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वार्षिक प्रतिवेदन
Annual Report
2023

ICAR-Central Institute for Subtropical Horticulture
Rehmankhera, Lucknow

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भाकृअनुप–केन्द्रीय उपोष्ण बागवानी संस्थान
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Preface

Dr. T. Damodaran
Director

I am extremely happy to present Annual Report: 2023 of ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, PO-Kakori, Lucknow (Uttar Pradesh). 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. India contributes about half of the mango production in world. Uttar Pradesh rank first position in the total mango production of the country. The substantial increase in the mango production and productivity in the subtropics covering the states of Uttarakhand, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Jharkhand, Chhattisgarh and North Eastern Region is due to concerted and integrated efforts of the farmers, state line departments, scientists and policy planners. The ICAR-CISH has played a lead role in this direction and acting as one of the custodians of mango research in the country.

The institute holds the pride of serving as the world's largest repository of mango germplasm collections, numbering to 775 and more than 3000 hybrids are 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. The year 2023 was more rewarding for the institute, as two varieties of mango (Ambika and Arunika) and four varieties of guava (Lalit, Shweta, Dhawal and Lalima) were recommended by the State Variety Release Committee (SVRC). Also, institute has facilitated obtaining PPV & FRA registrations for 14 farmers' varieties. A Design patent has been granted for Double vertical Hydroponics systems. Besides, three patents were filed by institute which includes; A Double Decker Temporary Immersion Bioreactor, A Nutrient formulation for Hydroponic culture of Leafy vegetable and method of preparation thereof, A Nutrient formulation for Hydroponic culture of Solanaceous vegetable and method of preparation thereof. Three applications for design registration were filed which includes; Triangular Hydroponics Systems, 'Y' system tree architecture, Tier' system of tree architecture for guava cultivation under HDP. The two technology of the institute i.e. ICAR-FUSICONT and ICAR-Bioimmunizer have been approved by the Council.

The institute has also initiated massive program on integrated management of old unproductive mango orchard through canopy reconfiguration. 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. In order to reduce pesticide load integrated management strategy has been devised including solar based insect traps, release of predators, and improvement of soil health using microbial formulations. Institute has also developed various value added products and focusing to address nutrient rich diet of mid-day meal program. We have also taken initiative to develop protocol for export of mango through sea route. 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 several startups during this period. ITMU facilitated to sign 14 MoUs.

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 Dy. Director General, Dr. S. K. Singh for supporting us in all programs. I thank our Asst. Directors General, Dr. V. B. Patel and Dr. Sudhakar Pandey for their support. Due acknowledgments to all the scientists, technical, supporting and administrative staffs of the institute for bringing out significant accomplishments. Special thanks are due to members of editorial board for bringing out annual report 2023.

Place: Lucknow
Date: July, 2024

(T. Damodaran)

Content

कार्यकारी सारंश / Executive Summary

वर्ष 2023 संस्थान के लिए अत्यंत लाभप्रद रहा। वार्षिक प्रतिवेदन की अवधि के दौरान, आम की दो किस्मों (अंबिका और अरुणिका) और अमरूद की चार किस्मों (ललित, श्वेता, धवल और लालिमा) को व्यावसायिक खेती के लिए राज्य किस्म विमोचन समिति (एसवीआरसी) द्वारा अनुशंसित किया गया। इन दो आम किस्मों (सीआईएसएच–अंबिका और सीआईएसएच–अरुणिका) को पीपीवी एवं एफआरए पंजीकरण प्रमाणपत्र प्राप्त हुए। इसके अलावा, संस्थान ने 14 किसानों की किस्मों के लिए पीपीवी एवं एफआरए पंजीकरण प्राप्त करने में सहायता प्रदान की। वर्ग 15–03 (399867–001) में "डबल वर्टिकल हाइड्रोपोनिक्स सिस्टम" के लिए एक डिज़ाइन पेटेंट प्राप्त हुआ। इसके अतिरिक्त संस्थान द्वारा तीन पेटेंट नामतः "डबल डेकर अस्थायी विसर्जन बायोरिएक्टर" (202311038991), पत्तेदार सब्जी के हाइड्रोपोनिक कल्चर हेतु एक पोषक तत्व निर्माण एवं इसे बनाने की विधि (202411024413) तथा सोलेनेसियस सब्जी के हाइड्रोपोनिक कल्चर हेतु एक पोषक तत्व निर्माण एवं इसे बनाने की विधि (202411024413) दायर किये गये। पेटेंट, डिजाइन और ट्रेडमार्क कार्यालय, नई दिल्ली में डिजाइन पंजीकरण के लिए तीन आवेदन [(त्रिकोणीय हाइड्रोपोनिक्स सिस्टम (399868–001), 'वाई' सिस्टम ट्री आर्किटेक्चर, (399865–001), एचडीपी के तहत अमरूद की खेती के लिए ट्री आर्किटेक्चर का टियर सिस्टम (399866–001)] दायर किये गये। इसके साथ–साथ पंजीकरण के लिए प्रस्तुत तीन ट्रेडमार्क आवेदन [हॉर्टइंड एबीआईसी, लोगो (6260921), उद्यानोदय का डिवाइस मार्क (6260922) एवं उद्यानोदय कार्यक्रम का लोगो (6260923)

किये गये जो 2023 के दौरान ट्रेडमार्क जर्नल में प्रकाशित हुए। संस्थान की दो प्रौद्योगिकियां (आईसीएआर–फ्यूजीकांट एवं आईसीएआर–बायोइम्यूनाइजर) को परिषद द्वारा अनुमोदित किया गया। सीआईएसएच–बायोइनहान्सर, सीआईएसएच–डीकम्पोजर प्रौद्योगिकी का व्यावसायीकरण मेसर्स नेचर ग्रीन बायोम, नई दिल्ली एवं खंडेलवाल बायोफर्टीलाइजर प्रा0 लि0, कर्नाटक को किया गया। जे0 यू0 एग्री साइंस प्रा0 लि0, नोएडा को अनुबंध सेवा प्रदान की गयी।

प्रतिवेदन की अवधि के दौरान, संस्थान में 34 इन–हाउस परियोजनाओं और 45 बाह्य वित्त पोषित परियोजनाओं

The year 2023 was more rewarding for the institute. During the period under report, two varieties of mango (Ambika and Arunika) and four varieties of guava (Lalit, Shweta, Dhawal and Lalima) were recommended by the State Variety Release Committee (SVRC) for commercial cultivation. PPV& FRA registration certificate was received for these 2 mango varieties i.e. CISH-Ambika and CISH-Arunika. Also, institute has facilitated obtaining PPV & FRA registrations for 14 farmers' varieties. A Design patent has been granted for "Double vertical Hydroponics systems" in class 15-03 (399867-001). Besides, three patents were filed by institute which includes; A Double Decker Temporary Immersion Bioreactor (202311038991), A Nutrient formulation for Hydroponic culture of Leafy vegetable and method of preparation thereof (202411024413), A Nutrient formulation for Hydroponic culture of Solanaceous vegetable and method of preparation thereof (202411024413). Three applications for design registration were filed with Patents, Designs and Trademarks office, New Delhi which includes; Triangular Hydroponics Systems (399868-001), The 'Y' system tree architecture, (399865-001), Tier' system of tree architecture for guava cultivation under HDP (399866-001). Furthermore, three trademark applications HortiInd ABIC, Logo (6260921), Device Mark of UDYANODAYA (6260922) and Logo of the Udyanodya Programme (6260923) submitted for registration were published in trademark journal during 2023. The two technology of the institute i.e. ICAR-FUSICONT and ICAR-Bioimmunizer have been approved by the Council.

During the period under report, 09 major programmes having 34 in house projects and 45 externally funded projects were executed in the institute including its regional station Malda, West Bengal. In genetic resource management of mango, a total of 775 mango accessions are maintained in the field gene bank. Nutraceuticals profiling of 55 mango hybrids was done. The total carotenoid content (mg/100g) was highest in H-3924 (12.29mg/100g) and lowest in H-2073 (1.06 mg/100g). The 55 mango hybrids were classified into four groups based on their total carotenoid content. The majority of the hybrids (26) fall into the range of 1.06-4.26 mg/100g. The total phenol content of the 55 mango hybrids was classified into six groups, with the majority of hybrids (25) falling in the range of 28.41-44.41 mg GAE/100g. Total flavonoid content varied from 5.00 mg QE/100g (H-3790,

वाले 09 प्रमुख कार्यक्रम निष्पादित किए गए, जिसमें इसका क्षेत्रीय स्टेशन मालदा, पश्चिम बंगाल भी शामिल है। आम के आनुवंशिक संसाधन प्रबंधन में, फील्ड जीन बैंक में कुल 775 आम की प्रजातियां अनुरक्षित हैं। 55 आम संकर किस्मों की न्यूट्रास्युटिकल्स प्रोफाइलिंग की गई। कुल कैरोटीनॉयड सामग्री (मिलीग्राम/100 ग्राम) एच–3924 में सबसे अधिक (12.29 मिलीग्राम/100 ग्राम) एवं एच–2073 में सबसे कम (1.06 मिलीग्राम/100 ग्राम) पायी गयी। कुल कैरोटीनॉयड सामग्री के आधार पर 55 आम संकर किस्मों को चार समूहों में वर्गीकृत किया गया। अधिकांश संकर (26) 1.06–4.26 मिलीग्राम/100 ग्राम की सीमा में पाये गये। 55 आम संकर किस्मों की कुल फिनोल सामग्री को छह समूहों में वर्गीकृत किया गया, जिसमें अधिकांश संकर (25) 28.41–44. 41 मिलीग्राम जीएइ/100 ग्राम की सीमा में थे। कुल फ्लेवोनॉयड सामग्री 5.00 मिलीग्राम क्यूइ/100 ग्राम (एच–3790, एच–3966) से 43 मिलीग्राम क्यूइ/100 ग्राम (एच–3925) तक भिन्न थी। आम के अधिकांश संकर (20) कुल फ्लेवोनोइड श्रेणी 19.80–27.20 मिलीग्राम क्यूइ/100 ग्राम में आते हैं। आम के संकरों के बीच कुल एंटीऑक्सीडेंट सामग्री में काफी भिन्नता थी, जो 0.04 मिमी ट्रोलॉक्स/100 ग्राम (एच–4065) से लेकर 1.17 मिमी ट्रोलॉक्स/100 ग्राम (एच–1076) तक थी। अधिकांश संकर (21) कुल एंटीऑक्सीडेंट श्रेणी 0.42–0. 61 मिमी ट्रोलॉक्स/100 ग्राम में आते हैं। 55 आम संकरों के न्यूट्रास्यूटिकल गुणों के लिए पीसीए विश्लेषण ने दर्शाया कि दो संकर (एच–3925 और एच–1076) अलग–अलग हैं, जिनमें अद्वितीय न्यूट्रास्यूटिकल प्रोफाइल पाया गया। इन जीनोटाइप का उपयोग भविष्य के प्रजनन कार्यक्रमों में उन्नत न्यूट्रास्यूटिकल गुणों के साथ नई आम किस्मों को विकसित करने के लिए किया जा सकता है।

2023 के दौरान, कुल 202 संकरों का फल भार, फल लंबाई, फल चौड़ाई, बीज वजन, बीज लंबाई, बीज चौड़ाई, बीज मोटाई, टीएसएस एवं गूदे के प्रतिशत हेतु मूल्यांकन किया गया। फल के भौतिक मापदंडों के लिए, संकरों ने परिवर्तनशीलता की एक विस्तृत श्रृंखला दिखाई। फलों का वजन 97.0–790.0 ग्राम तक पाया गया, जिसका औसत 305.90 ग्राम था।

अधिकांश एक्सेशन्स में फलों का वजन 200–250 ग्राम तक पाया गया। गूदे का प्रतिशत एक महत्वपूर्ण पैरामीटर पाया गया, जो 55.07–85.67 प्रतिशत के बीच था, जिसमें

H-3966) to 43 mg QE/100g (H-3925). The majority of mango hybrids (20) fall in the total flavonoid range of 19.80-27.20 mg QE/100g. The total antioxidant content varied significantly between mango hybrids, ranging from 0.04 mM Trolox/100g (H-4065) to 1.17 mM Trolox/100g (H-1076). The majority of hybrids (21) fall in the total antioxidant range of 0.42-0.61 mM Trolox/100g. PCA analysis of 55 mango hybrids for their nutraceutical attributes illustrated that two hybrids viz., H-3925 and H-1076 are outliers, possessing unique nutraceutical profiles. These genotypes can be used in future breeding programs to develop new mango varieties with enhanced nutraceutical properties.

During 2023, a total 202 hybrids were evaluated for fruit weight, fruit length, fruit breadth, stone weight, stone length, stone breadth, stone thickness, TSS and pulp percent. For fruit physical parameters, the hybrids showed a wide range of variability. The fruit weight ranged from 97.0 g to 790.0 g, with a mean of 305.90 g. Fruit weight in the maximum accessions ranged from 200 g to 250g. The pulp percentage was found to be an important parameter, ranging from 55.07 percent to 85.67 percent with average pulp percent 71.55. Most of the hybrids have around 70 percent pulp. The TSS ranged from11.40°B to 25.20B with mean 17.98°B. Besides, evaluation data of 59 accessions indicated the wide variability in various parameters such as fruit weight, fruit length, fruit breadth, stone weight, TSS, and pulp percent. The fruit weight ranged from 73g to 1233 g, with a mean of 388.51g. The pulp percent ranged from 48.61percent to 82.49 percent with a mean of 72.57 percent. Pulp TSS was found to be in range from 11.45°B to 28.40°B. In molecular characterization of mango hybrids, 09 SSR markers mined from transcriptome data (unpublished) representing putatively associated with flowering, color, sugar transport and cellular metabolism were utilized for characterizing and fingerprint selected elite hybrids derived from Dashehari x Tommy Atkins and Dashehari x Eldon. Of these nine, *MiSSRCM133*, *MiSSRCL64* and *MiSSRFL18* were able to differentiate the hybrids. In hybridization programme, using 17 different cross combinations, 36166 flowers were crossed on 7925 panicles. As a result, 154 mango hybrids fruits were obtained from the crosses made during 2022-2023, however, only 103 stones germinated. A separate hybrid block for 26 promising hybrids has been established for multiplication of plants and large-scale availability of scions. The work on rootstock improvement was also initiated.

Germplasm collections in guava, bael, aonla were made in different hot spot areas and augmented in the field

औसत गूदा प्रतिशत 71.55 था। अधिकांश संकरों में लगभग 70 प्रतिशत गूदा होता है। कुल घुलनशील शर्करा (टीएसएस) 11.40–25.20 डिग्री ब्रिक्स के बीच था, जिसका औसत 17.98 डिग्री ब्रिक्स था। इसके अलावा, 59 एक्सेशन्स के मूल्यांकन डेटा ने विभिन्न मापदंडों जैसे फल वजन, फल लंबाई, फल चौड़ाई, बीज वजन, टीएसएस एवं गूदे के प्रतिशत में व्यापक परिवर्तनशीलता का संकेत दिया। फल का वजन 73–1233 ग्राम के बीच था, जिसका औसत 388.51 ग्राम था। गूदे का प्रतिशत 48.61–82.49 प्रतिशत के बीच था, जिसका औसत 72. 57 प्रतिशत था। गूदे का टीएसएस 11.45–28.40 डिग्री ब्रिक्स के बीच पाया गया। आम के संकरों के आणविक लक्षण वर्णन में, ट्रांसक्रिप्टोम डेटा (अप्रकाशित) से निकाले गए 09 एसएसआर मार्कर्स का उपयोग, जो कथित रूप से पुष्पन, रंग, शर्करा परिवहन और कोशिकीय चयापचय से जुड़े हैं, का उपयोग दशहरी X टॉमी एटकिन्स और दशहरी X एल्डन से प्राप्त चयनित उत्कृष्ट संकरों के लक्षण वर्णन और फिंगरप्रिंट के लिए किया गया। संकरण में 17 विभिन्न क्रॉस संयोजनों का उपयोग करते हुए 7925 पुष्पगुच्छों पर 36166 फूलों का संकरण किया गया। परिण ामस्वरूप, 2022–2023 के दौरान किए गए संकरण से 154 आम संकर फल प्राप्त हुए, हालांकि, केवल 103 गुठली ही अंकुरित हुई। पौधों के गुणन और बड़े पैमाने पर कलमों की उपलब्धता हेतु 26 आशाजनक संकरों के लिए एक अलग संकर ब्लॉक स्थापित किया गया, साथ ही रूटस्टॉक सुधार पर भी काम शुरू किया गया।

विभिन्न हॉट स्पॉट क्षेत्रों में अमरूद, बेल, आंवला के जर्मप्लाज्म संग्रह कर फील्ड जीन बैंक में संवर्धित किए गए। एसएनपी मार्कर्स और फेनोटाइपिंग डेटा का उपयोग करके आम में जीनोम वाइड एसोसिएशन विश्लेषण के परिणामस्वरूप फल की गुणवत्ता के लक्षणों के साथ महत्वपूर्ण रूप से संबद्ध मार्कर्स की पहचान हुई। जामुन, बेल और आंवला में नए एसएसआर मार्कर विकसित किए गए और डीएनए फिंगरप्रिंटिंग के लिए पीसीआर परख का उपयोग करके मान्य किया गया। एक नया डबल डेकर, स्व–प्रकाशित टीआईएस बायोरिएक्टर डिजाइन और विकसित किया गया। सीआईएसएच द्वारा विकसित टीआईएस बायोरिएक्टर प्रणाली की तुलना केले की किस्म जी–9 के जैव–प्रतिरक्षित पौधों के जैव प्रवर्धन हेतु ठोस चरण ऊतक संवर्धन प्रणाली से की गई। 'क्विक लीफ एरिया– तीव्र एवं सटीक पत्ती क्षेत्र मापक सॉफ्टवेयर' को परिष्कृत और मान्य किया गया। 'क्विक लीफ–एलडब्ल्यूए

gene bank. Genome wide association analysis in mango using SNP markers and phenotyping data resulted in identification of significantly associated markers with fruit quality traits. Novel SSR markers were developed in Jamun, Bael and Aonla and validated using PCR assay towards DNA fingerprinting. A novel double decker, self illuminated TIS bioreactor was designed and developed. 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 'Quick Leaf Area- Fast and accurate leaf area measurement software', which was refined and validated. Quick Leaf_LWA v.1.02' was developed. An attempt was made using GIS tools for classification and change detection of mango cropped area by Remote Sensing Data of Puralia region to explore possibility of mango introduction/ area expansion.

A package of Refined Mango Rejuvenation Technology was developed which involves thinning out of centrally located branch and heading back of two opposite branches and completing the process of cutting over a period of three years. This was found to be the best method to rejuvenate old and unproductive mango trees. On farm trial on evaluation of different methods of rejuvenation technology was laid out on farmer's field in village Hannikhera, Mall block, Lucknow in Refined CISH Rejuvenation technology showed and heading back treatments showed better results. The Bagging treatments were imposed after four week of fruit set in Dashehari, Amrapali and Arunika mango under HDP. Bagging of fruits significantly enhanced fruit quality in terms of uniformity in skin colour, firmness, TSS and TSS/acid ratio. A farmer from Bhadeshar Mau who grew turmeric in association with pigeonpea and got 400 kg of turmeric produce from 40 kg seed turmeric. Guava yield and qulaity was found to be enhanced through Espalier architecture. in cv. CISH-Lalit, CISH-Shweta and CISH-Lalima. Organic carbon recorded maximum (0.56%) in T1 and 0.51% in T5 treatment in an experiment on Input use efficiency under high density planting in guava. Highest plant diameter was recorded with vertical bed system followed by horizontal bed system in soilless culture of vegetables.

Survey of mango orchards was conducted in 22 districts in UP and blossom blight, powdery mildew, anthracnose, floral malformation, sooty mould and wilt were reported as the major diseases; and dieback, twig drying, red rust, bacterial blight were minor ones. Survey of guava orchards was conducted in 15 districts and 37.03% orchards were found infested with root-knot nematode. Incidence of anthracnose

वी.1.02' विकसित किया गया। आम की शुरूआत/क्षेत्र विस्तार की संभावना का पता लगाने के लिए पुरलिया क्षेत्र के रिमोट सेंसिंग डेटा द्वारा आम की फसल वाले क्षेत्र के वर्गीकरण और परिवर्तन का पता लगाने के लिए जीआईएस उपकरणों का उपयोग करने का प्रयास किया गया।

आम के परिष्कृत जीर्णोद्धार प्रौद्योगिकी का एक पैकेज विकसित किया गया, जिसमें केंद्र में स्थित एक शाखा को छांटना एवं दो विपरीत शाखाओं को शीर्ष से काटना और तीन वर्षों की अवधि में काटने की प्रक्रिया को पूरा करना शामिल है। पुराने और अनुत्पादक आम के पेड़ों को फिर से जीवंत करने का यह सबसे अच्छा तरीका पाया गया। जीर्णोद्धार प्रौद्योगिकी के विभिन्न तरीकों के मूल्यांकन पर फार्म परीक्षण लखनऊ के मॉल ब्लॉक के हन्नीखेड़ा गाँव में किसान के खेत पर परिष्कृत सीआईएसएच जीर्णोद्धार तकनीक ने बेहतर परिणाम दिखाए। सघन बागवानी के तहत दशहरी, आम्रपाली और अरुणिका आम में फल लगने के चार सप्ताह बाद थैलाबंदी (बैगिंग) उपचार किया गया। फलों की बैगिंग से छिलके के रंग, दृढ़ता, टीएसएस और टीएसएस/अम्ल अनुपात में एकरूपता के मामले में फल की गुणवत्ता में काफी वृद्धि हुई। भदेसर मऊ के एक किसान ने 40 किलोग्राम हल्दी के बीज द्वारा हल्दी के साथ अरहर की खेती द्वारा 400 किलोग्राम हल्दी की पैदावार की। अमरूद की सी.आई.एस.एच.–ललित, सी.आई.एस.एच.–श्वेता और सी.आई.एस.एच.–लालिमा किस्मों में स्पेलियर आर्कीटेक्चर तकनीक द्वारा उपज और गुणवत्ता में वृद्धि पायी गयी। अमरूद में उच्च घनत्व वाले रोपण के तहत इनपुट उपयोग दक्षता के एक प्रयोग में टी1 में कार्बनिक कार्बन अधिकतम (0.56 प्रतिशत) और टी5 में 0.51 प्रतिशत दर्ज किया गया। सब्जियों की मिट्टी रहित प्रणाली में ऊर्ध्वाधर बेड प्रणाली में क्षैतिज बेड प्रणाली की तुलना में पौधे का उच्चतम व्यास दर्ज किया गया।

उत्तर प्रदेश के 22 जिलों में आम के बागों का सर्वेक्षण किया गया और पाया गया कि आम के बागों में मुख्य रोग बौर झुलसा, चूर्णी फफूंद, एन्थ्रेक्नोज, पुष्प विकृति, कालिखी फफूंदी और विल्ट थे; तथा डाईबैक, टहनी सूखना, लाल जंग, जीवाणु झुलसा मामूली रोग थे। प्राकृतिक खेती के प्रयोग के तहत कीटों और बीमारियों के खिलाफ बेवॉवेरिया बेसियाना, मेटारिज़ियम रॉबर्टसी, ट्राइकोडर्मा हर्ज़ियानम, बैसिलस एमाइलोलिक्विफेसिएन्स, fruit spots were recorded on about 25.0% fruits and Cercospora fruit spot on 12.5% fruits during rainy season crop. Incidence of wilt and decline was recorded around 2.1 and 16.5 percent respectively. Fixed plot observations indicated moderate incidence and low severity of powdery mildew; and low incidence and severity of blossom blight on mango cv. Dashehari. However, incidence and severity of shoulder browning disease of mango cv. Mallika fruits was recorded high (100% and 46.2 PDI respectively) in fixed orchard.

Evaluation of cow based organic products and bio-control agents along with pesticides against insect-pests and diseases of mango done in an orchard of 7 years old trees of mango cv. Amrapali by spraying at critical stages indicated that the spray with Bevauveria bassiana, Metarhizium robertsii, Trichoderma harzianum, Bacillus amyloliquifaciens, Agniyashtra, Bramhashtra, Dashparni Ark, and neem oil were effective against the insect pests and diseases. Evaluated the role of transplanting depth on root-knot disease development in guava and found Fluopyrum highly effective in eliminating the nematode infection in roots irrespective of the depths of planting. Reduction in root-knot index was recorded with increase in depth in other treatments. Evaluation under controlled and infected field conditions indicated that the efficacy of Trichoderma harzaianum was better than Bacillus amyloliquefaciens against Ceratocystis fimbriata and Berkeleomyces basicola.

Mango mealy bug, mango hopper, inflorescence midge, black inch worm (emerging), mango leaf webber, inflorescence web worm, Gatesclarkeana sp. (emerging), Dudua sp(emerging), mango leaf cutting weevil, oriental fruit fly mango shoot borer and guava shoot borer were found to infest the crop with different degree of damage as per weekly pest record data. The incidence of thrips was low as compared to previous years. Mango varietal screening against looper (Hyposidra talaca) in 20 mango varieties indicated its highest incidence on Langra. Nine number of different host plants of Hyposidra talaca were recorded during the year.

Methodology for the monitoring the soil pupating panicle midge in mango field through ground polythene sheet was developed. The sapling device of soil arthropod complex has been designed and under development process. Among the new tools and devices for pest management, Auto rotating sticky light trap, Modified web remover (under testing), Multi-layered and dual-coloured glue trap (modified CISH glue trap), pesticky trolley (under testing) and self perpetuating parasite cage were designed and tested.

अग्नियास्त्र, ब्रम्हष्ट्र, दशपर्णी अर्क और नीम के तेल का छिड़काव प्रभावी पाया गया। मिली बग, हॉपर, पुष्पक्रम मिज, काला इंची कीट (उभरता हुआ), आम का पत्ता जाल, पुष्पक्रम जाल कीट, गेट्सक्लेरकेना प्रजाति (उभरता हुआ), दुदुआ प्रजाति (उभरता हुआ), आम का पत्ता काटने वाला घुन, ओरिएंटल फल मक्खी, आम का अंकुर छेदक और अमरूद का अंकुर छेदक फसल को अलग–अलग स्तर पर नुकसान पहुंचाते पाए गए। आम के खेत में मिट्टी में पॉलीथीन शीट के माध्यम से प्यूपेटिंग पैनिकल मिज की निगरानी के लिए कार्यप्रणाली विकसित की गई। मिट्टी के आर्थ्रोपोड कॉम्प्लेक्स के सैपलिंग डिवाइस, ऑटो रोटेटिंग स्टिकी लाइट ट्रैप, संशोधित वेब रिमूवर (परीक्षण के तहत), मल्टी–लेयर्ड और दोहरे रंग के ग्लू ट्रैप (संशोधित सीआइएसएच–ग्लू ट्रैप), पेस्टिकी ट्रॉली (परीक्षण के तहत) और सेल्फ परपेचुएटिंग पैरासाइट केज को डिजाइन और परीक्षण किया गया।

वाष्पशील सुगंध, आम के फलों की पकने की गुणवत्ता से संबंधित विशेषता और साथ ही उपभोक्ता वरीयता हेतु आम और अमरूद के वाणिज्यिक किस्मों जिन्हें एंटी राइपनर–1 एवं एंटी राइपनर–2 के साथ उपचारित किया गया था उसमें शेल्फ लाइफ वृद्धि हेतु उत्साहजनक परिण ाम प्राप्त हुए। आम से शराब बनाने की एक नई विधि को मानकीकृत किया गया जिसमें 11 प्रतिशत अल्कोहल था। आम का आंवला प्राश आम के गूदे को आंवला जूस, आंवला पोमेस तथा मसालों के साथ मिलाकर तैयार किया गया। आम की गिरी से मक्खन निकालने की प्रक्रिया को मानकीकृत किया गया। 0.02 प्रतिशत हेक्सानल के साथ उपचारित एवं सफेद गैर–बुने हुए बैग में पैक किए गए फलों की शेल्फ लाइफ अधिकतम पायी गयी। दशहरी आम के फलों के निर्यात हेतु एक प्रोटोकॉल विकसित किया गया जिसमें आम को एक विशिष्ट अवधि के लिए 2.5 प्रतिशत मेट वॉश घोल में डुबोकर 13 डिग्री सेल्सियस पर संग्रहीत किया गया, जिससे शेल्फ लाइफ में 35 दिनों की बढ़ोत्तरी के साथ गुणवत्ता पैरामीटर बेहतर पाए गए। कोलेटोट्रीकम ग्लोओस्पोरियोइड्स के पैथोजेनिक आइसोलेट में इन विट्रो स्थितियों के तहत मेट वॉश की प्रभावकारिता पर किये गये प्रयोग में पाया गया कि 2.5 प्रतिशत मेट वॉश रोगाणु के दमन में प्रभावी था और शेल्फ लाइफ को 27 दिनों तक बढ़ाने में कारगर है। मैंगिफेरिन युक्त माइक्रोएनकैप्सुलेशन / माइक्रोस्फीयर / कोएसेरवेशन फॉर्मूलेशन की तैयारी और विशेषता

Among non pesticide options, water soluble polymers (glue) and entomopathogenic fungi against thrips and various concentration of soap against mango leaf webber were evaluated but their efficacy was not much satisfactory. Efficacy of Glue (water soluble polymers) and Entomopathogenic fungi (Beauvaria bassiana & Metarhizium anisopliae) against hopper in organic mango orchard was found to be unsatisfactory.

Tree height reduction through lower branches girdling in September followed by heading back in late October at the uniform height of 17 feet gave new flush in November. The orchard was bio-intensified with flowering plants, well nourished with organic matter, application of non pesticide tools and regulated irrigation. The monitoring of insect pests and the soil emerging insects in the orchard was carried out. There was low incidence of trunk borer with 100 percent survival of headed back trees. Three feet deep water channel between two rows of trees in the experimental plot (for irrigation/ drainage), planted both the sides with marigold, lilly and justicea served as early indicator of mango pests and also as shelter for natural enemies.

Volatile aroma that is characteristic to mango commercial cvs were characterized. Mango and guava treated with anti ripener I) anti ripener II showed encouraging results in enhancing shelf life. A novel method of wine production from mango was standardized which had 11% alcohol. Mango aonla prash was prepared by blending mango pulp with aonla juice industry waste (aonla pomace) and spices. The procedure for extracting mango kernel butter has been standardized. The fruits treated with 0.02% hexanal and packaged in white non-woven bags had a shelf life. A protocol was developed for the export of mango fruits cv. Dasheahri, where it was dipped in 2.5 % MET WASH solution for a specific period and stored at 13 °C. The quality parameters was found to be superior with enhanced shelf life for nearly 35 days. The experiment on efficacy of MET WASH was initially conducted under in vitro conditions pathogenic isolate of Colletotrichum gloeosporioides. It was found that 2.5 % of MET WASH was effective in suppressing the pathogen and enhances the shelf life upto 27 days. A protocol for preparation and characterization of Microencapsulation/Microsphere/ Coacervation formulation containing Mangiferin was developed and is submitted for patenting. Guava Churan, nutribite, Karonda Juice-Fortified Aonla Candy were prepared and evaluated for storage and organoleptic test. A protocol for development of Bael Aonla blended low sugar RTS was developed.

के लिए एक प्रोटोकॉल विकसित कर पेटेंट के लिए प्रस्तुत किया गया। अमरूद चूरन, न्यूट्रीबाइट, करौंदा जूस–फोर्टिफाइड आंवला कैंडी उत्पाद तैयार कर भंडारण और ऑर्गेनोलेप्टिक परीक्षण के लिए मूल्यांकित किये गये। बेल, आंवला मिश्रित कम शुगर आरटीएस हेतु प्रोटोकाल विकसित की गयी।

l;idl vkj lg;kx

संस्थान ने 2023 के दौरान विभिन्न संगठनों, विश्वविद्यालयों, एजेंसियों, समाजों और उद्यमियों के साथ 27 संपर्क और सहयोग स्थापित किए गये। वर्ष के दौरान बिहार स्टेट बायोडायवर्सिटी बोर्ड, पटना; महाकेसर मैंगो भागीदार संघ, महाराष्ट्र; भारत भू–सर्वेक्षण, लखनऊ; अग्रणी नियो फार्मर्स प्रोड्यूसर कंपनी लिमिटेड, मालदा; आलोकिनी फार्मर्स प्रोड्यूसर कंपनी लिमिटेड, मालदा; नेचर ग्रीन बायोम, नई दिल्ली; इनोवा एग्री बायो पार्क प्रा0 लि0, कर्नाटक; जिला ग्रामीण विकास प्रकोष्ठ, मलदा; मेसर्स खंडेलवाल बायोफर्टीलाइजर्स, कर्नाटक; पीपीवी एवं एफआरए, नई दिल्ली; कृषि विज्ञान केन्द्र, धौरा, उन्नाव; भारतीय मौसम विज्ञान विभाग, नई दिल्ली; चन्द्रशेखर आजाद कृषि एवं प्रौद्योगिकी विश्वविद्यालय, कानपुर एवं आइटीएम यूनीवर्सिटी, ग्वालियर के साथ 14 समझौता ज्ञापनों पर हस्ताक्षर किए गए।

vU; xfrfofèk;k¡

आईसीएआर–सीआईएसएच ने 2023 के दौरान स्टेक होल्डर्स मीट (2) और उद्यमिता विकास कार्यक्रम (2) आयोजित किए। संस्थान के वैज्ञानिकों ने 10 विभिन्न विश्वविद्यालयों एवं 3 संस्थानों के स्नातक, परास्नातक एवं पी.एच.डी. के लिए 46 छात्र–छात्राओं को उनके शोध प्रबंध कार्य में मार्गदर्शन किया।

Linkages and Collaborations

Institute has established reasonable linkages and collaborations with the different organizations, universities, agencies, societies and entrepreneurs during 2023. Over all 14 MoU/MoAs were signed between the ICAR-CISH and other stakeholders.

Consultancies, IP Protection and Technology Commercialization

ICAR-CISH filed 3 patents, 4 designs (1 registered), 6 copyrights (3 RoC generated), and 3 trademarks and facilitated framers to the registration of 14 farmers' mango varieties. ITMC/VTIC of ICAR-CISH, Lucknow organized 6 Meetings in which 3 varieties/ technologies were identified. Three technology licenses were given to 4 different licensees during this period. Two contract cum collaborative research proposals were initiated with Ju-Agriscience Ltd. and Innova Food Park for different-different research works. Two IP awareness programmes were organized.

Other Activities

ICAR-CISH organized a number of Gostis, stake holders meet and entrepreneurship development programs during 2023. The institute organized training programmes in which >200 stakeholders (farmers, enterpreneurs, students) were trained from different states. The institute scientists have guided in students in their dissertation work for M.Sc and Ph.D from 5 different Universities. A number of our scientists attended advanced training courses in other institutes for professional development. Dr. T. Damodaran, Director ICAR-CISH, Lucknow delivered series of talks in different platforms regarding horticulture research and development as well as the accomplishments of the Institute in horticulture sector. A farmer–scientist interaction meets were organized during 2023 both in main centre ICAR-CISH, Lucknow and Regional Research Station, Malda, West Bengal.

3A Crop Improvement and Biotechnology

Mango (*Mangifera indica* L.)

Collection

During the year 2023, one farmers' variety was collected and planted in the field gene bank.

Field gene bank

A total of 775 mango accessions were maintained in the field gene bank. Gaps in the field gene bank were filled, and 49accessions were multiplied for planting.

Characterization

Profiling of major nutraceuticals in mango hybrids

A total of 55 mango hybrids were assessed for total phenols, total flavonoids, total carotenoids, and total antioxidants (Fig. 1). The total carotenoid content (mg/100g) was the highest in H-3924 (12.29 mg/100 g) and lowest in H-2073 (1.06 mg/100 g). The 55 mango hybrids were classified into four groups based on their total carotenoid content. The majority of the hybrids (26) fall into the range of 1.06-4.26 mg/100 g. Based on total phenol content, 55 mango hybrids were classified into six groups, with the majority of hybrids (25) falling in the range of 28.41-44.41 mg GAE/100 g. The total phenol content was the highest in H-1076 (95.79 mg GAE/100 g) and lowest in H-3491 (12.41 mg GAE/100g). Total flavonoid content varied from 5.0 mg QE/100 g (H-3790, H-3966) to 43.0 mg QE/100 g (H-3925). The majority of mango hybrids (20) fall in the total flavonoid range of 19.80-27.20 mg The total antioxidant content varied significantly between mango hybrids, ranging from 0.04 mM Trolox/100 g (H-4065) to 1.17 mM Trolox/100 g (H-1076). The majority of hybrids (21) fall in the total antioxidant range of 0.42-0.61 µM Trolox/100 g.

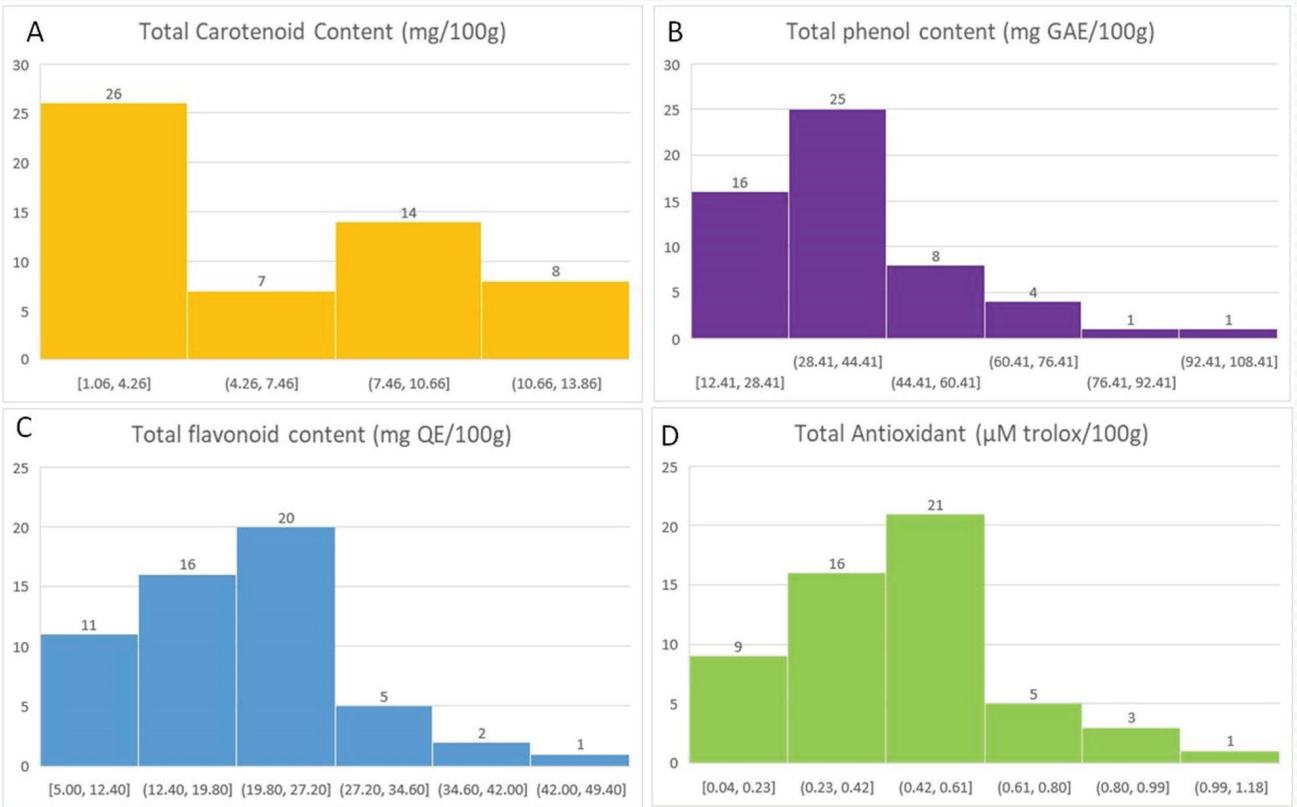


Fig. 1 Distribution of mango hybrids for different biochemical traits. A) total carotenoid content, B) total phenol content, C) total flavonoid content, D) total antioxidants

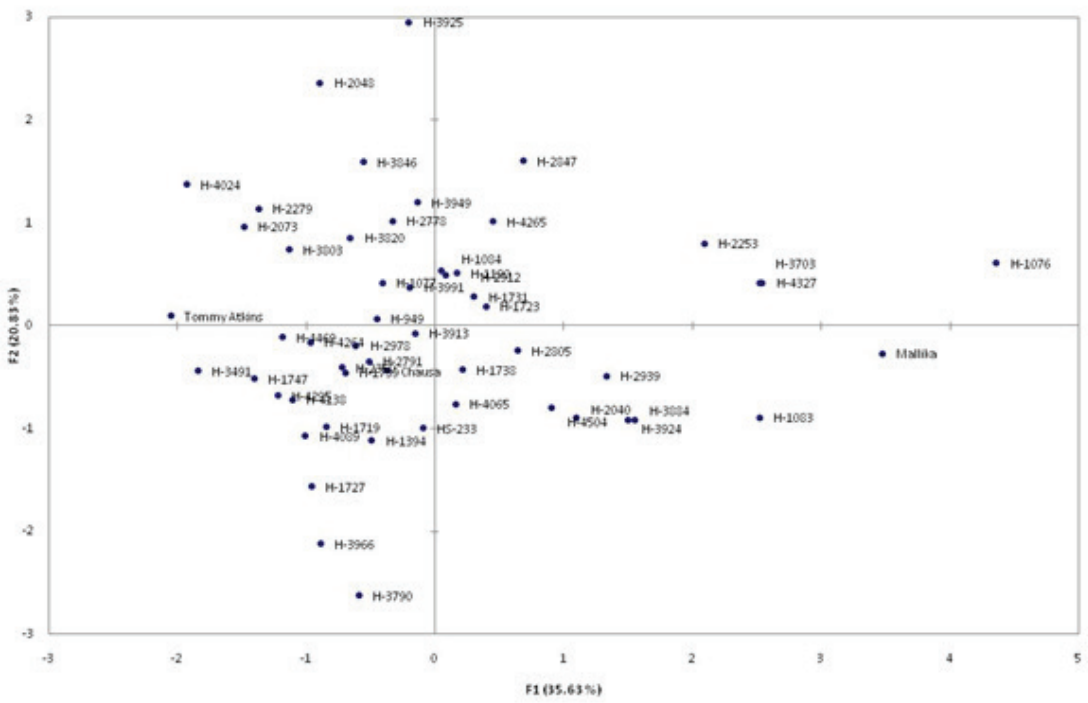


Fig. 2 PCA Biplot of mango hybrids for their nutraceutical attributes

The PCA biplot (Fig. 2) of 55 mango hybrids for their nutraceutical attributes illustrates that hybrids such as H-3925 and H-1076 are outliers, possessing unique nutraceutical profiles. These genotypes can be used in future breeding programs to develop new mango varieties with enhanced nutraceutical properties.

Clustering based on metabolite profiling of mango

Clustering based metabolite profiling of promising mango hybrids and varieties was carried out (Fig. 3).

Documentation of germplasm

Evaluation

Evaluation data of 59 accessions indicated wide variability in various parameters such as fruit weight, fruit length, fruit breadth, stone weight, TSS, and pulp content. The weight of fruit differed most significantly. The fruit weight ranged from 73g to 1233 g, with a mean of 388.51g. Fruit weight in the maximum accessions ranged from 300 to 325 g. The pulp percent ranged from 48.61 to 82.49 percent with a mean of

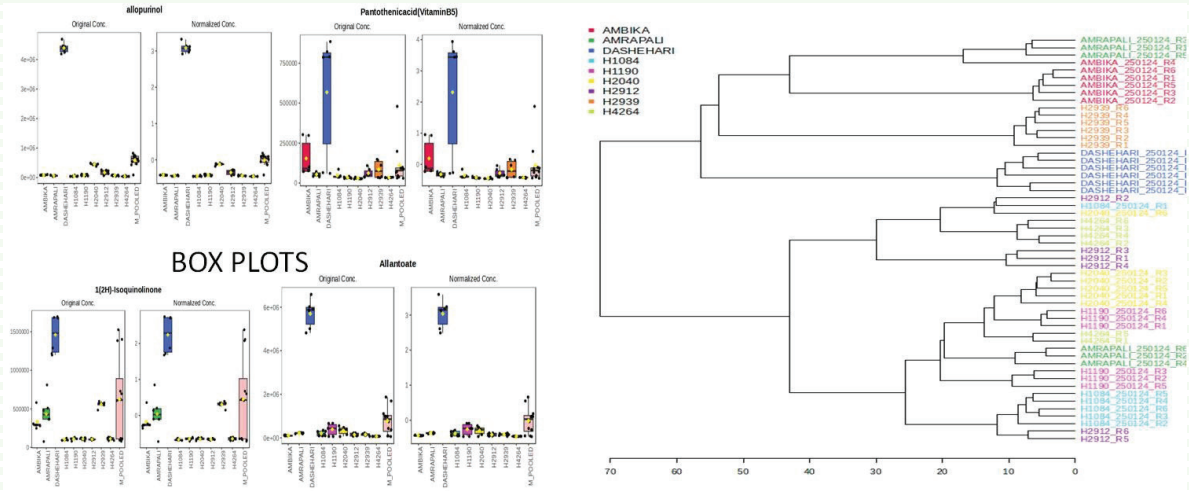


Fig. 3 Clustering based on Metabolite profiling of mango

72.57 percent. The majority of accessions contain 75 percent pulp. TSS was found to be ranging from 11.45 to 28.40 °B. TSS of 18.52 °B was found in the majority of accessions, but some had more than 22 °B (Fig. 4).

Evaluation of hybrids

During 2023, a total of 202 hybrids were evaluated for traits viz., fruit weight, fruit length, fruit breadth, stone weight, stone length, stone breadth, stone thickness, TSS and pulp percent. For fruit physical parameters, the hybrids showed a wide range of variability. The fruit weight ranged from 97.0 g to 790.0 g, with a mean of 305.90 g. Fruit weight in the maximum accessions ranged from 200 g to 250g. The pulp percentage was found to be an important parameter, ranging from 55.07 percent to 85.67 percent with average pulp percent of 71.55. Most of the hybrids have around 70 percent pulp. The TSS ranged from11.40 °B to 25.20 °B with mean 17.98 °B (Fig. 5).

Mango rootstock improvement

Comparative effects of ML-2 and ML-6 on vegetative growth of Dashehari scion were examined. It was found that ML-6 was at par with the performance of ML-2 for traits *viz.*, length of scion, no. of leaves, leaf length but in case of mean leaf width ML-6 was found superior (4.83 cm) as compared to ML-2 (4.39 cm). The effect of these rootstocks on dwarfness assessed from mean internode length was also evaluated during early growth period (first year of growth). Mean internode length was significantly lower (6.12 cm) in case of ML-2 grafted plants as compared to ML-6 grafted plants (8.77 cm). However, the difference for number of internodes between these two rootstocks was non-significant. Fruits harvested from ML-2 and ML-6 rootstocks were assessed for morphometric traits (Fig. 6). ML-6 had significantly higher fruit weight (34.4±5.9 g), fruit length (55.28±4.35 cm), fruit breadth

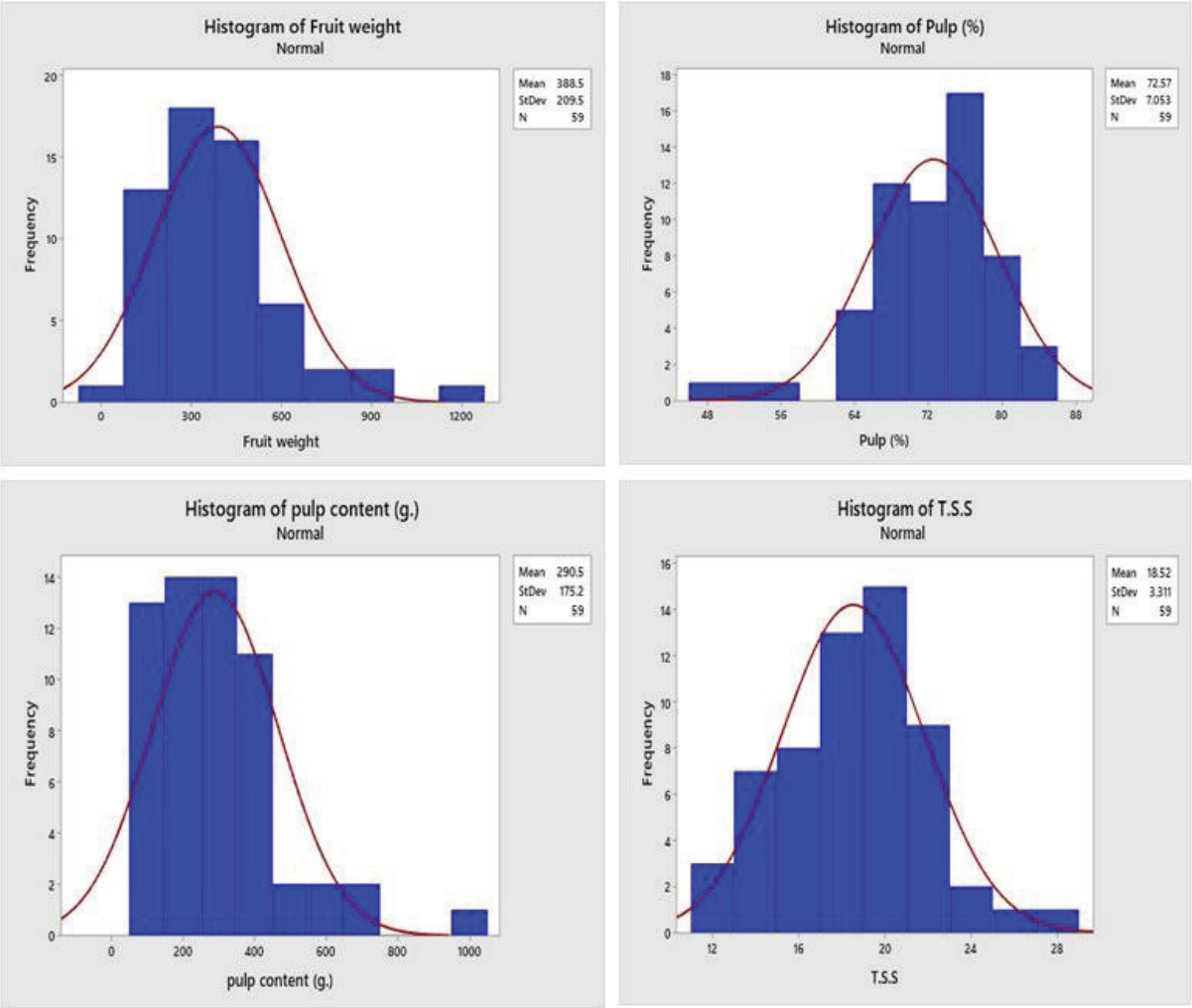


Fig. 4 Fruit weight, pulp weight, pulp percentage and TSS in Mango accessions

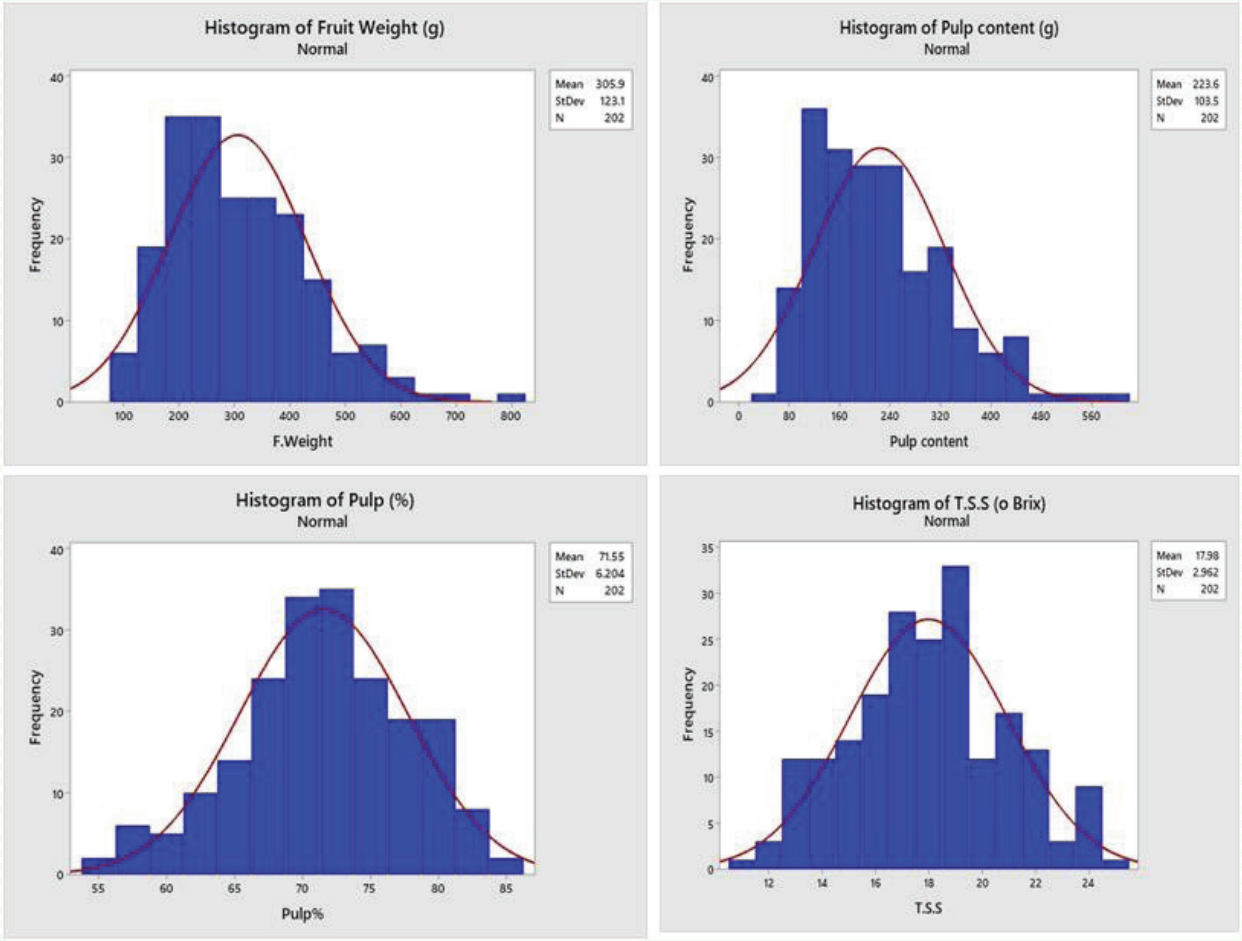


Fig. 5 Fruit weight, pulp weight, pulp percentage and TSS in Mango hybrids

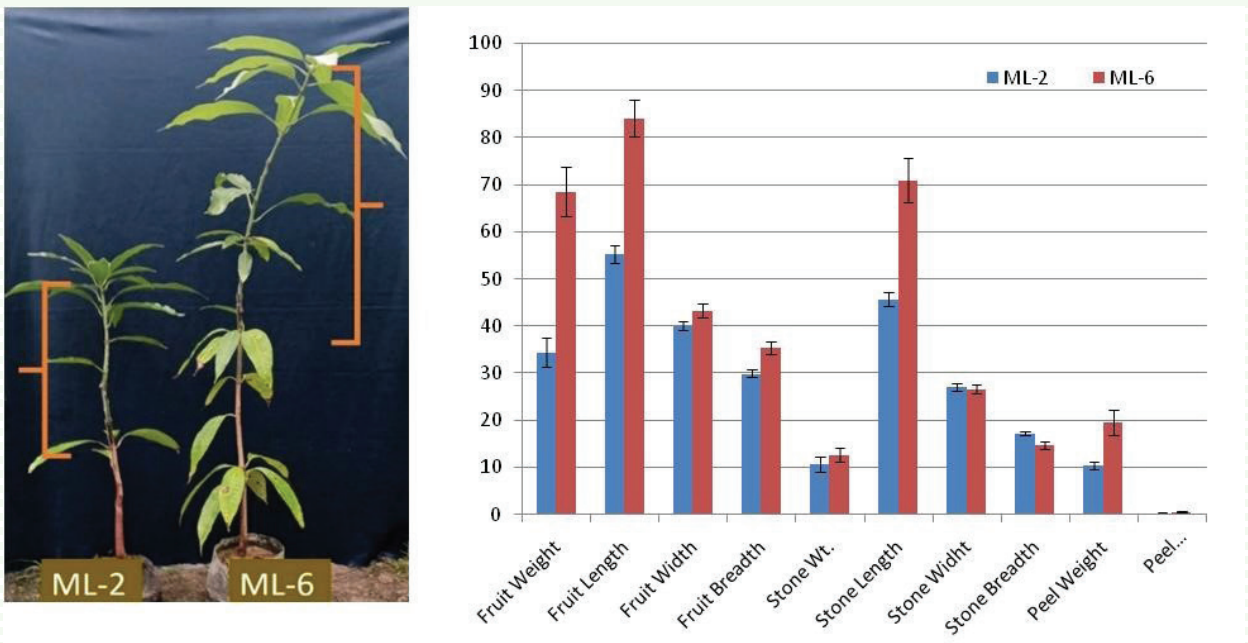


Fig. 6 ML-2 and ML-6 rootstock assessment for morphometric traits

(35.39±1.46 cm), peel weight (19.63±2.28 g) and stone length (71.01±4.84 cm). For two traits *viz.*, fruit width and peel thickness the two rootstocks did not show significant differences.

