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भा.कृ.अनु.प.-केन्द्रीय उपोष्ण बागवानी संस्थान

ICAR-Central Institute for Subtropical Horticulture

रहमानखेड़ा, लखनऊ / Rehmankhera, Lucknow

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Annual Report
2021

भा.कृ. अनु.प.-केन्द्रीय उपोष्ण बागवानी संस्थान

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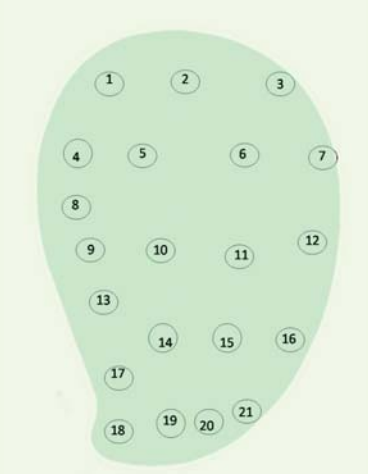

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Preface

I am delighted to present the Annual Report of ICAR-Central Institute for Subtropical Horticulture, for the year 2021. COVID-19 pandemic during past two years has reinforced the importance and enhanced the demands of fruits and vegetables owing to their immunity boosting characteristics. Recently, fruit producers have observed the effect of climate change on fruit crop production and pest and disease incidence pattern. One of the emerging issues where research is focused, is on the management of erratic flowering and thrips incidence in mango as affected by climate change.

Institute carried out research on various aspects of fruit improvement, production, protection and post harvest under various flagship/externally funded and Institute based projects. There are 775 mango germplasm collections in Institute field gene bank. Molecular study of 20 SSR markers colocated in gene sequences related to flowering, peel colour, transcription and translation process have been validated in standard mango genotypes. Similarly survey, evaluation and selection program was carried out in guava, aonla and other mandate crops. Canopy architecture management revealed their significance by higher yield of 'A' grade fruits. Modified banding technique was found useful in managing mealy bug of mango. In post harvest, series of products including aonla herbal dispersible tablet, strawberry and karonda based products were developed.

The institute has accorded prioritization to the innovation and IP protection within the gambit of our mandate. One IP was granted for 'CISH Trap-2' (solar opeated agriculture insect trap), while two patents have been filed for 'CISH Glue Trap' and 'Bioimmunized tissue culture technology'. Copyright was granted for bilingual mobile app on 'Processed Products of Bael' and 8 more copyright applications were submitted that are aimed to support stakeholders in processing sector. Institute has signed MoU with various private partners for commercialization of seven institute technologies. The institute amplified horticulture based entrepreneurship opportunities by hosting several brainstorming sessions, orientation programs for ABI-entrepreneurs, interface mettings, Buyer-Seller programs and also through establishment of the ABI facilities. On farm entrepreneurship for nursery raising was a win-win experiment for the institute and benefeciaries from the landless category.

Institute catered to its stakeholders that include small and marginal farmers and disadvantaged groups by facilitating input delivery and technical support through various schemes like NEH plan and SCSP. Twenty training programs and exposure visits were organized for extension officers, farmers, agriculture officers and students from several states, in which the institute technologies were popularized. Emphasis was given to government flagship schemes of Mera Gaon Mera Gaurav, wherein more than 23 awareness campaigns and demonstrations were conducted. Swachh Bharat Abhiyaan was carried out in many villages and the institute premises to carry forward the momentum generated in last few years. Farmers Fair was celebrated in the month of March, wherein more than 600 farmers participated. Around 1.7 lakh grafts of various fruits were produced during the year and distributed to the stakeholders that is an important step in providing superior planting materials. The institute is taking forward its organic research through Paramparagat Krishi Vikas Yojna (PKVY) by on-farm production of organic inputs and their characterization. Integrated Bee Development Centre in RRS Malda has made some remarkable strides in honey production and its quality analysis.

I appreciate the efforts of Dr. S. Rajan (Former Director) and Heads of the Divisions and institute staff for their contributions in the report. I am indebted to Dr. T. Mohapatra, Secretary DARE and DG, ICAR, and Dr. A.K. Singh, DDG (Horticultural Sciences), ICAR, and others in SMD for their continued support and guidance.

Place: Lucknow

Date : 12 July, 2022

Neelima Garg

(Neelima Garg)
Director

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कार्यकारी सारांश / Executive Summary

वर्ष 2021 के दौरान, आम की 09 किस्मों को मलिहाबाद के किसानों के बाग से एकत्र किया गया, जिससे फील्ड जीन बैंक में आम का कुल 775 जननद्रव्य संकलन हो गया है। आम की 27 किस्मों और 11 संकर किस्मों के गूदे में कुल कैरोटेनॉयड्स, फिनोल, फ्लेवोनोइड्स और एंटीऑक्सिडेंट्स की मात्रा का आंकलन किया गया। प्रजाति की तुलना में संकरों में उच्च कैरोटीनॉयड, फिनोल, फ्लेवोनोइड और एंटीऑक्सिडेंट पाए गए। लगभग 136 जननद्रव्य संकलनों की फल विशेषताओं का आंकलन किया गया, जिनमें से फलों के वजन में सबसे अधिक विभिन्नता पायी गयी। इसी तरह, फलों के वजन, फलों की लंबाई, फलों की चौड़ाई, गुठली का वजन, गुठली की लंबाई, चौड़ाई, कुल घुलित शर्करा (टी.एस.एस.) और गूदा प्रतिशत के लिए लगभग 349 संकरों का मूल्यांकन किया गया। अंबिका हाफ सिब (29) और अरुणिका हाफ सिब (50) का मूल्यांकन फल की गुणवत्ता के आधार पर किया गया और फलों के वजन, गूदा प्रतिशत और टी.एस.एस. में भिन्नताएं पाई गईं। वर्ष के दौरान 24 संकर संयोजन में 15550 पुष्पगुच्छ का संकरण में उपयोग हुआ। अरुणिका × मल्लिका के संयोजन में अधिकतम फलों का विकास हुआ और आम्रपाली × टॉमी एटकिंस में 80% से अधिक अंकुरण सफलता मिली। पुष्पन, फल के छिलके के रंग, जीन प्रतिलेखन–जीन अनुवाद प्रक्रियाओं और अजैविक तनाव प्रतिक्रिया से संबंधित जीन अनुक्रमों में सह–स्थित लगभग 20 एस.एस.आर. मार्करों को मानक पीसीआर द्वारा विभिन्न आम की प्रजातियों में मानकीकरण किया गया और ई.एस.टी. –एस.एस.आर. का जीन भंडारण में निक्षेप किया गया। द्वि–आयामी वैद्युतकण संचलन आधारित प्रोटिओम विश्लेषण द्वारा आम के पुष्पण संबंधी प्रोटीन की पहचान करी गयी। शीर्षस्थ पुष्पण और वानस्पतिक विभज्योतक के ट्रांसक्रिप्टोम तथा आरएनए अनुक्रमण का तुलनात्मक अध्ययन और जीन अभिव्यक्ति विश्लेषण भी किया गया। दशहरी में प्रमुख माइक्रो आरएनए और उनसे संबंधित लक्ष्यों की अभिव्यक्ति की स्थिति की पहचान भी सुनिश्चित हुई।

इसी प्रकार अमरूद के उत्कृष्ट जननद्रव के संकलन के लिए सर्वेक्षण, मूल्यांकन और चयन कार्यक्रम चलाया

During the year 2021, 09 mango varieties (scions) from farmer's orchards of Malihabad region of Uttar Pradesh were collected for augmentation of genetic resources. Thus making a total of 775 mango accessions in the field gene bank. The total carotenoids, phenols, flavonoids and antioxidants were quantified in the pulp of 27 mango varieties and 11 mango hybrids. Hybrids were found to have higher carotenoids, phenols, flavonoids and antioxidants as compared to varieties/ cultivars. Around 136 accessions were characterized for fruit traits among which fruit weight (FW) trait differed most significantly. Similarly, around 349 hybrids were evaluated for their fruit weight, fruit length, fruit breadth, stone weight, stone length, stone breadth, stone thickness, Total Soluble Sugar (TSS) and pulp per cent. A total of 29 Ambika half sibs and 50 Arunika half sibs were evaluated for its fruit quality traits and were found to show variations in fruit weight, pulp percent and TSS. Hybridization of 15550 panicles were done in 24 cross combinations. Fruits were set maximum in the cross combination of Arunika × Mallika followed by Amrapali x Tommy Atkins with more than 80% germination success was achieved in the later hybrid progeny. About 20 SSR markers co-located in gene sequences related to flowering, peel color, transcription and translation processes and stress response were validated in different mango genotypes using standard PCR assay and deposited in EST- SSR repository. Two dimensional electrophoresis based proteome analysis of leaf proteins of flowering shoot of mango cv. Dashehari revealed differential expression of proteins associated with flowering. Comparative differential gene expression analysis of both transcriptome and small RNA sequencing of FBD and VBD of mango cv. Dashehari, facilitated identification of expression status of key miRNAs and their corresponding targets.

Likewise, survey, evaluation and selection program was carried out and 12 elite guava

गया तथा उत्तर प्रदेश के प्रयागराज और फर्रुखाबाद जिलों से 12 अभिजातीय अमरूद के जीनोटाइप एकत्र किए गए, जिससे फील्ड जीन बैंक में कुल 150 संकलन हो गए हैं। फलों की गुणवत्ता विशेषताओं के आधार पर कुल 28 अमरूद की किस्मों का मूल्यांकन किया गया, जो कि फलों के वजन, टी.एस.एस. और बीज कठोरता जैसे लक्षणों के लिए समृद्ध जीनोटाइपिक भिन्नता को दर्शाता है। अमरूद की 'पुर्तगाल' किस्म में अधिकतम बीज की कठोरता (16.30 किग्रा/सेमी^{2}) और 'बेहत कोकोनट' किस्म में न्यूनतम (9.17 किग्रा/सेमी^{2}) पायी गयी। फलों की गुणवत्ता के लक्षणों के आधार पर कुल 117 संकर पौध की विशेषता का आंकलन हुआ। हाफ–सिब संकरों के मूल्यांकन से पता चला कि कुछ लाल गूदे वाली संकर किस्में फलों के वजन, टी.एस.एस. और बीज कोमलता के लिए आशाजनक थी। संकरों जैसे कि R24-P493, R13-P271, A13-P269 और R14-P280 में अधिक फल वजन, उच्च टी.एस.एस. एवं कोमल बीज पाये गए। अमरूद की 'झेंशु' प्रजाति के जीनोम से 80 जीनोमिक एस.एस.आर. की पहचान और विकास किया गया। इन एस.एस.आर. को अमरूद के 28 अन्य जननद्रव्य संकलनों में पुष्टि की गयी, जिसमें किस्में, संकर और *सिडियम* प्रजाति शामिल थीं। अमरूद के बीज के ट्रांसक्रिप्टोम डेटा से बी.एच.एल.एच., एम.वाई.बी., एन.ए.सी. से युक्त लगभग 60 अनुलेखन कारक कुलों की पहचान की गई जो आगे जीन अभिव्यक्ति अध्ययन के लिए उपयोग किए जा सकते हैं। फील्ड जीन बैंक में संरक्षित 20 जामुन के जननद्रव्य संकलनों का मूल्यांकन वृक्ष वृद्धि लक्षणों एवं फलों की गुणवत्ता विशेषताओं के लिए किया गया। उच्च फल भार (15.32 ग्राम), गूदा (90.60%), टी.एस.एस. (13.4 ब्रिक्स) और फल उपज (66.0 किग्रा/पेड़) के आधार पर, 13 वर्ष की आयु में जे–15 किस्म को आशाजनक पाया गया। छत्र की केन्द्र खुली प्रणाली में अधिकतम फल उपज (80.00 किग्रा/पौधे) बिना कटाई–छटाई वाले पौधे (50.00 किग्रा/पौधे) की तुलना में उत्तम पायी गयी।

पंद्रह बेल के जननद्रव्य संकलनों का उनके भौतिक–रासायनिक मापदंडों के लिए विश्लेषण किया गया। समग्र मूल्यांकन के आधार पर 13 वर्ष के एक जननद्रव्य संकलन 'टी–37' को सबसे अधिक आशाजनक पाया गया। बारह बीजू जननद्रव्य जो वर्ष 2021 के दौरान फलन में आए थे, उनके फलों का भौतिक–रासायनिक मापदंडों के आधार पर मूल्यांकन किया गया, जिनमें से दो बीजू जननद्रव्य संकलनों 'एस–31' तथा 'एस–57'

genotypes were collected from Prayagraj and Farrukhabad districts of Uttar Pradesh. Thus making a total of 150 field gene-bank collections. A total of 28 guava accessions were evaluated using fruit quality attributes which indicated rich genotypic variation for traits like fruit weight, TSS and seed hardiness. Seed hardiness was found to be minimum (9.17 kg/cm^2) in 'Behat Coconut' and the maximum (16.30 kg/cm^2) in 'Portugal' veriety. A total of 117 hybrid seedlings were characterized using the fruit quality traits. Evaluation of half-sib population revealed that some red pulp hybrids were promising in terms of fruit weight, TSS and seed softness. Hybrids R24-P493, R13-P271, A13-P269 and R14-P280 had higher fruit weight, high TSS and soft seeds. Eighty genomic SSRs identified and developed from guava genome *cv.* 'Zhenshu' were validated in 28 other guava germplasm accessions which included varieties, hybrids and *Psidium* species. About 60 transcription factor families comprising of bHLH, MYB, NAC were identified in the transcriptome data of guava seed which could be further used for gene expression studies. Evaluation of 20 jamun accessions, being maintained in the field gene bank, was done for tree growth traits and fruit quality attributes. Based on the higher mean fruit weight (15.32 g), pulp content (90.60%), TSS (13.4 ºBrix) and fruit yield (66.0 kg/tree), accession J-15 was found to be promising on 13th years of age. Open center system of canopy recorded maximum fruit yield /plant (80.00 kg/plant) compared with control (50.00 kg/plant).

Fifteen bael germplasm accessions were analysed for their physico-chemical parameters. On the basis of overall assessment one accession *viz.*. 'T-37' was found to be most promising at the age of thirteen year. Twelve seedling germplasm which came to bearing during 2021 were evaluated for their physico-chemical parameters among which two seedling germplasm accessions i.e., 'Seedling S-31' and 'Seedling S-57' were found to

सबसे अधिक आशाजनक पाए गए। एनसीबीआई डेटाबेस से प्राप्त एस.आर.ए. अनुक्रमों से लगभग 300 अपूर्ण एस.एस.आर. (आई.एस.एस.आर.) की खोज की गई और लगभग 100 एस.एस.आर. प्राइमर डिजाइन किए गए जिनका बेल के एस.एस.आर. फिंगर प्रिंटिंग के लिए सत्यापन चल रहा है। आंवला में समग्र प्रदर्शन के आधार पर 3 जननद्रव्य संकलन अर्थात 'टी–7', 'टी–8' और 'टी–9' आशाजनक पाए गए। किस्म सी.आई.एस.एच. A–31 एवं सी.आई.एस.एच. A–33 को विटामिन 'C' और कुल फिनोल के उपलब्धता के आधार पर सबसे ज्यादा आशाजनक पाया गया।

एक अस्थायी विसर्जन बायोरिएक्टर के डिजाइन मापदंडों की पहचान की गई है जिसे केले और पपीते के *इन विट्रो* गुणन के लिए उन्नत किया जाएगा। केले की जी–9 किस्म के उत्पादन के लिए एक कम लागत वाली वायवीय अस्थायी विसर्जन प्रणाली को 2 लीटर के 4 टैंकों के साथ डिजाइन और निर्मित किया गया है। बायोरिएक्टर प्रणाली में केले की गुणन दर 4 गुना अधिक थी। त्वरित पत्ती क्षेत्र मापन सॉफ्टवेयर जो विगत वर्षों में पत्ती क्षेत्र के मापन के लिए विकसित किया गया था, उसे पत्ती के किनारों के विवर्ण को ध्यान में रखते हुए परिष्कृत किया गया तथा R^2 का मान 0.994 पाया गया जिससे इसकी वैधता सिद्ध होती है।

वृक्षों की विभिन्न छत्र संरचना के प्रबंधन से दशहरी प्रजाति के आम में वृद्धि की विशेषताओं से यह पता चला कि वृक्षारोपण के छह वर्ष बाद अनुपचारित पौधों की तुलना में टी–3 वृक्षों (काट–छाँट से तैयार किए गए 3 प्राथमिक और 3 सहायक शाखाओं वाले पौधों) में सबसे अधिक 'ए' श्रेणी के फल (84.53 प्रतिशत) तथा दुगुनी से अधिक उपज हुई। आम की किस्म दशहरी में सघन रोपण प्रणाली की छत्र पुनरभिविन्यास के दौरान अधिकतम फल (54.28 प्रति पेड़) 2.5 मीटर × 5.0 मीटर की दूरी वाले पेड़ों में दर्ज किए गए, जिनकी औसत उपज 11.99 कि.ग्रा. प्रति पेड़ थी, भले ही छँटाई की ऊंचाई कुछ भी हो। जीर्णोद्धार के लिए आंकलन किए गए 6 उपचारों में सबसे अच्छी कार्यनीति उपचार टी–5 थी, जिसमें मुख्य तने की सघनता को कम करना शामिल था, इस प्रक्रिया को 3 साल में पूरा करने हेतु प्रति वर्ष दो शाखाओं के शीर्ष भाग को हटा दिया जाता है। विभिन्न छोटे आकार के फलदार पौधों जैसे कि अमरूद की किस्में श्वेता, ललित एवं धवल, शरीफा की किस्में एटमोया × अलानगर एवं अर्का सहान, बेर की

be most promising. Around 300 imperfect SSRs (iSSR) were predicted to from SRA sequences obtained from NCBI database and around 100 SSR primer pairs were designed and validation is underway for SSR fingerprinting of Bael germplasm accessions. In aonla, on the basis of overall performance, 3 accessions i.e., 'T-7', 'T-8' and 'T-9' were found promising. CISH- A-31 and CISH- A-33 verieties were found to be most promising having high content of vitamin 'C' and total phenol.

Design parameters have been identified of a temporary immersion bioreactor which will be upscaled for *in vitro* multiplication of banana and papaya. A low cost pneumatic temporary immersion system has been designed and built with a 4 tanks of 2 liter each for production of banana sucker of variety G-9. Multiplication rate (MR) of banana was 4 times higher in bioreactor system. Quick Leaf Area Software that was developed in previous years for measurement of leaf area was refined by taking into consideration of discoloration of border area. The R^2 value was found to be 0.994, that will aid in its validity.

Growth attributes in mango cv. Dashehari as affected by different canopy architecture management revealed highest number of 'A' grade fruits (84.53%) and more than double yield in T3 (plants trained to 3 Primary and 3 secondary branches) compared to control (six years after planting). In canopy re-orientation of high-density planting system of mango cv. Dashehari, irrespective of pruning heights, maximum fruits (54.28/tree) were recorded in trees of 2.5 m × 5.0 m spacing with average yield of 11.99 kg/tree. Among 6 treatments evaluated for rejuvenation, best strategy was treatment T5 involving thinning out of central leader, two branches/year and one branch/year were headed back to complete the process in 3 years. Different short statured fruit crops viz., guava cvs. Shweta, Lalit and Dhawal, custard apple cvs. Atemoya × alanagar and Arka Sahan, ber cv. Apple Ber,

किस्म सेब बेर, अनार की किस्म भगवा तथा ड्रैगन फल (*हायलोसेरियस कोस्टारेसेनसिस*) का जीर्णोद्धारित बागों में भराव फसलों के रूप में उनके प्रदर्शन हेतु आंकलन किया गया और प्रारंभिक अध्ययन में अमरूद की किस्म श्वेता सबसे अच्छी प्रतीत होती है।

आम की किस्मों लंगड़ा, लखनऊ सफेदा, बॉम्बे ग्रीन, दशहरी, मल्लिका और आम्रपाली में विभिन्न फीनोलॉजिकल चरणों के दौरान प्रकाश (प्रत्यक्ष और विसरित) और गैस विनिमय मापदंडों की उपलब्धता में महत्वपूर्ण भिन्नता पाई गई। स्वस्थ और आंतरिक विगलन जैसे विकार प्रभावित दशहरी आम के गूदे के जैव रासायनिक विश्लेषण से स्वस्थ गूदे की तुलना में प्रभावित गूदे में अल्फा–एमाइलेज, सेल्युलेज और पॉलीफेनोल ऑक्सीडेज की अधिकतम गतिविधि का पता चला। पेड़ों की मुख्य तने एवं आंतरिक शाखाओं की छँटाई के दो साल उपरांत, इनके नीचे प्रत्यक्ष प्रकाश की उपलब्धता में वृद्धि हुई तथा पत्तियों का क्लोरोफिल तत्व, कार्बन डाइऑक्साइड की कुल एकत्रीकरण दर, रंध्र प्रवाहकत्त्व एवं वाष्प दबाव की कमी में सुधार हुआ। मेलाटोनिन उपचारित पेड़ों (100 माइक्रोमोलर की दर से) तथा अनुपचारित (असिंचित) पौधों में 'ए' ग्रेड (फलों का वजन ≥ 250 ग्रा.) के फलों की उपज में एक मौलिक अंतर पाया गया। टपक सिंचाई पद्धति तथा पोषक तत्व निर्धारण ने अति–घनत्व वाले वृक्षारोपण के तहत आम्रपाली प्रजाति की आम की वृद्धि, उपज और गुणवत्ता को प्रभावित किया। सघन बागवानी पर एक प्रयोग में, अम्बिका एवं आम्रपाली प्रजाति के आम में पेड़ों की पंक्तियों के बीच तथा पंक्ति के भीतर छत्र का औसत फैलाव सबसे अधिक पाया गया। आम्रपाली आम को रोपण के 5 वर्ष बाद उपज (10.53 टन प्रति हेक्टेयर) की दृष्टि से श्रेष्ठ पाया गया।

अमरूद की किस्में ललित, श्वेता व लालिमा को सघन बागवानी के तहत लगाया गया और एस्पालियर संरचना प्रणाली के तहत काट–छाँट किया गया, जिससे ललित और लालिमा (क्रमशः 78.30 और 65.30 मि.मी.) में मुख्य तना की अधिकतम परिधि प्रदर्शित है। छँटाई के दो साल बाद, कुल प्रकाश उपलब्धता, दक्षिण दिशा में पौधे की केंद्रीय शाखाओं की छँटाई (खुली प्रणाली) में 26.33 प्रतिशत तथा अनुपचारित पौधों में 53.89 प्रतिशत थी जबकि उत्तर दिशा में खुली प्रणाली में केवल 21.39 प्रतिशत और अनुपचारित पौधों में 46.85 प्रतिशत थी। बेल की दस किस्मों (सी.आई.एस.एच. बी–1, सी.आई. एस.एच. बी–2, एन. बी–5, एन. बी–9, एन. बी–16, एन.

pomegranate cv. Bhagwa and dragon fruit (*Hylocereus costarecensis*) were assessed for their performance as filler crops in rejuvenated orchards and guava cv Shweta seems to be best in the preliminary studies.

Significant variation in availability of light (direct and diffuse) and gas exchange parameters was found during different phenological stages in mango cvs. Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali. Biochemical analysis of healthy and 'Jelly-seed' affected mango cv. Dashehari pulp revealed higher activity of α-amylase, cellulase and polyphenol oxidase in affected pulp as compared to healthy pulp. Two years after centre opening, direct light availability beneath the trees increased, leaf chlorophyll content, net assimilation rate, stomatal conductance and vapour pressure deficit were improved. A radical difference was found in the yield of 'A' grade fruits (fruit weight ≥ 250g) in melatonin treated trees (@ 100 μM) (39%) compared to control plants (un-irrigated). Drip irrigation and nutrient scheduling influenced the growth, yield and quality of mango cv. Amrapali under high density plantation (HDP). In an experiment on high density orcharding, average canopy spread within row and between rows were found maximum in Ambika and Amrapali. Amrapali was found superior in terms of yield (10.53 t/ha) at 5 years after plantation.

Guava cv. Lalit, Shweta and Lalima planted under high density plantation and trained at espalier architecture system significantly exhibited maximum trunk girth in Lalit and Lalima (78.30 and 65.30 mm, respectively). Two years after pruning, total light availability was 26.33 per cent in control to 53.89 per cent in open system in south direction whereas only 21.39 per cent in control to 46.85 per cent in open system in north direction. Ten bael cultivars (CISH B-1, CISH B-2, NB-5, NB-9, NB-16, NB-17, Pant Aparna, Pant Shivani, Pant Sujata and Pant

बी–17, पंत अपर्णा, पंत शिवानी, पंत सुजाता और पंत उर्वशी) का आंकलन फलों के गिरने तथा शीत तनाव प्रतिरोध के लिए किया गया। सर्दियों के दौरान अधिक फल गिरने वाली किस्मों में ठंड के तनाव के कारण वृक्षों की छत्र को अधिक क्षतिग्रस्त पाया गया। ठंड के तनाव से एन. बी–16 और सी.आई.एस.एच बी–1 के वृक्षों का छत्र सबसे कम प्रभावित (लगभग 5 प्रतिशत) पाया गया, जबकि सी.आई.एस.एच बी–2 में यह सबसे अधिक (लगभग 40 प्रतिशत) प्रभावित हुआ, उसके बाद पंत शिवानी और एन. बी–17 (लगभग 35 प्रतिशत) का स्थान रहा। आड़ू की किस्में फ्लोर्डाप्रिंस, अर्लीग्रांडे, प्रताप और सहारनपुर प्रभात लखनऊ के उपोष्ण कटिबंधीय जलवायु के तहत उपयुक्त पाई गईं। उत्तर प्रदेश में लखनऊ के रहमानखेड़ा से क्रमशः *स्यूडोमोनास प्लेकोग्लोसिसिडा* और *एसिनेटोबैक्टर बेरेजिनिये* के रूप में पहचाने जाने वाले दो राइजोबैक्टीरिया उपभेदों आर–4 एवं आर–7 में पौधों की वृद्धि को बढ़ावा देने वाले गुण पाए गए और साथ ही दो अलग–अलग पादप रोगजनक कवक (*फ्यूजेरियम ऑक्सीस्पोरम* एमटीसीसी–284 और *पाइथियम* प्रजाति एमटीसीसी–10247) के खिलाफ विरोधी पाए गए।

पूरे वर्ष आम में, भुनगा, थ्रिप्स, लीफ वेबर्स और सेमीलूपर्स की जनसंख्या की गतिशीलता देखी गई। हॉपर की अत्यधिक आबादी पहले 13वीं एसएमडब्ल्यू और फिर 29वें एसएमडब्ल्यू में पाई गई। थ्रिप्स की अत्यधिक आबादी 13वें एसएमडब्ल्यू (मार्च के सप्ताह) के दौरान देखी गई, जबकि लीफ वेबर की अत्यधिक आबादी 31वें एसएमडब्ल्यू में 0.75 जाले/पेड़ के साथ देखी गई। सेमीलूपर (*हाइपोसिड्रा तालाका*) का प्रकोप 13 से 26वें एसएमडब्ल्यू के बीच देखा गया जिसमें 19वीं एसएमडब्ल्यू के दौरान सबसे अधिक संख्या पाई गई। रोगों की गतिशीलता के लिए लखनऊ, सीतापुर, लखीमपुर खीरी, हरदोई, शाहजहांपुर, बरेली, मुरादाबाद, बिजनौर और मेरठ जिलों में आम के बागों का सर्वेक्षण किया गया। फरवरी महीने में लखनऊ, सीतापुर और लखीमपुर जिलों के विभिन्न स्थानों पर ब्लॉसम ब्लाइट, पुष्प विकृति, लीफ एन्थ्रेक्नोज और सूटी मोल्ड का मध्यम से गंभीर प्रकोप देखा गया जबकि पाउडर फफूंदी और बैक्टीरियल लीफ ब्लाइट का प्रकोप कम पाया गया। जुलाई के महीने में मुरादाबाद, बिजनौर और मेरठ जिलों में आम की लंगड़ा और चौसा किस्मों में उकठा रोग (15% बाग) और टहनी सूखने (22.5% बाग) की समस्या पाई गई। लंगड़ा और चौसा आम

Urvashi) were evaluated for fruit drop and cold stress resistance. In cultivars having more fruit drop during winter, canopy was found to be more damaged due to cold stress. Canopy of NB-16 and CISH-B1 was found to be least affected by cold stress (5% approx) whereas in CISH B-2, it was most affected (40% approx) followed by Pant Shivani and NB-17 (35 per cent approx). Peach cvs. Flordaprince, Earligrande, Pratap and Saharanpur Prabhat were found suitable under subtropical climate of Lucknow. Two rhizobacterial strains R4 and R7 identified as *Pseudomonas plecoglossicida* and *Acinetobacter bereziniae* respectively from Rehmankhera, Lucknow, Uttar Pradesh were found to have plant growth promotion properties as well as was antagonistic against two different plant pathogenic fungi (*Fusarium oxysporum* MTCC – 284 and *Pythium* spp. MTCC – 10247).

In mango, the population dynamics of leafhoppers, thrips, leaf webbers and semiloopers were monitored throughout the year. The hopper population was observed in two peaks, the first peak was recorded during the 13th SMW and the second during the 29th SMW. Thrips peak population was observed during the 13th SMW (week of March) while peak leaf webber incidence was observed 31st SMW with 0.75 webs/tree. The incidence of semilooper (*Hyposidra talaca*) was observed between the 13th to 26th SMW with peak during 19th SMW. A survey of mango orchards were conducted in Lucknow, Sitapur, Lakhimpur Kheri, Hardoi, Shahjahanpur, Bareilly, Moradabad, Bijnor, and Meerut districts for disease dynamics. Moderate to the severe incidence of blossom blight, floral malformation, leaf anthracnose, sooty mould and low incidence of powdery mildew and bacterial leaf blight were recorded at various locations in Lucknow, Sitapur, and Lakhimpur districts during February. Increased incidence of wilt (15% orchards) and twig drying (22.5% orchards) was observed in Moradabad, Bijnor,

के फलों पर बिजनौर और मेरठ जिलों में बैक्टीरियल कैंकर की घटना दर्ज की गई। *लोरेन्थस* की उपस्थिति लखनऊ जिले में (11.2%) उच्च और अन्य जिलों में (2.0–3.8%) निम्न दर्ज की गई।

रहमानखेड़ा, लखनऊ में फूल आने के दौरान खर्रा रोग का प्रकोप एवं गंभीरता 2.5–5.0 पीडीआई के साथ कम दर्ज की गई। ब्लॉसम ब्लाइट का प्रकोप 9वें एसएमडब्ल्यू में लगभग 100% पाया गया और 11वें एसएमडब्ल्यू में सबसे अधिक गंभीरता (57.0 पीडीआई) दर्ज की गई। रहमानखेड़ा में जून के दूसरे पक्ष से फल तुड़ाई तक आम की किस्म "मल्लिका" के फलों में शोल्डर ब्राउनिंग रोग का प्रकोप देखा गया।

उत्तर प्रदेश से विभिन्न बागों से लायी गई उकठा रोग से संक्रमित आमों की जड़ों के पास की मिट्टी से आम में उकठा रोग के कारक (*सिराइटोसिस्टिस फिम्ब्रियता*) के पीसीआर हेतु प्राइमर (-F-$^{5'}$TAGTGAGATGAATGCTGTTTTGGTG-$^{3'}$; CF-R1-$^{5'}$AAAAGTTGAGCGGGTTTAGCGGC-$^{3'}$) बनाये गए। आम की किस्म बंगलोरा के फलों के धब्बे की कारकी फफूंद *कोलेटोट्रिचम ग्लियोस्पोरोइड्स, अल्टरनेरिया* स्पी और एक नई कवक *पैरासिम्पोडिएला यूकेलिप्टी* (OM442435) के रूप में पहचान की गई। उकठा रोग से ग्रसित आम के पेड़ों से मिलने वाले कवक *लेसीओडिप्लोडिया थियोब्रोमे* की रोगजनकता की पुष्टि की गई। राइजोस्फेरिक प्रतिपक्षी जीवाणु (पीसीईबी–5, पीसीईबी–8, जीआरएसबी–21, बीआरएसबी–1, जीआरएसबी–10बी, जीआरएसबी–15ए, और जीईबी–16बी) और कवक (ट्राइको–के और ट्राइको–एफ) द्वारा उत्पादित वाष्पशील कार्बनिक यौगिकों की *बर्कलेयोमाइसेस बेसिकोला* के लिए विरोधी प्रभाव का दोहरे पेट्री डिश प्रणाली से निरीक्षण किया गया। कवक आइसोलेट्स (ट्राइको–के और ट्राइको–एफ, ट्राइकोडर्मा प्रजाति) द्वारा सौ प्रतिशत तक कवकजाल का निषेध प्राप्त किया गया। जीवाणु प्रतिपक्षी आइसोलेट्स में बीआरएसबी–1 द्वारा सबसे अधिक कवकजाल अवरोध प्राप्त किया गया।

संशोधित बैंडिग तकनीक का मैंगो मिलीबग नियंत्रण के लिए मूल्यांकन किया गया और संशोधित तकनीक सेलोटेप बैडिंग बिना ऊपरी प्रतिबंध के (1.04 मिलीबग/बड), नियंत्रण (control) की तुलना में अधिक प्रभावी पायी गयी (23 मिलीबग/बड)। थ्रिप्स का पहला

and Meerut districts during July. Incidence of bacterial canker was recorded in Bijnor and Meerut districts on fruits of mango *cvs.* Langra and Chausa. The incidence of *Loranthus* was recorded high (11.2%) in Lucknow district and low (2.0-3.8%) in other districts.

Incidence and severity of powdery mildew at Rehmankhera, Lucknow was recorded low in the flowering season of mango with PDI 2.5-5.0. Blossom blight incidence was recorded around 100% during 9th SMW and the peak severity (57.0 PDI) during 11th SMW. Incidence of shoulder browning disease in the fruits was recorded in *cv.* 'Mallika' during the second fortnight of June to till harvest at Rehmankhera.

A early detection PCR based assay was developed for detection of mango wilt pathogen (*Ceratocystis fimbriata*) using primers (-F-$^{5'}$-TAGTGAGATGAATGCTGTTTTGGTG-$^{3'}$; CF-R1-$^{5'}$AAAAGTTGAGCGGGTTTAGCGGC-$^{3'}$) from rhizospheric soil of wilted mango trees collected from different orchards of Uttar Pradesh (UP). *Colletotrichum gloeosporoides*, *Alternaria* spp. and a new fungal isolate identified as *Parasympodiella eucalypti* (OM442435) were isolated from fruit spots of mango cv. Bangalora. The pathogenicity of *Lasiodiplodia theobromae* isolated from the wood tissues of wilted mango trees was reconfirmed. Double Petri dish dual-culture assay was performed to observe the antagonistic effect of volatile organic compounds produced by rhizospheric antagonistic bacterial (PCEB-5, PCEB-8, GRSB-21, BRSB-1, GRSB-10b, GRSB-15a, and GEB-16b) and fungal (TrichoK and TrichoF) isolate on *Berkeleyomyces basicola*. Hundred percent of mycelial inhibition was obtained for fungal isolates (TrichoF and TrichoK, *Trichoderma* spp.). Among bacterial antagonistic isolates, the highest percent of mycelial inhibition was obtained in case BRSB-1.

Modified banding technology was evaluated for controlling of mealybug in mango. It was found that the modified method with cello tape banding without upper restriction (1.04) were more effective when compared to control (23

उद्भवन मार्च के अंतिम सप्ताह के दौरान देखा गया था, जिसके बाद अप्रैल के दूसरे सप्ताह में 296 थ्रिप्स/700 ग्राम मिट्टी के साथ सबसे अधिक उद्भवन दर्ज किया गया। प्रारंभ में आम के बाग़ में थ्रिप्स के खिलाफ चौदह कीटनाशकों का मूल्यांकन किया गया, जिनमें से एबामेक्टिन और एमामेक्टिन बेंजोएट उपचार प्रभावी पाए गए। अमोनियम एसीटेट (4%) को मादा फल मक्खियों को आकर्षित करने में बहुत प्रभावी पाया गया और 12 दिनों के भीतर 33 मादा फल मक्खी पकड़ी गई। फल मक्खियों के प्रति आकर्षण के लिए पौधों के अर्क का मूल्यांकन किया गया जिसमें वानस्पतिक अर्क ए (अप्रकाशित) सबसे अधिक प्रभावी पाया गया। लार्वा पैरासिटॉइड *ब्रैकॉन हेबेटर* द्वारा पत्ती के जालाकीट का 1 मीटर और 2 मीटर की दूरी पर 90 और 70 प्रतिशत क्रमानुसार उच्चतम परजीवीकरण दर्ज किया गया। खेत की परिस्थितियों में बीन फली छेदक *मरुका वित्रता,* (क्राबीड़ैः लेपिडोप्टेरा) के खिलाफ भी इस वानस्पतिक अर्क का मूल्यांकन किया गया। जैव नियंत्रण एजेंटों और कीटनाशकों का आम के तना छेदक (*बटोसेरा रूफोमाकुलाटा*) खिलाफ विरोधी क्षमता का मूल्यांकन किया गया और *बेवेरिया बेसियाना* के मामले में सबसे ज्यादा कीटडिंभों की मृत्युदर देखी गयी। फ्लॉपीरम 25 + ट्राइफ्लोक्सीस्ट्रोबिन 25 एससी/ 0.08% का स्प्रे ब्लॉसम ब्लाइट के प्रबंधन में सबसे प्रभावी पाया गया। ट्राइफ्लॉक्सीस्ट्रोबिन का रोगनिरोधी स्प्रे कटाई के समय शोल्डर ब्राउनिंग के प्रबंधन के लिए सबसे प्रभावी पाया गया। 200 किलो फल देने वाले 30 साल पुराने पेड़ पर इलाज का 70.00 रुपये खर्च होने का अनुमान लगाया गया।

अमरूद में, पूरे वर्ष कीट गतिविधि की निगरानी की गई। 31 से 51वें एसएमडब्ल्यू के दौरान फल मक्खियों का प्रकोप देखा गया। 33वें एसएमडब्ल्यू के दौरान 60.5 प्रतिशत व्यापकता के साथ कीट की सर्वाधिक व्यापकता दर्ज की गई। 16 से 46वें एसएमडब्ल्यू के दौरान अमरूद के फल छेदक की व्यापकता देखी गई। 43वें और 48वें एसएमडब्ल्यू के दौरान 40 संक्रमित कलियों/पेड़ों के साथ प्ररोह बेधक का चरम प्रकोप दर्ज किया गया। 14 से 25वें एसएमडब्ल्यू के दौरान सेमीलूपर पाए गए। 23वां एसएमडब्ल्यू 5.95 लार्वा/शूट के साथ चरम प्रकोप देखा गया। अमरुद में *फ्यूजेरियम ऑक्सीस्पोरम* और *मेलोइडोगाइन एंटरोलोबी* के कारण

mealy bugs /bud). The first emergence of thrips was observed during the last week of March with the peak emergence recorded at the second week of April with 296 thrips/ 700 g of soil. Initially, fourteen insecticides were evaluated against mango thrips under field conditions, among which Abamectin and Emamectin benzoate treatments were found effective. Ammonium acetate (4%) was found very effective in attracting female fruit flies with 33 female fruit fly catches within 12 days. Plant extracts were evaluated for attraction to fruit flies in which the highest number of male fruit flies was attracted in botanical extract A (undisclosed). The highest parasitization of leaf webber by larval parasitoid *Bracon hebetor* was recorded at 1 m and 2m distance with 90 and 70 per cent parasitization, respectively. The same was evaluated against filed bean pod borer, *Maruca vitrata,* **(**Crambidae: Lepidoptera) under field conditions. Biocontrol agents and insecticides were evaluated against mango stem borer *Batocera rufomaculata and* the highest mortality of the grubs observed in *Beuveria bassiana*. The spray of fluopyram 25 + trifloxystrobin 25 SC @ 0.08% was found most effective in managing the blossom blight. Prophylactic spray of Trifloxystrobin was most effective at the time of harvesting for managing shoulder browning. The cost of treatments was estimated to be Rs. 70.00 for bagging of fruits for a 30 years old tree yielding 200 kg fruits.

In guava, pest dynamics were monitored throughout the year**.** Incidence of fruit flies was observed in 31st to 51st SMW. The peak incidence of the pest was recorded during 33rd SMW with 60.5 percent incidence**.** Incidence of guava fruit borer was observed during 16th to 46 SMW. The peak incidence of shoot borer was recorded during 43rd and 48th SMW with 40 infested buds/ trees. Semilooper incidence was observed during 14th to 25th SMW. Peak incidence was observed 23rd SMW with 5.95 larvae /shoot. *Pseudomonas aeruginosa* and *Bacillus* spp. were the most

होने वाले उकठा रोग के प्रबंधन एवं पौधे के विकास की वृद्धि करने में *स्यूडोमोनास एरुजीनोसा* और *बेसिलस स्पी.* सबसे प्रभावशाली पाए गए।

फल मक्खियों की संख्या की गतिशीलता 32वें से 41वें एसएमडब्ल्यू तक दर्ज की गई। 32वें एसएमडब्ल्यू के दौरान फल मक्खियों की सबसे अधिक व्यापकता 6.40 प्रतिशत फलों की क्षति के साथ पायी गयी। इसी तरह, 32वें से 40वें एसएमडब्ल्यू तक ककड़ी के पतंगे की व्यापकता देखी गई। पतंगे की सर्वाधिक व्यापकता 33वें एसएमडब्ल्यू के दौरान 39.32 प्रतिशत के साथ दर्ज की गई थी। बेल में फल का गिरना एक गंभीर समस्या रही है, इसलिए रहमानखेड़ा में 24वें एसएमडब्ल्यू (जून 2021) के दौरान फलों के बनने के ठीक बाद से इसकी निगरानी की गई।

क्रोमैटोग्राफिक (एचपीएलसी) विश्लेषण से यह पता चला है कि आम की राइजोस्फीयर मिट्टी में (आम्रपाली किस्म) थायोमेथोक्सम के 0.2 एवं 2.0 ग्रा./ली. क्रमशः छिड़काव के 60 दिनों के बाद अपने प्रांरभिक स्तर 5.62 और 41.17 मिग्रा/किग्रा से अपघटित होकर 0.60 और 2.10 मिग्रा/किग्रा हो गया। आम के राइजोस्फीयर की मिट्टी में जीवाणुओं की जनसंख्या में वृद्धि एवं थायोमेथोक्सम के सतत क्षरण ने थायोमेथोक्सम का अपघटन करने वाले जीवाणुओं की उपस्थिति का संकेत दिया। आम की आठ किस्मों (बॉम्बे ग्रीन, एल्डन, बनेशान, शारदाभोग, किशनभोग, हिमसागर, फजरी और जरदालु) तथा दस संकर आम में तीन न्युट्रास्यूटिकल (लुपियॉल, मैंजीफेरिन और कैरोटीन) का पके आम के गूदे में आंकलन किया गया तथा संकर H-1042 को न्यूट्रास्यूटिकल मूल्यों में अच्छा पाया गया (β-कैरोटीनः 45.06 माइक्रोग्राम/ग्राम) आम्रपाली आम की पत्तियों में सबसे ज्यादा β-कैरोटीन (120.3 माइक्रोग्राम/ग्राम) पाया गया जबकि लंगड़ा में सबसे ज्यादा लुपियॉल और चौसा में सबसे ज्यादा मैंजीफेरिन पाया गया। आम के मल्लिका किस्म को 2% और 1% हेक्सानल के साथ उपचारित करने पर शेल्फ लाइफ 12 और 10 दिनों की थी जबकि अनउपचारित फलों की 08 दिन थी। आम की मल्लिका किस्म को *एल.प्लानटारम* 10^8 कोशिका/मिलीग्रा. और सीएमसी (2%) से उपचारित करने पर शेल्फ लाइफ 12 दिन थी। आम के छिलकों के महीन पाउडर का उपयोग कुछ रासायनिक यौगिकों के साथ अमावट को तैयार करने के लिए किया गया।

effective treatments in managing the disease of guava wilt and decline caused by *Fusarium oxysporum* and *Meloidogyne enterolobii* complex and enhancing plant growth.

Population dynamics of fruit flies was recorded from 32nd to 41st SMW. The peak incidence of the pest was recorded during the 32nd SMW with 6.40 percent fruit damage by the fruit flies. Similarly, Cucumber moth *Diphenia indica* incidence was observed from 32nd SMW to 40th SMW. The peak incidence of the pest was recorded during 33rd SMW with 39.32 percent. Fruit drop of bael has been a serious issue, therefore it was monitored at Rehmankhera just after the formation of fruits during the 24th SMW (June 2021).

