D.F.O. Social Former, Maharashtra. (July 20, 2022).
24. Prof. N. Kumar, Former Vice-Chancellor, TNAU, Coimbatore, Tamil Nadu (July 22, 2022).
25. Dr. (Mrs.) Chandish Balal, Ex. Director, ICAR-NBAIR, Bengaluru, Karnataka (July 22, 2022).
26. Dr. A.N. Ganeshmurthy, Dean, College of Agriculture, CAU, Imphal Manipur (July 22, 2022).
27. Dr. Jai Singh, Ex. Director, ICAR CIPHET, Ludhiana (July 22, 2022)
28. Dr. Ambika B Gaikwad, Principal Scientist, Division of Genomic Resources, ICAR National Bureau of Plant Genetic Resources, New Delhi (July 22, 2022)
29. Shri Markendey Singh, Farmer, Bihar (August 10, 2022).

30. Dr. Mathura Rai, Former Director, ICAR-IIVR, Varanasi (August 23, 2022).
31. Mr. Sandeep Kr. Singh, Add. Project Manager, Uttar Pradesh Rajkiya Nirman Nigam Ltd. Lucknow, (August 24, 2022).
32. Mr. Deo Singh, MACC, Malihabad (August 25, 2022).
33. Dr. N.P. Singh, Vice Chancellor, Banda University of Agriculture, Banda, U.P. (August 26, 2022).
34. Mr. Indres Vikram Singh, Ex. M.L.A. Semir Kothi, Raebareli, U.P. (August 27, 2022).
35. Mr. Rana Singh Parihar, Program Manager Shram Bharti, Kanpur. (August 27, 2022).
36. Prof. N.B Singh, Vice Chancellor, KMC, University, Lucknow (October 09, 2022).
37. Dr. Ram Chet Chaudhary, Chairman, PRDF, Participatory Rural Développent Fondation, Gorakhpur, U.P. (October 13, 2022).
38. Dr. Indra Kumar Chaurassia,, President/ Editor, Bhartiya Patrakar Welfare Association, Lucknow (October 17, 2022)
39. Shri Maneshwara Nand, Divya Jyoti Jagrati Sansthan, Nurmahal, Punjab, (November 11, 2022).
40. Dr. Arjun Singh Saini, Director General Horticulture, Haryana (December 21, 2022).



Meteorological Parameters

January to December 2022

Month	Temperature (°C)		Humidity (%)		Sunshine (hr / day)	Wind speed (km/hr)	Wind Direction (code)	Rainfall (mm)	No of rainy days (days)	Evaporation in 24 hour (mm)
	Max	Min	Max	Min						
January	19.2	7.2	91.0	63.4	3.8	1.9	20.3	28.0	2	3.2
February	24.4	8.1	83.2	64.7	6.9	3.0	23.5	4.6	1	5.3
March	34.2	13.1	75.6	56.7	8.4	2.5	23.0	0.0	-	6.5
April	41.3	18.5	68.4	41.3	9.1	2.4	22.9	0.0	-	8.8
May	39.1	24.2	68.7	48.5	8.5	3.4	23.5	11.6	1	9.6
June	41.1	26.1	66.9	42.1	8.0	3.4	18.7	84.6	1	9.7
July	35.0	26.9	94.9	66.4	7.4	3.9	20.4	99.8	5	8.6
August	33.5	25.8	95.8	77.2	8.1	3.4	20	178	9	7.7
September	32.6	24.8	95	76.1	6.4	3.3	20.3	210.6	5	6.04
October	30.9	19.2	94.3	72.2	6.9	1.6	20.6	147.6	3	5.4
November	28.3	11.3	92.5	62.8	6.9	1.1	22.7	0.0	-	6.1
December	24.1	6.3	91.1	63.8	6.5	1.3	23.2	0.0	-	5.6
								764.8	27	

Meteorological data recorded during January to December 2022 at the Institute's observatory indicated highest and lowest mean monthly maximum temperature 41.1° C and 19.2 °C which were recorded during the month of June and January, respectively. Similarly the highest and lowest mean monthly minimum temperatures were recorded 26.9 °C and 6.3°C during the month of July and December, respectively.

Maximum and minimum relative humidity varied between 66.9 to 95.8 per cent and 41.3 to 77.2 per cent, respectively. Average wind speed of 1.1 to 3.9 km/hr and average bright sunshine hours of 3.8 to 9.1 hours were also recorded. Average range of evaporation 3.2 to 9.7 mm recorded in January and June months, respectively. Total annual rainfall of 764.8 mm received and distributed over 27 number of rainy days during the year 2022. The highest precipitation of 210.6 mm was recorded in the September month.

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

स्वच्छ भारत, समृद्ध भारत

स्वच्छ भारत

एक कदम स्वच्छता की ओर

INTERNATIONAL YEAR OF MILLETS 2023

भाकृअनुप ICAR

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केन्द्रीय उपोष्ण बागवानी संस्थान CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE

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