Polyembryonic rootstocks were assessed for proportion of polyembryony

Seeds harvested during 2023 from varieties ML-2, ML-6, Vellaikolumban, Pahutan, CJ-1, CJ-2, EC-95862, Kurukkan, Olour, Nekkare, Kitchner, and Phillipino were sown in polybags. The proportion of polyembryony ranged from 20-80%, the highest being recorded in CJ-2 (80%).

Molecular characterization of mango hybrids

Nine SSR markers mined from transcriptome data (unpublished) representing putatively associated with flowering, color, sugar transport and cellular metabolism were utilized for characterizing and fingerprint selected elite hybrids derived from Dashehari x Tommy Atkins and Dashehari x Eldon. Of these nine, *MiSSRCM133*, *MiSSRCL64* and *MiSSRFL18* were able to differentiate the hybrids (Fig. 7).

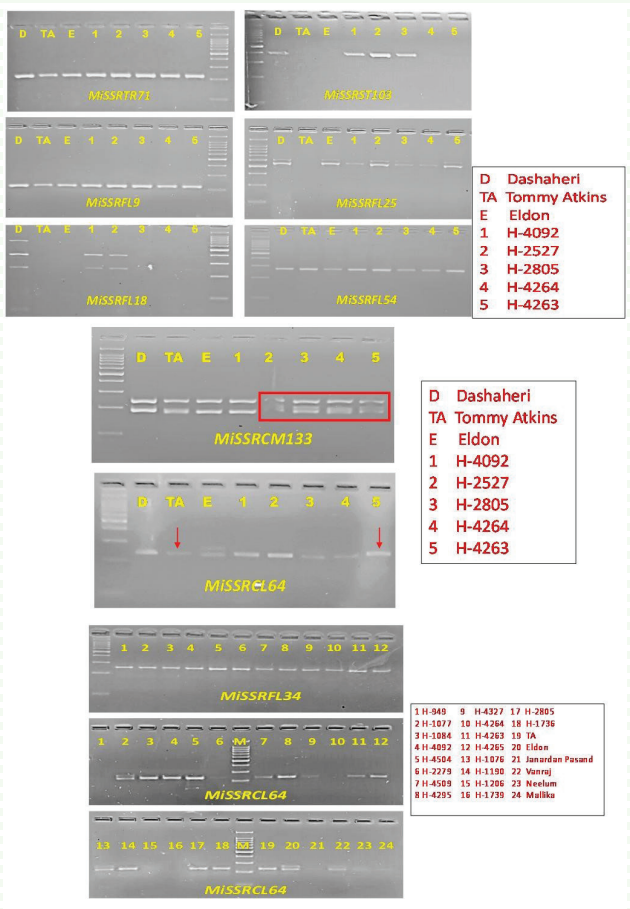


Fig.7. Molecular characterization of elite hybrids and their parents using SSR markers

Hybridization and establishment

During 2023, using 17 different cross combinations, 36166 flowers were crossed on 7925 panicles (Table 1). Although 154 hybrids fruits were obtained from the crosses made, only 103 stones germinated (Table 1).The basis for selection of cross combination during 2022-23 is given in Table 2.

Establishment of hybrid block

Hybrid block for 26 promising hybrids have been established for multiplication of plants and adequate availability of scion shoots for further multiplication.

Impact of climate change on reproductive growth stages, yield, and quality in mango genotypes

The influence of climate change on reproductive growth stages, yield and quality of six mango genotypes each exhibiting distinct maturity behaviors viz., early, medium, and late maturity were studied. Dashehari initiated panicle development earlier than other varieties, namely Ambika, Bombay Green, Mallika, Chausa, and Gaurjeet. Chausa and Gaurjeet were identified as the late bearers. Panicle development stages (510 to 519) completed earlier in Dashehari, Bombay Green, and Ambika by the last week of February. Subsequently, the flowering stage (610-619) commenced early in Dashehari following panicle development. Temperature emerged as a significant factor during this stage, as genotypes exhibiting delayed panicle development demonstrated earlier flowering. Ambika, Mallika, and Gaurjeet initiated flowering in the first week of March coinciding with rising temperatures. The flowering period extended for 18-20 days in Dashehari, followed by Ambika, Bombay Green, and others. Fruit development phase (701 to 709) also occurred earliest in Dashehari, followed by Ambika and Bombay Green in the last week of March. Fruit maturity period (800-809) was similarly earliest in Dashehari, occurring in the first week of June, followed by Bombay Green. A comprehensive assessment of pollen viability and *in-vitro* pollen germinationwas conducted during the active pollination period (9thto 12thStandard Meteorological Week). The peak pollination period occurs during the 10thand 11thStandard Meteorological Weeks, when the maximum temperature ranges from 30-34°C and the minimum temperature ranges from 13-14.5°C. Fig. 11 reveals that pollen viability percent ranged from 65.66% (Mallika) to 90% (Gaurjeet). *In vitro* pollen germination percent varied from 12.99% (Ambika) to 37.36% (Gaurjeet) (Fig. 8).

Table 1: Hybrid seedlings from hybridization during 2023

S. No.	Cross combinations	Panicles used	Number of flowers	Number of fruits set (on May 1, 2023)	Number of fruits harvested	No. of stone sown	No. of stone germinated
1	Amrapali x Sensation	1000	4216	0	-	-	-
2	Arunika x Mallika	550	2646	35	21	21	10
3	Dashehari x Tommy Atkins	1050	5124	84	70	70	66
4	Dashehari x Sensation	500	2538	98	19	19	16
5	Mallika x Tommy Atkins	1200	5907	15	1	1	1
6	Nisar Pasand x Gulabkhas	200	894	0	-	-	-
7	Nisar Pasand x Shardabhog	500	2227	0	-	-	-
8	Neelum x Sensation	300	1143	0	-	-	-
9	Totapuri x Sahib Pasand	300	1901	0	-	-	-
10	Osteen x Chausa	400	1048	9	2	2	1
11	Sensation x Chausa	350	1662	60	23	23	7
12	Tommy Atkins x Chausa	300	1377	70	16	16	2
13	Olour x Vellaikolumban	275	1267	2	-	-	-
14	Kurukkan x H-13-1	250	905	1	1	1	-
15	Vellaikolumban x Olour	350	1431	0	-	-	-
16	Vellaikolumban x H-13-1	300	1489	16	1	1	-
17	H-13-1 x Vellaikolumban	100	391	1	-	-	-
	TOTAL	**7925**	**36166**	**391**	**154**	**154**	**103**

Table 2. Basis for selection of cross combinations during 2023

S.N.	Cross combinations	Q+C	RB	WA	AB
1	Amrapali x Sensation	+		+	
2	Arunika x Mallika	+	+		
3	Dashehari x Tommy Atkins	+	+	+	
4	Dashehari x Sensation	+	+	+	
5	Mallika x Tommy Atkins	+	+		
6	Nisar Pasand x Gulabkhas	+			
7	Nisar Pasand x Shardabhog	+			
8	Neelum x Sensation	+		+	
9	Totapuri x Sahib Pasand	+			
10	Osteen x Chausa	+	+	+	
11	Sensation x Chausa	+	+	+	
12	Tommy Atkins x Chausa	+	+	+	
13	Olour x Vellaikolumban			+	+
14	Kurukkan x H-13-1			+	+
15	Vellaikolumban x Olour			+	+
16	Vellaikolumban x H-13-1			+	+
17	H-13-1 x Vellaikolumban			+	+

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

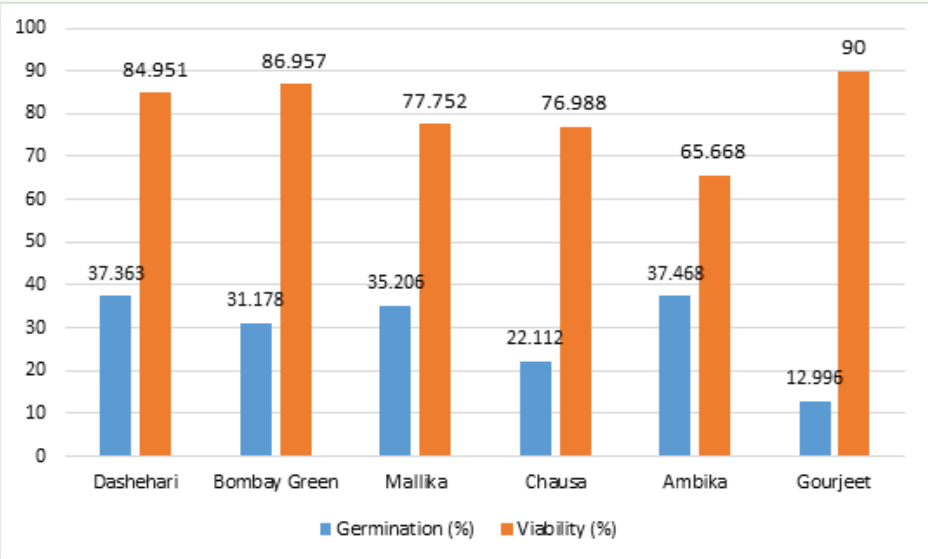


Fig. 8 In-vitro pollen germination and pollen viability percent in mango genotypes

Genome wide association mapping

The maximum variation was observed for pulp weight (55%), and the minimum for stone thickness (15%) during while it was maximum for pulp weight (55.24%) and minimum for stone thickness and stone width (14.28 and 15.86%). Analysis of Variance revealed significant variation for morphometric traits among accessions in association panel assessed during both 2021-22 and 2022-23 except for fruit thickness during the 2 years and stone weight, stone width, and stone thickness during 2022-23. Correlation analysis revealed that there was significantly higher correlation of fruit weight with pulp weight (0.99), peel weight (0.81), fruit thickness (0.88), fruit width (0.84) and fruit length (0.73). Assessment of different model for GWAS was done and it was found that BLINK and MLMM were more efficient in detecting false discovery rate as compared to GLM, MLM and Farm CPU. Structure analysis revealed three sub-populations in the association panel. LD decay was estimated to be 11.47 kb. GWAS for the two years data was carried out separately and significant association for different morphometric traits viz., fruit weight (chromosome 13), fruit width (chromosome 5), stone weight (chromosome 18) and stone width (chromosome 5) was detected (Fig. 9).

GWAS using an association panel of 128 members was performed to identify associated markers for fruit traits. GWAS was performed using generalized linear model using TASSEL version 5.2 as well as BLINK model. In the GLM analysis using TASSEL with K=5, predicted 4083 markers associated with the fruit traits. Mixed linear model also predicted the markers. Around 71 and 322 SNP markers were identified to be significantly associated with fruit thickness (–log10p: > 3) and fruit weight (–log10p: > 4), respectively. For pulp

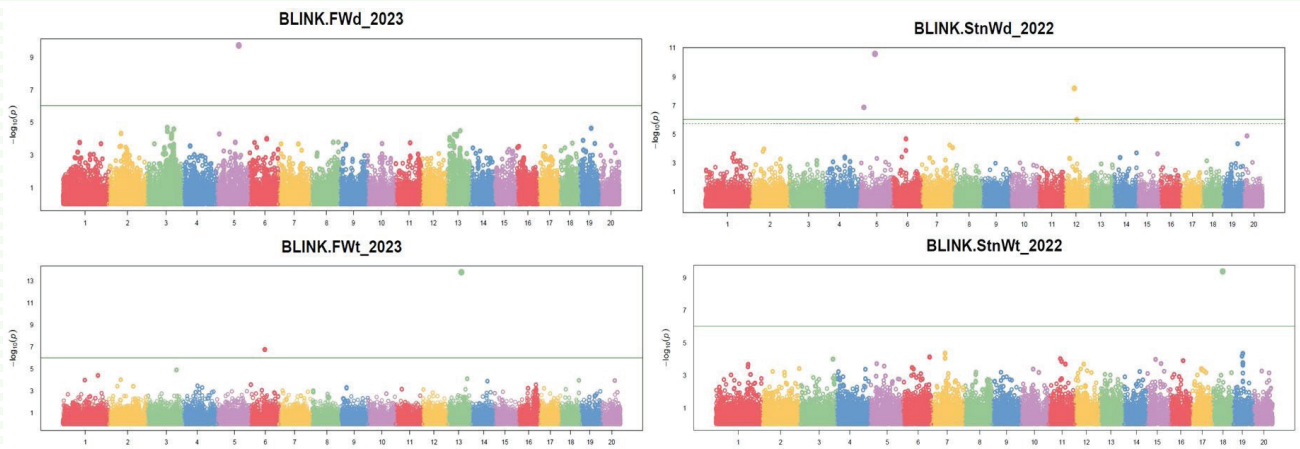


Fig. 9 Distribution of SNP markers associated with different fruit traits on different chromosomes

weight trait 110 SNP markers were predicted to have significant association (–log10p: > 3). Markers identified in the BLINK model which were found to be concordant with the results of GLM of TASSEL were selected as significant and consistent markers. BLINK model was efficient to detect the best marker-trait associations based on the minor allele frequency 0.5 and unrestricted/ unfiltered heterozygousity in terms of high statistical and computational efficiency using two season phenotypic data sets. K-matrix with K= 5 was derived from PCA analysis for the training population. K-matrix, phenotypic data and SNP data were integrated in the GWAS analysis which resulted in identification of three SNPs viz., SNC_058137.1_3967144, SNC_058138.1_9694033 and SNC_058138.1_9694033 which were significantly associated with traits viz., fruit thickness (-log 10 (p):74) , peel weight (-log 10 (p):9.09) and stone width (-log 10 (p):29.27), respectively. These SNPs explained the phenotypic variations of 99.8%, 25.83% and 98.88%, respectively.

Characterization of nanoformulation using FTIR and DLS

In the Fourier Transform Infrared Spectroscopy (FTIR) analysis of the nanoformulation, we obtained spectra of silver nanoparticles exhibiting prominent peaks at 2900, 1600 and 1300 cm^{-1}. A peak at 1700 cm^{-1} corresponds to C=C stretching (nonconjugated). Conjugated nanoparticle was obtained in 2900 cm^{-1} (Fig. 10). Dynamic light scattering analysis using Cordouan Technologies equipment and NanoQ software identified 17.74 nm, 112.77nm 518 nm particle sizes and maximum intensity 74.56, 18.18 to 7.27 %, respectively. (Std. Emulsion state: 100 to 1000 nm).

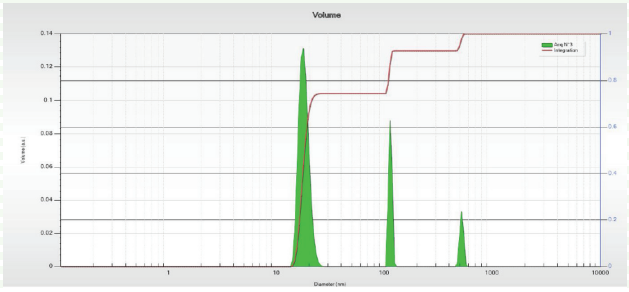


Fig. 10 FTIR spectrum showing peaks of nano particles

Effect of vivipary and excessive heat unit accumulation on jelly seed disorder in mango

We studied incidence of vivipary and heat unit accumulation or growing degree days (GDD) in the fruits of medium and late maturing mango cv. 'Dashehari' and 'Amrapali', respectively and its effects

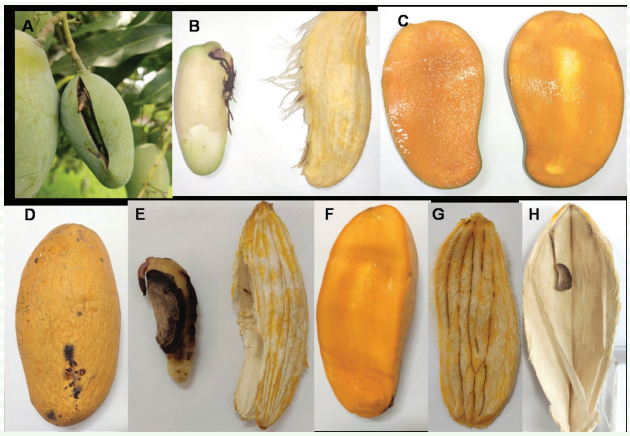


Fig. 11 Ripe Dashehari mango fruit (A) Viviparous 'Amrapali' fruit (B) 'Amrapali' Stone with germinating embryo from non-jelly seed fruit. (C) 'Amrapali' non-jelly seed affected fruit with germinating embryo (D) Ripen 'Dashehari' fruit (E) Stone with germinating embryo from non-jelly seed 'Dashehari' fruit. (F) Cotyledon and embryo in 'Dashehari' (G) Non-jelly seed Dashehari fruit

on the occurrence of jelly seed in mango. Jelly seed occurrence, heat unit accumulation, total soluble solid (TSS), carotenoids, antioxidants, calcium, potassium, zinc, copper and phenolic compound contents in viviparous non jelly pulp was undertaken. Our findings show that excessive heat unit accumulation and vivipary/seed germination are not the cause/ factors that induce jelly seed disorder (Fig. 11). Vivipary and jelly seed formation are independent biological phenomenon. Total Soluble Solids, phenolic content, carotenoid content and antioxidants were significantly higher in viviparous fruit. Data for nutritional status of soil (organic carbon, P, Ca, K, Zn, Cu and Fe); leaf (P, Ca, K, Zn, Cu and Fe) and viviparous fruit pulp (Ca, K, Zn and Cu) were analysed. Data reveals that soil, leaf and pulp have sufficient nutrients and there was no deficiency of calcium or any other nutrient in soil/ leaf. Plants and harvested fruits also do not show any nutrient deficiency symptom.

Mining, identification and characterization of SWEET family genes in mango

Sugar transporters are extremely important for mango plant since sugars play an important role in starch accumulation and sugar content is also a major component of fruit quality and economic value. Sugars Will Eventually be Exported Transporters (SWEET) are a novel type of sugar transporter that plays crucial roles in multiple biological processes. We have conducted a genome-wide analysis of SWEET genes in mango genome, and analyzed their gene structure, protein motifs and expression patterns. A total of 13 candidate SWEET loci were identified in mango genome, which

could be classified into subfamilies (Fig. 12) Majority of MiSWEETs shared similar gene structures and conserved motifs. This comprehensive study serves to facilitate our understanding of MiSWEET during fruit ripening processes and provide a good foundation for further functional investigation of SWEETs in fruit ripening and quality fruit formation.

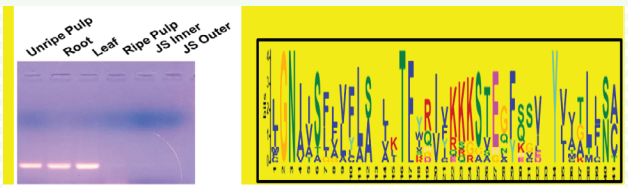


Fig. 12 Expression of SWEET 7 in different tissue and SWEET Motif.

Guava

Germplasm collection and characterization

The guava growing areas of Bithoor in Kanpur district of Uttar Pradesh were surveyed for recording the genetic variability in fruit quality attributes. A total of 19 accessions were collected and characterized using fruit quality parameters. Considerable variability was recorded in fruit length (4.82-7.58 cm), fruit width (4.96-7.32 cm), fruit weight (67.4-200.6 g), thickness of outer pulp (0.44-1.38 cm), fruit firmness (4.30-10.02 kg/cm^2), TSS (7.86-12.10^o Brix), and seed hardness (12.86-19.76 kg/cm^2). Overall, one accession (Bithoor-19) was found promising in terms of aforementioned attributes as well as fruit appearance and taste. It has been multiplied for planting and evaluation. Similarly, 30 germplasm accessions obtained from Fruit Research Station, Rewa, Madhya Pradesh were also characterized using fruit quality traits. The fruit weight varied between 24.8 g (China) and 388.80 g (Allahabad Safeda). The thickness of outer pulp was the minimum (0.26 cm) in China and the maximum (1.92 cm) in Portugal. The fruit firmness ranged between 3.94 kg/cm^2 (Pear Shaped) and 6.16 kg/cm^2 (Kothrud). The seed hardness was the minimum (9.96 kg/cm^2) in Kothrud and the maximum (14.77 kg/cm^2) in Dharwad. The TSS ranged between 8.22 ^{o} Brix (China) and 13.02^o Brix (Allahabad Surkha). These genotypes are also evaluated for biochemical attributes such as ascorbic acid content, total phenols, total flavonoids, and lycopene.

Field gene bank

A total of 169 guava accessions including 7 *Psidium* species are being conserved in the field gene bank. A total of 45 accessions were multiplied in 2023 for gap filling.

Evaluation of guava germplasm

Characterization of 31 accessions conserved in the field gene bank revealed rich genetic variability in different fruit quality parameters. The fruit length was the minimum (5.20 cm) in RCGH-4 and the maximum (9.73 cm) in Waikea. The fruit diameter ranged between 3.87 cm (RCGH-4) and 9.67 cm (Seedling-1). The fruit weight was the maximum (430.33 g) in Seedling-1 and the minimum (112.33 g) in Portugal. The thickness of outer pulp ranged between 0.70 cm (GTS-1) and 2.60 cm (Seedling-1). The fruit firmness was the minimum (3.67 kg/cm^2) in GJAC-2 and the maximum (9.80 kg/cm^2) in CISH G-1. The seed hardness varied from 11.42 kg/cm^2 (Allahabad Safeda) to 19.84 kg/cm^2 (Patillo). The TSS was the lowest (7.97^o Brix) in Spear Acid and the highest (13.37^o Brix) in CISH G-1.

Evaluation of hybrid progenies

A total of 93 hybrid progenies from different cross combinations (Lalit x Purple Guava, Allahabad Safeda x Purple Guava, CISH G-1 x Purple Guava, Shweta x Purple Guava, etc.) were characterized using fruit quality parameters. The fruit length was the minimum (5.31 cm) in R24-P488 and the maximum (8.30 cm) in R8-P148. Fruit diameter ranged between 5.23 cm (R24-P488) and 7.33 cm (R8-P148). The fruit weight was the maximum (245.33 g) in R8-P148 and the minimum (104.67 g) in R24-P488. The thickness of outer pulp was the lowest (0.60 cm) in R24-P501 and the highest (1.57 cm) in HGL-740. The fruit firmness ranged between 2.77 kg/cm^2 (R14-P282) and 5.97 kg/cm^2 (R12-P240). Seed hardness varied from 10.56 kg/cm^2 (R4-P64) to 15.96 kg/cm^2 (R24-P492). The pulp TSS was the minimum (9.17 ^{o}Brix) in A10-P190 and maximum (13.97 ^{o}Brix) in HGL-515.

Promising hybrids identified

Evaluation of half-sib population revealed that some red-pulped hybrids were promising in terms of fruit weight, total soluble solids, fruit appearance and taste. Of such hybrids, R13-P264 (Lalit x Purple Guava), R14-P281 (Purple Guava x Lalit), and R4-P64 (Allahabad Safeda x Purple Guava) have been multiplied for further evaluation (Fig. 13).

QTL mapping in guava

A systematic study was conducted by genotyping and phenotyping 60 progenies of F_2 generation from a biparental mapping population derived from a cross between Lalit (L) and Purple Guava (PG). Phenotypic data showed higher heritability with moderate-to-high values of heterogeneity coefficients (50-85%). Genotyping of the progenies of F_2 generation using

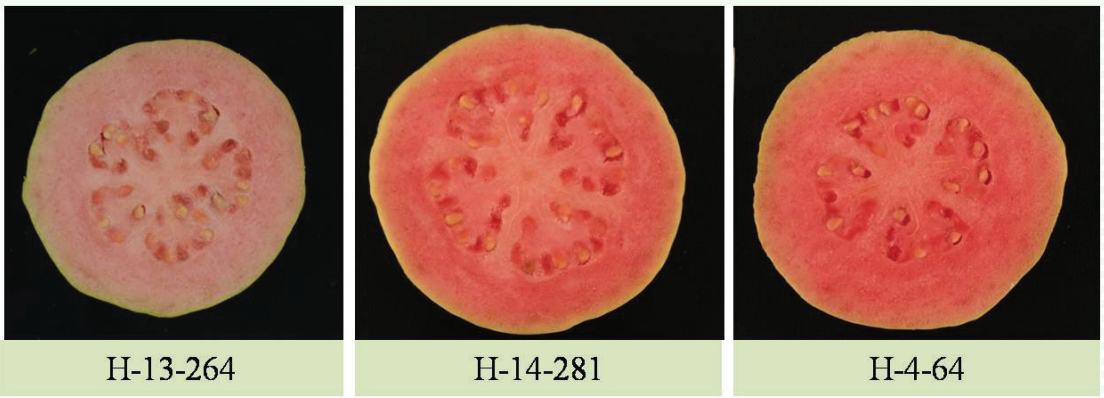


Fig. 13 Promising guava hybrids.

both genic and genomic SSRs (80) and consistent RAPD markers (10) were scored as A and B alleles for 'L' and 'PG', respectively. Using genotyping and phenotyping data in QTL IciMapping V4.2 software, 4 QTLs for the seed hardness located on 4 chromosomes *viz*., 1, 2, 3 and 5 were identified; which were designated as *qSH1*, *qSH2*, *qSH3* and *qSH5*, respectively (Fig. 14). LOD values for all the identified QTLs were greater than 8, with PEV ranging between 1.05 and 1.8. Highest LOD score was for recorded for *qSH5.1* (10.40 cM) with linked markers *mPg*SSR17 and *mPg*SSR55 on left and right borders of the QTL. Maximum numbers of linked markers were detected in major QTL *qSH2* located on chromosome 2 offering scope for fine mapping. This study paves the way for screening hybrid progenies for the soft seeded fruits and expedites the breeding program through selection using markers linked with donor allele (QTL).

Transcriptome analysis for mining key genes governing seed core trait

Seed core and seed hardness are two key characters of interest for breeding of guava varieties. An attempt was made to understand the molecular aspects of small seed core formation. RNA sequencing of two contrasting hybrids for seed core (large and small) from a mapping population in a cross between Lalit x Purple guava was done and their DEG analysis revealed a large array of genes related to lignin degradation, and lycopene synthesis typically upregulated in small seed core progeny in contrast to lignin biosynthesis in large seed core progeny. Cinnamoyl-CoA reductase, Laccase-7, Laccase-14, Laccase-1, and Laccase-12 involved in lignin biosynthesis were significantly upregulated in large seed core progeny. Whereas,

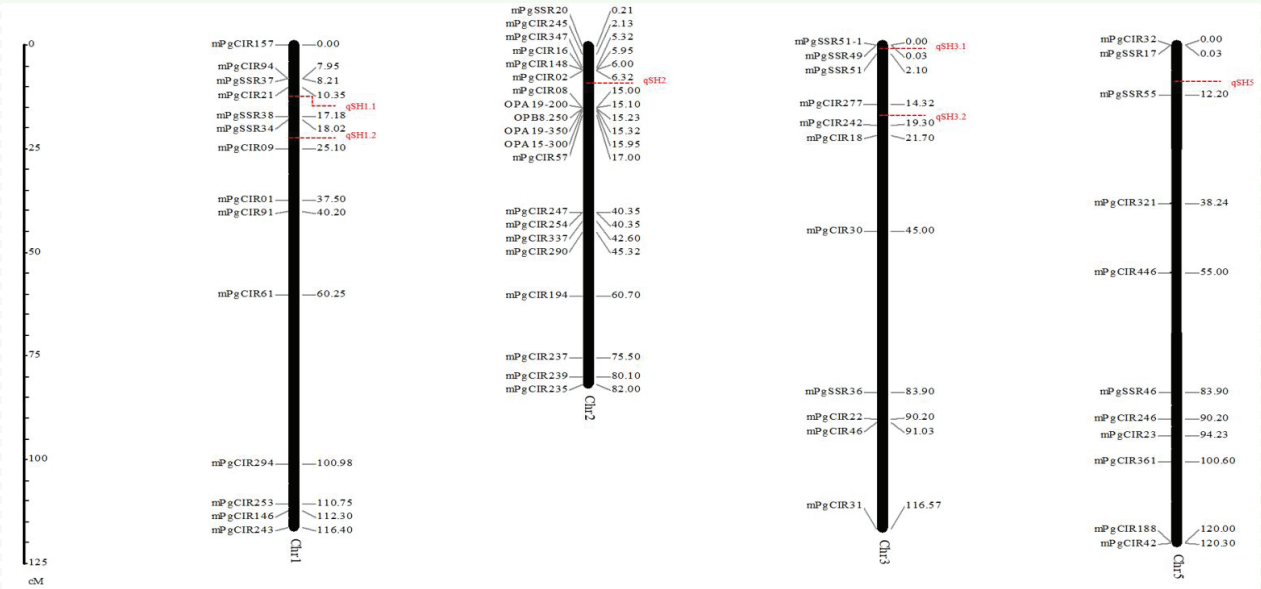


Fig. 14 A partial linkage map of guava showing seed hardiness related QTLs in Chromosomes 1, 2, 3 and 5

Peroxidase 4, Peroxidase 41, Peroxidase 43, Peroxidase 64 involved in lignin degradation were downregulated in Purple guava and small seed core progeny. These genes were validated through real-time PCR which paves way for establishing the molecular basis of seed core development in guava.

In silico identification of microRNAs and their target genes from transcriptome of guava

29 putative pgu-miRNAs from 27 families were identified in the guava fruit transcriptome data using c-mii tool. *The predicted miRNA represented different miRNA family i.e.* miRNA162, miRNA169, miRNA172, miRNA398, miRNA854, miRNA156, miRNA159, miRNA414, miRNA5658, and miRNA5021 etc (Fig. 15). The lengths of these miRNAs were between 20 and 22 nt. The content for the G+C ranges from 41 % to 64% with an average of 51%.The average observed for A/U was 1.12 and G/C was 0.97. The MFE of identified miRNAs ranged between –11.5 to −535kcal/mol, while The MFEI for the identified mango pre-miRNAs was ranged between −0.30 to −0.95 kcal/mol. *Predicted miRNA target genes were transcription factors (MYB, NAC, ERFs), enzymatic and structural genes (*glutathione transferase, calmodulin-like protein 5, auxin efflux carrier component 4, ubiquitin-activating enzyme E1 2, WRKY33, MYB, ERFs, Serine/threonine protein kinase etc.*)* involved in various metabolic pathways.

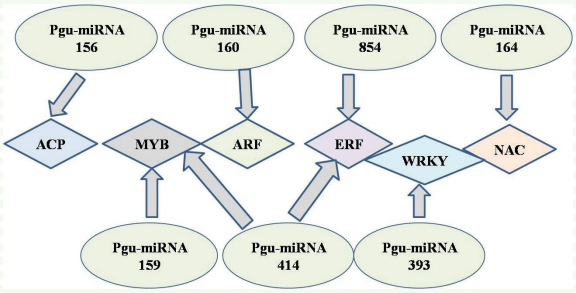


Fig. 15 miRNAs identified in Guava

Jamun (*Syzygium cumini* Skeels)

Germplasm collection and characterization

Different areas of Lucknow, Hardoi and Barabanki districts of Uttar Pradesh were surveyed during the 2023 fruiting season for recording the genetic variability in fruit quality parameters. A total of 55 accessions including 23 from Lucknow, 22 from Hardoi and 10 from Barabanki were characterized using fruit quality traits. Fruit length ranged between 2.31 cm (Luck-14) and 3.73 cm (Luck-23). Fruit diameter ranged between 1.67 cm (Luck-19) and 2.54 (Har-1). The maximum (14.82 g) and minimum (5.60 g) fruit weight was recorded in Har-1 and Luck-14, respectively. The seed weight ranged between 0.39 g (Har-15) and 2.03 g (Luck-11). Total soluble solids ranged between 11.11° Brix (Har-20) and 19.96° Brix (Luck-12).

Promising genotypes

Based on some major fruit quality attributes including fruit weight (> 12.0 g), pulp content (> 85.0%) and TSS (> 12.0° Brix) and fruit taste, four accessions, namely, Luck-11, Luck-23, Har-1 and Bar-2 were found to be promising (Fig. 16). These accessions have been multiplied for further evaluation.

Characterization of germplasm

A total of 14 jamun accessions, being conserved in the field gene bank, were characterized using fruit quality attributes. The maximum (3.68 cm) fruit length was

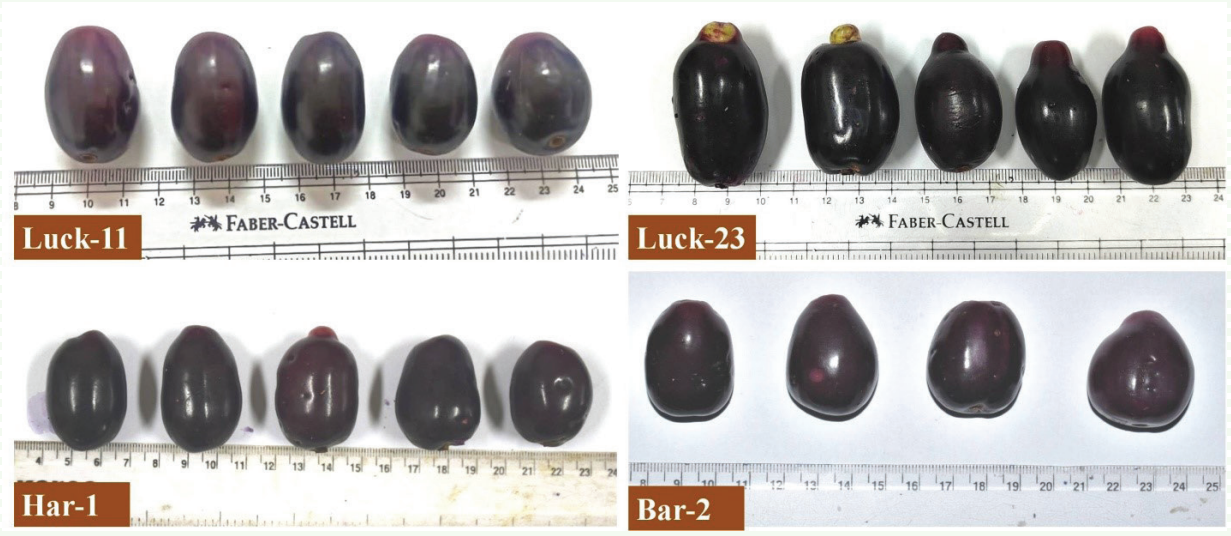


Fig. 16 Promising Jamun genotypes

recorded in J-15 while it was the minimum (2.30 cm) in J-4. The fruit diameter varied between 1.93 cm (J-39) and 2.53 cm J-36). The fruit weight was the highest (15.23 g) in J-15 and the lowest (5.55 g) in J-44. The seed weight ranged between 0.75 g (J-45) and 1.45 g (J-15). The average TSS was found to be 11.89° Brix, varying between 11.0° Brix (J-4) and 13.32° Brix (J-22). Some accessions including J-12, J-15, J-35 and J-36 recorded high pulp content (> 90.0%). Overall, accession J-15 was found the most promising in terms of fruit weight (15.23 g), pulp content (90.23%) and TSS (12.96° Brix).

Profiling of bioactive compounds

Fifteen genotypes including four commercial cultivars (CISH J-37, CISH J-42, Konkan Bahadoli and Goma Priyanka) were also characterized using liquid chromatography–mass spectrometry (LC–MS) for profiling the bioactive compounds in the fruit pulp of jamun. Preliminary analysis has indicated the presence of a range of polyphenols, flavonoids, anthocyanins, and alkaloids with known health benefits.

Genomic resources

Novel EST-SSRs have been identified and >100 markers were designed from self generated Jamun transcriptome resource. Around 40 simple compound SSR markers were used for PCR validation on 6 Jamun germplasm accessions (Fig. 17).

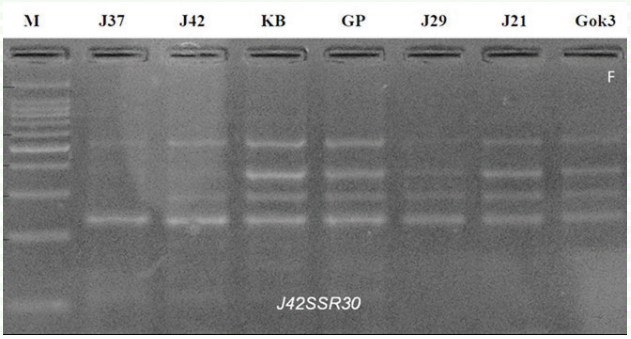


Fig. 17 The allelic variations of jamun germplasm resolved in agarose gel

Bael (*Aegle marmelos* L.)

Germplasm collection and evaluation

Fifteen (15) accessions were collected from Ayodhya, Basti and Siddharthnagar (UP). The fruit weight varied from 258.50-1311.57 g, fruit length ranged from 6.83-13.37 cm, fruit circumference lies in between 25.40-46.07 cm, shell weight ranges from 52.05-165.30 g, the no. of seeds/fruit were 84-163, TSS varied from 31.14-41.20 ^{0}B, acidity ranged between 0.34-0.52 %, vitamin C content varied between 12.74-21.48 mg/100 g pulp, total sugars varied between 15.05-21.83 % and total phenol ranged from 1.35-2.72% (Fig. 18).

Fourteen vegetative multiplied bael accessions were also evaluated and analysed for physico-chemical parameters. The fruit weight ranged from 746.67-1973.0 g, fruit length as 9.07-20.67 cm, fruit circumference varied from 37.50-51.53 cm, number of seeds per fruits ranged between 90-189, having shell weight of 134.78-311.01 g, shell thickness between 2.12-3.44 mm, no. of seeds sac lies ranged between 12.00-15.67 and seed weight between 8.62-21.32 g. Fruit yield was recorded between 22.75-63.39 kg/plant, TSS ranged from 34.47-41.83 °B, acidity varied from 0.32-0.52 %, vitamin 'C' ranged between 12.97-22.67 mg/100 g pulp, and total sugars between 16.98-21.02% among different accessions evaluated. On the basis of overall assessment, the accession T_{37} was found to be most promising with respect to fruit weight, yield and quality parameters.

Fig. 18. Variability in bael collected from different parts of the country

Genomic resources

Around 200 novel SSRs have been identified from genome of Bael. Around 10 SSR markers were used for PCR validation on 12 bael germplasm accessions (Fig. 19).

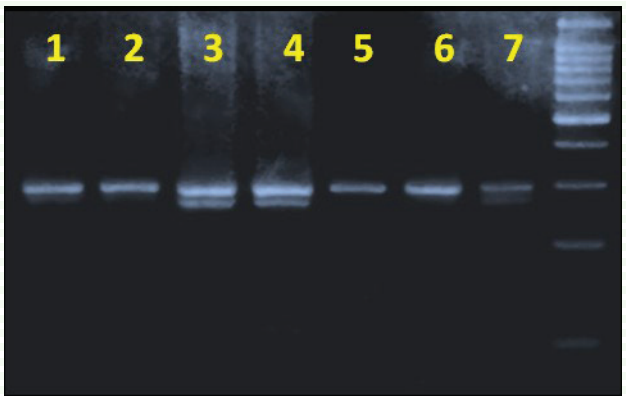


Fig. 19 Agarose gel profile showing polymorphism among Bael germplasm for marker mAmSSR3.

Aonla (*Embilica officinalis* Gaertn.)

Germplasm collection

Rewa, Satna and Shahdol districts of Madhya Pradesh state were surveyed and 22 accessions were collected. Fruit samples were analysed for various physical and biochemical parameters. The fruit weight varied from 8.78-37.66 g, fruit length from 22.8-37.28 mm, fruit diameter between 24.84-42.69 mm, stone weight between 0.70-1.64 g, TSS from 8.24-12.72 ^{0}B, vitamin C between 240.07-513.85 mg/100g pulp, acidity from 1.64-3.58 % and total phenol between 1.32-1.96% among different collected accessions (Fig. 20). Based on these parameters, accessions A-1, A-18, and A-19 were found superior (Fig. 21). The scions shoot of these accessions have been collected and grafted, and being maintained for evaluation.

Fig. 20 Variability of aonla collected during 2023

Fig. 21 Variability of seed and fruits collected from three districts of MP

Germplasm evaluation

Ten aonla accessions are being maintained in the field gene bank. After analysis of their physico-chemical properties, it was observed that the fruit weight varied from 23.53-34.50 g, fruit length ranged between 25.0-37.13 mm, fruit width between 30.46-43.9 mm, TSS from 8.4-9.8 ^{0}B, acidity between 2.12-3.12 %, vitamin 'C' from 311.25-490.13 mg/100 g pulp and total phenol between 0.67-1.76 % among the evaluated germplasm. CISH-A-10 showed superiority with respect to fruit quality attributes *i.e.*, high vitamin 'C' content (409.12 mg/100 g pulp), high total phenols (1.76 %), high TSS (9.4°B), high acidity (2.61%), higher fruit weight (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 %), and fruit weight of (33.41 g) (Fig. 22).

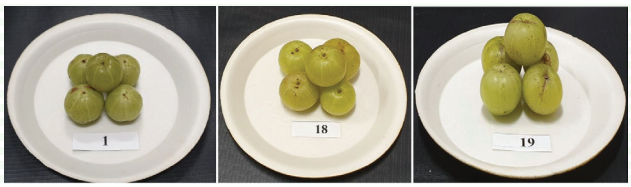


Fig. 22 Elite aonla selections

Bioengineering and Computer applications

Design and Development of novel DDTIB Bioreactor

A novel double decker, self illuminated TIS bioreactor was designed and developed consists of a body made of polycarbonate which is transparent and can stand heating 121^{0}C. The size of DDTS (1) is 186x166x134 mm. The size of upper chamber (2) is 186x166x134 mm and the lower chamber (3) 186x166x50 mm and led box (4) 186x166x10mm. The upper chamber also has in built sealing system at bottom which inserted to lower chamber. Upper chamber have a separate lid which is air tight using silicon seal inside a groove of the lid for closing the chamber a separate led box also placed on it which gives light to upper chamber to ensure 4000 par light to the plants. After sterilizing all parts the bioreactor is ready to use. The body is filled with generally 600ml of nutrient solution in the lower chamber. Then sterile plant material is placed on the upper chamber on silicon sheet which have 4 hole 10mm diameter for draining the extra nutrients. The filters are connected to 2 timers, and 2 air pumps *via* silicon tubes to regulate gas exchange. When a pressure is applied to the middle filter the nutrient solution is forced to upper chamber and covers the plant material. When pressure is relieved the nutrients will drain back through the holes in the bottom of the chamber. In order to facilitate air to go out from the tube connected to the middle filter a solenoid valve can fitted in the line. No liquid will be left on the upper chamber the problem of hyperhydricity can be avoided. The immersion time and frequency like duration and frequency of ventilation are set by the timers. Since the DDTIS has own lighting system several units can be placed above. Every tissue culture container requires illumination for 16 hour a day for growth and development. Self illuminating reactor top fitted with a timer can do away with requirement of expensive CULTURE RACKS. Most TIB systems have inseparable media compartment except twin type TIB. Twin type TIB takes twice the space as DDTIB. DDTIB can be separated from main reactor container and could be utilized for replacement of

medium or adjustment of pH/EC, hormones etc from time to time. DDTIB offers innovative design suitable for micropropagation of large number of crops at commercial scale

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

Optimization of TIS Bioreactor for banana

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 same. Bioreactor medium did not contain agar as a gelling agent. The immersion frequency of 3 minutes at 6 hour of 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 the study that no. of shoots and shoot length got significantly improved under temporary immersion bioreactor compare to conventional tissue culture.

Regeneration frequency in TIS vs. Solid Phase TC of banana cv. G-9

A higher regeneration frequency was observed in TIS system in banana cv. G-9 up to three subculture cycle. In 3 weeks time 82% 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, lack of hyper-hydricity due to gaseous exchange.

Evaluation of TIS bioreactor produced plantlets on secondary hardening

The morphological evaluation of plantlets produced through bioreactor and SPTC during secondary hardening revealed that plant height was significantly higher in bioreactor produced plantlets whereas no. of leaves, shoot diameter, fresh plant weight, dry plant weight and no. of roots were non-significant (Table 3).

Morphological evaluation of TIS Bioreactor regenerated in comparison to conventional TC plants

The plants regenerated through DDTIB bioreactor and conventional tissue culture using semi-solid medium were planted (CV. G-9) at R.B. Road campus in RBD design. The morphological data taken after 6 months of planting revealed that height and girth of pseudo stem

Table 3. Effect of TIS bioreactor on secondary hardening of TC plants of banana

Particulars	TIS	SPTC
Plant height (cm)	46.90±2.23[a]	25.70±9.16[b]
No. of leaves	4.67±1.15[NS]	4.34±1.15 [NS]
Shoot diameter (mm)	6.72±0.55 [NS]	7.60±1.24 [NS]
Fresh plant wt. (mg)	15603.00 ± 3291.16 [NS]	7762.00 ± 4226.118 [NS]
Dry plant wt. (mg)	2204.00 ± 263.251 [NS]	1639.00 ± 1121.78 [NS]
No. of roots	6.00 ± 1.00 [NS]	5.67±2.08 [NS]
Root length (cm)	18.30±0.95[b]	25.70±3.63[a]
Fr. Wt. of root (mg)	5113.00±614.14[a]	1652.33±275.61[b]
Dry wt. of root (mg)	258.33±76.17 [NS]	244.67±120.79 [NS]

of plantlets regenerated from both the method were statistically at par. However, significant difference was observed in terms of leaf length, leaf width and leaf area per plant which was significantly higher in plants regenerated through bioreactors (Table 4).

Table 4. Morphological evaluation of TIS vs Solid Phase IC regenerated plantlets under field condition

Growth Parameters	Bioreactor regenerated Plant	Conventional TC regenerated Plant (Control)
Pseudostem Height (cm)	51.1±6.37	48.1±4.35
Pseudostem Girth (cm)	24.62±1.76	23.76±1.52
Leaf Length (cm)	53.10±3.91	38.42±3.30
Leaf Width (cm)	13.72±1.34	10.37±1.04
Number of Leaves	7.7±0.40	8±0.33
Leaf Area per Plant (m^2)	49.86±10.97	28.63±6.39

Photosynthetic rate of banana leaves

Fully developed banana leaves of TIS and SSPTC were taken into consideration at field level for recording of the photosynthetic rate (Pn) with the help of portable Infrared Gas Analyzer (IRGA; CIRAS-3, Nu-tech). The study showed improved Pn rate and gas exchange parameters in bioreactor system (Fig. 23).

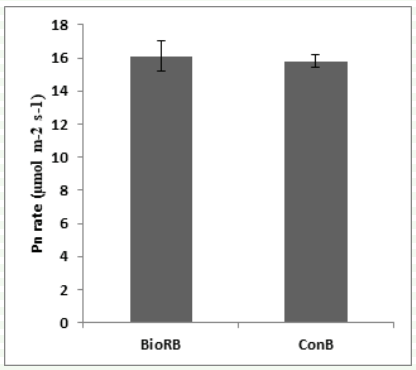


Fig. 23 Pn rate (µmol m-2s-1)of bioreactor VS SSTC regenerated plants of banana

Refinement and validation of Quick Leaf Area Ver. 1.05 software

The 'Quick Leaf Area- Fast and accurate leaf area measurement software', which was developed during previous years was refined and validated during year under report. For validation, around seventy leaves of different shapes comprising Mango (M), Guava (G), Jamun (J), Bael (B), Custard apple (CA), Hibiscus (H), Litchi (L) and Mulberry (Mb) were collected from ICAR-CISH research farm, Rehmankhera. The leaf area measured by''Quick Leaf Area'' software was as good as leaf area measured by leaf area meter, Licor's LI-3100 C. The accuracy result revealed that the correlation coefficient R^2 equals to 0.998. Accuracy rate and root mean square error were 98.694 % and 0.570, respectively indicating better efficiency of the software in terms of accuracy.

Software for automatic measurement of leaf length, width and aspect ratio

Quick Leaf_LWA v.1.02'' has been developed in Matlab to quickly and automatically measured the length, width and aspect ratio of leaves using scanned leaves images. An attempt has been made to improve the accuracy by using low pass filter and median filter. It was found that low pass filter was more effective than median filter in smoothing the images and reducing the noise. The software has been tested for accuracy of measurement using green leaves of mango, guava, hibiscus and Jamun. RMSE for measurement of length, width and aspect ratio were found to be 0.420, 0.18 and 0.121, respectively. Similarly, R^2 value for were recorded as 0.993, 0.994 and 0.984, respectively for length, width and aspect ratio.