Chromatographic (HPLC) analysis revealed that thiamethoxam degraded from its initial level of 5.62 and 41.17 mg kg^{-1} to 0.60 and 2.10 mg kg^{-1} in rhizosphere soil of mango (cv. Amrapali) after 60 days of application from 0.2 and 2.0 g L^{-1} doses, respectively. An increase in bacterial population in treated soil and continuous degradation of thiamethoxam indicated the presence of thiamethoxam degrading bacteria in mango rhizosphere soil. Three nutraceuticals (lupeol, mangiferin, and β-carotene) were estimated in the ripe pulp of eight mango varieties (Bombay Green, Eldon, Baneshan, Shardabhog, Kishanbhog, Himsagar, Fazri, and Zardalu) and ten mango hybrids among which H-1042 was found promising in nutraceutical value (β-carotene: 45.06 µg/g). Amrapali leaves contained maximum β-carotene (120.3µg/g), while Langra had maximum lupeol and Chausa with maximum mangiferin. Mango fruits cv. Mallika treated with 2% and 1% hexanal had a shelf life of 12 and 10 days, respectively as against 8 days of shelf life in untreated fruits. Mango fruits cv. Mallika treated with *L. plantarum* at 10^8 cells/ml plus 2% CMC had a higher shelflife of 12 days under ambient conditions. Fine powder of mango peel was utilized along with certain chemical compounds to prepare the vegan leather, a rough type of product.

समुद्री मार्ग के माध्यम से निर्यात करने के लिए आम के पोस्ट कोल्ड स्टोरेज के लिए एक प्रोटोकॉल विभिन्न उपचार के साथ किया गया, जिसमें गर्म पानी (46.8 °C) का 1 घण्टे का उपचार सबके लिए उभयनिष्ठ था। अध्ययन से पता चला कि 32 दिनों की शेल्फ लाइफ और तीन दिनों के भण्डारण से साथ आमों को दुनिया के अन्तर्राष्ट्रीय बाजार में समुद्री मार्गो के माध्यम से निर्यात किया जा सकता है। इथरेल और सोडियम हाइड्रॉक्साइड की विभिन्न सान्द्रता का उपयोग करके आम को पकाने के लिए एक सुरक्षित पाउच विकसित करने के लिए एक प्रयोग किया गया। उपचार के 120 घंटे बाद यह पाया गया कि आम का पक्वन अनउपचारित आम की तुलना में टी.एस.एस., अम्लता और दृढ़ता के आधार पर काफी बेहतर था। 1989 से ऐतिहासिक समय श्रृखंला डेटा का उपयोग करके भारत से आम के निर्यात की भविष्यवाणी करने के लिए एक मॉडल विकसित किया गया।

अमरूद की ललित किस्म को हेक्सानल (0.015%) के द्वारा उपचारित करने पर, भण्डारण के आठवें दिन टी एस एस 15.13 ब्रिक्स, अनुमापन योग्य अम्लता और एसकॉर्बिक अम्ल क्रमशः 0.4390, 159.46 मिलीग्रा./100 ग्रा. और सी.एम.सी. (2%) से उपचारित करने पर फल की शेल्फ लाइफ 6 की बजाय 8 दिन हो गई। बाजार में उपलब्ध आंवला कैंडी आम तौर पर गहरे रंग की और चिपचिपी प्रकृति की होती है जिनमें मिठास ज्यादा और कुरकुरापन कम होता है। *लैक्टोबैसिलस* जीवाणु का उपयोग करके अधिक गुणवत्ता वाली कैंडी तैयार करने की तकनीक विकसित की गई जिससे बनी कैंडी उच्च पोषण और अधिक आकर्षक थी।

शहद में आंवला स्लाइस को संरक्षित करने के लिए एक पद्धति का मानकीकरण किया गया जो विटामिन–सी एवं फेनोलिक्स से समृद्ध है। भारतीय मसालों और जड़ी–बूटियों का उपयोग करके एक गुड़ आधारित मैंजीफेरिन–लुपियॉल समृद्ध आंवला प्राश विकसित किया गया। गुड़ आधारित आंवला मघ पारंपरिक मघ से बेहतर पायी गयी। गर्म पानी में घुलने वाली आंवला हर्बल टैबलेट को आंवला, जड़ी–बूटियों और अन्य अवयवों का उपयोग करके विकसित किया गया जो कि उच्च–स्वास्थ्य गुणों एवम् एंटी–ऑक्सीडेंट यौगिकों से समृद्ध है।

A protocol for post-cold storage of mango to export through sea route, an experiment was designed with treatments along with mandatory quarantine hot water treatment at 46.8 °C for 1 hour was common for all the treatments. The study revealed that mangoes could be exported to the international market through sea routes to different parts of the world with 32 days shelf life and three days storage at ambient conditions. An experiment was conducted to develop a safe ripening sachet for the ripening of mango by using the different concentrations of ethrel and sodium hydroxide. After 120 hours it was found that mango ripening was significantly better in terms of TSS, acidity, and firmness in treatment (T_3) as compared to control. A model was developed to forecast the export of Mangoes from India using the historical time series data from 1989.

Guava fruits cv. Lalit treated with 0.015% hexanal were more efficient and had TSS of 15.13°B, titratable acidity of 0.43 %, and ascorbic acid content (159.46 mg/100g) on the 8th day of storage. Similarly, guava fruits cv. Lalit treated with *L. plantarum* + 2% CMC had a shelf life of 8 days compared to the control for 6 days. Aonla candy available in the market is generally deeper in color and sticky in nature. In most cases, it possesses above optimum sweetness and low crispiness. An improved technology was evolved for better quality candy preparation through microbial intervention using *Lactobacillus* bacteria which had high nutritional and aesthetic values.

A methodology was standardized for preserving aonla slices in honey and the product is rich in vitamin C and phenolics. A jaggery-based mangiferin-lupeol enriched aonla prash was developed using Indian spices and herbs. A jaggery-based aonla wine was prepared which was superior over conventional ones. Hot water-dispersible aonla-herbal tablet was developed using aonla, herbs, and other ingredients and is rich in anti-oxidant compounds having high pro-health properties.

स्ट्राबेरी से प्यूरी, स्क्वैश, क्रश, कैंडी, फ्लेक्स, बार, चोको कैंडी और प्रोबायोटिक पेय तैयार किया गया। करौंदा पाउडर जो कि विटामिन–सी का एक अच्छा स्त्रोत है (38 मिग्रा / 100 ग्राम), उसे तैयार किया गया तथा इसे खाद्य ग्रेड लचीली पैकेजिंग सामग्री में कमरे के तापमान पर आसानी से संग्रहित किया जा सकता है। करौंदा पाउडर का उपयोग विभिन्न प्रकार के रसोई उत्पादों में एक कार्यात्मक घटक और प्राकृतिक रंग के रूप में किया जा सकता है। करौंदा का तत्काल पेय मिश्रण करौंदा पाउडर, अदरक पाउडर, काली मिर्च, साइट्रिक अम्ल और शर्करा के साथ तैयार किया गया। पॉलीथीन थैली में यह उत्पाद, कमरे के तापमान पर 3 महीने के भण्डारण के लिए अत्यधिक स्वीकार्य पाया गया। करौंदा, सेब, पपीता के विभिन्न अंशों से पोषक जैम और जेली तैयार करने के लिए प्रक्रिया को इष्टतम किया गया और लंबे समय तक भण्डारण के दौरान सुरक्षित और स्थिर पाया गया।

संस्थान ने आईपी सुरक्षा को प्राथमिकता दिया और सीआईएसएच ट्रैप–2 के लिए एक पेटेंट प्रदान किया गया है, और दो पेटेंट दायर किए गए हैं। संस्थान ने 8 मोबाइल ऐप के लिए आवेदन किया और 1 मोबाइल ऐप के लिए कॉपीराइट मिला। सात संस्थान प्रौद्योगिकियों के व्यावसायीकरण के लिए विभिन्न निजी भागीदारों के साथ समझौता ज्ञापन पर हस्ताक्षर किए गये। एबीआई सुविधाओं की स्थापना के माध्यम से बागवानी आधारित उद्यमिता के अवसरों को भी प्रोत्साहित किया गया। संस्थान ने एनईएच योजना और एससीएसपी जैसी विभिन्न योजनाओं के माध्यम से इनपुट वितरण और तकनीकी सहायता की सुविधा प्रदान करके छोटे और सीमांत किसानों को पूरा किया। विस्तार अधिकारियों और किसानों के लिए बीस प्रषिक्षण कार्यक्रम और एक्सपोजर दौरे आयोजित किए गए। मेरा गांव मेरा गौरव और स्वच्छ भारत अभियान की प्रमुख सरकारी योजनाएं भी चलाई गईं।

Puree, squashes, crush, candy, dried halves (flakes), bar, choco-candy and probiotic drink were developed from strawberry. Karonda powder a good source of vitamin C (38 mg100g^{-1}) was prepared which could be was stored at room temperature after being wrapped in food-grade flexible packaging material. Karonda powder can be utilized in a variety of culinary products as a functional ingredient and natural colourant. Karonda instant beverage mix was formulated with ginger powder, black pepper, citric acid and sugar to obtain instant beverage mix. The product packed in polyethylene pouches was found to be highly acceptable for 3 months storage at room temperature. The process conditions were optimized based on various combinations to prepare nutri jam and jelly from various fractions of Karonda, Apple, and Papaya and found microbiologically safe and stable during prolonged storage (beyond six months).

The institute has accorded prioritisation to IP protection and one IP was granted for 'CISH Trap-2', and two patents have been filed in the year. Copyright was granted for 1 mobile app and 8 more were submitted and institute has signed MoU with various private partners for commercialisation of seven institute technologies. Horticulture based entrepreneurship opportunities were encouraged through establishment of the ABI facilities. The institute catered to small and marginal farmers by facilitating input delivery and technical support through various schemes like NEH plan and SCSP. Twenty training programs and exposure visits were organized for extension officers and farmers, government flagship schemes of Mera Gaon Mera Gaurav and Swachh Bharat Abhiyaan were carried out in many villages.

Introduction

Brief History

The ICAR-Central Institute for Subtropical Horticulture (CISH) was started as Central Mango Research Station on September 4, 1972 under the aegis of the ICAR-Indian Institute of Horticultural Research, Bengaluru. The Research Station was subsequently upgraded to an independent Institute which was named Central Institute of Horticulture for Northern Plains in June 1984. The Institute was later rechristened as Central Institute for Subtropical Horticulture in June 1995, and the present laboratory-cum-administrative building came up at block-II at Rehmankhera during May, 1999. It is serving the nation by working on basic, strategic and applied research to enhance sustainable productivity, quality and utilization of subtropical horticultural crops. It is world renowned repository of subtropical horticultural crop genetic resources and is NAGS for mango. The Institute has two experimental farms, one located at Rehmankhera, approximately 25 km away from the city and another at Telibagh, Raebareli (R.B.) Road. The experimental farm at Rehmankhera has an area of 132.5 hectare comprising of 4 blocks in which nursery block, world mango germplasm, Indian mango collections, mango hybrids, clones and germplasm of other mandated fruit species have been planted. The Institute has modern nursery facilities, well-established experimental orchards and equipped laboratories to meet the emerging challenges

in the niche areas of research on subtropical fruit crops. It has strived to upgrade the infrastructure facilities during various five year plans so that assets like state-of-art tissue culture facility, molecular biology and genomics laboratory, microbiology laboratory, processing pilot plant, bio control laboratory are being used to work in niche areas of horticulture research. The well established modern scientific nursery unit of the Institute is supported by mother blocks, polyhouses, shade net houses, mist chamber, sterilization chamber etc. Large number of quality planting materials have been produced for mango, guava, aonla, bael, jamun, litchi, strawberry and vegetable crops with traceability and these are being supplied as core/genuine planting materials to the farming communities. The institute also supports human resource development through Skill India Programme and various government and other sponsored schemes. Recognizing the importance of capacity building in harmony with ICAR focus of Student Ready, the Institute has in place MOUs with many universities of the state for supporting research activities leading to the award of M.Sc. and Ph.D. degrees. The Institute has also been recognized by IGNOU, New Delhi as one of its study centres for offering one year Diploma course on value added products from fruits and vegetables and a Certificate course on organic farming. The National Horticulture Mission has also identified the Institute as a nodal centre for imparting training on rejuvenation of old and unproductive mango orchards and high density planting system in guava. Institute is keenly pursuing the programmes towards doubling farmer's income, wherein mango based farming system technologies have been integrated to enhance profitability of farmers under Farmer FIRST, SCSP and other extension projects. The Institute also renders other quality services to the growers, viz., responding to queries on orchard related problems through Kisan Call Centre and phone-in-live programme, services on soil and nutrient constraints, agro-advisory services, pest and disease problems, on-farm visits, production and supply of bio-control agents, hand holding of KVKs and other agriculture/ horticulture universities with emphasis on North Eastern states and taking care of other multi-stakeholders. The Institute continues to be an active partner with the National Horticulture Mission and National Horticulture Board units for its outreach activities of promoting integrated development of horticulture. The ICAR-CISH Regional Research Station along with KVK at Makdumpur, Malda (West Bengal) are catering to the needs of subtropical horticulture for Eastern India through infrastructure development for fruit and vegetable nursery production, bee keeping and honey processing and bottling unit, water conservation ponds and allied activities.

VISION

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

MISSION

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

MANDATE

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

Objectives

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

Nursery

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

Table. Planting material produced during 2021

S.No.	Crop	No. of Plants
1.	Guava	70,149
2.	Mango	48,000
3.	Banana	33,500
4.	Bael	11,280
5.	Lemon	9,118
6.	Jamun	2,600
7.	Litchi	1,600
8.	Aonla	509
9.	Grape	320
	Total	177,076

Agriculture Knowledge Management Unit

The Agricultural Knowledge Management Unit (AKMU) is entrusted with responsibility of managing computational facilities, maintaining the Institute's network, the website and managing the video calling and conferencing facilities. The Institute is also complying with MISFMS system which monitors all employees' data like pay roll, leave processing stage/records, e-service book/ record, establishment records and as such there is utter transparency in recording system.

Library and Information Centre

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

Organizational Set-up

The Institute research staff functioning is organized through four Divisions (Crop Improvement and Biotechnology, Crop Production, Crop Protection and Post Harvest Management) at headquarters Lucknow; one Regional Research Station and KVK at Malda (W.B.) respectively. The Precision Farming Development Centre (PFDC) was established

by NCPAH to promote Precision Farming & Plasticulture Applications in horticulture. The institute also promotes vertical farming and soilless culture for vegetables through facilities developed by support of Rashtrya Krishi Vikas Yojna (RKVY). The institute is taking forward its organic research through Paramparagat Krishi Vikas Yojna (PKVY) a sub-component of Soil Health Management (SHM) scheme. The institute has recently been entrusted with the responsibility to promote and support the entrepreneurship ecosystem in horticulture through setting up of Agri-Business Incubator (ABI) Centre.

Staff Position

Overall Staff position for the institute including RRS Malda as on 31.12.2021 is given below

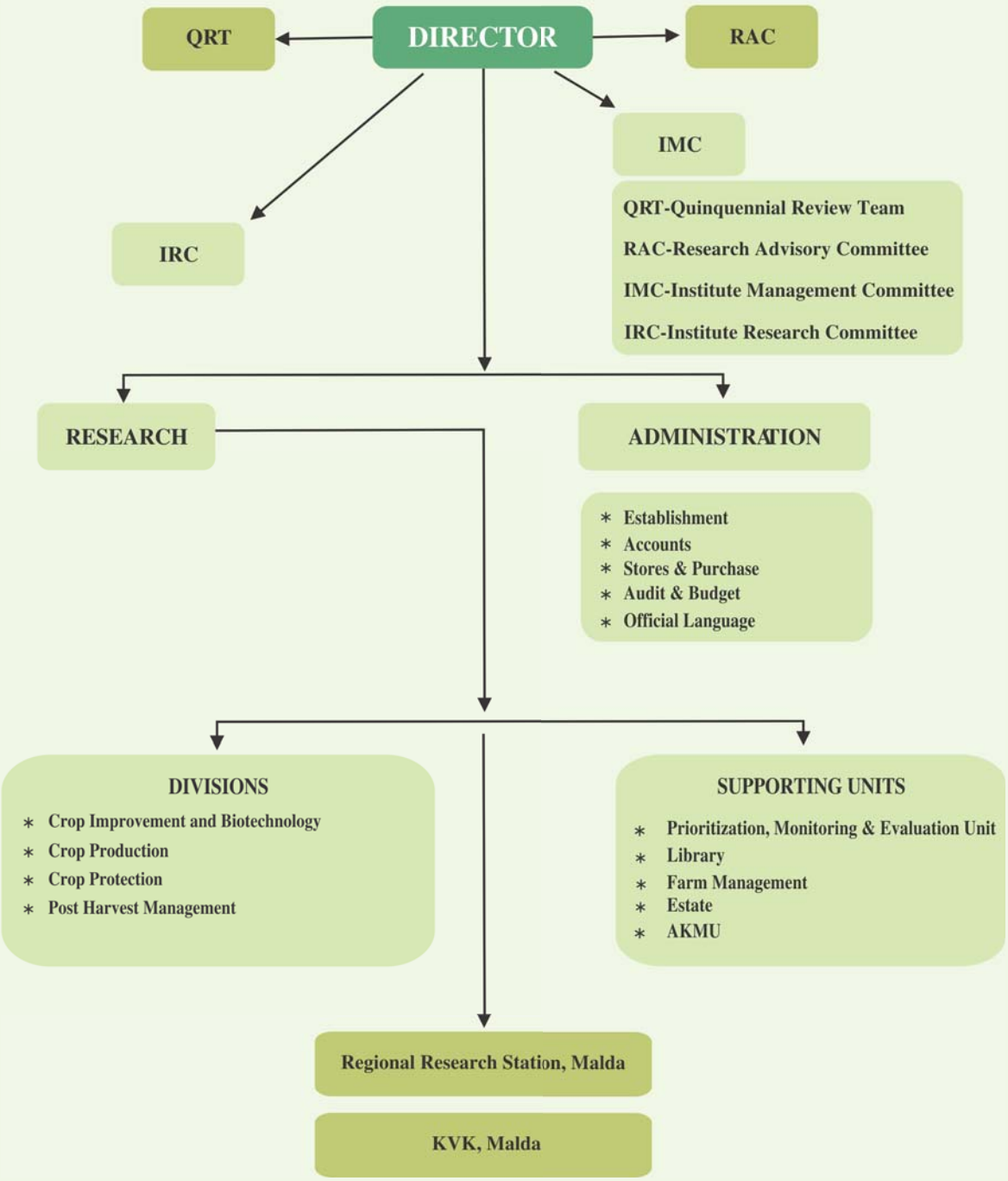
क्र.सं. S.N.	वर्ग Category	संस्वीकृत पद Sanctioned	भरा In Position	रिक्त Vacant
1	आर.एम.पी. (निदेशक) RMP	01	00*	01
2	वैज्ञानिक Scientific	51	40	11
3	तकनीकी Technical	41	26	15
4	प्रशासनिक Administrative	26	15	11
5	कुशल सपोर्ट स्टॉफ Skilled Support Staff	39	08	31
	योग Total	158	89	69

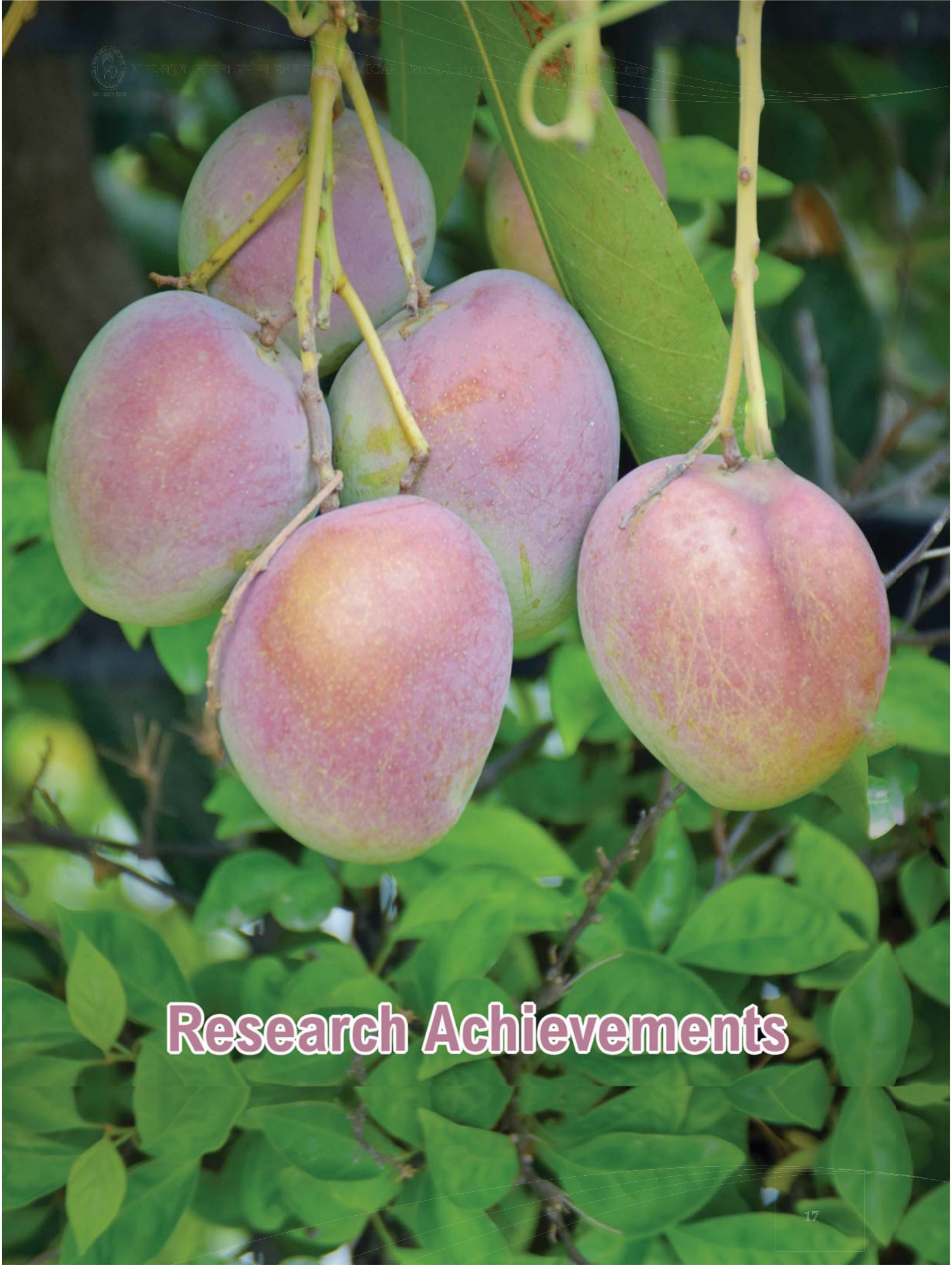
* Acting Charge assigned by Council w.e.f. 01.12.2021.

प्राप्तियां (2021–22) Revenue Receipts for the Year 2021-22 **(In Lakhs)**

क्र.सं. S.No.	राजस्व प्राप्ति की वसूली Realization of Revenue Receipts	लक्ष्य Target	उपलब्धि
1	बिक्री और सेवाओं से आय Income from sales / services		44.39
2	फीस से होने वाली आय Income from fees/Sub.		00.80
3	रॉयल्टी और प्रकाशन से आय Income from Royalty / Publication		00.05
	कुल Total	46.00	45.24

Organogram


DIRECTOR
QRT
RAC
IMC
IRC
QRT-Quinquennial Review Team
RAC-Research Advisory Committee
IMC-Institute Management Committee
IRC-Institute Research Committee
RESEARCH
ADMINISTRATION
* Establishment
* Accounts
* Stores & Purchase
* Audit & Budget
* Official Language
DIVISIONS
* Crop Improvement and Biotechnology
* Crop Production
* Crop Protection
* Post Harvest Management
SUPPORTING UNITS
* Prioritization, Monitoring & Evaluation Unit
* Library
* Farm Management
* Estate
* AKMU
Regional Research Station, Malda
KVK, Malda



Research Achievements

Division of Crop Improvement and Biotechnology

Mango (*Mangifera indica* L.)

Collection

During the year 2021, scions of 09 farmers' mango varieties were collected from Malihabad region, Uttar Pradesh and grafted on seedling plants for conservation and further evaluation.

Field Gene Bank Planting

Being a national active germplasm site, a total of 775 mango accessions are being maintained in the field gene bank. Gaps in the field gene bank were filled, and 24 accessions were multiplied for planting in the germplasm field.

Characterization

Profiling of major nutraceuticals in mango

Total carotenoids, phenols, flavonoids and antioxidants were estimated in the pulp of 27 mango varieties. Total carotenoids were found to vary from 1.29 mg/100g to 7.08 mg/100g. Total phenol contents ranged from 32.71 mg/100g to 126.46 mg/100g, while total flavonoids content varied from 13.0 mg/100g to 32.00 mg/100g. The total antioxidant ranged from 0.33 µmol Trolox/100g to 1.21 µmol Trolox/100g (Fig. 1).

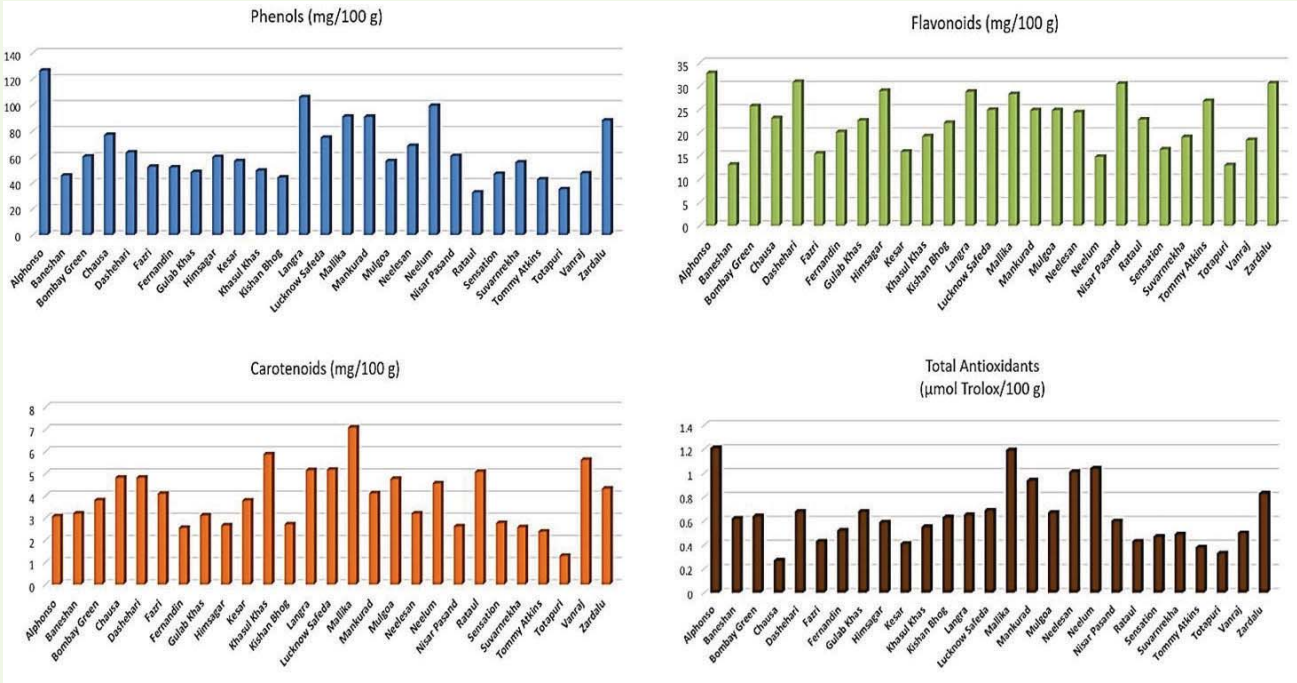


Fig.1. Profiling of major nutraceuticals in mango

Total carotenoids, phenols, flavonoids and antioxidants were quantified in the pulp of eleven hybrids. The total carotenoids ranged from 2.61 mg/100g to 7.17 mg/100g. The total phenol contents ranged from 38.81 mg/100g to 90.83 mg/100g, while the total flavonoid contents varied from 11.93 mg/100g to 37.0 mg/100g. Among the eleven hybrids under evaluation, the hybrid with the highest total antioxidants had 0.93 µmol Trolox/100g, while, the hybrid with the lowest total antioxidants had 0.52 µmol Trolox/100g.

Germplasm evaluation

Evaluation data of 136 accessions indicated the wide variability in the various parameters such as fruit weight, fruit length, fruit breadth, stone weight, TSS, and pulp percent. The weight of fruit varied most significantly. The fruit weight ranged from 74 g to 154.8 g, with a mean of 274.51 g/ fruit. Fruit weight in most of the accessions ranged from 200 g to 400 g (Fig. 2). The total soluble solids (TSS) was found to be in the range of 10.0°B to 26.2 °B. TSS of 16-20°B was found in the majority of accessions, but –a few recorded more than 22°B (Fig. 2). The pulp percent ranged from 44.57 percent to 83.10 percent with a mean of 64.65 percent, majority of accessions had 60-70 percent pulp.

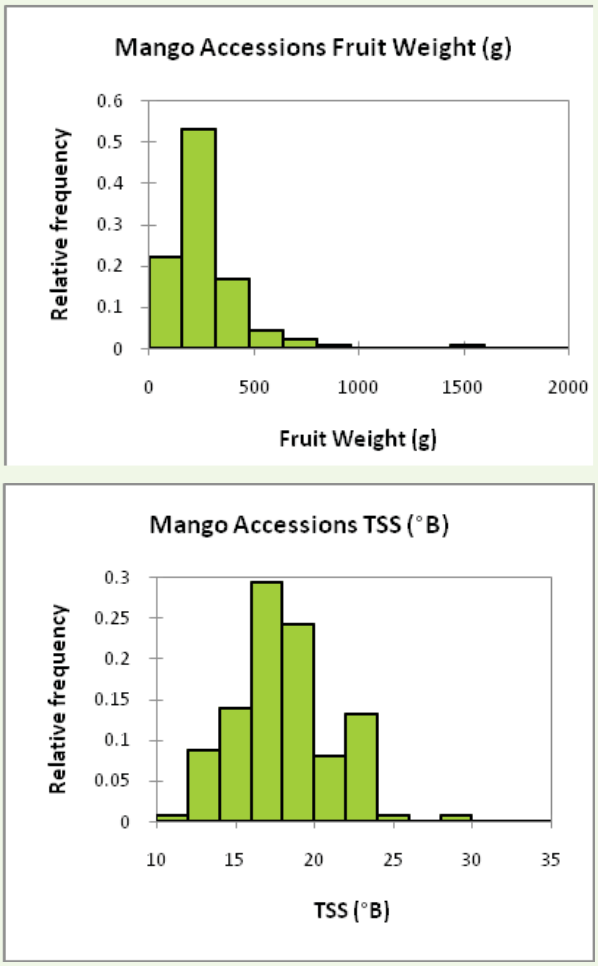
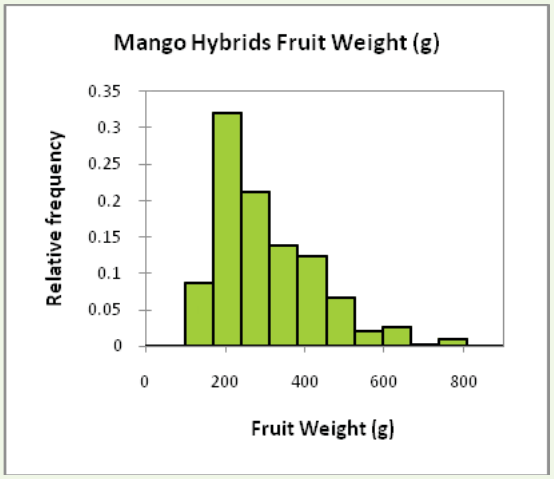


Fig.2. Fruit weight and TSS in different mango accessions

Hybrids evaluation

During 2021, a total of 349 hybrids were evaluated for fruit weight, fruit length, fruit breadth, stone weight, stone length, stone breadth, stone thickness, TSS and pulp per cent. For fruit physical parameters, the hybrids showed a wide variability. Out of the total number of hybrids evaluated, weight of 80 no. of hybrid fruits ranged from 150 g to 200 g, 195 no. of hybrid fruits weight ranged from 200 g to 400 g and 75 no. of hybrid fruits weight was >400 g with a maximum weight of 741.66 g (Fig. 3). The majority of the hybrids had fruit weight ranging from 200 to 400 g, indicating the possibility of selecting hybrids with higher fruit weight. The TSS ranged from 9.80 °B to 26.40 °B. TSS of 16 to 22°B was found in the majority of hybrids, however, some hybrids had TSS of >24°B (Fig. 3). The pulp percentage was found to be an important parameter, ranging from 41.49 percent to 85.10 percent. Most of the hybrids have 65-75 percent pulp and some have >80 percent pulp.



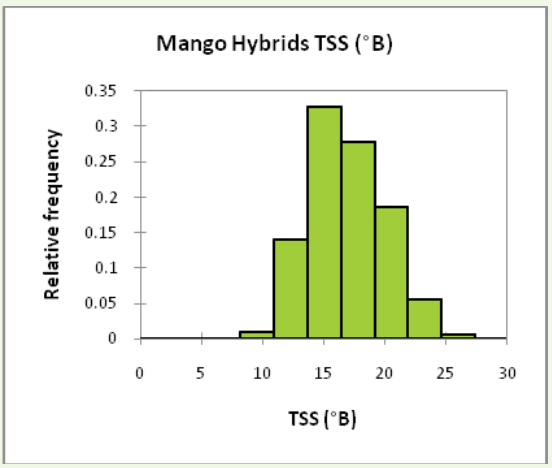
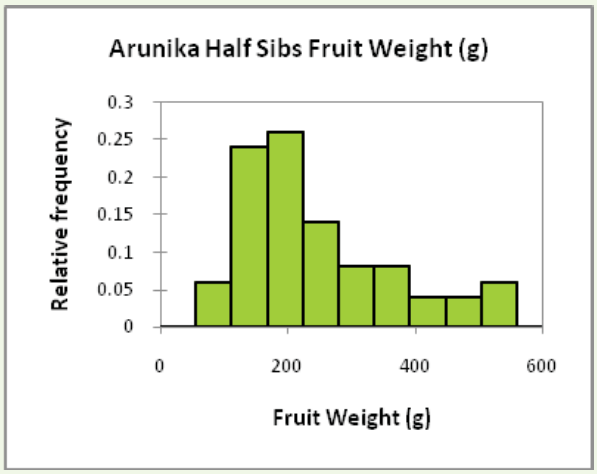
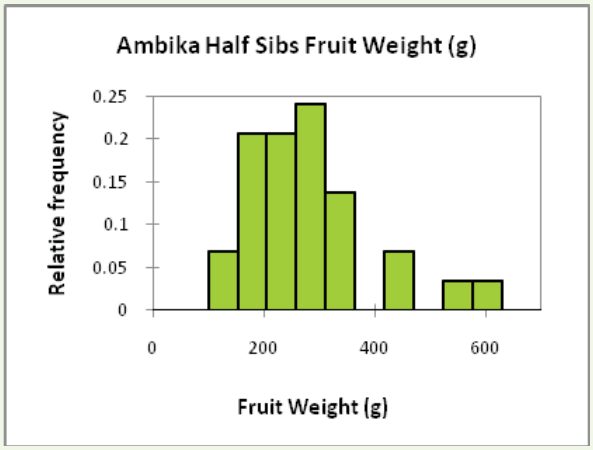


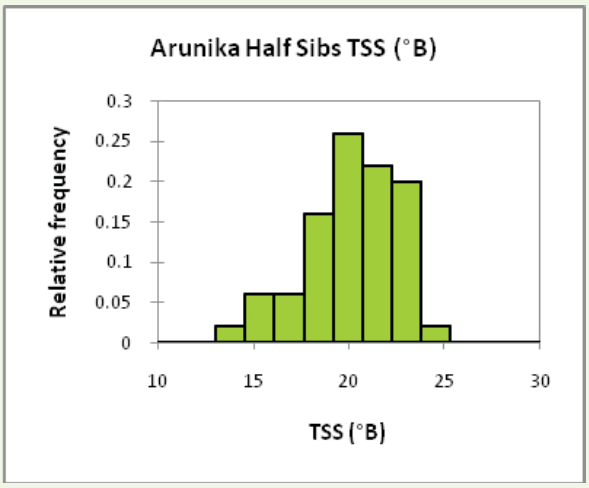
Fig. 3. Fruit weight and TSS in different mango hybrids

Evaluation of half-sibs

During 2021, a total of 29 Ambika half sibs and 50 Arunika half sibs were evaluated. Among the Ambika half sibs evaluated, fruit weight ranged from 101 g to 623 g, with a mean of 284.28 g. Pulp percent ranged from 56.57 percent to 82.55 percent. TSS was found to range from 15.9°B to







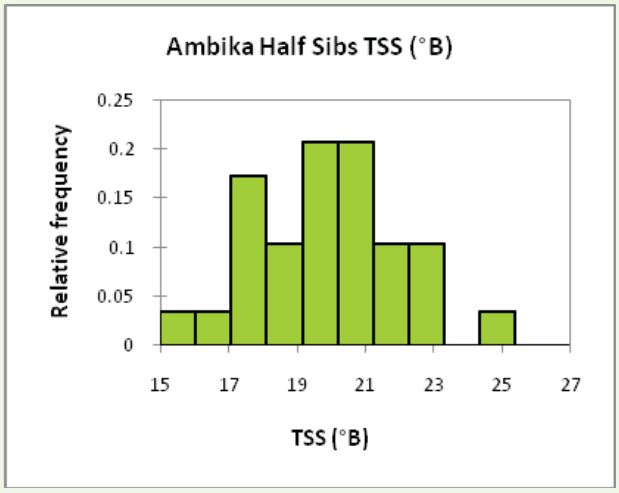


Fig.4. Fruit weight and TSS in different Ambika and Arunika half sibs

25.3°B (Fig. 4). Among the Arunika half sibs, the fruit weight ranged from 95 g to 556 g, with a mean of 244.63 g. The pulp percent ranged from 47.84 percent to 81.77 percent. TSS was found to range from 14.3°B to 24.6 °B (Fig. 4).

Biochemical estimations of germplasm from eastern ecosystem

During 2021, 105 germplasm of mango were collected from Malda and Murshidabad districts of West Bengal to explore diversity and identify potential varieties. Characterization has been done for physical and physiological traits of mango fruit using DUS guidelines and pulp quality analysis respectively. Pulp quality of selected mango germplasm was used to quantify different minerals, phenol and flavonoids. Cu concentration was highest in Bimli (40.7mg/kg), whereas lowest level of Cu concentration was recorded in Laxmanbhog (2.2mg/kg). The maximum Mn concentration was recorded in Bimli (8.16mg/kg) and least was recorded in MM-87 (1.82 mg/kg). Mango germplasm Champa (88.93mg GAE/g) recorded highest phenolic content, while least was estimated in Amrit Kunna (3.06mg GAE/g). Variations were also recorded for flavonoids, TSS, Zn, Fe and Na content among the germplasm evaluated (Fig. 5).

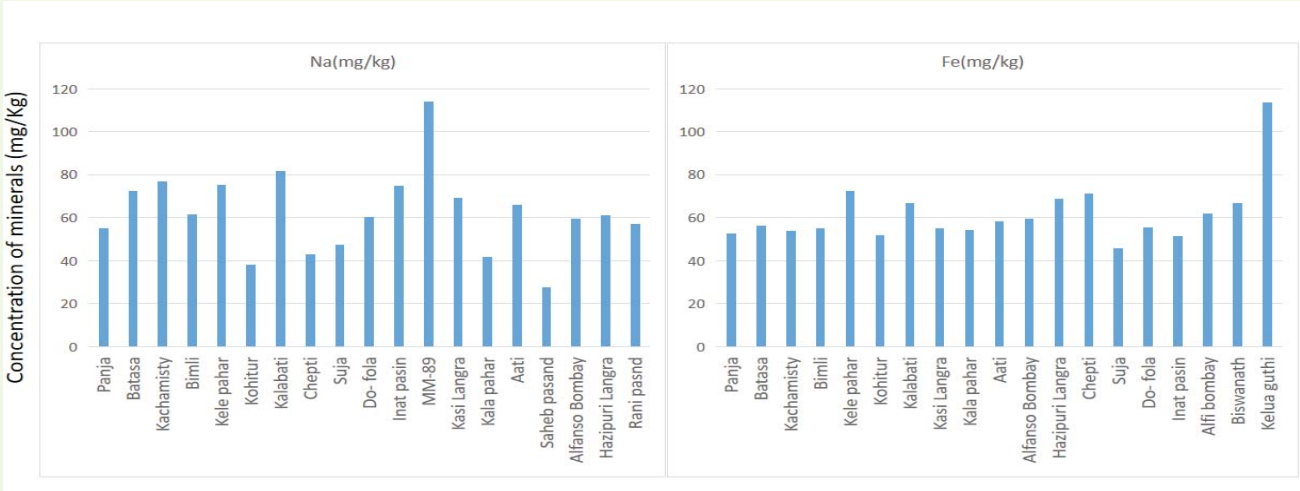


Fig. 5. Estimation of minerals (Na and Fe) in different mango cultivars in Malda and Murshidabad districts of West Bengal

Hybridization and establishment

During 2021, using 24 different cross combinations, 78449 flowers were crossed on 15550 panicles (Table 1). As a result, 312 mango hybrid fruits were obtained from the crosses made during 2020-2021, however,178 stones germinated (Table 1). The basis for selection of cross combination during 2020-21 is given in Table 2. In 2019-20, 64 seedlings were raised from hybrid combinations to test the F1 progeny of mango hybrids.

Table 1: Hybrid seedlings from hybridization during 2020-21

S.No	Cross combinations	Panicles used for hybridization	Number of flowers	Number of fruits harvested	Number of stone germinated
1	Arunika × Mallika	1550	7356	80	41
2	Amrapali × Tommy Atkins	1300	6973	56	41
3	Amrapali × Sensation	1400	7534	46	27
4	Amrapali × Arunika	1300	6863	27	12
5	Amrapali × H-1739	800	4923	43	25
6	Ambika × Sharda Bhog	400	1762	2	1
7	Bombay Green × Sharda Bhog	200	815	1	1
8	Chausa × Manipur Dwarf	100	648	-	-
9	Dashehari × Gulab Khas	500	1898	4	3
10	Dashehari × Bombay Green	700	3175	3	1
11	Dashehari × Sharda Bhog	200	1032	6	3
12	Dashehari × Tommy Atkins	1250	6445	8	7
13	Dashehari × Sensation	1150	6096	7	5
14	Dashehari × Arunika	500	2434	-	-
15	Langra × Arunika	1050	5395	14	9
16	Langra × Sharda Bhog	550	2846	3	1
17	Mallika × Arunika	700	3121	6	1
18	Mallika × Sharda Bhog	100	514	2	-
19	Mallika × Tommy Atkins	350	1515	2	-
20	Mallika × Sensation	100	479	2	-
21	Neelum × Ambika	750	3732	-	-
22	Neelum × Arunika	450	2253	-	-
23	Totapuri × Manipur Dwarf	50	252	-	-
24	Zardalu × Sensation	100	388	-	-
	TOTAL	**15,550**	**78,449**	**312**	**178**

Table 2. Basis for selection of cross combinations during 2020-21

S.N.	Cross combination	Q+C	RB	WA	AB
1	Arunika × Mallika	+	+	+	
2	Amrapali × Tommy Atkins	+	+	+	
3	Amrapali × Sensation	+	+	+	
4	Amrapali × Arunika	+	+	+	
5	Amrapali × H-1739	+	+	+	
6	Ambika × Sharda Bhog	+	+	+	
7	Bombay Green × Sharda Bhog	+		+	
8	Chausa × Manipur Dwarf			+	+
9	Dashehari × Gulab Khas	+		+	
10	Dashehari × Bombay Green		+	+	
11	Dashehari × Sharda Bhog	+	+		
12	Dashehari × Tommy Atkins	+	+	+	
13	Dashehari × Sensation	+	+	+	
14	Dashehari × Arunika	+	+	+	
15	Langra × Arunika	+	+	+	
16	Langra × Sharda Bhog	+		+	
17	Mallika × Arunika	+	+	+	
18	Mallika × Sharda Bhog	+		+	
19	Mallika × Tommy Atkins	+	+	+	
20	Mallika × Sensation	+	+	+	
21	Neelum × Ambika	+	+		
22	Neelum × Arunika	+	+		
23	Totapuri × Manipur Dwarf			+	+
24	Zardalu × Sensation	+	+	+	

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

Genomics resources augmentation and validation of trait specific SSR markers

About 50 SSR primers were identified, designed and synthesized from transcript sequences generated from RNA sequence data from fully annotated leaf transcriptome datasets of mango cvs, Amrapali (SRA: SRP070908), and Chausa (SRA: SRP072727). Twenty primers were validated in different mango genotypes using standard PCR assay. Fifteen of them being monomorphic were eliminated and rest of them were used for further population structure and marker–trait analysis. The EST- SSR repository developed in the previous year was augmented with 20 validated trait specific SSR primers, that were identified. These markers were co-located in gene sequences related to flowering, peel color, transcription and translation processes and stress response (Table-3).

Table 3: Development and validation of EST-SSR markers co-located in genes governing specific traits

S. No.	Primer Code	Motif	Product size (bp)	Pathway	Gene involved	Monomorphic /Polymorphic
1.	*Mi*FL SSR14	(TTG)5	194	Flowering	transcription factor (*ERF*)	P
2.	*Mi*FL SSR19	(TCA)5ccaccacca cggcggcggcgg(TCA)7	240	Flowering	transcription factor (*zf-HD*)	P
3.	*Mi*FL SSR31	(CAGCAA)3	182	Flowering	Circadian clock regulator	P
4.	*Mi*FL SSR34	(AAAC)7	208	Flowering	Xyloglucan endotransglucosylase/ hydrolase	P
5.	*Mi*FL SSR58	(TGATCA)3	207	Flowering	transcription factor (*bZIP*)	P
6.	*Mi*CL SSR60	(GAC)5gaagag (GAA)5	188	Color	transcription factor (*BSD*)	P
7.	*Mi*CL SSR61	(GAA)6	217	Color	glucosyltransferase	P
8.	*Mi*CL SSR64	(CCCCAG)3	230	Color	UDP-glycosyltransferase 13	M
9.	*Mi*CL SSR65	(TC)6	164	Color	Phenylalanine ammonia-lyase	P
10.	*Mi*CL SSR66	(ATC)5	164	Color	Phenylalanine ammonia-lyase	P
11.	*Mi*CL SSR68	(GTGAT)4	181	Color	Homeobox-leucine zipper protein Anthocyaninless	M
12.	*Mi*TT SSR89	(CTT)5	221	Transcription & Translation	Eukaryotic translation initiation factor 2 subunit beta	M
13.	*Mi*TT SSR90	(TGT)5	153	Transcription & Translation	transcription factor (*GATA*)	M
14.	*Mi*TT SSR97	(TCTTCC)3	231	Transcription & Translation	component Tic110 of inner envelope TIC translocation system	M
15.	*Mi*ST SSR103	(CGG)6	172	Stress	transcription factor (*WRKY*)	P

Proteome profiling of flowering responsive proteins

Two dimensional electrophoresis based proteome analysis of leaf proteins of flowering shoot of mango cv. Dashehari followed by their spot characterization studies revealed that proteins of differential spots associated with flowering were detected (Fig.6A). Based on the molecular sizes and isoelectric focus points, differentially accumulated proteins was identified using mapping strategy against Citrus IEF database, which identified that these proteins were related with different pathways such as transcriptional regulation, hormonal signaling, flowering time, signal transduction and transport pathways. Phenyl propanoid pathway, cell wall and cytoskeleton metabolism related proteins were the predominant ones which were also known to be associated with flowering. The categories and the percentage of proteins placed in each category were illustrated in pie chart (Fig. 6B).

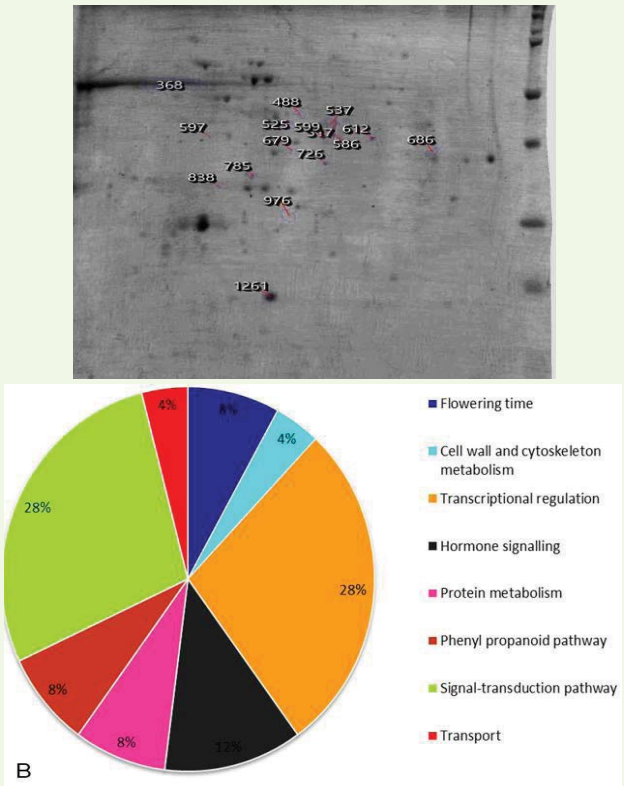


Fig. 6. Two dimensional electrophoresis analysis of leaf proteins of flowering shoot of mango cv. Dashehari. (A) Silver stained polyacrylamide gel profile showing protein spots. (B) Pie chart representing different classification of proteins identified from spots identified in 2D gel.

Comparative analysis of RNA-sequencing and small RNA-sequencing of floral buds (FBD) and vegetative buds (VBD)

Comparative differential gene expression analysis of both transcriptome and small RNA sequencing of FBD (floral bud) and VBD (vegetative bud) of mango cv. Dashehari, facilitated identification of expression status of key miRNAs and their corresponding targets (Table 4). Certain miRNAs viz., ath-miR408-5p, mtr-miR319c-3p, tcc-miR390b were significantly down-regulated in FBD, with corresponding target genes being significantly up-regulated (*RcLAC3, cpTcTCP13, DlARF*) and this seems to have crucial role in induction of flowering as well as in vegetative to floral transition (V-R transition). Three miRNAs viz., *miR399, miR169* and *miR2111* that are novel candidates associated with long-distance signaling for reporting P or N status were also detected in FBD. Although, novel miRNAs and their respective target genes that were detected (related to flowering) were non-significant in their expression levels. Validation of these miRNAs and their targets is underway through RT-PCR assay which would be able to establish the miRNA mediated regulation of floral induction and V-R transition.

Table 4: miRNA mediated regulation of genes related to floral induction & V-R transition

miRNAs	Expression (Log_2FC)	Regulation & Significance	Target protein	Gene code	Expression (Log_2FC)	Regulation & Significance	Role in flowering
sof-miR396 / hbr-miR396b	-2.7092 -2.7092	Down, S Down, S	Haloacid dehalogenase-like hydrolase family protein/ Growth regulating factor (GRF) family transcription factor#	*CsHAD/* *TcGRF*	0.2958 -4.2008	Up, NS Down, S	Induces flowering Reduces vegetative growth and promotes V-R transition
tcc-miR390b/ ahy-miR160-5p	-1.40473 -4.3546	Down, NS Down, S	Auxin response factors	*DlARF* *CsARF8*	4.0183 0.6699	Up, S Up, NS	Early auxin responsive genes, induce flowering and role in flower development

bra-miR2111a-5p	-10.2249	Down, S	F-box/kelch repeat superfamily protein	*CsKFB*	0.9942	Up, NS	Novel candidate long distance signals for reporting P or N status in the plant system
mtr-miR319c-3p/ sly-miR319c-3p	-6.9418 -5.48041	Down, S Down, S	Teosinte Branched 1, cycloidea and PCF transcription factor 2/ Topless related protein 2 (TPR2)#	*cpTcTCP13/* *CsTPR*	2.8243 0.8454	Up, S Up, NS	Promotes early flowering and sometimes insensitive to miR319 regulation
tae-miR171a/ huv-miR171b-3p/ cpa-miR171b	-6.1805 -4.2824 -6.1805	Down, S Down, S Down, S	Scarecrow like protein	*TcSCR8*	1.7094	Up, NS	SCR belongs to GRAS family transcription factor either promotes or delays flowering
vun-miR319b/ ath-miR319b	-6.91559 -7.3366	Down, S Down, S	Myb domain protein 108/ MYB-APL1	*VvMYB108* *CsMYB-APL1* *CsMYB33*	0.4614 0.4915 -1.7009	Up, NS Up, NS Down, NS	Regulates flowering time with complex networks (Myb33, 65 and 108 works together)
stu-miR399a-3p	-3.1164	Down, S	Phosphate-2 starvation response/ Ubiquitin ligase	*TcPHO2/* *CsUBC12*	-0.2529 1.80223	Down, NS Up, NS	Temperature and P-starvation responsive Repressor, UBC12 is required for flower development
sbi-miR172f	-8.6399	Down, S	Apetella like protein#	*AP2*	4.08589	Up, S	Repressor in photoperiod induction
aly-miR159a-3p	-1.2837	Down, S	Lectin protein kinase family protein	*CsLPK1* *TcCLK* *ZjLLK4.1*	0.4632 0.2979 0.5364	Down, NS Down, NS Down, NS	Favoring vegetative growth; role in self incompatibility

Up-Up-regulated, Down-Down-regulated, S-Significant, NS-Non-significant

In silico lncRNA identification in jelly seed transcriptome

Raw sequence reads form mango *cv Dashehari* Jelly seed transcriptome data was used for lncRNA prediction using bioinformatics pipeline. 170027 transcripts with length >200bp were obtained. Filtering transcript with ORF length less than <100 bp gives 14674 transcripts. Further transcript filtration for UTR region gave 13240 transcripts out of which 3291 putative lncRNA were identified. Among identified lncRNA many give rise to different miRNA *i.e.* miR394, miR5015, miR854,miR5021etc. Expression analysis of precursor miRNA *i.e.*miR164, miR5021, miR5658 and miR414 in unripe pulp, ripe pulp and jelly seed of mango was validated (Fig. 7).

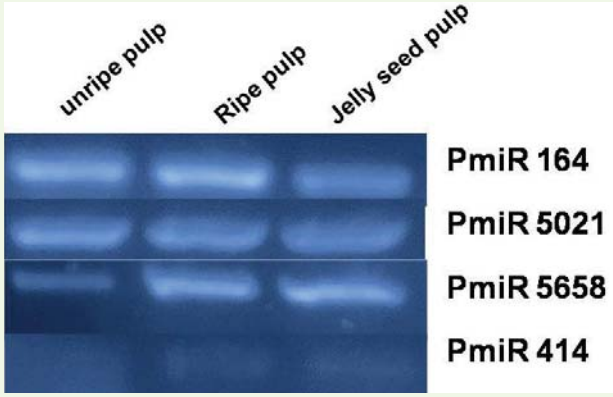


Fig. 7. Expression (RT-PCR) of different precursor miRNA in unripe pulp, ripe pulp and jelly seed of mango cv. Dashehari

Biochemical and gene expression in jelly seed

TSS and phenols were estimated in non jelly pulp and jelly pulp of mango fruit. TSS of non jelly pulp was higher compared to jelly pulp (12.0°-17.9° Brix). Phenolics ranged from 152.76 µg/g and 118.76 µg/g in non jelly pulp and jelly pulp. TSS and phenol was found to be significantly less in the jelly pulp as compared to non jelly pulp of same fruit. Calcium content in jelly pulp was less compared to non jelly pulp. Expression analysis of Ca^{2}+ responsive/signalling genes and pectate lyase was low in jelly pulp compared to non jelly pulp.

Guava (*Psidium guajava* L.)

Germplasm collection

Guava survey, evaluation and selection program was carried out and 12 guava genotypes were collected from Prayagraj and Farrukhabad districts of Uttar Pradesh. These genotypes differed considerably for the traits of interest. Fruit weight ranged from 111.2g in PitauraRed to 279.0g/ fruit in 'Allahabad Safeda', 'Makanpur', seed hardiness from 10.40kg/cm² in 'Pitaura White' to 14.25 kg/cm² in 'Mai Kayamganj', TSS from 10.8°B in Pitaura Red to 12.8 °B in 'Faizbag Kayamganj', and Vitamin C from 75.86 mg/100 g pulp in 'Mai Kayamganj' to 120.69 mg/100 g pulp in 'Pitaura White'. This reflects a good scope for selecting superior soft-seeded cultivars from the guava growing areas of Uttar Pradesh.

Field gene bank

Presently, 150 accessions of guava including 7 *Psidium* species are being maintained in the field gene bank. A total of 55 accessions were vegetatively multiplied in 2021 for gap filling in the field gene bank.

Germplasm evaluation

A total of 28 guava accessions were evaluated using fruit quality attributes indicated rich genotypic variation for traits like fruit weight, TSS and seed hardiness. The fruit length ranged from 5.75 cm to 8.90 cm, and fruit width from 5.30 cm to 8.80 cm. The lowest fruit weight (95.0 g) was recorded in 'Hybrid Red', while the highest (397.0 g) in '5A Gangapur'. The TSS varied from 7.60° Brix (Smooth Green) to 15.10° Brix (Pear Shaped). Seed hardiness was the minimum (9.17 kg/cm²) in 'Behat Coconut' and the maximum (16.30 kg/cm²) in 'Portugal'.

Evaluation of guava hybrids and half-sib population

A total of 117 hybrid seedlings were characterized using the fruit quality traits. Fruit length ranged between 4.87 and 8.30 cm and fruit width between 5.02 and 8.04 cm. Similarly, fruit weight varied

between 75.33 and 291.0 g, TSS between 7.40 and 14.80º Brix and seed hardiness between 7.45 and 20.27 kg/cm^2. This indicates good scope for developing superior guava cultivars by selection from the half-sib population.

Promising hybrids identified

Evaluation of half-sib population revealed that some red pulp hybrids were promising in terms of fruit weight, TSS and seed softness. Hybrids R24-P493, R13-P271, A13-P269 and R14-P280 had higher fruit weight, high TSS and soft seeds (Fig. 8).

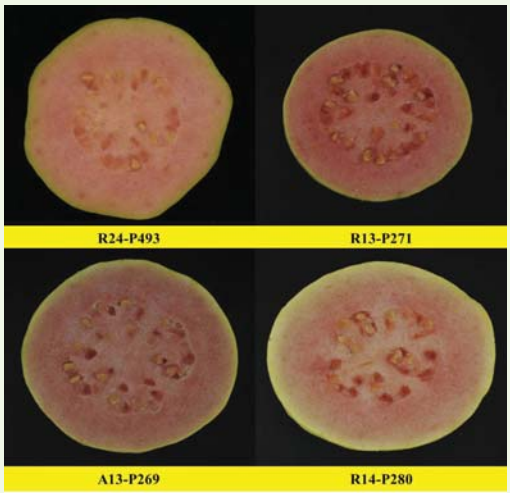


Fig. 8. Promising guava hybrids.

Genomic resources and SSR genotyping

Eighty genomic SSRs (simple sequence repeats) identified and developed from guava genome *cv.* 'Zhenshu', 'Hainan University', GCA_002914565.1 were validated in 28 guava germplasm accessions which included varieties, hybrids and *Psidium* species (Fig. 9). SSR regions in the exonic segments of genes were categorized based on pathways such as lignin biosynthesis (Table-5), phenyl-propanoid pathway, antioxidant reactive oxygen species scavenging system and resistant genes. These SSR markers were mapped on the genome and were found to be distributed in all the 11 chromosomes. Similarly, comparative genome analysis of re-sequencing data of 3 *Psidium* species *viz.*, *Psidium guineense*, *P. molle* x *P. guajava* and *P. araca (P. cattleyanum* sub. sp. *lucidum)* was done using CLC workbench which helped in the identification of a large array of single nucleotide variations (SNVs) that has potentials to be developed into SNP markers.

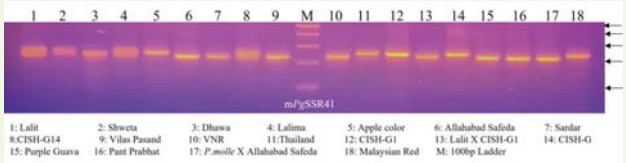


Fig.9. Agarose gel profile showing allelic variations of mPgSSR41

Table 5: Genomic SSR markers identified co-located in genes of lignin biosynthetic pathway in guava

S. No.	SSR id	Gene	Repeat Type	Motif	Repeat no.	Chr.	Position (bp)	Product Size (bp)
1	m*Pg*SSR41	4-coumarate-CoA ligase (*4CL*)	5	ACACG	4	Chr2	41762-41781	223
2	m*Pg*SSR42	Caffeoyl-CoA O-methyltransferase (*CCOAMT*)	2	AT	9	Chr5	67879-67896	285
3	m*Pg*SSR43	CaffeoylshikimateEsterase (*CSE*)	3	AGA	5	Chr2	56145-56159	232
4	m*Pg*SSR44	Cinnamoyl-CoA reductase 1 (*CCR*)	2	AG	9	Chr5	1536-1553	299
5	m*Pg*SSR45	Cinnamoyl-CoA reductase 1 Like (*CCRL*)	6	CGGCTC	4	Chr2	3071-3094	226
6	m*Pg*SSR46	Caffeic acid 3-O-methyltransferase(*COMT*)	2	GA	10	Chr7	46647-46666	263

Transcriptome analysis of guava seed

Transcriptome analysis of guava seed generated 10 GB of high quality data which was further used together for *de-novo* assembly using Trinity. The assembly contained >95,000 transcripts with an N_{50} scaffold length of >2000 bp. 50100 CDS were predicted using TransDecoder tool. BlastX annotation revealed that maximum hits were against *Rhodamnia argentea*. A total 60 transcription factor families were identified, out of which majority of TF families were found to be annotated against bHLH, MYB, NAC. The GO distribution was carried out using Blast2GO pro. where in 3400 fall under biological process, 2800 fall under cellular component.

Jamun (*Syzygium cumini* Skeels)

Characterization/Germplasm Evaluation

Observations on flowering, fruiting behavior and yield and quality parameters were taken.

Tree characters

A total of 20 jamun accessions, being maintained in the field gene bank, were characterized using tree growth traits and fruit quality attributes. The evaluated genotypes showed wide variability for most of the traits, indicating good scope for selecting the high yielding jamun cultivars. The tree height was minimum (6.10 m) in J-15 and the maximum (10.65 m) in 'J-6'. Canopy spread in the east-west direction was the minimum (5.10 m) in J-3 and the maximum (11.90 m) in 'J-580'. Similarly, the canopy spread in north-south direction was the lowest (4.66 m) in 'J-28' and the highest (11.40 m) in 'J-576'.

Physico-chemical characteristics of different accessions/ varieties

Data on physico-chemical characteristics of 13 year old trees revealed that the average fruit weight ranged between 4.48 g (J-580) and 15.32 g (J-15), fruit length between 2.57 cm (J-2) and 3.62 cm (J-12) and fruit width between 1.74 cm (J-577) and 2.66 cm (J-12). Accessions 'J-12',' J-15' and 'J-085' had very high pulp content (>90.0 %). Based on the higher mean fruit weight (15.32 g), pulp content (90.60%), TSS (13.4 ºBrix) and fruit yield (66.0 kg/tree), accession J-15 was found to be promising.

Canopy management of variety CISH-Jamwant for enhanced productivity

Pruning treatments were imposed to maintain different systems of canopy i.e. open centre system and palmette system. Observations on flowering, fruiting behavior, yield & quality parameters in relation to fruit maturity in different directions after pruning were recorded. Pruning of branches were performed during mid October with open center and palmate system of canopy. Flowering was started in open center and palmate system on current season and one year old shoots after 3rd week of March. Initiation of flowering periods varies 2-3 days only, however, fruit setting periods were recorded at 5-7 days interval. Maximum fruit yield/plant, TSS, average fruit weight was recorded in open system of tree. Open center system of canopy recorded maximum fruit yield /plant 80.00 kg/ plant compared with control 50.00 kg/plant.

Bael (*Aegle marmelos* Correa.)

Clonally multiplied germplasm evaluation

Forty three vegetatively multiplied bael accessions have been maintained in the field gene bank for evaluation. During 2021, fifteen accessions were analysed for their physico-chemical parameters. Fruit weight varied from (908.33- 2355.00 g), fruit length (15.33-23.33 cm), fruit circumference (41.00-51.67 cm), number of seed/fruit (72.33-191.00), number of seed sac per fruit (12.00-18.00), seed weight percentage (0.68-1.78 %), shell weight (131.53-244.30 g), shell percentage (7.50-19.80 %), shell thickness (2.27-3.43 mm), pulp percentage (80.20-92.50 %) and fruit yield (23.75-61.27 kg/tree) among the different accessions was evaluated. With regard to chemical parameters, TSS ranged from 30.11-42.10^{0}B, acidity 0.32-

0.63%, vitamin 'C' content 12.81-25.64 mg/100g pulp, total phenol content 1.64-2.75%, total sugar 15.60-22.57%, reducing sugar 6.29-9.43% and non- reducing sugar 6.63-14.52% among the evaluated accessions. On the basis of overall assessment an accession *i.e.*,.'T-37' having fruit weight (1268.33 g), fruit yield (72.27 kg/tree), TSS 38.50°B, seed percentage 0.68%, shell thickness (2.47 mm), vitamin 'C' content (12.82 mg/ 100 g pulp) and total phenol content (2.35 %) was found most promising at the age of thirteen year (Fig. 10).

Fig. 10. Elite bael germplasm line selected 'T-37' (A) fruit bearing in a branch, (B) close up view of fruit on a tree, (C) fruits

Seedling germplasm evaluation

One hundred thirty eight seedlings were raised from promising bael genotypes collected from different parts of U.P, Bihar and M.P. were planted during the year 2003. Among them 12 seedling germplasm which came to bearing during 2021 were evaluated for their physico-chemical parameters. The fruit weight varied from (1018.33-1846.67 g), fruit length (11.20-21.70 cm), fruit circumference (40.33-49.00 cm), number of seeds/fruit (73.33-161.00), number of seed sac per fruit (13.00-16.00), seed percentage (0.67-2.27 %), shell weight (116.39-271.83 g), shell thickness (2.12-3.15 mm), pulp percentage (80.10-89.43 %) and fruit yield (37.21-70.23 kg/ tree). TSS varied from (33.00- 42.33°B), acidity (0.34-0.62%), vitamin 'C' content (13.08-28.15 mg/100g), total phenol content (1.67-3.01%), total sugar (15.81-22.17%), reducing sugar (6.63-10.96%) and non- reducing sugar (8.83-13.70%). On the basis of overall assessment, two seedling germplasm accessions *i.e*. Seedling S-31 having fruit weight (1018.33 g), fruit yield (52.00 kg/tree), TSS (42.33°B), seed percentage (0.93%), shell thickness (2.83 mm), 'vitamin C' content (28.15 mg/ 100 g pulp) and total phenol content (3.01%); and 'Seedling S-57' having fruit weight (1230.00 g), fruit yield (46.00 kg/ tree), seed percentage (1.34 %), shell thickness (2.12 mm), TSS (34.34°B), 'vitamin C' content (28.15 mg/100g pulp) and total phenol content (2.85%) were found to be most promising (Fig. 11).

Fig. 11. Fruits of elite bael germplasm lines selected (A) 'S-31' and (B) 'S-57'

Characterization of Bael germplasm from Malda district

Explorations were conducted for identification of superior bael accessions from homestead gardens of district Malda (West Bengal). Eight bael accessions were collected based on higher fruit size and other fruit quality traits following DUS guidelines. The maximum fruit weight (2.8 kg) was observed in Bael-10/21 and the minimum weight (1.1 kg) in Bael -3/21. The highest TSS content (44.4°B) was recorded in Bael- 3/21.

Genomic Resources

Six SRA sequences generated from transcriptome studies (RNA-sequencing) available in the public domain (NCBI) database were annotated and SRA sequence (SRX6949960: RNA-seq data using Ion torrent platform) was used for mining

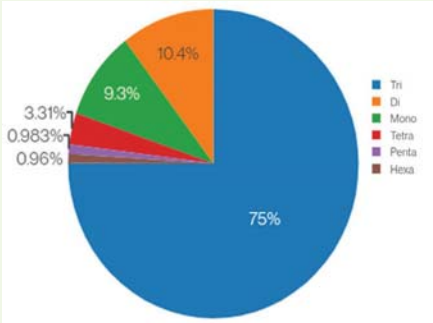


Fig. 12. Piechart showing distribution of imperfect SSR types

SSR regions. Around 300 imperfect SSRs (iSSR) were predicted to be predominant followed by perfect (pSSR) and compound (cSSR) due to the shorter length of the reads in the sequence datasets (Fig. 12). Around 100 SSR primer pairs were designed and validation is underway to be utilized in developing discriminatory markers for SSR fingerprinting of Bael varieties.

Aonla (*Embilica officinalis* Gaertn.)

Germplasm collection

Different districts of Madhya Pradesh viz., Rewa, Satna and Sahdol were surveyed and 19 accessions were marked and passport data were recorded. Fruit samples were analysed for various physical and biochemical parameters. The fruit weight varied from (9.23-43.87 g), fruit length (12.10-18.73mm), fruit diameter (12.80-22.67 mm), stone weight (0.53 -1.67 g), TSS (7.03-12.40 0B), ascorbic acid content (359.44-440.24 mg/100g pulp), acidity (0.66-2.22 %), total sugar (5.15-10.93 %), total phenol (0.85-2.25 %). On the basis of overall performance, 3 accessions i.e., 'T-7', 'T-8' and 'T-9' were found promising (Fig, 13). The scion shoots of these promising accessions were collected, used for grafting and multiplied in the nursery for planting in the field.

Fig. 13. Elite aonla lines selected (A) 'T-7', (B) 'T-8' and (C) 'T-9'

Germplasm evaluation

During the period under report, fruiting in aonla germplasm block was very low. The quality parameters of promising aonla accessions viz., CISH-A-31 and CISH-A-33 were assessed. The fruit weight (42.93 g) maximum recorded in CISH-A-33.fruit yield 43.12-53.10 kg/ plant, ascorbic acid ranged from 335.58-490.12 mg/100g pulp and total phenol content ranged between 0.98-1.73 per cent with maximum (1.73%) in CISH A-33 followed by CISH A-31. Both these accessions, CISH- A-31 and CISH-A-33 were found to be most promising having high content of vitamin 'C' and total phenol (Fig. 14).

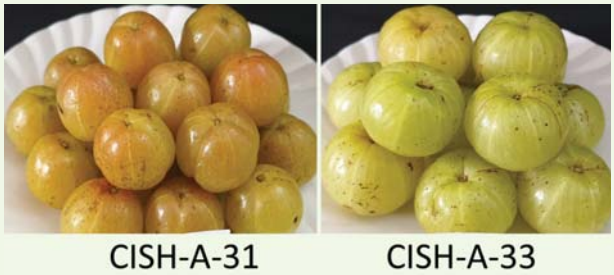


Fig. 14. Fruits of elite aonla lines selected (A) 'CISH-A-31' and (B) 'CISH-A-33'

Banana

Design and Development of Tissue Culture Bioreactor system for banana

Efforts were made to design a temporary immersion bioreactor system that consists of intermittently moistening the tissue with a liquid medium for short period of time, thereby mitigating shortcomings of conventional system A low cost pneumatic temporary immersion system, automated using timer circuit has been designed and built with a 4 tanks of 2 liter each, which will be upscaled for in vitro multiplication of banana and papaya. The parameters identified for design are duration of propagation process, immersion frequency and duration of aeration. The system was compared with different tissue culture systems of banana variety G-9 as described in table 6.Thirty days after the incubation, the multiplication rate (MR) was expressed as ratio of average number of shoots obtained from each sucker per bottle/bioreactor. The shoot biomass was expressed as ratio of fresh weight of shoot and dry weight of shoot after 4 weeks of culture. Preliminary data obtained revealed that (table 6) multiplication rate (MR) of banana was 4 times higher in bioreactor system (3 minute immersion after every 8 hours), while shoot biomass

enhanced more than 2 times, as compared to solid phase tissue culture system. The immersion frequency has been programmed for intervals of 1,2,3,4,5,6,7,8, hours respectively and aeration duration of 0,20,30,40,50, 60, 70 and 80 seconds are being parameterized.

Table 6. Effect of different tissue culture system on MR and shoot biomass of banana

Treatments	MR	Shoot Biomass (4 weeks)
Solid phase tissue culture system	2.16	8.8
Static liquid phase tissue culture system with 4 time air supplementation for 3 minutes	1.72	7.2
Agitated liquid phase tissue culture system with 4 time air supplementation for 3 minutes	3.30	9.6
Temporary immersion bioreactor system	9.60	16.2

Bioinformatics and Computational Biology

Refinement and validation of Quick Leaf Area Ver. 1.02 software

The software developed in previous years was refined during this year for better result under report. The refinement was done by taking into consideration of discoloration of border area. For validation, seven standard coloured geometric shapes were drawn as '.jpg 'images at 300 dpi resolutions (Fig.15).

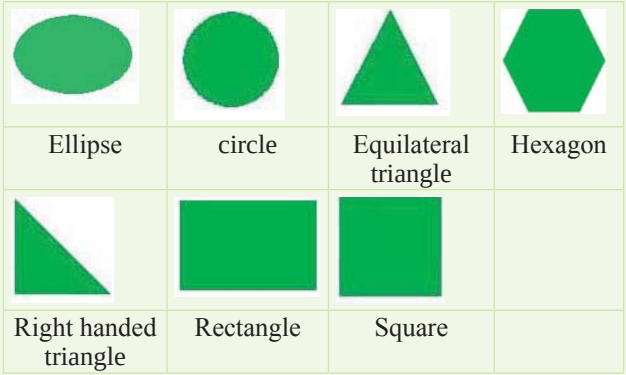


Fig.15. Different standard shapes (not to original size)

Computer program was executed using colored geometric shapes of known dimensions shown in fig.15. The result of the area of different geometric shapes as produced by software is shown in fig. 16.

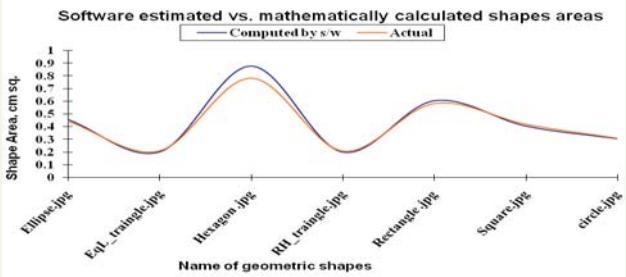


Fig. 16. Chart showing the comparison of different shape areas estimated by software vs. Actual

The result revealed that the RMSE value is 0.0367, which shows that estimated area by software has good agreement with actual area (i.e. mathematically derived area) of different geometric shapes. Error rate between estimated and actual areas is -0.79%. It was also found that the software slightly underestimated the area in some cases. The R^2 value was found to be 0.994.

Division of Crop Production

Mango (*Mangifera indica* L.)

Canopy architecture management in young orchard

Growth attributes in mango cv. Dashehari as affected by different canopy architecture management revealed highest number of 'A' grade fruits (84.53%) and 122.78 per cent more yield in T_3 (plants trained to 3 Primary and 3 secondary branches) compared to control at six years after planting. Pulp percentage, total soluble solids and ascorbic acid content were highest in T_1 (plants trained to 3 Primary and 2 secondary branches) and T_3 while titrable acidity content was lowest.

Canopy re-orientation in cv. Dashehari under high density plantation

The canopy re-orientation of high-density planting system of mango cv. Dashehari was started in 2015, involving 2 spacing (2.5 m × 2.5 m and 2.5 m × 5.0 m), 3 pruning height (1.5 m, 2.0 m and 2.5 m) and mulching. The growth yield and quality attributes after 5

years showed encouraging trends. Irrespective of pruning heights, maximum fruits (54.28 tree^{-1}) were recorded in trees of 2.5 m × 5.0 m spacing with average yield of 11.99 kg tree^{-1} and yield efficiency of 0.48 kg cm^{-2} TCSA (Fig. 1). However, maximum fruit numbers (37.47 and 35.17), yield (9.65 and 7.75 kg tree^{-1}) and yield efficiency (0.36 and 0.28 kg cm^{-2} TCSA) were recorded in trees pruned at 1.5 and 2.0 m, height respectively (Fig. 2).

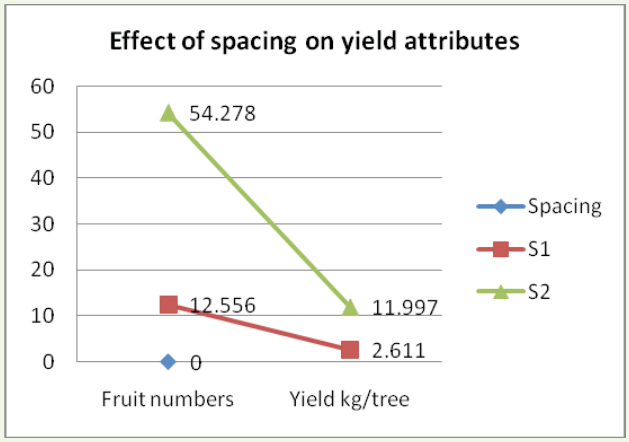


Fig. 1. Yield attributes in old and unproductive HDP mango cv. Dashehari

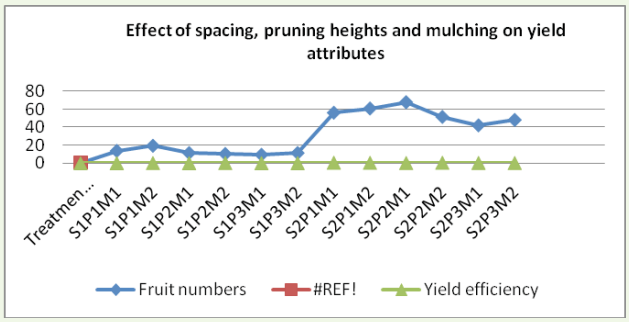


Fig. 2. Yield attributes in treatment combinations of HDP mango

Canopy management in old, unproductive and senile orchards

The experiment was initiated in January 2016 was continued with a view to refining the old mango rejuvenation technology for enhanced success and profitability. Treatments included heading back of primary branches to varying heights and training systems. The treatments were compared with performance of mango trees under old ICAR-CISH rejuvenation technology (T_1-Control) where trees were headed back to 2.5-3.5 m height. In case of T_2, central leader was kept higher (4-4.5 m) with side branches headed back to 2.5-3 m height while in T_3, central leader was restricted to 2.5-3 m with side branches upto 1.5-2 m height. In case of 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.

Maximum mortality (50%) of plants after cutting was recorded in T_3 followed by 20% in both T_1 and T_4. In the first year and second year, fruit yields from 50 to 100 kg tree^{-1} in T_5 and 100-150 kg tree^{-1} in case of T_6 were obtained from the un-pruned branches. Fruit size was far better in case T_5 as compared to T_6 due to lesser no of branches and fruits. At fourth year after cutting, maximum tree height (5.45 m) was recorded in T_5 followed by T_4. Minimum height was recorded in T_3 (4.25 m). Canopy spread in North–South direction was maximum in T_5 (5.49 m) followed by T_4 (5.47 m) and minimum in T_3 (3.80 m). Canopy spread in East-West direction was maximum in T_4 (5.80 m) followed by T_5 (5.04 m). Maximum death of primary branches and minimum number of secondary branches limb^{-1} was noticed in T_3. Best canopy development was noticed in T_5 with an average of 6 well distributed secondary branches per primary limb (Fig. 3).

Five years after rejuvenation, direct light availability at marble stage ranged between 41 – 63 per cent. Net assimilation rate (20.83 µmol CO_2 m^{-2}s^{-1}) stomatal conductance (217.47 mol H_2O m^{-2}s^{-1}) and vapour pressure deficit (4.28 kPa), total chlorophyll content (8.87 mg g^{-1} fresh weight) was found maximum in T_5. Furthermore, total and reduced glutathione was also more in the leaves of T_5 trees (344.21 and 284.58 µmol g^{-1} fresh weight, respectively). Hence, T_5 may be considered as suitable strategy for rejuvenation of old and senile mango trees.

Fruit yield was the highest in T_5 (28.35 kg tree^{-1}) followed by T_6 (18.78 kg tree^{-1}), T_4 (16.98 kg tree^{-1}), T_2 (11.64 kg tree^{-1}), T_1 (9.8 kg tree^{-1}) and T_3

(9.45 kg tree^{-1}). Analysis of physical and quality parameters revealed average fruit weight from 198 g to 254 g/fruit. Total soluble solids ranged in between 11.66 and 18° Brix while acidity was from 0.17 to 0.277 per cent. Vitamin C ranged between 22.91 and 35.41 mg 100g^{-1} pulp.

Fig. 3. Fruit bearing tree (T_5)

Evaluation of filler crops in rejuvenated orchard in cv. Dashehari

Rejuvenated orchard was used to explore the possibility of growing filler crops for enhanced profitability and sustained productivity. Different short statured fruit crops were grown as filler crops such as guava cvs. Shweta, Lalit and Dhawal, custard apple cvs. Atemoya × Balanagar and Arka Sahan, ber cv. Apple Ber, pomegranate cv. Bhagwa and dragon fruit (*Hylocereus costarecensis*). Plant height of guava cvs. Shweta and Lalit varied from 2.8 m to 4.3 m and 2.9 m to 3.65 m, respectively. Custard apple cvs. Balanagar and Arka Sahan × Balanagar (A×B) attained heights from 1.25 m to 3.5 m. Plant height in pomegranate cv. Bhagwa varied from 1.06 to 1.6 m. Plant spread (E-W) in guava and custard apple varied from 2.8 m to 3.6 m and 1.2 m to 2.90 m, respectively. Plant spread in north-west direction in guava and custard apple varied from 1.2 m to 3.85 m, respectively. Maximum height was observed in guava cv. Shweta while spread was maximum in guava cv. Lalit. Fruit yield in guava was obtained from 15.2 to 21.3 kg tree^{-1}. Height of dragon fruit varied from 1.2 m to 2.3 m.

Physiological studies in rejuvenated and non-rejuvenated orchards

Five years after rejuvenation, at marble stage of fruiting, availability of diffuse light beneath the tree in non rejuvenated and rejuvenated trees was 76.33 per cent and 33.00 per cent respectively. Net assimilation rate was 8.77 and 18.33 µmol CO_2 m^{-2}s^{-1} and stomatal conductance was 107.33 and 203.31 mol H_2O m^{-2}s^{-1} in leaves of non-rejuvenated and rejuvenated trees, respectively. However, vapour pressure deficit was more in rejuvenated trees (3.93 kPa) compared to non-rejuvenated trees (1.55 kPa). Total chlorophyll was also more in fresh leaves of rejuvenated trees (8.77 mg g^{-1}) compared to non-rejuvenated trees (4.63 mg g^{-1}). Furthermore, total and reduced glutathione was more in rejuvenated trees (337.77 and 279.71 µmol g^{-1} fresh weight, respectively) compared to non-rejuvenated trees (129.59 and 90.76 µmol g^{-1} fresh weight, respectively). Epicuticular wax in leaves of non rejuvenated trees was 0.24 mg cm^{-2} leaf area whereas in rejuvenated trees it was 0.52 mg cm^{-2} leaf area. After rejuvenation, newly emerged leaves of rejuvenated trees were exposed to direct sunlight and are better adapted to cope with the challenge of variable environmental conditions.

Physiological variations in different cultivars

Significant variation in the availability of light (direct and diffuse) and gas exchange parameters was found during different phenological stages of mango cvs. Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali. Diffuse light during bud development stage ranged 39.63 to 51.67 per cent, during maturity of fruits 57.33 to 68.44 per cent. A decrease in photosynthesis rate was recorded during inflorescence emergence and flowering stage. During fruit development stage, photosynthesis rate ranged between 10.33 – 14.47 µmol CO_2 m^{-2}s^{-1}, stomatal conductance ranged from 78 to 139 mol H_2O m^{-2}s^{-1} and vapour pressure deficit ranged from 1.87 to 3.23 kPa. Total chlorophyll and carotenoid content in fresh leaves varied from 5.33 to 7.78 mg g^{-1} and from 0.533 to 0.737 mg g^{-1}, respectively.

Variation in the antioxidant pool and antioxidant enzymes activity was found which specify the

variation in the environmental stress tolerance and resilience of cultivars to variable climatic conditions. Total glutathione content in leaves at flowering stage varied from 153.67 to 233.67 µmol g^{-1} fresh weight. Reduced glutathione was found to vary from 126.19 to 201.67 µmol g^{-1} fresh weight. The activity of glutathione reductase enzyme varied from 0.8123 to 3.1349 mmol substrate min^{-1} mg^{-1} protein. Further, total ascorbate content varied from 5.23 to 9.77 mmol g^{-1} fresh weight and ascorbate peroxidase activity varied from 2.29 to 7.67 mmol substrate min^{-1} mg^{-1} protein.

Considering the increasing awareness and growing interest among farmers/ general public in lowering the CO_2 emissions from different sources, carbon sequestration by six commercial cultivars of mango viz., Langra, Lucknow Safeda, Bombay Green, Dashehari, Mallika and Amrapali was estimated. Carbon sequestration potential of approximately 35–40-year-old mango trees was found to vary from 43.23 to 46.77 kg CO_2 per year (approx).

Jelly seed

The incidence of jelly seed was more in tree ripened (score 4 to 5) and late harvested fruits of Dashehari as compared to timely harvested (JS score 0 to 1). The TSS content was less in JS pulp as compared to healthy fruits. The activity of polygalacturonase (PG) was higher in jelly seed (147.72 galac mg-1 h-1 mg-1 pro) as compared to healthy fruits (92.19 galac mg-1 h-1 mg-1 pro). Furthermore, higher activity of α-amylase, cellulase and polyphenol oxidase was recorded in affected pulp (1.44 g kg^{-1} h^{-1} maltose liberated, 0.075 Ug^{-1} and 0.0208 Ug^{-1}, respectively) as compared to healthy pulp (0.81 g kg^{-1} h^{-1} maltose liberated, 0.031 Ug^{-1} and 0.0084 Ug^{-1}, respectively). Total antioxidant capacity was more in healthy pulp (628.77 mmol kg^{-1} Trolox) as compared to 'jelly-seed' affected pulp (547.27 mmol kg^{-1} Trolox), an indication of oxidative stress in 'jelly-seed' affected tissues.

Centre opening in mid-age orchard of cv. Dashehari

The experiment was initiated for giving the proper shape to over-grown trees of mango cultivar Dashehari for facilitating light penetration, improve yield and quality of fruits through centre opening (Fig. 4). The treatments comprised removal of one, two, three centrally located branches, crown thinning and control (no pruning). Pruning was done in January 2019. In the first year after cutting, Maximum average fruit yield (82.3 kg $tree^{-1}$) was recorded in the treatment where only one branch was thinned out from the centre. It was closely followed by two branch removal (61.4 kg $tree^{-1}$), control (37.6 kg $tree^{-1}$) and crown thinning (26.2 kg $tree^{-1}$). The year 2021 was relatively off year, and an average yield of 13.0 to 63.3 kg $tree^{-1}$ was obtained. Maximum fruit yield was obtained from one branch removal. Fruits of more than 250-g size were highest in two branch removal (78%).

Two years after centre opening, direct light availability beneath the trees increased from 25 – 59 per cent, leaf chlorophyll content ranged from 5.33 – 8.89 mg g^{-1} fresh weight, net assimilation rate from 7.67 – 12.57 µmol CO_2 $m^{-2}s^{-1}$, stomatal conductance from 162.57 – 191.23 mol H_2O $m^{-2}s^{-1}$ and vapour pressure deficit from 2.52 – 3.68 kPa. In addition, membrane lipid peroxidation varied from 3.43 – 7.12 nmol MDA mg^{-1} protein h^{-1} was recorded.

Fig. 4. Centre opening in mango cv. Dashehari

Evaluation of melatonin application for moisture stress tolerance

Three foliar spray of melatonin @ 00, 20, 50, 100 and 150 µM were applied at three phenological stages (fruit set, pea and marble stage) in 17-year-old mango trees. To compare with irrigation, a set of trees was given 3 irrigations and un-irrigated trees were maintained as negative control. At 3rd year, old leaves were comparatively less affected by moisture stress than the new flush. Total chlorophyll content in mature leaves of un-irrigated trees was 8.12 mg g^{-1} compared to 13.33 mg g^{-1} fresh weight in leaves of melatonin treated trees.

Activities of catalase, peroxidase, superoxidase dismutase and glutathione reductase in leaves varied from 32.55 µmol min^{-1} mg^{-1} protein, 0.633 µmol min^{-1} mg^{-1} protein, 805.77 U mg^{-1} and 9.43 µmol min^{-1} mg^{-1} protein in trees treated with melatonin @ 100 µM to 79.55 µmol min^{-1} mg^{-1} protein, 1.478 µmol min^{-1} mg^{-1} protein, 1079.21 U mg^{-1} and 17.473 µmol min^{-1} mg^{-1} protein in un-irrigated trees. In the irrigated and melatonin treated plants difference in activities of these enzymes was found to be non-significant. A radical difference was found in the yield of 'A' grade fruits (fruit weight ≥ 250g) in melatonin treated trees (@ 100 µM) (39%) and negative control plants (un-irrigated) (14%).