Classification and Change Detection of Mango Crop Area by Remote Sensing Data and GIS

Collection, Pre-processing and classification of optical satellite images for mango crop classification of Purulia district, West Bengal was done covering the towns such as Jhalda, Anara, Balarampur, and Raghunathpur-Adra. Purulia lies between latitudes 22.60 and 23.50° N and longitudes 85.75 and 86.65° E which covered 6259 square km (Fig. 24).

Two landsat 8 images were downloaded by using USGS Earth Explorer. It was found that none of single image covered Purulia district. However, two images were combined by mosaicing. Both satellite images are pre-processed by using radiometric calibration to convert raw pixels to the reflectance values. Atmospheric correction was not performed as these images are already atmospherically corrected.

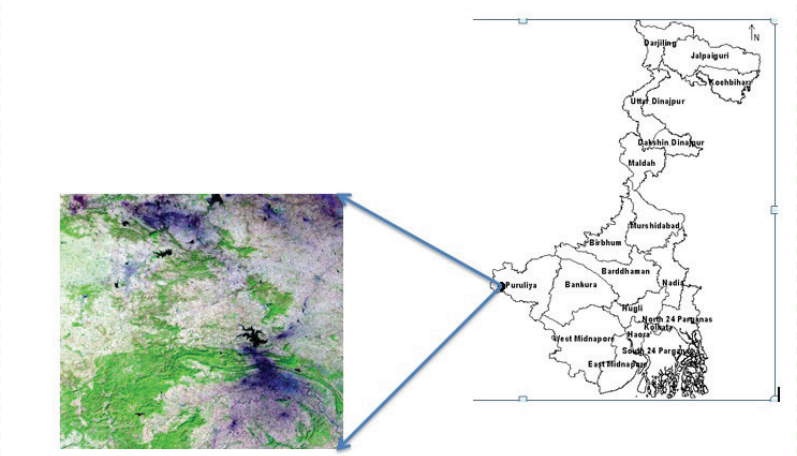


Fig.24. Location map with true color image

Mango (*Mangifera indica* L.)

Canopy Management

An experiment was initiated at ICAR-CISH, Lucknow with an objective to harness of solar energy through canopy modification in mango cv. Dashehari. Treatments 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). Results of experiment indicated that fruit weight varied from 222.02 to 267.57 g and maximum (267.57 g) was recorded in T_1(P3S2). Fruit number per tree varied from 70.37 to 93.46 and maximum (93.46 /tree) was recorded in T_5 (control). Maximum fruit yield (20.98 kg/tree and 8.39 t/ha) was recorded in T_3 treatment. Maximum TSS (20.13^{O}B) was estimated in T_1 (P3S2) in mango cv. Dasheari at 5x5m spacing.

Fig. 1 Field view of canopy architecture management in young mango orchard cv Dashehari

Canopy reorientation of overcrowded orchard

The experiment was started in 2016-17 and concluded in 2023 and RPP III was submitted. The experiment was conducted on 22 years old overcrowded and unproductive high density mango plantation var. 'Dashehari'. The experiment was carried out in factorial randomized block design comprising three factors, viz. planting density (S 1 = 2.5 m X 2.5 m and S 2 = 2.5 m X 5.0 m), pruning height (P 1 = 1.5 m, P 2 = 2.0 m and P 3 = 2.5 m) from ground. The primary scaffolds were left 50-60 cm from top and mulching (M 1 = Organic mulching and M 2 = control) having 12 treatment combinations. It was observed that after 15 years onwards trees become overcrowded, unproductive and attained 4-5 meter height, 2.5-3.90 m canopy spread having canopy volume of 18-70.08 m^3. The total light interception was minimum (400-500 lux) in canopy periphery while maximum (9,000-10,000 lux) on the top of the canopy. The cumulative effect of all these factors leads to the decline in productivity of HDP orchard after 15 years. The study revealed that pruning improved the direct light interception within the tree canopy which has been reflected in the results. The canopy volume was significantly higher in S 2 (16.19, 17.45 and 26.84 m 3) as compared to S 1 (11.99, 13.49 and 12.04 m 3) across the years. Further, canopy volume was recorded maximum (30.56 m 3) in 2.5 X 5.0 m spacing (S 2) with 2.5 m pruning height (P 3) along with mulch basin (S 2 P 3 M 2). Moreover, maximum number of fruits per tree and yield were recorded (28.28, to 54.27 fruits per tree) and (8.28 and 12.00 kg/tree) respectively with 2.5 X 5.0 m spacing (S 2) across the years. Thus higher yield was observed with S 2 P 2 M 2 in totality.

Fig. 2 Bearing in 2.5x2.5.0 m spacing after 6 years severe pruning in HDP Dashehari

Fig. 3 Bearing in 2.5x5.0 m spacing after 6 years severe pruning in HDP Dashehari

Rejuvenation in mango orchard

The 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) where in 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 up to 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. The refined rejuvenation technology was also demonstrated in two locations i.e. Mal, Malihabad and Udhwapur, Sitapur.

The data recorded during 2023 indicate that tree height of rejuvenated mango trees varied from 6.54 m to 8.28 m. Maximum average tree height of 8.28 m was recorded in T-5 followed by T-6 (7.25 m). Average canopy spread in east-west direction was 6.20 to 8.07 m among different treatments while it was 6.5 to 8.02 m in north-south direction among different treatments. Trees exhibited vigorous growth in all the directions. Maintenance pruning was done every year in the month of December to contain the tree height and canopy. Flowering was observed in all the trees and average fruit yield varied from 30.5 kg/tree to 72.2 kg/tree among different treatments. Maximum fruit yield of 72.2 kg was recorded in T-5 and this was closely followed by T-6 with the average fruit yield of 61.8 kg/tree. 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 gram/fruit. Enhanced fruit size was due to relatively reduced fruiting this year. Total soluble solids varied from 16-19^{0}B while ascorbic acid contents varied from 22.9 to 31.25 mg/100g.

Damage by trunk borer and anthracnose: Data were also recorded on the extent of damage caused by stem borer to mango trees. The trunk borer infestation data were recorded during November every year. The major infestation occurred in the rainy season during 2016 and no further infestation was recorded in any treatment in following years with the exception of T2 and T3. Maximum infestation was recorded in T3 followed by T2, T1, T4, T6 and T5 respectively. Differences in borer infestation were significant among all the treatments except T1 and T4.

Table 1. Average trunk borer infestation/ branch

Tr No.	2016	2017	2018	2019	2020
1	0.89	0.89	0.89 [c]	0.89	0.89
2	0.90	0.94	0.94 [b]	0.94	0.94
3	1.32	1.48	1.54 [a]	1.54	1.54
4	0.88	0.88	0.88 [c]	0.88	0.88
5	0.04	0.04	0.04 [e]	0.04	0.04
6	0.16	0.16	0.16 [d]	0.16	0.16
$LSD_{0.05}$	0.11	0.13	0.14	0.14	0.14

After the rejuvenation work done during January 2016, the new growth came out at variable extent in different treatments, and the infection of anthracnose fungus on new flushes was recorded despite fungicide spray. Low infection was recorded during summer months but it was high during rainy and post rainy season. Data indicated that ratio of new growth was proportionate to extent of cutting of branches and accordingly incidence of disease occurred. Incidence was recorded higher in T1 to T4 in comparison to T5 and T6 during 2016 and 2017, but it become at par among the treatments during 2018 and in later years.

A package of Refined Mango Rejuvenation Technology was developed (T-5) which involves thinning out

Table 2. Average incidence (%) of leaf anthracnose

Tr No.	2016	2017	2018	2019	2020	2021	2022	2023
1	82.5	72.5	61.5	52.8	45.0	48.2	45.6	43.9
2	85.0	70.0	57.5	50.5	48.5	42.5	46.2	46.7
3	83.3	68.4	55.0	52.5	51.7	50.6	52.5	48.2
4	81.3	71.5	67.5	62.0	55.9	51.2	49.2	46.7
5	56.5	62.5	65.0	55.0	52.7	45.6	47.8	44.1
6	52.5	58.2	63.7	65.0	52.5	48.6	45.8	42.7
$LSD_{0.05}$	11.7	10.5	9.2	7.9	7.7	7.3	6.9	6.7

of centrally located branch and heading back of two opposite branches and completing the process of cutting over a period of three years. This was found to be the best method to rejuvenate old and unproductive mango trees. It not only ensures regular fruit yields but also avoids damage by stem borer infestation due to reduced intensity of pruning as compared to old rejuvenation technology where all the branches are headed back at the same time. If rejuvenation process is to be completed period of 5 years, farmers may adopt the heading back of one branch every year after thinning out central leader as this also gives comparable results in terms of tree survival, canopy growth and fruit yield except that the canopy development is slow. This also avoids damage by stem borer to a great extent.

Fig. 4a Performance of orchard rejuvenation at farmer's field

Centre opening in mid-age mango

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 58.4 kg to 124.6 kg/tree. Highest fruit yield (124.6 kg/ tree) was recorded in two branches cutting from the centre followed by three branch cutting (84.2 kg/tree). Minimum fruit yield was recorded in control (No pruning). Fruit size varied from 212 g to 309 g/fruit. Total soluble solids ranged in between 17-19^{0}B while acidity and ascorbic acid contents of fruit varied from 0.16-0.22% and 32.3 to 44.8 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 5.2-6.9 m while it was 10.8 to 12.6 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. Maintenance pruning was done every year in the month of December to contain the tree height and canopy.

On-farm demonstration of mango rejuvenation

On farm trial on evaluation of different methods of rejuvenation technology was laid out on farmer's 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 (T 1), Refined CISH Rejuvenation technology (T2), Heading back by maintaining one nurse branch (T 3) 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 significant effect of treatments on tree height reduction, which continued during third 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 2023 and it was concluded that during third year, yield of 27.85 kg /plant was recorded from T 1, and 16.12 kg / plant from T 2 , 37.85 kg/plant from T3 while it was about 42.65 kg / plant in control. In order to enhance income from orchard, fruit quality is a more important factor and it was recorded during the harvesting season. All treated trees which

Table 3. Effect of different rejuvenation techniques on yield of mango.

Treatment details	Fruit yield during 2021		Fruit yield during 2022		Fruit yield during 2023	
	Fruit Yield/ plant (kg)	A grade fruits (%)	Fruit Yield/ plant (kg)	A grade fruits (%)	Fruit Yield/ plant (kg)	A grade fruits (%)
Old CISH Rejuvenation technology	-	-	-	-	27.85	60
Refined CISH Rejuvenation technology	85.5	40	55.5	50	16.12	52
Heading back by maintaining one nurse branch	40.0	40	43.5	50	37.86	55
control	50.0	5	50.0	12	42.65	9

came in bearing produced 52-60 percent fruits of A grade (250gm), while percentage of A grade fruits in control was only 9 percent. There was no mortality of any tree due to any biotic or abiotic stress after heading back or during growth period.

Physiological studies were also carried out. Observations on availability of light were recorded at the marble stage of the fruit set. It was (direct light) was 79.33 percent in T2 and only 28.67 percent in control. Similarly, chlorophyll content ranged from 5.87 mg/g FW in T4 to 9.23 mg/g FW in T2. Photosynthesis rate varied from 5.12 ìmol $CO_2/m^2/s$ in T4 to 12.37 ìmol $CO_2/m^2/s$ in T2. Stomatal conductance was found to vary from 204.74 mol $H_2O/m^2/s$ in T4 to 283.73 mol $H_2O/m^2/s$ in T2. Similarly vapour pressure deficit was found to vary from 2.06 kPaain t4 to 3.47 kPa in T2.

Input Use Efficiency

An experiment on drip irrigation and fertigation scheduling for productivity and quality of HDP mango was initiated during 2017 with an objective to optimize drip/fertigation schedule for HDP mango. There are three drip irrigation schedule (100,80,60 %ER) as main plot and three fertigation schedule (100,80,60% RDF)

Fig. 4b Field view of drip irrigation and fertigation in HDP mango cv. Amrapali

as subplot treatment and replicated thrice under split plot design. Maximum fruit yield (12.26 t/ha) was recorded in 100 drip irrigation and 100% fertigation in mango. However, the nutrient use efficiency (54.8 kg/kg nutrients) and water use efficiency (4.31 kg/m^3) was recorded in 80% drip irrigation and 80% fertigation. Total soluble solids (23.5 ^{O}B) was recorded in 80% drip irrigation and 80% fertigation in Amrapali mango spaced at 5x2.5m under subtropical conditions.

Pre-harvest fruit bagging in mango

The experiment on bagging has been initiated during March 2022 with an objective to optimize suitable bagging material and time of bagging in mango. There were seven types of bagging materials used for experimentations. The Bagging treatments were imposed after four week of fruit set in Dashehari, Amrapali and Arunika mango under HDP.

Blue colour bag

Red colour bag

Yellow colour bag

Brown colour bag

White colour bag

Fruit Tech bag

Orange colour bag

Bagging of fruits significantly enhanced fruit quality in terms of uniformity in skin colour, firmness, TSS and TSS/acid ratio. Fruit bagging of Amrapali at marble stage significantly enhanced fruit colour, firmness (0.98 N) and acidity (0.33%) in mango cultivar Amrapali under HDP.

Fig. 5 Bagged and unbagged fruits of Amrapali

Impact of microbial formulations in organic production system of mango

The research project entitled "Impact of microbial formulations in organic production system of mango (*Mangiferaindica* L) under Indian subtropics" was initiated in 2023 with following objectives.

Objectives

- Testing and evaluation of microbial formulations with organic inputs for soil and plant health restoration.
- Comparative analysis of microbial formulations and organic inputs application and their validation in organic production system.
- Economic analysis of various treatments and development of package of practices of sustainable organic crop production of mango.

The treatments to be imposed during experimentation are as under;

Treatment	Details
T1	Absolute control
T2	FYM (100 Kg)
T3	Vermicompost (50 Kg)
T4	FYM (100 Kg) + Bioenhancer (20 Kg)
T5	FYM (100 Kg) + Biozapper (20 Kg)
T6	Vermicompost (50 Kg) + Bioenhancer (20 Kg)
T7	Vermicompost (50 Kg) + Biozapper (20 Kg)
T8	FYM (50%) + VC (25%) +Bioenhancer (25%) + Biozapper (25%)

Soil fertility and leaf nutrient status: Before imposing treatments, initial fertility status was also analyzed as presented in table 4 while leaf tissue analysis data were given in table 5 shows that the orchard soil is slightly alkaline and fertility status of orchard soil is not good with very low organic carbon content. The leaf nutrient status is also moderate level.

Table 4. Initial fertility status of organic mango orchard

S. No.	Parameters	Soil profile depth (cm)				Average
		0-15	15-30	30-60	>60	
1.	Soil pH	7.57	7.53	7.43	7.40	7.48
2.	Organic carbon (%)	0.58	0.51	0.43	0.43	0.49
3.	Phosphorus (Kg/ha)	21.87	20.47	20.90	15.20	19.61
4.	Potassium (Kg/ha)	130.78	129.98	101.08	62.78	91.16
5.	Calcium (%)	1.67	1.57	1.56	1.54	1.58
6.	Zinc (ppm)	0.67	0.59	0.46	0.46	0.55
7.	Copper (ppm)	3.16	3.17	2.19	1.54	2.52
8.	Iron (ppm)	3.17	2.27	2.27	2.18	2.72

Table 5. Leaf tissue analysis of organic mango orchard

S. No.	Parameters	Value
1.	Phosphorus (%)	0.147
2.	Potassium (%)	0.816
3.	Calcium (%)	2.814
4.	Zinc (ppm)	27.67
5.	Copper (ppm)	16.67
6.	Iron (ppm)	248.33

Tree vigour : In order to assess tree vigour, marphometric parameters of all plants under experimentation were also recorded and treatment layout based average values are presented in table 6. Data on tree vigour shows that there is variation in tree height and girth and tree spread is more than tree height. Moreover, variations were nonsignificant.

Table 6. Bench mark marphometric parameters of organic mango orchard.

Treatment	Tree height (m)	Tree spread (m)		Trunk girth (m)
		North-South	East-West	
T1	7.73	9.75	10.42	1.47
T2	7.49	9.52	9.14	1.46
T3	8.31	9.54	9.76	1.55
T4	7.55	10.36	10.62	1.61
T5	7.31	9.80	9.62	1.41
T6	6.48	9.22	9.32	1.30
T7	8.88	8.42	8.42	1.22
T8	6.97	9.41	9.46	1.43
Mean	7.59	9.50	9.54	1.43
SEd	0.16	0.123	0.07	0.029
SEm±	0.35	0.267	0.15	0.062
C.D. (5%)	0.12	0.087	0.05	0.02

Baseline population dynamics of microbes: Microbial enumeration was performed at different depth of the orchard soil samples (0-10 cm; 10-20 cm and 20-30 cm) and microbial population was observed in terms of Gram+, Gram-, *Azotobacter*, *Actinomycetes* and fungi populations on the different selective media as presented in fig. 6.

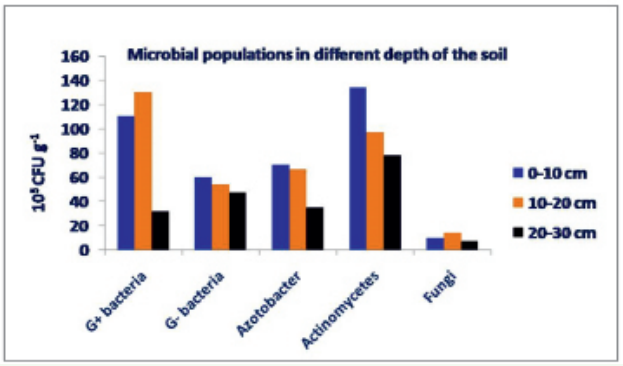


Fig. 6 Microbial population in different depth of soil in organic mango orchard

Soil enzymatic actions: The soil enzymes (DHA-Dehydrogenase and FDA-Fluoreceindiacetate activity) status was also observed (Fig. 7). Based on microbial activity and their population dynamics the top layer (0-10cm) and middle layer of soil (10-20 cm) were assessed most active as compared to the bottom layer (20-30 cm) of the soil. Similarly, the oxidative properties of microbes in terms of soil enzymes activity the top layer showed best DHA and FDA activity.

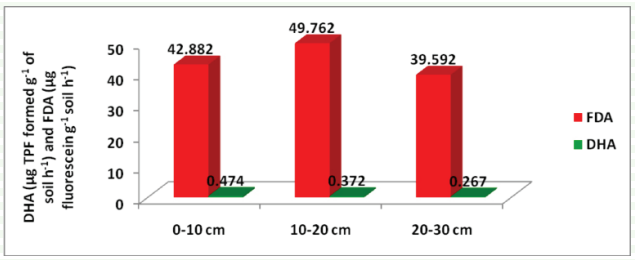


Fig. 7. Enzymes status of orchard soil at different depth

Pest and disease management: For management of pest and diseases, drenching of *Trichoderma* in trenches and foliar spray of *Beauveriabassiana* and *Metarhizium anisopliae* (5ml/l) were done**.** Besides, use of yellow sticky trap, use of solar light based trap, polythene banding on tree trunk, spraying of copper sulphate + calcium on tree trunk and spray of neem oil were also done to minimize pest and diseases problems.

Identification, dynamics, loss assessment and devising management tools and schedule for prevailing and emerging insect pests

Microbial enumeration and soil enzyme activity at different depth of the soil of mango orchard was carried out. Soil samples were collected from different depth of soil (0-10 cm; 10-20 cm and 20-30 cm) and observed microbial population in terms of Gram$^+$, Gram$^-$, azotobacter, Actinomycetes and fungi populations on the different selective media. In addition, soil enzymes (DHA-Dehydrogenase and FDA-Fluoreceindiacetate activity) status was also observed. Based on microbial activity and their population dynamics the top layer (0-10cm) and middle layer of soil (10-20 cm) were assessed most active as compared to the bottom layer (20-30 cm) of the soil (fig.8). Similarly, the oxidative properties of microbes in terms of soil enzymes activity the top layer showed best DHA and FDA activity (fig.9).

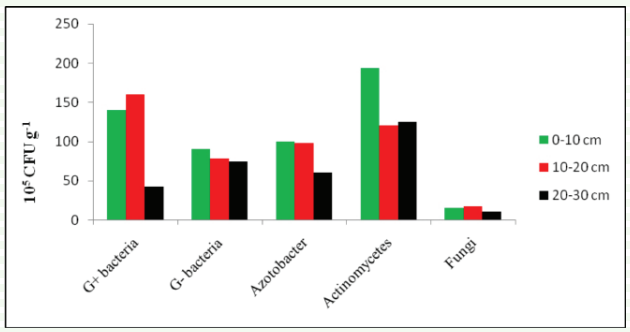


Fig. 8 Microbial population at different depth of the soil

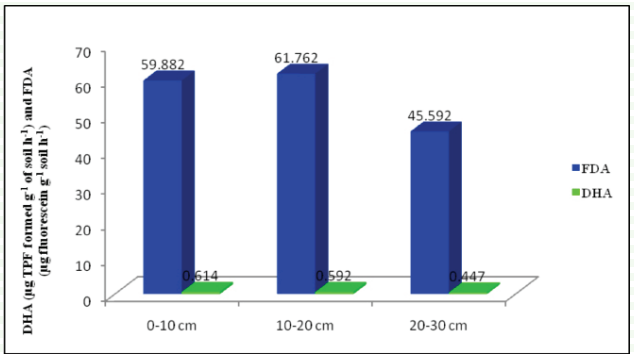


Fig. 9 Soil enzymes (DHA & FDA) at different depth of the soil samples

Management of jelly seed and spongy tissue in Mango

A study was conducted to quantify the incidence of jelly seed (JS) in Dashehari and devising its management modules. The higher incidence of JS was noticed in the fruits that harvested after 3week of June. Further, the incidence was higher in tree ripened fruits as compared to artificially ripened fruits. Hydrolyzing enzymes (PME & PG) activity was higher while Cacontent is low in Jelly seed pulp. In order to manage the disorder, efficacy of Ca, B, K and polyamine was tested in 7 treatment combinations. Study revealed that application of putrescine (2.0 mM) after 40 and 60 days of fruit set was the most effective treatment in reducing the jelly seed incidence (less than 10%). Ca Cl_2dihydrate (2.0%) was also effective in the management of jelly seed. It was observed that the impact of treatments was more pronounced when spray was followed with fruit bagging. Further, incidence of spongy tissue was investigated in Mallika variety of mango and fifty fruit of Mallika were taken into consideration. It was observed that the incidence percentage was not significant this year and it was 8%. Moreover fruit bagging was also done 60 days after fruit set, and it was observed that fruit weight was higher but TSS (^{0}B) was low in case of bagged fruit as compared to un-bagged fruits.

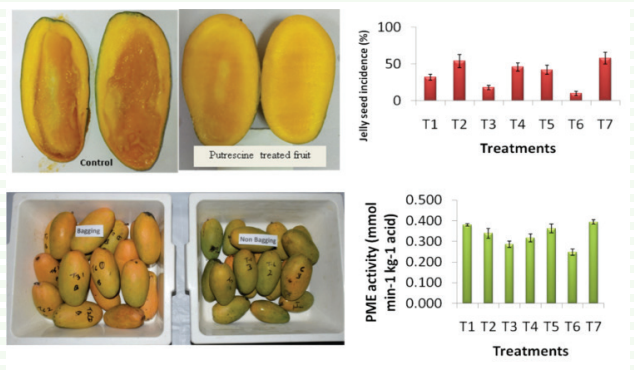


Fig. 10 Management of jelly seed in Dashehari Mango

Fig. 11 Pictorial representation of Spongy tissue and normal fruits of Mallika

Evaluation of Natural Farming Models in Mango

The experiment was initiated in 2023 both at CISH Rehmankhera Farm and Raebareli Road Farm with the objectives of evaluating various systems of natural, bio-natural and traditional modern/chemical farming for sustaining quality production of mango. Besides, various organic/bio-dynamic/natural farming products will also be evaluated for their efficacy against various diseases and insect pest management in mango. The treatments included thre models of organic/natural farming as given below :

1. Package of Natural Farming was imnposed which includes use of ghanjeevamrit (50kg/ tree), digging of trench (3 ft wide and 2 ft deep) in between tree rows, filling it with dry wood and organic wastes, intercropping in available interspaces with legumes/green manuring, mulching around trees, application of jeevamrit at @ 200-400 litre/acre once/twice a month and irrigation around tree canopy to maximize wafsa (soil moisture).
2. Bio natural Farming-Natural Farming + use of bio-formulations + integrated disease and insect pest management using non-chemical methods, canopy management+ use of organic products
3. Traditional/Modern farming using chemicals/ pesticides; Recommended package of practices (GAP) will be adopted including recommended doses of fertilizers (macro and micronutrients), insecticides, etc

During the period under report, soil samples were analysed and initial data were also recorded on fruit yield and quality parameters. Soil organic carbon varied from 0.47% to 0.53% in natural farming plot while it was 0.46% to 0.52% in bio-natural and chemical farming plot at RB Road Farm. The soil organic carbon ranged from 0.38% to 0.44% at Rehmankhera farm under experimental plots. Fruit yield varied from 46 to 67 kg/tree at RB Road farm while it was 62-71 kg/tree at Rehmankhera farm. Fruit size at RB Road campus ranged from 105.5 to 129 g which was probably due

to heavy fruit set due to better activity of pollinators under natural/organic farming conditions. TSS ranged from 19-21^{0}B at RB Road Farm which was slightly higher than the fruits produced at Rehmankhera Farm (16-19^{0}B). Fruit size at Rehmankhera Farm was recorded in the range of 212-334g/fruit. Phenolics content were also studied under natural and chemical farming. Principal Component Analysis PCA-1 and PCA 2 collectively account for 99.21% of the entire dataset. Specifically, epicatechin, catechin, chlorogenic acid, caffeic acid, and gallic acid exhibit a positive influence in natural farming samples, while ellagic acid and para-coumaric acid are positively influenced under bio-natural farming.

Intercroping in mango

Filler crops such as guava cv Shweta, Lalit and Dhawal, custard apple cv Atemoya X Balanagar and ArkaSahan, ber cv Apple Berand pomegranate cv. Bhagwa and dragon fruit (*Hylocereus costarecensis*) where evaluated. Growth parameters were recorded during the period under report. Plant height of different guava cultivars like Shweta, Lalit and Dhawal varied from 2.56 m to 4.3 m. Custard apple cv Balanagar and ArkaSahan X Balanagar (AXB) attained plant height from 2.3 m to 3.5 m. Plant height in pomegranate cv Bhagwa varied from 2.52 to 3.1 m. Plant spread (E-W) in guava and custard apple varied from 3.1 m to 3.5 m and 2.8 m to 3.40 m, respectively. Plant spread in north-west direction in guava and custard apple varied from 2.5m to 3.9 m and 2.7 m to 3.2 m, respectively. Maximum plant height was observed in guava cvLalit while spread was maximum in guava cv Shweta. Dragonfruit could not survive during rains due to water logging.

Guava cv Shweta gave the best fruit yield in association with mango trees. Fruit yield in guava was obtained from 40 to 42.3 kg/tree in addition to 52-61 kg/tree of mango yields. Guava cvShweta proved most compatible and profitable filler crop among the crops evaluated in the experiment. Guava plant has dwarf nature and manageable canopy.

Introduction of nontraditional fruits

Three cultivars of loquat *(Eriobotrya japonica*) viz., *Golden, Gola* and *Talehte*; four cultivars of Avocado (*Persea Americana) viz.,* Arka Ravi, Arka Supreme, CHES Purple and CHES Nursery and three cultivars of longan (*Dimocarpus longan*) are planted in field. All plants are under vegetative growth phase. Plants of paniala (*Flaucortia jangomas*) were also collected from eastern UP.

Evaluation of soil, tree and climatic indicators in mango orchards

Observation on Langra orchard showed soil organic carbon had 0.41 to 0.52 per cent having average values of 0.47 ± 0.04 per cent while available phosphorus and potassium had contents of 23.20 to 34.20 (average values of 28.87±2.95 mg/kg) and 94.40 to 128.75 (average of 112.32±10.50 mg/kg) respectively. Analysis data showed Zn and Ca contents of 0.90±0.24 mg/kg and 1215.55±131.88 mg/kg respectively. It was observed that Cu and Fe contents in soils of Langra orchards had variability of 0.69 to 1.78 and 3.98 to 5.62 mg/kg respectively. The water holding capacity of the Langra orchards had as low as 8.76 to 9.48 per cent whereas maximum 13.41 to 13.68 per cent only. It was noted that WHC of Langra orchard had 12.49 ± 0.89, 12.35±1.93 and 10.69±1.38 per cent at 0-10, 10-20 and 20-30 cm soil depth respectively. Bulk density of 1.4 to 1.8 g/cc was estimated. Results showed orchards had 1.56 ± 0.13, 1.63±0.12 and 1.66 ± 0.08 g/cc bulk density at three corresponding soil depth respectively. Fruit yield of 50 to 100 kg per tree was harvested and lower Langra fruits were obtained from the orchards. Lower soil organic carbon and water holding capacity needs to be improved for further increasing the orchard efficiency *vis-à-vis* export purpose.

Soil Fertility and Yield Assessment in mango cv Amrapali: Representative soil samples were collected from tree root zone depths at 0 to 30 and 30 to 60 cm soil depths. Results suggested low soil organic carbon of 0.43 to 0.56 per cent; available P and K were of 41.14 to 71.28 and 207.24 to 281.93 kg/ha respectively. In case of micronutrients like Zn, the content recorded as 0.62 to 1.18 mg/kg whereas Cu and Fe contents of 1.02 to 1.81 and 3.70 to 6.14 mg/kg were recorded. Tree yields were very good and variability of fruit in Amrapali was recorded from 80.0 to 180.3 kg/tree. Data suggested that the soil and tree health management is crucial for maintaining soil and orchard sustainability.

Statistical approach for estimating soil nutrients and production in Dashehari orchard: Statistical approach to quantify fruit production and soil nutrients are very much essential to have an idea about the present production scenario and future needs to maintain orchard sustainability. Analyzed data showed soil organic carbon was 0.53 to 0.68 per cent while available phosphorus and potassium was 50.38 to 74.80 kg/ha and 219.78 to 332.97kg/ha respectively. Results indicated that Zn contents of 0.51 to 0.96 mg/kg whereas Cu and Fe contents in soils of Dashehari orchards had variability of 0.48 to 1.12 and 3.74 to 5.12 mg/kg respectively. It was inferred from the statistical

histographic distribution that the highest frequency distribution falls in 0.55 to 0.60 percent, 60 to 65 mg/kg, 275 to 325 mg/kg soil organic carbon, soil phosphorus and potassium respectively (Fig. 4). In case of micronutrients, maximum frequency distribution was recorded in 0.5 to 0.6, 8 to 10 and 4 to 5 mg/kg for Zn, Cu and Fe. Fruit yield of 60 to 100 kg per tree was harvested from the orchards. Soil organic carbon and other soil health parameters needs to be improved for further increasing the orchard productivity.

Assessing farm efficiency of Mallika orchard: Assessing the orchard efficiency using statistical tools is very much essential and required to know the present condition of the mango orchards and strategies to be implemented for the future to enhance the performance of the Mallika orchard. Keeping this is view, soil and fruit yield components were estimated for evaluating the orchard performances (Fig. 11). Root zone depth (0-30 cm) soil samples were collected and processed. Analytical data indicated soil organic carbon of 0.49±0.04 per cent; available P and K were of 32.11±3.56 and 100.34±8.373 mg/kg respectively. Soil Ca content of 1470.85±190.04 mg/kg was estimated. In case of micronutrients like Zn, the content recorded as 0.81± 0.14 mg/kg whereas Cu and Fe contents of 1.06±0.26 and 4.06±0.53 mg/kg were recorded. Histographic distribution of these indicators suggested that only in four per cent frequency level maximum SOC (%) varied from 0.45 to 0.55 per cent levels while Potassium at 5 per cent frequency level with highest content of 90 to 100 mg/kg level. Frequency distribution pattern also indicated Zn levels 0.6 to 0.7 and 0.9 to 1.0 mg/kg falls at maximum 3 to 4 per cent distribution and in contrast, 30 to 35 mg/kg at 7 per cent levels of phosphorus (Fig. 12). The maximum contents having highest frequency levels were obtained for Fe, Cu and Ca were of 3.5 to 4.0, 0.8 to 1.0 and 1200 to 1600 mg/kg respectively. Scientific distribution strongly recommends to follow the resource conservation and management practices for improving the soil indicators condition. Fruit yield of 1 to 3 t/ha can be obtained and to improve the efficiency level up to 6 to 8 t/ha, soil and tree health management needs to be co-opted for export purpose.

Fig. 13 Mallika fruits for quantifying orchard efficiency

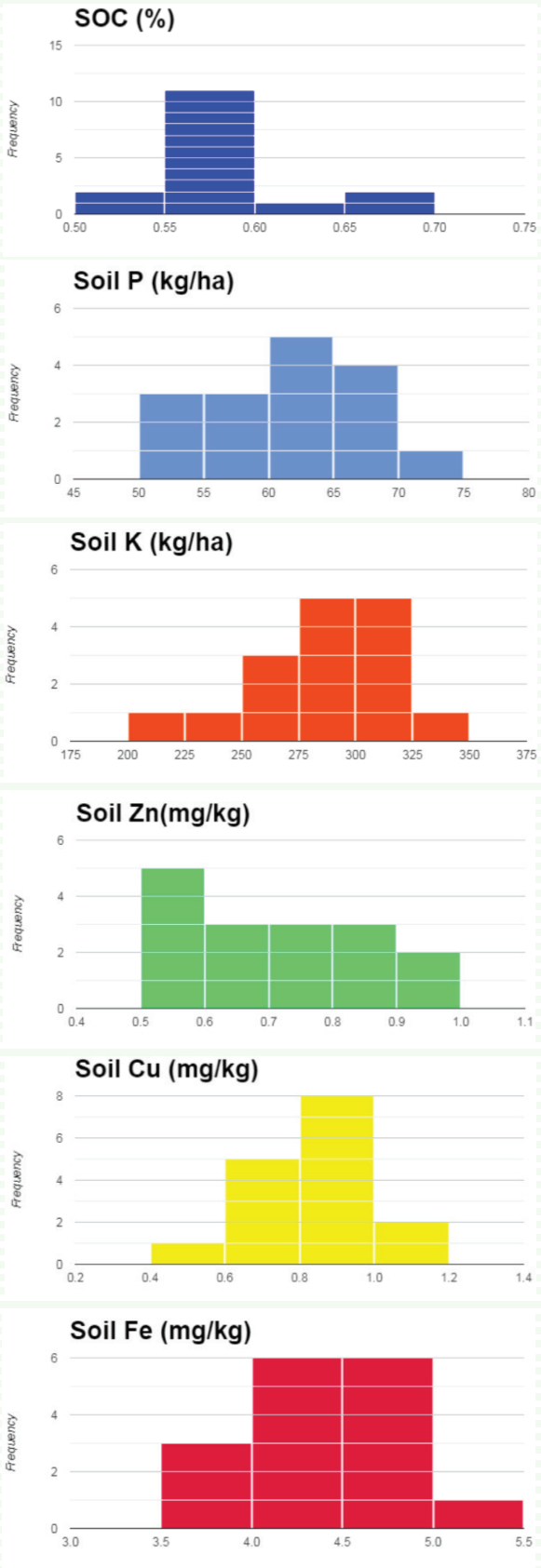


Fig.12 Frequency distribution of soil nutrients of Dashehari mango orchard

Assessing moisture conservation *vis-à-vis* yield variability in existing mango orchards: Scientific analysis of soil-tree-water-environmental interactions is very much crucial for assessing the atmospheric demands during the vegetative and reproductive phase of fruit production. It was observed that fruit set as well as its development depends on number of tree, soil and atmospheric factors that are directly influencing on final fruit bearing of existing mango orchards. The response of trees to the existing environmental condition is very sensitive issue for fruit setting cum fruit retaining. Scientific analysis indicated that during the fruit season of 2023, the net shortwave radiation was 5.32 to 21.80 MJ/m^2/day while net long wave radiation was recorded as 0.63 to 5.40 MJ/m^2/day. The net radiation received in the existing mango orchards was calculated as 3.98 to 18.33 MJ/m^2/day. Each day reference evapotranspiration (ET_0) was estimated and it was noted that 0.95 to 7.84 mm/day and each day pan evaporation of 2.00 to 10.80 mm/day was existed. The bright sun shine (BSS) hours of as low as 0.0 h to maximum of 11.70 h respectively was observed. Moisture conservation based on soil dryness and weather demands having high ambient temperatures with dry hot pan evaporation and ET_0 is important for fruit setting to development.

Fig.14 Moisture conservation *vis-à-vis* fruit variability in existing mango orchards

Appraisal soil and water conservation measures in existing mango orchards: It was recorded that existing mango trees were significantly impacted by the variations of temperatures on the flowering pattern, fruit set and fruit bearing capacity during 2023. Highest maximum temperature (Tmax) of 43.5°C was existed in mango orchards during 2023 season. Lower maximum temperature (Tmax) of 8 to 10°C was recorded. In case of minimum temperature (Tmin), highest values of 28.5°C was noted while lowest values of 2.0 to 1.0°C was noted in 2023 fruiting season. The relative humidity information when analyzed, it was inferred that 61 percent of highest and 29 to 32 per cent lowest RHmax. In order to find out how much reference evapotranspiration (ET_0) was existed during fruit seasons of 2023, modified Penman-Monteith equations was used to estimate. The ET_0 values indicated that each day variability was high and as low as 0.95 to as high as 7.84 mm/day was estimated. Similarly, maximum bright sunshine hours of 11.7 to 12.0 h was recorded. Thus moisture conservation was ensured for fruit production (Fig.15).

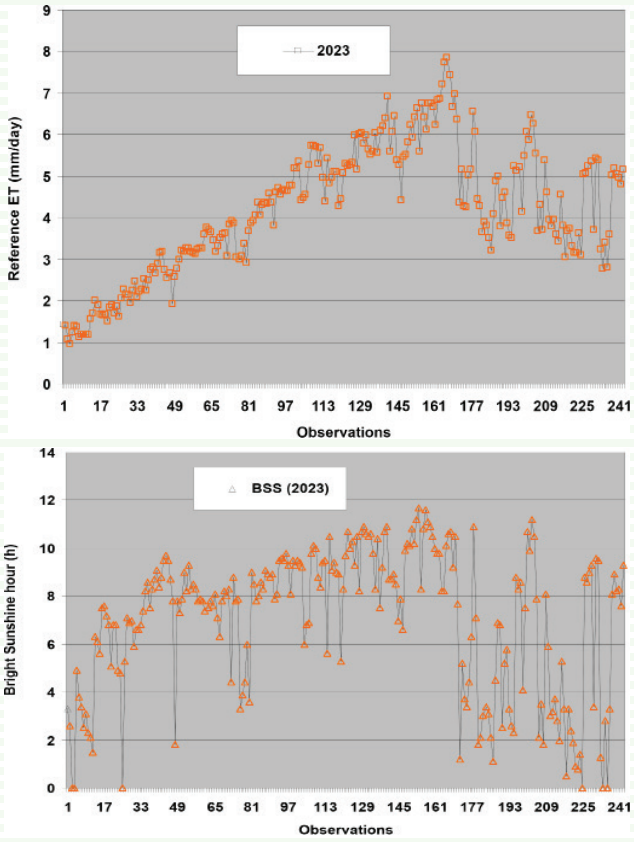


Fig.15 Variability of temperature and relative humidity, ET_0 and BSS in existing mango orchards during 2023

Heat stress mapping in existing mango orchards: Univariate statistical analysis indicated that net shortwave radiation during the fruit growth and development of 2023 were recorded as 8.96 to 21.80 (mean of 16.39±3.69 MJ/m^2/day), net longwave radiation of 0.63 to 4.56 (Mean value of 2.45±1.15 MJ/m^2/day) and net radiation dynamics of 8.21 to 18.33 (mean value of 13.94±2.66 MJ/m^2/day respectively. It was interesting to note that greater ET_0, pan evaporation and BSS values were recorded in fruit growth and developmental stages; 2.76 to 7.84 (mean of 5.08±1.23 mm/day), 2.00 to 10.80 (mean value of 7.71±1.76 mm/day) and 0 to 11.70 (mean value of 6.68±3.52 h) were observed. The heat stress map of existed mango orchards experienced the environmental conditions were developed and it was revealed that radiations dynamics had impact on ET_0. Similarly significant correlation of BSS and pan evaporation was also noticed.

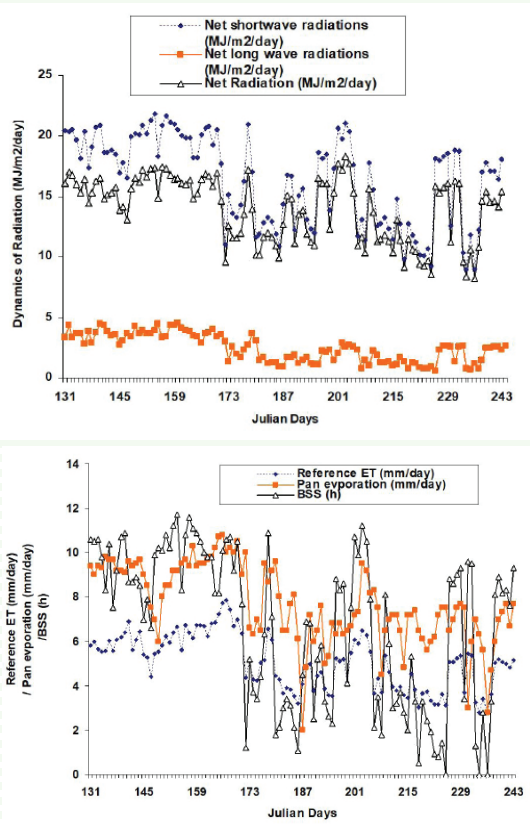


Fig. 16 Dynamics of radiations, ET_0, Pan Evaporation and BSS in existing mango orchards during 2023

Guava (*Psidium guajava* L.)

Enhancing guava productivity through Espalier architecture

The experiment was initiated in 2016-17, involving 2 training architecture i.e. Espalier architecture and traditional system planted at 1.5x3.0 m and 3x3m distance with 3 guava varieties i.e. CISH-Lalit, CISH-Shweta and CISH-Lalima. The Yield and quality attributes after 5 years revealed that maximum fruit numbers (190.25) and yield (32.93 kg) per tree was recorded in CISH-Lalit and average fruit weight recorded maximum (183.25 g/ fruit). Irrespective of

Fig. 17 Bearing in different tiers of espalier architecture of guava after 5 years

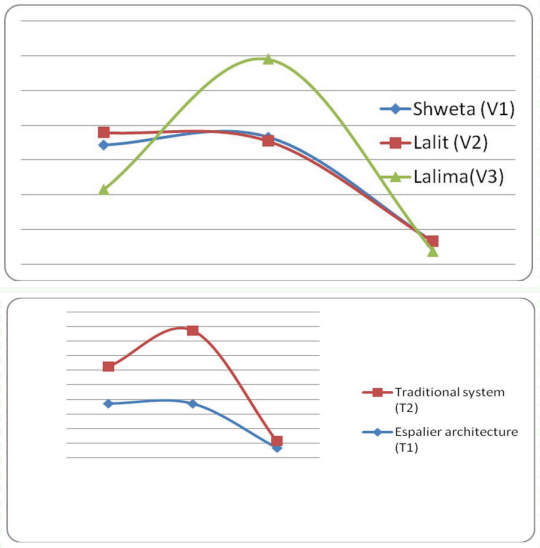


Fig. 18 Yield attributes of guava varieties on espalier architecture
Fig Yield attributes of guava on different tree architecture

variety maximum fruit numbers (186.33) and yield (33.66 kg)/ tree recorded in Espalier Architecture after 5 years. The bearing pattern reveals that maximum fruit numbers recorded on 3rd, 4th& 5th tiers lower most tiers (bottom) 1st and 2nd tiers have less fruit/ tier.

Physiology of Guava under canopy management: Physiological efficiency of winter guava was tested under espalier (4 tiers) and traditional system. Physiological parameters like chlorophyll content along with photosynthetic rate, stomatal conductance,

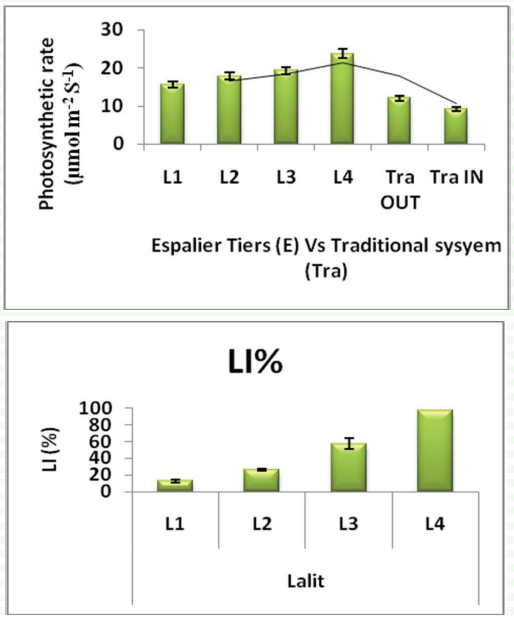


Fig. 19 Photosynthetic rate and LI (%) under canopy management (espalier) Vs traditional system. L1- lower tier, L2,L3- Middle, L4- Upper tier, TraOUT- Traditional sytem outer canopy, TraIN- Traditional system inside orchard canopy.

and transpiration rate were recorded under both the system. Study revealed that rate of photosynthesis was higher in upper tier (L4) leaves; it might be due to better light interception and availability of higher PAR in upper canopy layer, which in turn provide better radiation use efficiency and assimilation rate (figure 19). Further under traditional system the rate of photosynthesis varies when observation was recorded on outer canopy and inside canopy in the orchard. Due to due to dense canopy inside orchard, poor light interception (PAR) was received by the canopy which in turn reflected in the form of low rate of photosynthesis. Further, it was estimated that 40 % reduction in Pn under traditional system as compared to espalier system. Over all under modified canopy management (espalier) plant were more physiologically efficient as compared to traditional system.

Input use efficiency under high density planting in guava

To standardize the input use efficiency under high density planting in guava cv. CISH- Lalit, planted on raised bed at 3X3 m in 2016-17. Only 75% of RDF was applied through drip irrigation system at 80% ER and bed was covered with 100 micron black polythene mulch. Fertilizer and manure was applied @10 kg FYM and 50-25-50 g NPK in two split doses in February and September – November. The dose stabilized after 5 years (187.50- 93.75-187.50g) NPK applied. The NPK of 40-40-20% after fruit set, 20-0-60% NPK during fruit growth and 40-60-40% NPK after fruit harvest per tree. Trees were trained in open center leader system of 4-5 scaffolds branches. Regular annual pruning of grown up trees were carried out in mid to last week of May. For bahar treatment, no irrigation and fertilizer applied from March to June end. Yield per tree was recorded maximum (30.19 kg/tree) in T19 75% RDF, *0 5ER, raised bed with mulching and micronutrient spray in September. Similarly yield efficiency and fruit number/tree were also recorded maximum in T1. Fruit weight was recorded significantly maximum (224.88g/fruit) in T1 and (218.78 g/ fruit) in T2, pulp to seed ratio was recorded maximum, 69.75 and 65.25 in T1 and T2 respectively. Guava shelf life varies 4-5 days in different treatments. Maximum B:C ratio (2.78) noted in T1. Water use (L/day) recorded maximum (19.95 L/day) in T5, lowest 13.9 (L/day) in T1. The pH value of soil vary 7.17 (T5) to 7.25 (T1). Organic carbon recorded maximum (0.56%) in T1 and 0.51% in T5 treatment. EC and Nitrogen content in soil did not recorded significant increment. The pooled data showed that no significant increased in K_2O in soil in pooled analysis; however progressive increased in K_2O has been recorded over the years in soil.

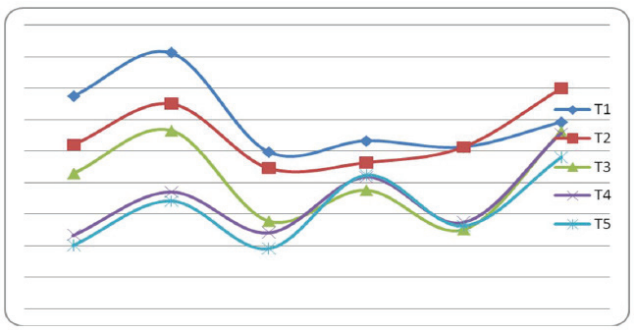


Fig. 20 Year wise (2017-2022) yield (kg/tree) in different treatments of guava

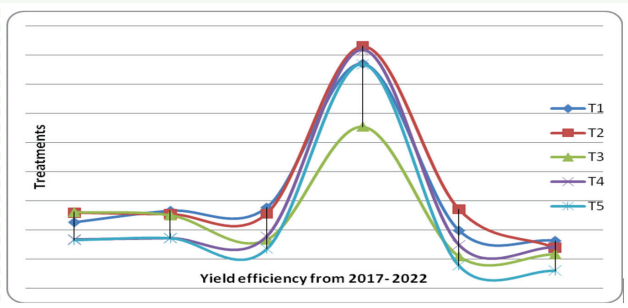


Fig.21 Effect of different inputs on yield efficiency (kg/m^3) in different treatment of guava

Approaches to maximize winter season guava production

To standardize the pruning intensity and timing in guava an experiment was initiated from 15th April to 15th June in 7 years old guava variety Lalit. Irrespective of pruning intensity maximum fruit numbers (246.0) noted in D5 (15th June pruning), while lowest (133.30) on 30 April pruning. Maximum fruit weight (168.80 g) recorded in D2 (30th April). Due to fruit load maximum branch breaking incidence (3.01) noted on D1 (15th April) while minimum branch breaking (1.80) on D5 (15th June) irrespective of pruning time. Maximum fruit number (233.50) noted in P1 (20 %) pruning intensity. Yield was noted maximum (28.60 kg/tree) in P1 and lowest in P2 (22.60 kg/tree).

Development and testing of microbial formulations for guava

Development of Guava wilt quencher (GWQ) bio-formulation and its testing in Guava (*Psidiumguajava* cv. Allahabad safeda) wilt management. By using enrichment techniques isolation, identification and characterization of microbes from leaf, stem, roots and rhizosphere of healthy, partially wilted and fully wilted guava plants parts. Microbes isolated from healthy plants tested for the plant growth

Fig. 22 Experimental setup

promotory activities, compatibility tests, biocontrol action etc. and finally selected microbes were used for the development of guava wilt quencher bio-formulation. GWQ bioformulation tested under pot trails with guava (Allahabad safeda) plants and find out that pots treated with GWQ (+) showed better *Dehydrogenase* (0.827 µg TPF g^{-1} of soil $hour^{-1}$) and *Fluorescein diacetate* (64.117 µg fluorescein g^{-1} soil $hour^{-1}$) activities with higher microbial counts (69 x 10^7 CFU ml^{-1}) on nutrient agar and 26 x 10^3 CFU mL^{-1} on Rose Bengal agar medium as compared to the without treated/ control showed 0.0718 µg TPF g^{-1} (DHA) of soil $hour^{-1}$, 43.952 µg fluorescein g^{-1} soil $hour^{-1}$ (FDA), 19 x 10^5 CFU mL^{-1} (on nutrient agar media) and 12 x 10^3 CFU mL^{-1} (on Rose Bengal agar media). GWQ also showed excellent antagonistic interaction with *Fusariumoxysporium* MTCC – 284 with 89.93 % inhibition of growth after 6 days of time intervals.

Banana (*Musa paradisiaca*)

Bioformulations and fertilizers on productivity and quality of banana

Banana cultivar Grand Naine planted at 1.8x1.8 m spacing at RB Road campus of CISH, Lucknow. Results clearly indicated that maximum fruit yield (70.75 t/ ha) was recorded in 100% RDF followed by 100% NP+organo-mineral formulations (62.85 t/ha) and 50% RDF+50% Fusicont (57.22 t/ha) in banana under subtropics. The overall microbial population found to be better in plot treated with bioformulations in banana under subtropics.