Drip fertigation scheduling in high-density orchards

Drip irrigation and nutrient scheduling influenced the growth, yield and quality of mango cv. Amrapali under high density plantation (HDP). Trees irrigated through drip at 80 and 100 per cent pan evaporation rates (PER) significantly exhibited highest canopy volume (1.678 m^3 and 1.673m^3, respectively) Fruit yield was maximum in trees drip irrigated at 100 per cent PER (4.12 t ha^{-1}) followed by those of 80 and 60 per cent PER (3.70 and 3.58 t ha^{-1}, respectively). Among fertigation schedule, fruit yield varied from 3.81 to 3.48 t ha^{-1} and the variations were non significant. Maximum TSS was recorded in trees drip irrigated at 60 per cent PER (22.58° Brix) and among fertigation schedule, highest TSS (22.08° Brix) was recorded in trees supplied with fertilizers at 80 per cent RDF.

Soil moisture status (0-30 cm soil depth) monitored at monthly intervals under different irrigation regimes revealed maximum soil moisture (24.50%) in trees drip irrigated at 100 per cent PER followed by those of 80 per cent PER (22.12%) and 60 per cent PER (19.37%) during 15th March and the situation prevailed upto 15th June. Among fertigation schedule, maximum soil moisture (21.81%) was found in trees supplied with 100 per cent RDF followed by those of 80 and 60 per cent RDF (20.85 and 19.28%, respectively), however, the variations were non-significant (Figs. 5 & 6).

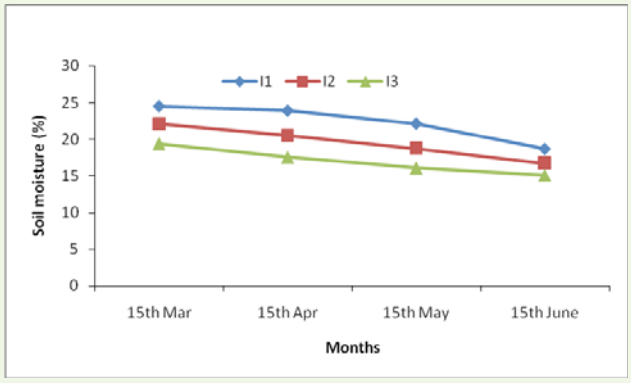


Fig. 5. Effect of drip irrigation regime on soil moisture status at periodical intervals in mango

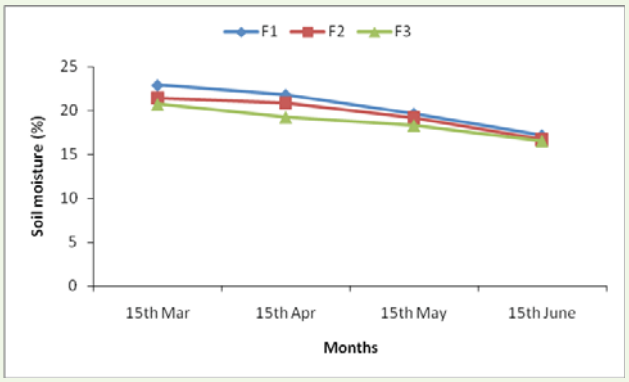


Fig. 6. Effect of fertigation scheduling on soil moisture status at periodical intervals in mango

Evaluation of soil and climatic indicators in orchards

Scientific analysis of extra terrestrial radiation in any sites is a pre-requisite for gaining knowledge on its dynamics and the extra terrestrial radiation

(Ra) varied from 21.78 to 40.73 MJ m^{-2} day^{-1} over mango orchards in Rehmankhera, Malihabad, Lucknow, Uttar Pradesh. The summer (32.8 to 40.68 MJ m^{-2} day^{-1}), monsoon (28.94 to 40.14 MJ m^{-2} day^{-1}) and winter (22.04 to 27.53 MJ m^{-2} day^{-1}) months had different levels of radiation.

Over hundred soil properties of mango orchards of seven villages in Uttar Pradesh were used for calculation of soil nutrient index of each village orchards. Results indicated that nutrient index values of soil organic carbon varied between 1.05 to 2.67. The soil available phosphorus was 1.00 to 1.56 and soil available potassium ranged between 1.29 to 1.91, respectively. The soil available Zinc had 1.24 to 1.78 index values. All the mango orchards had nutrient index values of soil available Cu as 1.00. For both soil available Mn and Fe, the soil nutrient index value recorded as 2.00. All these values were sufficient enough to indicate the status of the mango orchards in terms of their health ratings. The present scientific analysis showed widespread variations in terms of nutrient indexing in mango orchards. The characterization of soil available Zinc in most of the mango orchards rated under low. The available copper falls under low in mango orchards of all the villages. It is interesting to note that soil available manganese and iron designated as medium in all the mango orchards of all the surveyed villages.

Guava (*Psidium guajava* L.)

Enhancing productivity through espalier architecture

Guava cvs. Lalit, Shweta and Lalima planted under high density plantation and trained at espalier architecture system significantly exhibited maximum trunk girth in Lalit followed by Lalima (78.30 and 65.30 mm, respectively). Radial growth of the scaffold branches showed that the scaffold branches at the top most tiers were thicker than lower most. Similarly bearing pattern showed that maximum number of fruits were recorded on topmost 4th and 3rd tier of branches in Lalit (57.50 and 54 fruits $tier^{-1}$, respectively) while minimum in 2nd tier of branches from ground (21 fruits $tier^{-1}$). Similar bearing trends were recorded in Lalima and Shweta cultivars. Average fruit numbers were recorded maximum in Lalit (106.3) followed by Shweta (103.5). Fruits were smaller in size in rainy season (97-120 g $fruit^{-1}$), while fruits were larger in winter season (215-258 g $fruit^{-1}$). Average yield was recorded highest in Shweta (18.44 kg $tree^{-1}$) while minimum in Lalima (16.90 kg $tree^{-1}$) (Figs. 7 & 8).

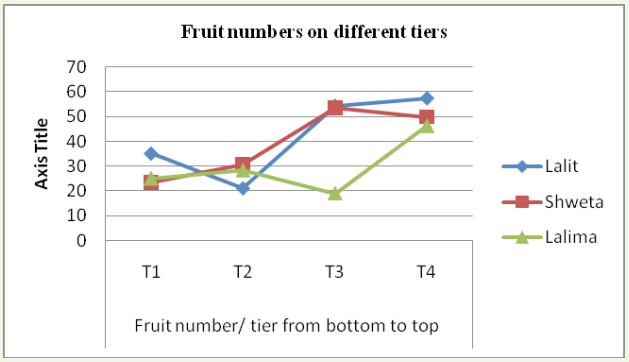


Fig. 7. Bearing pattern on different tiers of espalier architecture

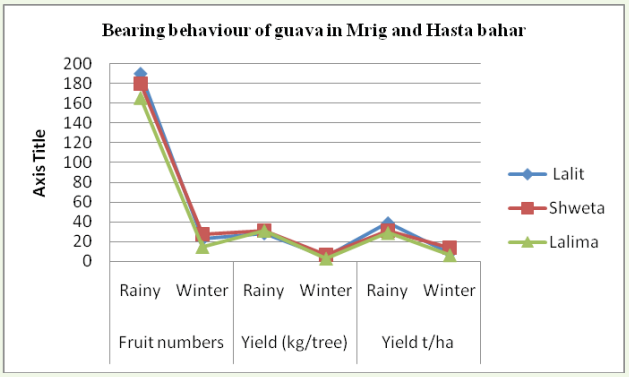


Fig. 8. Yield attributes of guava in Mrig and Hasta bahar of espalier architecture

Jamun (*Syzyjium cumini* Skeels)

Physiological studies in orchard for canopy management

Pruning was imposed to maintain open centre system and palmette system canopy architecture. Two years after pruning, total light availability was 26.33 per cent in control to 53.89 per cent in open system in south direction whereas only 21.39 per cent in control to 46.85 per cent in open system in north direction. Net assimilation rates in south and north direction were 6.17 and 5.67 µmol CO_2 m^{-2} s^{-1} in control and 14.87 and

9.07 µmol CO_2 m^{-2} s^{-1} in open system of pruning respectively. Similar variation in stomatal conductance was also recorded, which ranged 52.12 to 37.67 mol H_2O m^{-2} s^{-1} in control and 93.33 to 69.77 mol H_2O m^{-2} s^{-1} in open system in south and north, respectively. Values for light availability and gas exchange parameters for palmette system were in between the values in control and open system of training.

Bael (*Aegle marmelos* Correa.)

Physiological evaluation of different cultivars for fruit drop

Ten bael cultivars (CISH B-1, CISH B-2, NB-5, NB-9, NB-16, NB-17, Pant Aparna, Pant Shivani, Pant Sujata and Pant Urvashi) were evaluated for fruit drop and cold stress tolerance. In cultivars having more fruit drop during winter, canopy was found to be more damaged due to cold stress. Canopy of NB-16 and CISH-B1 was found to be least affected due to cold stress (5% approx leaf damage) whereas in CISH B-2, it was most affected (40% approx leaf damage) followed by Pant Shivani and NB-17 (35 per cent approx leaf damage). Electrolyte leakage in different cultivars was found to vary from 11.37% – 38.33% and lipid peroxidation varied from 6.68 – 17.49 n mol MDA formed mg protein^{-1} h^{-1}.

Other Fruits

Banana

Evaluation of organo-formulations and fertilizer application in banana

The experiment was conducted at Research Farm of ICAR-CISH, R.B. Road, Lucknow during September 2019 in banana cv. Grand Naine with 10 different treatments viz.; control (T_1), application of recommended dose of nitrogen and phosphorus (T_2), application of recommended dose of fertilizers as nitrogen, phosphorus and potassium (100% RDF) (T_3), recommended dose of nitrogen and phosphorus application along with organo- mineral formulation-K (T_4), 50 per cent RDF along with 50 per cent CSR Bio (T_5), 100 per cent CSR Bio (T_6), 50 per cent RDF along with 50 per cent Fusicont (T_7), 100 per cent Fusicont (T_8), CISH Bio-enhancer (T_9) and 50 per cent RDF along with CISH Bio-enhancer (T_{10}) (Fig. 9). Maximum fruit yield (85.75 t ha^{-1}) was recorded in T_3 followed by T_4 (78.64 t ha^{-1}) and T_7 (69.50 t ha^{-1}). Minimum fruit yield (34.68 t ha^{-1}) was recorded in control (T_1). Total Soluble Solids were found maximum in T_3 (21.17 °Brix).

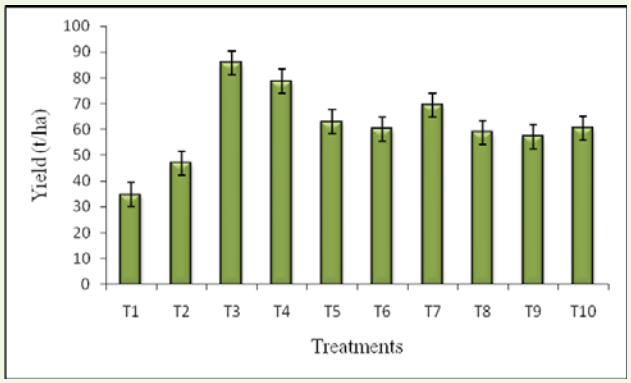


Fig. 9. Effect of organo-formulations and fertilizers on fruit yield of banana

Peach

Improving fruit size and quality under subtropics

The experiment was initiated during 2015-16 for identification of suitable varieties and improving fruit size and quality under subtropics. Peach cvs. Flordaprince, Earligrande, Pratap and Saharanpur Prabhat were found suitable under subtropical climate of Lucknow. Earliest maturity was recorded in Flordaprince and Sharbati (60-70 days after full bloom) while Pant Peach-1 and Shan-e-Punjab took 80-93 days after full bloom for achieving maturity stage. Fruit weight varied from 28 g to 80 g. For improving fruit size, hand thinning at 15 cm interval at 30-40 days after full bloom or 150 ppm GA_3 spray at full bloom stage was found to be best. Maximum fruit weight (95-108 g) was registered in fruits retained after thinning at 15 cm interval or those treated with 150 ppm GA_3. Yield efficiency was recorded maximum in fruits retained after thinning at 15 cm interval (1.54 kg cm^{-2}) and those treated with 150 ppm GA_3 (0.69 kg cm^{-2}). After 5 years

maximum yield per tree (25-40 kg tree^{-1}) was recorded in Earligrande, followed by Pratap and Saharanpur Prabhat.

Development of techniques for off season high value vegetable production

Hydroponic cultivation of Lettuce (*Lectuca sativa* L.)

Seven varieties of lettuce (V_1 - Bingo, V_2 - Tango, V_3 - Lolo Rosa, V_4 - Grad Rapid, V_5 - Summer Star, V_6 - Black Rose and V_7 – Romaine) were evaluated under three levels of electric conductivity (E_1 - 1.8, E_2 - 2.0 and E_3 - 2.2 dSm^{-1}) and three levels of pH (P_1 - 5.5, P_2 - 6.5 and P_3 - 7.5) so as to optimize the levels of EC and pH of nutrient solution and also to identify the suitable variety of lettuce for cultivation under hydroponic system. There was a linear increase in yield and quality attributing traits with increase of electric conductivity of growing nutrient solution. Crop growth increased with enhancement of EC levels of nutrient. Irrespective of varieties, plants grown under E_3 recorded maximum plant height, number of leaves, highest leaf weight with maximum shoot and root weight *vis-a-vis* maximum total antioxidants, carotenoids and total ascorbic acid (Figs. 10 & 11).

Hydroponics solution pH fluctuated because of unbalance anion and cation exchange reaction with absorption of nutrients by roots thereby affected the nutrient uptake due to non-buffering capacity of nutrient solution. Yield and quality of lettuce was also affected by different levels of pH of growing medium. Crop grown under P_2 resulted plant growth, shoot and root weight and also highest yield, besides increase in total antioxidants, carotenoids as well as total ascorbic acid content in the produce. (Figs. 12 & 13).

Lettuce variety Bingo recorded highest yield, average leaf and shoot weight where as maximum plant height, number of leaves per plant and average root weight was recorded in variety Lolo Rosa and leaf length and leaf width was found maximum in the verity Grand Rapid. Bio-chemical study revealed highest total antioxidants, carotenoids and total ascorbic acid content in produce of variety Black Rose (Figs. 14 & 15).

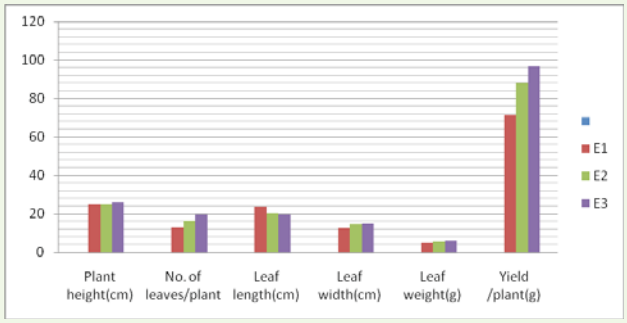


Fig. 10. Effect of EC levels (dSm^{-1}) on yield and yield attributing traits of hydroponic lettuce

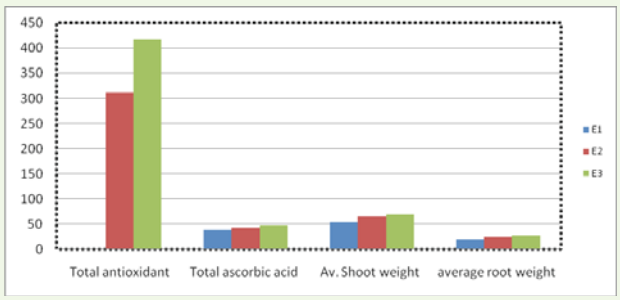


Fig. 11. Effect of EC levels (dSm^{-1}) on qualitative traits of hydroponic lettuce

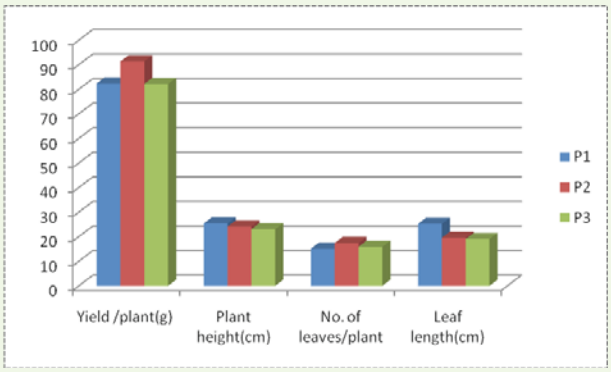


Fig. 12. Effect of pH levels on yield and yield attributing traits of lettuce

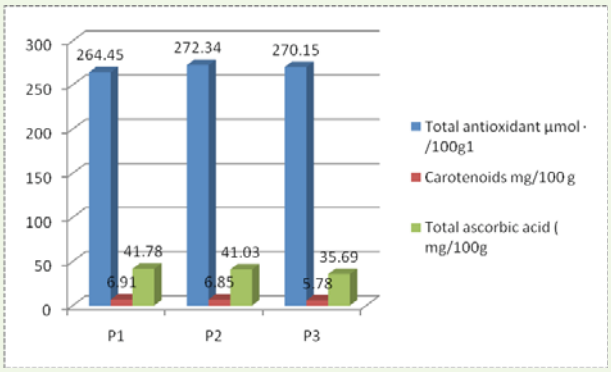


Fig. 13. Effect of pH levels on quality attributing traits of lettuce

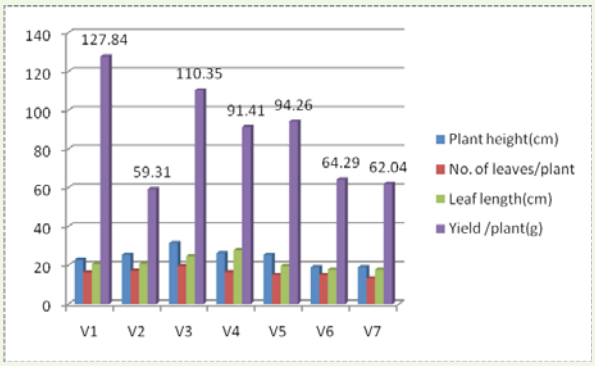


Fig. 14. Effect of varieties on yield and yield attributing traits of lettuce

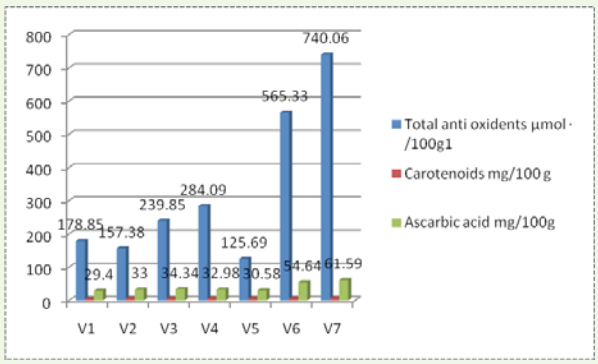


Fig. 15. Effect of varieties on quality attributing traits of lettuce

On farm trail

High density planting system in mango

High density orchards of ICAR-CISH mango varieties Arunika and Ambika along with orchards of mango cvs. Amrapali and Mallika were established in 2017 in more than 2 hectares area. Average canopy spread of 1.10-1.14 m, canopy volume of 0.89-0.92 m^3 were registered in Amrapali and Arunika after 4 years of plantation. Average number of fruits per tree were found maximum in Amrapali and Arunika (40.17 and 33.87, respectively). Maximum yield per tree (9.48 and 7.28 kg $tree^{-1}$) were obtained in Amrapali and Ambika respectively, while average fruit weight was recorded maximum in Mallika (292.67 g). Average canopy spread within row and between rows were found maximum (229.67 - 239.00 cm and 232.00 - 237.00 cm) in Ambika and Amrapali. Amrapali was found superior in terms of yield (10.53 t ha^{-1}) 5 years after plantation (Fig. 16).

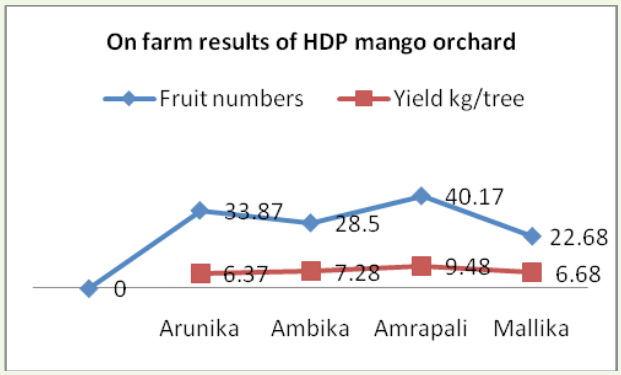


Fig. 16. Yield attributes of CISH mango varieties

Comparative study of conventional and refined rejuvenation technology in mango

On farm trial for comparison of existing and refined rejuvenation technology was conducted at farmer's field in the Hannikhera village of Mall block in the district Lucknow, Uttar Pradesh. Old trees of mango cv. Dashehari were given four treatments during December 2020 and January 2021 viz., T_1 – rejuvenation of trees using existing/ old rejuvenation technology, T_2 – rejuvenation of trees using refined rejuvenation technology, T_3 – heading back and maintaining one nurse branch, T_4 – control/ untreated. Each treatment was replicated on twenty-five trees. At the marble stage of the fruit set, availability of direct light was 56.33 per cent in T_2 while only 32.87 per cent in control. Similarly, maximum chlorophyll content (7.87 mg g^{-1}) was recorded in T_2 whereas minimum (4.23 mg g^{-1}) in T_4. Photosynthesis rate varied from 6.37 µmol CO_2 m^{-2} s^{-1} in control to 13.65 µmol CO_2 m^{-2} s^{-1} in T_2. Somatal conductance was found to vary from 188.18 – 249.63 mol H_2O m^{-2} s^{-1} and vapour pressure deficit 2.77 – 3.12 kPa. It seems that in refined rejuvenation technology, removal of 2-3 branches in one year and completing the rejuvenation process in 3 year makes the tree better adapt to the change in environmental/ microclimatic condition.

During treatment imposition, branches of different thickness (diameter of 9.0-35.0 cm) were headed back and thinned out. There was effect of branch thickness on emergence of new sprouts. Branches of 9 to 24 cm diameter having

cross section area (CSA) of 63.58 to 452.16 cm^2 were found more suitable for new ideal canopy development while branches of more than 24 cm diameter (CSA > 530.66 cm^2) were found to be not suitable for development of desired canopy because there were only 1 to 7 sprouts near cut end and there was no option of thinning of shoots and keeping outward developing shoots (Fig. 17).

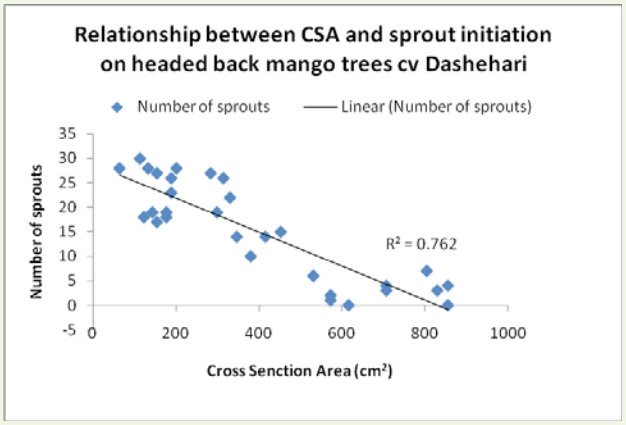


Fig. 17. Relationship between CSA of headed back mango branches and initiation of new sprouts

During the rejuvenation process, branches of different length were maintained after heading back. The length of headed back branches were 120 cm, 90 cm, 60 cm, 30 cm and < 30 cm (i.e., 20 and 15 cm). Observations were also recorded on length of headed back branch and sprout initiation. It was recorded that there was profuse sprouting (20.8 to 21.8 per branch) on headed back branches with length of 60 to 120 cm range. There was moderate sprouting (7.2 sprouts $branch^{-1}$) on stumps of 30 cm and there was no sprouting on stumps of less than 30.0 cm (Fig. 18).

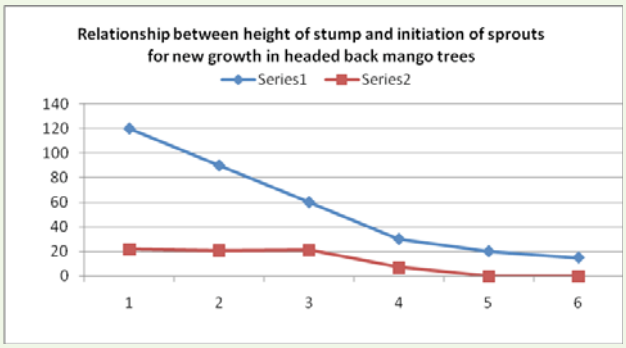


Fig. 18. Relationship between height of stump and sprouting on headed back mango trees cv. Dashehari

There was profuse flowering in treated trees during February 2021 except in T_1. Yield was recorded during June 2021 and it was observed that yield of 85.5 kg $tree^{-1}$ was recorded in T_2 and 40.0 kg $tree^{-1}$ in T_3 while it was about 50 kg $tree^{-1}$ in control. There were more than 40 per cent 'A' grade fruits in T_2 and T_3 while only 5 per cent in T_4. Among all the treatments, there was no mortality of tree due to pest incidence or any disease.

Identification of potent plant growth promoting bacterial strains

Two rhizobacterial strains R_4 and R_7 were identified as *Pseudomonas plecoglossicida* and *Acinetobacter bereziniae* respectively from Rehmankhera, Lucknow, Uttar Pradesh (Table 1). Both strains were tested for plant growth promoting attributes (IAA, and HCN production P, K, and Zn solubilization). It was observed that strain R_4 showed 23.53 µg mL^{-1} IAA as well as 9.85 µg mL^{-1} HCN production, and it solubilized 71.89 µg mL^{-1} phosphate, 52.72 µg mL^{-1} potassium and 57.75 µg mL^{-1} Zinc. While, strain R_7 produced 25.19 µg mL^{-1} IAA as well as 18.25 µg mL^{-1} HCN production, and solubilized 33.33 µg mL^{-1} phosphate, 46.14 µg mL^{-1} potassium and 49.12 µg mL^{-1} Zinc. (Fig. 19). Antagonistic interaction of two rhizobacterial strain R_4 and R_7 was checked with two different plant pathogenic fungi (*Fusarium oxysporum* MTCC – 284 and *Pythium* spp. MTCC – 10247). It was observed that R_4 efficiently antagonized to *Pythium* spp. MTCC – 10247 (suppression of 58.34% hyphal growth) and *Fusarium oxysporum* MTCC – 284 (suppression of 53.84% hyphal growth) (Fig. 20). Strain R_7 also showed a significant bio-control action against *Pythium* spp. MTCC – 10247 (inhibition of 50% hyphal growth) and *Fusarium oxysporum* MTCC – 284 (inhibition of 76.92% hyphal growth).

S. N.	Culture name	Location/ villages	Identified as (NCBI Blast)	NCBI Accession no.
	R-4	Rehmankhera	*Pseudomonas plecoglossicida*	MZ268247
	R-7	Rehmankhera	*Acinetobacter bereziniae*	MZ268246

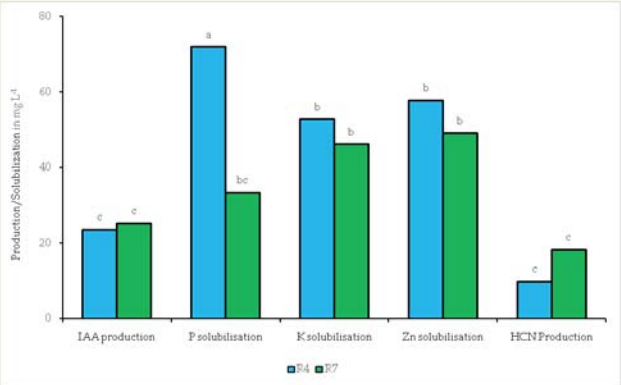


Fig. 19. Plant growth promoting activities of bacterial cultures

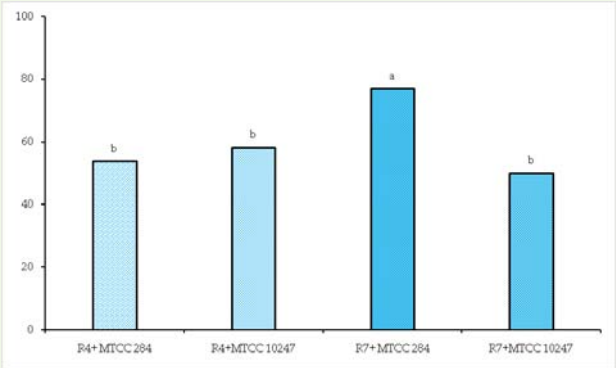


Fig. 20. Bio-control action of selected test isolates against *Fusarium oxysporum* (MTCC – 284) & *Pythium* spp. (MTCC – 10247)

Division of Crop Protection

Mango (*Mangifera indica* L.)

Population dynamics

Leafhoppers

The population dynamics of the leaf hoppers were out studied thought the year 2021. The hopper population was observed in two peaks, the first peak was recorded during the 13th SMW (Last week of March) with 15.9 hoppers/panicle and the second peak was observed during the 29th SMW (Second fortnight of July) with 12.4 hoppers/panicle (Fig. 1).

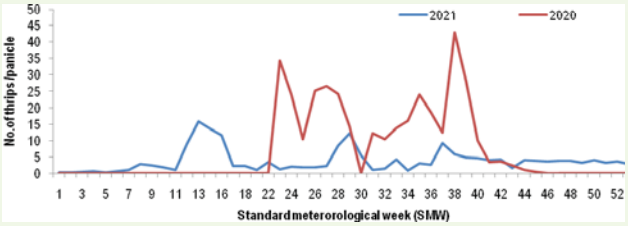


Fig.1. Population dynamics of mango leafhoppes.

Thrips

Thrips population was observed between the 3rd to 30th SMW during 2021. The peak thrips population was recorded during the 13th SMW (week of March) with 35.4 thrips/tap (Fig. 2).

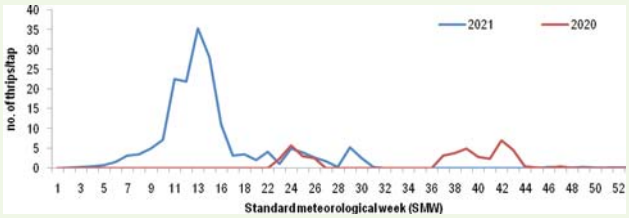


Fig. 2. Population dynamics of mango thrips

Leaf webber

The leaf webber incidence was observed between 29th to 47th SMW during 2021. The peak incidence of the leaf webber was recorded during the 31st SMW with 0.75 webs/tree (Fig. 3).

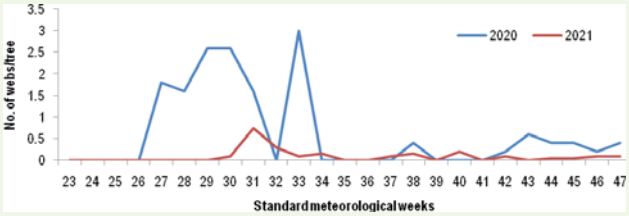


Fig. 3. Incidence of mango leaf webber

Semilooper

The incidence of semilooper (*Hyposidra talaca*) was observed between the 13th to 26th SMW during 2021. The peak incidence of the pest was recorded during the 19th SMW with 3.3 larvae/twig (Fig. 4).

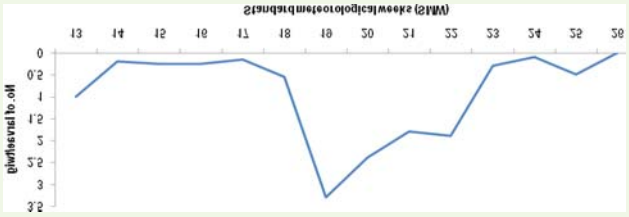


Fig. 4. Population dynamics of mango semilooper

Survey for mango disease dynamics

A survey of mango orchards were conducted in Lucknow, Sitapur, Lakhimpur Kheri, Hardoi, Shahjahanpur, Bareilly, Moradabad, Bijnor, and Meerut districts. Moderate to the severe incidence of blossom blight (18.3-48.5%), floral malformation (3.1-7.5%), leaf anthracnose (20.0-37.5%) and sooty mould (12.5-32.5%); and low incidence of powdery mildew (2.5-12.5%) and bacterial leaf blight (2.5-12.5%) were recorded at various locations in Lucknow, Sitapur, and Lakhimpur districts during February. Increased incidence of wilt (15% orchards) and twig drying (22.5% orchards) was observed in Moradabad, Bijnor, and Meerut districts during July. Incidence of shoulder black tip (1-3%) was also recorded in several orchards in Bijnor and Meerut districts on fruits of *cvs.* Langra and Chousa. Incidence and severity of shoulder browning was recorded 25.5-39.0% and 2.5-11.0%, respectively; in Moradabad, Bijnor, and Meerut districts during July. Severe incidence of bacterial canker was recorded in Bijnor and Meerut districts on fruits of mango *cvs.* Langra and Chausa. The incidence of Loranthus was recorded high (11.2%) in Lucknow district and low (2.0-3.8%) in other districts.

Disease dynamics

Powdery mildew

Incidence and severity of powdery mildew at Rehmankhera, Lucknow during 2021 was recorded low in the flowering season of mango. The first incidence was recorded during the 11th SMW, with hightest to peak (12.5%) during the 13th SMW (Fig.5). The severity of the diseases ranged from 2.5-5.0 PDI.

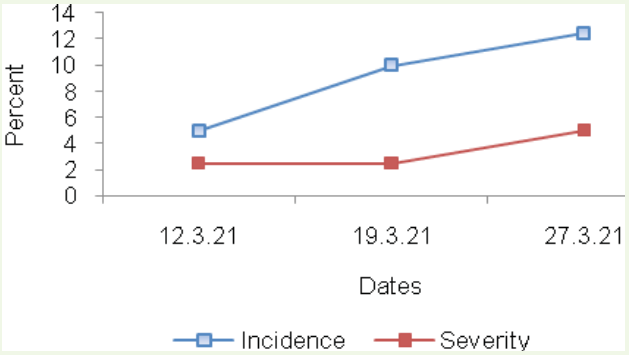


Fig. 5. Incidence and severity of powdery mildew at Rehmankhera, Lucknow

Blossom blight

Incidence and severity of blossom blight at Rehmankhera, Lucknow was recorded high in the flowering season of mango during 2021. The panicle emergence was recorded during the second fortnight of December 2020 to February 2021 and the incidence of the disease from January to March 2021. The incidence was recorded around 100% during 9th SMW and

the peak severity (57.0 PDI) during 11th SMW (Fig. 6).

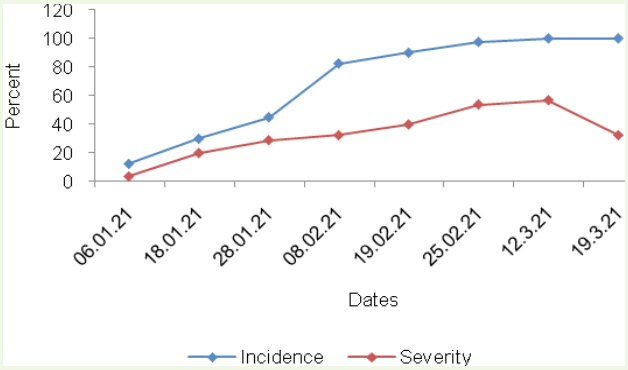


Fig. 6. Incidence and severity of blossom blight at Rehmankhera, Lucknow

Shoulder browning

Incidence of shoulder browning disease of mango fruits was recorded on *cv.* 'Mallika' during the second fortnight of June to till harvesting at Rehmankhera. The incidence and severity of the disease gradually progressed and incidence reached near to 100 percent during 28th SMW and the maximum severity (41.0 PDI) was recorded at harvest (Fig. 7). Heavy and constant rains not only supported disease development but also compelled to harvest the fruits earlier than previous years due to severe disease development and rotting of fruits.

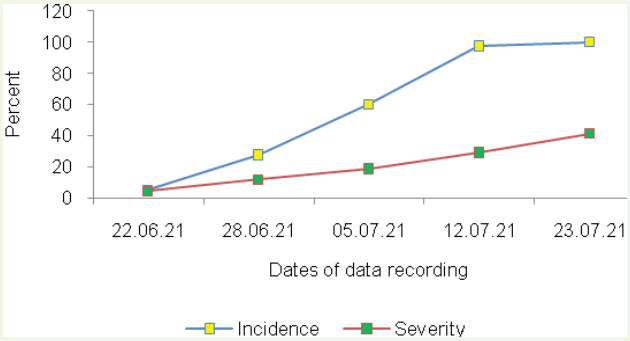


Fig. 7. Incidence and severity of shoulder browning at Rehmankhera, Lucknow

Development of detection assay for mango wilt/mango sudden decline (MSD) caused by *Ceratocystis fimbriata*

The mango wilt pathogen (*Ceratocystis fimbriata*) specific primers (-F-5'-TAGTGAGATGAATGCTGTTTTGGTG-3'; CF-R1-5' AAAAGTTGAGCGGGTTTAGCG GC-3') was designed and used to detect the pathogen from rhizospheric soil of wilted mango trees collected from different orchards of Uttar Pradesh (UP). DNA was isolated from the soil as well as wood samples of affected trees. Good quality DNA in the wood samples were obtained which was evident from the UV-Spectrometric quantity and quality analysis with A260/A280: (1.17-1.50) and -A260/A230: (0.42-1.0). The pathogen was successfully detected from the soil of completely wilted mango trees as well as trees that were in the initial phase of wilting. However, no amplification was obtained in the DNA isolated from the rhizospheric soil of banana, guava, and vegetable crops (Fig. 8 I) and trunk wood samples of wilted mango trees. The primers were able to detect the *C. fimbriata* at DNA concentration of even 0.1 pg/25 µl of final volume both from the pure fungal culture and rhizospheric soil and produced the amplicons of expected size i.e. ~470 bp and ~350 bp.The intensity of band decreased with the reduced DNA concentration (Fig. 8 II).

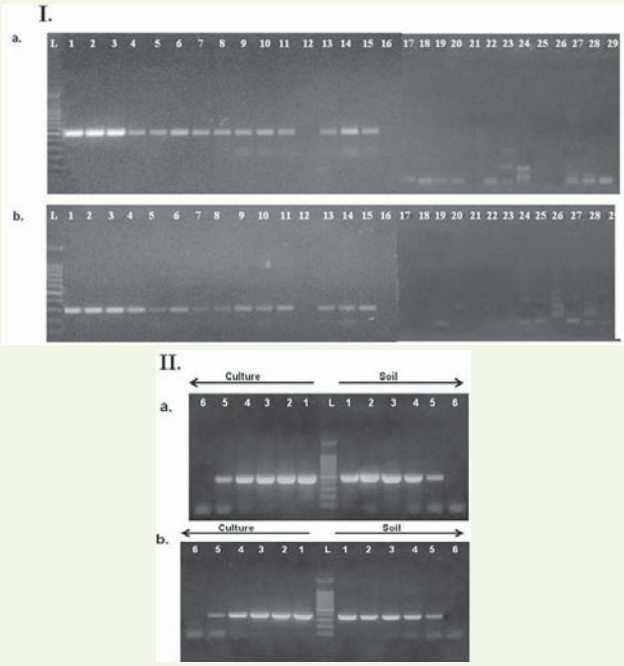


Fig. 8: I.: Detection of *Ceratocystis fimbriata* from soil samples of partially and completely wilted mango trees (Lane 1-15: rhizospheric soil samples of partially and completely wilted mango trees, 16: healthy mango tree, 17-20: guava rhizospheric soil, 21-24; Banana rhizospheric soil, 25-28: Vegetable rhizospheric soil, 29: sterilized soil); **II.:** Sensitivity assay of primers using different concentrations of DNA isolated from *Ceratocystis fimbriata* culture and soil sample (Lane 1: Stock DNA, 2: 1000 pg, 3: 100 pg, 4: 10 pg, 5: 0.1 pg, 6: nuclease-free water).

Isolation of *Parasympodiella eucalypti* associated with fruit spot from mango cv. Bangalora

The symptoms of fruit spot were observed in the orchards of Rehmankhera farm in mango cultivar Bangalora (Fig. 9a). The samples were collected and isolations were taken on Potato dextrose media (PDA) and Mathur's media. (Fig. 9b & 2c) Apart from *Colletotrichum gloeosporoides* and *Alternaria* spp., a new fungal isolate was isolated which sporulated profusely on Mathur's media. The pathogenicity was proved to establish Koch's postulates using detached leaf assay. The symptoms on inoculated mango leaves (cv. Dashehari) were observed on the 5th day of inoculation Fig. 9d). The molecular identification based on sequencing of partial rRNA gene suing ITS1/ITS4 primer pairs was performed and the fungus was identified as *Parasympodiella eucalypti* (OM442435). However, the study is subjected to further pathogenicity tests on mango fruits of different cultivars and the extent of this disease in field conditions.

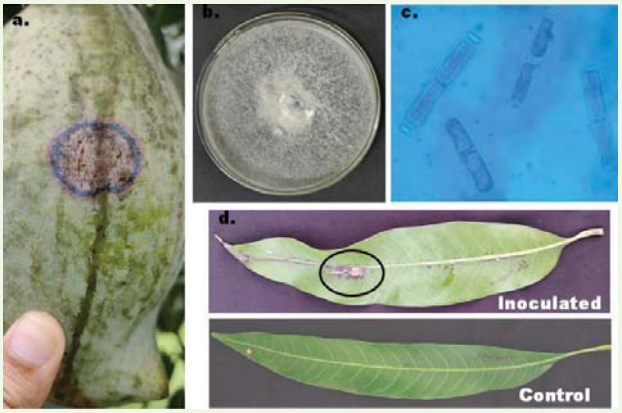


Fig. 9 a. Symptoms observed on Mango cv. Bangalora in Mango orchards, Rehmankhera. **b.** Mycelial growth of *Parasympodiella eucalypti* on Mathur's media. **c.** Microscopic observations of spores under 40X. **d.** Pathogenicity assay on detached leaves of Mango cv. Dashehari

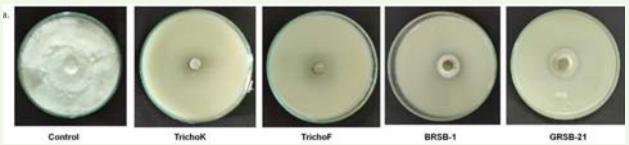
Isolation and pathogenicity test of *Lasiodiplodia theobromae* from wilted mango trees

The pathogenicity of *Lasiodiplodia theobromae* which was regularly isolated from the wood tissues of wilted mango trees was established in 2 years old mango trees (Fig. 3a). The inoculations were done by removing the bark of the stem (1cm x 1cm) and placing the 5 mm mycelial disk and covering it with plastic parafilm. The mycelial disk of plain PDA was placed in the case of control plants. Symptoms were observed in the case of inoculated plants (Fig. 10), and the control plants remained asymptomatic. The fungus did not sporulate on PDA as well as pine needle media. The identity is confirmed through ITS sequencing as *Lasiodiplodia theobromae*.

Fig. 10. Symptoms produced on inoculated mango plants

In vitro analysis of the antagonistic potential of rhizospheric bacterial and fungal isolates against mango wilt and root rot pathogen

Double Petri dish dual-culture assay was performed to observe the antagonistic effect of volatile organic compounds produced by rhizospheric antagonistic bacterial (PCEB-5, PCEB-8, GRSB-21, BRSB-1, GRSB-10b, GRSB-15a, and GEB-16b) and fungal (TrichoK and TrichoF) isolate on *Berkeleyomyces basicola*. Hundred percent of mycelial inhibition was obtained in the case of fungal isolates (TrichoF and TrichoK,–*Trichoderma* spp.). In the case of bacterial antagonistic isolates, the highest percent of mycelial inhibition was obtained in case BRSB-1 followed by GRSB-21 with 75.65 and 73.83 percent mycelial inhibition, respectively (Fig. 11a & b).



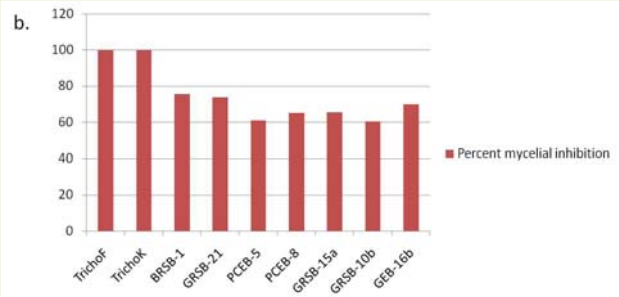


Fig. 11 (a) Mycelial growth of *Berkeleyomyces basicola* in control plate as well as in plates exposed to volatile organic compounds **(b)** Percent mycelial inhibition of *Berkeleyomyces basicola* by antagonistic rhizospheric bacterial and fungal isolates

Modified banding technology for mango mealybug

Modified banding technology was evaluated against the mango mealybug. The results indicated that the number of mealybugs ascended at the lower band was found significantly different among the treatments ($F_{6, 159}$=4.69; p<0.001). The highest number of mealybugs (248) stopped at the lower band was found in modified method with gum band, followed by the modified method with cello tape banding without upper restriction (172). The number of mealybugs congregated at the upper band indicated a difference among the treatments ($F_{6, 159}$ =4.71; p<0.001. The lowest number of mealybugs was found in the treatment modified method with gum band (0.54) followed by crack filling without upper restriction (7.42).

The number of mealybugs found in the buds of mango was also found significant among the treatments ($F_{6, 159}$=7.92<0.001). Among the compared banding methods, mealybugs were found only in the modified method with cello tape banding without upper restriction (1.04) and control (23 mealy bugs /bud).

Emergence pattern of mango thrips from soil

Monitoring of mango thrips emergence was done by collecting 700 grams of soil from below the canopy of mango trees. The first emergence of thrips was observed during the last week of March and peak emergence recorded during the second week of April with 296 thrips/ 700 grams of soil.

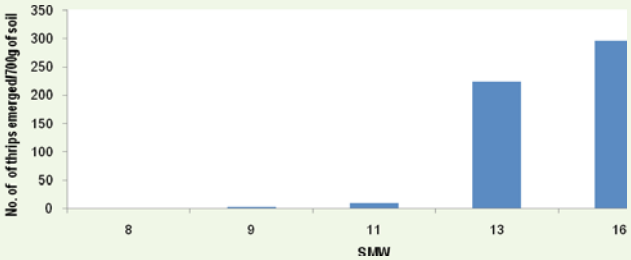


Fig. 12. Thrips emergence from soil

Bio-efficacy of newer insecticide molecules against mango thrips

Initially, fourteen insecticides were evaluated against mango thrips under field conditions. (Table 1) After 3 days of spray, a significant difference in as found amoung different treatment (F=8.47; p<0.00). Low incidence of thrips was found in the treatments with Abamectin and Emamectin benzoate with 9 and 9.7 thrips panicle^{-1}, respectively. Among these 14 insecticides, 11 were further evaluated in the field conditions. After 3 days of spray, the treatment effect is found significantly different (F=7.45; p<0.000), wherein low incidence of thrips were observed in Fipronil and Abamectin with 0.25 and 0.5 thrips panicle^{-1}. After 7 days of spray, all the treatments were at par with each other (F=26.09; p<0.00) except control (73.7 thrips panicle $^{-1}$) (Fig. 13).

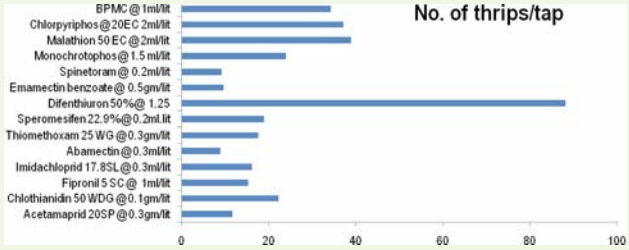


Fig. 13. Bio-efficacy of different insecticides against mango thrips in field conditions

Table 1. Bio-efficacy of different insecticides against mango thrips in the field conditions

Treatments	Before spray	Three DAS	Seven DAS
Acetamaprid 20SP @0.3gm/lit	8.00^{abc}	6.75^{ab}	17.50^{b}
Imidachloprid 17.8SL @0.3ml/lit	9.00^{abc}	1.75^{bc}	10.00^{b}
Speromesifen 22.9% @0.2ml.lit	7.50^{bc}	1.25^{bc}	10.50^{b}
Chlothianidin 50 WDG @0.1gm/lit	5.00^{c}	1.00^{bc}	10.25^{b}

Thiomethoxam 25 WG @0.3gm/lit	18.00[a]	1.25[bc]	22.50[b]
Difenthiuron 50% @ 1.25	10.00[abc]	1.25[bc]	13.50[b]
Fipronil 5 SC @ 1ml/lit	15.75[ab]	0.25[c]	8.75[b]
Spinetoram @ 0.2ml/lit	13.75[abc]	0.75[c]	9.50[b]
Abamectin @0.3ml/lit	8.75[abc]	0.50[c]	15.50[b]
Emamectin benzoate @ 0.5gm/lit	12.75[abc]	1.25[bc]	24.25[b]
Control	12.75[abc]	10.75[a]	73.75[a]
F value	3.53*	7.45**	26.09**

Means with the same letter are not significantly different.

Evaluation of attractants for female fruit flies

Different attractants were evaluated for trapping of female fruit flies (Table 2 & Fig. 14). The treatments were found to be significantly different with respect to female fruit fly ($F_{3, 40}$=4.334; p=0.010) catches. Ammonium acetate was found very effective in attracting female fruit flies with 33 female fruit fly catches within 12 days. Different doses were also evaluated and ammonium acetate at 4 % attracted the highest number of female fruit flies.

Table 2. Mean attraction fruit flies to the substrate (Mean±SE)

Treatments	Male	Female
Ammonium acetate + Water (10gm +20ml)	9.182±2.920	3.000±0.905
Ammonium acetate + Acetic acid + Water (10gm + 5ml + 20ml)	5.273±2.472	0.182±0.122
Ammonium acetate + Acetic acid + Vinegar + Water (10gm +5ml + 5ml + 20ml)	8.364±2.257	1.000±0.539
Ammonium acetate + Putrision + Water (10gm + 2ml + 20ml)	10.909±2.995	1.455±0.413
$F_{3,40}$	0.775	4.334*

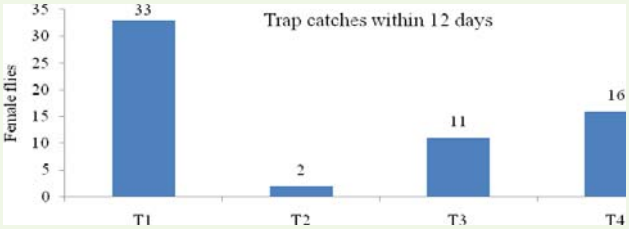


Fig. 14. Number of female fruit flies attracted in different substrates

Effect of different concentrations of ammonium acetate (AA) on fruit fly attraction

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

Table 3. Attraction of fruit flies to the different concentrations of AA (Mean±SE)

Treatments	Male	Female
Ammonium acetate 1%	25.250± 6.060	1.250 ± 0.479
Ammonium acetate 2%	34.750 ± 5.329	1.000 ± 0.707
Ammonium acetate 3%	36.000 ± 2.160	1.500 ± 0.957
Ammonium acetate 4%	14.500 ± 3.969	3.000 ± 0.816
Ammonium acetate 5%	17.500± 5.867	2.250 ± 1.031
Ammonium acetate 6%	8.250± 1.181	0.250 ± 0.250
F value	6.25 **	1.63NS

Field efficacy of *Bracon hebetor* on mango leaf webber

Larval parasitoid *Bracon hebetor* was evaluated against mango leaf webber (*Orthaga euadrusalis*) under field conditions by placing the third instar larvae in parasite recovery cages at different distances. The average parasitization of leaf webber by *B. hebetor* under field conditions was 62.5%. The highest parasitization of leaf webber was recorded at 1m and 2 m distance with 90 and 70 percent parasitization, respectively (Fig. 15 & 16).

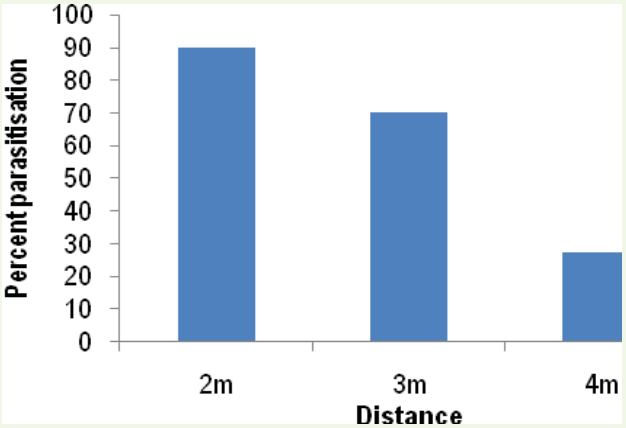


Fig. 15. Parasitisation of *Bracon hebeter* on mango leaf webber.

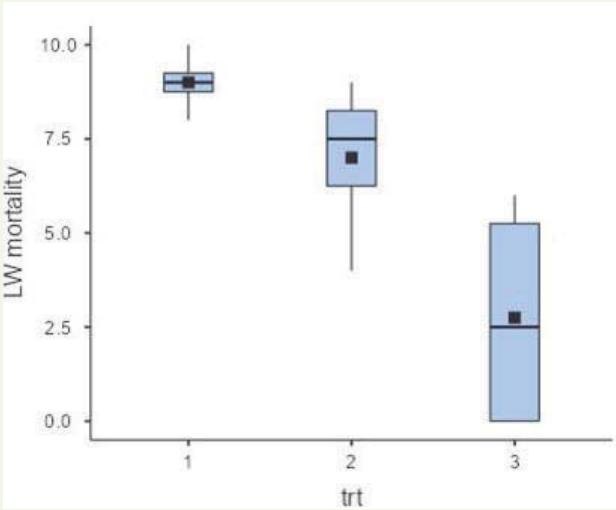


Fig. 16. Efficacy of *B.hebetor* on mango leaf webber

Field efficacy of *Bracon hebetor* on field bean pod borer

Larval parasitoid *B. hebetor* was also evaluated against field bean pod borer, *Maruca vitrata*, **(**Crambidae: Lepidoptera) under field conditions. The incidence (25.16 to 12.96 percent) of the pest was reduced up to 50 percent after two weeks of the introduction of *B. hebetor* in the field bean ecosystem (Fig. 17).

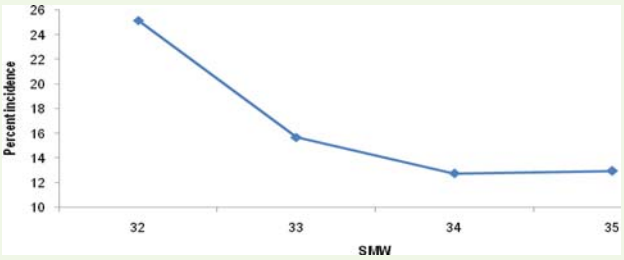


Fig. 17. Efficacy of *B.hebetor* on field bean pod borer *M.vitrata*

Bio-efficacy of insecticides and bio-agents against mango stem borer

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

Management of blossom blight on early panicles

An experiment was carried out to evaluate fungicides for the management of blossom blight (Table 4). The early panicles sprayed with fungicides were found to enhance the fruit set and yield. The spray of fluopyram 25 + trifloxystrobin 25 SC @ 0.08% was found most effective in managing the blossom blight followed by tebuconazole 430 SC @ 0.1%, azoxystrobin 11 + tebuconazole 18.3 SC @ 0.1%, trifloxystrobin 50WG @ 0.04% and carbendazim 12 + mancozeb 63 WP @ 0.2%, Propineb 70WP @ 0.2% respectively (Table 4). The disease management resulted in yield enhancement in comparison to untreated control.. The results indicated that the early panicles may give good yield following disease control measures.

Table 4. Effect of fungicide spray on blossom blight and yield of mango *cv.* Dashehari

Treatments	Dose (%)	06.01.21	18.01.21	28.01.21	08.02.21	19.02.21	25.02.21	No. of fruits/ tree
Fluopyram 25 + Trifloxystrobin 25 SC	0.08	1.6 ab	3.2 e	3.3 e	6.0 d	12.0 cd	34.0 d	336.0 a
Fluopyram 400 SC	0.05	4.1 a	16.7 b	20.8 b	22.2 b	32.3 b	47.7 b	213.3 b
Trifloxystrobin 50WG	0.04	0.1 ab	1.7 e	9.2 de	13.7 c	16.0 c	37.3 c	226.7 ab
Tebuconazole 430 SC	0.10	0.7 ab	2.5 e	9.2 de	10.3 c	14.0 cd	35.2 c	288.0 a
Azoxystrobin 23SC	0.10	0.9 ab	9.2 d	10.8 d	19.3 b	30.0 b	40.3 c	328.0 a
Azoxystrobin 11+Tebuconazole 18.3 SC	0.10	1.2 ab	8.3 d	9.2 de	8.7 cd	12.0 cd	36.0 c	206.7 b
Difenoconazole 25EC	0.05	1.8 ab	12.5 c	20.8 b	20.0 b	30.8 b	43.3 bc	188.3 b
Kresoxim - Methyl + Cholorothalonil (15 + 56 WG)	0.10	3.6 a	12.5 c	17.5 c	22.5 b	30.8 b	46.0 b	255.0 ab
Carbendazim 12 + Mancozeb 63 WP	0.20	1.9 a	4.2 de	4.2 e	14.0 c	20.3 c	37.7 c	280.0 a
Propineb 70WP	0.20	1.6 ab	6.7 d	13.3 d	17.7 bc	30.0 b	38.3 c	296.7 a
Untreated control	0.00	3.6 a	20.0 a	29.0 a	32.5 a	40.0 a	54.0 a	31.0 c
CD (0.05)		1.8	3.1	3.3	3.4	5.5	5.6	60.9

Management of shoulder browning

Prophylactic spray of fungicides, difenoconazole @ 0.05%, propineb @ 0.2%, trifloxystrobin 50WG @ 0.04%, azoxystrobin 23SC @ 0.1% and bagging of fruits were done on trees of mango *cv.* Mallika during June 21-22, 2021 at the onset of monsoon. Suppressive effect of all the treatments on severity of shoulder browning was highly significant in comparison to control (Table 5). Best management of shoulder browning disease was achieved by bagging of fruits (PDI 7.0) followed by trifloxystrobin (PDI 9.1), difenoconazole (PDI 12.0), and azoxystrobin (PDI 14.1), respectively. Trifloxystrobin treatment was next effective treatments at the time of harvesting (July 23, 2021). The cost of treatments was estimated Rs. 40.00 for propineb, Rs. 60.00 for difenoconazole, Rs. 70.00 for trifloxystrobin, Rs. 120.00 for azoxystrobin and Rs. 1600.00 for bagging of fruits for a 30 years old tree yielding 200 kg fruits.

Table 5. Efficacy of fungicides on shoulder browning at Rehmankhera

Treatments	Incidence (%)			Severity (PDI)		
Dates	22.06.21	07.07.21	23.07.21	22.06.21	07.07.21	23.07.21
Control	5.00	93.33 a	100 a	4.17	19.17 a	41.00 a
Bagging	5.00	5.00 c	30 b	3.33	4.17 bc	7.00 c
Trifloxystrobin	5.00	38.33 b	100 a	3.33	5.00 bc	9.10 bc
Difenoconazole	6.67	33.33 b	100 a	4.17	6.67 b	12.00 b
Azoxystrobin	6.67	36.67 b	100 a	2.50	8.33 b	14.13 b
Propineb	5.00	28.33 b	100 a	3.33	8.67 b	15.33 b
CD (0.01)	N/A	15.14	7.52	N/A	3.26	4.48

Guava (*Psidium guajava* L.)

Population dynamics

Fruit flies

Incidence of fruit flies was observed in 31st to 51st SMW. The peak incidence of the pest was recorded during 33rd SMW with 60.5 percent incidence (Fig. 18).

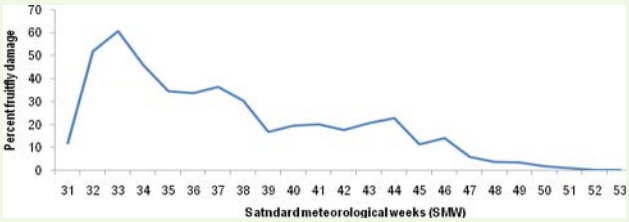


Fig. 18. Percent Incidence of fruit flies in guava during 2021

Fruit borer

Incidence of guava fruit borer were observed during 16th to 46 SMW. The peak incidence of the pest was recorded during 41st SMW with 2.2 percent incidence (Fig. 19).

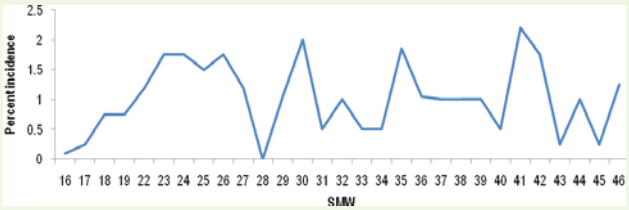


Fig. 19. Percent incidence of guava fruit during 2021

Shoot borer

The incidence of shoot borer was observed round the year. The peak incidence of the pest was recorded during 43rd and 48th SMW with 40 infested buds/trees (Fig. 20).

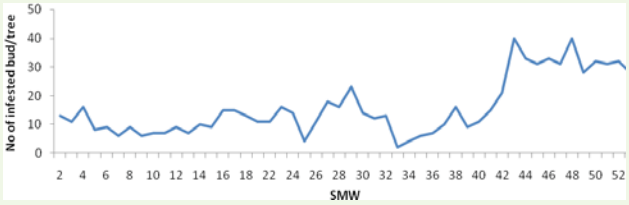


Fig. 20. Incidence of guava shoot borer during 2021

Semilooper

Semilooper incidence was observed during 14th to 25th SMW. Peak incidence was observed during 23rd SMW with 5.95 larvae /shoot (Fig. 21).

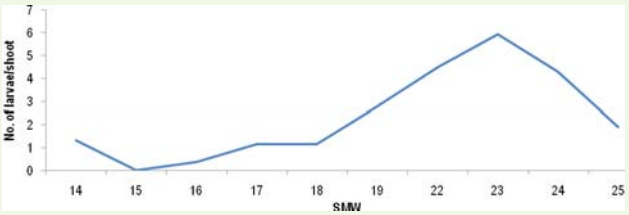


Fig. 21. Incidence of guava semilooper during 2021

Bio-management of guava wilt and decline

Experiments using bio-control agents for the management of guava wilt and decline caused by *Fusarium oxysporum* and *Meloidogyne enterolobii* complex have been conducted under controlled conditions with several effective options. The rate of application per kg of soil was 10^6 cfu/ml for bio-control agents, 2.5 and 25 ml for panch gavya, 100 g for vermicompost, 50 g cow pat pit, and 1 ml for fluopyrum. The growth of plants inoculated with both the pathogens and treated with *Pseudomonas aeruginosa* alone, *Bacillus* spp. alone, *Purpureocillium lilacinum* + *Bacillus* spp., *Trichoderma asperellum* + *Bacillus* spp., vermicompost + *Bacillus* spp., and vermicompost + *P. aeruginosa* was recorded higher than uninoculated control. Minimum colonization of roots by *F. oxysporum* was recorded in *P. lilacinum*, panch gavya 2.5 ml, vermicompost + *Bacillus* spp., and vermicompost + cow pat pit. The root-knot index caused by *M. enterolobii* was recorded minimum in plants treated with *P. aeruginosa* followed by panch gavya (25 ml), *Bacillus* spp., *P. lilacinum* + *Bacillus* spp., vermicompost + *P. aeruginosa*, and vermicompost + *Bacillus* spp. The results indicated that *P. aeruginosa* and *Bacillus* spp. were the most effective treatments in managing the disease and enhancing plant growth (Fig. 22). The next effective treatments were vermicompost + *Bacillus* spp., *T. asperellum* + *Bacillus* spp., vermicompost + *Bacillus* spp., vermicompost + *P. aeruginosa*, and *P. lilacinum* + *Bacillus* spp. The performance of *P. aeruginosa* and *Bacillus* spp. in enhancing the growth was better than fluopyrum but a little bit inferior in suppressing the nematode infection.

Treated with Pseudomonas aeruginosa | Untreated inoculated | Uninoculated Control

Fig. 22. Biomanagement of guava wilt and decline

Population dynamics of fruit flies in pointed guard

Fruit flies incidence on the pointed guard was recorded from 32nd to 41st SMW. The peak incidence of the pest was recorded during the 32nd SMW with 6.40 percent fruit damage by the fruit flies (Fig. 23).

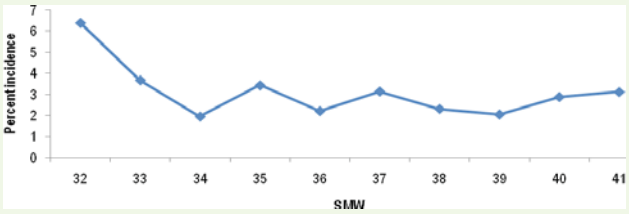


Fig. 23. Percent incidence of fruit flies in pointed guard during 2021

Cucumber moth

Cucumber moth *Diphenia indica* incidence was observed from 32nd SMW to 40th SMW. The peak incidence of the pest was recorded during 33rd SMW with 39.32 percent incidence (Fig. 24).

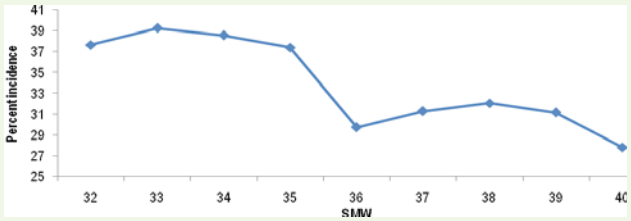


Fig. 24. Percent incidence of cucumber moth in pointed guard during 2021

Fruit drop of Bael

Fruit drop of bael has been a serious issue, therefore it was monitored at Rehmankhera just after the formation of fruits.The maximum fruit drop (166.3 fruits) was recorded during 26th SMW, which continued till 30th SMW. with >50 fruits/ week (Fig. 25). After which, the number of dropped fruits per week was reduced but continued on regular basis till 50th SMW. The dropped fruits were examined and infection of fungi was found more frequent in later stages.

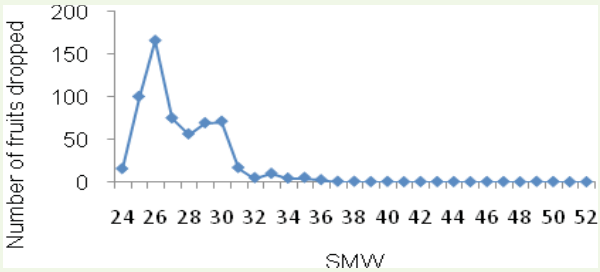


Fig. 25. Fruit drop of Bael during 2021

Division of Post Harvest Management

Mango (*Mangifera Indica* L.)

Estimation of nutraceuticals in pulp

Three nutraceuticals (lupeol, mangiferin, and β-carotene) were estimated in the ripe pulp of eight mango varieties (Bombay Green, Eldon, Baneshan, Shardabhog, Kishanbhog, Himsagar, Fazri, and Zardalu) and ten mango hybrids (H-1000, H-1042, H-1723, H-2146, H-3669, H-3803, H-3998, H-4208, H-4267, and H-4509). In the case of varieties, lupeol content was found maximum (52.03 μg g^{-1}) in Shardabhog closely followed by Kishanbhog (49.80 μg g^{-1}), mangiferin content was maximum in Baneshan (4.03 μg g^{-1}) and minimum in Bombay Green (0.25 μg g^{-1}), while the amount of β-carotene was maximum (42.66 μg g^{-1}) in Bombay Green and minimum (1066 μg g^{-1}) in Zardalu. In the case of hybrids, lupeol, mangiferin and β-carotene contents were recorded maximum in H-1042 (7.69 μg g^{-1}), H-1042 (8.41 μg g^{-1}), and H-4509 (76.66 μg g^{-1}), respectively. H-1042 was found a promising hybrid from a nutraceuticals point of view as it contained a good amount of β-carotene also (45.06 μg g^{-1}).

Estimation of nutraceuticals in leaves

An experiment was conducted to analyze three nutraceuticals (lupeol, mangiferin, and β-carotene) in leaves of five commercial mango cultivars (Dashehari, Langra, Chausa, Mallika, and Amrapali) by HPLC as the report of mango leaves possessing these nutraceuticals is available in the literature. The preliminary study revealed that leaves of Indian mango cultivars are also a good source of these nutraceuticals especially β-carotene and mangiferin. Amrapali leaves contained the maximum amount of β-carotene (120.3µg g^{-1}), while Langra leaves possessed the maximum amount of lupeol (51.45µg g^{-1}) and the maximum amount of mangiferin was recorded in Chausa leaves (37.5mg g^{-1}).

Shelf-life enhancement cv. Mallika by use of hexanal

Mango fruits cv. Mallika were treated with 1% and 2% hexanal for enhancing the shelf life under ambient conditions. Untreated fruits were treated as the control in the study. The fruits were analyzed for different physicochemical parameters at regular intervals of storage (0, 4, 6, 8, 10, and 12 days). The fruits treated with 2% and 1% hexanal had a shelf life of 12 and 10 days, respectively as against 8 days of shelf life in untreated fruits.

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

Mango fruits cv. Mallika was treated with *Lactobacillus plantarum* at 10^8 cells ml^{-1}, *Lactobacillus plantarum* at 10^8 cells ml^{-1} plus 2% CMC (Carboxy Methyl Cellulase) for 10 minutes and stored under ambient conditions. The fruits treated with *L. plantarum* plus CMC reported cumulative physiological loss of weight (CPLW) of 8.22% and firmness of 1.14 Kg cm^{-2} on the 10th day of storage while, the control fruits exhibited CPLW of 11.32% and firmness of 0.66 Kg cm^{-2}. The fruits were also assessed for other quality parameters such as TSS, acidity, total carotenoids, and antioxidants. Fruits treated with *L. plantarum* at 10^8 cells ml^{-1} plus 2% CMC had a higher shelflife of 12 days under ambient conditions.

Development of mango peel leather (vegan leather)

Vegan leather is a type of leather which is prepared from fruit wastes. Several trials were conducted to prepare leather (vegan leather) from mango peel waste which can be used for making fancy items like purse, bags etc. Extremely fine powder of mango peel was utilized along with certain chemical compounds to prepare the leather. A rough type of product could be fabricated that needs further improvement.

Protocol for post-cold storage of mango to export through sea route

An experiment was designed with treatments control (T_1), sodium hypochlorite (T_2), ethylene (T_3), and sodium hypochlorite + ethylene (T_4) to mango which was applied prior to cold storage. Mandatory quarantine hot water treatment at 46.8 °C for 1 hour was common for all the treatments. Each treatment was applied on 100 fruits and packed in CFB boxes and stored at low temperature. Fruits were withdrawn at four different times i.e. after 15 days, 21 days, 28 days, and 32 days of storage, and quality parameters were analyzed immediately after withdrawal and after three days of storage at room temperature. After 15 days of storage TSS, acidity, and firmness of all treatments were analyzed and no significant differences were reported in each treatment hence, it was continued. No disease incidence was noticed in all the treatments during

the first 15 days of storage. After 21 days and 28 days in cold storage, there were no significant changes noticed in TSS and acidity as compared to the previous withdrawal (15 days), hence it was continued and after 32 days in cold storage + three days at room temperature (total 35 days), it was found that fruits treated with fungicide and ethylene reported high TSS (20° Brix), low acidity (0.25%) and yellow colour significantly appeared on shoulders of the fruits and disease incidence was lower with less number of spoiled fruits as compared to other treatment. Therefore, it is concluded from the experiment that a combination of ethylene and fungicide with mandatory quarantine prior to cold storage significantly reduced spoilage and maintains sensory characters during -post-withdrawal at 32 days and three days storage at ambient conditions. Hence, the mango can be exported to the international market through sea routes to different parts of the world with 32 days shelf life and three days storage at ambient conditions.

Protocol for the development of environment-friendly mango ripening sachet

An experiment was conducted to develop a safe ripening sachet for the ripening of mango by using the different concentrations of ethrel and sodium hydroxide. The ethrel and sodium hydroxide was soaked in cocopit powder and five combinations (treatments) of both were used for the ripening of the fruits. The calculated amount of each five treatments ethrel and sodium hydroxide was mixed and put in a small sachet, one sachet was put in a 5 kg fruit box and it was stored at room temperature. After 120 hours it was found that mango ripening was significantly better in terms of TSS, acidity, and firmness in treatment (T_3) as compared to control.

Trend and instability in the area, production, productivity of mango in UP and India

Compound Annual Growth rate was used to estimate the trends in the area, production, and productivity of mango in Uttar Pradesh and India. Production and productivity of mango in UP grew at a rate of 3.89 and 3.64 percent, respectively. However, the growth in the area was just 0.23% per annum for the period from 1991 to 2020. Area and Production of Mango in India grew at the rate of 2.88 and 3.23 percent, respectively. The instability in mango production (14.40%) is high due to the instability in productivity (13.21%) in UP. Uttar Pradesh is the major mango-producing state in the country. The productivity of mango in UP (17.21 t ha^{-1}) is almost double in comparison to India's average productivity (9 t ha^{-1}). Because of the market glut during peak production, farmers are forced to sell at a lower price in local markets (the modal price of Rs. 2500.00 t^{-1}) which is the major problem in the Uttar Pradesh mango value chain. Thus, there is a need for policy intervention in terms of transportation subsidies / free train facilities for distant marketing of mangoes directly from the farmers/ farmer producer organizations which help in realizing higher prices. Appropriate policies and infrastructure facilities in terms of mango pack houses, cold storage structures are necessary to meet the untapped potential in the International market.

Model for Forecasting Mango Exports from India

A model was developed to forecast the export of Mangoes from India using the historical time series data from 1989. Though the data for 2020 and 2021 are available, these years were not considered for the analysis as the exports in these years were hampered because of the COVID-19 pandemic in the entire world. Initially, the stationarity of the time series was tested by using the Augmented Dickey-Fuller test which indicated that data was non-stationary (Fig. 1). Then the data was Box-Cox transformed and then differenced at the first order to remove the trend component. Box-Cox transformed first order differenced series showed stationarity (Fig. 2). Lag of AR and MA was worked out through PACF and ACF plots, respectively. By observing the values of ACF and PACF different combinations of ARIMA were made and the

best combination was selected. ARIMA (10, 0, 1) model was found best and was for forecasting the export of mangoes from India. Forecasting of mango exports was made from 2020 to 2028 (Fig. 3). Though 2020 and 2021 were very tragic with the incidence of lockdown during the peak mango season, India has exported about 21 and 26 thousand tones of mangoes, respectively. The forecast of export for 2020 and 2021 was around 35 and 37 thousand tones, respectively. It is expected that India is likely to export 58 thousand tones of fresh mangoes in 2025. In comparison with total production, the quantum of exports is very low. Hence, efforts are needed to reach out to the niche markets. Indian mangoes are comparatively costly in the distant International market because of high air freight

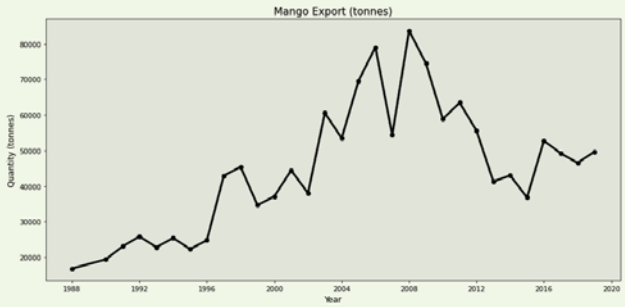


Fig. 1. Trend line of mango export from India

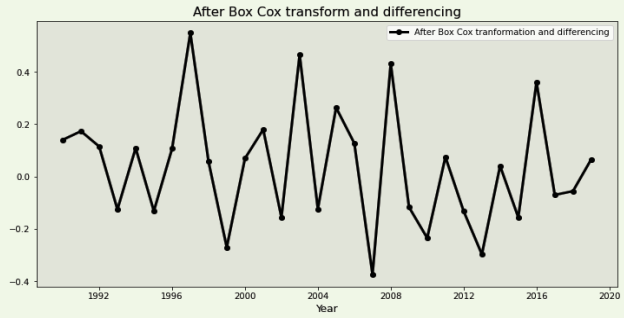


Fig. 2. Box Cox transformed first order differenced series

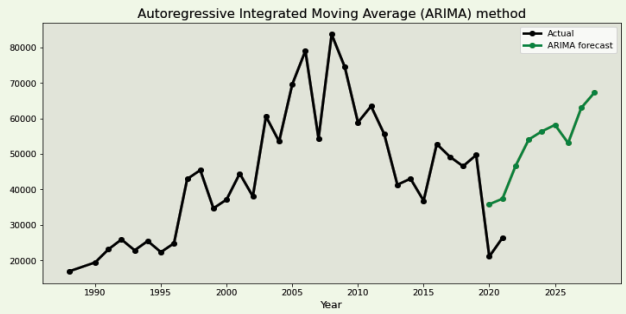


Fig. 3. Forecasting of mango exports from India (2020 to 2028)

charges. Hence, export through sea route should be focused upon. There is a need to conduct R&D activities to enhance the shelf life of mango making it suitable for export via sea route.

Residue determination of thiamethoxam in soil and its impact on soil enzymes

Chromatographic (HPLC) analysis revealed that thiamethoxam degraded from its initial level of 5.62 and 41.17 mg kg^{-1} to 0.60 and 2.10 mg kg^{-1} in rhizosphere soil of mango (cv. Amrapali) after 60 days of application from 0.2 and 2.0 g L^{-1} doses, respectively. Higher degradation from higher doses was recorded in soil. The rate of dissipation followed pseudo-first-order kinetics in soil with calculated half-life values of 23.10 and 13.86 days from lower and higher concentrations, respectively. Data from soil enzymatic shift for Dihydroacetate (DHA) and Flourescein Diacetate Activity (FDA) revealed that no shifting was occurred in control soil at 0 to 60 days while in treated soil DHA was slightly changed from 0.164 µg g^{-1} to 0.168 µg g^{-1} in T_1 and from 0.155 µg g^{-1} to 0.157 µg g^{-1} in T_2. FDA changed from 0.761 µg g^{-1} to 0.717 µg g^{-1} in T_1 but no significant change was observed in T_2. An increase in bacterial population in treated soil and continuous degradation of thiamethoxam indicated the presence of thiamethoxam degrading bacteria in mango rhizosphere soil.

Microbial degradation of thiamethoxam in broth

Thiamethoxam was applied in Minimal Salt Medium (MSM) at varying concentrations (2.0, 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0%) along with two different bacterial populations to study its degradation by bacteria in broth. Those bacteria were isolated from thiamethoxam contaminated mango orchard soil. The MSM was incubated at 30 °C for 30 days and sampling was done at 5 days intervals. After 30 days, bacteria 1 was found more effective in degrading thiamethoxam than bacteria 2 in MSM as degradation was 2 – 3 times higher in bacteria 1 than in bacteria 2. The degradation of thiamethoxam in control samples ranged between 30511.50 to 80631.99

µg ml^{-1} from seven concentrations, whereas by bacteria 1 it ranged between 171.82 to 401.65 µg ml^{-1} and by bacteria 2 it varied from 409.47 to 1101.11µg ml^{-1}. The data revealed that both the bacteria were highly effective in degrading thiamethoxam in broth.

Guava (*Psidium guajava* L.)

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

Guava fruits cv. Lalit were treated with hexanal at 0.01%, 0.015%, and 0.02% for comparing the shelf life of guava under ambient conditions. Untreated fruits were also maintained as control. At regular intervals of 0, 4, 6, 8, and 10 days of storage these fruits were analyzed for different physicochemical parameters. On the 8th day of storage, the fruits treated with 0.015% hexanal were more efficient and had TSS of 15.13°B, titratable acidity of 0.43%, and ascorbic acid content (159.46 mg 100 g^{-1}).

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

Guava fruits cv. Lalit were treated with *L. plantarum*, *L. plantarum* + 2% CMC (Carboxy Methyl Cellulase). The fruits were packed in brown paper bags and stored under ambient conditions. The fruits were analyzed for different storage parameters at regular intervals of 0, 4, 6, 8, and 10 days. The fruits treated with *L. plantarum* + 2% CMC had a shelf life of 8 days compared to the control for 6 days.

Aonla (*Embilica officinalis* Gaertin)

Preparation of improved aonla candy through microbial intervention

Aonla candy available in the market is generally deeper in color and sticky in nature. In most cases, it possesses above optimum sweetness and low crispiness. An improved technology was evolved for better quality candy preparation through microbial intervention. The technology involved lactic acid fermentation of aonla under anaerobic conditions using *Lactobacillus*. The slices were dried in an electric dehydrator to an intermediate moisture level at 60 °C. The technology produces a liquid by-product as aonla probiotic drink, which contains a high population of living *Lactobacillus* bacteria. The resultant candy was attractive light in color, non-sticky, optimum sweet, and highly crispy. The candy (Fig. 4) was found to have 18.4% moisture, 84° B TSS, 2.35% acidity, 327 mg 100 g^{-1} vitamin-C, and 2.43% total phenolics. Further, a spiced version of improved aonla candy was also prepared using Indian spices. It was dried open at room temperature to an intermediate moisture level. It contained 30.9% moisture, 700°B TSS, 1.80% acidity, 245 mg 100 g^{-1} vitamin-C and 1.88% total phenolics.

Fig. 4. Improved aonla candy

Preservation of aonla slices-in-honey

Aonla and honey are food materials of immense medicinal importance. A methodology was standardized for preserving aonla slices in honey. It is a honey-based seedless preserve form of product that is easier to prepare and more convenient to eat and serve. Unlike preservation, preparation does not involve a cumbersome pricking process, requiring extra labour and time. It can easily be taken with spoons or forks, so more convenient to serve. Besides, the product possesses honey which is a better alternative to sugar as for as human health is concerned. The product was found to contain 52°B TSS, 1.66% acidity, 225 mg 100 g^{-1} vitamin-C, and 1.48% total phenolics.

Development of honey-based aonla candy

A process for honey-sweetened aonla candy was standardized. The product is a dry version of aonla slices-in-honey which is prepared by drying the honey-sweetened slices in an electric dehydrator to an intermediate moisture level to maintain softness as well as crispiness of

the product (Fig. 5). It is extra-convenient to eat, pack and carry. The nutrients here are present in more concentrated form so more health-promoting.

Fig. 5. Honey-based aonla candy

Development of mangiferin-lupeol enriched aonla prash

Mango fruit especially peel contains two important bioactive compounds, namely, mangiferin and lupeol. These are very potent against cancer. A mangiferin-lupeol enriched aonla prash was developed using Indian spices and herbs (Fig. 6). The product was found to contain 1.99% fibre, 70°B TSS, 3.86% acidity, 69 mg 100 g^{-1} vitamin-C, 4.65% total phenolics and 9.11% reducing sugars. A jaggery-based mangiferin-lupeol enriched aonla prash was also tried containing 73°B TSS, 4.42% acidity, 66 mg 100 g^{-1} vitamin-C, 3.61% total phenolics, and 4.70% reducing sugars.

Fig. 6. Mangiferin-lupeol enriched aonla prash

Development of Gur Prash

A jaggery (gur) based prash containing aonla as chief ingredient besides Indian herbs and spices was formulated. Earlier, aonla prash was developed using other form of sweetening agent. Jaggery is a natural and raw form of sugar which also contains certain plant compounds that are beneficial for health. Unlike chyavanprash, it is non-sticky in nature with pleasant jaggery taste and flavor. Gur Prash (Fig. 7) was found to contain 81.7 mg 100 g^{-1} vitamin-C, 2.90% total phenolics and 13.2% reducing sugars.

Fig. 7. Gur Prash

Development on jaggery based aonla wine

Generally, sucrose sugar is used for the production of wines. However, it is not a very health-friendly stuff and is responsible for many kinds of human diseases. Jaggery (gur), on the other hand is more natural and safe sweetening agent. So, a jaggery-based aonla wine was prepared and evaluated. The prepared wine had 9% ethanol, 7.8°B TSS, 1.24% acidity, 105 mg 100 ml^{-1} vitamin-C, 929 mg 100 ml^{-1} total phenolics and 0.17% reducing sugars.

Hot water-dispersible aonla-herbal tablet

Hot water-dispersible aonla-herbal tablet was developed using aonla, herbs and other ingredients and is rich in anti-oxidant compounds having high pro-health properties. Earlier, sachet-based aonla tea was developed by the Institute. However, it was not environmental friendly as disposal of the sachets was a problem. Hence, auto dispersible aonla-herbal tablet was developed which sorted the problem of discarding the sachets (Fig. 8). Tablet is completely soluble and leaves no un-edible part as residue. These tablets when dipped in hot water disperses very easily without the need of stirring which makes them friendly to use while traveling. The sensory evaluation of the

product was done by a panel of 12 semi-skilled judges on the basis of colour, aroma, taste and overall acceptability and the average scores were 9.17, 9.00, 9.17, and 9.17, respectively. 100 ml of prepared drink comprises 1000 µg of vitamin C, 40 mg of phenolics, and has TSS of 4.8° B, 0.19 g of acidity. The product can be stored at room temperature for six months without any loss in chemical or sensory properties.

Fig. 8. Hot water-dispersible aonla-herbal tablet

Strawberry products

Strawberry contains a very pleasant aroma and attractive red color due to the rich amount of anthocyanins present in it. Puree, squashes, crush, candy, dried halves (flakes), bar, choco-candy and probiotic drink were developed from strawberry (Fig. 9). Pure strawberry pulp was found to contain 7.2°B TSS, 1.36% acidity, 13.7 mg 100 g^{-1} vitamin-C, 155 mg 100 g^{-1} total phenolics, 17.2 mg 100 g^{-1} anthocyanins, and 2.66% reducing sugars.

Fig. 9. Strawberry products

Karonda (*Carissa carandas*)

Karonda powder

Dehydration of Karonda fruits under regulated conditions resulted in karonda powder with excellent colour and flavour. Karonda powder was found to be a good source of vitamin C (38 mg 100 g^{-1}). The powder was stored at room temperature after being wrapped in food-grade flexible packaging material. Karonda powder can be utilized in a variety of culinary products as a functional ingredient and natural colourant.

Karonda instant beverage mix

Karonda instant beverage mix was formulated with ginger powder, black pepper, citric acid and sugar to obtain instant beverage mix. The beverage mix reconstituted in water resulted in highly acceptable beverage with deep red colour, flavour and overall quality. The beverage mix had a TSS of 15° B. The product packed in polyethylene pouches was found to be highly acceptable for 3 months storage at room temperature.

Karonda nutri jam and jelly

The process conditions were optimized based on various combinations to prepare nutri jam and jelly (Fig. 10) from various fractions of Karonda, Apple, and Papaya. The sensorial accepted products packed in Glass container were stored at low temperatures (4±1 °C) and found microbiologically safe and stable during prolonged storage (beyond six months).

Fig. 10. Karonda nutri jam and jelly

Flagship & Externally Funded Projects

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

Name of the PI: T. Damodaran

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

Multiplication of nematodes

To establish the role of plant-parasitic nematodes in aggravating the banana wilt caused by *Fusarium oxysporum* f. sp. *cubense* race TR4 surveys were conducted and the plant-parasitic nematodes isolated from soil samples were inoculated in the rhizosphere of banana *cv.* Grand Naine under sterile conditions. Almost 7 months after inoculation species of *Meloidogyne, Xiphinema, Helicotylenchus, Tylenchorhynchus, Rotylenchulus,* and *Pratylenchus* were found to multiply well and *Hoplolaimus* at a low level.

Genetic diversity of *Fusarium oxysporum* f.sp. *cubense* isolates assessed through ISSR markers

For assessing the genetic diversity of 41 Foc isolates, total DNA was isolated and PCR using DNA of all the 41 isolates were performed with 8 ISSR markers. The PCR products were checked on 1.2% agarose gel, bands were scored and the presence or absence of bands indicated as 1 or 0, respectively. The dendodram was constructed using the NTSYS software which clearly differentiated the TR4 and Race 1 isolates by clustering the TR4 isolates from UP and Bihar in Clade A and Race 1 isolates from Assam, Gujarat, Tamil Nadu and Andhra Pradesh in clade B (Fig. 1). SCAR marker development for specific identification of TR4 and Race 1of *Fusarium oxysporum* f.sp. *cubense* is underway.