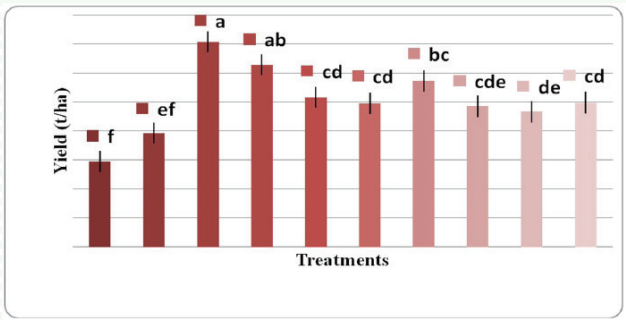


Fig. 23 Effect of bioformulations and fertilizer on fruit yield of banana cv. Grand Naine

Vegetables

Soilless Culture Technology

To find out suitable hydroponic growing system for strawberry six hydroponic structures including control (Grow bag system, Horizontal NFT system, Vertical NFT System, Horizontal Bed drip System, Vertical bed system, control soil growing) were evaluated in three replications on variety Confutera. Cocopeat, vermiculite and perlite in 3:1:1 ratio was used as growing media. CISH- nutrient Solution for hydroponic strawberry was used. The electric conductivity of solution was maintained between 0.80-1.20 and pH was kept between, 5.5 to 6.5.The horizontal bed system recorded highest plant height (11.46 cm) closely followed by vertical bed system (11.18 cm). The highest plant diameter was recorded with vertical bed system (22.60 cm) followed by horizontal bed system (22.50 cm). Highest plant diameter (22.6 cm) was recorded with vertical bed system followed by horizontal bed system (22.5cm) where as lowest plant diameter was recorded in Horizontal NFT system. The number of leaf per plant varied significantly under different growing system. Highest number of leaf / plant was recorded with horizontal bed system (16.80) which statically at par with control (15.26). The lowest number of leaf / plant vertical NFT system. The highest number of fruit / plant (20.92) was observed with

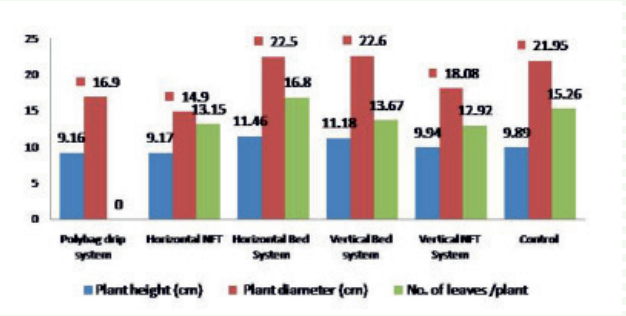


Fig. 24 Effect of different growing systems on plant growth of Strawberry

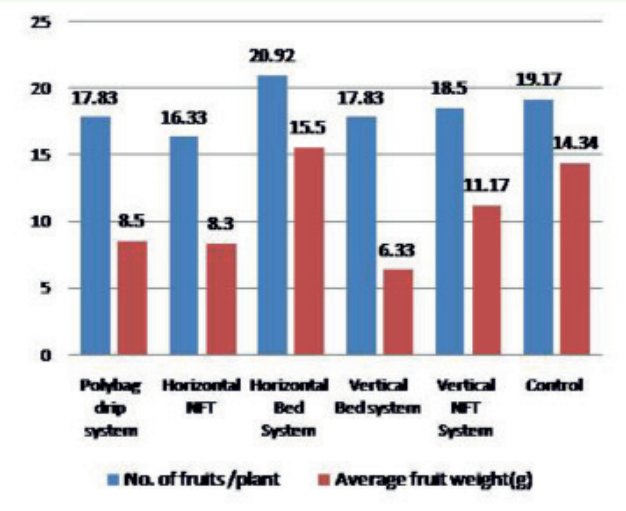


Fig. 25 Effect of different growing systems on fruit number and fruit weight

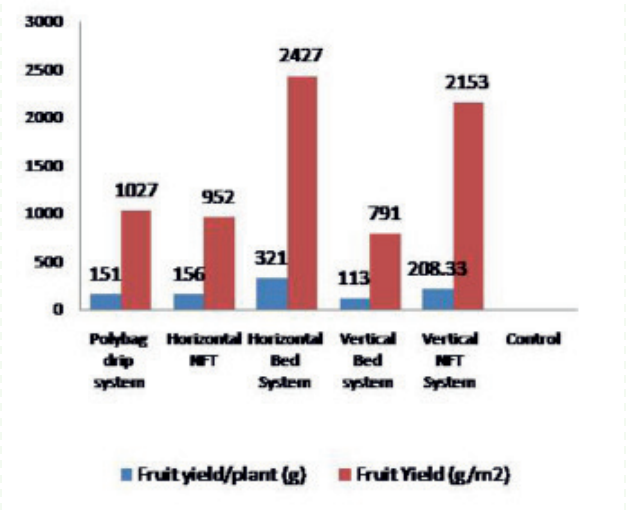


Fig. 26 Effect of different growing systems on fruit yield

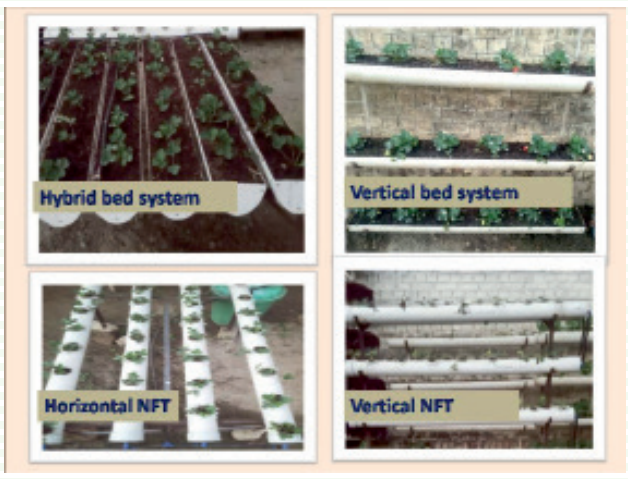


Fig. 27 Hydroponic Growing Structure

horizontal bed system followed by control (19.96). The average fruit weight (15.5g) recorded with horizontal bed system followed control (14.4g).The highest yield per plant (321g) was recorded with horizontal bed system followed by control (307g) .Maximum fruit yield /m^2 was recordedwith horizontal bed system (2427g) closely followed by control (2153g).

Improving Knowledge and Skill of Stakeholders

On farm testing cum demonstration on HDP mango

Demonstrations on high density planting of six mango varieties viz Langra, Chousa, Amrapali, Mallika, CISH-Arunika and CISH-Ambika were carried out at farmers field of Phoolpur Jharia, Mishrikh villages in Sitapur district of Uttar Pradesh. The plants of these varieties of mango were planted at a spacing of 5x5 mt. in 2020. The observations were recorded on vegetative growth i.e. plant height, trunk girth and canopy spread in month of October-November 2023. The data revealed that maximum plant height (2.17 mt) was recorded in Langra variety followed by Mallika (2.08 mt) and Amrapalli (1.95mt). However,

Table 7. Growth and yield attributes of HDP mango at Sitapur

Variety	Plant height (m)	Trunk girth (mm)	Canopy spread (m)	Flowering (%)
Amrapali	1.94	22.20	1.88	96.40
Langra	2.17	22.40	2.03	26.00
Arunika	0.95	11.98	1.03	94.76
Ambika	0.99	11.98	1.07	81.82
Mallika	2.08	21.64	1.61	95.94
Chausa	1.94	20.80	1.40	5.52
CD at 5%	0.39	3.36	0.39	3.83
CV	17.35	13.67	19.34	4.31

Fig. 28 Training to develop efficient canopy on mango at farmer's field

lowest plant height was noticed in Arunika (0.95 mt). Langra variety showed maximum trunk girth (22.40 mm) followed by Amrapali (22.20 mm) which were significantly higher than Arunika (11.98mm). Maximum canopy spread (2.03mt) was noticed in Langra variety followed by Amrapali (1.88 mt) and Mallika (1.61 mt). Early flowering was noted in Amrapali and also maximum flowering (96.4%) was recorded in Amrapali variety followed by Mallika and Arunika. Minimum flowering (5.52%) was observed in Chausa variety (Table 7).

On farm testing and refinement of off season vegetable production technology

The present investigation was carried out in the adopted villages located in Kakori and Mall blocks in Lucknow district with the objective to identify the yield performance and monetary returns under demonstration and farmers practices of different vegetable crops of cauliflower, cabbage, tomato, brinjal chilli and broccoli. Seedlings of these crops were raised in protrays and distributed to the farmers. The data presented in Table 8 on yield of crop/ ha showed that cabbage yielded higher (600 q/ha) than all other vegetables. Tomato, brinjal, cauliflower and broccoli were also high yielders compared than chilli (Fig 29). The economic analysis of the data revealed that tomato under demonstration recorded higher gross returns (Rs.228000), higher net returns (Rs. 177300) and higher B: C ratio (4.40) as compared to other vegetables. Replacement of local varieties of with the improved varieties of cauliflower, cabbage, tomato, brinjal chilli and broccoli would increase the production and net income of these vegetable crops.

Table 8. Yield, Gross return, Net return and B:C Ratio of different vegetables at farmers field

Crop	Variety	Yield (q/ha)	Gross return	Net return	B:C Ratio
Cauliflower	Ruchi	350	180000	130000	3.15
Cabbage	Maharani	600	140000	90000	2.18
Tomato	Benka	450	228000	177300	4.40
Brinjal	Navneet	380	210000	150000	3.20
Chilli	Mistika	150	85120	41507	2.05
Broccoli	Denasty	340	190000	140000	3.50

Fig.29 Farmer harvesting cauliflower and broccoli at Dasdoi village

Canopy management through rejuvenation and centre opening at farmers' fields

Demonstration on refined technology of Mango Rejuvenation was conducted on 60 years old mango trees cultivar Dashehari, at farmer's field at Udhwapur village in district Sitapur of Uttar Pradesh. Rejuvenation was started in December 2018 with the heading back of selected two branches and removal of top most upright growing branch. After cutting the branch, anti-fungal paste was smeared as recommended (Fig 30). Stem borer infestation was managed by cleaning of holes and application of dichlorvos soaked cotton in the infested holes. About 45-60 kg of mango fruits/tree was obtained in 2023 in spite of poor flowering and fruiting due to unfavourable weather conditions.

Fig. 30 Demonstration on mango Rejuvenation Technology at farmer's field

Evaluation of potential intercrop in mango orchard

This activity was started during the period in collaboration with CSIR-NBRI and KVK, Unnao to evaluate the turmeric variety Kesri at the CISH Rehmankhera farm as well as at farmers fields. Twenty farmers from Lucknow, Sitapur and Unnao were selected for the purpose. Five hundred kilograms of turmeric rhizomes var Kesri was procured from NBRI and distributed to the farmers @ 25 kg/farmer. The rhizomes of turmeric were sown by the farmers in the month of July,2023 in well prepared field. Farmers recorded rhizome yield of 14-16 tonnes/ha. Many farmers didn't harvest the crop and left as such for the next year. A farmer from Bhadeshar Mau who grew turmeric in association with pigeonpea and obtained 400 kg of turmeric produce from 40 kg seed turmeric. Farmers are well motivated for growing turmeric in their mango orchards (Fig 31).

Fig.31 Turmeric cultivation with pigeon pea at farmers fields at Bhadeshar Mau

Demonstration of improved varieties of guava at farmers field for enhance profitability

Demonstration of four improved varieties Shweta, Dhawal, Lilit and Lalima of guava were carried out at farmers field in 2022 to assess their performance and profitability. It is observed that 100 percent plants were survived and well growing. Dhawal variety showed maximum plant height (1.67 mt) and trunk girth (3.20 cm) while Lalit variety was recorded low plant height (1.35 mt) and trunk girth (2.09 cm) (Fig 32).

Fig. 32 Performance of improved varieties of guava at farmers field

Performance of Aruika variety at farmer's field

Demonstration of Arunika variety of mango was conducted at farmer's field at Bakshi Ka Talab in Lucknow district of Uttar Pradesh. The plants of Arunika variety of mango were planted by farmer under high density planting system in 2016-17. After six years of planting, farmers were obtained 30- 35 fruits/ plants (Fig 33). The average fruit weight and yield were 250 g and 15 kg/ plant, respectively.

Fig. 33 Performance of Aruika variety under high density planting system at farmer's field

3C Crop Protection

Identification, dynamics, loss assessment and devising management tools and schedules for insect pests of subtropical fruit crops

Assessment of losses, identification and development of management tools and schedule

(i) Pollination failure and incidence of caterpillars

During the crop cycle, flowering occurred on a comparatively higher scale than the previous year. However, the pollination couldn't happen due to lack of pollinators and fruit setting was very poor. Therefore, the photosynthates extensively produced new shoots. Consequently, the incidence of defoliator insects was higher than usual.

(ii) Mango Mealy bug (*Drosicha mangiferae* Green)

The incidence of the mango mealy bug was observed from the 6th Standard Meteorological Week (SMW) to 20th SMW. The nymphs and adults were found infesting mostly the twigs and inflorescence peduncle. By regular monitoring, the mealy bug population was counted from randomly selected twig of different directions of the tree. However, the incidence of Mealy bug in this region was negligible but in some un-ploughed plots, the population of mealy bugs was very high (27.15 mealy bugs/ twig)

(iii) Mango hopper (*Ideoscopus clypealis, I. nitidulus Amritodus atkinsoni)*

The population dynamics of the mango hoppers was recorded throughout the year. The new vegetative flush and inflorescence were found to be infested with *I. clypealis* and *I. nitidulus* whereas, the infestation of *A. atkinsoni* was found much later and mostly on tree trunks. The hopper population was observed in two peaks, the first peak of the hopper population was recorded during the 15th SMW with 11.25 hoppers/panicle/tap and the second peak was observed during the 25th SMW with 13 hoppers/panicle/tap in 2023.

(iv) Mango thrips (*Scitothrips dorsalis & Other species)*

Incidence of thrips was observed with the help of yellow and blue sheets. Randomly selected new emerging leaves were tapped over the sheet and dropped thrips were counted. Both nymphs and adult thrips were found to infest the new shoot and inflorescence. The observation was taken between 5th and 47th SMW during 2023. The Thrips population was observed in two peaks, the first peak of the thrips population was recorded during the 10th SMW with 39.20 thrips/tap and the other one was observed during the 19th SMW with 20 thrips/tap.

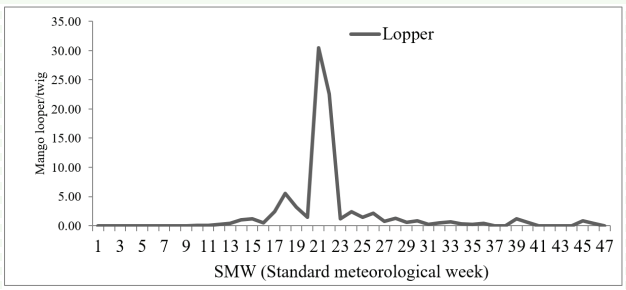
(v) Inflorescence midge (*Erosomyia mangiferae* (Felt)

The incidence of Midge was observed between the 5th and 15th SMW during 2023. Weekly observations were taken from the mango orchard by counting the damaging spots (symptom) per panicle. The peak incidence of the pest was recorded during the 10th SMW with 4.05 Spot/twig.

(vi) Black Inch worm (*Hyposidra talaca* (Walker (1880)

The incidence of *Hyposidra talaca* was observed especially from 10th to 46th SMW during 2023. In the four directions of tree canopy, randomly selected twig was considered to take data. Number of caterpillars feeding on leaves of selected twigs was counted. Peak incidence of the pest was recorded during the 21th SMW with 30 larvae/ twig. The loopers cause the severe damage on new leaves and in some cases cut the peduncle of developing fruits and caused the feeding spots on the fruits by nibbling.

This is the new emerging insect on mango in this region. Due to regular rainfall in summer, this year the mango orchards became highly prone for insects especially mango loopers thereby the incidence of *Hyposidra talaca* was very high.

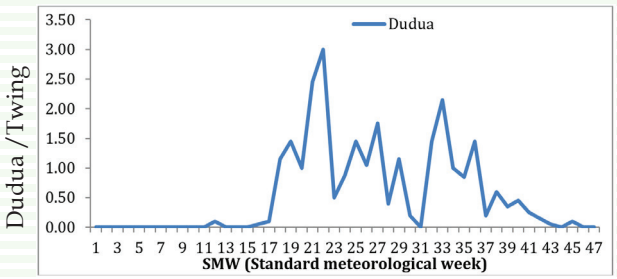


(vii) Mango leaf webber (*Orthaga euadrusalis* Walker)

The leaf webber incidence was observed between 31th and 47th SMW during 2023. Visual counting of the webs from each tree canopy was followed regularly. Peak incidence of the leaf webber was recorded during 42th SMW with 13.40 webs/tree.

(VIII) Inflorescence web worm (*Dudua aprobola* (Meyrick, 1886)

Incidence of inflorescence web worm was observed by counting larvae visually on the twig or fruit selected from all four directions of the tree. This observation was taken between 12th and 45th SMW during 2023. The peak incidence of the leaf webber was recorded during the 22th SMW with 3 larvae/twig.



(ix) Gatesclarkeana sp. (leaf eating caterpillar)

The *Gatesclarkeana* sp. incidence was observed from 33th to 47th SMW during 2023. Numbers of larvae were counted from randomly selected twig from all (four) directions. The peak incidence of the *Gatesclarkeana* sp. was recorded during the 40th SMW with 2.20 larvae/twig.

(x)Mango shoot caterpillar (*Penicillaria jocosatrix* (Guenee))

Penicillaria jocosatrix incidence was observed from 33th to 46th SMW during 2023. By regular monitoring, the caterpillars' population was counted from randomly selected twig of different directions. The peak incidence of the *Penicillaria jocosatrix* was recorded during the 40th SMW with 1.80 larvae/twig.

(xi) Mango leaf cutting weevil (*Apoderous marginatus* Pascoe)

The *Apoderous marginatus* incidence was observed between 33th and 46th SMW during 2023. As the main damaging stage of this pest is adult, they were counted from the randomly selected twig of all the directions. The peak incidence of the *Apoderous marginatus* was recorded during the 40th SMW with 1.80 adult/twig.

(xii) Oriental fruit fly (*Bactrocera dorsalis* (Hendel))

CISH fruit fly traps were installed in the mango orchard @ 10traps/ha. and the trapped adult fruit flies were counted every week. The mango fruit fly incidence was observed between 15th and 43th SMW during 2022. The peak incidence of the fly was recorded during the 28th SMW with 565.35 flies/trap/week.

(xiii) Mango shoot borer (*Chlumetia transversa* (Walker, 1863))

The *Chlumetia transversa* incidence was observed between 31th and 38h SMW during 2023. The main damage symptoms of this pest were hole in new emerging shoots. Data were taken in of all the directions 5 twigs. The peak incidence of the *Chlumetia transversa* was recorded during the 36th SMW with 2.80 damaged twig/ 5 twigs.

(xiv) Varietal screening of looper (*Hyposidra Talaca*) in different mango varieties

A total of 20 varieties of mango waere screened and sever incidence of *Hyposidra talaca* was recorded in variety of Langra followed by Dashehari and least in fazli (Table 1).

Table-1 Incidence of semilooper in different varieties

Incidence of looper (*Hyposidra talaca*) in mango varieties						
Varieties	**On Trunk/Ft²**	**On Ground/ Ft²**	**Hanging /Ft²**	**On New Flashes**	**On 5 Fruits/tree**	**Mean**
Dasheri	2.40	2.80	1.20	5.80	0.80	2.60
Langda	3.50	2.60	2.25	3.25	2.00	2.72
Chausa	1.60	1.40	1.00	2.30	0.60	1.38
Ambica	0.60	0.00	0.80	2.40	1.00	0.96
Arunica	0.50	0.20	0.40	2.50	1.20	0.96
Banglora	1.25	2.00	1.50	3.00	2.25	2.00
Saheb pasand	0.20	0.00	1.00	2.33	0.40	0.79
Fazali	0.00	0.00	0.00	0.20	0.00	0.04
Bright Columan	0.60	0.00	0.80	3.00	2.80	1.44
Hathijhool	1.00	0.60	0.40	6.20	0.00	1.64
Shukul	0.40	0.20	0.15	4.00	0.00	0.95
Alifelia	0.40	0.40	0.10	4.50	0.00	1.08
Kala pahad	0.00	0.00	0.40	3.60	0.00	0.80
Kisan bhog	0.00	0.75	0.00	1.80	1.00	0.71
Bathui	0.00	0.00	0.40	5.80	0.00	1.24
Khasamkhas	0.20	0.00	0.40	5.40	3.20	1.84
Aamin khurd	0.40	0.20	0.20	4.75	1.20	1.35
Mohan bhog	0.20	0.60	0.00	7.80	0.80	1.88
Galash	0.00	0.00	0.20	3.20	0.20	0.72
Lalima	0.00	0.00	0.40	1.80	0.00	0.44

(xv) Host range of *Hyposidra talaca*

After regular monitoring of the orchards it was found that *Hyposidra talaca* attacks on a wide range of other fruit crops. To examine the damage caused by this looper, three levels (severe, mild, low) were determined according to percentage damage. It was recorded that *Hyposidra talaca* attacks severely on Mango, Guava and Litchi, moderately attacks in Beal, Jamun, Khirni and Karonda while least attack was found in Mahua, Pear and Sapota (Table 2).

Table-2: Host range & damage level of *Hyposidra talaca* on different hosts

SN.	Host name	Level of damage	Leaf Damage %
1	Mango	Severe	60-80%
2	Litchi	Severe	60-80%
3	Guava	Mild	40-60%
4	Khirni	Mild	40-50%
5	Pear	Mild	30-40%
6	Beal	Low	20-30%
7	Mahua	Low	15-20%
8	Karonda	Low	15-20%
9	Sapota	Low	5-10%
10	Mango	Severe	60-80%


Mango


Guava


Karonda


Litchi


Jamun


Mahuwa


Sapota


Pear

(xvi) Monitoring the ground fall of oil pupating panicle midge in mango field on ground polythene sheet

To Monitor the seasonal incidence of gall midge on mango, ten number of 1m^2 size polythene sheets were placed under the canopy of mango trees and after 24 hours, numbers of fallen midge larvae were counted. The peak duration of incidence was observed between 23/2/2023 to 4/4/2023. Maximum numbers of gall midge larvae were observed on the date of 15/03/2023 with average larvae of 595.2 larvae/m^2 area.

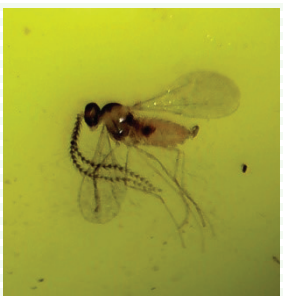
(xvii) Monitoring the fall of panicle midge in mango panicle covered by polythene bags

The panicles of mango were covered by transparent polythene bags to count the actual numbers of midge larvae and fruits damaged by them. After un-wrapping the bags, numbers of fallen fruits per panicle damaged by midge were counted (Table 3). This trial was conducted 27-03-2023 to 31/03/2023.

Table-3: Panicle midge larvae in polythene bag

Date	Mean No. of Midge/Panicle/ polythene bag	Midge Infected fruits/ Panicle/ polythene bag
27/03/2023	2.9	8
28/03/2023	2.6	6
29/03/2023	3.1	10
30/03/2023	2	7
31/03/2023	1.8	6

(xiii) Monitoring the soil emerging insects in mango orchard



This trial was conducted by placing the 10 thermocol boxes under the tree of mango orchard. These boxes were made sticky from inside and total sticky area was 425 inch^2. Data was taken every 10th day after installing the boxes between 20/2/2023 & 20/4/2023. It was seen that maximum trapped insects were adult of mango gall midge (10.93) followed by mango thrips (3.07) (Table 4).

New tools and devices for pest management

(i) Auto rotating sticky light trap

This is the advance and combined version light trap and yellow sticky trap. Due to presence of LED lights this sticky trap is used during day time and at night as well against light & colour loving

Table 4. Emergence of insects from mango orchard soil

		No. of insects inside of box/Paper sheet							
S.No	**Insects**	**20/02 /2023**	**1/3/ 2023**	**10/3 /2023**	**20/03 /2023**	**31/03 /2023**	**10/4 /2023**	**20/04 /2023**	**Mean**
1	Midge adult	6.20	9.20	8.60	7.80	18.80	15.80	10.12	10.93
2	Beetle	0.80	0.60	0.80	1.00	2.00	1.40	1.04	1.09
3	Thrips	2.60	1.00	3.40	3.00	4.60	4.00	2.92	3.07
4	Dudua adult	0.40	0.40	0.20	0.40	0.00	0.20	0.28	0.27

pests. Two bearings are placed in the centre of this trap which rotates it according to the wind. When the trap rotates, the yellow sticky surfaces cover the whole space around the trap and all insects flying near this trap get stuck. Three sticky surfaces are set in this trap that's why it attracts the insect from all directions (Table 6).

First model: was designed with battery charging system on top of the trap stand, PVC sheets were inserted into PVC pipes and a rod was inserted into the pipe so that the sheets along with PVC pipe rotates on wind blow. Here, the LEDs were fitted on three plates on the mid body of the PVC pipe (Table 5).

Green LED White LED Blue LED

Final prototype

Table 5. Specification of prototype

Length of sheet	46cm
Width of sheet	22cm
Surface area of one side of a sheet	1288 sqcm
Total surface area available for insect catch	2576 sqcm
LED colours	White, Blue and Green
Number of LED in each row	3
Switch on time	5.30 PM
Battery	Re-chargable Lithium.

Table 6. Trapping potential of Auto rotating sticky light trap (7 days data for each month)

Month	Day time	Night time	Total
August	487	3096	3583
September	1003	3044	4047
October	1021	2899	3920
November	877	2885	3762

In second model, the steel pipes of two diameters were used. One was inserted in another and battery was fitted on the top. The battery was brought to office in day time for charging. Iron spokes were fitted to hold the PVC sheets and LEDs were fitted externally.

The third model was made from PVC pipe, the battery was concealed inside the pipe from the top. Thin iron plates were fitted to hold the PVC sheets. The LEDs were fitted from the inside of the pipe. However, the whole assemble was brought to office in day time for charging.

In fourth model, battery and LEDs were fitted inside the pipe, switch on/ off mechanism was fitted from out side, iron spokes were fitted to hold the PVC sheets.

Thus the final model was achieved and tested for its insect attraction capacity in day as well as in night hours.

(ii) Modified web remover

- The existing CISH web remover was modified with respect to various structural and functional parameters and was evaluated against the webbings caused by mango leaf webber (*Orthaga euadrusalis*).
- The first modified web remover was comparatively heavier in operation (need of light weight, higher strength materials) and involve drudgery. Whole structure is a conductor of electricity in the first modification. Partial insulating materials may be given in handle to avoid any contact to electricity and further damage.The possibility of attaching two different designs of web remover (wide and narrow to target different size of webs and to avoid damage to healthy leaves) with light materials in a hinge type system needs to be explored.
- In the second modified web remover, there were addition of a movable shaft which can regulate the

Table 7. Comparison between original web remover and its modifications

Sl. No.	Parameters	Original web remover	First modification web remover	Second modification
	Structural characteristics			
1	Number of pegs	7	12	9
2	Center of gravity	Middle of the handling rod	Towards anterior part 1.5 ft from the anterior part	
3	Length of penetration	6 cm	10 cm	10 cm
4	Angle of pegs from the line of handle	140°	90°	90°
5	Orientation of pegs	Outward	Perpendicular	Perpendicular
6	Any addition	-	Extra pegs	Adjustment in number of pegs with movable adjustable shaft
	Functional Parameters (scorings varies from (1-10)			
1	Coverage of surface area .	4	9	9
2	Firmness of holding/ ease of holding .	6	6	7
3	Chances of damage to other healthy leaves.	2	7	7
4	Ability of penetration and gripping to the webs.	3	7	7
5	Drudgery	3	9	4
6	Degree of getting stuck within leaves.	3	9	7
7	Ease of carrying (weight).	8	5	7
8	Durability (materials)	7	7	7
9	Number of attempts made to remove the web.	46	24	19
10	No of attempts when healthy leaves were damaged along with operation.	4	12	7

width of the opening of pegs. So that smaller and larger sized webs can be targeted minimizing the damage to healthy leaves. Further any elongated bamboo pole can be attached in the second modified web remover to make it safer while operating in electrocuted orchard (Table 7).

- In third modified embodiment the above parameters were added.

(iii) Multi-layered and dual-coloured glue trap (modified CISH glue trap)

It is modifies form of previous CISH- multilayered white oil based glue trap. In this embodiment, a multi-layered white-oil glue-based long-lasting insect sticky trap is made that comprises: a plurality of colored sheets coated with an oil-based glue, wherein each of a colored sheet (blue and yellow) is coated with the white oil-based glue, wherein the white oil-based glue is configured to be transparent in nature. Glue coated colored sheets (blue and yellow) are superimposed one over another. Three circular holes placed over one margin of the superimposed glued colored sheets. Each circular hole from the plurality of circular holes are configured to be at equal distance from each other. Three plastic wires are configured to be inserted in the three circular holes of the superimposed colored sheet. The superimposed colored sheets are fastened by joining two ends of each plastic wire from each hole to form of a ring in order to hang the superimposed colored sheets through a string in a crop field. Two non-sticky sheets are placed over the glue coated superimposed colored


Blue surface


Yellow surface

Table 8. Comparative Specification and catch potential of old multilayer sticky trap with new model of trap

Specification	Multilayered- dual coloured white oil based trap (new model)	Multilayered white oil based trap (old model)
Number of sheets	4	4
Colours of sheets	Blue and Yellow in single embodiment	Yellow and blue in separate embodiment
Glue type	White oil based glue used in previous CISH-glue trap	White oil based glue
Dimension of sheets and Surface area	33x27cm=891sqcm x2=1782sqcm	22x27cm=594sqcmx2=1188 sqcm
Insect catch for 7 days in		
August	3191	2705
September	2487	2100
October	2445	2155
November	2417	2116
Efficacy of stickiness	Continued	Continued

sheets, wherein a first non-stick sheet is placed over one side and a second non-sticky sheet is placed over another side of the superimposed colored sheets; and a base stand configured to receive the superimposed colored sheets through the string, wherein the base stand comprises a hanger or hook in order to hang the string passing through the rings of the at least two plastic wires. The superimposed sheets are configured to hung over the base stand up to a height of a canopy of the crop and the first non-sticky sheet is removed from the glue-coated surface in order to allow insects to stick onto the glue-coated sheet; after a particular time period, said glue-coated surface is turned to other side and the first non-sticky sheet is affixed over said turned surface, wherein a second surface of the glue-coated colored sheet acts to allow insects to stick onto the glue-coated sheet (Table 8). Thus, in one trap two sticky sheets of blue and yellow colour attract the insect of different orders.

Development and refinement of IPM schedules for the targeted pests of subtropical fruits

(i) Efficacy of Glue (water soluble polymers) against thrips

Concentrations of Glue 705 & Glue 5000 [Water soluble polymers (WSP)] were diluted at the ratio of 1:5, 1:7.5 and 1:10 with water and sprayed on the mango canopy wherever thrips population was high.

After spraying, the numbers of thrips were counted per tap of twig in the four directions of tree canopy and this data was compared with pre spray data. It was found that WSP arrested the free movement of the thrips thereby helpful to control the thrips population. Treatment-1 (Glue 705) 1:5 ratio gave the best result as compared to the other treatments. No phytotoxic effect was observed on the sprayed plant parts (Table 9).

Table 9. Efficacy of glue (water soluble polymers) against thrips

SN.	Treatment	Dosage/1lit.	Absolute population				
			DBS	3 DAS	7 DAS	10 DAS	Mean
T1	Glue705	01:05	9.75 (3.20)	3.75 (2.06)	5.25 (2.40)	7.50 (2.83)	5.50 (2.45)
T2	Glue705	01:07.5	18.00 (4.30)	4.25 (2.18)	6.50 (2.65)	11.00 (3.39)	7.25 (2.78)
T3	Glue705	01:10	14.75 (3.91)	5.50 (2.45)	7.75 (2.87)	14.25 (3.84)	9.17 (3.11)
T4	Glue5000	01:05	16.00 (4.06)	4.00 (2.12)	5.75 (2.50)	8.50 (3.00)	6.08 (2.57)
T5	Glue5000	01:07.5	12.50 (3.61)	4.75 (2.29)	7.00 (2.74)	12.25 (3.57)	8.00 (2.92)
T6	Glue5000	01:10	23.75 (4.92)	6.50 (2.65)	8.75 (3.04)	14.75 (3.91)	10.00 (3.24)
T7	Control		18.5 (4.36)	19.25 (4.44)	24.75 (5.02)	35.5 (6.00)	26.50 (5.20)
SEM			NS	0.31	0.30	0.15	0.09
CD			NS	0.92	0.90	0.46	0.26
CV			-	24.3	20.3	8.2	4.7

(ii) Efficacy of pesticides & entomopathogenic fungi on mango thrips

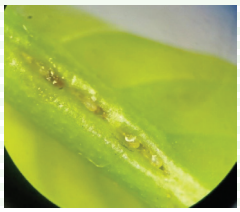
Pesticides and entomo-pathogenic fungi were sprayrd on randomly selected mango trees after taking the pre spray data. After 3rd 7th and 10th days of spray, thrips population was recorded from each replication of treatments. For taking the observation, random twigs were selected from the four directions of the tree canopy and tapped upon the A4 sized yellow plastic sheet and thrips were counted dropped on it. Acetamiprid 0.33g/litre spray gave the best result as compare to rest of the treatments (Table 10).

Table 10. Bio-rational effects of various doses of pesticides & Entomopathogenic fungi on mango thrips

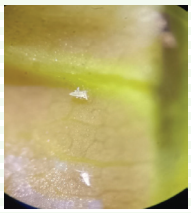
S.No.	Treatment	Dosage/1lit.	Absolute population				
			DBS	3 DAS	7 DAS	10 DAS	Mean
T1	*Emamectin benzoate* 5% SG	0.5 ml	30.00	12.00	7.50	16.00	11.83
T2	Abamectin 1.9% EC	0.3 ml	20.25	9.00	5.25	12.00	8.75
T3	Fipronil 5% SC	1 ml	28.75	8.50	3.50	10.50	7.50
T4	Acetamiprid 20% SP	0.3 ml	22.50	5.25	2.75	8.50	5.50
T5	Metarhizium anisopliae 1×10^8 CFU/gm	5 gm	21.75	29.75	66.13	95.19	63.69
T6	Beauvaria bassiana 1×10^8 CFU/gm	5 gm	23.75	27.50	58.00	89.00	58.17
T7	Neem oil 10000ppm	3 ml	22.25	15.50	21.00	46.50	27.67
T8	Glue 705	1:10	21.00	12.50	17.00	37.25	22.25
T9	Control	-	20.75	30.13	67.25	99.00	65.46
	SEM		NS	2.63	3.45	4.15	8.49
	CD		NS	7.67	10.07	12.11	25.46
	CV		NS	31.5	25.0	18.1	48.9

(iii)Efficacy of Glue (water soluble polymers) against Hopper in organic orchard of mango

Glue 705 & Glue 5000 (Water soluble polymers) (WSP) were diluted at the ratio of 1:5, 1:7.5 and 1:10 with water and sprayed on the mango canopy wherever hopper population was high. It was found that WSP arrested the free movement of the hopper thereby helpful to control the population of mango hopper. Treatment-1 (Glue 705) 1:5 gave the best result as compare to the other treatments (Table 11). No phyto-toxic effect on the sprayed area was observed.



Eggs of Mango Hopper



Nymph of Mango Hopper

(iv) Effect of various treatments on hopper in organic mango orchard

On randomly selected hopper infested trees, Glue and Entomopathogenic fungi (*Beauvaria bassiana*

Table 11. Efficacy of Glue (water soluble polymers) used for Hopper

S.No.	Treatment	Dosage/1lit.	Absolute population				
			DBS	3 DAS	7 DAS	10 DAS	Mean
T1	Glue705	01:05	4.00 (2.12)	1.00 (1.22)	1.75 (1.50)	0.75 (1.12)	1.17 (1.29)
T2	Glue705	01:07.5	3.50 (2.00)	1.75 (1.50)	2.75 (1.80)	1.25 (1.32)	1.92 (1.55)
T3	Glue705	01:10	4.75 (2.29)	2.25 (1.66)	3.50 (2.00)	4.75 (2.29)	3.50 (2.00)
T4	Glue5000	01:05	5.00 (2.35)	1.50 (1.41)	2.25 (1.66)	2.25 (1.66)	2.00 (1.58)
T5	Glue5000	01:07.5	3.75 (2.06)	2.50 (1.73)	3.25 (1.94)	3.25 (1.94)	3.00 (1.87)
T6	Glue5000	01:10	4.75 (2.29)	3.00 (1.87)	4.25 (2.18)	5.00 (2.35)	4.08 (2.14)
T7	Control		3.25 (1.94)	5.25 (2.40)	6.25 (2.60)	6.50 (2.65)	6.00 (2.55)

& Metarhizium anisopliae) were sprayed, & sticky polythene was wrapped with white glue on trunk. After completing all the treatments, a yellow CISH Glue trap was hung near the main trunk of each treatment and number of mango hoppers was counted on 5th DAS then the sheet of glue trap was turned and the data was taken again 10 DAS. Foliar spray of Glue 705 (water soluble polymers) gave the best result in reducing the mango hopper (Table 12).

(v) Evaluation of efficacy of soap and various pesticides against mango leaf webber by leaf dip method

For this experiment fresh and equal amount of leaves were dipped in the treatment solutions and put into the petri dishes. Six larvae of same instar of leaf webber were released inside the each petri dish and left for next 48 hours. After 48 hours, numbers of alive larvae was counted. T2 Quinalphos 2ml/litre + 10 gm soap gave the best result with 1.33 alive larvae (Fig. 1).

(vi) Bio-efficacy of bio-control agents on mango leaf webber (Leaf dip method)

For this experiment fresh and equal number of leaves were dipped in the treatment solutions for one minute and put into the petri dishes. Six larvae of same instar of leaf webber were released inside the each petri dish and left for next 72 hours. Observations were taken after 24, 48 and 72 hour. Treatment T-5 Soap 20gm/ litre gave the best result (Fig. 2).

Table 12. Bio-efficacy of bio-control agents against mango hopper

S.No.	Treatments	Dose	Absolute population			
			DBS	3 DAS	7 DAS	Mean
T1	*Beauvaria bassiana*	5 ml/litre	32.25	24.125	18.50	21.31
T2	*Metarhizium anisopliae*	5 ml/litre	30.50	25.375	20.63	23.00
T3	Gum 705 (1:5)	1:5 Ratio	30.75	14.375	10.38	12.38
T4	Plastic Wrap with white Glue	1meter long	31.40	46.875	42.50	44.69
T5	Control	-	32.25	54.25	58.50	56.38

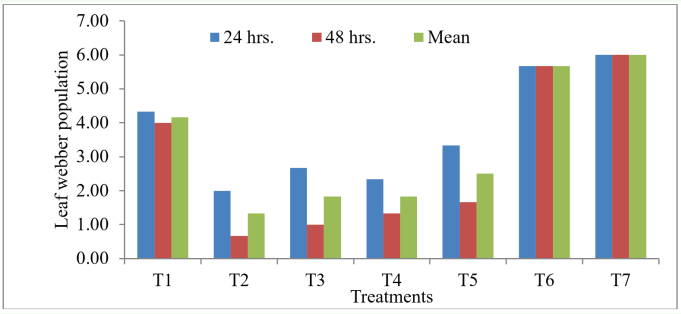


Fig.1 Evaluation of efficacy soap and various pesticides against mango leaf webber

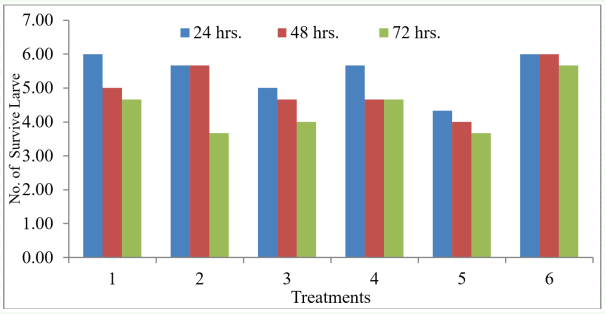


Fig. 2 Bio-efficacy of bio-control agents on mango leaf webber

Recuperation of elderly mango orchards through conservation practices and bio- intensification for pesticide load reduction

(i) Tree height reduction

The lower branches in each treatment were gridled in the month of September and were headed back in late October at the uniform height of 17 feet. Due to girdling most of the lower branches produced the new flush in November. As such there was low incidence of trunk borer and there is 100 percent survival of headed back trees.

Tree before head back Severed trees

(ii) Treatments details

The treatment effect was monitored on the quantity of mango production. The average fruit weight in mango T-4 gave the best result (254.76gm/fruit) as compare to the rest of treatments, while T-1 gave

the best result (160.8 kg/tree) in terms of fruit yield as compare to the rest of the treatments (Table 13).

T1	Tree height reduction +Sub-soiling+ NPK basal broad cast + Biochar + Bio- enhancer + Maccuna+NPK foliar, annual tillage
T2	Tree height reduction +Sub-soiling+ NPK foliar + Biochar + Maccuna, sod culture
T3	Tree height reduction +Sub-soiling+ NPK ring application + Biochar + Maccuna+NPK foliar, minimum tillage
T4	Tree height reduction + Sub-soiling + Maccuna + NPK foliar, sod culture
T5	Tree height reduction + Maccuna + NPK foliar, sod culture
T6	Tree height reduction + Biochar + radish/til/ mustard + NPK foliar, minimum tillage
T7	Control (traditional practices of the region)

Table 13. Mango yield and fruit weight in different treatments

Yield and other variables of mango			
Treatments	Average Weight (gm.)	No. of fruits/crate	Yield (Kg./Tree)
T1	230.49	108.47	160.8
T2	222.16	112.53	139.2
T3	247.04	101.20	65.8
T4	254.76	98.13	56.7
T5	218.89	114.21	83.9
T6	209.61	119.27	132.5
T7	221.90	91.80	20.8

(iii) Marigold used as a trap crop in mango

Marigold and justicea were planted along the channel made between two rows of trees in the experimental plot. It was observed that some mango insect pests were getting attracted towards marigold plants which was helpful in early monitoring and trapping of insects in the mango orchard (Table 14).

(iv) Incidence of mango stem borer in pruned and un pruned orchards of mango

It was found that the incidence of mango stem borer in pruned orchard was higher in comparison to non-pruned plots (Fig. 3).

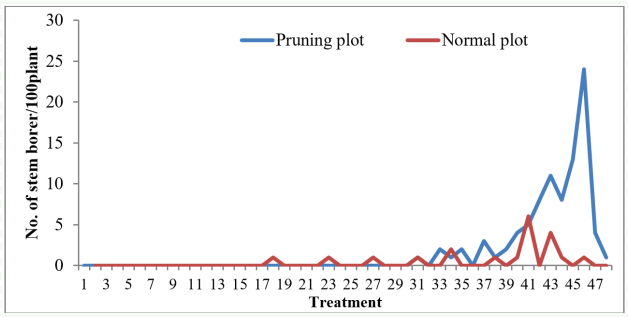


Fig. 3 Comparison of incidence of mango stem borer in pruning plot to normal plot

Mango

Survey for disease dynamics

Survey of mango orchards was conducted in Auraiya, Ayodhya, Barabanki, Bareilly, Bijnor, Bulandshahar, Hardoi, Hathras, Kanpur Dehat, Kasganj, Kaushambi, Lucknow, Meerut, Moradabad, Muzaffar Nagar, Prayagraj, Rampur, Saharanpur, Shahjahanpur, Shamli, Sitapur, Unnao districts. Major emphasis was given on survey of blossom diseases and average incidence (52.5%) and severity (21.4 PDI) of blossom blight, and incidence (17.4%) and severity (12.2 PDI) of powdery mildew were recorded in the districts around Lucknow. However, severe incidence of blossom blight was recorded in western Uttar Pradesh after thunder storm and rains in the end of March. The overall, direct losses due to unseasonal rains, thunder/ hail storm were estimated around 7.5%. However, the high humidity and wetness of plant surface caused due to rains increased the incidence of blossom blight and anthracnose of fruits may be considered responsible for 5-10% indirect losses due to unseasonal rains. The incidence and severity of shoulder browning was recorded high (68.5% and 44.5 PDI respectively) this year. Surveys conducted during the year indicated that blossom blight, powdery mildew, anthracnose, floral

Table 14. Marigold as trap crop for *Hyposidra* and *Dudua* in Mango

Marigold as trap crop for *Hyposidra* and *Dudua* in Mango						
Date	13-04-2023		28-04-2023		02-05-2023	
Pests	Marigold	Mango	Marigold	Mango	Marigold	Mango
Looper	3.10	1.20	7.6	2.40	8	5.51
Dudua	3.60	0.00	7.9	0.10	8.1	1.15
H. armigera	0.3	0	0.9	0	1.2	0
S.litura	0.4	0	1	0	1	0

malformation, sooty mould and wilt were the major diseases; and dieback, twig drying, red rust, bacterial blight were minor ones. Incidence of Loranthus has been observed higher than previous years.

Disease dynamics

Powdery mildew

Incidence and severity of powdery mildew on mango *cv*. Dashehari at Rehmankhera was recorded moderate during the flowering season 2023. The first incidence was recorded during the 7th SMW, and it reached to peak (50.0%) during the 11th SMW (Fig. 4). The severity of the diseases ranged from 0.83-10.0 PDI.

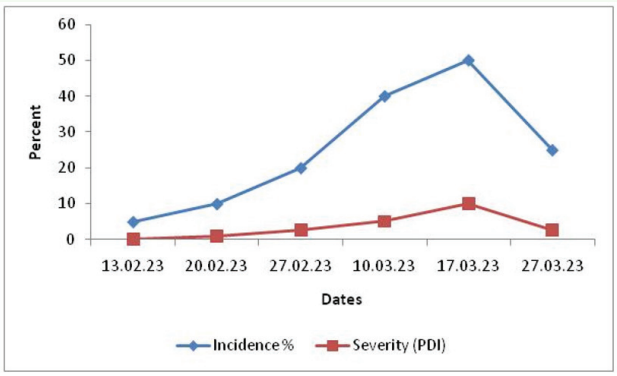


Fig. 4 Incidence and severity of powdery mildew at Rehmankhera

Blossom blight

Incidence and severity of blossom blight on mango *cv*. Dashehari at Rehmankhera was recorded low during the flowering season 2023. Emergence of panicles was observed in the orchard at ideal time i.e. in the first week of February 2023 and the incidence of the disease from second week of February to end of March due to highly favourable temperature. The incidence was recorded maximum (20%) and the peak severity (8.07 PDI) during 11th SMW (Fig. 5).

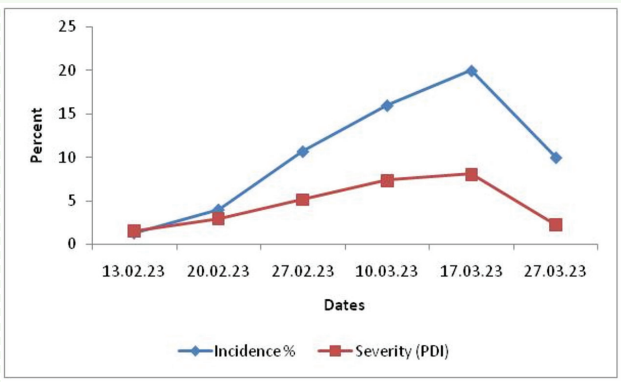


Fig. 5 Incidence and severity of blossom blight at Rehmankhera

Shoulder browning

Incidence of shoulder browning disease of mango fruits was recorded on *cv*. Mallika during the second fortnight of June to till harvest at Rehmankhera. The incidence and severity of the disease gradually progressed and incidence reached to 100 percent and the maximum severity (46.2 PDI) was recorded at harvest i.e. during 29th SMW (Fig. 6). Heavy and constant rains not only supported disease development but also compelled to harvest the fruits earlier due to severe disease development and rotting of fruits.

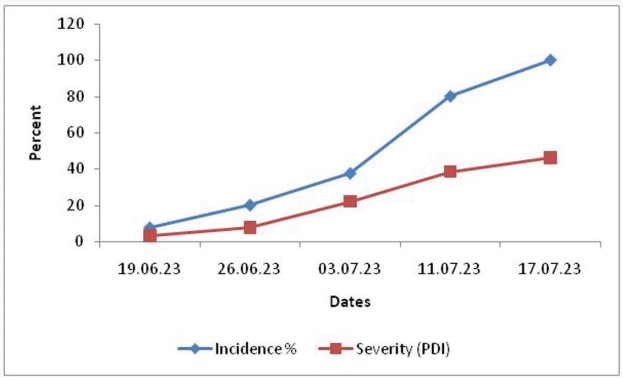


Fig. 6 Incidence and severity of shoulder browning at Rehmankhera

Root-knot nematode and seasonal disease status of guava

Survey of guava orchards was conducted in Ayodhya, Barabanki, Bijnore, Bulandshahar, Etah, Jhansi, Kasganj, Kaushambi, Lucknow, Meerut, Mazffar Nagar, Prayagraj, Saharanpur, Shamli and Sitapur districts. In total 27 guava orchards were critically observed and 10 were found infested with root-knot nematode, which indicated lesser infestation as compared to previous year data. Incidence of anthracnose fruit spots were recorded on about 25% fruits and *Cercospora* fruit spot on 12.5% fruits during rainy season crop. Negligible (<3%) incidence of dieback, algal rust, scab/canker and sooty mould; and *Phytophthora* fruit rot not observed at all in rainy season crop. Incidence of wilt and decline was recorded around 2.1 and 16.5 percent respectively.

Guava productivity issue in Prayagraj area

Decrease in productivity in traditional Koushambi and Prayagraj guava belt has been reported by the State Horticulture Department. In order to understand the reasons behind low productivity of guava scientists visited the area, conducted discussions with 3 groups of farmers and visited several orchards. The limitations behind the low productivity were: 1. guava plantings

are seedling ones lacking genetic uniformity; 2. pruning practice is yet to be adopted, which is essential to regulate the crop, get better fruiting and returns; 3. insufficient and improper disease and insect pest management practices are being followed; 4. farmers do not have knowledge of proper nutrition of guava orchards; and 5. orchards are mostly old (10-14 years) with week status. Farmers have been more interested in taking winter season crop but not able to manage rainy season crop properly to achieve good fruiting during winter. The low summer temperature and unseasonal rains are the major factors to enhance rainy season crop and less fruiting during winter season

Evaluation of traditional and non-traditional pest management options in mango

Evaluation of cow based organic products and bio-control agents along with pesticides against insect-pests and diseases of mango was done in an orchard of 7 years old trees of mango *cv.* Amrapali by spraying at critical stages (panicle emergence, before flower open, full bloom, after fruit set, marble stage, fruit maturity). Results indicated that the powdery mildew severity was reduced by all the treatments in comparison to control and it was best managed by the spray of lime sulfur @ 0.4% among organic products. The population build-up of hoppers was most effectively suppressed by the spray of imidachloprid & thiamethoxam, *Bevauveria bassiana,* and neem oil (71.5%) followed by Agniyashtra, Dashparni Ark, *Metarhizium robertsii,* and Bramhashtra respectively. The population of thrips at the time of fruit set was significantly suppressed by the spray of imidacloprid & thiamethoxam (60.0%), *B. bassiana* (48.6%) followed by Agniyashtra (34.3%) as compared to control. Other treatments could only slightly suppress the thrips population. Shoulder browning disease was managed by the spray of difenoconazole @ 0.05%, *Trichoderma harzianum* + *B. bassiana, Bacillus amyloliquifaciens* + *M. robertsii* and Agniyashtra. The number of fruits per tree was recorded as maximum (323.75) in spray with chemical pesticides followed by *T. harzianum* + *B. bassiana, B. amyloliquifaciens* + *M. robertsii,* Agniyashtra, and Bramhashtra; significantly higher than control (151.75).

Role of transplanting depth in guava root-knot disease management

In order to evaluate the role of transplanting depth on root-knot disease development, 72 day-old seedlings having 10 galls per root system were planted in field at depth of 1-10, 11-20 and 21-30 cm with untreated and treated with Fluopyrum 34.48% SC @ 1 ml in 1 litre of water and 100 g neem cake with 1 litre suspension of *Bacillus amyloliquefaciens* containing 20000 cells per ml of water during August 2022. On termination 1 year after transplantation, Fluopyrum was found highly effective irrespective of the depths of planting, and it eliminated the nematode infection in roots. Maximum root-knot index (RKI) was recorded in untreated seedlings planted at 1-10 cm depth followed by untreated at 11-20 cm, untreated at 21-30 cm, neem cake with *B. amyloliquefaciens* at 1-10, 11-20, and 21-30 cm, respectively (Fig. 7). The significant variation in RKI at different depths in untreated plants confirmed the hypothesis that the nematode activity is reduced with the increase in depth. In neem cake with *B. amyloliquefaciens* treated plants, maximum RKI was recorded at top-depth planting and it was significantly higher to lower depths, reconfirming the hypothesis. The results suggest that the planting of guava grafts should be done with the treatment with Fluopyrum and as deep as possible to minimize the chances of nematode survival and spread from infected grafts.