Flagship project: Integrated Management of Guava wilt

Name of the PI: P.K. Shukla

Name of the Co-PIs: S. Rajan, Maneesh Mishra, MuthuKumar M., Israr Ahmad, Gundappa, Nidhi Kumari, Govind Kumar

Invitro evaluation of antinematicidal properties of rhizospheric bacteria and fungal isolates against *Meloidogyne enterolobii*

To analyze the anti-nematicidal properties of biocontol agents *viz.*, TrichoK, TrichoF, BRSB-1, GRSB-21, GRSB-10b, GRSB-15a, GEB-16b, PCEB-5, PCEB-8 against *M. enterolobii,* the J2 of *M. enterolobii* were harvested. The J2 population was kept at 200±20 J2/ml and cell free supernatant of overnight and 7 days old culture of bacterial and fungal biocontrol agents, respectively were used. All the antagonistic agents resulted in more than 70 per cent J2 mortality, however, maximum mortality (100%) was observed in case of TrichoF, GRSB-10b and GEB-16b isolates while least was obtained in case of PCEB-5 (75.44%) isolate.

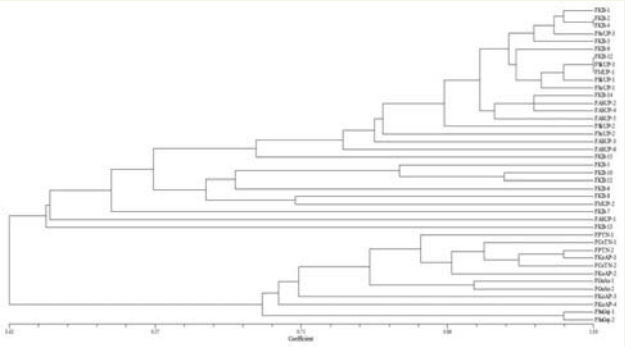


Fig. 1. Dendogram of 41 *Fusarium oxysporum* f.sp. *cubense* isolates constructed using NTSYS software based on ISSR data

Plant growth promoting properties of potential biocontrol agents

Seven bacterial isolates *viz.*, BSRB-1, GRSB-21, PCEB-5, PCEB-8, GRSB-15a, GRSB-10b and GEB-16b showing antagonism against

F. oxysporum and *Berkeleyomyces basicola* were also tested for their plant growth promoting abilities like IAA production, Phosphorus solubilization, Zinc solubilization, Potassium solubilization, Siderophore production, Ammonia production and Amylolytic activity. All isolates were found positive for ammonia and IAA production. However, BRSB-1 was found to be best as it possessed all the plant growth promoting properties tested (Fig. 2).

Molecular identification of potential biocontrol agents

Seven bacterial isolates possessing potential antagonistic abilities against *F. oxysproum* and *Meloidogyne enterolobii*, thus were subjected to molecular identification by sequencing the 16S rRNA region. Based on BLASTn and phylogentic tree analyses, the isolates were identified as BRSB-1- *Pseudomonas aeruginosa* (OL913866), GEB-16b- *Bacillus subtilis* (OL913865), GRSB-18-*B. subtilis* (OL91386), GRSB-15a- *B. rugosus* (OL913863), GRSB-10b *B. rugosus* (OL913862), GRSB-21 (OM541330), PCEB-5 (OM541331) and PCEB-8 (OM541332) *B. amyloliquefaciens*.

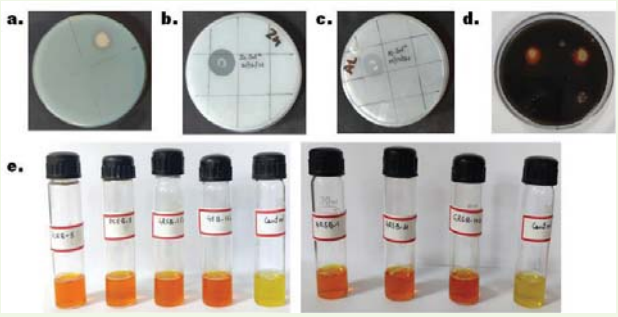


Fig. 2. a. Phosphorus solubilization b. Zinc solubilization c. Potassium solubilization d. Siderophore production and e. Ammonia production assay of BRSB-1 isolate

Management of guava root-knot nematode in infected grafts

An experiment was carried out under net house pot conditions with different doses of carbofuran which indicated the suppression of nematode activity and improvement in the growth of grafts. Data recorded at 100 days after application of a maximum dose of 10 g carbofuran/ 2 kg of soil, resulted in having 65-80 percent reduction in the population of juveniles in the soil as compared to control. The results indicated that a single application of nematicide may provide relief but further care in infected plants is necessary for long-term protection.

Evaluation of bio-agents against wilt complex

Maximum plant weight was recorded in T6 and T7 followed by T13, T14, and T18, which indicated the growth enhancement despite infection (Table 1). No difference in the growth of plants in uninoculated and inoculated with *Fusarium oxysporum* indicated that infection of fungus does not affect plant growth at an early age. The minimum colonization of roots by *F. oxysporum* was recorded in T9, T3, T4, T10, T11, T1, and T14. The root-knot index caused by *Meloidogyne enterolobii* was most effectively suppressed by T8 followed by T6, T2, T7, T13, T14, T4, T11, and T12. The population of *M. enterolobii* juveniles in soil was recorded minimum in T6, T8, T13, T2, T3, T7, T10, T11 and T14. These results indicated that T6 is the most effective biocontrol agent in managing the disease and enhancing the growth of plants. The next effective treatments were T13, T7 and T14. Fluopyrum @ 1 ml/kg of soil, *Pseudomonas aeruginosa*, and *Bacillus* CISH @ 10^6 cfu per kg of soil alone and in combination with vermicompost @ 100 g per kg of soil was found to be most effective. Application of *T. viride* @ 10^6 cfu per kg of soil in combination with vermicompost @ 100 g per kg of soil was also found good.

Close observation of roots of plants treated with T6, T7, T12, T13, and T14 indicated that the roots available at the time of inoculation were severely infected with the nematode but further growth of roots was rarely affected (Fig. 3). This indicated that the bio-control agents initially could not suppress the nematode within a few days after inoculation, but later generations of nematodes were suppressed. Thus Bio-control agents, *P. aeruginosa*, *Bacillus* CISH, and *Trichoderma viride* solely or in combination with vermicompost were found to be effective.

Table 1. Effect of treatments on plant growth and infection of *F. oxysporum* and *M. enterolobii* in guava roots

S. No.	Treatments (applied @ per kg of soil)	Plant height (cm)	Plant weight (g)	RKI	Root colonization (%)	J2/g soil
1	Cow pat pit (50 g)	17.50 ^{cd}	5.93 ^{de}	3.50 ^{a}	30.00 ^{c}	6.50 ^{b}
2	Panch gavya (25 ml)	24.25 ^{b}	11.05 ^{cd}	1.31 ^{bc}	60.00 ^{b}	1.75 ^{de}
3	Panch gavya (2.5 ml)	15.50 ^{d}	5.08 ^{e}	3.25 ^{a}	15.00 ^{d}	2.25 ^{d}
4	*Paeciliomyces lilacinus* Tropical (5 g)	19.00 ^{cd}	7.78 ^{de}	2.31 ^{b}	15.00 ^{d}	3.75 ^{d}
5	*Trichoderma viride* Tropical (5 g)	19.75 ^{cd}	8.25 ^{d}	2.81 ^{ab}	60.00 ^{b}	9.50 ^{a}
6	*Pseudomonas aeruginosa* (10^6 cfu)	29.75 ^{a}	22.63 ^{a}	1.13 ^{c}	60.00 ^{b}	0.50 ^{e}
7	*Bacillus* CISH (10^6 cfu)	33.25 ^{a}	21.15 ^{a}	1.63 ^{bc}	45.00 ^{bc}	3.50 ^{d}
8	Fluopyrum (1.0 ml)	27.50 ^{ab}	13.75 ^{c}	0.38 ^{d}	42.50 ^{bc}	0.50 ^{e}
9	Vermi compost (100 g) + Cow pat pit (50 g)	20.38 ^{c}	9.53 ^{d}	3.13 ^{a}	12.50 ^{d}	6.75 ^{b}
10	Vermi compost (100 g) + Panch gavya (25 ml)	18.25 ^{cd}	6.53 ^{de}	3.44 ^{a}	15.00 ^{d}	3.75 ^{d}
11	Vermi compost (100 g) + *P. lilacinus* Tropical (5 g)	20.25 ^{cd}	7.25 ^{de}	1.94 ^{b}	17.50 ^{cd}	2.25 ^{d}
12	Vermi compost (100 g) + *T. viride* Tropical (5 g)	18.00 ^{cd}	9.38 ^{d}	2.13 ^{b}	60.00 ^{b}	11.00 ^{a}
13	Vermi compost (100 g) + *P. aeruginosa* (10^6 cfu)	27.75 ^{ab}	19.50 ^{ab}	1.56 ^{bc}	50.00 ^{b}	0.50 ^{e}
14	Vermi compost (100 g) + *Bacillus* CISH (10^6 cfu)	22.13 ^{c}	18.18 ^{b}	1.56 ^{bc}	32.50 ^{c}	3.00 ^{d}
15	Inoculated (*M. enterolobii* only) control	20.25 ^{cd}	4.03 ^{e}	3.38 ^{a}	0.00 ^{de}	10.75 ^{a}
16	Inoculated (*Fusarium oxysporum* only) control	33.50 ^{a}	13.70 ^{c}	0.00 ^{d}	47.50 ^{b}	0.00 ^{e}
17	Inoculated (nematode + fungus) control	20.25 ^{cd}	6.68 ^{de}	2.56 ^{ab}	77.50 ^{a}	9.75 ^{a}
18	Uninoculated control	33.50 ^{a}	14.63 ^{c}	0.00 ^{d}	0.00 ^{de}	0.00 ^{e}
	$CD_{0.05}$	3.99	2.95	0.65	13.75	1.73

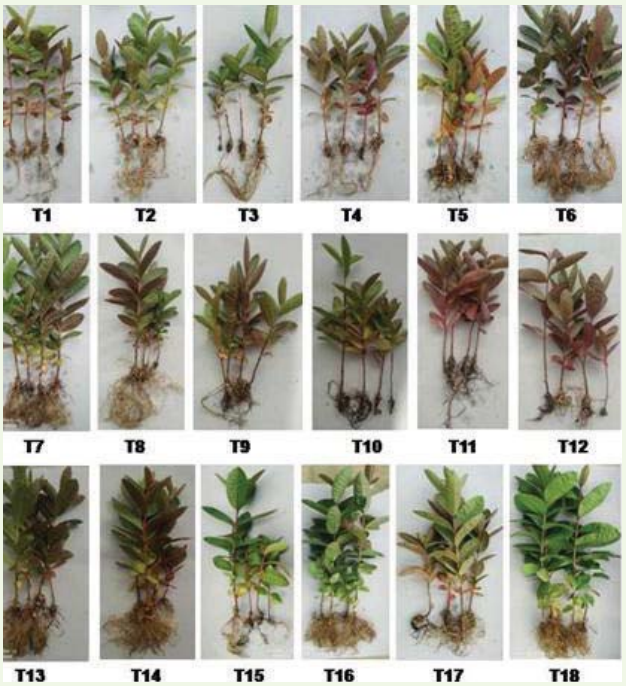


Fig. 3. Effect of treatments on plant growth and infection of *F. oxysporum* and *M. enterolobii* in guava roots

Endophytic Plant Growth Promotory (PGP) microbes for biocontrol action and plant growth promotion

Two bacterial cultures were isolated from rhizosphere region of healthy and wilted guava plant and identified as L1- *Acinetobacter pittii* (MZ268245) and L4-*Pseudomonas aeruginosa* (MZ268248). Plant growth promoting characteristics (IAA, and HCN production P, K, and Zn solubilization) for strains L1 and L4 were performedStrain L1 produced 45.53 µg mL^{-1}IAA, 17.85µg mL^{-1}HCN, and solubilize 63.89 µg mL^{-1}phosphate, 66.72 µg mL^{-1} potassium, and 49.75 µg mL^{-1} Zinc. Strain L4 produced 35.53 µg mL^{-1} IAA, 17.85µg mL^{-1} HCN, and solubilize 52.37 µg mL^{-1} phosphate, 49.53 µg mL^{-1} potassium, and 29.75 µg mL^{-1} Zinc. Biocontrol action of both rhizobacterial strains (L1 and L4)

were tested with two different plant pathogenic fungi (*Fusarium oxysporium* MTCC–284 and *Pythium* spp. MTCC 10247). L1 showed a good antagonistic interaction with *Fusarium oxysporum* MTCC – 284 (suppress 69.23% hypha growth) than *Pythium* spp. MTCC 10247 (suppress 6.5 hypha growth) Moreover, strain L4 showed maximum growth inhibition with *Pythium* spp. MTCC 10247 (suppress 91.67% hypha growth) while reduced growth of *Fusarium oxysporum* MTCC – 284 (inhibit 84.61% hypha growth).

Identification and Characterization of MYB transcription factor family

The MYB transcription factor superfamily is one of the largest superfamilies modulating various biological processes in plants including root development. Transcriptome analysis of *Psidium molle* root revealed 10 different MYB transcription factors *i.e.* MYB3, MYB4, MYB5, MYB6, MYB23, MYB82, MYB86, MYB90, MYB114, MYB308. The identification and characterization of *MYB* family genes, motif and exon/intron composition and expression levels were analyzed. Genes of MYB transcription factors were dispersed throughout the genome. The motif compositions and exon/intron structures within each group within the R2R3-MYB or MYB-related subfamily were highly conserved. The logo sequences of the R2 and R3 repeats of R2R3-MYB subfamily members were also highly conserved with those in these repeats of several other plant species.

Inter-Institutional Collaboration ICAR-CISH and CSIR-NBRI, Lucknow :

Application of whitefly-trap-cum death sink cotton to protect vegetables and horticultural crops from whitefly vectored viral diseases in India

Name of PI: Maneesh Mishra

Name of Co-PI: Nidhi Kumari

ICAR-CISH got the permission from RCGM for transferring the GM cotton seeds (Event138NBRIvar. Coker 310 expressing *Msc14* gene) from the laboratory of Dr P.K. Singh, Sr. Principal Scientist, CSIR-NBRI, Lucknow to ICAR-CISH, Lucknow (Permit number: BT/BS/17/199/2006-PID). The experiment to see the effect of GM cotton line Event 138 NBRI as trap crop in Papaya crop in the spread of white fly transmitted Papaya Leaf Curl Virus (PaLCuV) has been initiated on 04-08-2021 (Fig. 4).

Fig. 4. Papaya var. Red lady guarded by GM cotton in the periphery

Farmer's First Project: Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules

Name of PI: Maneesh Mishra

Names of Co-PI: R.A. Ram, S.K. Shukla, S.R. Singh, P.K. Shukla, Ashok Kumar, Anil Kumar Verma, Gundappa, S.C. Ravi and Alok Kumar Gupta

Impact assessment of direct and digital marketing of GAP-mango

In order to augment income of GAP adopted mango farmers during corona pandemic, mango outlets were opened with the help of

Directorate of Horticulture & Food Processing, Lucknow and community based organization (CBO) *Awadh Aam Utpadak Evam Bagwani Samiti*, Nabipanah, Malihabad was linked to two online mango marketing agencies (through mobile application). These agencies were incubated under Agri-business Incubation Centre of CISH in 2020. The firms purchased GAP mangoes from three villages of Malihabad adopted under FFP. The fruits were disinfected / washed and packed using CISH developed CFB boxes. The packed mango were marketed through online app Mango Baba and through the mango outlets in Lucknow, Uttar Pradesh. A total number of 25 farmers (56.25 tonnes of mango) were imvolved in the digital marketing. The direct marketing augmented income to the tune of 85 % in the price compared to conventional marketing during pandemic. Total sales revenue generated was Rs. 11,75,000.00 in 2021.

Entrepreneurship Development in Commercial Hatechery by Mango farmers

A community hatchery was established in 2019 at farmer's field under FFP to promote mango orchard based poultry farming. Later, a SHG *"Sahbhagita"* was established under FFP for promotion of mango based poultry farming. Under this programme, two commercial hatcheries at Malihabad region under the trade name "Aryan Baagwaan Poultry Farm" and another hatchery by a transgender as "Mohini Kadaknath Poultry Farm" were established. Firms rear the chicks up to period of 7-14 days in the brooding units and maintain the vaccination schedule. After the period, when the birds attain the body weight of 100-150 gm, firms sell them to the other farmers as per the demand @ Rs. 60-70/- per birds. In this process both the firms earned upto Rs. 3,76,800.00 as net profit in 2021. Commercial hatchery in mango belt gives a BC ratio of 1:2.44 (Table 2).

Table 2. Profitability of commercial hatchery of ICAR poultry breeds

Particulars	Quantity	Unit Rs	Total cost (Rs)
Fertile eggs	12000	12	144000.00
Expenditure for electricity and generator	6 month	3000 per cycle	18000.00
Rent of house	12 month	1000 per month	12000.00
Labour	8 month	8000 per Month	64000.00
Cost of feed/ waters up to 10 days at the rate Rs 25	9600 chicks	560 kg feed	14000.00
Vaccination	9600 chicks	Rs. 1/ chicks	9600.00
Total Expenditure			261600.00
Total income (5% mortality)	9120 chicks	Rs 70/ chicks	638400.00
Net Profit per annum			376800.00
B:C ratio			2.44

Entrepreneurship in value addition of mango pulp and mango pulp based ice cream

Processing protocol for Dashehari mango pulp was developed under FFP. A group of women trained on value addition of mango from FFP village were facilitated to form Self Help Group called "Swawlamban". The SHG produced and stored mango pulp and were involved in value addition of mango squash and RTS. M/S Little Native, Kanpur incubated under CISH-ABI, Lucknow was linked to Swawlamban for marketing of Dashehari pulp. Similarly, M/S Sweet Well Ice cream, Lucknow marketed mango pulp based ice cream and earned revenue of Rs.10.0 lakhs and employed 15 persons (Table 3).

Table 3. Profitability of commercialization of Dashehari mango pulp

Item	Quantity	Unit Price (Rs)	Total Cost (Rs)
Mango (Kg)	200	10	2000
Mango Pulping cost (75%)	150	10	1500
Boiling cost	150	6	900
Sugar (kg)	280	40	11200
II Class preservatives			150
Labour	2	300	600
Cost of bottle and packaging	600	11	6600
Mango squash (Liter)	600	120	72000
Branding and packaging (Liter)	600	10	6000
Total input			28950
Net profit			43050
B C ratio			2.48

Demonstration of fodder crops in mango orchards

FFP demonstrated *Panicum* grass as fodder crop in mango orchard and later collaborated with ICAR-Central Fodder & Grassland Research Institute, Jhansi to introduce perennial sorghum as fodder for milch animals. These smart interventions have solved the problem of expensive fodder for animals and on farm production led to self-sufficiency. Fodder yield recorded from different farm demonstrations indicated 1.75 to 2.50 kg green fodder per meter per cut. It results in indirect economic benefits like saving cost of feed by 47% and increase in milk yield.

Mushroom production for landless

During the lockdown, farmer FIRST project encouraged entrepreneurship development in button, milky and oyster mushroom production. During 2021, training was provided to more than 50 farmers on production of oyster and milky mushroom. A total of 35 households are cultivating mushroom in the study area. The critical inputs like spawn, formaldehyde and polysheet were provided to the farmers. Paddy straw and structure for mushroom production were arranged by the farmers themselves. The average net income of Rs. 6380.00 per q of oyster mushroom and Rs. 5760.00 per q of milky mushroom was realized. Five farmers were trained for the production of button mushroom. Farmers grew an average of 800 kg of button mushroom with the help of 15q compost and realized a net income of Rs. 53540.00. The benefit cost ratio for oyster, milky and button mushroom production was 1:4.94, 1:3.57 and 1:2.55, respectively.

Entrepreneurship development through secondary hardening of nursery TC Banana

In order to enhance entrepreneurship among rural youth, five farmers were selected on capacity build in secondary hardening of TC banana nursery. A critical input of 1000 primary hardened TC plants of G-9 banana was given to each farmers in the month of March. A low cost shade net house was constructed by farmers. The farmers sold hardened tissue culture plants locally at the rate of Rs.14 /plants during the month of June and July. Each farmer earns average net profit Rs. 20,790.00 from this enterprise which gives a BC ratio of 1: 1.48.

Demonstration of CISH-Bioenhancer and CISH-Fasal Shakti on broccoli

Demonstration of CISH-Bioenhancer and CISH-Fasal Shakti on Broccoli was undertaken at 10 farmers' field under Farmer FIRST Project, where these products were applied independantly or in combination for evaluation. The plant height (51.35 cm), number of leaves (21) and weight of plant (858 gm) was found highest when CISH-Bioenhancer and CISH-Fasal-

Shakti were applied simultaneously as compared to individual application over control plants in which plant height, number of leaves and weight of plant was recorded to be 43.51 cm, 13 and 185.25 g, respectively.

ICAR Extramural Research project: Generation of bio-efficacy and toxicological data for commercialization of bio-formulation ICAR-FUSICONT towards the management of banana wilt caused by *Fusarium oxysporum* f.sp. *cubense* tropical race 4 (Interinstitutional Collaboration; ICAR-CISH and ICAR-CSSRI, RRS, Lucknow)

Nodal Officer: S. Rajan

Name of PI: T. Damodaran

Names of the Co-PIs: Muthukumar M. and Maneesh Mishra

WGS of banana wilt pathogens (Foc-TR-1 and Foc-TR-4) and biocontrol agent (ICAR-FUSICONT)

Whole genome sequencing (WGS) of the banana wilt pathogens, viz., *Fusarium oxysporum* f.sp. *cubense* TR1 (Andhra Pradesh) and TR4 (Katiyar), was done using Illumina HiSeqX platform following 150 x PE Sequencing chemistry. Around 7-8 GB data was obtained and data is assembled for reference mapping with Foc genome available in database reported by ICAR-NRC-Banana, Trichy. Comparative genomics analysis was performed for developing diagnostic markers for detection of Foc-TR-4 and validated. Similarly, WGS of the biocontrol agent (CSR-T-3/ICAR-FUSICONT-*Trichoderma reesei*), the principal microorganism of ICAR-FUSICONT, was also carried out for developing signature sequences and reference mapping was done against reference genome of *T. reesei* strain QM6a. CBH1 gene of *Trichoderma reesei* was identified as an inducible gene in the presence of pathogen (Foc-TR-4) based on the gene expression analysis and also possessing unique DNA signatures for its identification, validation is underway.

Network project on transgenics in crops: Functional genomics of mango: Metagenome analysis and expression profiling for identification of incitant microorganisms associated with mango malformation disease

Name of PI: Dr. Anju Bajpai

Names of the Co-PIs: S. Rajan and Muthukumar M.

Funding agency: ICAR, New Delhi

Whole metagenome analysis of floral malformed tissues of mango cv. Beauty Mclean and Mallika with characteristic malformation symptoms were used for validation. Presence of *Fusarium mangiferae* in the phyllosphere associated metagenome was recorded and led to retreival of the COG sequences (Clusters of Orthologous Groups of proteins) through COGNIZER (v0.9b) to assess the functional capacities of microbial communities present in the samples. The top hit microbial population identified in the study was *Fusarium mangiferae*, followed by other *Fusarium* species such as *Fusarium proliferatum, F. oxysporum* and *Giberrella fujikorrii*. Polyketide synthase gene (FUM1a) involved in Fuminosin/ Fusaric acid biosynthesis, was identified in large counts in cv. Beauty Mcclean metagenome which were represented from *Fusarium proliferatum, F. oxysporum and Giberrella fujikorrii*. Three scaffolds containing *FUM1a* sequences coding for polyketide synthase gene were validated by standard PCR assay (Fig. 5B). Gene expression analysis in cDNA samples of control panicle and malformed panicle in three mango cultivars Dashehari, Mallika and Bappakai showed differential patterns of fungal specific *FUM1a* expression with typical upregulation in malformed panicles indicating its association in MMD (Fig. 5). It was found to be up-regulated in higher fold in Dashehari malformed panicle followed by Mallika and Bappakai.

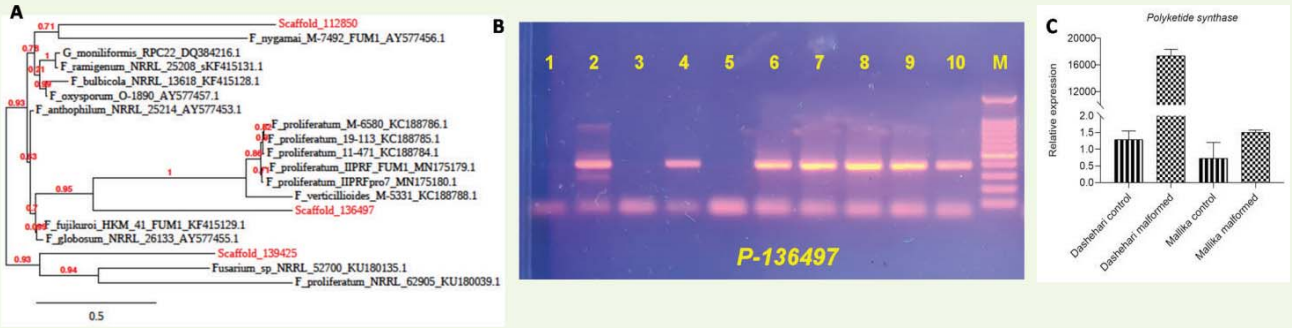


Fig. 5. Metagenome analysis of floral malformed tissues (A) Phylogenetic tree of *Polyketide synthase* (FUM1a) gene, (B) PCR validation, (C) Real time validation

Computational and gene expression analysis of floral induction and vegetative bud formation genes

Genes associated with floral induction and vegetative bud formation were converted into protein sequences and used for domain analysis to predict functional motifs. *Glucan synthase* domains were identified in callose synthase like 2 protein of vegetative bud (*MiCSL2-VBD*) identical to *Citrus chinesis* and *C. clementina*. TTL1, a protein containing TPR motifs required for abscisic acid responses and osmotic stress tolerance was also identified. These proteins have been found to be essential for responses to other hormones such ethylene, cytokinin, gibberellins and auxin in *Arabidopsis*. Thus, proteins containing TPRs are emerging as essential determinants for signal transduction pathways mediated by most plant hormones. Gene expression analysis in 4 cultivars *viz.*, Dashehari, Langra, Chausa and Amrapali revealed high fold expression of *CSL2* in vegetative buds compared

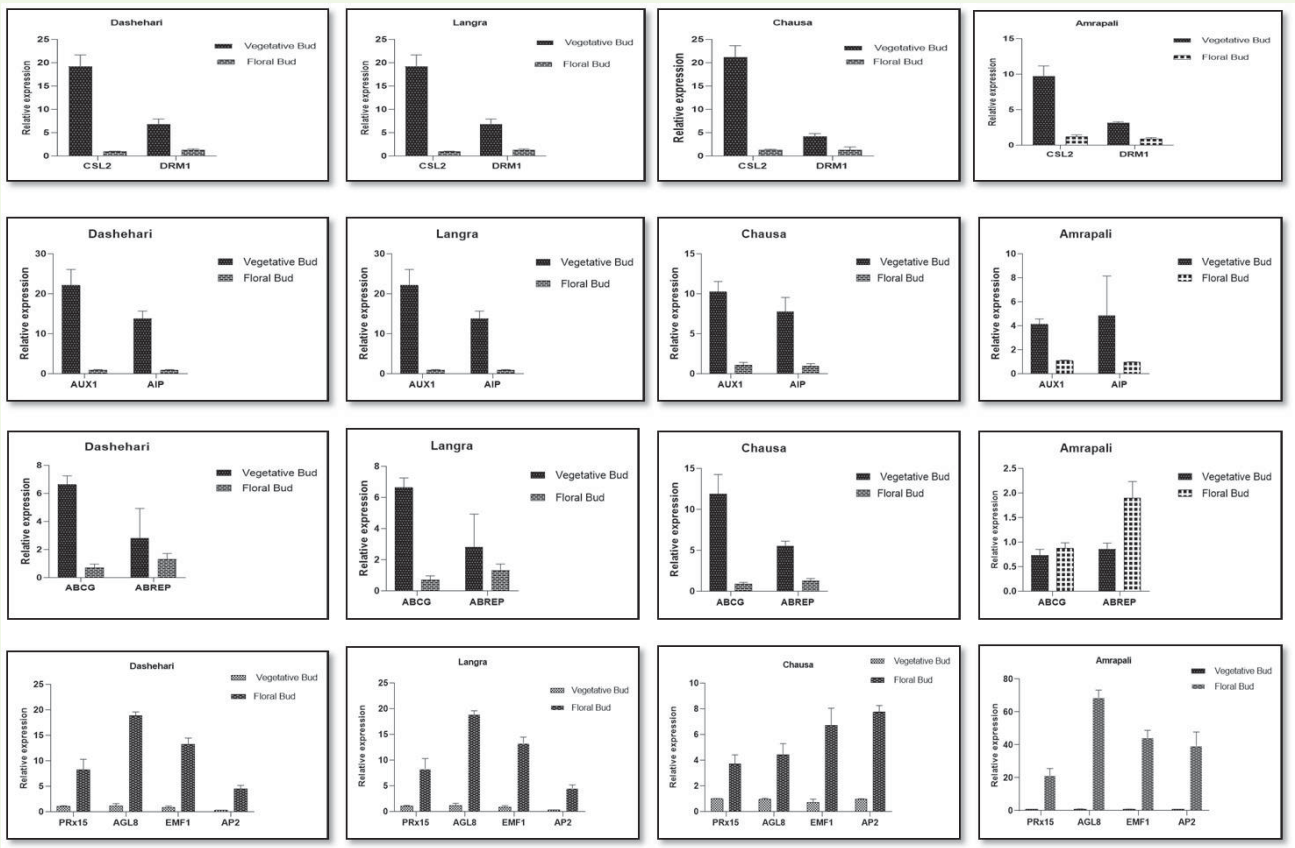


Fig. 6. Gene expression analysis of floral meristem differentiation genes

to floral bud (Fig. 6). Similarly, *DRM1* a dormancy related transcription factor was also upregulated in vegetative shoots. On the other hand, floral buds displayed higher fold expression of callose breakdown related genes and floral transition pathway related genes. Physical mapping of 47 transcripts related to inflorescence differentiation were mapped to mango genome. SSR co-localized with these functional genes were also mapped and will be used in mapping populations.

Development and evaluation of a nano-formulation for priming canopies towards floral induction

A nano-formulation treatment applied during October 2020 in alternate bearing mango cv. Langra was evaluated for assessing its effect on flowering. Priming canopies of mango cv. Langra showed early floral induction (15 days advancement in comparison to control) and enhanced flowering intensity.

National DUS Centre for Mango

Name of PI: Shailendra Rajan

Name of Co-PI: Ashish Yadav, Visambhar Dayal

Funding Agency: PPV & FRA, New Delhi

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 133 varieties, leaf characterization of 35 varieties and inflorescence characterization of 28 mango varieties have been carried out in 2021 as per revised guidelines. On-site DUS testing of 22 extant or farmer's varieties was continued by collecting data of varieties.

DUS characterization of guava

Name of PI: Shailendra Rajan

Name of Co-PI: Anshuman Singh, Visambhar Dayal

Funding Agency: PPV&FRA, New Delhi

The guava accessions (150) 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 2021, 29 accessions were characterized using DUS descriptors for fruit traits. Similarly, 25 accessions were characterized using leaf descriptors and 15 using flower descriptors.

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

Name of PI: Dr. A.K. Singh

Name of Co-PI: Anju Bajpai

Funding Agency: PPV & FRA, New Delhi

Assessment of qualitative characteristics of different accessions/ Varieties:

Morphological data for each character is being recorded every year as per DUS guideline. Seven reference varieties were characterized with growth habit, tree foliage (all 7 accessions having dense foliage type) and petiole length *i.e.* 4 accessions were found petiole length medium (1.5 to 2.5 cm) and 3 accessions / varieties were found petiole length long (> 2.5 cm).

Physico-chemical characteristics of different accessions/ varieties

A total of 40 accessions are being maintained in the field gene bank. In 2021, 4 varieties were characterized using tree growth traits and 7 varieties using fruit quality parameters. The tree height ranged between 6.93 m (Konkan Bahadoli) and 9.20 m (CISH- 42), canopy spread in north-south direction between 4.63 m (Konkan Bahadoli) and 6.20 m (CISH-42 and Goma Priyanka), canopy spread in north-south direction between 5.13 m (Konkan Bahadoli) and 6.73 m (CISH- 42), and trunk girth between 85.66 cm (Konkan Bahadoli) and 112.33 cm (CISH- 42). Based on these tree growth parameters, Konkan Bahadoli was found to have a dwarf, compact growth habit compared to other varieties, while CISH-42 was relatively more vigorous. Variety CISH-Jamwant (J-37) had the highest average

fruit weight (14.86 g) followed by Goma Priyanka (11.6 g) and Gokak-1 (10.28 g). Similarly, fruit length was also the maximum (3.56 cm) in J-37 followed by 3.25 cm in Gokak-1 and Gokak-2 both. The fruit breadth was the highest (2.45 cm) in J-37 and the lowest (1.75 cm) in J-42. The pulp content was found to be the highest (98.78%) in the seedless variety J-42 followed by 91.25% in J-37 and the lowest (70.64%) in Konkan Bahadoli. The TSS ranged between 11.30 ºBrix in Konkan Bahadoli and 14.50º Brix in Goma Priyanka. Fruit yield per tree was the highest (88.0 kg/tree) in J-37 and the lowest (10.40 kg/tree) in Goma Priyanka.

Characterization of aonla varieties for developing DUS test guidelines

Name of PI: Devendra Pandey

Funding Agency: PPV & FRA, New Delhi

Eight leading commercial varieties of Aonla viz., Kanchan, Krishna, NA-7, NA-10, NA-6, Banarsi, Chakaiya and Francis maintained in field gene bank were characterized during 2021 for different morphological and biochemical parameters as per DUS guidelines. Besides these, data for five varieties, 3 varieties named denomination Pink Suhana, Divya Aonla, Rani Aonla vide registration No.Reg/2021/463 submitted by Mr.Chintamani Singh r/o Vill-Badiour, Post- Hinautisirmour, Dist- Rewa (M.P) -486117, , and 2 varieties named denomination Sobhit Aonla and Ram Aonla vide registration No.Reg/2021/472 submitted by Yagyasaran Singh r/o Vill- Kathmana, Post- Hinautisirmour Dist- Rewa (M.P)-486117, , were also recorded. These 5 varieties are submitted for registration at PPV & FRA, New Delhi.

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

Name of PI: Devendra Pandey

Funding Agency: PPV & FRA, New Delhi

Eleven varieties viz., Pant Urvashi, Pant Aparna, Pant Shivani, Pant Sujata, CISH-B-1, CISH-B-2, NB-5, NB-16, NB-9, NB-17, and NB-7 have been maintained in the FGB of ICAR-CISH, Lucknow were characterized during 2021 for morphological and biochemical parameters as per DUS Guidelines. Physical and biochemical attributes of 3 bael varieties submitted for registration at PPV & FRA, New Delhi. The varieties viz., Dev Bael, Amrit bael and Raja bael submitted by Devesh Kumar Pandey r/o Vill & Post- Deverda, Gonda; Shiv Kumar Pandey r/o VPO- Rampur tengraha, Gonda and Girja Dutt Pandey r/o VPO- Rampur tengraha, Gonda viz., were also characterized.

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

Name of PI: Anju Bajpai

Name of Co-PI: Muthukumar M and S Rajan

Funding Agency: DST-CRG, New Delhi

Genotyping of the training population using GBS

Genotyping by sequencing approach was used for given 96 samples to perform SNP calling. Clean reads obtained after data filtration were used for SNP calling and number of SNPs was 419487 with 12 substitution types.

Phenotyping of training population for fruit quality attributes

Phenotypic data of 89 of training population were recorded for fruit traits and other horticulture traits of importance during 2021. Analysis of variance revealed significant differences for all the 16 quantitative traits except stone width and stone thickness (Fig. 7). The correlation of leaf area was found to be significant and positive only with petiole length (0.584), weight of fruit (0.260), fruit length (0.174), fruit width (0.235), fruit thickness (0.232), peel weight (0.190), stone weight (0.184), stone thickness (0.236) and pulp weight (0.268). Phenotypic data was used for clustering based on Jaccard's similarity coefficient that grouped all the cultivars into 5 clusters.

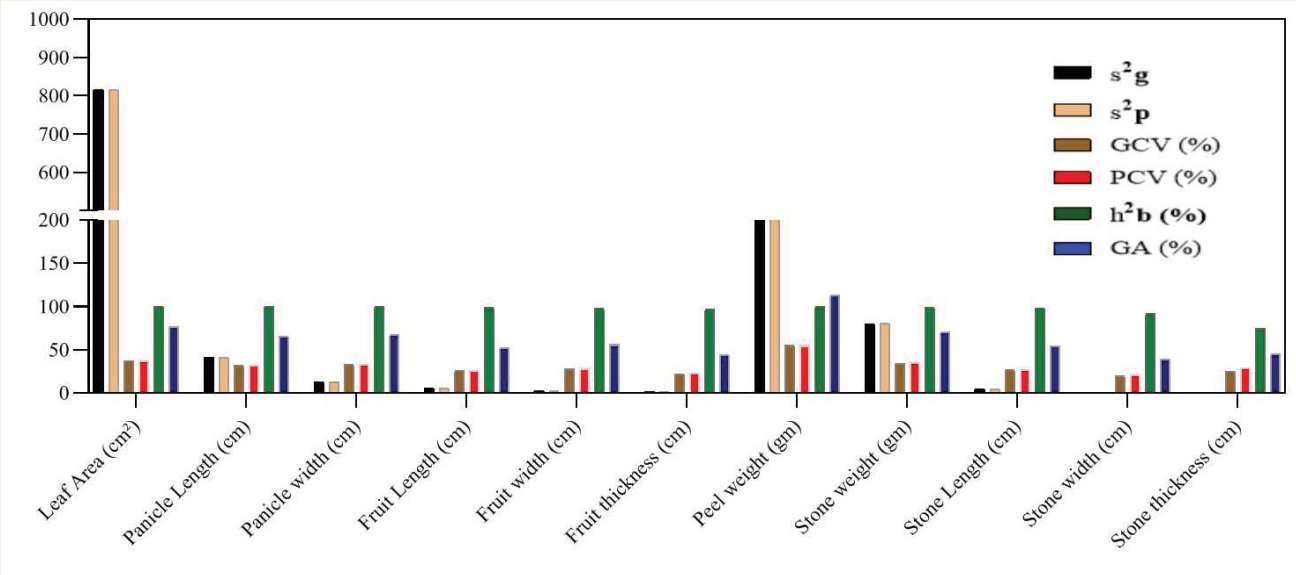


Fig. 7. Range, mean, estimates of variance components, broad sense heritability and genetic advance in 89 mango cvs.

σ^2g- genotypic variance, σ^2p- phenotypic variance, σ^2e- error variance, GCV- genotypic coefficient of variability, PCV- phenotypic coefficient of variability, ECV- environmental coefficient of variability, h^2b-Broad sense heritability, GA- Genetic advance

Genomics assisted identification of Resistance genes from wild relatives of guava against *Meloidogyne enterolobii* causing wilt

Name of the PI: Muthukumar. M.

Funding Agency: DST-SERB-EMEQ

Transcriptome analysis of contrasting *Psidium* speices against *Meloidogyne enterolobii*

RNA-Sequencing was performed with the root samples of *Psidium* species with contrasting nature to RKN resistance, i.e., *Psidium guajava* (susceptible) and *Psidium cattleyanum* sub. sp. *lucidum* (resistant) under control (healthy, nematode uninoculated) and RKN infected (root infection, galls, nematode inoculated) conditions. About 7-10 GB data is generated for all the 4 samples, the raw reads are quality filtered, assembled and annotated for identification of expressed genes. The genome annotations showed top hits with members of *Myrtaceae* viz., *Rhodamnia argentea*, *Syzygium oleosum* and *Eucalyptus grandis* and the RKN treated showed match with *Meloidogyne enterolobii* and *M. graminicola* (Fig.8). Bioinformatics data analysis on standard pipelines enabled identification of differentially expressed genes (DEGs) and the summary statistics is presented in Table 4. Interestingly, the resistant species have shown highest number of significantly up-regulated genes (#19312) and susceptible species have shown highest number of significant down-regulated genes (#18346) induced by RKN infection. Further analysis is underway to identify the candidate genes and elucidate the molecular mechanism of susceptibility or resistance.

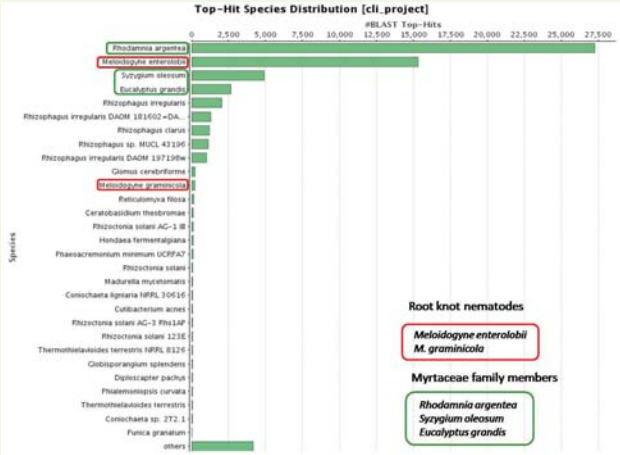


Fig. 8. Graphical representation of top hits of the assembled reads obtained in BLAST analysis of pooled 4 samples of root transcriptomes.

Table 4. Summary statistics of Differential expression analysis

DE Summary	RC vs SC	ST vs SC	RT vs RC	RT vs ST
Total Differentially expressed gene	38992	50670	37226	49902
Down-regulated	20267	30518	17919	20341
Up-regulated	18725	20152	19307	29561
Significantly Down-regulated	5521	18546	3878	6325
Significantly Up-regulated	6543	5633	2452	19312

C-control, T-RKN Treated, R-resistance, S-susceptible

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

Name of PI: Govind Kumar

Funding Agency: DST-SERB, New Delhi

In Carbosulfan biodegradation experiment, a total of 14 bacterial isolates were isolated from contaminated soils. Out of these 14 bacterial isolates, T5 showed maximum carbosulfan degradation in MS medium as well as in sterile (SS) and natural soil (NS) condition which also showed plant growth promoting attributes (P, K, Zn solubilization, HCN, IAA and NH3 production). Based on morphological, biochemical and molecular characterization strain T5 was identified as *Bacillus cereus* (MW228058.1). T5 also showed plant growth promoting characteristics such as for IAA production (46.72 µg mL^{-1}), Phosphate solubilisation (55.21 µg mL^{-1}), Potassium solubilisation (54.71 µg mL^{-1}), Zinc Solubilization (41.17 µg mL^{-1}), HCN (23.97) and Ammonium (19.77) production. Carbosulfan biodegradation experiment revealed 95.11% degradation was performed in MS medium after 30 days of incubation. Whereas, in sterile and natural soil, strain T5 degrade 68.25% in sterile soil and 75.67% in natural soil condition at 30 days of inoculation (Fig. 9). CISH-Biozapper microbial formulation for pesticide biodegradation, plant growth promotion and biocontrol action has been developed and tested in the field at I block of the institute, Lucknow and farmers field under Farmer FIRST programme. CISH-Trichocare combination of beneficial microbes for soil and plant health restoration under subtropics has been developed and tested in field trial for cowpea (*Vigna unguiculata*) at Ist block of the institute.