Fig. 7 Treatment (planting depth cm) 1-9 from left to right (1. Untreated (1-10), 2. Untreated at 11-20, 3. Untreated (21-30), 4. Fluopyrum (1-10), 5. Fluopyrum (11-20), 6. Fluopyrum (21-30), 7. Neem cake with *Bacillus amyloliquefaciens* (1-10), 8. Neem cake with *B. amyloliquefaciens* (11-20), 9. Neem cake with *B. amyloliquefaciens* (21-30)

Management of *Ceratocystis fimbriata* and *Berkeleomyces basicola* in mango

Experiments were carried out under controlled and infected field conditions to evaluate the efficacy of *Trichoderma harzaianum* and *Bacillus amyloliquefaciens* against *Ceratocystis fimbriata* and *Berkeleomyces basicola.* Root colonization assessed through root incubation technique (Fig. 8) indicated that both the bio-control agents were effective in significantly reducing root infection under controlled conditions in 10 days prior inoculation of 200 ml bio-control agent suspension containing 1000 cfus or cells per ml to the pathogen suspension (100 ml containing 10^4 cfu per ml). However, only *T. harzaianum* has been found significantly effective under field conditions. Both the experiments are still going on for getting long term results.

Fig. 8 Fungal growth on incubated mango root pieces

3D Post Harvest Management

Mango (*Mangifera indica* L.)

Volatile based characterization of mango cultivars

Volatile aroma is an important characteristics related to the ripening quality of mango fruits as well as a trait for consumer preference. Mango aroma consists of a complex blend of chemically heterogeneous volatile organic compounds (VOCs). Composition of VOCs in mango is cultivar specific. Hence, 11 commercial cultivars (viz., Amrapali, Chausa, Langra, Lucknow safeda, Mallika, Arunika, Ambika, Dashehari, Fazli, Totapuri and Neelgoa) were selected and stored at 22±2 ^{0}C. VOCs analysis was done at day 4 and 10. Volatile fingerprint of all the cultivars were different [Fig. 1 (A – N)]. Sesquiterpenes level gradually increases with storage time till day 10. Throughout the ripening process, there was a rise in total fatty acids. The creation of the distinctive aroma in the ripe mango fruit is linked with the increase in fatty acids during the ripening process. As fatty acids increased, ester production rose markedly.

In contrast to monoterpenes and sesquiterpenes concentrations of esters rose quite sharply during ripening, and are higher in overripe fruit. Monoterpene hydrocarbons (cis-ocimene, Y- and /3-pinene, myrcene and limonene) are important contributors to the flavour of fresh mango. In green mango either cis-ocimene or myrcene are the characteristic aroma compounds, depending on the cultivar/ variety. Ambika and Dashehari on long duration storage showed fair proportions of long chain saturated hydrocarbons 43.7% and 15.8%, respectively in the VOCs accumulated in the headspace portions. The ester compounds were recorded highest in Chausa (60.9) followed by Lagra (45.9%).

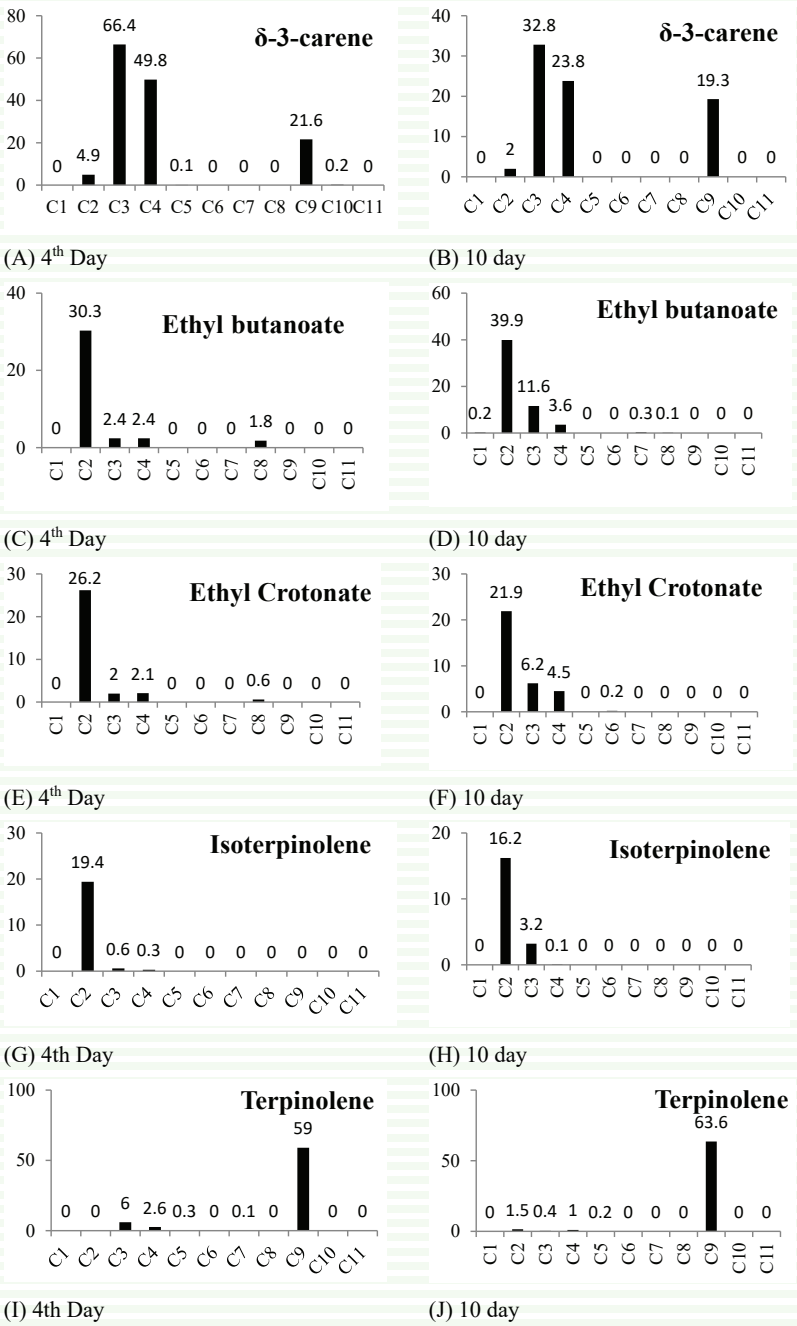


Fig. 1. (A – N) Volatile organic compounds in mango fruits

Cultivars : C1 Amrapali; C2 Chausa; C3 Langra; C4 Safeda; C5 Mallika; C6 Arunika; C7 Ambika; C8 Dashehari; C9 Fazli; C10 Totapari; C11 Neelgoa.

Effect of anti ripener on shelf life and post harvest physiological changes in mango

Mango fruits of cultivar Dashehari, Langra and Chausa treated with anti ripener I (@ 100, 150 and 200 µmol) anti ripener II (@ 1.0, 1.5 and 2.0 mM) were stored at 12 ± 1^{0}C and 85% relative humidity. Simultaneously, a set of control fruits was maintained without any treatment. Fruits were withdrawn at 7 days interval to find out treatment effects on shelf life and enzymatic activities/ biochemical parameters. Activity of catalase, peroxidase, superoxide dismutase, superoxide free radical formation, pectin methylestarase (PME), polygalactronase (PG) was found more in the pulp of control fruits as compared to pulp of treated fruits.

Activity of these enzymes was gradually increased during storage. At day 21 lipid peroxidation was found to vary from 4.7 – 6.4 nmol MDA formed/ mg protein/h in treated fruits to 13.57 nmol MDA formed/ mg protein/h in control. In control catalase activity was 868 mmol hydrogen peroxide decomposed.min^{-1}.mg^{-1} protein whereas in the pulp of treated fruits it varied from 391 – 547 mmol hydrogen peroxide decomposed. min^{-1}.mg^{-1} protein. Activity of peroxidase was found to vary from 1.67 – 3.34 m mol substrate min^{-1} mg^{-1} protein in the pulp of treated fruits to 6.21 m mol substrate min^{-1} mg^{-1} protein in the control. In control superoxide dismutase activity was 2157 enzyme U mg−1 protein as compared to 1129 - 1356 enzyme U mg−1 protein in the pulp of treated fruits. Super oxide free radical (O_2^-) formation in control was 5.57 nmol hydrogen peroxide formed mg−1 protein and in the pulp of treated fruits it was 0.87 – 1.61 nmol hydrogen peroxide formed mg−1 protein. Activity of polygalacturonase (PG) on day 21 varied from 4.97 µmol Gal.g FW.min in control to 2.27 – 2.81 µmol Gal.g FW.min in treated fruits. Activity of pectin methylestarase on day 21 was 3.21 mmol NaOH.g^{-1}FW.min^{-1} in control and 1.67 – 1.96 mmol NaOH.g^{-1}FW.min^{-1} in treated fruits.

Mango wine

Fresh mango pulp, sugar, yeast and enzymes were used in different proportions to prepare mango wine. After fermentation it was stored at 12 ± 1^{0}C and 85% relative humidity for ageing up to 4 months. Alcohol content in wine varied 8-11%. As fruit wine is prepared without distillation hence it has beneficial bioactive compounds of fruit.

Extraction of mango seed butter from Kernel

The procedure for extracting mango kernel butter has been standerdized. Mango seed butter was extracted from the mango kernel using a Soxhlet equipment and a rotatory evaporator with solvent n-hexane. The


Day 0


Day 21 Anti Ripener I


Day 21 Anti Ripener II


Day 21 Control

working temperatures ranged from 50 to 80°C. The Solvent Extraction technique extracts 14% of butter, with an extraction duration of 5 hours. This butter is highly valued and could serve as a suitable substitute for cocoa or shea butter. Mango kernel butter is a wonderful source of important fatty acids, minerals, and vitamins, and has moisturising characteristics that are useful in skin creams and other products.

Mango Aonla Prash

Mango aonla prash was prepared by blending mango pulp with aonla juice industry waste (aonla pomace) and spices. TSS of the product is 73 ^{0}B, acidity 2.1%, Vitamin 'C' 39.60mg/100g and total phenolics 3.14%.

Pre-harvest interventions for post harvest shelf-life enhancement of mango cv Dashehari

One month prior to harvest of mango fruits cv Dashehari one month prior to harvest was done with 0.02% hexanal, bagging of fruits with white non-woven bags and untreated control fruits for enhancing the shelf life under ambient conditions. The fruits were harvested on the first week of June were packed with two types of packaging materials i.e. white non-woven bags and brown paper bags and stored under room temperature. These fruits were analyzed for different physicochemical parameters at regular intervals of storage. The fruits treated with 0.02% hexanal and packaged in white non-woven bags had a shelf life of 12 days compared to control of 8 days of storage.

Pre-harvest interventions for post harvest shelf-life enhancement of mango cv Mallika

Pre-harvest spraying of mango fruits cv Mallika were done with 0.02% hexanal, bagging of fruits with white non-woven bags along with untreated control fruits for enhancing the shelf life under ambient conditions. The fruits were harvested on the first week of July were packed and stored under room temperature. 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 8 days compared to control of 6 days of storage. Irrespective of treatments, all the fruits were spoiled due to rotting.

Protocol development for export of Mango through Sea Route

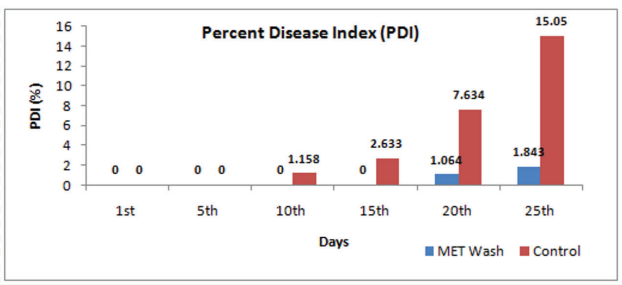
- India is a home for variety of mangoes and is the largest producer in the World. Despite this, currently only 1.5% of mangoes are exported. This can be attributed mainly to poor shelf life and incidence of post-harvest diseases.
- Experiment was conducted for developing a formulation by extracting the bio-metabolites from bacteria involves D-44 *Priestia aryabhattai* for shelf life and post-harvest diseases.
- The protocol was developed for the export of mango fruits cv. Dasheahri, where it was dipped in 2.5 % MET WASH solution for a specific period and stored at 13 °C.
- The quality parameters viz. TSS (°B), Acidity (%), Fruit firmness (lbs), Ascorbic acid (mg $100g^{-1}$), physiological weight loss (%), percent disease index (%), and peel colour were assessed up-to 27 days at five days interval. The experiment on efficacy of MET WASH was initially conducted under *in vitro* conditions pathogenic isolate of *Colletotrichum gloeosporioides*.
- It was found that 2.5 % of MET WASH was effective in suppressing the pathogen and enhances the shelf life upto 27 days. There was significant difference in the TSS content and use of met wash delayed the ripening process and resulted in enhanced shelf life.
- Fruit firmness and ascorbic acid content was significantly higher in treated fruits compared to control. However, there was no significant difference with regard to acidity.
- The physiological loss of weight was significantly higher (7.48 %) in control while it was just 4.32 % in treated fruits. After 25 days of storage, there was significant difference in disease incidence (15.05 and 1.84 % respectively in control and treated fruits).

Table 1. Effect of CISH METWASH on post harvest quality parameters of Mango Cv. Dashehari

	1st Day		5th Day		10th Day		15th Day		20th Day		25th Day	
	MET Wash	Control	MET Wash	Control	MET Wash	Control	MET Wash	Control	MET Wash	Control	MET Wash	Control
TSS (°B)	10.27h ± 0.67	10.00h ± 0.65	11.05g ± 0.72	11.82f ± 0.77	11.84f ± 0.77	14.26e ± 0.93	15.53d ± 1.06	15.36d ± 1.00	17.78c ± 1.16	18.34b ± 1.19	18.42b ± 1.20	19.66a ± 1.28
Acidity (%)	1.50a ± 0.09	1.51a ± 0.09	1.37b ± 0.11	1.33b ± 0.08	0.86d ± 0.05	1.17c ± 0.10	0.76e ± 0.03	0.50f ± 0.03	0.45fg ± 0.05	0.43gh ± 0.02	0.36h ± 0.02	0.42gh ± 0.02
Ascorbic acid (mg 100 g^{-1})	25.85d ± 1.68	26.06a ± 1.70	25.79e ± 1.68	25.96c ± 1.69	25.69f ± 1.67	25.49h ± 1.66	25.27j ± 1.64	25.30i ± 1.65	25.14g ± 1.66	25.28j ± 1.65	25.08b ± 1.69	25.79e ± 1.68

Table 2. Effect of CISH METWASH on percent disease index (PDI) of post harvest disease of Mango Cv. Dashehari

	1st	5th	10th	15th	20th	25th
MET Wash	0	0	0	0	$1.064^{e} \pm 0.069$	$1.843^{d} \pm 0.12$
Control	0	0	$1.158^{e} \pm 0.076$	$2.633^{c} \pm 0.172$	$7.634^{b} \pm 0.498$	$15.058^{a} \pm 0.982$



Effect of Agrochemicals on Quality of mango

The pesticide residue was found to detect less than 0.63 ppm in mango i.e., imidacloprid (0.52±0.01); buprofezin (0.49±0.01); carbendazim (0.63±0.01); and hexaconazole (0.48±0.01). Secondary polar metabolites were found correlated positively and negatively to treatments in PCA analysis.

Preparation and Characterization of Microencapsulation/Microsphere/ Coacervation formulation containing Bioactive Mangiferin

Mangiferin extraction involved grinding mango leaves into a fine powder, subjecting the powder to reflux extraction with an aqueous ethanolic solution, washing the resulting precipitates, and filtering to isolate mangiferin. Subsequently, mangiferin was micro-encapsulated using a biodegradable material that dissolves in an organic solvent along with the mangiferin extract of encapsulation yield(60–65%). The resulting product undergone analysis through thin-layer chromatography (TLC) and further confirmed by using High-Performance Liquid Chromatography (HPLC).

Harvest and Post harvest losses in different stages of supply chain

The study on the Dashehari mango supply chain identified losses at different stages. Harvesting accounted for a 2.8% loss, while packaging and handling contributed to a 2.5% loss. Transportation, including loading, unloading, and enroute, resulted in a 4% loss. Retailers observed a loss 4.9 % loss.

Supply chain management of mango

Farmers employ various channels for selling their mango produce, price spread and efficiency in each marketing channel was analysed. Majority of the farmers (65-70 %) lease their orchards to pre-harvest contractors. Additionally, 25-30% relied on local aggregators, followed by sale at local mandi to the commission agents (20-25% of the farmers). Only a few farmers market their produce through Farmers Producer Organizations (FPOs), and direct marketing. Price spread (Rs. 34000 t^{-1}) was highest in the marketing channel where pre-harvest contractors were involved followed by sales to local aggregators (Rs. 26000 t^{-1}). The producers share in consumers rupee stood at 87% in case of direct marketing to consumers where

farmers sale 'A' grade fruits. However, despite creating a win-win scenario for both producers and consumers, this approach is not adopted by most farmers due to concerns about jeopardizing the market for rest of their produce, low marketing skills and is not ready to take risk.

Guava

Effect of CISH anti ripener on shelf life and post harvest physiological changes in guava

Guava fruits of cultivar Lalit and Dhawal were treated with anti ripener I (@ 100, 150 and 200 µmol) and anti ripener II (@ 1.0, 1.5 and 2.0 mM) and stored at room temperature (i.e., 20±2^{0}C) and 72% relative humidity. At day 15 PLW ranged 6.66 – 8.75 in treated fruits and 11.23 in control. TSS of the fruits on day 15 in treated fruit varied from 12.37 – 13.14 ^{0}B whereas control fruits were over ripped on day 9 (TSS 16.20 ^{0}B) and rotting symptoms appeared after day 9.

Activity of polygalacturonase (PG) on day 15 varied from 5.69 µmol Gal.g FW.min in control to 2.51 – 3.171 µmol Gal.g FW.min in treated fruits. Activity of pectin methylestarase on day 15 was 4.05 mmol NaOH.g^{-1}FW. min^{-1} in control and 1.88 – 2.13 mmol NaOH.g^{-1}FW.min^{-1} in treated fruits.

Day 0

Day 9 (Control)

Day 15 (Anti Ripener I)

Day 15 (Anti Ripener II)

Day 15 (Control)

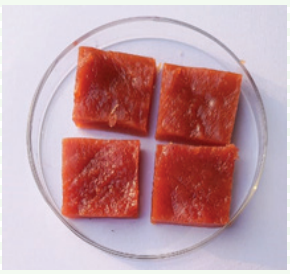
Day 15 (Control)

Guava Churan

Using blemished and non marketable fruits, guava churan was prepared. This product has 76.00 mg/100 g Vitamin-C and 760.00mg/ 100g total phenolics.

Guava Nutri Bite

Guava nutri bite method protocol was developed using beetroot juice fortification. Different combinations of guava pulp and beetroot puree, as well as other components, were employed. The products were evaluated for their physicochemical and sensory qualities, as well as their shelf life under ambient conditions. Other characteristics evaluated included phenolic profile by HPLC, total anthocyanin, TSS, titratable acidity, and ascorbic acid. The physical and chemical changes that happened following the manufacturing of the guava fruit bar were investigated, and a panel of 10 experts used the 9-point hedonic scale to evaluate the product's sensory quality. This fruit bar was stored at room temperature for over 60 days. According to storage studies, T6 (80% guava pulp, 15% beetroot puree, and 5% Others) is the best formulation for fruit bars in terms of physicochemical qualities and organoleptic testing. Additionally, the impact of storage on physicochemical and organoleptic qualities was detected.



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

Guava fruits cv Lalit were treated with @ 0.02ppm of quercetin, BHT, gallic acid and control fruits without any treatments for prolonging the shelf life of guava under ambient conditions. These fruits were analyzed for different physicochemical parameters at regular interval of 0, 4, 6, 8, 10 and 12 days of storage. The fruits treated with 0.02ppm gallic acid had a shelf-life of 12 days compared to other treatments.

Maintaining the fruit quality of guava by use of geranoil.

Guava fruits cv 'Shweta' were treated with geranoil @ 500 ppm, 1000 ppm 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 1000ppm of geranoil had a shelf life of 12 days compared to control for 8 days.

Aonla

Study on preservation of clarified aonla juice at different temperatures

Aonla juice was clarified using pectinase enzyme treatment @1ml/litre for one hour at room temperature (20±20C). The clarified juice, filled in glass bottles, was stored (i) in refrigerator (ii) at room temperature and (iii) at 35oC in incubator, along with untreated (control) juice. The juice initially contained 421 mg/100 ml vitamin-C and 2.74 per cent total phenolics. Observation up to four month of storage revealed decrease in vitamin-C in all treatments. More browning was found at 35o C as compared to at room temperature and refrigerated condition. After 120 days, HPLC analysis of aonla juice revealed catechin as the most abundant (7738 µg/ml) phenolic whereas p-coumaric acid as least (351µg/ml).

Optimization of process for development of Karonda Juice-Fortified Aonla Candy

Carissa fruits are high in vitamin C, iron, dietary fibre, carbs, lipids, proteins, and micronutrients. This study optimised the sugar syrup levels, dipping time, and drying temperature for developing karonda juice-fortified aonla candy. In this study, we examine the effect of different sugar concentrations (20, 40, and 60 °Brix), time and concentration of dipping aonla segments in karonda juice (30, 60, and 90 minutes), and drying temperature (45°C, 55°C, and 65°C) on the quality of aonla candy. The optimal parameters for producing the intended candy were 60°B sugar syrup and 55°C drying temperature. The corresponding values of responses were: TSS of 55°B, Ascorbic Acid 108.79 mg/100 g, Titrable Acidity 1.98%, and organoleptic properties such as flavour (8.55), colour (8.95), and texture (8.22). The high TA value may be attributed to the acidic nature of karonda juice.

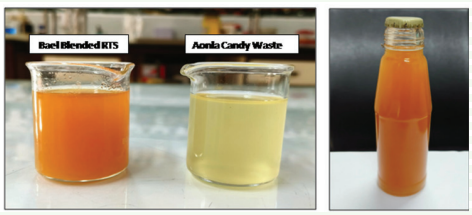
Bael fruit is rich source of riboflavin, thiamine, niacin and minerals. They also contain marmelosin and psorolin which are anti cancerous compounds. Aonla fruits are rich in vitamin C and phenolics compounds with numerous medicinal properties. The powders of mature fallen fruit of bael fruits have restorative and laxative property. Fallen fruit of bael powder provides excellent colour and flavour when they are blended with aonla candy liquid waste. During the aonla candy making the waste in liquid form was utilized by blending with bael powder for preparation of RTS (low sugar immunity booster). The juice, TSS and acidity of RTS are 20-22%, 15°B and 0.25% respectively.

Protocol development for Bael Aonla blended low sugar RTS

Bael fruit is rich source of riboflavin, thiamine, niacin and minerals. They also contain marmelosin and psorolin which are anti cancerous compounds. Aonla fruits are rich in vitamin C and phenolics compounds with numerous medicinal properties. The powders of mature fallen fruit of bael fruits have restorative and laxative property. Fallen fruit of bael powder provides excellent colour and flavour when they are blended with aonla candy liquid waste. During the aonla candy making the waste in liquid form was utilized by blending with bael powder for preparation of RTS (low sugar immunity booster). The juice, TSS and acidity of RTS are 20-22%, 15°B and 0.25% respectively.

Table 3. Biochemical parameters of Bael Aonla Blended Low Sugar RTS

Parameters	Fresh fruit	Sugar syrup	Bael blended RTS
TSS (°B)	12.8	64	15
Acidity (%)	1.15	1.08	0.35
Vitamin C (mg $100g^{-1}$)	210.08	94.18	33.24



3E External Funded Projects

Farmer FIRST Project: Enhancing Livelihood and Profitability Index of Malihabad Farmers through Diversified Horti-Enterprise Modules

PI: Dr. Maneesh Mishra

Co-PIs: Dr. S.C. Ravi, Dr. Alok Gupta, Dr. P.K. Shukla, Dr. S.K. Shukla, Dr. S.R. Singh

Salient Achievements

Demonstrated Mango GAP among 200 farmers and provide critical inputs like fruit bag, harvester, Bioenhancer, ICAR-fusicont. Demonstration on fruit bagging led to adoption of bagging technology by 2000 farmers which resulted in reduction of pesticide use (2-3 spray in GAP as against 8 sprays by non adopters) and improved biochemical parameters The bagged mangoes exhibit higher TSS at 16.5 °Brix, lower acidity at 1.3%, and greater firmness at 1.9 lbs compared to the non-bagged mangoes, which have a TSS of 14.2 °Brix, acidity of 1.5%, and firmness of 1.6 lbs, respectively. The total cost of cultivation was Rs. 1,83,482 and Rs. 1,94,510 per ha for non GAP and GAP adopters. There was an increase of net return by Rs. 50,000 per ha. The marketing of bagged fruits was linked CSR activity. Seven star Hotel chain Hyatt Regency, Lucknow provided free market space for bagged mango fruits. Non bagged fruits at Hyatt regency realized price of Rs.70/kg where as bagged fruits got Rs.150/kg. Demonstration on Mango orchard poultry farming in Malihabad among 30 farmers in 2023 led to spread of this technology in Mall, malihabad, itaunja block of Lucknow. Entrepreneurship development in secondary hardening of tissue culture plants of G-9 banana was given to 40 farmers in the month of April 2023. Through Secondary hardening of 50000 plants farmers earn average net profit Rs. 214,690.00 from this enterprise. Demonstrated of *Panicum* grass as fodder crop in mango orchard and later collaborated with ICAR-IGFRI, Jhansi to introduce perennial sorghum as fodder for milch animals. The increased the net return 12.77 % in cow and 7.55 % in buffalo per year. It results in increase in milk yield 4.29%. Ten front line demonstrations of marigold in 2.5 ha area and Gladiolus in 2 ha area in adopted village. The cultivation practices in this FLD (use of improved variety, balance dose of fertilizers, important inter-culture operations and plant protection measures) increased the yield of Marigold by 20 percent and Gladiolus by 44.44 percent on an average over the control farmers. CISH-FFP awarded by Performance Excellence Award 2022-23 for demonstrated outstanding performance in enriching knowledge and technology by ICAR – Agriculture extension division on 30th November 2023.

Evaluation of diversity and decline of indigenous seedling mango of Bihar and study for its conservation strategy

PI: Dr. Devendra Pandey

Co-PIs: Dr. Sanjay Kumar Singh

Funding Agency: Bihar State Biodiversity Board, Patna

Salient Achievements

Under the project, we surveyed the 12 districts of Bihar (in 25 development blocks) for assessment of seedling diversity and we identified 41 elite type genotypes of seedling mango which is being further evaluated (Table 1).

Fig. 1. a) Seedling of 'Dashahari' mango at Darbhanga yield 1500 fruit per trees at Darbhanga, Bihar; b) Coloured seedling mango from Pirapinti, Bhagalpur, Bihar

Table 1. Surveyed districts with blocks and no. of genotypes identified

S.No.	Name of the Districts surveyed	blocks	No. of elite type mango seedling (identified)
1.	Saran	Sonpur	3
2.	East Champaran	Sangrampur, Mehsi, Kotwa	3 +2
3.	Muzaffarpur	Mushahari, Saraiya	2 +1 +1 +2
4.	Sitamarhi	Bathnaha	1
5.	Madhubani	Basopatti, Pandaul and Jhanjharpur	2 +3 = 5
6.	Bhagalpur	Sadar, Pirpainti, Sultanganj, Sabour	2
7.	Banka	Rajaun	2
8.	Darbhanga	Hayaghat, Bahadurpur	1 + 6
9.	Samastipur	Pusa, Sarayranjan	1
10.	Purnea	Jalalgarh, Sadar	-
11.	Katihar	Sadar Block	3
12.	Vaishali	Paterhi Belsar, Goraul	3 + 2
Total No. of elite type seedling identified			41 genotypes collected for evaluation

Fig. 2. *Rari* mango as seedling grown in Pandaul, Madhubani

After grouping of seedling clones on the basis of possession of desirable characters, only 28 seedling types were characterized which revealed the existence of a great variability like *Chorbi* (sweet at unripe stage), *Nakubi* (with prominent beak), *Badwaria* (matures in August), *Piri* (Yellow at ripening), *Rajbhog* (high yielder with thin peel and stone), *Rari* (bearing even after 200 year old trees, bunch bearer, honey like taste), *Laru ka Mithua* (high yielder with less sweet), *Sajmania* (late maturity, high yielder) (Table 2).

The superior characters were also recorded in the seedling of *Kishanbhog*, *Sipia*, *Langda, Dashehari* and the yield varies from 1000-3000 fruits per tree (200-500 kg per tree), four seedling type had average fruit weight of 500-750 g, two genotypes found having shelf life of 10 days, three were fibreless, one genotypes ripened in October besides two identified as *Baramasi* mango. Four genotypes were identified as bunch bearer (Fig. 2&3).

Table 2. List of farmers having unique seedling mango with distinct attributes

S. No.	Name of Farmer (Name of Unique Seedling)	Address of the Farmer	Details of unique seedling mango	Remarkable attributes of seedling
1.	Mr. Kapildeo Jha (Rari mango)	Vill. Biraul, Block: Pandaul, (Madhubani)	Has 3500 mango trees (including 25 seedling), Yield: 10 q tree$^{-1,}$ Honey like taste, Regular Bearer, Late maturity, Fibreless, also growing *Nakubi* (prominent beak), *Bhadwaria* (matured in September month), *Chorbi* (sweet at maturity).	o Rari mango (bearing even after 200 years), o Bunch bearer (20-25 per bunch), o Late maturity and Yield: 10 q tree$^{-1,}$

2.	Shri. Kedar Prasad Thakur (Biju mango)	Vill. Baghnagari, Block: Saraiya, (Muzaffarpur)	Regular bearer (18-year-old tree), Highest yielder: 2,500 fruits per tree, Late maturity (third week of July) fibreless, yellow at ripening, Average Fruit weight: 5 fruit per kg	Highest yielder: 2,500 fruits per tree, Bunch bearers (15 fruits per bunch), Tolerant to fruit drop
3.	Shri. Jagannath Pandey (Seedling of Malda) (Seedling of Mallika)	Vill. Katarmala, Block: Goraul, (Vaishali)	10 % seedling, Yield: 2.5 q per tree (15-year-old), Average Fruit Weight: 417.6 g, Fibreless, thin stone, Tolerant to pests and diseases, Bunch bearer: 3- 4 fruits per bunch, TSS: 16.8 °B, Dark yellow at ripening, Pulp: 85 %	Yield: 2.5 q per tree (15 year old), Bigger sized fruit (417.6 g); Bunch bearer: 3- 4 fruits per bunch
4.	Mr. Sugandh Raj S/o Shri. Ayodhya Das (Seedling of 'Kishanbhog	Vill. Mishrawalia (Jagdish), Block: Paterhi Belsar, (Vaishali)	5 % seedling, Average Fruit weight: 281.96 g, TSS: 21.93 °B, Yield: 600-700 fruit per tree (15-year-old), Regular bearer, Resistant to pest and diseases, Late maturity (July first week), Dark yellow at ripening	TSS: 21.93 °B, Yield: 600-700 fruit per tree (15-year-old), Resistant to pest and diseases
5.	Mr. Arun Kumar Pandey (Seedling of 'Langra' Mango)		3 quintal per tree (1,000 fruits), Regular bearer, Late maturity (Last week of July), High fruit weight: 477.4 g, Thin stone with TSS: 21.10 °B, Dark yellow at ripening	3 quintal per tree (1,000 fruits), Late maturity (Last week of July), High fruit weight: 477.4 g, Thin stone with TSS: 21.10 ^{0}B
6.	Shri. Sanjay Kumar (Seedling of 'Langra' mango)	Vill. Mohabbat Chhapra, Block: Mehsi, (East Champaran)	Average Fruit weight: 543 g, TSS: 17.20 °B, Yield: 300-400 fruit per tree (26-year-old), Regular bearer, Better aroma and higher shelf life than 'Langra' Mango, Mid maturity (last week of June), Dark yellow at ripening	Average Fruit weight: 543 g, Yield: 300-400 fruit per tree (26-year-old), Better aroma and higher shelf life than 'Langra' Mango
7.	Shri. Madhaw Kumar Thakur (Seedling of 'Dashahari)	Vill. Surhachatti, Block: Hayaghat, (Darbhanga)	50 % seedling mango, Average fruit weight: 268.15 g, TSS: 18.65 °B, Regular bearer, Yield: 2,000 fruits trees^{-1}, Late maturity (in last week of July), Longer shelf life (15 days), Bunch bearer (8-10 fruits per bunch)	Yield: 2,000 fruits trees^{-1}, Longer shelf life (15 days), Bunch bearer (8-10 fruits per bunch
8.	Mr. Udai Kumar S/O Shri. Shivshankar Mishra (Seedling of Sipia)	Vili. Mishrawalia Afzalpur, Block: Paterhi Belsar, (Vaishali)	Yield: 4 quintal per tree, Bunch bearer, Size larger than 'Sipia' mango	Yield : 4 quintal per tree
9.	Shri. Kaushal Kishore Singh (Seedling of Langra)	Vill. Dwarikanagar, Block: Mushahari, (Muzaffarpur)	Regular bearer (20-year-old), yield: 600 kg per tree, thin stone, No anthracnose after harvest, Pulp: 80 %, Shelf life: 7 days	Regular bearer (20 year old), yield: 600 kg per tree, no anthracnose after harvest,

10.	Shri. Rajnath Jha (Seedling of Rajbhog)	Vill. Deep, Block: Jhanjharpur, (Madhubani)	Has 1,200 mango trees (including 300 seedling), Seedling of Rajbhog (35 years old), Thin peel and stone, Mid maturity, Yield: 2,000 fruits tree^{-1} /10 q tree^{-1}, Average fruit weight: 300 g, Alternate Bearer, Growing 35 variety of mango	Yield: 2000 fruits tree^{-1} i.e. 10 q tree^{-1}
11.	Mr. Narottam Mishra	Vill. Mohna, Block: Rajaun, (Banka)	Regular bearer, Average Fruit weight: 350 g	Yield : 2-3 q per tree (1,800 fruits per tree), Thinnest Stone, Regular Bearer, Late maturity, Fibreless
12.	Shri. Kalidas Banarjee (Seedling of Kala Pahad)	Vill. Rautara, Block: Sadar (Katihar)	-	-

Fig. 3 Fruiting in bunches (8-10 fruits per bunch) in seedling mango at Saraiya, Muzaffarpur

National DUS centre for mango crop

PI: Dr. Vishambhar Dayal

Co-PI: Mr. Amarkant Kushwaha

Funding Agency: PPV&FRA, New Delhi

Salient 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).

DUS characterization of guava

PI: Dr. Anshuman Singh

Co-PI: Dr. Vishambhar Dayal

Funding Agency: PPV&FRA, New Delhi

Salient 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 2023, 20 accessions were characterized using DUS descriptors for fruit traits. Similarly, 30 accessions were characterized using leaf descriptors. Two guava denominations, namely, 'Jarvi Red' and 'Ratnadip' were registered by PPV&FRA, New Delhi during period under report.

Development of morphological descriptors and DUS test guidelines for jamun (*Syzygium cumini* Skeels)

PI: Dr. Anshuman Singh

Co-PI: Dr. Anju Bajpai

Funding Agency: PPV & FRA, New Delhi

Salient achievements

A total of 48 varieties and accessions are being maintained in the field gene bank. In 2023, 10 accessions were characterized using the leaf and fruit descriptors. Leaf apex shape was acuminate in all the genotypes. Leaf base shape was acute in 6, and round in 4 genotypes. Mature leaf color was invariably dark green. The mature fruit colour was purple black in 7, and purple red in 3 genotypes. Mature fruit shape was predominantly round (7 genotypes). Mature fruit

colour was either purple white (5) or creamy white (5). The leaf length varied between 11.85 cm (J-31) and 14.87 cm (J-33). The leaf width was the minimum (6.26 cm) in J-36 and the maximum (7.99) in J-14. The fruit length was the highest (35.17 mm) in J-33 and the lowest (23.03 mm) in J-4. The fruit diameter varied between 19.29 mm (J-39) and 25.25 mm (J-36). The fruit weight was the minimum (6.26 g) in J-14, and the maximum (15.61 g) in J-33. The pulp content varied between 80.73% (J-14) and 92.10% (J-33).

Characterization of Aonla varieties for developing DUS test guidelines

PI: Dr. D. Pandey

Co-PI: Dr. Sanjay Kumar Singh

Funding Agency: PPV&FRA, New Delhi

Salient achievements

During the period, 9 leading commercial varieties are being maintained in the field gene bank. 01 variety has got communication from PPV&FRA, New Delhi to the farmer viz. Mr. ValunjBalasahebLahanu, Manmandir, KG Rajmarg, Aurangrur, Tal Akole, Ahmed Nagar, MS for Sanjeevani- Pinkas Farmer's variety. Another farmer Shri Chinta Mani Singh, Vill. Bariyar, PO. Hinouti via Sirmoor, Katra, Rewa (MP) has applied for registration of (1) Pink Suhana Aonla and (2) Diviya Aonla, (3) Rani AonlawithPPV&FRA, New Delhi. Another farmer Shri Yagya Saran Singh, Vill. Kathmana, PO. Hinouti, Rewa (MP) submitted application for (1) SobhitAonla and (2) Rama Aonla with PPV&FRA, New Delhi for its registration.

Validation of DUS Descriptors of bael (*Aegle marmelos* Correa)

PI: Dr. D. Pandey

Co-PI: Dr. Sanjay Kumar Singh

Funding Agency: PPV&FRA, New Delhi

Salient Achievements

During the period, the application for registration of 16 farmer's varieties has been applied to PPV&FRA, New Delhi out of which 3 got approval and communicated to the concerned farmers. The list is as follows in Table 3.

Table 3. Approved farmer's variety on Bael by PPV&FRA, New Delhi

Name of farmers	Address	Variety	Registration No
Sh. Ram PrakeshKesharwani	Chairman, Jai durga Krishak Club, Village &Post Lakhuri, Block: Bimhanidih, District Janjgeer- Champa, Chhattisgarh-495660	Swati Bael	REG/2016/1448
Sh. Ram PrakeshKesharwani	Chairman, Jai durga Krishak Club, Village &Post Lakhuri, Block: Bimhanidih, District Janjgeer- Champa, Chhattishgarh-495660	Amar Bael	REG/2016/1446
Sh. Ram PrakeshKesharwani	Chairman, Jai durga Krishak Club, Village &Post Lakhuri, Block: Bimhanidih, District Janjgeer- Champa, Chhattishgarh-495660	Barsati Bael	REG/2016/1444

Genome wide SNP markers associated with fruit traits for developing climate smart mango hybrids using genome selection

PI: Dr. Anju Bajpai

Co-PIs: Dr. Muthukumar. M., Mr. Amar Kant Kushwaha

Funding Agency: DST-SERB (CRG), New Delhi

Salient Achievements

Implementation of GS model for prediction of phenotype in the testing and validation population

For genomic selection the whole population was divided into three sets viz., training, testing and validation sets. Training population constituted of 94 members viz., majority being germplasm/accessions, followed by popular commercial cultivars/ parents and some well established hybrids. Validation population comprised of 31 members with known parentage and pedigree. For both the training and validation set, phenotypic data was generated. The third set of population i.e., test population included in the study had unreleased hybrids still in juvenile stage. Genomic selection model was implemented in three settings/ scenarios using these populations using gBLUP which revealed that the prediction accuracy assessed from R^2 values of correlation between observed and predicted values ranged from 0.18 (fruit thickness) to 1. The lower predicted accuracy in case of fruit thickness (R^2:0.18) and stone width (R^2:0.20) may be attributed to the presence of outliers

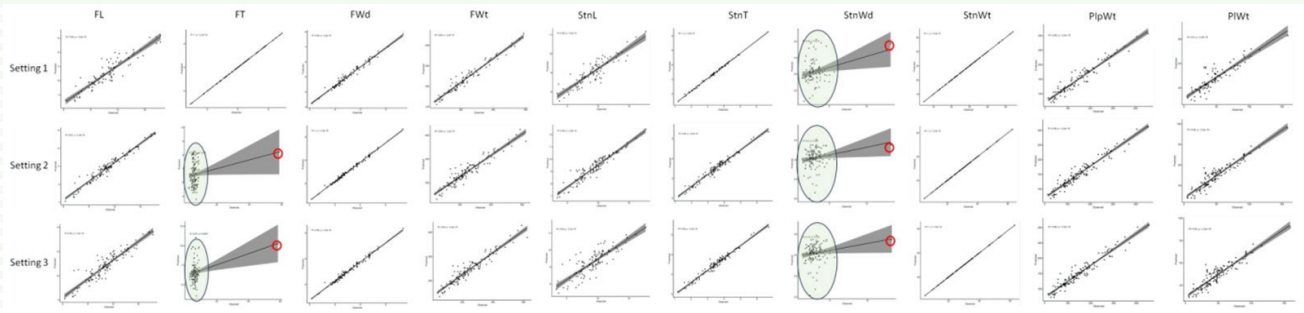


Fig. 4 Genomic selection prediction accuracy under different settings/ scenario. Setting 1: Training population comprising of a subset of hybrids without phenotypic data; Setting 2: Training population comprising of the same subset of hybrids with phenotypic data; Setting 3: Training population plus testing population

(extremely higher value to the nearest data points). Further, t- test was performed for testing the prediction accuracy which also corroborated with the significant difference attributed by these outliers. For all the other traits, significant R^2 values were recorded as evident in Fig. 4 which was also confirmed by non-significant differences between predicted and observed values of t-statistic.

Selection of superior hybrids from the test population using GS model

Predictions for the 10 target fruit quality traits were made for the 43 testing hybrids comprising of two sub-populations viz., 24 hybrid progenies of Amrapali crossed with Tommy Atkins and 19 hybrid progenies of parental cross between Amrapali and Sensation. Based on selection criteria of predicted phenotypes over their respective group averages and their female parent Amrapali, five hybrids in the cross combinations derived from Amrapali and Tommy Atkins such as AB106 (A x TA-2), AB107 (A x TA-3), AB109 (A x TA-5), AB121 (A x TA-17), AB124 (A x TA-20) and AB125(A x TA-21) were predicted to be superior and in the latter cross combination of Amrapali and Sensation, only one hybrid is predicted to have superior fruit quality traits, i.e., AB149 (A x S-20). All these 6 hybrids were predicted to have better fruit quality over the female parent, Amrapali in terms of higher values for fruit weight and fruit thickness and lower values in stone characters.

Micro biome analysis and their application for pesticide biodegradation and plant growth promotion in subtropical horticultural crops

PI: Dr. Govind Kumar

Funding Agency: DST-SERB (EEQ), New Delhi

Salient Achievements

On the basis of morphological characterization total 28 bacterial isolates were selected based on the compatibility interactions with nanomaterials like nanochitosan and other. Characterized microbes named as MAL1, MAL2, MAL3, MAL4, MAL5, MAL6, MAL7, ARU1, ARU2, ARU3, ARU4, ARU5, H1739, 6MY1, 6MY2, 6MY3, MR1, MR2, MR3, MR4, MR5, MR6, MR7, MR8, MR9, MR10, MR11 and MR12 (table 1& figure 1). Further plant growth promotion (PGP) screening of various isolates were showedsiderophore production, phosphate solubilization, Zinc solubilization, Potassium solubilization, IAA production, HCN production,

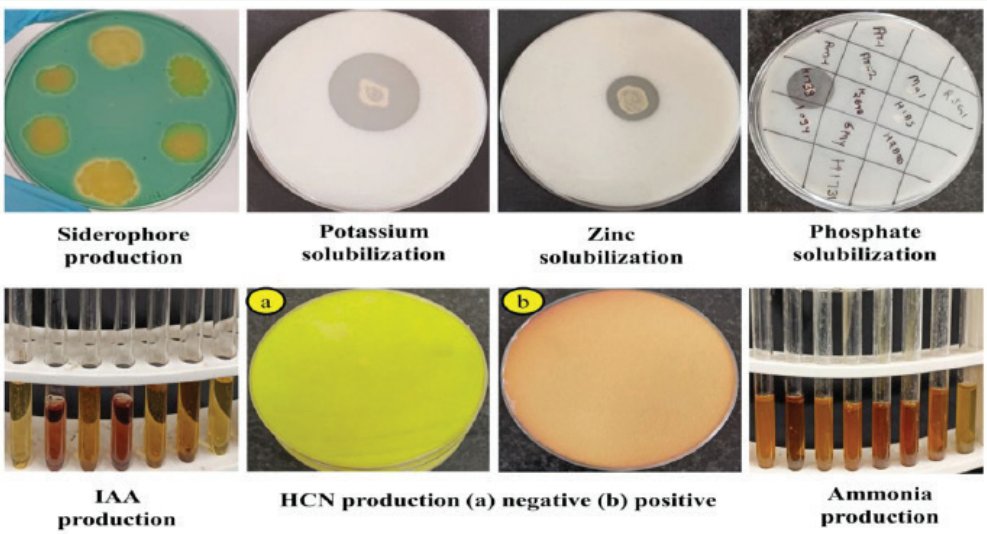


Fig. 5 Bacterial isolates and its screening results of plant growth promoting activity

Ammonia production and other PGP attributes (Fig. 5).Based on PGP attributes, compatibility with nanomaterials, 7 isolates (MAL1, ARU2, H1739, 6MY1, MR2, MR3 and MR4) were finally selected for further characterizations based on biochemical utilization and molecular identification (Table 4&5).

Table 4. Screening of Plant growth promoting activities of selected isolates

	Plant Growth Promotion (PGP) properties						
Isolates	**Siderophore Production**	**Phosphate solubilization**	**Zinc solubilization**	**Potassium solubilization**	**IAA production**	**HCN production**	**Ammonia production**
MAL1	+++	++	-	++	+	++	+
MAL2	-	-	-	++	+	-	+
MAL3	+	+	-	-	-	+	+
MAL4	-	++	-	+	-	+	+
MAL5	+	-	+	+	++	-	+
MAL6	+	+	+	+	-	+	-
MAL7	++	+	+	+	-	-	-
ARU1	+	+	++	-	+	-	-
ARU2	++	+	+	+	+	+	-
ARU3	+	-	+	-	+++	+	++
ARU4	-	-	+	-	+		-
ARU5	-	+	+	+	+	-	-
H1739	+	++	+++	+++	++	-	+++
6MY1	++	+	-	++	-	-	-
6MY2	+	+	-	-	+	+	-
6MY3	-	-	++	-	-	-	-
MR1	++	++	+	-	-	+	+
MR2	++	+	+	+	-	-	+
MR3	+	+	+	+	++	-	+
MR4	+	+	-	++	-	+	+
MR5	-	+	-	-	-	++	-
MR6	-	+	++	-	-	-	-
MR7	-	-	+	-	-	-	-
MR8	-	-	+	-	+	+	+
MR9	-	++	+	+	+	+	-
MR10	+	-	+	+	+	+	++
MR11	-	-	++	++	++	+	-
MR12	-	++	-	-	-	-	-

Table 5. Morphological, molecular and biochemical characterization of selected potential isolates

	Selected potential bacterial Isolates						
Characterization	**MAL1**	**ARU2**	**H1739**	**6MY1**	**MR2**	**MR3**	**MR4**
Gram staining	-	+	+	+	-	+	-
Morphological	Round shaped bunch form	Long rod shape	Long rod shaped chain forming	Round shaped tetrad	Short rod shape, chain form	Rod shape	Rod shape
Molecular	*Staphylococcus pasteuri*	*Bacillus pumilus*	*Bacillus sp.*	*Staphylococcus hominis*	*Bacillus sp.*	*Bacillus safensis*	*Serratia-marcescens*
Accession number	OR701828	OR701829	OR701831	OR701833	OR701834	OR701835	OR701836
ONPG	+	-	-	-	+	-	+
Lysin utilization	+	+	+	-	+	+	+
Ornithine utilization	-	+	-	-	-	-	-
Urease	+	-	+	+	+	-	+
Phenylalanine deamination	-	-	-	-	-	-	-
Nitrate reduction	+	-	-	+	+	-	+
H2S production	+	-	+	-	+	-	+
Citrate utilization	+	-	+	-	+	+	+
Voges Proskauer's	-	-	+	-	+	+	-
Methyl red	+	-	-	-	+	-	+
Indole	+	-	+	+	+	-	-
Malonate utilization	-	-	+	-	+	-	+
Esculin hydrolysis	+	-	+	-	+	+	+
Arabinose	+	-	-	-	+	-	-
Xylose	+	-	-	-	+	-	+
Adonitol	-	-	-	-	-	-	-
Rhamnose	-	-	-	+	-	-	-
Cellobiose	-	-	+	-	-	+	-
Melibiose	-	-	-	-	+	-	+
Saccharose	-	-	+	-	+	-	-
Raffinose	-	-	-	-	-	-	-
Trehalose	-	-	+	-	+	-	-
Glucose	+	-	-	-	+	-	+
Oxidase	+	-	+	-	+	+	+

Biochemical and molecular dynamics of jelly seed disorder in mango (*Mangifera indica* L.)

PI: Dr. Israr Ahmad

Co-PIs: Dr. Dinesh Kumar, Dr. A.K. Trivedi

Funding Agency: UPCST, Lucknow

Salient Achievements

Nutritional data of soil, leaf and pulp reveals that soil, leaf and pulp have sufficient nutrients and there was no deficiency of calcium or any other nutrient in soil/ leaf. Plants and harvested fruits also do not show any nutrient deficiency symptom. Moreover, during the study calcium and other micro nutrient deficiency symptoms were not manifested by the plants. The data on relative humidity, rainfall, temperature and growing degree days observed during the current year's fruit development and maturity period reveals that this year the maximum rainfall (44 mm & 75 mm) and maximum relative humidity (68.1% & 67%) during the later fruit developmental stages (May and June) was lower, while maximum mean temperature was highest (37.6°C and 38.7°C). Upto the end of May and June total cumulative heat accumulation was 739.5 and 1148.25.

TSS of jelly seed pulp (JS) was found lower than non jelly pulp (NJS) during the study and ranges from 18.78° Brix. to 20.83° Brix. In non jelly pulp average reducing sugar (mg/100gm) content varies from 2.42 mg/100gm to 4.35 mg/100gm. Jelly seed pulp has lower reducing sugar compared to non jelly seed pulp and shows decreasing trend during the study (3.32 to 1.48 mg/100gm). In non jelly pulp average starch content varies from 0.88 % to 0.39%. In Jelly pulp and non jelly pulp starch content almost remain similar. In non jelly pulp total carotenoids content varies from 3.52 mg/100gm to 4.76 mg/100gm while Jelly pulp has slight higher carotenoids compared to non jelly pulp and varies from 4.33 mg/100gm to 5.29 mg/100gm. In non jelly pulp total phenols content varies from 213.4 µg/gm to 246.0 µg/gm while in jelly pulp total phenols content varies from 186.9 µg/gm to 230.6 µg/gm. In non jelly pulp total flavonoids content varies from 1.42 mg/100gm to 1.59 mg/100gm while in jelly pulp total flavonoids content varies from 1.47 mg/100gm to 1.40 mg/100gm.

Development of low cost vitamin A rich weaning mix (baby food mix) from locally available food materials for nutritional upliftment of infants.

PI: Dr. Abha Singh

Funding Agency: UPCST, Lucknow

Salient Achievements

Survey in the rural area of Malihabad block of Lucknow district was conducted to know the common feeding practices and common weaning foods in the rural area through PRA and Group discussion and following findings were emerged.

The most preferred weaning food in the studied families was milk +sugar, soft boiled rice and boiled potatoes**.** These weaning foods are not balanced food for growing infants which are very much required for their growth and development. Majority of the families give only milk up to one year. Most of the studied families prefer Lactogen (powered milk) to cow's milk with the belief that it is more nutritious for their infants. Poor families due to money problems give over diluted and contaminated milk to their infants which causes diarrhea and under nutrition among them. Preferred process of preparation of weaning foods was boiling, roasting and mashing/ powdering. Main constraint regarding weaning foods was poverty, non-availability of foods in time and ignorance. In most of the families hygiene was not maintained during preparation and handling of foods which causes diarrhea among the infants. Almost all the nutrients rich foods are available in the studied area like energy rich rice and tubers, protein rich dals (green gram, black gram) oilseed (sesame seeds and groundnut), vitamin and mineral rich vegetable and fruits which can be used in preparation of balanced food for the proper nourishment of the infants.

Locally available food materials which are identified for development of weaning mix are Wheat, rice, jowar, bajara, pulses, almond and Vitamin A (beta carotene) rich fruits and vegetables such as carrot, orange fleshed sweet potato, bael and guava varieties.