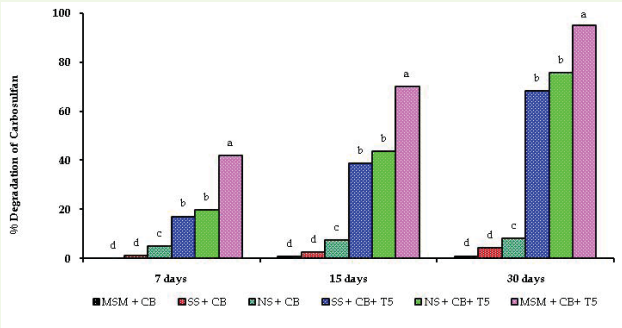


Fig. 9. Degradation percent of Carbosulfan in different time interval and in different media by strain T5

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

Name of PI: R.A. Ram

Name of Co-PI: Govind Kumar and Israr Ahmad

Funding Agency: UPCST, Lucknow

Microbial dynamics in on farm produced bio-formulations (bio-enhancers) such as Cow Pat Pit (CPP), Panchgavya (PG), and Vermiwash (VW)

In Vermiwash maximum number of fungi ($58x10^6$ CFU ml^{-1}), P-solubilising microbes ($26.4x10^6$ CFU ml^{-1}), bacteria ($22x10^6$ CFU ml^{-1}) and *Azotobacter* ($22x10^6$ CFU ml^{-1}) were enumerated. In Cow pat pit, maximum number of actinomycetes ($96x10^6$ CFU ml^{-1}) and *Pseudomonas* population were observed whereas Panchagavya contained maximum number of *Azotobacter* ($20.8x10^6$ CFU ml^{-1}). A total of 6 bacterial strains *viz.*, *Bacillus cereus* CISH-CPP2 (MT043902), *P. aeruginosa* CISH-CPP14 (MT043911), and *Pseudomonas sp.* CISH C-8

(MT043908) were identified from CPP, while *B. amyloliquefaciens* CISH-P8 (MT043909) from Panchgavya and *P. aeruginosa* CISH-V10 (MT043903), *B. cereus* CISH-V12 (MT043910) were identified from Vermiwash. All test strains were tested positive for plant growth promotory properties like P, Zn, K solubilization, IAA & siderophore production (Fig. 10) and also showed biocontrol action against potential plant pathogens like *Ceratocystis fimbriota* (MTCC-2281), *Pythium aphanidermatum* (MTCC-284), *Colletotrichum gloeosporioides* (MTCC-2190) & *Fusarium oxysporum* (MTCC-10247). Among all test strains, V11 strain from vermiwash and P8 from Panchagavya suppressed the growth of *C. gloeosporioides, C. fimbriota, P. aphanidermatum* and *F. oxysporum* by 42.67, 62.72, 21.14, 39.67 and 100, 71.67 45.70 and 66 per cent, respectively.

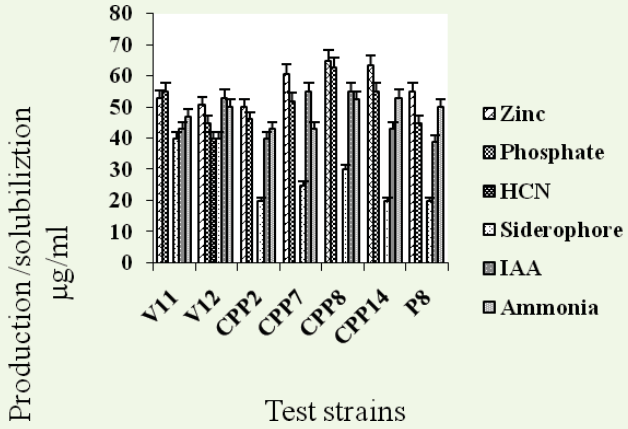


Fig 10. Plant growth promotory properties of slected test strain from Vermiwash, Cow pat pit and Panchgavya.

Development of integrated package for management of fruit drop of bael (*Aegle marmelos* Correa)

Name of the PI: P.K. Shukla

Funding Agency: UPCST, Lucknow

Association of pathogenic fungi

Twenty-three fungi were isolated from diseased fruits and leaves of bael and the pathogenicity of 6 was confirmed on the fruits and 9 on the leaves. The identification of these pathogenic fungi is in progress.

Management of fruit drop

In a field experiment, on a 17 years old bael trees indicated that spray of NAA + Tebuconazole on June 22 and NAA + trifloxystrobin on July 23, 2021 was effective in reducing the fruit drop during initial fruit development period (June–September) as compared to un-sprayed trees.

Standardization of container gardening of fruits for catering the nutritional requirements of city dwellers

Name of the PI: K.K. Srivastawa

Name of Co-PI: Dinesh Kumar

Funding Agency: UPCST, Lucknow

In Citrus variety 'Kagazilime' 'Sriganganagar Lime-1', and 'Kinnow' performed best in containers with good fruiting behavior. Pomegranate variety 'Mridula' was found most suitable for growing in the containers. In case of guava, 'Shweta', 'Lalit' cultivars were found most suitable for container farming. Phenological parameters in different fruits grown in container have 4-7 days' advancement in flowering and fruit maturity than field condition. In guava, 4-5 kg fruits, pomegranate 2-3 kg and in citrus group 3-4 kg fruits per containerized plants were harvested in 3rd year. Water requirement during summer was approximately 1.80-3.50 liter water/ container/day for different fruit crops; while during winters, it was 0.30-0.60 Liter / container/day. Container (30x45 cm) was made of polyethelene, UV stabilized sheet of 400 gauge thickness. These were filled up to 2/3rd portion with crop specific solarized growing media comprising different proportion of garden soil, sand, FYM and vermicompost. The planting of different fruit plants was done and finally container re-filled leaving 4-6 inch for irrigation (irrigation collection cup). Container plants were trained in dwarf bush type architecture. Pruning of citrus, pomegranates, mango and fig was done in the months of Dec-Jan, while for guava and ber in mid of May. Repotting of guava, citrus and pomegranate was done after 4 years in

December-January, by taking out complete root ball gently after light irrigation and removed 15-20% media along with roots from outer portion and the container as well as whole root ball was drenched by 2g/l Bavistin solution. Replanted in the same container and re-filled blank portion with media. NPK mixture was sprayed thrice @ 5g/l during fruit set, fruit development and after fruit harvest. Containerized fruit plants are sold at Rs 800-1000/- per plants, however cost of raising such plants was Rs 250-350/- per plants. B:C ratio was 1:3.5-4. The technology proposal has been approved by ITMU, VTIC of ICAR-CISH, Lucknow for licensing.

Evaluation of Bio-efficacy and phyto-toxicity of Flupyram 250 G/L + Trifloxystrobin 250G/L (Luna sensation 500SC) against anthracnose, powdery mildew and Leaf Spot and Tebuconazole 430 SC (Buonos) against anthracnose, powdery mildew and postharvest diseases in mango

Name of the PI: P.K. Shukla

Funded Agency: Bayer Crop Science Ltd., Lucknow

The bio-efficacy evaluation of tested chemicals indicated that both the fungicides are highly effective in managing the target diseases as compared to control; and effective in comparison to commonly used fungicides. The incidence of blossom blight, fruit anthracnose, stem end rot and shoulder browning was severe but incidence of powdery mildew was extremely low.

Network project on Micro organisms in agriculture and allied sectors

Microbial production of multienzyme preparation from mosambi peel using *Trichoderma asperellum*

Name of PI: Neelima Garg

Funding Agency: AMAAS, Mau

Out of 15 fungal isolates obtained from biodegrading organic substrates, maximum production (in terms of U $ml^{-1}min^{-1}$) of pectinase (551.5), cellulase (155.36) and amylase (293.2) was observed in isolate F-1 identified as *Trichoderma asperellum* strain NG 125 accession number MW287256. Optimization studies indicated that highest production (U $ml^{-1}min^{-1}$) of pectinase (595.7), cellulase (497.3) and amylase (440.9) by *Trichoderma asperellum* on mosambi peel substrate was observed at pH 5.5, incubation temperature of 30°C after 10 days of fermentation. Macro-nutrients addition @ 0.1% ammonium sulphate (as source of nitrogen), 0.01% potassium di-hydrogen ortho-phosphate (as source of potassium and phosphorus) enhanced the production of enzymes after 10 days of fermentation. Considering enzyme activity at 35°C as 100%, increased temperature resulted in negative effect on the enzyme activity. The Km and Vmax values of pectinase, cellulase and amylase are given in Table 5. With the objective of selecting for stable and cost-effective immobilization matrix, four natural fibre matrices viz., bagasse, rice husk, paddy straw and wheat straw were tested and compared. The immobilized enzyme yield on bagasse fibre martix, remained highest (pectinase- 92.2%, cellulase 72.9% and amylase 90.9.4%) after 2 months of storage at -20°C as compared to rice husk, wheat straw and paddy straw (Fig. 11, Table 6). With the commercial pectinase enzyme, the highest juice yield obtained was 72%, while with the crude multienzyme extract from *Trichoderma asperellum* it was 65% whereas in control it was only 30%. The juice extraction efficiency of the partially purified crude multienzyme preparation was 90.27% of commercial pectinase.

Table 5. Km and Vmax values of pectinase, cellulase and amylase produced by *Trichoderma asperellum*

Enzyme	Km (mg/ml)	Vmax (U ml^{-1} min^{-1})
Pectinase	0.5	311.1
Cellulase	2	114.9
Amylase	1	134.8

Table 6: Storage study of immobilized multienzymes preparation from *Trichoderma asperellum*

Matrix	Pectinase activity ($U\ ml^{-1}\ min^{-1}$)		Cellulase activity ($U\ ml^{-1}\ min^{-1}$)		Amylase activity ($U\ ml^{-1}\ min^{-1}$)	
	At zero time	After 2 months of storage	At zero time	After 2 months of storage	At zero time	After 2 months of storage
Baggases	308.6±0.85	280.1±3.9	392.6±2.9	283.0±2.0	303.3±2.3	271.3±2.0
Rice Husk	263.1±2.65	262.6±4.9	316.2±0.6	203.7±2.71	234.4±3.1	154.7±4.3
Paddy straw	291.1±0.60	212.0±1.0	319.6±49	102.1±4.33	267.9±2.5	110.7±0.0
Wheat straw	231.7±3.90	108.6±2.1	304.9±0.5	85.5±5.00	227.3±3.1	43.0±2.45

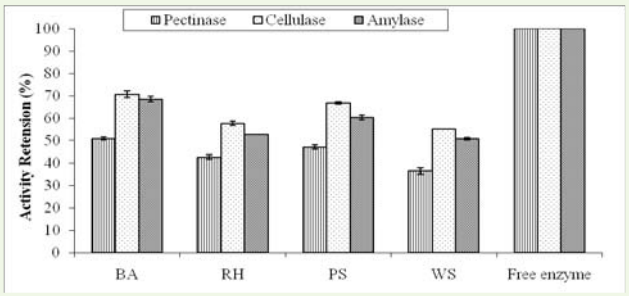


Fig 11. Activity retention (%) of pectinase, cellulase and amylase enzymes present in multiple enzyme preparation immobilized on different fibre matrices (BA- bagasse, WS- wheat straw, PS- paddy straw and RH-rice husk).

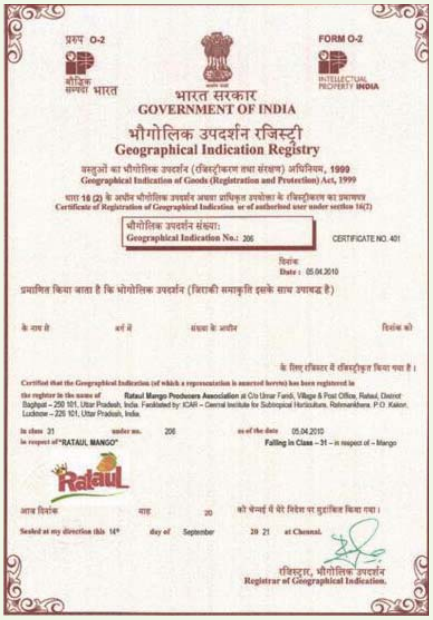
Geographical Indication for Langra, Chausa, Gaurjit and Rataul Mango

Name of the PI: Shailendra Rajan

Name of the Co-PI: Ashish Yadav

Funding agency: State Agricultural Produce Market Board, Uttar Pradesh

Safe guarding of IP issues related with mango varieties through GI registration of Langra, Chausa, Gaurjeet and Rataul mango varieties of Uttar Pradesh was done. Meetings were convened involving farmers and state Horticulture department officials for the preparation of GI registration documents. The applications are being submitted along with supporting documents to the "Registrar of Geographical Indications", Chennai for registering the mango varieties as Geographical Indication. The 'Geographical Indication No. 206' Certificate for 'Rataul Mango' has been issued by the Registrar of Geographical Indications", Chennai on September 14, 2021 (Fig. 12).



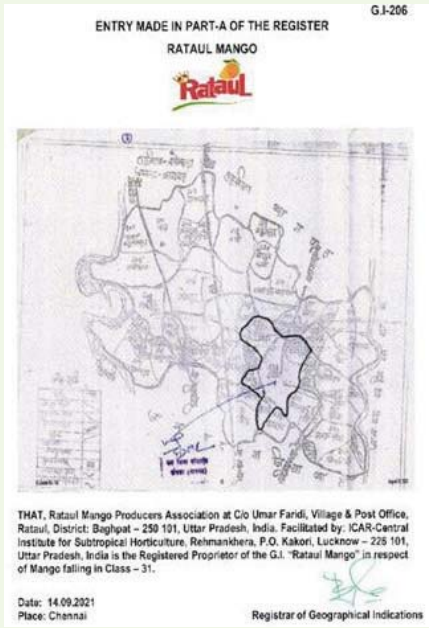


Fig. 12. Geographical Indication No. 206 Certificate for 'Rataul Mango'

Management of *Fusarium* wilt in NER banana using ICAR-FUSICONT Technology

Name of the PI: Shailendra Rajan / T. Damodaran

Name of the Co-PI: Maneesh Mishra and Ashish Yadav

Funding Agency: DBT, New Delhi

ICAR-FUSICONT technology has been commercialized globally through Agri-Innovate. About 1.2 tonnes of ICAR-FUSICONT has been produced in collaboration with ICAR-CSSRI, RRS, Lucknow and was supplied to the NER partners for field demonstrations in 2021.

Another novel technology i.e. lipo-polypeptide based biomolecule "BIO-IMMUNE" and the *in vitro* Bioimmunization technology, have been patented jointly. During 2021, 70,000 bio-immunized tissue cultured plantlets of banana variety Cheeni Champa, Malbhog and G-9 were produced using bio-immune during *in vitro* shooting and *in vitro* rooting stage. The bio-immune plants are being hardened in a advanced hardening facility which will be validated in NEH region for wilt tolerance.

Field validation and impact of the Bio-immunized banana plantlets

Bio-immunized tissue culture plants of banana variety G-9 were developed and validated jointly by ICAR-CSSRI and ICAR-CISH, Lucknow (Fig. 13). Field studies conducted in the hot spot regions of *Fusarium* wilt affected areas at Ayodhya district in Uttar Pradesh and Katihar district of Bihar revealed that bio-immunized plantlets (22,500) were able to sustain the disease incidence to about 98% for a period of 9 months after planting and 85% till harvest. Treatments involving two times drenching of 3% ICAR FUSICONT at 5th and 10th month after planting of bio-immunized plantlets showed 92 to 96% disease tolerance against the invasion of FOC TR4 suggesting the synergistic role in the management of the disease. The technology of bio-immunization was demonstrated in 20 farmer's fields with the immediate history of the FOC TR4 incidence to 30 to 50%. The adopter's fields were planted with bio-immunized plantlets while the non-adopters used tissue culture plantlets obtained from private tissue culture firm that was not subjected to in vitro immunization. The disease incidence percentage of the 20 adopters was significantly low (2.77%) compared to the 20 non-adopters (31.58%). The adopters also registered higher average yield per plant and high average net income (Rs.1,88,997) as compared to the non adopters whose income was reduced due to the high disease incidence.

Fig. 13. Bio-immunized tissue cultured plants of banana varieties Grand Naine and Cheeni Champa

AICRP Fruits

Testing the performance of new promising hybrids and selections of guava (MLT-3)

Name of the PI: Shailendra Rajan

Name of the Co-PI: Ashish Yadav

Guava varieties were tested to study their performance at various centres. The trial was laid out in row trial (five plants of each variety), with eleven varieties planted at a spacing of 5 x 5 m. On the basis of five years pooled data analysis, during 8thGroup Discussion of ICAR-AICRP on Fruits held online during March 03-06, 2021:

- CISH G-35 (Dhawal) was recommended for Ludhiana and Lucknow centres .
- Shweta (CISH-G-4) recommended and released for Rewa centre.
- Lalit (CISH-G-3) recommended and released for Udaipur centre.

Enhancing the input use efficiency in guava under HDP

Name of PI: K.K. Srivastava

The AICRP-Fruits experiment was initiated in 2015 on HDP guava variety Lalit, planted at 3x3 m, the results revealed that canopy spread and volume were significantly highest in T_1 [Raised bed cultivation + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100 micron UV stabilize black polythene + Micro nutrient spray ($ZnSO_4$ & Boric acid 0.2%)] (2.60 m^3 and 3.64 m^3, respectively). Similarly, fruit yield was significantly highest in T_1 (26.64 kg/tree) (Table 7).

Table 7. Effect of different inputs on growth characters and yield parameters in guava cv. Lalit under Lucknow condition

Treatments	Growth characters			Yield parameters			
	Plant height (m)	Stem girth (cm)	Canopy volume (m^3)	Fruits/ tree	Fruit weight (g)	Fruit yield (kg/ tree)	Yield efficiency (kg/m^3 canopy area)
T_1	2.68	12.48	18.91	121.00	217	26.64	7.31
T_2	2.63	11.65	12.19	109.00	223	23.21	8.31
T_3	2.51	10.98	17.40	89.00	211	18.77	5.55
T_4	2.47	10.55	12.92	103.00	197	20.89	8.19
T_5	2.88	12.65	11.70	93.00	228	21.20	7.70
CV	9.22	11.16	22.74	11.89	9.21	8.81	6.89
SE(m)	0.07	0.81	1.64	6.12	9.91	1.22	0.49
CD at 5%	NS	2.06	5.11	19.08	NS	11.03	1.12

T_1: Raised bed cultivation + Drip irrigation + Fertigation + Mulching + Micro nutrients spray, T_2: Raised bed cultivation + Drip irrigation + Fertigation + Mulching, T_3: Raised bed cultivation + Drip irrigation + Fertigation + Micro nutrients spray, T_4: Raised bed cultivation + Drip irrigation + Micro nutrients spray, T_5: Control

Survey and surveillance for new and emerging insect pest of mango

Name of PI: Gundappa

During the year 2020-21 mango semilooper *Hyposidra talaca* incidence was recorded during the 22nd SMW with 3.3 larvae/twig caused severe damage on new leaves, cut the peduncle and causing the spots on the fruits by nibbling.

Management of mango hoppers and thrips on mango by oil-based formulation of *Metarhizium anisopliae*

Name of PI: Gundappa

In the first spray *Metarhizium anisopliae* (oil-based formulation) @ 0.25ml /l was found effective in reducing the thrips population (41.75/ tap) after the 9 days. In the second spray *M. anisopliae* (oil-based formulation @0.5ml/ l) was found effective in reducing the thrips population (37.5/tap) after the 9 days. For hoppers in first spray, lowest number of hopper population (2.25 hoppers/panicle) was recorded in the treatment *M. anisopliae* (oil-based formulation) @0.25ml /l after 9 days of last spray. In the second spray the hopper population was lowest (2.25 hoppers/ panicle) in the treatment *M. anisopliae* (oil-based formulation @ 1ml/ l).

Evaluation of different botanical formulations for management of sucking pest complex in mango

Name of PI: Gundappa

Botanical formulations *viz.*, Azadirachtin @ 10,000 ppm (10 ml/l of water), AAVYA (4 g/l of water), Neem soap (IIHR product) at 10g/l water and Pongamia soap (IIHR product) at 10g/l water recorded lowest thrips population after 7 days.

Slow release pheromone formulation for the management of fruit fly in mango

Name of PI: Gundappa

Fruit fly catches in trap were found significantly different between the slow release pheromone formulation and conventional lure (control) (t =-3.7; df=169;p<0.019). Highest number of fruit flies were trapped in slow release pheromone formulation (248 fruit flies /trap/week) compared to the conventional lure (55.8 fruit flies /trap/ week).

New and emerging insect pests in guava

Name of PI: Gundappa

The increased incidence (4.3 %) of thrips was observed in various orchards of the state during the year 2021. The occurrence of semilooper (*Hyposidra talaca*) was also observed on the foliage and young fruits with 35.3 per cent incidence.

Slow release pheromone formulation for the management of fruit fly in guava

Name of PI: Gundappa

Fruit fly catches in trap were found significantly different between the slow release pheromone formulation and conventional lure (t =-3.88; df=129;p<0.001). Highest number of fruit flies were trapped in slow release pheromone formulation (55.2 fruit flies /trap/week) compared to the conventional lure (22.1 fruit flies /trap/ week).

Integrated management of post-harvest diseases (anthracnose, shoulder browning, stem end rot and Aspergillus rot) of mango fruits

Name of PI: P.K. Shukla

Pre-harvest spray of difenoconazole 25 EC @ 0.5 ml/l and post-harvest hot water treatment resulted in reducing the incidence and severity of anthracnose in mango *cv.* Mallika by 93% as compared to control.

New and emerging diseases of mango

Name of PI: P.K. Shukla

Surveys were conducted in different districts of Uttar Pradesh. Blossom blight, powdery mildew, leaf anthracnose and malformation were the major diseases with regular occurrence. Among minor diseases, wilt, red rust, bacterial blight, black banded etc were present but the severity and appearance of disease symptoms varied from orchard to orchard. Wilt and twig drying are the diseases of concern.

AICRP on Biological Control

Evaluation of bio-agents against root knot nematode infection in guava under controlled conditions

Name of PI: P.K. Shukla

Different bioagents were evaluated for control of guava wilt. In this study, results indicated that the maximum plant weight was recorded in T1+T4, T3+T4, T4+T5, T2, T14, and T16, which indicated the growth enhancement despite infection as compared to control (T16). No difference in the growth of plants in uninoculated and inoculated with *Fusarium oxysporum* indicated that infection of fungus does not affect plant growth at an early age. Minimum colonization of roots by *Fusarium oxysporum* was recorded in T1, T12, T7, T4, T9, T10 and T11. The root-knot index caused by *Meloidogyne enterolobii* was most effectively suppressed by T6, T2, T3, T4, T11 and T12. The population of *M. enterolobii* juveniles in soil was recorded minimum in T6, T4 and T5 (Table 8). Results indicated that the T6 combination is the most effective one in managing the disease and enhancing the growth of plants followed by T1, T8, and T12. Thus, *Purpureocillium lilacinum, Trichoderma asperellum, Bacillus* spp. @ 10^6 cfu per kg of soil has been found effective alone or in combination with vermicompost @ 100 g per kg of soil. Hence, the bio-control agents, *Purpureocillium lilacinum, Trichoderma asperellum, Bacillus* spp. in combination with vermicompost may be forwarded to field trials after making suitable powder-based formulation.

Table 8. Effect of treatments on *Fusarium oxysporum* and *Meloidogyne enterolobii* infection in guava plants

Tr. No.	Treatments (applied @/ kg of soil)	Plant height (cm)	Plant weight (g)	Percent root colonization	RKI	J2/g soil
1	*Purpureocillium lilacinum* (10^6 cfu)	20.25 ^{b}	4.65 ^{cd}	12.50 ^{d}	3.35 ^{a}	1.25 ^{b}
2	*Pochonia chlamydosporia* (10^6 cfu)	30.13 ^{a}	13.60 ^{ab}	60.00 ^{a}	2.63 ^{ab}	0.10 ^{c}
3	*Trichoderma asperellum* (10^6 cfu)	23.25 ^{ab}	11.43 ^{b}	50.00 ^{ab}	2.19 ^{ab}	0.35 ^{c}
4	*Bacillus* spp. (10^6 cfu)	21.50 ^{b}	7.95 ^{c}	30.00 ^{b}	2.06 ^{ab}	0.80 ^{bc}
5	Vermi compost (100 g)	20.00 ^{b}	7.58 ^{c}	60.00 ^{a}	2.88 ^{a}	1.00 ^{bc}
6	T1 + T4	24.50 ^{ab}	15.68 ^{a}	32.50 ^{b}	1.88 ^{c}	0.35 ^{c}
7	T2 + T4	20.50 ^{b}	8.58 ^{c}	27.50 ^{bc}	2.88 ^{a}	2.55 ^{a}
8	T3 + T4	29.25 ^{a}	17.80 ^{a}	44.00 ^{ab}	2.00 ^{ab}	1.40 ^{b}
9	T1 + T5	19.25 ^{b}	6.95 ^{c}	30.00 ^{b}	3.44 ^{a}	1.75 ^{b}
10	T2 + T5	18.25 ^{bc}	9.28 ^{bc}	30.00 ^{b}	3.31 ^{a}	1.10 ^{b}
11	T3 + T5	27.63 ^{a}	11.20 ^{b}	30.00 ^{b}	2.31 ^{ab}	1.15 ^{b}
12	T4 + T5	27.25 ^{a}	17.50 ^{a}	12.50 ^{d}	2.19 ^{ab}	1.40 ^{b}
13	Inoculated (nematode only) control	14.25 ^{c}	4.75 ^{cd}	0.00 ^{d}	3.19 ^{a}	2.45 ^{a}
14	Inoculated (*F. oxysporum* only) control	26.25 ^{a}	13.75 ^{ab}	60.00 ^{a}	0.00 ^{d}	0.00 ^{c}
15	Inoculated (nematode + fungus) control	17.63 ^{bc}	5.23 ^{cd}	65.00 ^{a}	3.76 ^{a}	1.00 ^{b}
16	Uninoculated control	25.25 ^{ab}	12.55 ^{b}	0.00 ^{d}	0.00 ^{d}	0.00 ^{c}
	$CD_{0.05}$	4.50	2.62	14.82	0.92	0.49

Treatments 1-12 were applied with *Fusarium* and *Meloidogyne* at the time of transplanting

Bio-efficacy of bio-pesticides for the management of mango insect pests

Name of PI: Gundappa

Under filed conditions, larval parasitoid *Bracon hebetor* parasitization on mango leaf webber (*Orthaga euadrusalis*) was recorded up to 62.5%. The bioagents were evaluated against the guava fruit borer, no bioagent was found to be effective in reducing the guava fruit borer incidence.

AICRP on Honey Bees and Pollinators

Quality analysis of Mellifera and Cerana honey

Honey quality analysis was done based on different parameters for comparison between Mellifera honey (Honey collected by *Apis mellifera*) from Lathyrus and Sesame flowers and Cerana honey (Honey collected by *Apis cerana*) from multifloral origin. Hydroxy-methyl-furfural (HMF) content was higher in Lathyrus followed by Sesame and Cerena whereas specific gravity was almost same in Lathyrus and Cerena honey. Refractive index was higher in Cerena honey followed by Sesame and Lathyrus. Acidity was high in Cerena honey followed by Lathyrus and Sesame honey. Sesame honey contained more antioxidants, flavonoids, phenolic components, but Lathyrus honey showed higher amounts of proteins (Table 9).

Table 9. Quality analysis of Mellifera and Cerena honey.

Parameters	Lathyrus honey (by *Apis mellifera*)	Sesame honey (by *Apis mellifera*)	Cerena honey (Multiflora honey by *Apis cerena*)
HMF content (mg/kg)	16.42	15.94	11.69
HMF (Fiehe's test)	Positive	Positive	Positive
Specific gravity (gm/cm^2)	1.46	1.32	1.46
Refractive index (%)	18.5	18.9	19.6
pH value	3.78	3.88	3.25
Free acidity (mEq/kg)	23.38	17.25	26.58
Lactone acidity (mEq/kg)	4.82	8.52	3.96
Total acidity (mEq/kg)	28.2	25.77	30.54
Antioxidant value	313	392	341
Protein value	484	367.44	386
Colour value :			
L	32.3	28	30.8
A	1	3.8	3.2
B	8.9	10.3	12.6
C	9	10.9	13
H	83.6	69.8	75.7
C (by cal)	8.95	10.97	13
H (by cal)	83.58	69.74	75.74
YI	39.36	52.55	58.44
WI	2232.25	2552.26	2378.82
mm Pfund	132.56	145.96	124.38
Vitamin C (mg/100 g)	14.2	13.5	14.9
Phenol content (GAE/100 g)	104.36	172.93	139.82
Flavonoid content (mg/l)	23.4	24.9	25.43

Elemental analysis of unifloral mellifera honey (Honey Collected by *Apis mellifera*)

Elemental analysis in different unifloral honey collected from existing floral diversity available in Malda and adjoining districts was assessed for proximate/ mineral composition. The maximum content of Sodium (Na) was noticed in sesame honey followed by litchi, Lathyrus and mustard honey. Potassium (K) was observed to be the most abundant element in honey. Sesame honey had highest content of potassium followed by litchi, Lathyrus and mustard honey. The highest level of Calcium (Ca) was observed in Lathyrus honey followed by Sesame, litchi and mustard honey. Copper (Cu) was high in sesame honey followed by Lathyrus, Mustard and Litchi honey. Zinc level was lowest in Lathyrus but maximum level was observed in litchi honey. Litchi honey had highest level of manganese (Mn) followed by sesame, Lathyrus and Mustard honey. Litchi honey also possessed high level of iron (Fe) as compared with Sesame, Lathyrus and Mustard honey (Fig. 14).

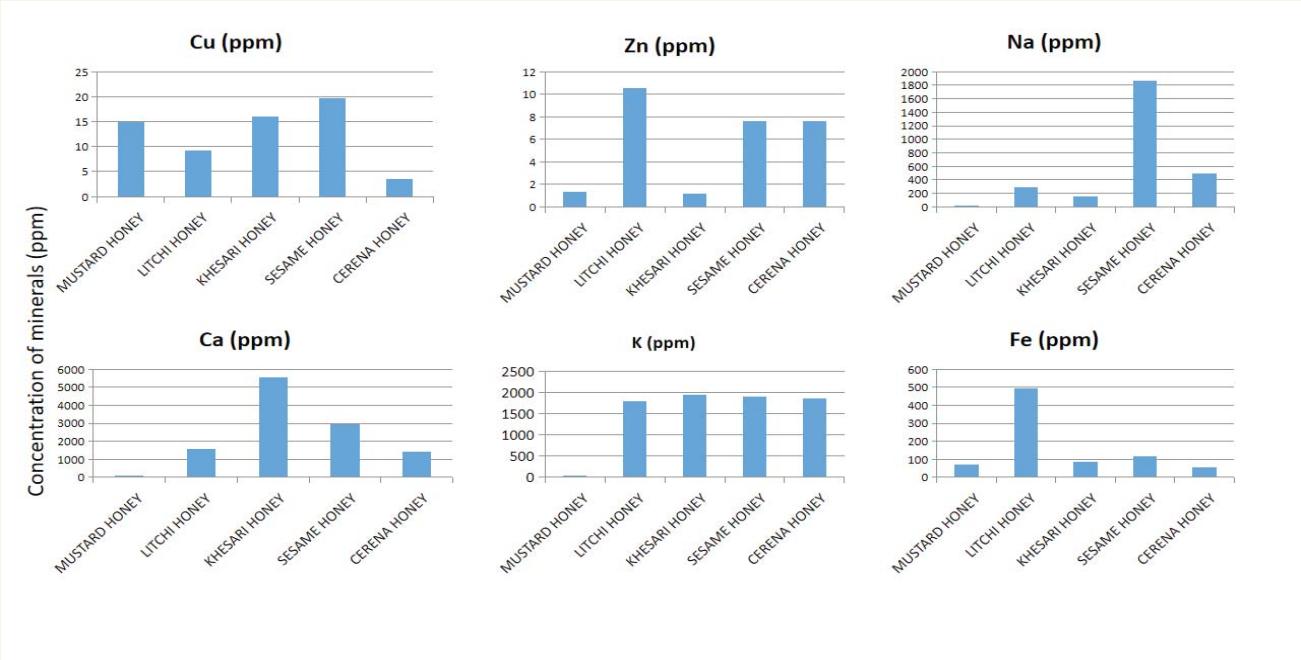


Fig. 14. Estimation of minerals (Cu, Zn, Na, Ca, K and Fe) from different types of honey

Elemental analysis of unifloral (mustard) mellifera honey at different harvesting stages

A study was conducted to assess and quantify composition of micronutrients in the mustard honey at different stages of harvesting (1st day to 9th day of last harvesting). It was found that the level of micronutrients was at peak on the 9th day of last harvesting.

Standarization of honey moisture control by indirect heating

According to FSSAI the moisture content of honey lies between 18.37-22%. But direct heating causes lose of many essential properties of honey, So honey moisture was controlled by indirect heating and according to the standardization method, 50-57 °C temperature is ideal for honey moisture reduction (Fig. 15).

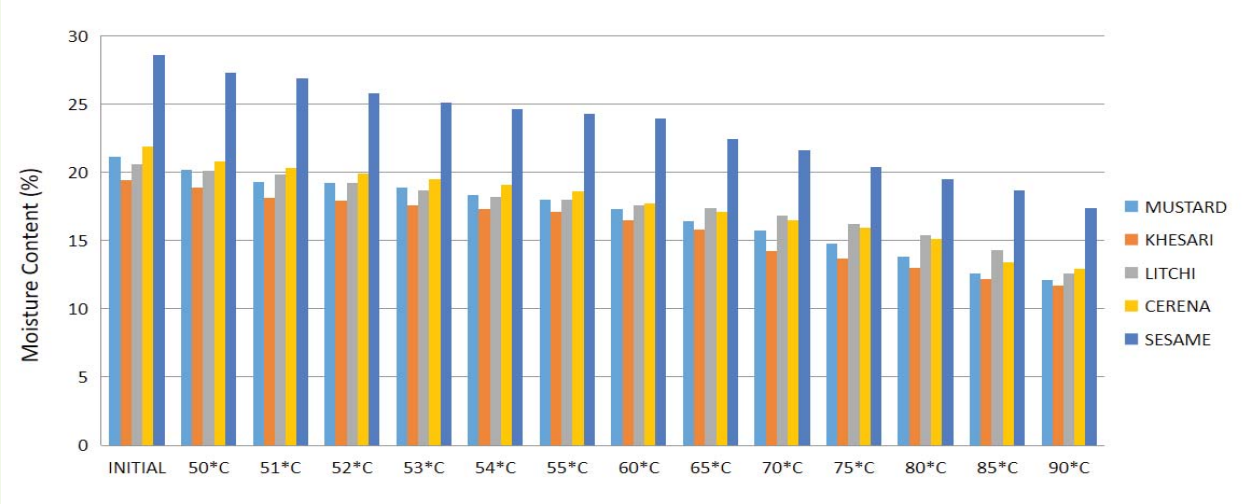


Fig. 15. Profile of variations in the moisture content among 5 Honey types at different temperatures of Indirect heating method

Transfer of Technology

Transfer of Technology

The knowledge and skill of stakeholders including farmers, state government officials, line departments of various states were upgraded through trainings, demonstrations, field visits, exposure visits, meetings, goshthies, awareness programmes, showcasing technologies in exhibitions in various places. The details of the programmes are given below:

Exhibitions

Institute staff participated in the State Level Fruit, Vegetable and Flower Show held at Raj Bhawan, Lucknow during 6-9 February, 2021 organized by the Department of Horticulture and Food Processing (Uttar Pradesh) and displayed technologies developed in the Institute.

Training Programmes

A training programme was organized for 14 Horticulture Extension officers from Bihar on "Production, plant protection and post harvest management of subtropical fruit crops" during 08-10, March, 2021. This training programme was sponsored by the Bihar Agriculture Management and Extension Training Institute (BAMETI).

Farmers/Students/Extension Functionaries Exposure Visit

A large number of farmers, rural women, students and dealers of pesticides visited the Institute's experimental field and laboratory during the year. The visitors were apprised about espalier and container gardening of guava, new varieties of mango, guava, bael, aonla and jamun developed by the institute. They were also exposed to technoligies like High density planting of mango and guava, polyhouse vegetables production, organic farming, modern nursery, drip irrigation, integrated management of insect and diseases of mango, crop diversification, land management and preparing squash/juices and other value added products and importance of nutrition in human health.

Sl. No.	Topic	Sponsoring agency	Dates	Participants
1	Technologies of subtropical fruits	Department of Horticulture, Sagar, Madhya Pradesh.	January 13, 2021	08 farmers from Sagar, Madhya Pradesh.
2	Technologies of subtropical fruits	Pragya Gramotthan Sewa Samiti, Fatehpur, Uttar Pradesh.	January 22, 2021	60 farmers from Fatehpur, Uttar Pradesh
3	Technologies of subtropical fruits	ATMA, Bihar	February 2, 2021	27 farmers from Munger and 50 farmers from Siwan, Bihar.
4	Technologies of subtropical fruits	ATMA, Bihar and Madhya Pradesh	February 3, 2021	30 farmers from Sewan, Bihar and 12 farmers of Sehore, Madhya Pradesh
5	Technologies of subtropical fruits	Foundation for Advancement of Science, Lucknow	February 11, 2021	9 farmers from Lucknow, Uttar Pradesh
6	Technologies of subtropical fruits	District Plant Protection Office, Barabanki.	February 12, 2021	37 Agriculture Extension Services for input dealers (DAESI) trainees from Barabanki, Uttar Pradesh
7	Technologies of subtropical fruits	Krishi Vigyan Kendra (SVPAUT, Meerut), Shahjahnpur	February 23, 2021	30 farmers from Shahjahnpur district of Uttar Pradesh
8	Technologies of subtropical fruits	ATMA, Rohtas, Bihar in collaboration with Indira Gandhi Institute of Cooperative Management, Lucknow	March 9, 2021	43 farmers and 3 officials from Rohtas, Bihar
9	Technologies of subtropical fruits	Department of Agriculture, Umaris, Madhya Pradesh	March 15, 2021	09 farmers from Umaris, Madhya Pradesh
10	Technologies of fruit processing and subtropical fruits	ATMA, Jamui, Bihar and Omkar Sewa Sansthan, Gauriganj, Amethi, Uttar Pradesh	March 17, 2021	13 rural women and 2 officials from Jamui, Bihar and 25 farmers from Sultanpur and Amethi, Uttar Pradesh
11	Technologies of subtropical fruits	ATMA, Munger, Bihar	July 28, 2021	56 farmers from Munger, Bihar
12	Technologies of subtropical fruits	ATMA, Arbal, Bihar in collaboration with Indira Gandhi Institute of Cooperative Management Rajajipuram Lucknow.	August 26, 2021	20 farmers and 2 officials from Arbal, Bihar
13	Technologies of subtropical fruits	Department of Horticulture, Shivpuri, Madhya Pradesh.	September 17, 2021	15 farmers and 1 official from Shivpuri, Madhya Pradesh
14	Technologies of subtropical fruits	Sam Higginbottom University of Agriculture, Technology & Sciences, Naini, Prayagraj, Uttar Pradesh	October 20 & 21, 2021	One hundred (100) students of B.Sc (Agriculture) final year along and four faculty members
15	Technologies of subtropical fruits	Plant Protection Officer, department of Agriculture, Barabanki, Uttar Pradesh under Diploma in Agricultural Extension Services for Input Dealer (DAESI).	October 22 2021	Eighty eight dealers of pesticides/ insecticide/ seeds/ fertilizers along with two officials from Barabanki, Uttar Pradesh

16	Technologies of subtropical fruits	Department of Horticulture, Bhind, Madhya Pradesh	November, 11, 2021	15 farmers including one official from Bhind, Madhya Pradesh
17	Technologies of subtropical fruits	Department of Horticulture, Satna, Madhya Pradesh	November, 18, 2021	15 farmers including one official from Satna, Madhya Pradesh
18	Technologies of subtropical fruits	Department of Horticulture, Hardoi, Uttar Pradesh	November, 27, 2021	60 farmers along with 2 officials from Hardoi, Uttar Pradesh
19	Technologies of subtropical fruits	Sam Higginbottom University and Bhalchandra Institute of Education & Management, Lucknow, Uttar Pradesh	November 29, 2021	Forty (40) Students of B.Sc (Agriculture) IV semester along with four faculty members

Mera Gaon Mera Gaurav

Institute conducted on farm demonstrations, organized awareness programmes, kisan goshthies, stake holders interaction and distributed planting materials under MGMG programme under the supervision of extension scientists. The details of the programmes are as below:

Sl. No	Topic	Event	Village name	Date	Participants
1.	Care of flowering and fruiting of mango orchards	Demonstration	Kanar	March 20, 2021	20
2.	Care of mango orchards for optimum productivity and sowing of vegetables during summer season	Awareness campaign	10 villages of Kakori and Malihabad blocks	March, 2021	40
3.	Application of planofix for control of dropping of fruits	Awareness campaign	Amethiya and Salempur	April, 2021	50
4.	Use of pheromone trap for management of fruit fly in mango orchards.	Awareness campaign	Nejabari	May, 2021	30
5.	Improved method of harvesting reduce post harvest losses	Awareness campaign	Rasoolpur	June , 2021	40
6.	Cleaning, grading and packaging of mango and conservation of rain water	Awareness campaign	Kushmora villages	July, 2021	25
7.	Management of mango orchard against insect pest and diseases	Awareness campaign	Habibpur	August , 2021	20
8.	Importance of nutrition of fruits and vegetables and encouraging farmers for development of nutrigarden	Awareness campaign	Kanar	September 18, 2021	30
9.	Weeding and fertilizer application in kinnow plants and fungicide application in rejuvenated mango plants	Demonstration	Kanar	September 18, 2021	16
10.	Under Special Swachhta Campaign organized awareness campaign on cleanliness and sanitation drive.	Swachh Bharat Abhiyan	Kanar and Naijabhari	October 16 , 2021	40
11.	Cleanliness and sanitation drive	Awareness campaign	Kanar and Naijabhari	October 16, 2021	40
12.	Waste management through making vermicompost	Stakeholders Meeting/ goshtie	Kanar	November 25, 2021	25
13.	Scientific method of vegetable production during winter season for nutrition security	Stakeholders Meeting/ goshtie	Kanar	November 28, 2021	25
14.	About 200 plants of pakchoi, chineses cabbage and pahari sarson to the farmers raised in the institute were distributed	Distribution of planting materials	Amethiya/ Salempur village in Kakori block	December 6, 2021	15

15.	Doubling farmers income through high value vegetables production	Awareness campaign	Amethiya/ Salempur	December 6, 2021	15
16.	Scientific method of high value vegetables and flower cultivation for nutritional and income security	Stakeholders Meeting/ goshtie	Amethiya and Salempur	December 10, 2021	25
17.	Demonstrated of shoot pruning in kinnow plants	Demonstration	Amethiya and Salempur	December 15, 2021	20
18.	Integrated management of insects and diseases in kinnow and mandarin plants at farmers field	Demonstration	Amethiya/ Salempur	December 15, 2021	20
19.	Organized meeting on Integrated management of insects and diseases in kinnow and mandarin plants care of suckers and nutrients management in banana	Stakeholders Meeting/ goshtie	Amethiya/ Salempur	December 15, 2021	20
20.	Organized awareness campaign on cleanliness and sanitation drive	Swachh Bharat Abhiyan	Sanyasibag village in Malihabad block	December 18, 2021	40
21.	Cleanliness and sanitation drive	Awareness campaign	Sanyasibag village	December 18, 2021	40
22.	Sanitation Campaign	Campaign	Mau	December 24, 2021	40
23.	Sanitation Campaigns on Swachhta Awareness	Swachh Bharat Abhiyan	Mau village in Malihabad block	December 24, 2021	40

Farmers' Fair

Farmers fair was organized at the Institute on 10th March, 2021 where more than 600 farmers participated in the event. Institute technologies were displayed and demonstrated for the benefit of the farmers and other stake holders.

Schedule Caste Sub Plan

Implementation of different activities under Schedule Caste sub plan in 36 villages of Mall, Kakori and Gosaiganj blocks of Lucknow district for nutritional security and financial upliftment of Schedule Caste community were done.

On-farm entrepreneurship development through nursery raising of fruit crops

Farmers' income was enhanced by providing critical input and technical support by the experts in the aera of nursery plant production. Out of three trained farmers, two were permitted to continue the activity with their own infrastructural facilities and inputs and only scion material was provided by institute. Farmers were promoted for market linkage through the institute. The activity enhanced farmer's income and generated revenue for the institute.

Variety	Quantity Handed over to RF2	Price/graft realized to beneficiaries (Rs.)	Price/graft realized to institute (Rs.)	Total value of produce (Rs.)	Revenue generation for CISH (Rs.)	Revenue of the beneficiaries (Rs.)
Langra	9000	30	70	630000	360000	270000
Chaunsa	2015	30	70	141050	80600	60450
Mallika	3000	30	80	240000	150000	90000
Amrapali	5600	30	80	448000	280000	168000
Dashehari	5700	30	70	399000	228000	171000
Allahabad safeda	3780	25	50	189000	94500	94500
Lalit	1500	25	60	90000	52500	37500
Sardar	315	25	50	15750	7875	7875
Dhawal	600	25	100	60000	45000	15000
Lalima	380	25	125	47500	38000	9500
Shweta	1800	25	60	108000	63000	45000
J-37	700	25	100	70000	52500	17500
Total	**34390**			**2438300**	**1451975**	**986325**

Field day on production of off-season vegetable cultivation

Field day on production of off-season vegetables was organized on 12th February, 2021 at ICAR-CISH, Rehmankhera and about 200 farmers participated in the field day. Seedlings of cucurbits were distributed to the selected farmers of adopted villages in Mall and Kakori block of Lucknow.

Performance evaluation of winter season vegetable seedling

Winter vegetable seedlings (2,43,741) were distributed to the farmers of adopted villages in Mall and Kakori block of Lucknow. Planting of seedlings was done in October-November. The growth and development of the vegetable seedlings were observed in the farmer field.