Biochemical parameters of Carrot powder

In analysis of Carrots, Orange variety has maximum TSS, acidity as well as total Carotenoids content (Fig. 6).

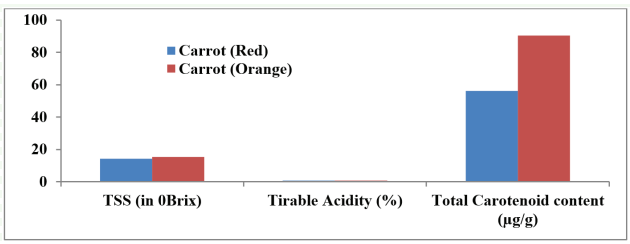


Fig. 6 Biochemical parameters of varieties of Carrots powder

Coloured sweet potato is rich source of energy, beta carotene and anthocyanin. Three varieties of carotene rich varieties are brought from Regional centre of CTCRI, Bhubaneswar and planted at our ICAR-CISH farm for multiplication. After harvesting these varieties, sweet potato powder will be incorporated

in various combinations of baby food mix and evaluated for best combination.. These sweet potato cuttings will be multiplied for next year and will be distributed in the rural area for adding coloured sweet potato in their daily diet.

The development of various fruits powders was standardized for inclusion in the baby food mix for enriching carotenoids and phenol contents in the mix. These are good antioxidants and very much required for the growth and development of infants. The process of developing weaning mix base was also finalized and various combinations of cereals, millets, pulses, oilseeds and fruit powders are in process. Organoleptic evaluations of various combinations are in process. The nutritional and proximate analysis of various combinations is in process and final stage for third party evaluation.

The various type of combination was used for making the weaning mix with the following combinations

Parameters	Source
Carbohydrate	Wheat, Rice Flake, Millet-jowar
Protein	Green Gram, Almond
Oil source	Almond
Minerals and Flavour	Fruit and Vegetable Powder

Various combinations by using the above sources were used to make the weaning mix product with their requisite quantity. It nutritional and proximate analysis is under the final stage for third party analysis.

Efficacy of Sspirotetramat 11.01 % + Imidacloprid 11.01 % w/w sc" insecticide on mango mealy bug funded by JU Agri Sciences Pvt. Ltd.

Crop: Mango, variety-Dashehari, treatments-7, design RBD, replication-4

Treatments	Dose and Stage of Product Application	Time of Application
T 1	"Spirotetramat 11.01 % + Imidacloprid 11.01 % w/w SC" @ 0.0135% g a.i. applied	Applied as foliar at ETL level of pests.
T 2	"Spirotetramat 11.01 % + Imidacloprid 11.01 % w/w SC" @ 0.018% g a.i.	Applied as foliar at ETL level of pests.
T 3	"Spirotetramat 11.01 % + Imidacloprid 11.01 % w/w SC" a.i. applied	Applied as foliar at ETL level of pests.
T 4	"Spirotetramat 11.01 % + Imidacloprid 11.01 % w/w SC" @ 0.036% g a.i. applied	Applied as foliar at ETL level of pests.
T 5	"Spirotetramat 11.01 % + Imidacloprid 11.01 % w/w SC" @ 0.018 % g a.i. (0.075% formulated product) applied	Applied as follar at ETL level of pests (Market standard).
T 6	0.0225% g "Dimethoate 30 % EC" @ 0.05% g a.i. (2475-3300 ml/ha formulated product) applied	Applied as foliar at ETL level of pests (Market standard).
T7	Control (Untreated Check).	-

Total number of treatments: 7

Season: Two seasons study (202-23 & 2023-24)

No. of Application/Spray: 3 spray to be done at the interval of 10-12 days.

1st Spray. As soon as infestation start.

2nd Spray: 10-12 days after 1 spray after the completion of observations of 1a spray

3rd Spray: 10-12 days after 2 spray after the completion of observations of 2nd spray

Observations Period: Observations to be taken at 3, 7 & 10 days after each application,

Observations:

1. Bio-efficacy Insect control
2. Phytotoxicity
2. Effect on natural enemies
4. Effect on yield
5. Benefit Cost Ratio (B/C Ratio)
6. Residue in Soil and Plant (samples to be collected by CRO at the time of harvest)

Efficacy evaluation of Flubendiamide 90 g/l + Deltamethrin 60 g/l (Fenos quick) on mango against fruit fly, leaf webber and shoot borer funded by bayer Crop Science Ltd BCS Crop Protection, Crop Science Field Solutions Plot No -109, Bani Mohanlalganj Road,Village Khatola, The- Sarojani nagar, Lucknow.

Crop : Mango, Variety – Dashehary, Target pests : Leaf webber, Shoot borer and fruit fly

Treatments	Dose and Stage of Product Application	Dosage / 100 lit of water		Application time & Water volume/ha
		a.i. (g)	Forml. (ml)	
T 1	Untreated Control	-	-	First spray to be given as soon as the pest population reaches ETL level. One or more sprays to be given as soon as pest population attains ETL level again. Water Volume: As required depending on size of the tree and plant protection equipment used
T 2	Flubendiamide 90 g/L + Deltamethrin 60 g/L (Fenos Quick)	2.7 + 1.8	30	
T 3	Flubendiamide 90 g/L + Deltamethrin 60 g/L (Fenos Quick)	3.6 + 2.4	40	
T 4	Flubendiamide 90 g/L + Deltamethrin 60 g/L (Fenos Quick)	4.5 + 3	50	
T 5	Flubendiamide 480 g/L SC (Flubendiamide 39.35% w/w SC)	4.8	10	
T 6	Deltamethrin 100 g/L EC (Deltamethrin 11% w/w EC)	3	30	
T7	Quinalphos 25 % EC	50	200	
T8	Flubendiamide 90 g/L + Deltamethrin 60 g/L (Fenos Quick)	9 + 6	100	

Evaluation of Betacyfluthrin 90 g/l +Imidacloprid 210 g/l OD (Solomon) on banana on aphid and scarring beetle.Funded by Bayer Crop Science Ltd, BCS Crop Protection, Crop Science Field Solutions.

Crop: Banana, variety: G9, target pests: Aphids and Leaf and fruit scarring beetle

Treatments	Dose and Stage of Product Application	Dosage / 100 lit of water		Application time & Water volume/ha
		a.i. (g)	Forml. (ml)	
T 1	Untreated Control	-	-	First spray to be given as soon as the pest population reaches ETL level. One or more sprays to be given as soon as pest population attains ETL level again. Water Volume: As required depending on size of the plant and plant protection equipment used
T 2	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD (Solomon)	4.05 + 9.45	45	
T 3	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD (Solomon)	5.4 + 12.6	60	
T 4	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD (Solomon)	6.75 +15.75	75	
T 5	Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC)	6.75	270	
T 6	Imidacloprid 200 g/L SL (Imidacloprid 17.8% w/w SL)	15.8	79	
T7	Dimethoate 30 % EC	29.7	99	
T8	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD (Solomon)	13.5 + 31.5	150	

No. of Treatments:- 8

No. of Replications:-5

No. of Plants/Replication:- 15

Note: As per agreement with the funding agencies, we cannot publish the data without their permission, hence results are not given.

KISAN DRONE Technology

PI : Dr P. K. Shukla

Co-PI : Dr Karma Beer

Salient Achievements

The nano urea was applied in various crops for its efficacy in crops through KISAN DRONE at the speed of 4 meter per second with 200 micron droplet size at the altitude of 7 feet above canopy of mango and 15 feet above the crops like wheat, potato, tuberose and rose. The effect of wind was minimum at this height rather than other heights. The srying was uniform with minimum disturbance through propeller wind. The demonstration at farmer's field of drone was also performed in various villages of Mal Malihabad region (Fig. 7&8, Table 6&7).

S.No	Name of the Crop	Concentration of Nano Urea
1	Mango	2.5 %
2	Wheat	2.0%
3	Potato	2.0%
4	Rose	2.0%
5.	Tuberose	2.0%

Design and Development of Ergonomically Efficient Fruit Harvesters for Mango, Guava and Bael

PI : Dr Karma Beer

Salient Achievements

Survey of study area for different harvesting methods and tools has been completed. The harvesting practices are followed by farmers is laggi + shaking by irrigating the field and fruit harvester is least adopted technology by farmers. 3-D prototype of mango, guava and bael has been developed. The working model for mango has been developed it will be tested in upcoming mango season.

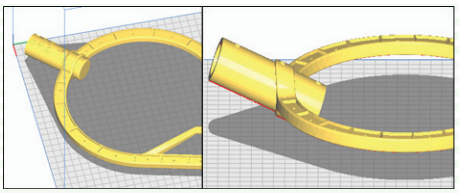


Table 6. Harvesting Practices, it's Adoption and Loss in Kakori and Malihabad

Harvesting Practice	P1	P2	P3	P1	P2	P3
	Malihabad			Kakori		
Adoption of Practices (%)	44.05	52.15	4.10	45.35	48.01	6.74
Aggregate Loss (%)	4.64	9.56	1.64	5.85	10.40	1.85

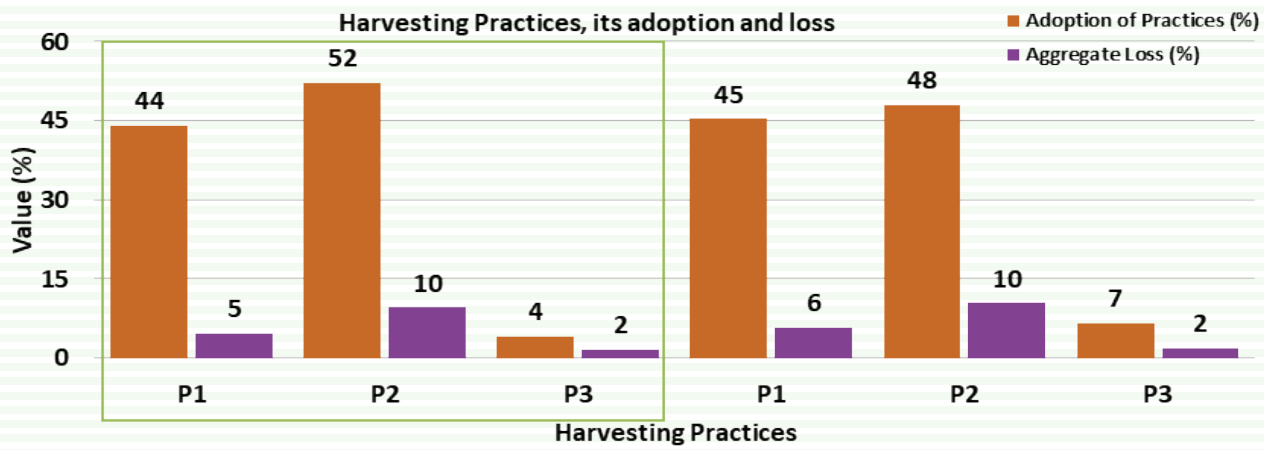


Fig. 7 Harvesting practices, it's adoption and loss

Mango harvesting loss (%) at different canopy height

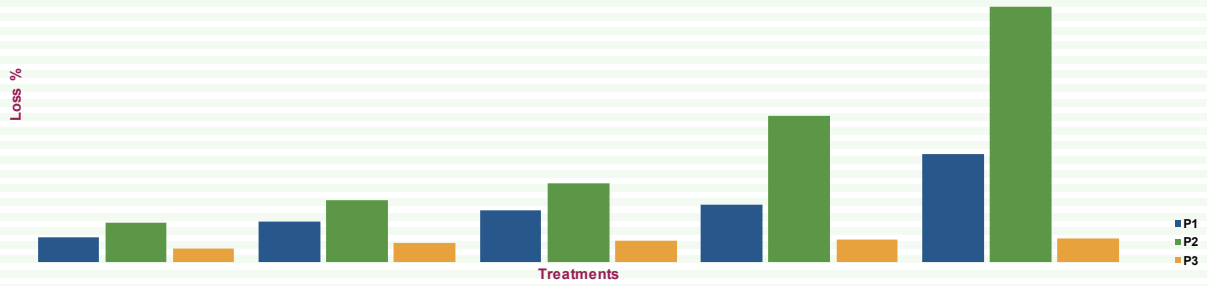


Fig. 8 Mango harvesting loss (%) at different canopy height

Table 7. Mango harvesting loss (%) at different canopy height

Canopy Height (Feet)	P1	P2	P3	Aggregate Loss
0-10'	2.05	3.20	1.10	1.27
11-15'	3.30	5.10	1.55	1.99
16-20'	4.25	6.50	1.75	2.50
20-30'	4.75	12.00	1.85	3.72
>30'	8.85	21.00	1.95	6.36
Total	23.20	47.80	8.20	15.84
Average	4.64	9.56	1.64	3.17

P1- Harvesting by shaking and Laggi in Irrigated field
P2- Harvesting by shaking and Laggi in non Irrigated field
P3- Harvesting by Pole Harvester

Setting Up of Mini Honey Testing Laboratory

Funding Agency: External funded by National Beekeeping and Honey Mission, National Bee Board

Salient Achievements

The laboratory infrastructure is now in place, providing a conducive environment for conducting comprehensive honey testing procedures. Required instruments for honey testing has been successfully procured and installed within the institute, aimed at ensuring that honey products meet stringent regulatory standards and fulfill consumer expectations.

TDF-Impact evaluation of WADI projects in UP

PI: Dr. Ravi, S. C.

Funding Agency: NABARD, RO, Lucknow

Salient Achievements

Sonbhadra (Sonebhadra) is the second largest district of Uttar Pradesh with highest area under forest is a house of vast number of tribal population. To augment the income, promote sustainable livelihood enhancement of the tribes of the region, NABARD implemented WADI projects with the help of Project Implementing Agencies from 2014-15. The preliminary survey was conducted at Myorpur, Duddhi, Nagwan and Chopan blocks of Sonabhadra District, Uttar Pradesh (Fig. 9). The results indicated that the intervention by NABARD through WADI projects in these areas has been successful in bringing positive economic changes. There was a magnificent increase in income (varying from 222.7 % to 276.5 %) and savings (varying from 171.9 % to 293.4 %). Herfindhal index of crop diversification was approaching zero (decreased as compared to before scenario) in all the project areas, indicating that crop diversification was more post WADI implementation. The efforts made by NABARD through the WADI projects have yielded highly positive results, significantly increasing the area under irrigation. All regions recognized the program's asset generation and housing improvement. WADI has improved recipients' infrastructure and quality of life.

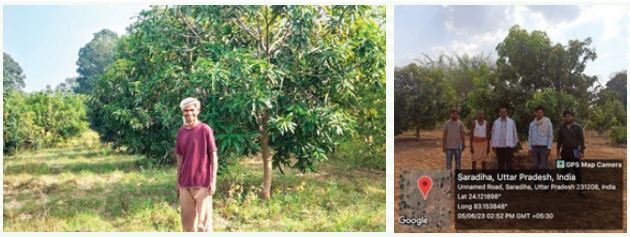


Fig.9 Survey of the WADI beneficiaries

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

Augmentation and evaluation of germplasm in mango

PI: Dr. Ashish Yadav

Salient Achievements

Collected 01farmers mango variety for planting at Field Gene Bank of ICAR-CISH. ICAR-CISH is actively playing its role as NAGs Centre for Mango.

Scion breeding in Mango (Amrapali x Vanraj)

PI: Dr. Ashish Yadav

Salient Achievements

A total of 2054 flowers were crossed on 400 panicles. A total of 05 hybrid mango fruits were harvested and seeds sown for germination. 04 no. of hybrid mango seeds germinated and plants are growing well.

Root stock breeding in Mango

PI: Dr. Ashish Yadav

Salient Achievements

A total of 1489 flowers were crossed on 300 panicles using cross combinations Vellaikolumban x H-13-1 and a total of 391 flowers were crossed on 100 panicles using cross combinations H-13-1x Vellaikolumban. A total of 16 and 01 hybrid mango fruits were harvested, respectively and seeds sown for germination. However, only 01 no. of hybrid mango seeds germinated for Vellaikolumban x H-13-1 cross combinations and plant is growing well.

MLT-2 for mango hybrids

PI: Dr. Ashish Yadav

Salient Achievements

Scions of Pusa Deepshikha, Pusa Manohari and Pusa Lalima received from IARI and grafted immediately on the same day. Scions of Arka Suprabhat also grafted to increase the number of plants. Besides, Aphonso, Mallika and Amrapali scions were also grafted for the initiation of the trial. The experiment was laid out in the field and grafted plants were transplanted in the field in the month of December.

AICRP Varietal Trial in Jamun

PI: Dr. Anshuman Singh

Co-PI: Dr. Vishambhar Dayal

Salient Achievements

Tree growth and fruit quality attributes were recorded in 9-year old trees of four varieties including CISH J-37 (Jamwant), CISH J-42, Konkan Bahadoli and Goma Priyanka. The tree height varied between 5.47 m (Konkan Bahadoli) and 6.42 m (CISH J-37). The trunk circumference was the minimum (56.67 cm) in Konkan Bahadoli and the maximum (85 cm) in CISH J-37. The canopy spread in the east-west direction was the maximum (5.90 m) in Goma Priyanka, and the minimum (3.73 m) in Konkan Bahadoli. Similarly, the canopy spread in north-south direction was the lowest (3.50 m) in Konkan Bahadoli and the highest (5.73 m) in CISH J-42. The highest fruit weight (17.02 g) was recorded in CISH J-37, and the highest pulp content (94.44%) in CISH J-42. The fruit TSS ranged between 11.53 ^{o}Brix (Konkan Bahadoli) and 13.12 ^{o}Brix (CISH J-37). Variety CISH J-37 out-yielded other cultivars in fruit yield (24.45 kg/tree) while it was the lowest (10.55 kg/tree) in CISH J-42.

Effect of planting density and canopy management in jamun

PI: Dr. Anshuman Singh

Co-PI: Dr. Vishambhar Dayal

Salient Achievements

The experiment was laid out as per the technical program. Jamun variety CISH J-37 has been planted at different spacings (8 x 8 m, 8 x 6 m, and 8 x 4 m). The plants are in vegetative stage.

National Networking: National Agricultural Innovation Fund (NAIF) Project

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

PI: Dr. Muthukumar. M

Co-PI: Dr. Govind Kumar

Salient Achievements

ICAR-CISH filed 3 patents, 4 designs (1 registered), 6 copyrights (3 RoC generated), and 3 trademarks and facilitated framers to the registration of 14 farmers' mango varieties. ITMC/VTIC of ICAR-CISH, Lucknow organized 6 Meetings in which 3 varieties/

technologies were identified. Three technology licenses were given to 4 different licensees during this period. Two contract cum collaborative research proposals were initiated with Ju-Agriscience Ltd. and Innova Food Park for different-different research works. Two IP awareness programmes were organized. Over all 14 MoU/MoAs were signed between the ICAR-CISH and other stakeholders.

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

PI: Dr. Maneesh Mishra

Co-PI: Dr. S.C. Ravi and Dr. Alok Gupta

Eighteen new incubates/startups were admitted for incubation on various technologies such as Development of app on nutrition management in banana and, Pest & disease management of mango, Development of Mango wine, Technology on Hydroponics of high value vegetable crops, Value addition of mango and guava, Millet based fruit products and Export of mango through sea route by CISH technology etc. Eight startups were graduated this year. A revenue of Rs. 12,77,694/- was generated in the form of royalty by the startups. A new incubation programme "Udyanoday-1" was launched on 29th December, 2023. Three B2B, Investors and stakeholders meetings; and seven agri-business development / awareness programmes were organized during the period. Three startups M/S Seedling Agrotech, Lucknow, U.P., M/S Mittan Agritech Private Limited, Lucknow, U.P. and M/S Subhekshaa Agro Solutions Pvt. Ltd, Lucknow, U.P. have developed their brands with the name of AgroSage, Grow Sure and Madhuram, respectively. Two products, Mango Leather and Mango squash were launched by the CISH startup M/s Shrishti Food Products, Malda, W.B. in Horticulture Investor's Meet – 2023.

4 Transfer of Technology

Events organized

Post Budget Webinar

ICAR-CISH, Lucknow participated in the post-budget webinar on "Agriculture and Cooperatives" conducted by the Ministry of Agriculture & Farmers' Welfare, Government of India on 24th February 2023. The event was addressed by the Hon'ble Prime Minister, Shri Narendra Modi. He informed that Agricultural budget has now been increased to more than 1,25,000 crores today. He emphasized that various important decisions are being taken in agricultural budget, in the direction, of making nation 'Atmanirbhar'. The webinar was attended by the Director, Dr. T. Damodaran and all scientists of the Institute. On this occasion, progressive farmers were also invited for interaction. Shri Dayashankar Singh, Irada Foundation, Lucknow, Shri Shobha Ram, Kela Utpadak, Ayodhya, Shri Deepak Shukla, Aam Utpadak, Sitapur, Shri Ram Kishor Maurya, Society for Conservation of Mango Diversity, Lucknow and Sh. Upendra Singh, Avadh Aam Utpadak Ewam Bagwani Smiti, Lucknow attended the programme and interacted with institute scientists on digitization of horticulture.

Mango Buyer-Seller Meet – 2023

A Mango Buyer-Seller Meet was organized by the Agri-Business Incubation Centre for mango export promotion on 28th April 2023. Mango exporters, farmers, traders, FPOs, community based organizations (CBO) from various parts of UP and ICAR-CISH scientists were linked through this meeting for the successful export of mango.All the experts and participants visited to the Mango Pack House, Malihabad for inspecting the facilities of mango processing and packaging before export. About 57 mango growers participated in this mango buyer and seller meet.

Incubate-Mentors Brainstorming Meeting

ICAR-CISH, Agri-Business Incubation Centre, Lucknow organized an "Incubate-Mentors Brainstorming Meeting" on 10th May, 2023. In this meeting different horticultural startup ideas of entrepreneurs were critically discussed with the expert scientists and strengthened their ideas for converting into successful start-ups. A total of 21 participants (scientists / mentors, entrepreneurs / startups and stakeholders) attended the meeting.

Scientist-farmers interactions meet cum Institute visit

A group of 51 farmers from Shivpuri district of Madhya Pradesh visited the Institute on December 8, 2023. Farmers were sensitized about subtropical fruit production, protection, processing and improved varieties for enhancing income. Farmers were encouraged to grow underutilized fruits like bael and aonla with drip irrigation cum mulching. Scientific cultivation of Karonda, mango varieties like Dashehari, Mallika, Amrapali were presented. Importance of micronutrient management *vis-à-vis* water conservation for quality fruit production was also explained.

Azadi ka Amrit Mahotsav

Awareness Programme for School Children about Future Career Opportunities through Horticultural Research

ICAR- CISH, Lucknow organized an awareness programme for school children under *Azadi ka Amrit Mahotsav* on '*Future Career Opportunities through Horticultural Research*' on 27th April, 2023 at Vidyasthali Inter College, Kanar, Lucknow. Dr. T. Damodaran, Director, ICAR-CISH, Lucknow in his address stressed that horticultural research and education have a tremendous potential for bringing out transformative improvements in the lives of Indian farmers. He said that education during formative years plays a critical role in shaping the young minds. While exhorting the school children to pursue higher studies in horticultural sciences, he remarked that cutting-edge horticultural research to ensure the food, nutrition, income, employment and environmental security of a burgeoning global population. Mrs. Shipra Verma, Principal, Vidyasthali informed about educational and extra-curricular activities at the school. Dr. P. L. Saroj, Head, Crop Production Division presented a detailed account of research and education infrastructure under the Indian Council of Agricultural Research. He also highlighted the vast career opportunities through horticultural research. The programme was attended by about 120 school children and school staff. Dr. Anshuman Singh, Senior Scientist and Dr. Karma Beer, Scientist coordinated the programme.

Nutri-Garden Awareness Programme

ICAR- CISH, Lucknow organized an awareness programme under *Azadi ka Amrit Mahotsav*, on 'Nutri-gardens for food, nutrition and income security' in Sarsanda village of Lucknow district on 28th June, 2023. The program was attended by about 80 farmers, farm women and rural youth from Sarsanda and adjoining villages. Dr. T. Damodaran, Director, ICAR-CISH, Lucknow in his address encouraged the farmers to adopt an integrated value-chain based approach to reap the premium benefits from the cultivation of mango and other horticultural crops. He assured the farmers of adequate technical backstopping from ICAR-CISH for sustainable farming. Dr. Abha Singh, Principal Scientist informed the farmers and farm women about simple approaches and precautions for increasing the nutrient bioavailability from the food. She underlined the importance of traditional fruits, vegetables and millets in alleviating the hunger and malnutrition risks. Dr. Anshuman Singh, Senior Scientist informed about improved varieties of subtropical fruits of mango, guava and jamun. Dr. V. Dayal, Scientist, presented an overview of initiatives being taken up under SC-SP program for empowering the farmers. Dr. Karma Beer, Scientist, informed the farmers about methods and approaches for preparing the value added products from ripe and unripe mango fruits. Dr. S. S. Das, Scientist, discussed about different nutri-rich fruits and vegetables for eradicating the malnutrition. The program was coordinated by Dr. Anshuman Singh, Dr. Karma Beer and Dr. Vishambhar Dayal.

Trainings organized

Scientific Cultivation, High Density Planting & Canopy Management in Guava

ICAR- CISH, Lucknow in collaboration with Bhawana Sewa Sansthan, Lucknow organized two-days training program on 'Scientific cultivation, high density planting and canopy management in guava' for 26 guava growers of Shahjahanpur district, Uttar Pradesh from January11-12, 2023. During this training, the experts delivered lectures on improved varieties of guava, plant propagation, orchard establishment & early care, irrigation & fertilizer management, training, pruning & canopy management, integrated management of insect-pests and diseases, post-harvest management and value addition, etc. Dr. S. K. Shukla, Principal Scientist was the Course Director, and Dr. Anshuman Singh, Senior Scientist was the Coordinator of this training program.

Mango and Guava Crop Management

Training programme on 'mango and guava crop management' for the officials of Bayer Crop Science Private Limited was organized during January 23-24, 2023 at ICAR-CISH, Rehmankhera, Lucknow. Eight lectures and visits to CISH-Museum and experimental field were conducted to elaborate on various aspects of mango and guava crop management. Thirty-five officials of Bayer Crop Science Private Limited physically and 15 virtually participated in the program. The program was Co-ordinated by Dr. P.K. Shukla, Principal Scientist (Plant Pathology).

Skill development for Micro-irrigation technician

Skill development training on 'Micro-irrigation technician' was organized under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) by PFDC, ICAR-CISH, Lucknow in collaboration with National Committee on Plasticulture Application in Horticulture, New Delhi.Fourty trainees participants from six states of India participated. The objective of the trainings was to promote entrepreneurship in Micro-irrigation, by skill development in micro irrigation using latest techniques, tools and technologies in agriculture and micro irrigation industry to address mission of Government of India "More crop per drop" successful.

Third party assessment was made by Agriculture Skill Development Council of India. The success rate of trainees was 96.66 %. The training was Co-ordinated by Dr. S.R. Singh, Principal Scientist, Horticulture.

Training-cum-awareness program on 'Shree Anna'

ICAR-CISH, Lucknow organized a training-cum-awareness programme on 'Shree Anna' in the adopted village Gopalpur under the scheduled castes sub-plan on 29th March, 2023. In this programme, 113 women and men farm households participated in the programme. Dr. Abha Singh provided the introduction on nutritional importance of Shree Anna and how to include them in regular diet. Farmers were encouraged by Dr. P. L. Saroj to start the production of 'Shri anna'. Dr. Vishambhar Dayal made the farmers aware about the nutrients present in Shree Anna. The program was Co-ordinated by Dr. P.L. Saroj and Dr. Vishambhar Dayal under the guidance of Dr. T. Damodaran, Director of the institute.

Orchard establishment for extension activists and farmers

The ICAR-CISH organized 3 days training programme from 7th June to 9th June 2023 at ICAR-CISH, Lucknow. Twenty extension functionaries of Akhil Bhartiya

Samaj Sewa Sansthan (ABSSS) and SRIJAN staff from Shivpuri, Madhya Pradesh, Niwari, M.P., Chitrakoot U.P. and Banda districts participated in the programme. Principal Scientist Dr. K.K. Srivastava, was the Co-ordinator and Dr. Govind Kumar was Co-coordinator. The extension functionaries and farmers were given hands on training in guava canopy management, pruning, high density orcharding, orchard floor management, insect-pest and disease management.

Celebrations

74th Republic day celebration

The 74th Republic Day was celebrated on 26 January 2023 at the ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow. The Director of the institute, Dr. Damodaran, unfurled the national flag in the main campus at Rehmankhera. In his address, he emphasized the achievements made by the institutue and motivated everyone to work unitedly to achieve national goals.

40th Foundation Day of ICAR-CISH

The '40th Foundation Day' of the institute was celebrated on June 01, 2023 at Rehmankhera campus under the chairmanship of Dr. Major Singh, Member, Agricultural Scientists Recruitment Board, ICAR, New Delhi. Dr. Singh underlined the importance of research oriented towards evaluation of nutraceutically rich horticulture crops for improving nutritional security and livelihood of growers. Dr. T. Damodaran, Director, ICAR-CISH, Lucknow, summarized the achievements of the institute in the last 40 years and highlighted the importance of climate resilient horticulture, research on nutraceutical rich varieties of mango, guava and jamun and enriching research on the value chain for domestic and export markets. Dr. Shailendra Rajan, Former Director of the institute, presented the results of long-term breeding of mango and guava at the institute. Dr. Ajit Shashni, Director, ICAR-National Botanical Research Institute, Lucknow, Dr. R. Viswanathan, Director, ICAR-Indian Institute of Sugarcane Research. and Dr. U.K. Sarkar, Director of ICAR-National Bureau of Fish Genetic Resources, Lucknow were present in the programme.

World Soil Day 2023

World Soil Day was celebrated at Sarsanda, Lucknow, U.P. on December 5, 2023 under SC sub plan. Dr. S.K Shukla, Dr. Tarun Adak, Dr. Vishambhar Dayal and Dr. Dinesh Kumar actively participated in the programme. About 40 farmers, women and men took enthusiastically participated. Soil and tree health management in fruit production systems was discussed. Scientists discussed about the water management and orchard practices for ensuring fruit yields. Hindi literature of scientific zinc and boron management in guava cultivation was distributed among the farming community.

Exhibitions

Participation in State Level Kharif Productivity Goshthi- 2023 organized by Department of Agriculture, Uttar Pradesh

Directorate of Agriculture, Uttar Pradesh organized one day (May 26, 2023) State Level Kharif Productivity Goshti and Exhibition at Krishi Bhawan, Lucknow. ICAR- CISH participated and showcased institute technologies. After inauguration, Sri. Surya Pratap Shahi, Hon'ble Minister of Agriculture, Agril. Education and Research, Uttar Pradesh visited the stall. More than 2000 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.

Participation in State level Fruit, Vegetable and Flower Show-2023 organized at Rajbhawan, Lucknow

Directorate of Horticulture and Food Processing, Lucknow organized four days (February 17-20, 2023) Fruit, Vegetable and Flower Show at Rajbhawan, Lucknow. Hydroponic system for growing vegetables of tomato, lettuce and salad, Guava varieties Lalit, Lalima and Shweta, Bael varieties CISH B1 and CISH B2, processed fruit products, mango harvester, fruit fly trap, exotic vegetables and cherry tomato were the major attraction for visitors at the institute stall. More than 7000 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.

Participation in Bundelkhand Krishi Mela evam Krishi Pradarshini organized by Rani Lakshmi Bai Central Agricultural University, Jhansi

Rani Lakshmi Bai Central Agricultural University, Jhansi organized two days (February 26-27, 2023) Bundelkhand Krishi Mela evam Krishi Pradarshini at Rani Lakshmi Bai Central Agricultural University Jhansi. 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. Dr. Naresh Babu, Principal Scientist and Shri. Arvind Kumar, ACTO took feedback from the visitors and solved their queries regarding plant propagation, cultivation method, plant protection and processed products of fruits of mango, guava, bael and jamun.

Participation in Farmers Fair & Agro- Industrial Exhibition organized by Acharya Narendra Dev University of Agriculture & Technology, Kumarganj, Ayodhya

Acharya Narendra Dev University of Agriculture & Technology, Kumarganj, Ayodhya organized two days (March 17-18, 2023) Farmers Fair & Agro- Industrial Exhibition on the theme Millet crop production and Value-added products at Acharya Narendra Dev University of Agriculture & Technology, Kumarganj, Ayodhya. More than 6000 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.

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

Several training-cum-exposure visits were organized in the institute research farms for State Government officers and farmers from various districts of Bihar, MP, Himachal Pradesh, Tamil Nadu, Uttarakhand, Chhattisgarh 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 & diseases, improved varieties of mango and guava, grafting, planting methods, crop diversification, etc. Students from schools and Agriculture Colleges also visited the institute as part of their course curriculum. The visits were coordinated by Dr. Naresh Babu, Principal Scientist, Dr. Tarun Adak, Senior Scientist, Mr. Arvind Kumar, ACTO and Mr. Dhruv Kumar, S.T.A.

S.N.	Date	Place	Number of Farmers/ officials/students
1.	18.01.2023 to 23.01.2023	Rajkiya Girls Inter College, Sarosa-Bharosa, Kakori and Veerangana Uda Devi Government Inter College, Mall, Lucknow	715 students of class 9-12th standard with 15 faculty members
2.	01.02.2023	Saran, Bihar	55 farmers
3.	07.02.2023	Rewa, Madhya Pradesh	24 farmers including 2 officials
4.	16.02.2023	Datia, M.P	21 farmers including 1 official
5.	21.02.2023	Gorakhpur	40 farmers including one official
6.	24.02.2023	Kangra, Himachal Pradesh	20 farmers and Horticulture officials
7.	24.02.2023	Teekamgarh, Madhya Pradesh	7 farmers including 1 official
8.	24.02.2023	Tamil Nadu Agricultural University (Women's Parish Trichy), Coimbatore	67 final year graduate students and two professors
9.	02.03.2023	Chhatarpur, Madhya Pradesh	8 farmers including 1 official
10.	02.03.2023	Satna, Madhya Pradesh	8 farmers including 1 official
11.	02.03.2023	Tamil Nadu Agricultural University (Women's Parish Trichy), Coimbatore	69 students and two professors
12.	27.03.2023	Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and forestry, Pauri, Uttarakhand	19 students of M.Sc. and 2 faculty members
13.	31.03.2023	Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh	33 B.Sc (Hons.) Agri. VI Sem. students along with 2 faculty members
14.	26.04.2023	Kabirdham, Chhattisgarh	15 farmers
15.	24.05.2023	Maharishi University of Information Technology Lucknow, Uttar Pradesh	50 students of B.Sc. (Ag.) and 10 students M.Sc. (Biotechnology)

16.	20.07.2023	District Development Managers (DDMs), NABARD from National Bank Staff College	45 NABARD officials
17.	09.08.2023	Babina blocks of Jhansi district of Uttar Pradesh	25 farmers
18.	10.08.2023	Chandrabhanu Gupta Agriculture Post Graduate College of Lucknow University, Lucknow	60 students of B.Sc (Hons.) Agriculture VI semester
19.	16.11.2023	Kendriya Vidyalaya, IIM Road Lucknow	250 students

Workshop and training on ideal agricultural practices in mango orchards

Understanding the importance of ideal agricultural practices in increasing the export of mango from Uttar Pradesh and producing high quality mango, a workshop was organized by the Institute today on Sept.4, 2023. In this workshop, 23 progressive gardeners from major mango producing districts of the state (Saharanpur, Bijnor, Meerut, Amroha, Kasganj, Lucknow, Sitapur, Barabanki, Raebareli, Amethi and Banaras) participated.

Training programme on high density planting, management and rejuvenation of old and unproductive orchards of mango and guava

ICAR- CISH, Lucknow organized three days training programme on high density planting, management and rejuvenation of old and unproductive orchards of mango and guava during Sept. 13-15, 2023 for the farmers. Twenty seven farmers including two representatives from Raigarh district of Chhattisgarh were participated in training. coordinated the programme.

Training programme on Entrepreneurship development among women through horticulture and fruit processing

ICAR-CISH, Lucknow organized three days training programme on entrepreneurship development for women through horticulture and fruit processing during Sept. 20-22, 2023. Twenty five women including two representatives from Farrukhabad district of Uttar Pradesh were participated in training. At the outset of programme, Dr.T. Damodaran, Director underline the importance of horticulture and fruit processing and scope of quality product and improved packaging of the products that will enhance income of women.

Scientist-farmer's interactions meet cum Institute visit

A group of 35 farmers from Mahoba district of Uttar Pradesh visited at ICAR-CISH Lucknow on September 27, 2023. Farmers were sensitized about subtropical fruit production, protection, processing and improved varieties for enhancing income. Importance of fruits and vegetables in ensuring food and nutritional security was discussed.

One Day Farmers Training on Improved Production Technology on Jute production for Malda district

A awareness cum training program on improved Production Technology on Jute production was organized on Dec.15, 2023 with collaboration of Directorate of Jute Board, Kolkata at CISH-KVK/ RRS Malda. The program was inaugurated by Dr.Luxman Ram Buldak, Director Directorate of Jute Board Kolkata. He emphasis on increase of jute production and coverage. During the program Dr. Dipak Nayak, I/c Head RRS Malda give brief details of initiative, which were taken for production and processing of good quality of fiber through technology

interventions. Dr. D.K. Raghav Head CISH-KVK Malda discussed about the diversification and value addition of jute fiber for packaging, which will be helpful to reduce the plastic consumption and pollution also. Mr. Anuj Kumar Asst. Director of Jute Board gave details of schemes, which is implementing for the farmers in possible area of jute production. The technical expert from Jute board delivers the detail of technology for increasing the productivities in low land area of district. Total 40 female farmers were attended from Agrani FPO of district.

Exhibition

Participation in *Akhil Bhartiya Akhil Bhartiya Kisan Mela Evam Krishi Udyog Pradarshini* organized by CSAU&T, Kanpur

Chandra Shekhar Azad University of Agriculture & Technology, Kanpur organized three days (October 8-10, 2023) *Akhil Bhartiya Kisan Mela Evam Krishi Udyog Pradarshini*. Scientist and Technical Officer of ICAR- CISH participated and showcased institute technologies.

Horticulture Entrepreneur Conference-2023

Horticulture Investors Meet-2023 was organized by the Institute on October 10, 2023. There was a detailed discussion among the entrepreneurs with the Agricultural Production Commissioner to increase the export of mango from the mango fruit belt of Uttar Pradesh. Various agricultural entrepreneurs of the country, start up managers, agricultural producers' associations, etc. along with representatives of reputed institutions and industries of the country like CEO (Invest in UP) of Uttar Pradesh Government, General Manager of APEDA Dr. Vineeta Sudhanshu, Khandelwal. A total of 150 participants participated along with Dr. Bal Krishna, Chairman of Biofertilizers and representatives of Jain Irrigation Systems and VNR. The program was conducted by Ms. Nimisha Maheshwari and vote of thanks was given by Dr. Manish Mishra.

Farmers fair organized by BUA&T, Banda

ICAR-CISH participated and showcased institute technologies during three days (October 27-29, 2023) Farmers Fair organized by Banda University of Agriculture & Technology, Banda. The Fair was inaugurated by Honourable State Minister of Jal Shakti Shri Ramkesh Nishad on October 27, 2023 in the presence of Honourable Vice chancellor of BAU&T, Banda Dr. N.P. Singh and other dignitaries. Information of mango varieties Ambika and Arunika, Amarpali, Mallika; guava varieties Dhaval, Shweta, Lalima and Lalit; bael varieties CISH B1 and CISH B2, jamun J 37 and J 42, high density planting, rejuvenation of old and unproductive mango orchards, management of irregular bearing in mango, integrated pest and disease management in mango, different species of pointed gourd vegetable, processed and value added products of mango, bael, guava and aonla, grafted plants of guava and citrus and bio products of bio- enhancer and Fusicont were made big attraction for visitors at the institute stall.

National Dialogue/National workshop on guava: Challenges and Strategies

One day National Dialogue/National workshop on guava was organized in collaboration with All India coordinated Research Improvement Project on fruits on 15 December 2023 at ICAR-CISH, Lucknow. The Program was inaugurated by Dr. B. Singh, Honorable V.C. Narendra Deo University of Agriculture and

Technology, Kumarganj Ayodhya, Uttar Pradesh. Dr. B. Singh underlined the importance of crop specific dialogue rather many crops, such discussion helps in chalking out strategies. Dr. Singh emphasized that study required to be conducted on rootstock and scion interaction technology development required to develop in guava in view of charging

Scheduled Caste Sub Plan

Field demonstration of garlic farming under SCSP

About 1200 kg of garlic seedsvariety (G-282) were provided to 443 farmers in mall 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 first week of November gave higher yield and better quality as compare to the late planting.An area of about 22000 square meters was undertaken for demonstration of garlic.

Field demonstration of rabi season onion farming under SCSP

About 50 kg of onion seeds variety (NHRDF-Red, NHRDF-Red3, NHRDF-Red -4) were distributed to 478 farmers in mall 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 nurserywerepreprared in month of November gave higher yield and better quality as compare to the late sown. An area of about 5.0 hectare was undertaken for demonstration of onion.

Promotion and performance evaluation of coriander variety "GDLC-1-TL" under SCSP.

Farmers from villages of Mall and Kakori block of Lucknow district were selected for coriander cultivation under kitchen garden and commercial cultivation. The coriander seeds (30 kg) were provided to 350 farmers. An area of about 3.0hectare was under taken for the demonstration and cultivation. The yield of green coriander was around 6.0 tons per hectare and grain yield. The activity was resulted in the income generation of Rs.2.59 lakhs to the beneficiary

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

During the year of 2023-24 more than 478 farmers family supported for crop improvement of 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 improved nutritional security of farm family.

Demonstration and promotion of Cole crops vegetable for livelihood improvement of schedule caste family *under SCSP*

Cole crops vegetables seedlings (nos. 140357) cauliflower, cabbage and broccoli were distributed to the farmers of adopted village in Mall and Kakori blocks of Lucknow. The growth and yield performance of cole crops vegetables were observed in the farmers' fields. An area of about 4.5 hectare was under taken for the demonstration and cultivation.

Distribution of grafted mango plants

More than 5119 plant of mango variety (Amrapali, Mallika, Dashehari, Langra, Chausa, Arunika, Ambika, Husnhara and Ramkela) developed institute were distributed to the farmers of 40 villages in Mall and Kakori block of Lucknow. The farmers were provided technical assistant from the expert for better establishment of orchards.

Distribution of Red lady papaya plants under SCSP

More than 9583 plants of red lady papaya seedling plants were distributed to the farmers (220 nos of farmers) of 40 villages in Mall and Kakori block of Lucknow. The farmers were provided technical assistant from the expert for better establishment of orchards.

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 40 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 upto15-20 percent more in compare to without use.

Participation of SCSP farmer's communities in various programs

S.No	Name of training/ Field day/ meeting	Venue	Date	No of participants
01	Nutri-Garden awareness Programs	Sarsanda	28.06.2023	80
02	Processing and preservation of Fruit crops	CISH,Rehmankhera, Lucknow	25.07.2023	35
03	Seeds distribution program and Training on Improved production technology for horticultural crops	CISH,Rehmankhera, Lucknow	03.11.2023	441
04	Celebration of soil day	Sarsanda	05.12.2023	264
05	Celebration of National farmer's day	Gopramau	22-12-2023	50
06	Implementing good agriculture practices for pesticides residue	Sarsanda	12.01.2024	54

5 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 ICAR. 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 which is facilitated by the Agri-Business Incubator (ABI) of the Institute.

Technology commercialization:

Two technologies viz., CISH-Bioenhance and CISH-decomposer were commercialized during 2023 and MoU were signed with the licensees i.e., M/s Nature Green Biome, New Delhi and M/s Khandelwal Bio-fertilizers Pvt. Ltd., Belagavi, Karnataka, respectively.

1. On the occasion of Horticulture Investor's Meet-2023, ICAR-CISH, Lucknow inks a Memorandum of Understanding (MoU) with M/s Nature Green Biome, New Delhi, on October 10, 2023 for commercialization of "CISH-Bioenhancer".

2. ICAR-CISH, Lucknow signed a MoU with Innova Agri Bio Park Private Limited, Malur, Karnataka for collaborative research on Development of sea route protocol for export of mango and banana and (ii) Value added& shelf life extension in the fruit products through cryogenic technology.

3. ICAR-CISH, Lucknow signed a Memorandum of Understanding (MoU) with M/s Khandelwal Bio-fertilizers Pvt. Ltd., Belagavi, Karnataka on November 17, 2023 for commercialization of CISH- Decomposer.

MoU's/MoA signed:

In total around MoUs were signed during 2023 which are categorized into different classes (Fig.).

S. N.	Title of MOU/MoA	Date	Period	Name of partner
1.	MoU for Evaluation of Diversity and decline of indigenous seedling mango of Bihar and study on conservation strategies.	15.03.2023	Two years	Bihar State Biodiversity Board, Patna
2.	MoU for facilitating Students' Training/ Postgraduate research	26.06.2023	Five years	C.S.A. University of Agriculture and Technology, Kanpur

3.	MoU for demonstration, trials and promotion of ICAR-CISH technologies and varieties in Maharashtra.	20.07.2023	One year	Mahakesar Mango Bagaitdar sangh (Mango Grower Association), Maharashtra
4.	MoU for research focusing on the agro-economic studies related to the applicability and suitability of glauconite as a fertilizer would be investigated under this MoU.	28.08.2023	Two year	Geographical Survey of India, NR Lucknow, Uttar Pradesh
5.	Agreement for availing the Common Food Processing Facilities on Food Processing and Value Chain Management.	01.08.2023	Three year	Agrani Neo Farmers Producer Company Ltd., Kendpukur, Malda, West Bangal
6.	Agreement for availing the Common Food Processing Facilities on Food Processing and Value Chain Management.	01.08.2023	Three year	Alokini Farmers Producer Company Ltd., Kendpukur, Malda, West Bangal
7.	MoU for Commercialization of CISH-Bioenhancer technology	10.10.2023	Three Year	Nature Green Biome, Block C, Naraina Village, New Delhi,
8.	MoA for handholding, training &services of common facility centre to DRDC, Malda	10.11.2023	Three Year	District rural development cell, Malda, West Bengal
9.	MoU for collaborative research on Development of sea route protocol for export of mango and banana and (ii) Value added& shelf life extension in the fruit products through cryogenic technology.	10.10.2023	Three Year	Innova Agri Bio Park Private Limited, Malur, Karnataka
10.	MoU for facilitating Students' Training/ Postgraduate research.	16.11.2023	Five Year	ITM University Gwalior, Madhya Pradesh
11.	MoU for licensing of CISH-Decomposer	17.11.2023	Five Year	M/s Khandelwal Bio-fertilizer Pvt. Ltd., Karnataka
12.	MoU for IMD's Installation facilities at RRS Malda for weather forecasting.	25.11.2023	Five year	India Metrological Department, Ministry of earth, GOI, New Delhi
13.	MoA for providing sales outlet for the sales of value added products of KVK, Unnao.	14.12.2023	Three year	KVK, Dhaura, Unnao, Uttar Pradesh
14.	Deed of Agreement for Development of DUS testing guideline for Karonda.	27.12.2023	Three year	PPVFRA, New Delhi

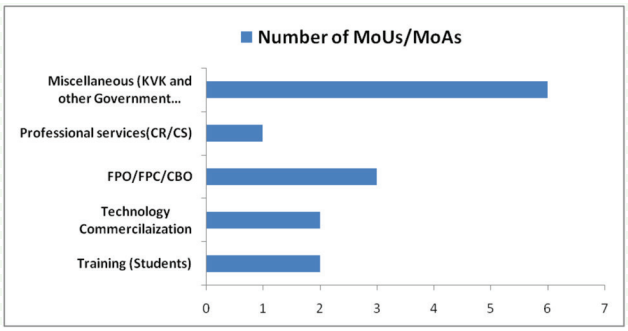


Fig. Classification of MoUs signed under various categories.

IP protection

The IPs generated by the inventors of ICAR-CISH is being protected by filing them under different categories.

Patents

During 2023, three patents were filed by institute which includes; A Double Decker Temporary Immersion Bioreactor (202311038991), A Nutrient formulation for Hydroponic culture of Leafy vegetable and method of preparation thereof (202411024413), A Nutrient formulation for Hydroponic culture of Solanaceous vegetable and method of preparation thereof (202411024413).

PPV&FRA registration

PPV& FRA registration certificate was received for 2 institute varieties i.e. CISH-Ambika and CISH-Arunika. Institute has facilitated obtaining PPV&FRA registrations for 14 farmers' varieties viz., Modi mango (REG/2021/200); Taimuria (REG/2014/837); Gol Bhadaiyan (REG/2014/839); Aamin Khurd(REG/2014/841); Markeara (REG/2014/846); Heere Hayat (REG/2014/847); Nayab (REG/2014/848); Gilas (REG/2014/851); Aamin Tehsil (REG/2014/853); Johri Safeda (REG/2014/855); Aamin Abbasi (REG/2014/856); Aamin Abdul Ahad Khan (REG/2014/857); Lakhnawwa Safeda (REG/2014/858); Surriaya (REG/2014/860).

Trademarks and Designs

During 2023, 3 applications for design registration were filed with Patents, Designs and Trademarks office, New Delhi which includes; Triangular Hydroponics Systems (399868-001), The 'Y' system tree architecture, (399865-001), Tier' system of tree architecture for guava cultivation under HDP (399866-001). Furthermore, three trademark applications Horti-Ind ABIC, Logo (6260921), Device Mark of UDYANODAYA (6260922) and Logo of the Udyanodya Programme (6260923) submitted for registration, were published in trademark journal during 2023. A Design patent has been granted for "Double vertical Hydroponics systems" in class 15-03 (399867-001).

INTELLECTUAL PROPERTY INDIA

ORIGINAL

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 399867-001

तारीख / Date : 13/11/2023

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *DOUBLE VERTICAL HYDROPONICS SYSTEMS* से संबंधित है, का पंजीकरण, वेणी 15-03 में Indian Council Of Agricultural Research (Icar) के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 15-03 in respect of the application of such design to *DOUBLE VERTICAL HYDROPONICS SYSTEMS* in the name of Indian Council Of Agricultural Research (Icar).

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्यधीन प्रावधानों के अनुसरण में।
In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 11/01/2024
Date of Issue

नियंत्रक महा पेटेंट-डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

Copyrights

ICAR-CISH has produced clarifications for copyrights filed for the following technologies; Ripe mango products (in Hindi), Aonla (Indian gooseberry products (in English), Ripe mango products (in English), Guava processed products (in English), Guava kitchen recipes, and Raw mango products (in Hindi).

Entrepreneurship Development

Nine new entrepreneurs were incubated in ABI during the reporting period on technologies such as Development of app on nutrition management in banana and, pest & disease management of mango, Development of Mango wine, Technology on Hydroponics of high value vegetable crops, Value addition of mango and guava, Millet based fruit products and Export of mango through sea route by CISH technology. The brand names AgroSage, Grow Sure and Madhuram have been developed and initiated their businesses by three startups. Mango leather and Squash, two products of M/s Shristi Food Products, Malda, W.B. were launched by Shri Manoj Kumar Singh, IAS and Agriculture Production Commissioner, Government of Uttar Pradesh. The ABI centre of the institute was renamed as Hort-Ind Agri-Business Incubation Centre (Hort-Ind ABIC). Moreover, a one year incubation programme named "UDYANODAY-1" was also launched at the end of this year. More than ten Entrepreneurship and Agri-business Development and Awareness Programmes were organized. The details of the Hort-Ind ABIC activities are given as follows:

1. Technology Mentoring and Startups Incubation

An Incubation-Interaction Meeting was organized on 24th March, 2023 (in hybrid mode) to review the startup proposals of entrepreneurs. A total of nine startups namely; M/S Bongeo Industries Private Limited, Lucknow, U.P., M/S Rasha Wines, Lucknow, U.P., M/S Landtouch Agricultural Industries Pvt. Ltd., Ayodhya, U.P., M/S Seedling Agrotech, Lucknow, U.P., M/S Mittan Agritech Private Limited, Lucknow, U.P., M/S Shapez Enterprises Pvt. Ltd., Lucknow, U.P., M/S Subhekshaa Agro Solutions Pvt. Ltd, Lucknow, U.P., M/S Nutraceutical Rich Organic India Pvt. Ltd., Prayagraj, U.P. and M/S Dr. Nature, Lucknow, U.P. were incubated in various horticultural technologies viz. technologies such as Development of app on nutrition management in banana and, pest & disease management of mango, Development of Mango wine, Technology on Hydroponics of high value vegetable crops, Value addition of mango and guava, Millet

based fruit products and Export of mango through sea route by CISH technology.

2. Entrepreneurs/ Startups initiated

Three startups M/S Seedling Agrotech, Lucknow, U.P., M/S Mittan Agritech Private Limited, Lucknow, U.P. and M/S Subhekshaa Agro Solutions Pvt. Ltd, Lucknow, U.P. have developed their brands with the name of AgroSage, Grow Sure and Madhuram, respectively. These startups initiated selling their products like saffron (aeroponically / hydroponically grown), micronutrients and litchi honey.

3. Product/Technology Developed

Mango leather and Squash, two products from Malda based startup; M/s Shristi Food Products were developed which were launched by Shri Manoj Kumar Singh, IAS and Agriculture Production Commissioner, Government of Uttar Pradesh.

4. Entrepreneurship and Agri-Business Development Programmes

i. **Technologies Review - "Hydroponics and CISH- Bio-Zapper"**

A Technology Review Meeting was organized on February 15, 2023 under the Chairmanship of Director, ICAR-CISH, Dr. T. Damodaran in the committee hall of the institute. In this meeting, various hydroponics technologies and CISH- Bio-Zapper technology were presented by the inventors Dr. S.R. Singh and Dr. Govind Kumar, respectively. The technologies were critically analyzed by the Director and provided technical inputs to strengthen the technologies. The technologies were of high commercial value and have great potential to attract huge market, he added.

ii. **One day workshop on "IPR Issues in Horticultural Sciences"**

A one-day workshop on "IPR Issues in Horticultural Sciences" was organized by the CISH-Agri-Business Incubation (ABI) Centre under the chairmanship of the Director, Dr. T. Damodaran on April 13, 2023 in the committee hall of the institute. Dr. Maneesh Mishra, PI, ABI introduced the programme and welcomed all the experts. Director of the institute briefed the insights on institute research activities and its protection through IP tools. Chief Guest of the programme, Dr. Neeru Bhooshan, ADG, IP&TM & PME, ICAR Hqrs., New Delhi addressed the IP issues coming across while horticultural practices and technologies. She also emphasized on protecting all the rights for the security of research and developments of the institute and ICAR. Dr. Vikram Singh, Senior Scientist, I/c IP&TM Unit, ICAR, N. Delhi highlighted IPR portfolio management and its impact on Horticulture Sciences. Another IP expert from Delhi University, Dr. Ashwini Siwal, Assistant Professor & Director, Entrepreneurial Law Clinic, Faculty of Law, DU focused on the Importance of IPR portfolio for Public Research Organizations. Several issues and queries were meticulously discussed with expert panel by about twenty-two participants including scientists and entrepreneurs. The workshop was closed with vote of thanks by Dr. Muthukumar M., I/c ITMU, CISH.

iii. **Scientist-Farmer-Stakeholder Interaction Meeting**

A Scientist-Farmer-Stakeholder interaction meeting was organized on April 14, 2023 under the Chairmanship of Secretary DARE and Director General, Indian Council of Agricultural Research Dr. Himanshu Pathak. A large number of mango farmers, Farmer Producing Companies, Community Based organization, Exporters, Traders and Industry personnel attended the meeting. Dr. T. Damodaran, Director, ICAR-CISH informed that our Institute will provide technical backstopping to stakeholders for mango export through sea route. ICAR-CISH has already geared up for geo tagging of mango plants at farmers field. Besides, Institute is aggressively pursuing bagging technology in mango for significant reduction in pesticide uses, uniform colour development and freedom from pesticide residue in fruits. During the program Secretary DARE and DG, ICAR handed over Incubation Letter to M/S Dr. Nature, Lucknow a newly incubated Start Up by Agri-Business Incubation Centre of ICAR-CISH who is ready to export mango to UAE and Oman using CISH technology. Around 50 refer van container of mango will be travelling to middle-east through Mundra Sea port this year. Dr Himanshu Pathak, DG, ICAR said that the efforts of the ICAR-CISH in promotion of export of mango from Northern India will expand the revenue basket of India. Dr. Neeru Bhooshan, ADG (IPTM), ICAR appreciated the efforts made by ICAR-CISH on developing Start Ups in horticultural technologies.

iv. **EDP on Women and IP: Accelerating Innovation and Creativity**

ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow celebrated "World Intellectual Property Day" on April 26, 2023 by organizing an EDP on the theme "Women and IP: Accelerating Innovation and Creativity" under the chairmanship of Dr. T. Damodaran, Director. Incharge ITMU welcomed the gathering and gave an overview on WIPO and the theme of the program. Director in his introductory talk advised the Scientists to be proactive and come up with new innovations that

would have IP value. Dr. Poonam Jayant Singh, Senior Scientist from ICAR-NBFGR delivered a special lecture on "Thinking out of box" and Dr. Anju Bajpai, Principal Scientist, ICAR-CISH delivered a talk on "IP avenues in Horticulture with special emphasis on Biotechnological Innovations". The program ended with a formal vote of thanks by Dr. Maneesh Mishra, In-charge ABI. This program was jointly organized by Intellectual Technology Management Unit (ITMU) and Agri-Business Incubator (ABI) units of the Institute. Total 44 participants including scientists, technical and administrative staff of the institute participated in this program.

v. **Mango – Buyer Seller Meet – 2023**

A Mango Buyer-Seller Meet was organized by the Agri-Business Incubation Centre for mango export promotion on April 28, 2023. Mango exporters, farmers, traders, FPOs, community based organizations (CBO) from Lucknow, Sitapur, Hardoi, Lakhimpur and other nearby districts and ICAR-CISH scientists were linked through this meeting for the successful export of mango. The programme was inaugurated with lamp lightening & ICAR song by the Chief Guest, Dr. R.K. Pal, Advisor, FSSAI and Former Director, ICAR-NRC Pomegranate, Solapur, Dr. V.B. Patel, ADG, Fruit & Plantation Crops, ICAR, N. Delhi, Dr. B. K. Pandey, Former ADG, Horticulture ICAR, N. Delhi, Director, ICAR-CISH, Dr. T. Damodaran and other dignitaries. Dr. Maneesh Mishra, organizer of the event and Principal Scientist introduced all the experts and briefed about the meeting. Dr. Damodaran addressed that GI-125 Malihabad-Mango is a world class mango. However, it needs to be reached in various countries through developing a proper channel and export system. ICAR-CISH is providing a platform for establishing the connection of mango growers, FPO and CBO to the exporters. Moreover, the institute is ready to provide CISH technology of mango export for safe transportation in containers through sea route. Furthermore, Dr. B. K. Pandey shared the SOP of mango export with exporters and farmers and narrated the important points to be taken care from harvesting to export. Chief Guests, Dr. R.K. Pal and Dr. V.B. Patel expressed their words of appreciation for the efforts made for the development and support of mango farmers and export. They also ascertained to the stakeholders for supporting and helping in this endeavour. Mango growers, representatives of Awadh Aam Utpadak Ewam Bagwani Samiti and TAFARI FPC conveyed the problems of farmers in connecting with exporters. They also raised the issue of getting decent mango rates to the farmers. Sh. Dayashankar Singh from IRADA Foundation addressed the problem of middle man in trading and supply chain of mango. The exporter Mr. Akram Baig and Mr. Vaiju Gangadhara, Manager Administration, Fair Exports (India) Pvt. Ltd. and Lulu Group, India assured mango farmers to solve their problems and ready to take mangoes for export at their best prices. They mentioned that Indian mangoes have huge market and demand in international market and showed willingness to work with mango farmers. All the experts and participants visited to the Mango Pack House, Malihabad for inspection the facilities of mango processing and packaging before export. About 57 mango growers were directly benefitted through this mango buyer and seller meet.

vi. **Incubatee – Mentor Brainstorming**

ICAR-CISH, Agri-Business Incubation Centre organized an "Incubate-Mentors Brainstorming Meeting" in physical mode which was held on May 10, 2023 under the chairmanship of Dr. T. Damodaran, Director of the Institute. In this meeting different horticultural startup ideas of entrepreneurs were critically discussed with the expert scientists to strengthen their ideas and convert them into successful startups. A total number of 21 participants (scientists / mentors, entrepreneurs / startups and stakeholders) attended the meeting in the CISH committee hall. PI, ABI, Dr. Maneesh Mishra, welcomed and introduced all the participants. He emphasized the importance of good startup incubation for the development and growth of any startup in the early stage. He also summarized the role and benefits of incubation at CISH-ABI. All incubate were distributed with the

CISH-ABI incubation plan which was explained in detail by Dr. Mishra. Director of the institute, Dr. T. Damodaran warmly expressed appreciation for the growth and developments of startups and entrepreneurship in horticulture. He interacted with all startups directly and acknowledged that startups are emerging in the field of horticulture now who have potential of substantial outcome. The Director also guided the forward linkages to the startups like hydroponics technology startups may be further connected with government schemes like mid-day meal through PPP mode. Millet based startup may go into techno-commercial solutions. Development of wine from subtropical fruits like mango and guava etc. and export of mangoes are of high economic value and contribution, he added. The meeting was then divided into breakout sessions based on the horticultural technologies.

vii. **AGRI UDAAN Immersion cum Road Show 6.0 Event**

An AGRI UDAAN Immersion cum Road Show 6.0 Event was organized by the Association for Innovation Development of Entrepreneurship in Agriculture (a-IDEA) NAARM, Hyderabad in collaboration with ICAR - Indian Institute of Sugarcane Research (IISR), Lucknow on 8th August 2023. ICAR-Central Institute for Subtropical Horticulture was the partner of the program. Moreover, several CISH startups namely, M/s Parashar Agrotech Bio Pvt. Ltd, Varanasi, U.P., M/S Mittan Agritech Private Limited, Indira Nagar, Lucknow, U.P., M/S Landtouch Agricultural Industries Pvt. Ltd., Ayodhya, U.P. and M/S Rasha Wines, Gomti Nagar, Lucknow, U.P. participated in the event.

viii. **IPR awareness programme with NIPAM -TIFAC**

ICAR-CISH, Lucknow organized a IPR awareness programme with NIPAM -TIFAC on September 8, 2023. Total 38 participants (Scientists, Research Scholars, students and other staff members) were

presented.

ix. **B2B Meeting for establishment of integrated Pack House of mango**

A B2B Meeting for the Establishment of Integrated Pack House of Mango was organized on October 10, 2023 under the chairmanship of Shri Manoj Kumar Singh, IAS and Agriculture Production Commissioner, Government of Uttar Pradesh which led to allotment of land by U.P. government. The meeting was held among three institutions, Dr. K.S. Ravi, Managing Director, Innova Agri Bio Park Private Limited, Malur, Karnataka, a Public-Private Partnership enterprise supported by the Ministry of Food Processing Industries (MoFPI), Government of Bharat and Food Karnataka Limited (FKL), under the Government of Karnataka; Shri Manoj Kumar Singh, IAS and Agriculture Production Commissioner, Government of Uttar Pradesh and ICAR-CISH, Lucknow, Director, Dr. T. Damodaran. Stakeholders agreed on the pact that the Government of Uttar Pradesh will provide 15 acres land in Uttar Pradesh; Innova Agri Bio Park, Bengaluru will set up the State of Art One Stop Solution facility with Gamma Irradiation facility having all the modern equipment and logistic support for the processing and export of Agri-Horti commodities and ICAR-CISH will be the knowledge partner of Innova Agri Bio Park Private Limited for establishment of the facility.

x. **Horticulture Investor's Meet-2023**

ICAR-CISH, Agri-Business Incubation Centre organized a Horticulture Investor's Meet-2023 on October 10, 2023. About 150 number of persons participated in the program. Among the participants 17 no. of industries, 14 FPO/FPC/CBO, 15 Startups, 01 NGO, 04 banks were there, besides, persons from academia, state department, KVK, progressive farmers, print & digital media. In this meet, an agreement was made between ICAR-CISH, Lucknow and Innova Agri Bio Park Private Limited, Malur, Karnataka for the (i) Development of sea route protocol for export of mango and banana and (ii) Value added & shelf-life extension in the fruit products through cryogenic technology in presence of Chief Guest, Shri Manoj Kumar Singh,

IAS and Agriculture Production Commissioner, Government of Uttar Pradesh. Shri Singh told that currently UP's GDP is 22 Lakh Crores, out of that 25% comes from agriculture sector with total production of about 1.0 Lakh Tonnes. He assured to support/ promote the ICAR-CISH technologies towards achieving the goal of One Trillion Dollar economy.

5. "Udyanoday-1" Incubation Programme

A one year incubation programme for early stage horticultural startups was launched on December 29, 2023 by the Hort-Ind Incubation Centre. The programme was divided into two phases viz. Pre-Incubation Phase and Incubation Phase. The first one included 30 days intensive mentoring session for startups followed by the Incubation Phase for the technological development.

6 Human Resource Development

Trainings Attended

1. Dr. A. K. Trivedi, participated in the three days "Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Oflicers of ICAR" from 27th February to 01 March, 2023 at ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad.
2. Dr. A. K. Trivedi, participated in the National Training Conclave 2023 at Convention Centre, ITPO, Pragati Maidan, New Delhi on June 11, 2023.
3. Dr. A. K. Trivedi, participated (online) in the IP Awareness/ Training Program under National Intellectual Property Awareness Mission on September 08, 2023.
4. Dr. Abha Singh attended ICAR sponsored short course on Women friendly nutria smart interventions for alleviating malnutrition in rural areas organized by ICAR – Central Institute for Women in Agriculture, Bhubaneswar, Odisha during 03 – 12 January, 2023.
5. Dr. Abha Singh attended Training Programme under CSIR Integrated Skill Initiative on Post harvest technologies for fruits and vegetables organized by CFTRI-Mysuru during 21August – 01 September, 2023.
6. Dr. Karma Beer attended training on "Agriculture Drone Operator Training" conducted by Drone Destination at Bhora Kalan, Gurugram from 08-09, June, 2023
7. Dr. Karma Beer attended training on "Remote Pilot Certificate (RPC)" conducted by Drone Destination at Bhora Kalan, Gurugram from 05-07, June, 2023
8. Dr. Ravi, S. C. attended a capacity building programme on "Advances in Managing Climate-Water-Food Nexus" organized by the Department of Agricultural Economics, UAS, Dharwad and Indian Institute of Technology, Dharwad from 30th January to 11th February, 2023.

Seminars/ Symposia/ Conferences Attended

1. Dr. P.L. Saroj attented "International Seminar on Exotic and Underutilized Horticultural Crops" at IIHR, Bengaluru from 17-19 October, 2023.
2. Dr. A.K. Trivedi, participated in Progressive Horticulture Conclave (PHC 2023) Transforming Horticulture: Science into Technology, February 3-5, 2023 at G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand.
3. Dr. A.K. Trivedi, participated in National Conference of Plant Physiology - 2023 on Physiological and Molecular Approaches for Climate Smart Agriculture, December 09-11, 2023 organized by Indian Society for Plant Physiology, New Delhi & ICAR-Indian Agricultural Research Institute, New Delhi at ICAR-Indian Agricultural Research Institute, New Delhi.
4. Dr. Karma Beer attended 10th Indian Horticulture Congress- 2023 conference on Unleashing Horticulture Potential for Self- Reliant India at AAU, Assam 06-09 November, 2023.
5. Dr. Karma Beer attended national seminar on practices for recent advances in global agriculture and technology and innovation (PRAGATI-2023) on 29-30, December, 2023 organized by IQAC and Faculty of Agriculture, Janta College, Bakewar, Etawah.
6. Dr. Muthukumar. M and Ravi, S.C attended XVI Agriculture Science Congress 2023 on "Transformation of Agri-Food Systems for achieving Sustainable Development Goal" and ASC Expo during 10-13 October, 2023 organized jointly by NAAS, ICAR and ICAR-CMFRI, Kochi.
7. Dr. Damodaran, T., Dr. Shukla, P.K., Dr. Ashish Yadav, Dr. Sanjay Kumar Singh, Dr. Muthukumar. M, Dr. P.Barman and Dr. Amar Kant Kushwaha attended 10th Indian Horticulture Congress 2023 on "Unleashing Horticultural Potential for Self-Reliant India" during 6-9 November, 2023 organized by College of Veterinary Campus, Assam Agricultural University, Khanapara, Guwahati.

Workshops/ Meetings Attended

1. Dr. H.C. Verma attended Training cum Workshop on "Airborne Hyperspectral Remote Sensing for Agriculture". NAHEP-CAAST sponsored Training cum Workshop on organized by the Division of Agricultural Physics, ICAR-Indian Agricultural Research

Institute, New Delhi during January 16-25, 2023.

2. Dr. H.C. Verma attended one day National workshop on '' Guava Industry Challenges and Strategies'' on 15-12-23 at ICAR-CISH, Lucknow.
3. Dr. Karma Beer participated in trial shipment of Export of Banana to Amsterdam through sea route at INI Farm Packhouse, Baramati, Pune on 06th November, 2023.
4. Dr. Ravi, S. C. attended Krishi Niryat Bandhu Meeting as an expert on 18 August, 2023 organized by Directorate of Agricultural Marketing & Agricultural Foreign Trade, Uttar Pradesh, Lucknow.
5. Dr. Karma Beer attended the buyer-seller meet as expert at Mango festival organized by HOFED on 14/07/2023.
6. Dr. Ravi, S. C. attended the buyer-seller meet as expert at Mango festival organized by HOFED on 14/07/2023.
7. Dr. Ravi, S. C. attended a state level workshop on "Uttar Pradesh mein jal vayu parivarthan ka prathirodh – Jalvayu smart prathovo ki bhoomika" organized by NABARD, RO, Lucknow during 31 March, 2023.
8. Dr. Ravi, S. C. attended the national review workshop of Farmer FIRST programme at CSK Himachal Pradesh Agricultural University, Palampur from 28th to 30th November, 2023
9. Dr. Ravi, S. C. attended the Zonal Review Meeting/Workshop of FFP at ICAR-ATARI, Kanpur on November 8, 2023.
10. Dr. Ravi, S. C. attended online workshop on FFP Portal and FFP Mobile App during January 12, 2023.
11. All the Scientists of the Institute attended one day National workshop on '' Guava Industry Challenges and Strategies'' on 15-12-23 at ICAR-CISH, Lucknow.
12. Dr. H. C. Verma attended Training cum Workshop on "Airborne Hyperspectral Remote Sensing for Agriculture". NAHEP-CAAST sponsored Training cum Workshop on organized by the Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi during January 16-25, 2023.
13. Shukla P.K. attended 10th Indian Horticulture Congress 2023 Unleasing Horticultural Potential for Self Reliant India, held at AAU, Guwahati, Asam during 6-9 November, 2023.
14. Shukla P.K. attended international workshop on 'Production of clean planting material at NAAS Complex, New Delhi during 23-24 August 2023.
15. Shukla P.K. attended national workshop on Guava at ICAR-CISH, Lucknow on 15 December 2023.
16. Shukla P.K. attended Meeting for formulation of clean plant production project at NAASC, New Delhi on December 7, 2023.

7 Awards and Recognition

Awards

1. Dr. T. Damodaran was awarded Sh. Girdhari Lal Chadha Gold Medal in Fruit Science by Indian Academy of Horticultural Sciences, New Delhi during 10th Indian Horticulture Congress 2023 on "Unleashing Horticultural Potential for Self-Reliant India", from 6-9 November, 2023 at AAU, Guwahati.
2. Dr. A. K. Trivedi was awarded as Fellow, Indian Society of Horticultural Research & Development during Progressive Horticulture Conclave (PHC2023) Transforming Horticulture: Science into Technology, February 3-5, 2023 at G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand.
3. Dr. Ravi, S.C. was awarded Best Oral Presentation for the paper titled "Exploring Nagaland's Culinary Traditions: A Gateway to Entrepreneurship Development authored by Amrutha,T and A. K. Mohanty, A. K. Singha, R. Bordoloi, Chikkathimme Gowda H. R. and Ravi, S.C during ICAR-Agripreneurs Meet cum National Symposium on "Strategies for promotion of Incubatee in Agriculture and Allied sectors in North Eastern Region of India" held on October 4-5, 2023.

Recognitions

1. Dr. T. Damodaran acted as Chief Guest for the inauguration of training programme 'Cell Culture: Techniques and Applications' at NBFGR, Lucknow (UP) on 30-10-2023.
2. Dr. T. Damodaran acted as Member of Screening Committee for screening of applications at Rani Lakshmi Bai Central Agricultural University, Jhansi on 26-10-2023.
3. Dr. P.L. Saroj acted as Member, Research Council, Banda University of Agriculture and Technology, Banda (UP) and participated in the Council's meeting on 18/3/2023.
4. Dr. P. L. Saroj acted as Member, Board of Studies, School of Agricultural Sciences and Technology, Baba Saheb Bhim Rao Ambedkar Central University, Lucknow (UP).
5. Dr. P.L. Saroj acted as Chief Guest in a Seminar organized by State Legislature Institute of Pensioners, Vidhan Sabha Bhawan, Lucknow (UP) on 8/6/2023.
6. Dr. P.L. Saroj acted as Member, Screening Committee for Sh. Girdhari Lal Chadha Award in Fruit Science 2023, awarded by Indian Academy of Horticultural Sciences (IAHS), New Delhi dt. 27/7/2023.
7. Dr. P.L. Saroj acted as Chairman for screening of applications for Best Scientist/ Technical and Administrative personnel award to be given by ICAR-CISH, Lucknow on 19/5/2023.
8. Shukla, P.K. acted as panelist for panel discussion on Clean Plant Production in Perennial Horticultural Crops during 10th Indian Horticulture Congress-2023 held during November 6-9, 2023, at College of Veterinary Science, Assam Agricultural University, Guwahati, Assam.
9. Shukla, P.K. acted as the External Examiner to conduct the Offline practical examination of Diseases of Field and Horticultural crops and their management- II (AG339) for Faculty of Agricultural Science and Technology, Integral University, Lucknow.

Editorial Board Member/ Professional Society Positions

1. Dr. A. K. Trivedi, was elected Vice-President of the Indian Society for Plant Physiology.
2. Dr. P. L. Saroj was nominated as International Coordinator, Indian Society of Horticulture Research and Development (ISHRD), Uttarakhand, ISSN (Print): ISSN-0970-3020
3. Dr. P. L. Saroj working as Editor, Current Horticulture, Society for Horticulture Research and Development, Ghaziabad (UP), ISSN (Print): 2347-7377.
4. Dr. A. K. Trivedi, served as Consulting Editor, Journal of Environmental Biology (NAAS Score 6.70).
5. Dr. A. K. Trivedi, served as Editorial Board Member, Agricultural Reviews (NAAS Score 4.84).
6. Dr. A. K. Trivedi served as a member Board of Studies, Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.
7. Dr. S. K. Dwivedi acted as Member, Advisory Board of Journal "Heliyon" Section Agriculture, Cell press, ISSN: 2405-8440

8. Dr. Anshuman Singh served as Editor in Peer J.
9. Shukla, P.K. nominated as Editor (Fungal Pathology) of the journal Indian Phytopathology for the period 2023 to 2025.

Chairman / Co-chairman / Rapporteur in Technical Sessions of Seminar

1. Dr. P.L. Saroj acted as Co-Chairman of Technical Session III on dated 18/10/2023 during International Seminar on Exotic and Underutilized Horticultural Crops" at IIHR, Bengaluru from 17-19 October, 2023.
2. Dr. Tarun Adak acted as Convener,e Technical Session IV: Environmental Conservation, Soil Carbon Management and Advanced tools for Sustainable Agriculture on 9th December, 2023 in the National Conference on "Natural Resource Conservation and Management for Agricultural and Environmental Sustainability" organized during December 8 to 9, 2023 at NBFGR, Lucknow, UP.
3. Dr. Ravi, S. C. acted as rapporteur of Technical Session III in the workshop on "*Amrood Udyog ki Chunouthiya Evam Ranneethiyo*" during 15 December, 2023.
4. Shukla, P.K. acted as co-chairman in technical session V: Value addition in agriculture, processing technology, entrepreneurship development and export' in Kisan Mela at IIVR, Varanasi held during 02-05 February, 2024.

Lead talks/ Invited talks/ Guest lecture delivered

1. Dr. P.L. Saroj delivered a lead lecture on "Production of underutilized arid fruit crops" during International Seminar on Exotic and Underutilized Horticultural Crops" at IIHR, Bengaluru from 17-19 October, 2023.
2. Dr. A. K. Trivedi delivered an invited talk on 'Post Harvest Handling and Storage of Subtropical Fruits: Recent Approaches to Enhance Shelf Life' during Progressive Horticulture Conclave (PHC 2023) Transforming Horticulture: Science into Technology, February 3-5, 2023 at G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand.
3. Dr. A. K. Trivedi delivered an invited talk on 'Adaptation and Management Strategies of Fruit Orchards under Climate Change Scenario' during webinar on climate change adaptation and sustainable agricultural practices organized by 'National Institute of Agricultural Extension Management' (MANAGE), Hyderabad on June 30, 2023.
4. Dr. A. K. Trivedi delivered an invited talk on 'Technologies Related with Post Harvest Management of Plantation and Horticultural Crops' during workshop on Technology Application in Farm and Off Farm Sectors at Bankers Institute of Rural Development (BIRD), Lucknow on November 02, 2023.
5. Dr. S. C. Ravi presented lead paper presentation on "Exploring Nagaland's Culinary Traditions: A Gateway to Entrepreneurship Development" was made by Amrutha, T., A. K. Mohanty, A. K. Singha, R. Bordoloi, Chikkathimme Gowda H. R. and Ravi, S.C. during ICAR-Agripreneurs Meet cum National Symposium on "Strategies for promotion of Incubatee in Agriculture and Allied sectors in North Eastern Region of India" held on October 4th and 5th, 2023.
6. Dr. Ravi, S.C., presented lead paper presentation on "Agri-Business Potential of North East Spices: A case of Lakadong Turmeric" was made by Chikkathimme Gowda, H. R., Amrutha, T., N. Uttam Singh, Aniruddha Roy, Anjoo Yumnam, Kamni P Biam, Pampi Paul, B. P. Singh and Ravi, S. C. during ICAR-Agripreneurs Meet cum National Symposium on "Strategies for promotion of Incubatee in Agriculture and Allied sectors in North Eastern Region of India" held on October 4th and 5th, 2023.

Lectures delivered

1. Dr. Karma Beer delivered the lecture on Post Harvest Management on Mango on 18/05/2023 organized by HOFED.
2. Dr. Ravi, S. C. delivered a lecture on "Economic feasibility of perennial crops: Methods and issues" in one month training of Undergraduate students of Gopal Narayan Singh University, Rohtas, Bihar held during December 01-31, 2023.
3. Dr. Ravi, S. C. delivered a talk on "Novel Technologies to Boost Mango Exports from UP" in a online programme on November 7, 2023.
4. Shukla, P.K. on-line delivered lecture on, "Integrated disease management in guava" to the UG students of College of Horticulture and Forestry, Dr. YSPUHF, Neri, Hamirpur (H.P.) on 28 February, 2023.
5. Shukla, P.K. delivered lecture on, "Aam ke pramukh keet evam vyadhi prabandhan" UP Mango Festival in 15 July 2023.

External examiner

1. Dr. Karma Beer was the external examiner for M.Sc. (Ag.) III semester in Post Harvest

Technology for Fruit Crops in Subhash Chandra Post Graduate College, Hardoi on 29/04/2023.

2. Dr. Karma Beer was the external examiner to set question paper for M.Sc. Horticulture, 1st Semester on "Propagation and Nursery managements of Fruit Crops (FSC 503)".
3. Dr. Karma Beer was the external examiner to set question paper for B.Sc. Hons. Agriculture, 1st Semester on "Fundamentals of Horticulture HFS 112)".

Radio/ TV talks

1. Dr. Ravi, S. C. delivered a TV talk on "Agro eco tourism: Scope and Opportunities on 18.01.2023 under Krishi Darshan Programme of DD, Uttar Pradesh.
2. *Aam ki saghan bagvani*. AIR, Lucknow recorded on 23.06.2023.
3. *Amrud ke uktha evam kshay rog ke prabandhan men savdhaniyan aur takniki*. Doordarshan Lucknow on 25.07.2023.
4. *Aam ke bagon men samayik karya.* AIR, Lucknow recorded on 24.11.2023.

8 Linkages and Collaborations

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

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, bael and karonda.
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, IInd 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 research funding.
8. Mandi Parishad, U.P. for preparation of work plan and its implementation for GI patenting of Langra, Chausa and Rataul mango of U.P.
9. 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 and Impact evaluation study of tribal development projects implemented by NABARD.
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. M/s Bayer Crop Science Limited, Khasra No.563, Amar Shaheed Path, Lucknow, Uttar Pradesh for three contract research.
12. M/s Parashar Agrotech Bio Pvt. Ltd., Varanasi signed MoU for five years w.e.f. November 11, 2020 for licensing CISH Trap container.
13. 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.
14. M/s Ranaji Biotech India Pvt. Ltd., Kanpur signed MoU for five years w.e.f. November 30, 2020 for licensing CISH glue trap.
15. 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).
16. M/s Scientia *in vitro* Agritech signed MoU for five years w.e.f. January 12, 2021 for production and commercialization of *in vitro* immunization of tissue culture banana technology, Lucknow.
17. 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.
18. M/s Saavi Industries Sangli Maharashtra signed MoU for five years w.e.f. January 19, 2021 for licensing CISH Pest Hammer.
19. G. H. Raisoni University, Chhindwara, MP signed MoU for five years w.e.f. February 04, 2021 for facilitating students training/ postgraduate research.
20. 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.

21. Amity University, Lucknow signed MoU for five years w.e.f. August 09, 2021 for facilitating students training/postgraduate research.
22. Ch. Charan Singh Meerut University, Meerut signed MoU for five years w.e.f. September 08, 2021 for facilitating students training/ postgraduate research.
23. 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).
24. M/s Balaji Agro Foods, Lucknow signed MoU for five years w.e.f. October 26, 2021 for mango based immunity booster products.
25. RML Avadh University, Ayodhya signed MoU for three years w.e.f. November 20, 2021 for facilitating students training/postgraduate research.
26. 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.
27. Mahatma Jyotiba Phule Rohilkhand University, Bareilly signed MoU for three years w.e.f. March 8, 2022; for facilitating students training/ postgraduate research..
28. 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..
29. 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.
30. Banda University of Agriculture and technology, Banda signed MoU for five years w.e.f. August 26, 2022; for facilitating students training/ postgraduate research.
31. M/s JU Agriscience Ltd, Noida signed MoU for five years w.e.f. December 12, 2022 for testing bio-efficacy of "Spirotetramat 11.01% + Imidacloprid 11.01% w/w SC" insecticide on Mango.
32. Bihar State Biodiversity Board, Patna signed MoU for two years w.e.f. March 15, 2023 for Evaluation of Diversity and decline of indigenous seedling mango of Bihar and study on conservation strategies.
33. C.S.A. University of Agriculture and Technology, Kanpur signed MoU for five years w.e.f. June 26, 2023 for facilitating Students' Training/ Postgraduate research.
34. Mahakesar Mango Bagaitdar Sangh (Mango Grower Association), Maharashtra signed MoU for one year w.e.f. July 20, 2023.
35. Geographical Survey of India, NR Lucknow, Uttar Pradesh signed MoU for two years w.e.f. August 28, 2023 for research focusing on the agro-economic studies related to the applicability and suitability of glauconite as a fertilizer.
36. Agrani Neo Farmers Producer Company Ltd., Kendpukur, Malda, West Bangal signed MoU for three years w.e.f. August 01, 2023 for availing the Common Food Processing Facilities on Food Processing and Value Chain Management.
37. Alokini Farmers Producer Company Ltd., Kendpukur, Malda, West Bangal signed MoU for three years w.e.f. August 01, 2023 for availing the Common Food Processing Facilities on Food Processing and Value Chain Management.
38. M/s Nature Green Biome, Block C, Naraina Village, New Delhi signed MoU for three years w.e.f. October 10, 2023 for Commercialization of CISH-Bioenhancer technology.
39. Innova Agri Bio Park Private Limited, Malur, Karnataka signed MoU for three years w.e.f. October 10, 2023 for collaborative research on Development of sea route protocol for export of mango and banana and (ii) Value added& shelf life extension in the fruit products through cryogenic technology.
40. District rural development cell, Malda, West Bengal signed MoU for three years w.e.f. November 10, 2023 for handholding, training &services of common facility centre to DRDC, Malda.
41. ITM University Gwalior, Madhya Pradesh signed MoU for five years w.e.f. November 16, 2023 for facilitating Students' Training/ Postgraduate research.
42. M/s Khandelwal Bio-fertilizer Pvt. Ltd., Karnataka signed MoU for five years w.e.f. November 17, 2023 for licensing of CISH-Decomposer technology.
43. India Metrological Department, Ministry of earth, GOI, New Delhi signed MoU for five years w.e.f. November 25, 2023 for IMD's Installation facilities at RRS Malda for weather forecasting.
44. KVK, Dhaura, Unnao, Uttar Pradesh signed MoU for three years w.e.f. December 14, 2023 for providing sales outlet for the sales of value added products of KVK, Unnao.

9 Publications

Research Papers

1. Ahmad, I, and Nilesh Sharma. (2023). Genes expression analysis during fruit development and jelly seed in mango. *Journal of Eco-friendly Agriculture*, 18(1):110-114.
2. Ahmad, I., Sagar, P., Yadav, A. and Dinesh Kumar. (2023). Effect of vivipary and excessive heat unit accumulation on jelly seed disorder in mango (*Mangifera indica* L.). *Applied Fruit Science*, https://doi.org/10.1007/s10341-023-01016-1.
3. Ahmad, I., Soni, S.K., Muthukumar, M., and Devendra Pandey (2023). *In-silico* mining and characterization of MYB family genes in wilt-resistant hybrid guava. *J. Genet. Engg. Biotechnol.*, 21:74. https://doi.org/10.1186/s43141-023-00528-3.
4. Baradevanal, G., Chander, S., Singh, H.S., D S Reddy S Rajan 2023. Mapping the risk of quarantine pest *Sternochetus mangiferae* under different climate change scenarios through species distribution modelling. *Int J Trop Insect Sci* https://doi.org/10.1007/s42690-023-01000-y
5. Bairwa, R.K., Yadav, M.C., Gopalakrishnan, S., Kushwaha, A. and Joshi, M.A. (2023). Morphological and molecular analyses of grain traits in aromatic rice landrace accessions from Indo-Gangetic plain region of India. *Indian Journal of Plant Genetic Resources*, 36(02), pp.290-300.
6. Barik, S., Ponnam, N., Acharya, G. Meenu Kumari, Anil Kumar Adamala, Srinivas Petikam, Sangeetha G, Singh TH, Singh HS & Gouri Shankar Sahu . 2023. Assessment of Bacterial wilt-resistant *Solanum* genetic resources as rootstocks for yield and fruit quality traits in eggplant. *Australasian Plant Pathol.* 52, 253–269. https://doi.org/10.1007/s13313-023-00916-w.
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10. Das, S.K., A Kumar, A Yadav, R Laha and VK Mishra. 2023. Zero budget natural farming practices on yield of crops (Maize + soybean and Pea + coriander) in mid hill of Sikkim Himalayas. *Journal of Agriculture and Ecology*, Special Issue 2023, Vol 16. https://doi.org/10.58628/JAE-2316-208
11. Das, S.K., Ashish Yadav and Sita Kumari Prasad. 2023. Biochemical Characterization and Phytochemical Analysis of Different Buckwheat Germplasm in Mid Hill of Sikkim. *International Journal of Bio-resource and Stress Management. July* 2023, 14(7):952-960 https://doi.org/10.23910/1.2023.3487
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19. Kumar, S., Singh, Anshuman, Yadav, A., Bajpai, A., Singh, N. K., Rajan, S., Trivedi, M. and Muthukumar, M. (2023). Identification and validation of novel genomic SSR markers for molecular characterization of guava (*Psidium guajava* L.). *South African Journal of Botany*, 155: 79-89.
20. Kumari, N., Damodaran, T., Ahmad, I., Rajan S., Shukla, P.K., Muthukumar, M., Kushwaha, A.K., Singh, H., Gopal, R., Kumari, S., Yadav, Bora, P., and S.K. Jha. (2023). Distribution and diversity of *Fusarium oxysporum* f.sp. *cubense* TR4 causing banana wilt in Sub-tropics of India and comparative analysis of TR4 specific molecular detection methods. *J. Plant Biochem. Biotechnol.* doi: 10.1007/s13562-023-00842-4.
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25. Rathore, A.C., Mehta, H. and Saroj, P.L. (2022). Evaluation of fruit production, carbon sequestration and economic potential of mango (Mangiferna indica L.) in degraded lands of Indian Himalaya. British Journal of Multidisciplinary and Advance Studies: *Agriculture and Medical Sciences*, 3(1): 16-34.
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Marmelos and its Management. *Pest Management in Horticultural Ecosystems*. 28, 174 -183.

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32. Sharma, L., R. Kumar and Ashish Yadav. 2023. Morpho-Biochemical Characterization of Chayote (*Sechium edule* Jacq.) Genotypes from Sikkim Himalayas. *Environment and Ecology* 41 (3D): 2181-2192. DOI:https://doi.org/10.60151/envee/NEYZ6560.
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44. Verma, H.C. and Ahmed, T. (2023). Trends in the Compound Annual Growth Rate of Mango Crop Area and Production. *Journal of Agrisearch*, 10(4):239-248.

Book chapters

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2. Bansal, S., Muthukumar, M., and Kumar, S. (2023). Graphene/HgCdTe Heterojunction-Based IR Detectors. ***In***: Korotcenkov, G. (eds) Handbook of II-VI Semiconductor-Based Sensors and Radiation Detectors. Springer, Cham. https://doi.org/10.1007/978-3-031-20510-1_8.
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7. Singh, H.S. and Baradevanal, G. (2022). Pests In: Shishir Mitra (Eds) Jackfruit: Botany, Production and Uses.CABI 309p.
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Popular Articles

1. शुक्ल, सुशील कुमार, दामोदरन, टी., एवं सरोज, पी.एल. (2023), भारतीय आम : इतिहास के आइने में, *उद्यान रश्मि–आम विशेषांक*, पेजः 1–7
2. दयाल, विशम्भर, सिंह, आभा, सुभदर्शिनी दास, स्वास्ति, सरोज, पी. एल. एवं दामोदरन, टी. (2023), गुणों की खान–फलों का राजा आम, *उद्यान रश्मि–आम विशेषांक*, पेजः 8–13
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E-learning lesion developed

1. Amrutha T., Chikkathimme Gowda H. R., A. K. Mohanty, A.K. Singha, R. Bordoloi, Subrata Das and Ravi S.C. developed a E-learning Lesson on Village Social Accounting Matrix (SAM): An Impact Assessment Tool to Study the Effect of Programme/Policy Interventions onVillage Economy Dynamics.

Papers presented in Seminar/Symposia / Conferences/Webinars

1. Dr. H.C. Verma attended and presented a research paper in oral mode entitled '''A Comprehensive Analysis of Advanced Change Detection Technique for Planning and Monitoring Sustainable Mango Crop Areas Using Landsat-8 Images'' in 10th International Conference on computing for sustainable global development during 15-17 March, 2023 organized by Bharati Vidyapeeth's Institute of Computer Application and Management and technically supported by IEEE, Delhi chapter.
2. Dr. H.C. Verma attended and delivered oral presentation on the topic ''Generative AI for Augmenting Agricultural Researchers' Productivity- Opportunities and Challenges'' during 'National Conference on Generative AI in Practice for Empowering Agricultural Research Productivity'' Organised by Pune Chapter of National Academy of Agricultural Sciences(NAAS) and NRC Grapes, Pune, Pune from 11-12 SEPT 2023.
3. Dr. H.C. Verma attended Global multi-track conference STAR 2023 (online) from 8-14 October, 2023 and presented a paper in Oral mode entitled ''An Approach to Detect the Land Cover Change Using Histogram Based Thresholding for Landsat-8OLI Images'' during the conference jointly held by Unifacvest University, South America, Special Minds, India and Integral University, India.
4. Dr. H.C. Verma attended and delivered oral presentation titled '' Software for Fast and Accurate Quantification of Foliar Damage Caused by Leaf Spot Diseases of Mango using Digital Image Analysis'' in International Conference on "computational intelligence and cyber security(ICCICS-2023)", Nov. 08-09, 2023 organized by Lucknow University.
5. Dr. Karma Beer made oral presentation on "CISH MET WASH a novel bio-formulation for extending the shelf life and controlling the post harvest diseases in Mango Cv. Dashehari" during 10th Indian Horticulture Congress- 2023 conference on Unleashing Horticulture Potential for Self- Reliant India at AAU, Assam 06-09 November, 2023.
6. Dr. A. K. Trivedi, presented oral paper on Volatile Based Chemical Characterization of Mango Cultivars during National Conference of Plant Physiology - 2023 on Physiological and Molecular Approaches for Climate Smart Agriculture, December 09-11, 2023 organized by Indian Society for Plant Physiology, New Delhi & ICAR-Indian Agricultural Research Institute, New Delhi at ICAR-Indian Agricultural Research Institute, New Delhi.
7. Dr. Barman, P. presented oral paper on Influence of pre-sowing seed treatment with organic inputs at varying intervals on germination and growth attributes of papaya (*Carica papaya* L) under polyhouse conditions during 10th Indian Horticulture Congress 2023 on "Unleashing Horticultural Potential for Self-Reliant India", 6-9 November, 2023, AAU, Guwahati.
8. Dr. Ashish Yadav presented oral paper on Assessment of potential mango hybrids for bioactive compounds during 10th Indian Horticulture Congress 2023 on "Unleashing Horticultural Potential for Self-Reliant India", 6-9 November, 2023, AAU, Guwahati.
9. Dr. Muthukumar, M. presented oral paper on Genomics assisted breeding in mango for fruit quality traits using high density genome wide SNPs during 10th Indian Horticulture Congress 2023 on "Unleashing Horticultural Potential for Self-Reliant India", 6-9 November, 2023, AAU, Guwahati.
10. Dr. Sanjay Kumar Singh presented oral paper on Status of seedling mangoes of Bihar and its conservation strategies during 10th Indian Horticulture Congress 2023 on "Unleashing Horticultural Potential for Self-Reliant India", 6-9 November, 2023, AAU, Guwahati.
11. Dr. P.K. Shukla (2023). Clean Planting Material and Plant Production in Perennial Horticultural Crops. Presented in 10th Indian Horticulture Congress 2023 Unleasing Horticultural Potential for Self Reliant India, held at AAU, Guwahati, Asam during 6-9 November, 2023.

10 Research Projects

In-House Research Projects

S. No.	Project Title	Principal Investigator	Co-PI
	Crop Improvement & Biotechnology Division		
1.	Genetic resource management and improvement of mango	AshishYadav	Vishambhar Dayal Anshuman Singh, Amar Kant Kushwaha, P.K. Shukla, Swosti S. Das
2.	Genetic resource management and improvement of guava and jamun	Anshuman Singh	Ashish Yadav, Anju Bajpai, Vishambhar Dayal, Amar Kant Kushwaha, P.K. Shukla
3.	Genetic mapping and development of genomic tools to accelerate molecular breeding in fruits	Anju Bajpai	Muthukumar M, Israr Ahmad, H.C. Verma, Bharati Khilladi, Ashish Yadav, Devendra Pandey, Anshuman Singh, P. K. Shukla, Amar Kant Kushwaha
4.	Improvement of aonla and bael for higher yield and nutraceutical value	D. Pandey	Anju Bajpai, S.K. Singh, N. S. Singh
5.	Development of tissue culture system of fruit crops though bioreactor	Maneesh Mishra	Alok Kumar Gupta, T. Damodaran
6.	Development of ICT based advisory and analytical tools for subtropical fruit crops	H.C. Verma	A.K. Trivedi, P.K. Shukla, Tarun Adak
7.	Classification and change detection of mango crop area by remote sensing and GIS	H.C. Verma	Dipak Nayak
8.	Genome editing in papaya (Collaborative Project with CSIR-NBRI, Lucknow)	Maneesh Mishra	Amar Kant Khushwaha, Muthukumar. M.
	Crop Production Division		
9.	Impact of microbial formulations in organic production system of mango (*Mangifera indica* L.) under Indian subtropics	P. L. Saroj	Dinesh Kumar, H.S. Singh, Dushyant Mishra, Govind Kumar, Muthukumar M, Ravi S.C.
10.	Canopy management for improving productivity in mango and guava	K.K. Srivastava	S.K. Shukla, Dushyant Mishra, Dinesh Kumar, A.K. Trivedi, S.K. Dwivedi, P. Barman, Govind Kumar, P. L. Saroj, N.S. Singh
11.	Enhancing input use efficiency for higher productivity of subtropical fruits	Dinesh Kumar	S.K. Shukla, K.K Srivastava, S.R. Singh, Naresh Babu, Tarun Adak, S.K. Dwivedi, P. Barman, Govind Kumar
12.	Development of input efficient soilless culture technology for high value horticultural crops	S.R. Singh	Anil Kumar Verma
13.	Crop diversification in fruit production system for enhanced productivity and farmer profitability	S.K. Shukla	Dushyant. Mishra, S.R. Singh, Naresh Babu, K.K. Srivastava, A.K. Trivedi, P. Barman, Israr Ahmad, Govind Kumar, Ravi S.C.

14.	Development and evaluation of nano formulations for enhancing productivity and quality of horticultural crops	Dushyant Mishra	Dinesh Kumar, S.K. Shukla, Israr Ahmad, Bharati Khilladi, Govind Kumar
15.	Improving knowledge and skill of stakeholders for increasing production and productivity of subtropical horticultural crops **Renamed**-Demonstration and skill development of stakeholders for increasing production and productivity of subtropical horticultural crops	Naresh Babu	S.K. Shukla, K.K. Srivastava, S. R. Singh, Vishambhar Dayal, Ravi S.C. N.S. Singh **Collaborators from CSIR-NBRI, Lucknow** Dr. Rakesh Nainwal Dr. S.K. Sharma
16.	Management of abiotic stress and physiological issues in subtropical fruit crops	S.K. Dwivedi	Dushyant Mishra, Vishambhar Dayal, Alok Kumar Gupta, Govind Kumar
17.	Evaluation of soil, tree and climatic indicators in mango orchards	Tarun Adak	Naresh Babu
18.	Development of natural farming system models for subtropical horticultural crops **Renamed**-Evaluation of natural farming models for subtropical fruit crops	S.K. Shukla	Dushyant Mishra, Dinesh Kumar, P.K. Shukla, H.S. Singh, Govind Kumar, Tarun Adak, Bharati Killadi, Ravi, S.C.
19.	Quantifying carbon sequestration potential in subtropical Horticulture Ecosystem	Tarun Adak	Dinesh Kumar, H.C. Verma, S.K. Dwivedi
20.	Microbiome derived pre and post-harvest technologies development for clean mango production and its export	Govind Kumar	
	Crop Protection Division		
21.	Identification, dynamics, loss assessment and devising management tools and schedules for prevailing and emerging insect pests of subtropical fruit crops	H.S. Singh	Dinesh Kumar, S.K. Shukla, P.K. Shukla, S.K. Dwivedi, Govind Kumar, Snehashish Routray
22.	Disease diagnosis, devising detection tools and management practices for diseases of subtropical fruit crops	P.K. Shukla	Vimalkumar C.
	Post Harvest Management Division		
23.	Monitoring and assessment of post harvest physiological changes in subtropical fruits and strategies to minimize losses	A.K. Trivedi	N. Samrendra Singh, Alok Kumar Gupta, K.K. Srivastava
24.	Development of protocol for shelf life extension of sub-tropical fruits and vegetables	Bharati Killadi	Alok Kumar Gupta
25.	Developing protocols for value added products of fruits and vegetables	Abha Singh	Bharati Khilladi, Alok Kumar Gupta, Karma Beer, Nisha Sulakhe
26.	Minimization of post harvest losses, export promotion and export competitiveness of subtropical fruit crops	Karma Beer	Ravi S.C.
27.	Identification of constraints and opportunities for improving efficiency of mango and banana value chain in subtropics	Ravi S.C.	Karma Beer, Alok Kumar Gupta

28.	Assessing the effect of agrochemicals on quality and shelf life of subtropical fruits	N. Samrendra Singh	Bharati Khilladi, Amar Kant Kushwaha
29.	Rapid multiplication of guava through advanced propagation techniques	Alok Kumar Gupta	
30.	Impact assessment of ICAR-CISH guava varieties	Ravi, S.C	Anshuman Singh
	RRS, Malda		
31.	Genetic Resource Management and Utilization of Traditional Mango Varieties from West Bengal	Dipak Nayak	Prannath Barman
32.	Integrated orchard health management and crop diversification in mango orchard of Malda	Prannath Barman	Dipak Nayak, Govind Kumar

Externally Funded Projects

S.N.	Project Title	PI/Nodal Officer	Period
DST-SERB			
1.	Genome wide SNP markers associated with fruit traits for developing climate smart mango hybrids using genome selection	Dr. Anju Bajpai	2020-2023
2.	Nano-bioremediation of neonicotinoid pesticides used in subtropical horticultural crops	Dr. Govind Kumar	2023-2026
DBT			
3.	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			
4.	Development of integrated package for management of fruit drop of beal (*Aegle marmelos* Correa)	Dr. P.K. Shukla	2021-2024
5.	Biochemical and molecular dynamics of jelly seed disorder in mango (*Mangifera indica L.*)	Dr. Israr Ahmad	2022-2025
6.	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			
7.	Design and development of ergonomically efficient fruit harvesters for mango, guava and bael	Er. Anil Verma	2020-2023
8.	Production protocol, value addition and popularization of dragon fruit in Uttar Pradesh	Dr. P. L. Saroj	2023-2026
9.	Development of alternative pest management strategies in conjunction with safe pesticide for thrips management in mango	Dr. H.S. Singh	2023-2026
10.	Popularization of espalier architecture under high density planting system for enhanced quality and productivity of guava	Dr. K.K. Srivastava	2023-2026

PPV & FRA			
11.	Developing national repository and facilities for DUS testing in guava (*Psidium guajava*) and litchi (*Litchi chinesis*)	Dr. Anshuman Singh	2012-2023
12.	Characterization of aonla varieties for developing DUS test guidelines	Dr. Devendra Pandey	2012 -2023
13.	Validation of DUS descriptors of bael (*Aegle marmelos* Correa)	Dr. Devendra Pandey	2012 -2023
14.	Development of morphological descriptors and DUS test guidelines for jamun	Dr. Anshuman Singh	2012 -2023
15.	National DUS centre for mango crop	Dr. Ashish Yadav/ Dr. V. Dayal	2012 -2023
ICAR Networking Project			
16.	National Agriculture Innovation Fund: Component-I IP&TM	Dr. Muthukumar M.	2008-2023
17.	National Agriculture Innovation Fund: Component-II ABI	Dr. Maneesh Mishra	2019-2023
ICAR (Emeritus Scientist Scheme)			
18.	Evolving safe paclobutrazol use technology for regular cropping and avoiding decline in mango orchards	Dr. V. K Singh	2020-2023
PKVY			
19.	Promotion of organic farming practices for improving livelihood security of small and marginal farmers in Uttar Pradesh	Dr. R.A. Ram	2020-2023
RKVY			
20.	Agri-Drone Project	Dr. P.K. Shukla	2022-2025
MIDH			
21.	Hi-Tech Nursery Public Sector (4 ha)	Dr. Dipak Nayak	2020-2023
Farmers FIRST Programme (KVK Scheme)			
22.	Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules	Dr. Maneesh Mishra	2016-2023
Mandi Parishad, U.P. (Contract Service)			
23.	Preparation of work plan and its implementation for GI patenting of Langra, Chausa and Rataul mango of U.P.	Dr. Ashish Yadav	2020-2023
Seed Hub Project			
24.	Seed Hub Project at KVK Malda	Dr. Dipak Nayak	2017-2023
National Bee Board, New Delhi			
25.	Integrated Bee Development Centre (IBDC)	Dr. Dipak Nayak	2018-2023
26.	Setting up of Mini Honey Testing Laboratory	Dr. N.S. Singh	2023-2024
Crop Life India			
27.	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			
28.	Technology interventions for quality mango production for doubling income of mango growers in Malda Districts, West Bengal	Dr. Dipak Nayak	2020-2023
29.	Impact evaluation study of tribal development projects implemented by NABARD	Dr. Ravi S.C.	2023-2024
Tribal Sub Plan			
30.	Tribal Sub Plan	Dr. Dipak Nayak/ Dr.S.K. Shukla	2018-2024
Scheduled Caste Sub Plan			
31.	S.C. Sub Plan	Dr. Vishambhar Dayal	2018-2024
Inter-Institutional Collaborative Project (ICAR-CISH and CSIR-NBRI, Lucknow)			
32.	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)			
33.	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)			
34.	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)			
35.	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)			
36.	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
37.	Efficacy evaluation of Flubendiamide 90 g/l + Deltamethrin 60 g/l (Fenos quick) on mango" insecticide on Mango	Dr. H.S. Singh	2022-2024
38.	Evaluation of Betacyfluthrin 90 g/l +Imidacloprid 210 g/l OD (Solomon) in banana on aphid and scarring beetle	Dr. H.S. Singh	2023-2025

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. H.S. Singh
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

11 RAC/IRC/IMC Meetings

Research Advisory Committee (RAC) Meeting

Twenty seventh meeting of Research Advisory Committee (RAC) of the Institute was convened during July 12-13, 2023 at the institute under the Chairmanship of Dr. N. Kumar, Former Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The RAC Members, Dr. Jai Singh (Ex. Director, ICAR-CIPHET, Ludhiana), Dr. Ambika B. Gaikwad (Principal Scientist, ICAR-NBPGR, New Delhi), Dr.V.B. Patel (ADG, F&PC), Shri Indra Prakash Singh and Shri Jagmohan Singh Chand participated in the deliberations. Dr. Chandish Balal (Ex. Director, ICAR-NBAIR, Bengaluru) and Dr. A.N. Ganeshmurthy (Former Dean, College of Agriculture, CAU, Imphal) attended the meeting online. The committee reviewed the ongoing research work in the institute and presented following recommendations/ suggestions for future research work:

Specific recommendations:

1. Intensive screening of all 26 potential mango hybrids for important traits like regular bearing, fruit size, quality and tolerance to pest & diseases to be taken up to enable release of promising hybrids in a phased manner (2023-26). Molecular characterization of all the hybrids and root stocks should be completed by 2024.
2. Mutation breeding of the scion buds using gamma radiation and other methods in jamun to create new genetic variability for the traits like extended fruiting period, small seed and better shelf life to be initiated in 2023. The current programme on jamun improvement may be strengthened.
3. CISH should develop specific micro nutrient formulations for mango and guava (2023-25).
4. Rejuvenation pruning of mango in the ongoing experiment should be taken up immediately after harvest instead of December/January (current practice) to enhance better survival of the trees (2023 onwards).
5. Research work on developing integrated management practices for emerging pests like semi looper, dudua etc in mango (to be initiated from 2024).
6. The ongoing research work carried out for shelf life enhancement of mango need to be formulated as a technology on pilot prototype scale for domestic and export market through sea route (by 2024).

General recommendations:

1. Number of Institute funded research projects may be reduced to about 3-4 projects per division (2023-24).
2. A brainstorming session on mango breeding involving CISH Lucknow, IARI New Delhi and IIHR Bangalore needs to be conducted for identification of suitable parents for future crossing programme and for the development of i*n vitro* regeneration protocol (2023-24).
3. Current experiments on nano based flower inducing formulation in mango may be validated through AICRP (2024-26).
4. Genetic characterization of jamun and bael germplasm using SSR markers needs to be comprehensive with adequate number of markers (2023-25).
5. There is a need for assessing the carbon sequestration potential of mango orchards involving more number of grids in three major mango growing districts (2023-26).
6. CISH needs to develop low weight container and nutrient mix for urban horticulture using locally available agri by-products (2023-25).
7. Demonstration on management of guava wilt/ decline disease in hot spot regions may be taken up (from 2024-26).
8. Integrated practices for managing bacterial wilt of brinjal in Malda, Murshidabad, Purulia and Bankura need to be developed (2023-25).
9. Guava based value added products may also be developed for inclusion in the mid day meal programme in consultation with ICMR (2023-25).
10. Capacity building and on farm demonstration of Institute varieties and technologies in the hilly areas of Uttarakhand may be taken up in collaboration with KVK Chiniyalisod, Uttarkashi. CISH should focus on *ex-situ* germplasm conservation of minor/endangered fruit crops.

Institute Research Council (IRC) Meeting

48th Institute Research Council (IRC) Meeting

The of 48th IRC meeting of ICAR-CISH, Rehmankhera, Lucknow was held on 17th January, 2023 for consideration of two research proposals that could not be presented/ approved in the last IRC. The meeting was chaired by Dr. Devendra Pandey, Director (A), ICAR-CISH, and formally welcomed by Dr Anju Bajpai MS (PME) in the meeting. Two projects were approved during the meeting.

49th Institute Research Council (IRC) Meeting

The 49th IRC meeting of ICAR-CISH, Rehmankhera, Lucknow was held on May 25-26 and June 12-15, 2023 under the chairmanship of Dr. T. Damodaran, Director, ICAR-CISH. Division-wise and project-wise presentations of significant achievements were made by the project leaders. During the meeting, 29 on-going projects and nine new projects were discussed and reviewed. The chairman IRC, Dr. T. Damodaran emphasized that there is a need for re-orientation of ongoing research programmes and concluding the programmes where sufficient data have been generated. He also encouraged that the HoDs should put their efforts to bring externally funded projects. The Director flagged new researchable areas such as carbon foot print studies, microbiome applications, protocol for sea route export of subtropical fruits crops, sensor & AI applications in smart packaging and impact assessment.

Institute Management Committee (IMC) Meeting

ICAR-CISH, Rehmankhera, Lucknow organized 32nd meeting of Institute Management Committee (IMC) on November 17, 2023 through hybrid mode (physical & virtual). The Director and Chairman of IMC, Dr. T. Damodaran in his introductory remark expressed the necessity to convene the meeting of the IMC and appraised the overview of the research activities and other administrative steps taken to improve the functioning of the Institute. Dr. Maneesh Mishra, Principal Scientist & In-charge, PME, ICAR-CISH, Lucknow described activities/achievements of the institute achieved during 2022-23 highlighted on major ongoing programme/projects of the institute including externally funded projects also. Following agenda items were taken up during the meeting:

1. Action Taken Report on recommendations of 31st IMC Meeting
2. Purchase of RT-PCR (Real Time PCR Machine)
3. Re-designation of Skilled Supporting Staff as Multi-Tasking Staff (MTS)
4. Conversion of Type-I quarters at R.B. Road Campus into Girls Hostel
5. Ratify the reconstituted Institute Grievance Committee.
6. Approval for the purchase of capital items in the Financial Year 2023-2024

The IMC Committee members expressed satisfaction over the action taken by the Institute and requested to follow up left over the job. The IMC Members agreed to the above agenda items and Chairman IMC agreed.

Mango Buyer-Seller Meet – 2023

A Mango Buyer-Seller Meet was organized by the Agri-Business Incubation Centre for mango export promotion on 28th April 2023. Mango exporters, farmers, traders, FPOs, community based organizations (CBO) from various parts of UP and ICAR-CISH scientists were linked through this meeting for the successful export of mango. The programme was inaugurated by the Chief Guest, Dr. R.K. Pal, Advisor, FSSAI and Former Director, ICAR-NRC Pomegranate, Solapur, Dr. V.B. Patel, ADG (Fruit & Plantation Crops), ICAR, New Delhi, Dr. B. K. Pandey, Former ADG (Acting), Fruits & Plantation Crops ICAR, New Delhi, Director, ICAR-CISH, Dr. T. Damodaran and other dignitaries were present in the meet. Dr. Damodaran addressed that GI-125 Malihabad-Mango is a world class mango. However, it needs to be reached in various countries through developing a proper channel and export system. ICAR-CISH is providing a platform for establishing the connection of mango growers, FPO and CBO to the exporters. All the experts and participants visited to the Mango Pack House, Malihabad for inspecting the facilities of mango processing and packaging before export. About 57 mango growers participated in this mango buyer and seller meet.

Incubate-Mentors Brainstorming Meeting

ICAR-CISH, Agri-Business Incubation Centre, Lucknow organized an "Incubate-Mentors Brainstorming Meeting" on 10th May, 2023. In this meeting different horticultural startup ideas of entrepreneurs were critically discussed with the expert scientists and strengthened their ideas for converting into successful start-ups. A total of 21 participants (scientists / mentors, entrepreneurs / startups and stakeholders) attended the meeting.

WORKSHOPS

Intellectual Property Rights (IPR) awareness workshop

An awareness workshop was organized at ICAR-CISH on Sept. 8, 2023 under the National Intellectual Property Awareness Mission (NIPAM) by the Government of India under the initiative of *Azadi Ka Amrit Mahotsav*. A guest lecture on Intellectual Property Rights (IPR) was delivered by NIPAM-TIFAC Coordinator Mrs. Farah Bano, in her speech she said that if India has to develop and we have to gain technological expertise then we have to acquire more and more intellectual property. To establish our supremacy in intellectual property, we will have to establish rights over more and more different forms of intellectual property like patents, designs, trademarks, geographical indications, copyrights etc. Mrs. Bano explained in detail the process of filing patent registration. Dr. T. Damodaran, Director of the Institute, while welcoming the special guest, expressed hope that through this guest lecture, scientists will be able to get the necessary guidance for acquiring intellectual property. The program was conducted by Dr. M. Muththukumar, scientist of the institute and the vote of thanks was given by Dr. Anju Bajpai. About 48 participants including various scientists and other employees of the institute were present in this program.

Horticulture Entrepreneur Conference-2023

Horticulture Investors Meet-2023 was organized by the Institute on October 10, 2023. There was a detailed discussion among the entrepreneurs with the Agricultural Production Commissioner to increase the export of mango from the mango fruit belt of Uttar Pradesh and a It was agreed to invest to increase the export of Dussehri, Langda and Chausa and colored

varieties of mango like Ambika, Arunika varieties from different fruit belts of mango by setting up a food park. The chief guest of this program was Shri Manoj Kumar Singh, Agriculture Production Commissioner, Government of Uttar Pradesh along with Dr. K., Managing Director of Innova Agri Biopark, Bengaluru. S. Ravi, Dr. Bal Krishna, Chairman of Khandelwal Biofertilizers Belgaum, Karnataka and representatives of Jain Irrigation Systems agreed upon the terms and conditions required for the investment. The chief guest of this program, Mr. Manoj Kumar Singh, Agriculture Production Commissioner, Uttar Pradesh Government, inaugurated the program and in his address assured all possible assistance and providing land to the industries for setting up food parks. On this occasion, Dr. K., Managing Director of Innova Agri Foodpark, Bengaluru. S. Ravi and Dr. T. Damodaran, Director of Central Institute of Subtropical Horticulture, Rahmankheda, Lucknow, also signed an MoU. On this occasion, an MoU was also signed with Nature Green Biome, New Delhi for commercial production of CISH Bioenhancer (Microbial Consortium) developed by the Institute. Former Director of the Institute, Dr. Shailendra Rajan called for meeting the demand of farmers regarding plants in view of the need for intensive horticulture by producing more and more plants from the varieties developed by the Institute. In this program, Dr. P.M. Singh, who came from the Indian Vegetable Research Institute, presented the latest varieties of vegetables and other production technologies developed by the institute. Various agricultural entrepreneurs of the country, start up managers, agricultural producers' associations, etc. along with representatives of reputed institutions and industries of the country like CEO (Invest in UP) of Uttar Pradesh Government, General Manager of APEDA Dr. Vineeta Sudhanshu, Khandelwal. A total of 150 participants participated along with Dr. Bal Krishna, Chairman of Biofertilizers

and representatives of Jain Irrigation Systems and VNR. The program was conducted by Ms. Nimisha Maheshwari and vote of thanks was given by Dr. Maneesh Mishra.

National Dialogue/National workshop on guava: Challenges and Strategies

One day National Dialogue/National workshop on guava was organized in collaboration with All India coordinated Research Improvement Project on fruits on 15 December 2023 at ICAR-CISH, Lucknow. The Program was inaugurated by Dr. B. Singh, Honorable V.C. Narendra Deo University of Agriculture and Technology, Kumarganj Ayodhya, Uttar Pradesh. Dr. B. Singh underlined the importance of crop specific dialogue rather many crops, such discussion helps in chalking out strategies. Dr. Singh emphasized that study required to be conducted on rootstock and scion interaction technology development required to develop in guava in view of charging climatic conditions.

CELEBRATIONS

Inauguration of Technology Park

Dr. Himanshu Pathak, Secretary, DARE & Director General, Indian Council of Agriculture Research (ICAR) inaugurated 'Technology Park' by planting the first plant of climate resilient mango hybrid CISH-Arunika and salt tolerant rootstock of mango variety Sagarika at ICAR–CISH Telibagh Campus on 14th April 2023. Dr. T. Damodaran, Director, ICAR-CISH elaborated the need of technology park to showcase all the institute technologies at one place to provide easy access to farmers and other stake holders. The Technology Park will encompass the display and demonstration of all CISH Technologies. The DG ICAR assured for all the support in the establishment of the technology park at the institute for the benefit of famers.

74th Republic day celebration

The 74th Republic Day was celebrated on 26 January 2023 at the ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow. The Director of the institute, Dr. Damodaran, unfurled the national flag in the main campus at Rehmankhera. In his address, he emphasized the achievements made by the institutue and motivated everyone to work unitedly to achieve national goals.

40th Foundation Day of ICAR-CISH

The '40th Foundation Day' of the institute was celebrated on June 01, 2023 at Rehmankhera campus under the chairmanship of Dr. Major Singh, Member, Agricultural Scientists Recruitment Board, ICAR, New Delhi. Dr. Singh underlined the importance of research oriented towards evaluation of nutraceutically rich horticulture crops for improving nutritional security and livelihood of growers. Dr. T. Damodaran, Director, ICAR-CISH, Lucknow, summarized the achievements of the institute in the last 40 years and highlighted the importance of climate resilient horticulture, research on nutraceutical rich varieties of mango, guava and jamun and enriching research on the value chain for domestic and export markets. Dr. Shailendra Rajan, Former Director of the institute, presented the results of long-term breeding of mango and guava at the institute. Dr. Ajit Shashni, Director, ICAR-National Botanical Research Institute, Lucknow, Dr. R. Viswanathan, Director, ICAR-Indian Institute of Sugarcane Research and Dr. U.K. Sarkar, Director of ICAR-National Bureau of Fish Genetic Resources, Lucknow were present in the programme.

World Soil Day 2023

World Soil Day was celebrated at Sarsanda, Lucknow, U.P. on December 5, 2023 under SC sub plan. Dr. S.K Shukla, Dr. Tarun Adak, Dr. Vishambhar Dayal and Dr. Dinesh Kumar actively participated in the programme. About 40 farmers, women and men took enthusiastically participated. Soil and tree health management in fruit production systems was discussed. Scientists discussed about the water management and orchard practices for ensuring fruit yields. Hindi literature of scientific zinc and boron management in guava cultivation was distributed among the farming community. Growers were sensitized on soil health status, indexing and needs for soil health improvements. Use of Nano-urea and Nano-DAP was suggested to get greater benefits. Micronutrient management for quality fruit production was discussed. Spraying of micronutrients at pea, marble and fruit developmental stages in mango

and guava stage were suggested to get quality fruit. Incorporation of vermicompost, Jeevamrit, organic mulching, organic manures and microbial consortia like CISH-bioenhancer were recommended to growers. Farmers were encouraged for organic cultivation of vegetables and fruits. Soil health and food security was discussed. Celebration was concluded with vote of thanks to all the participants.

PROGRAMMES ORGANIZED UNDER AZADI KA AMRIT MAHOTSAV

Awareness Programme for School Children about Future Career Opportunities through Horticultural Research

ICAR- CISH, Lucknow organized an awareness programme for school children under *Azadi ka Amrit Mahotsav* on '*Future Career Opportunities through Horticultural Research*' on 27th April, 2023 at Vidyasthali Inter College, Kanar, Lucknow. Dr. T. Damodaran, Director, ICAR-CISH, Lucknow in his address stressed that horticultural research and education have a tremendous potential for bringing out transformative improvements in the lives of Indian farmers. He said that education during formative years plays a critical role in shaping the young minds. While exhorting the school children to pursue higher studies in horticultural sciences, he remarked that cutting-edge horticultural research to ensure the food, nutrition, income, employment and environmental security of a burgeoning global population. Mrs. Shipra Verma, Principal, Vidyasthali informed about educational and extra-curricular activities at the school. Dr. P. L. Saroj, Head, Crop Production Division presented a detailed account of research and education infrastructure under the Indian Council of Agricultural Research. He also highlighted the vast career opportunities through horticultural research. The programme was attended by about 120 school children and school staff. Dr. Anshuman Singh, Senior Scientist and Dr. Karma Beer, Scientist coordinated the programme.

Nutri-Garden Awareness Programme

ICAR- CISH, Lucknow organized an awareness programme under *Azadi ka Amrit Mahotsav*, on 'Nutri-gardens for food, nutrition and income security' in Sarsanda village of Lucknow district on 28th June, 2023. The program was attended by about 80 farmers, farm women and rural youth from Sarsanda and adjoining villages. Dr. T. Damodaran, Director, ICAR-CISH, Lucknow in his address encouraged the farmers to adopt an integrated value-chain based approach to reap the premium benefits from the cultivation of mango and other horticultural crops. He assured the farmers of adequate technical backstopping from ICAR-CISH for sustainable farming. Dr. Abha Singh, Principal Scientist informed the farmers and farm women about simple approaches and precautions for increasing the nutrient bioavailability from the food. She underlined the importance of traditional fruits, vegetables and millets in alleviating the hunger and malnutrition risks. Dr. Anshuman Singh, Senior Scientist informed about improved varieties of subtropical fruits of mango, guava and jamun. Dr. V. Dayal, Scientist, presented an overview of initiatives being taken up under SC-SP program for empowering the farmers. Dr. Karma Beer, Scientist, informed the farmers about methods and approaches for preparing the value added products from ripe and unripe mango fruits. Dr. S. S. Das, Scientist, discussed about different nutri-rich fruits and vegetables for eradicating the malnutrition. The program was coordinated by Dr. Anshuman Singh, Dr. Karma Beer and Dr. Vishambhar Dayal.

OTHERS

Post Budget Webinar

ICAR-CISH, Lucknow participated in the post-budget webinar on "Agriculture and Cooperatives" conducted by the Ministry of Agriculture & Farmers' Welfare, Government of India on 24th February 2023. The event was addressed by the Hon'ble Prime Minister, Shri Narendra Modi. He informed that Agricultural budget has now been increased to more than 1,25,000 crores today. He emphasized that various important decisions are being taken in agricultural budget, in the direction, of making nation 'Atmanirbhar'. He further mentioned about Digital Public Infrastructure platform and open platform of UPI for the agriculture sector as announced in the budget this year. The Prime Minister proposed the accelerator fund for agri-tech start-ups. He added that Agri-Tech domains have immense possibilities of investment and innovation as India inhabits more 3000 agri-startups today. Furthermore, the Prime Minister informed that government is working on the PM Pranam Yojana and Gobardhan Yojana for promoting natural farming and reducing chemical-based farming. The webinar was attended by the Director, Dr. T. Damodaran and all scientists of the Institute. On this occasion, progressive farmers were also invited for interaction. Shri Dayashankar Singh, Irada Foundation, Lucknow, Shri Shobha Ram, Kela Utpadak, Ayodhya, Shri Deepak Shukla, Aam

Utpadak, Sitapur, Shri Ram Kishor Maurya, Society for Conservation of Mango Diversity, Lucknow and Sh. Upendra Singh, Avadh Aam Utpadak Ewam Bagwani Smiti, Lucknow attended the programme and interacted with institute scientists on digitization of horticulture.

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विश्व हिंदी दिवस के अवसर पर भा.कृ.अनु.प.–भारतीय मृदा एवं जल संरक्षण संस्थान, देहरादून दारा 10 जनवरी 2023 को 'विश्व स्तर पर हिंदी के प्रसार में प्रवासी भारतीयों का योगदान' विषय पर आभाषी माध्यम से एक अंतर्राष्ट्रीय वेब संगोष्ठी का आयोजन किया गया जिसमें मुख्य अतिथि डॉ. गिरीश नाथ झा, वैज्ञानिक एवं तकनीकी शब्दावली आयोग, शिक्षा मंत्रालय, भारत सरकार थे। इस अवसर पर प्रो. पुष्पिता अवस्थी, हिंदी यूनिवर्स फाउंडेशन, नीदरलैंड, श्रीमती सुनीता नारायण, न्यूजीलैंड, डॉ. नितिन उपाध्याय, संयुक्त अरव अमीरात, श्रीमती रीता कौशल, आस्ट्रेलिया एवं डॉ. आराधना झा श्रीवास्तव, सिंगापुर ने विश्व में हिंदी की स्थिति एवं उसके प्रसार में प्रवासी भारतीयों के योगदान पर विस्तार से चर्चा की। इस अवसर पर आभाषी माध्यम से डॉ. नूतन पाण्डेय, सहायक निदेशक (हिंदी), केन्द्रीय हिंदी प्रशिक्षण संस्थान,नई दिल्ली कार्यक्रम से जुड़ी तथा विभिन्न संस्थानों से 100 से अधिक वैज्ञानिकों,अधिकारियों एवं कर्मचारियों ने आभाषी माध्यम से जुड़कर सभी विद्वतजनों के वक्तव्यों को सुना। केन्द्रीय उपोष्ण बागवानी संस्थान के अधिकारियों एवं कर्मचारियों ने भी आभाषी माध्यम से कार्यक्रम में प्रतिभाग किया।

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संस्थान राजभाषा कार्यान्वयन समिति की उक्त अवधि में चार बैठकों का आयोजन कर संस्थान में राजभाषा को बढ़ावा देने एवं संस्थान कर्मियो को हिंदी में अधिक से अधिक कार्य करने पर बल दिया गया। संस्थान के नोटिस बोर्ड,वार्षिक प्रतिवेदन एव नाम पटिटकाओं को द्विभाषी करना, क क्षेत्र में हिन्दी के पत्रों का प्रतिशत बढ़ाना, द्विभाषी पत्रों की संख्या को बढ़ाना, हिन्दी की पुस्तको को कृय करना एवं हिन्दी पखवाड़ा का आयोजन करना आदि सवंधित निर्णयों का कार्यान्वयन हेतु चार बैठकों का आयोजन क्रमशः दिनांक 22.02.2023, 16.06.2023, 01.09.2023 एवं 13.12.2023 में किया गया।

fgnh dk;'kkykvk dk vk;kt u

संस्थान के निदेशक एवं राजभाषा कार्यान्वयन समिति के अध्यक्ष डॉ टी. दामोदरन की अध्यक्षता में उक्त अवधि में चार कार्यशालाओं का आयोजन किया गया। दिनांक 22.03.2023 को "आद्र भूमि प्रबंधन"/Wetland Management विषय पर कार्यशाला का आयोजन किया गया जिसमे डॉ. राजेंद्र प्रसाद केन्द्रीय कृषि विश्वविद्यालय, समस्तीपुर, बिहार के पूर्व कुलपति डॉ.आर.सी.श्रीवास्तव द्वारा व्याख्यान प्रस्तुत किया गया। दिनांक 23.06.2023 को "आम में पौध संरक्षण की समस्याऐं एवं भविष्य की रणनीति"/Challenges & Strategies in Mango Plant Protection विषय पर आयोजित कार्यशाला में संस्थान के डॉ. एच. एस. सिंह, प्रधान वैज्ञानिक द्वारा एवं डॉ.रवि. एस.सी, वैज्ञानिक ने "मलिहाबाद क्षेत्र में आम काश्त की विधाऐं एवं समस्याऐं"/Systems & Challenges in Mango Production in Malihabad विषय पर व्याख्यान प्रस्तुत किया गया। दिनांक 29.09.2023 को "शोध संस्थानों में हिंदी का महत्व"/Importance of Hindi in Research Institutions विषय पर आयोजित कार्यशाला में केन्द्रीय मृदा लवणता अनुसंधान संस्थान,करनाल के पूर्व निदेशक डॉ. डी.के. शर्मा द्व ारा व्याख्यान प्रस्तुत किया गया। दिनांक 21.12.2023 को उधान में जैव प्रौद्योगिकी अनुप्रयोग/Biotechnology Applications in Horticulture विषय पर हिंदी कार्यशाला का आयोजन किया गया जिसमें संस्थान के डॉ. मुत्थु कुमार एम ने व्याख्यान प्रस्तुत किया तथा साथ ही राजभाषा के वार्षिक लक्ष्यों सहित संस्थान में हुई रंजभाषा गतिविधियों की जानकारी संस्थान के नोडल अधिकारी (राजभाषा) द्वारा प्रतिभागियों के बीच साझा की गयी। उपरोक्त सभी कार्यशालाओं में संस्थान के 152 वैज्ञानिक/अधि ाकारी एवं 73 कर्मचारियों ने प्रतिभाग किया।

vkn Hkfe ic/ku fo"k; ij dk;'kkyk dk vk;kt u
¼22-03-2023½

vke e ik/k lj{k.k dh leL;k,a ,o Hkfo"; dh j.kuhfr fo"k; ij vk;kftr dk;'kkyk dk vk;kt u
¼23-06-2023½

m/kku e t o ik|kfxdh vui;ksx fo"k; ij vk;kftr dk;'kkyk dk vk;kstu ¼21-12-2023½

Nekgh cBdk e ifrHkkx

नगर राजभाषा कार्यान्वयन समिति (नराकास) कार्यालय–2, भारतीय भूवैज्ञानिक सर्वेक्षण, लखनऊ द्वारा आयोजित प्रथम छमाही बैठक दिनांक 23.06.2023 एवं द्वितीय छमाही बैठक दिनांक 24.11.2023 में संस्थान ने प्रतिभाग किया तथा समीक्षित बिन्दुओं का पालन संस्थान में किया गया।

HkoKkfud lo{k.k] y[kuÅ ¼ujkdkl dk;ky;&2½ }kjk vk;kftr Nekgh cBd e ifrHkkx

lLFkku dh xg if=dk m/kku jf'e dk i'kfLr i= lEeku

नगर राजभाषा कार्यान्वयन समिति (नराकास) कार्यालय–2, भारतीय भूवैज्ञानिक सर्वेक्षण, लखनऊ द्वारा दिनांक 23.06.2023 को आयोजित प्रथम छमाही बैठक समीक्षा के दौरान केंद्रीय उपोष्ण बागवानी संस्थान द्वारा प्रकाशित संस्थान की रंजभाषा पत्रिका "उद्यान रश्मि" के अप्रैल 2022 से सितंबर 2022 अंक–1को प्रशस्ति पत्र से सम्मानित किया गया।

jkt Hkk"kk fgnh i[kokMk&2023

भा.कृ.अनु.प.–केन्द्रीय उपोष्ण बागवानी संस्थान में राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद द्वारा जारी

दिशा–निर्देशानुसार दिनांक 14 से 29 सितंबर, 2023 तक हिंदी पखवाड़ा का आयोजन किया गया। कार्यक्रम में मुख्य अतिथि के रुप सम्मिलित डॉ. डी. के. शर्मा, पूर्व निदेशक, केन्द्रीय मृदा लवणता अनुसंधान संस्थान,करनाल ने अपने संबोधन में हिंदी में और कार्य करने का आह्वाहन किया इस अवसर पर "शोध संस्थानों में हिंदी का महत्व" विषय पर एक कार्यशाला का भी आयोजन किया गया। कार्यक्रम में विशिष्ट अतिथि के रुप में उपस्थित डॉ. विश्व बंधु पटेल, सहायक महानिदेशक बागवानी, भारतीय कृषि अनुसंधान परिषद नई दिल्ली एवं भारतीय चावल अनुसंघान संस्थान, हैदराबाद के निदेशक डॉ. आर.एम. सुन्दरम ने भी संस्थान कर्मियों को संबोधित किया। उपरोक्त अवसर पर डॉ. श्याम नगीना पाण्डेय पूर्व सहायक महानिदेशक बागवानी,

fgnh i[kokMk d nkjku fgnh dh fofHkUu ifr;kfxrkvksa dk vk;kstu

fgnh i[kokMk d nkjku dfo lEesyu dk vk;kstu ¼26-09-2023½

fgnh i[kokMk lekiu lekjkg ¼29-09-2023½

भारतीय कृषि अनुसंधान परिषद नई दिल्ली द्वारा लिखित पुस्तक "ईर्ष्या की परिधि" जिसकी तीन प्रतियॉ संस्थान को पुस्तकालय में वाचन हेतु उपहार स्वरुप भेंट की थी का विमोचन भी किया गया। इस अवधि में विभिन्न प्रतियोगिताओं का आयोजन हुआ जिसमें 18 सितंबर को हिंदी में वाद–विवाद प्रतियोगिता, 20 सितंबर को हिंदी काव्य.पाठ प्रतियोगिता, 25 सितंबर को यूनिकोड में हिंदी टंकण प्रतियोगिता, 26 सितंबर वर्ष में हिंदी में सर्वाधिक कार्य प्रोत्साहन हेतु मूल्यांकन प्रतियोगिता एवं 27 सितंबर को हिंदी में निबंध लेखन प्रतियोगिता का आयोजन किया गया। इन विभिन्न प्रतियोगिताओं में संस्थान के वैज्ञानिक/तकनीकी/प्रशासनिक/शोध एवं संविदा वर्ग से कुल 60 से अधिक प्रतियोगियों ने प्रतिभाग किया। पखवाड़ा के मध्य 26 सितंबर, 2023 को संस्थान कर्मियों में हिंदी भाषा शैली, रस, अलंकार, छंद आदि से सुसज्जित रचनाओं से परिचय कराने हेतु एक कवि सम्मेलन का भी आयेजन किया गया जिसमें ग्वालियर, वाराबंकी, मैनपुरी एवं लखनऊ से सम्मिलित कवियों ने अपनी विभिन्न रचनाओं को उपस्थित श्रोताओं के समक्ष प्रस्तुत किया। पखवाड़ा का समापन दिनांक 29 सितंबर, 2023 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 50 प्रतियोगियों ने सफलता प्राप्त की जिन्हें नियमानुसार कार्यक्रम के समापन समारोह मे सम्मिलित मुख्य अतिथि, विशिष्ट अतिथि एवं संस्थान के निदेशक डॉ. टी. दामोदरन द्वारा पुरस्कृत किया गया। कार्यक्रम का संचालन अरविन्द कुमार,नोडल अधिकारी (राजभाषा) द्वारा किया गया एवं कार्यक्रम आयोजन हेतु सभी से मिले सहयोग के लिए धन्यवाद भी दिया गया।

13 Personnel

Institute Headquarters, ICAR-CISH, Lucknow (Uttar Pradesh)

Scientific			
S. No.	**Name of the officer**	**Degree**	**Designation**
1.	Dr. T. Damodaran	Ph.D.	Director
A. Division of Crop Improvement and Biotechnology			
1.	Dr. Anju Bajpai	Ph.D.	Principal Scientist (Genetics & Cytogenetics) & Head (w.e.f. 10.07.2023)
2.	Dr. Devendra Pandey	Ph.D.	Principal Scientist (Horticulture) & I/c Head (up to 15.03.2023)
3.	Dr. Maneesh Mishra	Ph.D.	Principal Scientist (Horticulture) & I/c Head (up to 9.07.2023)
4.	Dr. Ashish Yadav	Ph.D.	Principal Scientist (Horticulture)
5.	Dr. Sanjay Kr Singh	Ph.D.	Principal Scientist (Horticulture)
6.	Dr. Harish Chandra Verma	MCA	Scientist (SG) (Computer Application)
7.	Dr. Muthukumar M.	Ph.D.	Senior Scientist (Biotechnology)
8.	Dr. Israr Ahmad	Ph.D.	Senior Scientist (Biotechnology)
9.	Dr. Anshuman Singh	Ph.D.	Senior Scientist (Horticulture)
10.	Dr. Vishambhar Dayal	Ph.D.	Scientist (Horticulture)
11.	Dr. Swosti Suvardarsini Das	Ph.D.	Scientist (Horticulture)
12.	Dr. Amarkant Kushwaha	M.Sc.	Scientist (Genetic & Plant Breeding)
B. Division of Crop Production			
1.	Dr. Kundan Kishore	Ph.D.	Principal Scientist (Horticulture) & Head (w.e.f. 04.12.2023)
2.	Dr. P. L. Saroj	Ph.D.	Principal Scientist (Horticulture) & Head (I/c) (up to 03.12..2023)
3.	Dr. Sushil Kumar Shukla	Ph.D.	Principal Scientist (Horticulture)
4.	Dr. Dinesh Kumar	Ph.D.	Principal Scientist (Horticulture)
5.	Dr. Naresh Babu	Ph.D.	Principal Scientist (Horticulture)
6.	Dr. Kanchan Kumar Srivastava	Ph.D.	Principal Scientist (Horticulture- Fruit Science)
7.	Dr. Shyam Raj Singh	Ph.D.	Principal Scientist (Horticulture- Veg. Science)
8.	Dr. Dushyant Mishra	Ph.D.	Principal Scientist (Fruit Science)
9.	Dr. Tarun Adak	Ph.D.	Senior Scientist (Soil Physics/Soil & Water Conservation)
10.	Dr. Sharad Kumar Dwivedi	Ph.D.	Senior Scientist (Plant Physiology)
11.	Dr. Govind Kumar	Ph.D.	Scientist (Agricultural Microbiology)
C. Division of Crop Protection			
1.	Dr. Deepak Singh	Ph.D.	Principal Scientist (Plant Pathology) & Head (w.e.f. 27.12.2023)
2.	Dr. Hari Shankar Singh	Ph.D.	Principal Scientist (Agril. Entomology) & I/c Head (up to 15.03..2023
3.	Dr. Prabhat Kumar Shukla	Ph.D.	Principal Scientist (Plant Pathology) & I/c Head (up to 26.12..2023)
4.	Dr. Snehashish Rautray	Ph.D.	Scientist (Agricultural Entomology) (w.e.f. 20.7.2023)
5.	Vimal Kumar C.	M.Sc.	Plant Pathology (w.e.f. 21.7.2023)

D. Division of Post Harvest Management			
1.	Dr. Akath Singh	Ph.D.	Principal Scientist (Horticulture) & Head (w.e.f. 19.07.2023)
2.	Dr. Ajaya Kumar Trivedi	Ph.D.	Principal Scientist (Plant Physiology) & I/c Head (up to 18.07.2023)
3.	Dr. Abha Singh	Ph.D	Principal Scientist (Food & Nutrition)
4.	Dr. Bharati Killadi	Ph.D.	Principal Scientist (Hort-Veg. Science)
5.	Dr. Anil Kumar Verma	Ph.D	Scientist (SG) (FM&P) (retired on 31.03.2023)
6.	Dr. Alok Kumar Gupta	Ph.D	Scientist (Fruit Science)
7.	Dr. Karma Beer	Ph.D	Scientist (Fruit Science)
8.	Er. Gopal Carpenter	M.Tech.	Scientist (Farm Machinery & Power) (up to 22.03.2023)
9.	Dr. Ravi S.C.	Ph.D.	Scientist (Agricultural Economics)
10.	Ms. Nisha Sulakhe	M.Tech.	Food Process Engg. (wef 21.07.2023)

Technical

S. No.	Name of the officer	Degree	Designation
1.	Dr. Sudhir Kumar Singh Raghav	Ph.D. (Agronomy)	Chief Technical Officer (Field/ Farm Tech.)
2.	Sanjay Kumar	M.Sc. (Botany)	Chief Technical Officer (Lab. Tech.) (retired on 31.08.2023)
3.	Abhay Dixit	M.Sc. (Chemistry)	Chief Technical Officer (Lab. Tech.) (retired on 30.04.2023)
4.	Vinod Kumar Singh	Ph.D. (Botany)	Chief Technical Officer (Lab. Tech.) (retired on 30.04.2023)
5.	Dharmendra Kumar Shukla	M. Tech. (Food Technology)	Chief Technical Officer (Lab. Tech.)
6.	Arvind Kumar	M.Sc. (Ag.)	Assistant Chief Technical Officer (Lab. Tech.)
7.	Brajendra Kumar	M.Sc. (Hort.)	Assistant Chief Technical Officer (Field/ Farm Tech.)
8.	Priti Sharma	M.Sc. (Botany), M. Phil.	Assistant Chief Technical Officer (Lab. Tech.)
9.	Md. Afroz Sultan	M.Sc. (Agronomy)	Technical Officer (Programme Assistant-Lab. Tech.)
10.	Dr. N.C. Verma	Ph.D. (Library & Information Science)	Technical Officer (Library)
11.	Virendra Pratap Singh	8th	Technical Officer (Workshop-Driver)
12.	Virendra Kumar Yadav	B.A.	Senior Technical Assistant (Workshop-Driver)
13.	Dhurva Kumar	B.A.	Senior Technical Assistant (Field/ Farm Tech.)
14.	Sumit Kumar Soni	Ph.D. (Biotechnology)	Technical Assistant (Lab. Technician)
15.	Mohd. Riyaz	B.Sc.	Technical Assistant (Lab. Technician)
16.	Satyendra Singh	B.A.	Technician (Field/ Farm Tech.)
17.	Alok Shukla	M. Sc. (Biochemistry)	Technician (Lab. Technician)
18.	Arvind Kumar Singh	M. Sc. (Biotechnology)	Technician (Lab. Technician)
19.	Monika Singh	B. Sc., M.C.A, B.Ed.	Technician (Lab. -Computer)
20.	Hemant Kumar Pandey	B.A., M.B.A.	Technician (Field/ Farm Tech.)

Administrative			
S. No.	**Name of the officer**	**Degree**	**Designation**
1.	A. K. Yadav	B.A., LLB	Senior Administrative Officer
2.	Dhiraj Kumar Agnihottri	B.Com.	Senior Finance & Accounts Officer
3.	Rahul Bhat	B.Com., M.A. (Public Admin.)	Assistant Administrative Officer
4.	Sajeewan Lal Gautam	M.A.	Assistant Administrative Officer
5.	Gyani Prasad Mishra	Intermediate	Private Secretary (retired on 31.08.2023)
6.	Sulabh Singh Sengar	B.Tech. (Com. Sci. & Eng.)	Assistant
7.	Vijendra Singh	B.A.	Assistant
8.	Hardev Singh	B.A.	Assistant
9.	Ram Gopal	High School	Upper Division Clerk (24.01.2023)
10.	Mahendra Kumar	Intermediate	Upper Division Clerk
11.	Annapurna Gupta	B.A.	Upper Division Clerk
12.	Nitesh Kumar	B.Sc.	Stenographer Grade III
13.	Shreya Srivastava	B.Com.	Lower Division Clerk
14.	Surender	B.A.	Lower Division Clerk
15.	Kalpana Singh	B.A.	Lower Division Clerk

Skilled Supporting Staff		
S. No.	**Name**	**Designation**
1.	Sanjay Kumar	Multitasking Staff
2.	Maheshwari Devi	Multitasking Staff
3.	Rajesh Kumar	Multitasking Staff
4.	Gyan Wati	Multitasking Staff
5.	Anand Gautam	Multitasking Staff

Regional Research Station, Malda (West Bengal)			
Scientific			
S. No.	**Name of the officer**	**Degree**	**Designation**
1.	Dr. Dipak Nayak	Ph.D.	Senior Scientist (Fruit Science) & In-charge
2.	Dr. Prananath Barman	Ph.D.	Scientist (Horticulture-Fruit Science)
3.	Vimalkumar C.	M.Sc. (Ag.)	Scientist (Plant Pathology)

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.	Dr. Dushyant Kr Raghav	Ph.D.	Senior Scientist (Zoology) & Head KVK (wef 29.09.2023)
2.	Dr. Dipak Nayak	Ph.D.	Senior Scientist (Fruit Science) & In-charge (up to 28.09.2023)

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

Personalia

(01.01.2023 to 31.12.2023)

APPOINTMENTS

A. RMP

1. Dr. Damodaran Thukkaram, Pr. Scientist, ICAR-CSSRI RRS Lucknow was appointed to the post of Director, ICAR –Central Institute for Subtropical Horticulture, Lucknow w.e.f. 23.01.2023.

B. Scientific

1. Dr. (Smt.) Anju Bajpai, Pr. Scientist, ICAR-CISH, Lucknow was appointed to the post of Head, Crop Improvement & Biotechnology Division, ICAR –Central Institute for Subtropical Horticulture, Lucknow w.e.f. 10.07.2023 (A/N).
2. Dr. Akath Singh, Pr. Scientist, ICAR-CAZRI, Jodhpur was appointed to the post of Head, Post Harvest Management Division, ICAR –Central Institute for Subtropical Horticulture, Lucknow w.e.f. 19.07.2023.
3. Dr. Kundan Kishore, Pr. Scientist (Horticulture), ICAR-IIHR (CHES), Bhubaneswar was appointed to the post of Head, Crop Production Division, ICAR- Central Institute Lucknow w.e.f. 04.12.2023. (F.N.).
4. Dr. Deepak Singh, Pr. Scientist ICAR KVK CIAE, Bhupal was appointed to the post of Head, Crop Protection Division, ICAR- Central Institute Lucknow w.e.f. 27.12.2023. (F.N.).
5. Dr. Dushyant Kumar Raghav, Sr. Scientist was appointed to the post of Sr. Scientist cum Head, KVK, Malda (W.B.), ICAR-Central Institute for Subtropical Horticulture, Lucknow w.e.f. 29.09.2023. (F.N.).

C. New Entrants

1. Dr. Snehashish Routray, Scientist (Agricultural Entomology) 20.07.2023.
2. Sh. Vimal Kumar C., Scientist (Plant Pathology) 21.07.2023.
3. Ms. Nisha Sulakhe, Scientist (Agricultural Structures & Process Engineering) 21.07.2023.

TRANSFER

1. Er. Gopal Carpenter, Scientist (Farm Machinery & Power) was relieved on 22.03.2023 to join at ICAR- Central Institute of Agricultural Engineering, Bhopal (M.P.)
2. Dr. Ashish Yadav, Pr. Scientist was appointed as Head Sikkim Centre, ICAR Research Complex for NEH Region Umiam, Barapani w.e.f. 17.07.2023 however the period/ tenure was curtailed by Council by allowing him to join as Pr. Scientist ICAR-CISH, Lucknow w.e.f. 14.08.2023

PROMOTION/ CAREER ADVANCEMENT

A. Scientist

1. Er. Anil Kumar Verma, Scientist was re-designated as Senior Scientist w.e.f. 30.05.2019 for acquiring Ph.D.
2. Dr. Dipak Nayak, Senior Scientist (Fruit Science) was promoted to the next higher grade of Sr. Scientist in RGP 9000/- w.e.f. 15.12.2021.

3. Dr. Anshuman Singh, Senior Scientist (Fruit Science) was promoted to the next higher grade of Sr. Scientist in RGP 9000/- w.e.f. 04.10.2022.
4. Dr. Israr Ahmad, Senior Scientist (Biotechnology) was promoted to the next higher grade of Sr. Scientist in RGP 9000/- w.e.f. 07.02.2022.
5. Dr. Prananath Barman, Scientist (Fruit Science) was promoted to the next higher grade of Sr. Scientist in RGP 8000/- w.e.f. 01.01.2022.
6. Dr. Govind Kumar, Scientist (Agril. Microbiology) was promoted to the next higher grade of Scientist in RGP 7000/- w.e.f. 02.07.2022.

B. Technical

1. Md. Afroz Sultan, Technical officer was granted merit promotion to the grade of Sr. Technical Officer (T-6) w.e.f. 13.08.2020 by the Council's Order endorsed by ICAR RC ER, Patna .
2. Sh. Varnayudh Vratdhari Diptikar, Technical Officer (Prog. Assistant-Computer), KVK Malda was granted merit promotion to the grade of Sr. Technical Officer (T-6) w.e.f. 27.08.2019 by the order issued by ICAR-IIVR.
3. Dr. Om Prakash, Ex. STO, merit promotion to the grade of Assistant Technical Officer (T-7/8) w.e.f. 01.07.2008 by the order issued Council's letter F.No. TS-2(02)/2023-Estt-IV dated 09.03. 2023.

SUPERANNUATATION

A. Scientific

1. Dr. Anil Kumar Verma, Senior Scientist retired on 31.03.2023.

B. Technical

1. Dr. Vinod Kumar Singh, C.T.O. retired on 30.04.2023.
2. Sh. Abhay Dikshit, C.T.O. retired on 30.04.2023.
3. Sh. Sanjay Kumar, C.T.O. retired on 31.08.2023.

C. Administrative

1. Sh. G.P. Mishra, Private Secretary retired on 31.08.2023.

PROBATION CLEARANCE OF SCIENTISTS

1. Sh. Amarkant Kushwaha, Scientist
2. Dr. Ravi S.C., Scientist

Administrative Staff

1. Sh. Sulabh Singh Sengar, Assistant granted Ist MACP on dated 08.10.2022 vide letter no. 1-1(20)/Estt. dated 08.02.2024
2. Smt. Maheshwari Devi, MTS granted IIIrd MACP on dated 31.05.2021 vide letter no. 1-1(20)/Estt. dated 08.02.2024

OBITUARY

Shri Ram Gopal, UDC expired on 24.01.2023.

14 Distinguished visitors

1. Dr. Anil Yadav, Director, CSTUP, Lucknow (January 03, 2023).
2. Padam Shri Sunda Ram Verma, Progressive Farmer, Village and Post Danta Sikar Rajasthan (January 04, 2023).
3. Dr.V.K. Mishra, Ex. Head, CSSRI, Lucknow (February 03, 2023).
4. Dr. Anirban Pal, Sr. Principal Scientist, Bio-Prospection & Product Development, CSIR-CIMAP, Lucknow (February 03, 2023).
5. Shri A.K. Sachan, Deputy Agril. Director, SIMA, Lucknow (February 22, 2023).
6. Dr. Usman Sayeed, Assistant Processor (Assistant Proctor), Département of Agriculture, Intégral Institute of Agricultural Science and Technology, Lucknow (February 22, 2023).
7. Honorable Shri Priya Ranjan IFS, Joint Secretary, INM, MIDH, MoAFW, New Delhi (February 28, 2023)
8. Dr. Dinesh Kumar Tyagi, Ex. IFS, Ghaziabad (March 15, 2023).
9. Mohd. A . L. Bardan, Dubai (March 15, 2023).
10. Prof. Anand Parkash, Vice Chancellor, MGCU, Motihari, Bihar (March 21, 2023).
11. Prof. Birjesh Pandey, Prof. & Head, Department of Bio-Technology, Central University Motihari Bihar (March 21, 2023).
12. Dr.R.C. Srivastava, Former Vice Chancellor, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (March 22, 2023)
13. Dr. Hemant Kumar, Director and Dr. Ravi, Kumar Umrao, Senior Geologist, Geological Survey of India, Lucknow (April 11, 2023).
14. Dr. B.M.C.Reddy, Former Director, ICAR-CISH, Lucknow and Former Vice Chancellor APHU, Andhra Pardesh (April 13, 2023).
15. Dr. Smt. Neeru Bhooshan, ADG (IPTM&PME), ICAR, New Delhi (April 13, 2023 & October 03, 2023).
16. Dr. Himanshu Pathak, Secretary (DARE) and Director General (ICAR) (April 15, 2023)
17. Dr. V.B. Patel, ADG (F&PC), ICAR, New Delhi (April 28, 2023, July 12-13, 2023 & September 29, 2024).
18. Dr. R.K. Pal, Advisor, FSSAI and Former Director, ICAR-NRC Pomegranate, Solapur (April 28, 2023).
19. Dr. B. K. Pandey, Former ADG, Horticulture ICAR, New Delhi (April 28, 2023).
20. Dr. Valvir Singh, Deputy Director Extension, SRMU, Barabanki (May 11, 2023).
21. Dr. K.V Parsad, Director, ICAR-DFR, Pune (May 15, 2023).
22. Dr. A.K.Singh, DDG (Hort.) ICAR, New Delhi (May 16, 2023).
23. Dr. Major Singh, Member, Agricultural Scientists Recruitment Board, ICAR, New Delhi (June 01, 2023).
24. Dr. B.B. Naigaich, Former Director, ICAR-CPCRI, Shimla (June 14, 2023).
25. Dr.V.B. Dwivedi, Joint Director, Directorate of Horticulture, Lucknow (June 20, 2023).
26. Dr. A.K. Sachan, Under Secretary U.P., Govt. of India (Agril.) (June 27, .2023).
27. Dr. N. Kumar, Former Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (July 12-13, 2023).
28. Dr. Jai Singh (Ex. Director, ICAR-CIPHET, Ludhiana (July 12-13, 2023).
29. Dr. Ambika B. Gaikwad, Principal Scientist, ICAR-NBPGR, New Delhi (July 12-13, 2023).
30. Dr. Chandish Balal Ex. Director, ICAR-NBAIR, Bengaluru (July 12-13, 2023).
31. Dr. A.N. Ganeshmurthy Former Dean, College of Agriculture, CAU, Imphal (July 12-13, 2023).
32. Prof. (Dr.) N. B. Singh, Former Vice Chancellor, B.N. University, Udaipur, ITM University Campus, Gwalior (September 20, 2023).
33. Sh. Avnindra Kumar, Additional Municipal Commissioner & Dr. Shashi (Horti. Officer) , LMC (Local Municipal Corporation) (September 25, 2023).
34. Dr. D.K. Sharma, Former Director, ICAR-CSSRI, Karnal (September 29, 2024)
35. Dr. R.M. Sundaram, Director, ICAR-Indian Institute of Rice Research, Hyderabad (September 29, 2024)
36. Sh. Satish Kumar Singh, Senior Export Advisor, Ex. Export Manager, Mandi Parishad, U.P., Utkrisht Krishi Producer Company Ltd. (FPC), Lucknow (October 03, 2023)
37. Prof. Saba Siddiqui, Head Department of Agriculture, Integral Institute of Agricultural Science and Technology (October 31, 2023).
38. Sh. Anjaney & Sh. Anup (TSG), Directorate of Horticulture, Govt. of Bihar (November 16, 2023).

Visit of Dr. Himanshu Pathak, Secretary (DARE) and Director General (ICAR) (April 15, 2023)

Visit of Dr. R.K. Pal, Advisor, FSSAI and Former Director, ICAR-NRC Pomegranate, Solapur, Dr. V.B. Patel, ADG, Fruit & Plantation Crops, ICAR, New Delhi, Dr. B. K. Pandey, Former ADG, Horticulture ICAR, N. Delhi (April 28, 2023)

Visit of Dr. A.K.Singh, DDG (Hort) ICAR, New Delhi (May 16, 2023)

Dr. Major Singh, Member, Agricultural Scientists Recruitment Board, ICAR, New Delhi (June 01, 2023)

Visit of Chairman, RAC, Dr. N. Kumar, Former Vice Chancellor, TNAU, Tamil Nadu and RAC Members, Dr. Jai Singh (Ex. Director, ICAR-CIPHET, Ludhiana), Dr. Ambika B. Gaikwad (Pr. Scientist, ICAR-NBPGR, New Delhi), Dr.V.B. Patel (ADG, F&PC), Shri Indra Prakash Singh and Shri Jagmohan Singh Chand

Visit of Dr. Neeru Bhoosan, ADG (IPTM) ICAR New Delhi, (October 03, 2023)

Dr. R.M. Sundaram, Director, ICAR-Indian Institute of Rice Research, Hyderabad (September 29, 2024)

Dr. D.K. Sharma, Former Director, ICAR-CSSRI, Karnal (September 29, 2024)

15 Meteorological Parameters (CISH)

(January to December 2023)

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	19.6	6.1	83.3	63.4	4.6	1.8	21.8	0.0	-	4.9
February	27.8	8.6	83.0	64.7	8.1	2.3	19.5	0.0	-	5.9
March	31.6	14.0	84.2	64.3	7.4	2.5	19.9	41.6	3	6.2
April	35.9	16.95	73.9	55.1	8.7	2.8	18.8	43.0	2	7.1
May	37.6	20.8	68.1	54.0	9.5	2.9	20.7	44.8	3	8.7
June	38.7	25.5	67	45.5	8.24	4.4	18.5	75.2	4	9.2
July	33.9	26.4	95.4	72	5.4	3.2	24.0	371.3	13	6.7
August	33.8	26.0	95.2	71.9	4.7	2.8	21.1	255.8	5	6.4
September	33.9	25.2	94.8	67.1	5.4	2.5	23.3	212.8	3	6.8
October	33.0	22.0	94.4	71.5	7.7	1.8	20.8	0.0	-	7.0
November	28.7	12.2	88.8	67.9	4.5	0.7	20.8	0.0	-	5.7
December	23.7	8.5	81.9	61.1	4.4	1.0	19.4	32.2	2	4.4
								1076.7	35	

- Meteorological data recorded during January to December 2023 at the Institute's observatory indicated mean monthly maximum temperature 38.7° C was recorded during the month of June. Similarly mean monthly minimum temperature 6.1°C was recorded during the month of January.
- Maximum mean relative humidity 95.4% was recorded in July month and minimum mean 45.5% was recorded in June month. Average wind speed of 0.7 to 4.4 km/hr and average bright sunshine hours of 4.4 to 9.5 hours were also recorded. Average range of evaporation 4.4 to 9.2 mm recorded in December and June months, respectively. Total annual rainfall of 1076.7 mm received and distributed over 35 number of rainy days during the year 2023. The highest precipitation 371.3 mm was recorded in July 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.

NOTES

भाकृअनुप
ICAR

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