Field demonstration on strawberry production and value addition at farmer's field

To promote exotic and non-traditional fruit crops in the subtropics, tissue cultured strawberry transplants of Camarosa variety (18000) were distributed to 25 farmers at Hasnapur village of Mall block and Gopramau, Kakrabad, Sarsanda and Sarai Alipur villages of Kakori block, Lucknow. Field day on strawberries in subtropical areas was organized on 23rd February, 2021 at Sarasanda village involving 120 farmers to address problems of strawberry cultivation. Farmers were empowered with various steps of strawberry production before transplanting. Farmers were provided hands on training on value addition of strawberry and they were also provided handholding support for processing. Marketing arrangement for sale of their produce was also arranged by the institute.

Field demonstration for vegetable production through vertical structure

Demostration for vegetable production through vertical structure was done in 10 villages of Lucknow where 40 numbers of vertical structures were provided to the farmers with hands on training and technical support. Field day on Vertical Gardening was organized for 80 farmers at Sarai Alipur village on 8th February, 2021. Capacity building and training was also organized from time to time at field level. Leafy vegetables including spinach, coriander, leafy mustard, water spinach were found performing well in the vertical structures.

Field demonstration on honey bee production at community level

Training on beekeeping was provided to 10 SC farmers from Mohanlalganj and Gosaiganj block of Lucknow during 9-15th Feb, 2021 at Gosaiganj village. The farmers were provided with hands-on training on honey bee production and processing at the progressive farmer's field in Gosaiganj, Lucknow and were provided with 70 number of honey bee boxes with honey bee colony.

Field demonstration for commercial marigold production

Farmers from Karjhan village of Kakori block in Lucknow were selected for commercial marigold production and marigold seedlings were provided to 48 farmers. An area of about 13,50,000 square feet was undertaken for the demonstration. The activity has resulted in the income generation of Rs. 11.6 lakh to the beneficiaries.

Further 100 farmers were provided input of marigold seeds. An area of about 100 Bigha was undertaken for the demonstration.

Field demonstration of organic input production through vermin-bed

Vermicompost production through vermibed was demonstrated in Mall and Kakori block of Lucknow. 130 vermibed were distributed to the farmers populated with earth worms. Selected beneficiaries were provided hands on-training and field days were also organized for the benefit of the farmers. Cow dung and farm waste was converted in good quality of vermi-compost within 4 months resulting in less dependency on fertilizers and production of safe food.

Exploring extended market availability of locally grown fresh fruits through introduction of new crops at farmers' field

Field day was organized on 10th February 2021 at Bulakihar village on Apple Ber production. Apple Ber and Strawberry were selected as new crops for increasing fruit basket diversity during february to may. Strawberry is harvested from mid of February and continues till last week of April whereas, Apple ber starts fruiting from March and continues till May. About 4000 grafted ber and 18000 transplants of strawberry were transplanted in farmers' field in Mall and Kakori blocks of Lucknow.

Off season (Kharif) onion production at farmers' field

Field day and training was organized on production of kharif onion in subtropical areas on 8th January, 2021 at Kakrabad village involving 120 farmers. Sets of 'Agri found Dark Red' and Agri found light Red varieties of Onion were produced in open field conditions of the staff. The sets were provided to the farmers for transplanting in open field conditions during mid August. Harvesting of onion bulb was done during November and December which helped them to fetch a good market price. The farmers from success of off season 20 more villages were sensitized about the production technology.

Crop diversification for improving nutritional status

Field day on Nutri Garden was organized on 17th February, 2021 at Gopramau village, in which 200 farmers participated. During the year more than 500 farmers were supported for crop diversification activities with input support of seed material of vegetables (beet root, spinach, carrot, lady finger, coriander, cowpea, radish), planting material of fruits and technical knowledge for year round vegetable production. Availability of leafy vegetables and diverse fruits like lemon, banana mango, guava etc. were ensured improved nutritional security of farm families.

Field demonstration garlic farming

About 650 kg of garlic seeds (G-50 and G-282) ware provided to 200 farmers in Mall and Kakori blocks of Lucknow for field demonstration. After harvest of the produce, farmers have returned back a token quantity of seed material which will be used for further distribution to the new beneficiaries. Variation in yield and size of bulb was observed across villages and time of transplanting. Bulblet sowing in the second fortnight of October gave higher yield as compared to the late planting.

Field demonstration of Fruit fly trap

Field demonstration of Fruit fly trap for vegetable protection was done in Mall and Kakori blocks of Lucknow where 2000 number of fruit fly traps were provided to 800 farmers with hands on training. Field demonstration was also organized from time to time for the same.

Field demonstration of CISH Fasal Shakti

Field demonstration of CISH Fasal Shakti (micronutrient) was done in villages in Mall and Kakori block of Lucknow where 1000 packs of Fasal Shakti (1kg pack) were distributed to the farmers with hands on training and technical support.

Distribution of guava plants under SCSP

More than 22000 guava plants developed by the institute were distributed to the farmers of 24 villages in Mall and Kakori block of Lucknow as well as to KVK Dhaura, Unnav district. Farmers were provided with the knowledge and technical support from the experts for better establishment of the orchards.

Organic vegetable production through use of CISH-Bio-Enhancer

Field demonstration of organic vegetable production through use of CISH-Bio enhancer was carried out in Mall and Kakori block of Lucknow. About 8kg of CISH- Bio enhancer was distributed to the farmers besides providing the technical support.

Participation of farmers communities in various programs

S.N.	Name of field day/ Training/ Meeting	Date	Venue	No. of participants
1.	Azadi ka Amrit Mahotsav	26.08.2021	CISH	50
3.	PoshanVatika Maha-Abhiyan	17.09.2021	Kakrabad	100
4.	Kisan-Vaigyanik Samvad Ghosthi	28.09.2021	CISH	120
5.	Satarkata Jagrukta Saptah	30.10.2021	Masidha Hameer	13
6.	International soil day celebration	04.12.2021	Kakrabad	70
7.	PMs talk on Natural Farming	16.12.2021	CISH (online)	202
8.	Rejuvenation of mango orchards	21.12.2021	Hanni Khera (Mall)	65
9.	Farmers day celebration	23.12.2021	CISH	55






Promotion of organic farming practices for Improving Livelihood Security of small and marginal farmers in Uttar Pradesh

Ten clusters were formed in Barabanki, Hamirpur and Banda districts of Uttar Pradesh and training programmes for on farm production of organic inputs were organized as per PKVY guidelines along with exposure visits of the farmers to ICAR-IIPR, Kanpur, ICAR-CISH, Lucknow and BAU&T, Banda. Facility for on farm production of organic inputs viz; vermi compost, jeevamrita, Amritpani and biodynamic liquid pesticide has been created for all the 10 clusters. Various inputs viz; knapsack sprayers, vermi compost beds, neem oil, sticky traps, earthworms were distributed to all the registered farmers of each group. Total 12 training were organized for production of organic inputs at the farm.

Farmers counselling

About 50 farmers from UP, Bihar, Punjab, MP, Haryana, Rajasthan and Maharashtra visited the Institute and were guided, clarified their doubts on various aspects of subtropical fruit crop production.

Postal Queries

Grower's queries related to various aspects of subtropical fruits were attended through correspondence. The literature related to scientific cultivation of mango, aonla, guava and papaya were provided to them.

Farmer's Helpline

Two hundred seventy seven (277) calls were received from farmers from different states regarding availability of planting materials (27.45 %), insect pest management (23.21%), disease control (22.73 %), physiological disorders and other production aspects (10.81%), processing of fruit crops (9.90 %) and planting time and method (5.84 %). Scientists provided the solution through telephonic conversation under Kisan Call Centre.

Technological interventions for quality mango production for doubling income of mango growers in Malda district.

A series of awareness programme have been organized to mobilize mango growers for adoption of good agricultural practices in mango.

(i) On campus training was conducted on "Value Addition of Mango Fruits" by Dr. Dipak Nayak and Dr. Antara Das in ICAR-CISH, RRS/KVK, Malda (West Bengal) from 11 June, 2021 to 15 June, 2021. About 15 Rural Tribal Women have attended the training programme and aware about food processing and value addition of mango. They have prepared Juice, Pickle, Mango Slice, etc during the training programme.

(ii) A kisan gosthi was organised on the occasion of Kisan Diwas (12/23/2021) at Kendpukur, Malda. by Dr. Dipak Nayak and Dr. Antara Das , during the event several topics were discussed like Natural Farming, Integrated farming system with Mango, Jute Handicraft, Scientific Cultivation of Vegetable and fruits.

(iii) A training was organised with farm women of Nimroil village regarding "Formation of New FPO (Farmers Producer Organization)" on 04/16/2021. About 20 farm women were presented in the meeting.

Technology Commercialization and Entrepreneurship Development

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

Technology commercialization

1. ICAR-CISH, Lucknow signed a Memorandum of Understanding (MoU) with M/s Palvi Industries, Maharashtra on January 19, 2021 for commercialization of CISH-Trap-1 (Automated colour changing solar light insect trap with CFL having restrictor with regulated crop area illumination), CISH-Trap-2 (Solar operated dual UV light automated agricultural insect trap with restrictor having regulated crop area illumination), CISH-Trap-3 (Automatic electrical UV light source trap with restrictor having regulated crop area illumination) and CISH-Trap container. This MoU will facilitate the production and commercialization of these traps which will help the farmers to protect their fruit and vegetable crops from insects.

2. ICAR-CISH, Lucknow signed a MoU with M/s Scientia in vitro agritech, Lucknow on January 19, 2021 for commercialization of "*In Vitro* immunization of tissue culture banana technology". Dr. Shailendra Rajan, Director, ICAR-CISH; Dr. T Damodaran, Principal Scientist, ICAR-CSSRI RRS, Lucknow; Dr. Maneesh Mishra, Principal Scientist; Dr. Ravi S.C., Scientist and Ms. Mansi Rai Sharma of M/s Scientia In vitro Agritech, Lucknow were present. This MoU will facilitate the production and commercialization of bio-immune tissue culture plants.

3. ICAR-CISH, Lucknow has commercialized the "Rain-proof and long lasting fruit fly traps technology for fruit (CISH-OMAT) and vegetable (CISH-VMAT) crops" to two firms viz., M/s Life Speaks Ltd., Maharashtra and M/s Ranaji Biotech India Private Limited, Kanpur on January 19, 2021.
4. ICAR-CISH, Lucknow signed a MoU with M/s Saavi Industries Sangli, Maharashtra on January 19, 2021 for commercialization of CISH pest Hammer.
5. ICAR-CISH, Lucknow signed MoU with three firms viz., M/s Parasar Agrotech Bio Pvt Ltd, Varanasi on February 15, 2021, M/s. Ranaji Biotech India Private Limited, Kanpur on July 14, 2021 and M/s. Sai Enterprises, Lucknow on September 08, 2021 for the commercialization of CISH - Glue Trap (Multi-layered, white oil glue based long-lasting insect sticky trap for agriculture use). This MoU will facilitate the commercialization of white oil glue traps.

6. ICAR-CISH, Lucknow signed a MoU with M/s Balaji Agro Foods, Lucknow on October 02, 2021 for developing the mango based products.

7. ICAR-CISH, Lucknow signed a MoU with M/s Ranaji Biotech India Private Limited, Kanpur on November 30, 2021 for commercialization of CISH-Bio Enhancer.

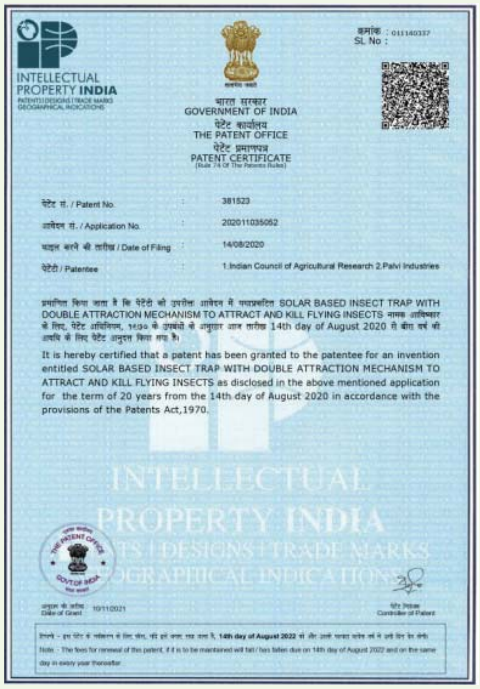
Other MoU's signed

S.No.	Name of MOU	Date	Period	Name of partner
1.	MoU for facilitating Students' Training/ Postgraduate research	04-02-2021	Five years	G H RAISONI University, MP
2.	MoU for facilitating Students' Training/ Postgraduate research	09-8-2021	Five Years	Amity University, Lucknow
3.	MoU to Promote and enhance research interests, sharing scientific knowledge, methodology	31-08-2021	Five years	ICAR-NINFET, Kolkata
4.	MoU for facilitating Students' Training/ Postgraduate research	08-09-2021	Three years	Ch. Charan Singh University, Meerut
5.	MoU for facilitating Students' Training/ Postgraduate research	20-11-2021	Three Years	Dr. Ram Manohar Lohiya Avadh University, Ayodhya

IP protection

Patent granted

A patent has been granted for the invention 'Solar based insect trap with double attraction mechanism to attract and kill flying insects (CISH Trap-2)' for a period of 20 years from August 14, 2020. The date of grant of patent is November 10, 2021.



INTELLECTUAL PROPERTY INDIA

भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
PATENT CERTIFICATE

पेटेंट सं. / Patent No. : 381523
आवेदन सं. / Application No. : 202011035052
फाइल करने की तारीख / Date of Filing : 14/08/2020
पेटेंटी / Patentee : 1.Indian Council of Agricultural Research 2.Palvi Industries

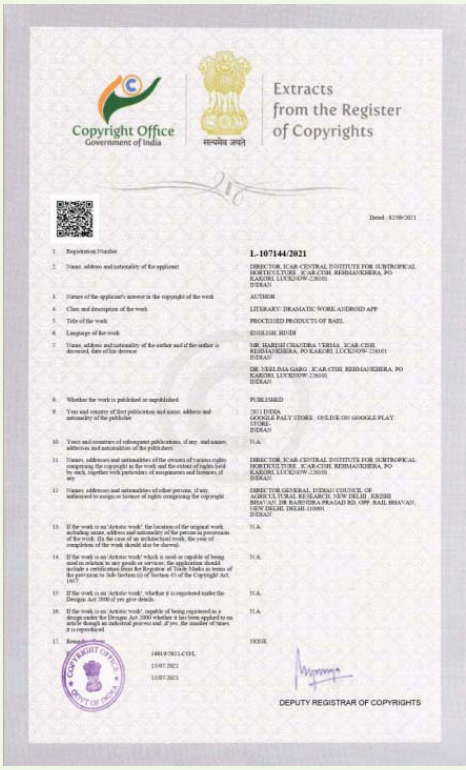
It is hereby certified that a patent has been granted to the patentee for an invention entitled SOLAR BASED INSECT TRAP WITH DOUBLE ATTRACTION MECHANISM TO ATTRACT AND KILL FLYING INSECTS as disclosed in the above mentioned application for the term of 20 years from the 14th day of August 2020 in accordance with the provisions of the Patents Act,1970.

Patents filed

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

Copyright granted

Copyright was granted for the mobile app on 'Processed Products of Bael' on September 2, 2021 (Diary No. 16019/2021-CO/L).



Copyright Office
Government of India

Extracts
from the Register
of Copyrights

Dated : 02/09/2021

1.	Registration Number	L-107144/2021
2.	Name, address and nationality of the applicant	DIRECTOR, ICAR-CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE , ICAR-CISH, REHMAN/SEHRA, PO KAKORI, LUCKNOW-226101 INDIAN
3.	Nature of the applicant's interest in the copyright of the work	AUTHOR
4.	Class and description of the work	LITERARY/ DRAMATIC WORK ANDROID APP
5.	Title of the work	PROCESSED PRODUCTS OF BAEL
6.	Language of the work	ENGLISH, HINDI
7.	Name, address and nationality of the author and if the author is deceased, date of his decease	DR. HARISH CHANDRA VERMA , ICAR-CISH, REHMAN/SEHRA, PO KAKORI, LUCKNOW-226101 INDIAN DR. NEELIMA GARG , ICAR-CISH, REHMAN/SEHRA, PO KAKORI, LUCKNOW-226101 INDIAN
8.	Whether the work is published or unpublished	PUBLISHED
9.	Year and country of first publication and name, address and nationality of the publisher	2021 INDIA GOOGLE PALY STORE , ONLINE ON GOOGLE PLAY STORE INDIAN
10.	Years and countries of subsequent publications, if any, and names, addresses and nationalities of the publishers	N.A.
11.	Names, addresses and nationalities of the owners of various rights comprising the copyright in the work and the extent of rights held by each, together with particulars of assignments and licences, if any	DIRECTOR, ICAR-CENTRAL INSTITUTE FOR SUBTROPICAL HORTICULTURE , ICAR-CISH, REHMAN/SEHRA, PO KAKORI, LUCKNOW-226101 INDIAN
12.	Names, addresses and nationalities of other persons, if any, authorized to assign or licence of rights comprising the copyright	DIRECTOR GENERAL, INDIAN COUNCIL OF AGRICULTURAL RESEARCH, NEW DELHI , KRISHI BHAVAN, DR RAJENDRA PRASAD RD, OPP. RAIL BHAVAN, NEW DELHI, DELHI-110001 INDIAN
13.	If the work is an 'Artistic work', the location of the original work, including name, address and nationality of the person in possession of the work. (In the case of an architectural work, the year of completion of the work should also be shown).	N.A.
14.	If the work is an 'Artistic work' which is used or capable of being used in relation to any goods or services, the application should include a certification from the Registrar of Trade Marks in terms of the provisions to Sub-Section (c) of Section 45 of the Copyright Act, 1957.	N.A.
15.	If the work is an 'Artistic work', whether it is registered under the Designs Act 2000 if yes give details.	N.A.
16.	If the work is an 'Artistic work', capable of being registered as a design under the Designs Act 2000 whether it has been applied to an article through an industrial process and, if yes, the number of times it is reproduced	N.A.
17.	Remarks, if any	NONE

1401/9/2021-CO/L
15/07/2021
15/07/2021

DEPUTY REGISTRAR OF COPYRIGHTS

Copyrights filed

- Copyright application was submitted for the mobile app Ripe mango products (in Hindi) [Diary No. 28093/2021-CO/L] on November 22, 2021.
- Copyright application was submitted for the mobile app Ripe mango products (in English) [Diary No. 28094/2021-CO/L] on November 22, 2021.
- Copyright application was submitted for the mobile app Raw mango products (in Hindi) [Diary No. 28091/2021-CO/L] filed on November 22, 2021.
- Copyright application was submitted for the mobile app Raw mango products (in English) [Diary No. 28087/2021-CO/L] on November 22, 2021.
- Copyright application was submitted for the mobile app Aonla Processed products (in Hindi) [Diary No.28779/2021-CO/L] on November 30, 2021.
- Copyright application was submitted for the mobile app Aonla (Indian Gooseberry) Products (in English) [Diary No. 28785/2021-CO/L] on November 30, 2021.
- Copyright application was submitted for the mobile app Guava Processed products (in English) [Diary No. 28790/2021-CO/L] on November 30, 2021.
- Copyright application was submitted for the mobile app Guava kitchen recipes [Diary No. 28801/2021-CO/L] on November 30, 2021.

Brainstorming on Boosting Horti-preneurship in India

ICAR-CISH, Lucknow organized a brainstorming session on "Challenges and Approaches for Boosting Horti-preneurship in India" on 12 January, 2021. The objective of the event was to impart the knowledge of horti-preneurship development and capacity building to the potential enthusiastic youth for boosting the startups in horticulture. The programme was conducted in association with Society for Development of Subtropical Horticulture (SDSH). In panel discussion, the experts Dr. S. Rajan, Director, ICAR-CISH, Lucknow; Dr. Maneesh Mishra, Principal Scientist, ICAR-CISH; Dr. T. Damodaran, Principal Scientist, ICAR-CSSRI RRS, Lucknow; Dr. Jyoti Dewan from Shri Ramswaroop Memorial University, Lucknow; Mr. Ravi Pandey, IIT Kanpur and Mr. Hari Shankar, Founder & Managing Director, Agnys Waste Management Pvt. Ltd., Kanpur discussed about the horti-startup challenges, adoptive measures, winning factors, feasibility analysis and necessary important components for horti-startups. Total 104 participants which included incubators, founders, innovators, investors, entrepreneurs, scientists, academicians, stakeholders and students from all across the country attended the programme. Participants discussed challenges on course of establishment of start-ups.

Orientation Programme

An orientation programme was organized for CISH-ABI-entrepreneurs on 12 January, 2021. MoUs were signed between ICAR-CISH and entrepreneurs for ICAR-CISH technologies namely Rain proof and long lasting fruit fly traps technology for fruit (CISH-OMAT) and vegetables (CISH-VMAT) crops, pulp processing, *in vitro* immunization of tissue culture banana technology and CISH Bio-enhancer.

Interface Meet

The interface meet between entrepreneurs, industries, start-ups and the Institute was held on 19th January, 2021 at the committee hall of the Institute and also virtually via Zoom. The aim of the interface meeting was to bring the entrepreneurs, Industrialists and the Institute under the same roof for commercializing the technologies developed by the Institute. Five technologies were commercialized during this interface meet.

Entrepreneurship development through Agri-Business Incubation (ABI) Centre

CISH-Agri-Business Incubation Centre has expanded its incubation with new entrepreneurs namely Mr. Brijesh Kumar Singh in Hydroponics, Mr. Vijayant Sharma in Mushroom Technology, Mr. Dipanker Mukherjee in Value Added Products and Mr. Vimarsh Bajpai for High Value Vegetable Crop Production. Furthermore, several startups like M/s Quantrello Digital Private Limited (Kolkata, West Bengal), M/s Ranaji Biotech India Private Limited (Kanpur, U.P.), M/s Farmers Family (Noida, U.P.) and M/s Agriyaan Technologies Private Limited (N. Delhi) are getting entrepreneurial support for their business strengthening in Block chain, ICAR-CISH Bio-enhancer, Mango Supply Chain Management and Tele-Acoustic Devices, respectively.

Mango Buyer-Seller Interface Programme

An online ''आम क्रेता–विक्रेता गोष्ठी'' ("Mango Buyer-Seller Meet") was organized by the ABI, CISH on 5th June, 2021. It was an interface meet for connecting mango farmers, fruit companies and State Horiculture Departments for improving the business model of horticultural produce. It was deliberated that unavailability of low cost, foldable ripening chambers were the major problem faced by the mango farmers. Dr. S. Rajan, Director, ICAR-CISH offered help to farmers in establishing the small scale ripening

chamber at the institute. Secretary of Avadh Aam Utpadak ewam Bagwani Samiti and Mother Dairy, Mall, Malihabad along with several other progressive farmers addressed the problems associated with mango marketing. Dr. R.K. Tomar, Director, HOFED, urged the farmers for making mango clusters so that post harvest training could be arranged for the farmers. He also stated that farmers can avail various grants for power spray, pack house and vending carts etc. offered by the state horticulture department. Several entrepreneurs shared their mango marketing experiences in the meeting. M/s All Fresh Supply Management Pvt. Ltd., N. Delhi expressed that demand of Malihabadi Dashehri has increased extensively in Gujarat. Dr. Maneesh Mishra, Principal Investigator, ABI, CISH apprised that several entrepreneurs have shown interest in CFB packed sanitized mango marketing. The meeting was concluded with an advice to farmers to work in a cluster approach with ICAR-CISH and HOFED so that they can accrue benifit by getting decent rates of mango in the market.

Association Meeting with Villgro Innovations Foundation

A meeting was conducted with Villgro Innovations Foundation, Chennai, Tamil Nadu on 30th July 2021 for deemed association with CISH-ABI. Company representative Mr. Mohammad Azhar presented the proposal and role of their association, curriculum and components of the program. Director, ICAR-CISH and participating scientists debated on the possible benefits, outcomes and impact of the program and association.

Entrepreneur Development Programme (EDPs)

Agribusiness Incubation Center organized an online entrepreneurs' interaction meeting on 23rd August 2021. A total number of 15 budding horti- entrepreneurs attended the meeting from Uttar Pradesh, Madhya Pradesh, West Bengal and Haryana through video conferencing. At the outset of the meeting, Dr. Maneesh Mishra (PI, ABI) told about the achievements and activities of the centre. During the meeting participants presented and shared their startup proposals to the Director and mentors. Dr. S. Rajan, Director, ICAR-CISH interacted with all participants and discussed their startup proposals. Few proposals like "Tele-Acoustic Device" by Mr. Piyush Kumar Singh (N. Delhi) and "Block Chain Technology" to improve the traceability and transparency of value chain by Mr. Ayon Hazra, Kolkata, West Bengal were found interesting and innovative.

Webinar on "Entrepreneurship Development in Horticulture: A New Paradigm"

A webinar on "Entrepreneurship Development in Horticulture: A New Paradigm" was organized by Dr. Maneesh Mishra, Principal Scientist & P.I.,

Agri-Business Incubation (ABI) Centre, ICAR-CISH on 16th November 2021. The objective of programme was to sensitize and capacity building of entrepreneurs in horticulture. Dr. S. Rajan, Director briefed about the avenues of entrepreneurship in horticulture. Dr. R. Nagaraja Reddy, Sr. Scientist & P.I., Medi-Hub TBI, ICAR-Directorate of Medicinal and Aromatic Plants Research (DMAPR), Anand, Gujarat explained the importance, uses and role of medicinal and aromatic plants in entrepreneurship development. Another speaker, Mr. S. Santhosh, CEO, Entrepreneurship Development and Innovation Institute (EDII), Trichy Agribusiness Incubation Forum (TABIF), Tamil Nadu Agricultural University, Trichy, Tamil Nadu highlighted the recent trends in agri-business and role of incubation helping in agri-startups. A total of 52 startups, entrepreneurs, enterprises, scientists, academicians, students, women entrepreneurs and technical staff from all corners of the country have participated in the webinar.

Human Resource Development

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

Trainings Attended

Name of participant	Training	Date
Dr. Sumit Kumar Soni	Online training programme on 'Time series data analysis' organized by ICAR-NAARM, Hyderabad.	January 4-9, 2021
Dr. Anju Bajpai	Online training programme on 'Emotional Intelligence at Workplace for Scientists/Technologists' organized by DST at COD, Hyderabad.	February 15-19, 2021
Dr. Ashish Yadav	Generic Online Training in 'Cyber Security' for Central Government Ministries/Department organized by Ministry of Electronics and Information Technology (MeitY), Government of India.	February 17, 2021
Skilled Support staff (6 nos.)	'Skill up-gradation and field Exposure visit' from at ICAR-CISH and IISR.	March 2-4, 2021
Dr. Karma Beer	Online training programme on 'Applications of Artificial Intelligence and Cloud Computing in Agriculture' from organized by ICAR-NAARM, Hyderabad.	March 15-20, 2021
Dr. Ashish Yadav	Online Training on 'DUS Testing' organized by Protection of Plant Varieties & Farmers' Rights Authority, New Delhi.	July 1, 2021
Dr. Nidhi Kumari	SERB-sponsored Hands-on training (online) on 'CRISPR/CAS9 mediated gene editing in plants' organized by the Department of Plant Sciences, the University of Hyderabad.	October 3-10, 2021.
Dr. Sumit Kumar Soni	One day virtual training programme on 'Implementation and use of Agricultural Research Management System'.	October 11, 2021
Dr. Bharati Killadi	Online training programme on 'Nano-technology and its advance application-2021' conducted by ICAR-CIRCOT.	November 22-26, 2021.
Dr. Ashish Yadav	National Online Training on 'Conservation, Management & Utilization of Horticultural Genetic Resources for Livelihood and Nutritional Security' organized by ICAR-IIHR, Bengaluru.	November 22-26, 2021
Dr. Ravi, S.C.	Online training programme on 'Impact Assessment of Agricultural Research and Technologies' organized by ICAR-NAARM, Hyderabad.	December 18-22, 2021
Scientists and PME Staff	Workshop cum training on 'ARMS: Newly developed research management System and & Krishi Portal' from organized by HRD Cell ICAR-CISH, Lucknow.	July 29-31, 2021
Mr. Rahul Bhat	'Establishment Matters' at ICAR-IISR, Lucknow.	December 20-23, 2021
Mr. Rahul Bhat	Online Training Programme on 'Administrative and Finance Management' for Section Officers/AAO/ AFAOs/Assistants of ICAR Headquarters/Institutes organized by ICAR-NAARM Hyderabad.	June 24 - 26, 2021

Mr. Rahul Bhat	Online Training Program on 'Budget Utilization Procedure' organized by NAARM, Hyderabad.	August 9, 2021
Mr. H.C. Verma	15 days virtual FDP on 'Next Gen Computing Technologies' organized by Integral University, Lucknow.	November 10-25, 2021

Conference Attended

- Neelima Garg attended '4th Inetrnational conference (virtual mode) on Current approaches in Agricultural, animal husbandry and allied sciences for successful entrepreneurship (CAAAAHASSE-2021)' jointly organized by Agro Environmental Development Society (AEDS), Majhra Ghat, Rampur, India and Centre for Agribusiness Incubation and Entrepreneurship, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (Madhya Pradesh) India during March 13-15, 2021.
- P.K. Shukla attended 'National e-Conference on Plant Health and Food Security: Challenges and Opportunities' organized by IPS, New Delhi during March 25-27, 2021.
- Shukla P.K. and Nidhi Kumari attended 'International e-Conference on Postharvest Disease Management and Value Addition of horticultural crops' organized by IPS, New Delhi during August 18-20, 2021
- Govind Kumar attended '3rd International Conference on Global Initiatives in Agricultural, Forestry and Applied Sciences (GIAFAS-2021)' Jointly Organized by Agricultural & Environmental Technology Development Society, U.S. Nagar, Uttarakhand, India, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh and Corteva agriscience at Shri Guru Ram Rai University, Dehradun, Uttarakhand, India during October 17-18, 2021.
- Tarun Adak and H.C. Verma attended '2nd International Web-Confence on Smart Agriculture for Resource Conservation and Ecological Stability' organized by Academy of Natural Resource Conservation and Management (ANRCM) during October 29-31, 2021.
- R.A. Ram, S.K. Shukla, P.K. Shukla, Naresh Babu, K.K. Srivastava, Dinesh Kumar, Dushyant Mishra, Ashish Yadav, Bharti Killadi, Tarun Adak, Anshuman Singh, Vishambhar Dayal, A.K. Gupta and Ravi SC attended '9th Indian Horticulture Congress-2021' organized by Indian Academy of Horticultural Sciences, New Delhi, India at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India during November 18-21, 2021.
- Anju Bajpai, Tarun Adak, Israr Ahmad, Muthukumar. M., Govind Kumar and Nidhi Kumari attended '5th International Conference on Innovative Approaches in Applied Sciences and Technologies (iCiAsT-2021)' organized by BBAU at BBAU Campus, Lucknow, Uttar Pradesh, India during December 3-5, 2021.
- A.K. Trivedi and S.K. Dwivedi attended 'National Conference of Plant Physiology-2021' organized by ICAR-National Institute of Abiotic Stress Management (NIASM), Baramati, Pune, Maharashtra in collaboration with Indian Society for Plant Physiology (ISPP), New Delhi at ICAR-NIASM, Baramati, India during December 9-11, 2021.
- Dushyant Mishra attended 'National Agricultural Scientist Conclave on Sunstainable Agriculture Through Integrated Inputs' Organized by BKS-BAERC at JNKVV, Jabalpur, Madhya Pradesh, India during December 10-11, 2021.
- Ravi, S. C., attended the '31st International Conference of Agricultural Economists' (virtual) from August 17-31, 2021.

- Swasti Suvadarsini Das attended '6th International conference on (Hybrid mode) Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2021)' organized by Astha Foundation, Meerut, Uttar Pradesh, India during December 13-15, 2021.

National/International Webinars Attended

- Muthukumar. M. attended Webinar on "Pan Genomes in plants: Beyond a single reference genome" organized by Biogene, India during February 1, 2021.
- Muthukumar. M. attended Webinar on "Scalable AAV Manufacturing: Addressing Challenges Across the Workflow" organized by Online web cast events of Thermo Scientific, India on February 3, 2021.
- A.K. Bhattacharjee attended National Web-Seminar on "Natural Resource Conservation and Management" held at ICAR-CSSRI RRS, Lucknow on March 20-22, 2021.
- Israr Ahmad attended International Webinar on "Genetic Engineering Approaches to Develop Climate-Smart Rice" organized by Bioingene.com on June 26, 2021.
- Israr Ahmad attended Kosambi International Webinar on "Plant Genomics" organized by Savitribai Phule Pune University on July 31-August 1, 2021
- Ashish Yadav attended International Webinar on "Exchange on Biochemical and Molecular Techniques (BMT) Guidelines and Implementation of BMT in DUS" organized by PPVFRA, New Delhi in collaboration with Department of Agriculture and Farmers' Welfare, Ministry of Agriculture, Government of India and Federal Ministry of Food, Agriculture and Consumer Protection (BMEL), Germany under Indo-German Cooperation on Seed Sector Development on April 8, 2021.
- P.K. Shukla and Gundappa attended National Webinar on "Canopy architecture management in perennial commercial horticultural crops" organized by UHS, Bagalkot, Karnataka, India on July 19-20, 2021.
- HC Verma attended one week online National Webinar on "Industry 4.0 and Internet of Things (I4 IoT)" organized by Integral University, Lucknow, Uttar Pradesh, India during July 26-30, 2021.
- A.K. Gupta and S.C. Ravi attended the National Seminar on "Horticulture for next generation in eastern India" organized by BAU, Sabour, Bihar during 5-6 August, 2021.
- Abha Singh attended the Webinar on "Mental health challenges faced by farming community" organized by ICAR-NIVEDI, Bengaluru on August 28, 2021.
- Israr Ahmad attended Webinar on "Physiological and agronomical intervention for increased productivity in small cardamom" organized by ICAR-IISR RS, Appangala, Karnataka, India on September 9, 2021.
- Israr Ahmad attended Webinar on "Microbial Management of crop residues for improvement of soil health: Useful methodologies to assess compost maturity and quality" under theme Azadi ka Amrit Mahotsav by ICAR-IARI, New Delhi on September13, 2021.
- P.K. Shukla attended Webinar under Azadi ka Amrit Mahosava on "Ecosystem for atmnirbhar Baharat: STI Institutions in U.P." organized by CST UP, Lucknow, Uttar Pradesh, India on September 13, 2021.
- Tarun Adak attended National Webinar on "Use of nanotechnology in Agriculture: Nano-Fertilizer" Jointly organized by ICAR-Research complex for eastern region, Patna & IFFCO, Limited, Patna Bihar, India during September 23, 2021.
- Abha Singh, Ashish Yadav, A.K. Gupta, S.C. Ravi and S.K. Soni attended Webinar on "Role of Fruits and Vegetables in Food and Nutritional Security" organized by ICAR-Central Institute for Subtropical Horticulture,

Rehmankhera, Lucknow, Uttar Pradesh, India on September 27, 2021.

- Abha Singh and A.K. Gupta attended the International Webinar on "Alternate Cropping Systems for Climate Change and Resource Conservation" organized by ICAR-IIFSR, Meerut during September 29 - October 1, 2021.
- Israr Ahmad attended International Webinar on "Ex-situ Conservation of Horticultural Genetic Resources for Livelihood and Nutritional Security" organized by ICAR-IIHR, Bengaluru, Karnataka, India on October 3, 2021.
- Ashish Yadav attended Webinar on "Entrepernureship Development in Horticulture: A New Paradigm" organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, Uttar Pradesh, India on November 16, 2021.
- P.K. Shukla attended IPS Platinum Jubilee Lecture on "Artificial intelligence for the real time plant disease detection and management" organized by ICAR-NRC for Banana, Tiruchirapalli, Tamil Nadu, India on November 25, 2021.
- Ashish Yadav, Muthukumar M., Karma Beer and S.C. Ravi attended International webinar on "Mango producing is not enough! Wakeup call on postharvest handling, processing technology, and value chain management" organized by Department of Agriculture and Environmental Sciences, NIFTEM, Kundli, Sonipat, Haryana, India on December 7, 2021.
- P.K. Shukla attended 5th Webinar on "Implementation and Use of Agricultural Research Management System" organized by IT Unit, ICAR-IASRI, New Delhi on December 9, 2021.
- Anju Bajpai, Devendra Pandey, A.K. Singh, Ashish Yadav and Muthukumar, M., attended International Webinar on "Exchange on Biochemical and Molecular Techniques (BMT) Guidelines and Implementation of BMT in DUS" organized by PPVFRA, New Delhi in collaboration with Department of Agriculture and Farmers' Welfare, Ministry of Agriculture, Government of India and Federal Ministry of Food, Agriculture and Consumer Protection (BMEL), Germany under Indo-German Cooperation on Seed Sector Development during December 16-17, 2021.
- A.K. Gupta attended Webinar on the topic "E-Commerce marketing for agri-enterprises" organized by ICAR-NIVEDI, Bengaluru, Karnataka, India on December 17, 2021
- Muthukumar. M. attended regional webinar on "Agro-Biodiversity conservation and use for climate resilience and livelihood improvement for small holder farmers" organized by ICAR-VPKAS, Almora, Uttrakhand, India on December 23, 2021.

Workshops attended

- P.K. Shukla attended gosthi on "*Uttar Pradesh men udyan fasalon ke niryat kee sambhavnayen*" at ICAR-CISH, Rehmankhera, Lucknow on November 25, 2021.
- P.K. Shukla attended Kisan Vaigyanik sangosthi on "*Jalvayu anukul kismen, prodhyogiki aur paddhatiyan*" at ICAR-CISH, Lucknow on September 28, 2021.
- Bharati Killadi attended the workshop on "Wet synthesis: gold and silver nano particles" under CSIR Integrated Skill Initiative organized by CSIR-IITR Lucknow on December 15, 2021.

Meeting Attended

- P.K. Shukla and Gundappa attended and VIII Group Discussion of ICAR-AICRP on Fruits through virtual mode from March 3-6, 2021.
- P.K. Shukla attended Zoom Bayer seller meet of ICAR CISH June 05, 2021.
- P.K. Shukla attended Zoom Meeting "*Barsat men amrud ke uchch gunvatta ke fal kee*

utpadan taknik" organized by ICAR-CISH, Lucnow on June 21, 2021.

- P.K. Shukla attended Zoom Meeting on "*Poudhshala Prabandhan*" organized by Directorate of Horticulture and Food Preservation, Lucknow for departmental officers and employees on July 13, 2021.
- P.K. Shukla attended Zoom Meeting on "Sensitization Workshop on ARMS and Monthly Reporting in ICAR-Institutions", organized by IT Unit, ICAR-IASRI, New Delhi October 18, 2021.
- P.K. Shukla and Gundappa attended Training programme on "Export of fruits and vegetables" organized by APEDA at Prayagraj on October 22, 2021.
- P.K. Shukla attended **"**Entrepreneurship Development in Horticulture: A New Paradigm" organized by ABI, ICAR-CISH on November 16, 2021
- P.K. Shukla attended VTIC meeting for 'technology presentation and approval', organized by ITMU-ICAR-CISH on November 22, 2021.
- Ravi, S.C. attended the Scientific Advisory Committee meeting of Krishi Vigyan Kendra (ICAR), Kalakankar, Pratapgarh as Expert, Agricultural Economics at KVK Campus, Kalakankar, Pratapgarh, Uttar Pradesh on September 9, 2021.
- A.K.Verma, K. Beer and S.C. Ravi attended the *'Krishi Niryat Bandhu'* meeting as Experts organized by Directorate of Agricultural Marketing and Agriculture Foreign Trade, Uttar Pradesh on December 22, 2021.

Awards and Recognitions

Individuals Awarded

- Bajpai, A. was conferred 'SERS Fellow' award by Scientific Educational Research Society, Meerut on the occasion of 5th International Conference on Innovative Approaches in Applied Sciences and Technologies (iCiAsT-2021) at BBAU, Lucknow during December 03-05, 2021.
- Kumar, G. was awarded 'Young Scientist Award (2021)' in the field of Agricultural Microbiology on the occasion of 3rd International Conference on 'Global Initiative in Agricultural, Forestry and Applied Sciences for Food Security, Environmental Safety and Sustainable Development (GIAFAS-2021)' at SGRR University, Dehradun, Uttarakhand on October 17-18, 2021.

Best Paper/Poster Award

- Dayal, V., S. Rajan, A. Yadav and A. Singh received 'Best Poster Award' for poster 'Modified BBCH Scale of Guava' during "9th Indian Horticultural Congress-2021" held at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh during November 18-21, 2021.
- Muthukumar, M. received 'Best Oral Paper' for paper entitled 'Metabolite profiling-based characterization of *Psidium* species with resistance to root-knot nematode (*Meloidogyne enterolobii*), the causal agent of guava decline' in "5th International Conference on Innovative Approaches in Applied Sciences & Technologies (iCiAsT-2021)" at BBAU, Lucknow during December 03-05, 2021.
- Singh, B., N. Garg, P. Mathur, S. Vaish and S. Kumar received 'Best Poster Award' for the paper entitled 'Production of pectinase, cellulase and amylase by *Trichoderma asperellum* using mosambi peel as substrate' in "International Web Conference on Innovative and Current Advances in Agriculture and Allied Sciences (ICAAAS-2021)" during July 19-21, 2021.

Recognitions

- Adak, T. acted as Convener in the session soil health management in 2nd International Web-Conference on 'Smart Agriculture for Resource Conservation and Ecological Stability' organized by ANRCM, Lucknow on 31st October, 2021.
- Barman, P. is serving as Member of Editorial Board, *Agriculture Letters*, a monthly e-news letter for agri-allied sciences, Open Access Publishing, Raichur, Karnataka.
- Barman, P. is serving as Member of Editorial Board, *SCIREA Journal of Agriculture*, an International, Scientific Peer-Reviewed Open Access Journal published online by SCIREA.
- Barman, P. worked as a Coordinator for 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) at ICAR-CISH, Lucknow from March 01 to March 31, 2021.
- Garg, N. delivered Lead Lecture on 'Microbial interventions for value addition of fruits and vegetables' in the International e-Conference on 'Postharvest Disease Management and Value Addition of Horticultural Crops' organized by Division of Plant Pathology, ICAR-IARI, New Delhi during August 18-20, 2021.
- Gundappa delivered a talk on 'Aam Ke Bagon Me Keet Prabandhan' at Doordarsan, Lucknow on 14.12.2021.
- Kumar, G. worked as a Co-Chairman in the oral presentation session under theme II-Natural resource management, food and environmental security in the of 3rd International Conference on 'Global Initiative in Agricultural, Forestry and Applied Sciences

for Food Security, Environmental Safety and Sustainable Development (GIAFAS-2021)' at SGRR University, Dehradun, Uttarakhand during October 17-18, 2021.

- Kumar, G. worked as a coordinator for 'Organic Growers' training under ASCI (QP-AGR/Q1201) at ICAR-CISH, Lucknow from February 05 to March 07, 2021.
- Ravi, S.C. was a panelist in panel discussion on 'Trends of farm income in Uttar Pradesh' in 34th National Conference of Agricultural Marketing held at Department of Economics, BBAU, Lucknow held on March 17, 2021.
- Shukla, P.K. delivered a talk on *'Aam Ke Bagon Ki Sam-Samyik Dekhbhal'* at Doordarshan, Lucknow on December 16, 2021.
- Shukla, P.K. delivered a talk on *'Varsha Uparant Bagon Ki Dekhbhal'* at AIR, Lucknow on September 08, 2021.
- Srivastava, K.K. recorded for All India Radio, Lucknow on 'Baagon Me Samiyak Karya' on October 07, 2021.
- Trivedi, A.K. is serving as Editorial Board Member of Agricultural Reviews, Agricultural Research Communication Centre Publications, Karnal, Haryana.
- Yadav, A. is serving as Executive Editor, *Journal of Food and Agriculture Research*, Published Bi-annually by ARF India, Academic Open Access Publishing, 1935, Sector-23, Gurgaon-122017, Haryana.
- Yadav, A. served as Expert Member in a Consultative Group constituted by Geographical Indications Registry, Chennai for the evaluation of GI application No. 729 for Ladakh Raktsey Karpo Apricot, Leh, Ladakh and GI application No. 752 for Kodungallur Snap Melon (Kodungallur Pottuvellari), Kerala.
- Yadav, A. served as Member of Screening Committee for *'DHARTI MITR Award'*, awarded by Organic India, Lucknow, India during December 15-16, 2021.

Lectures Delivered

- Bajpai, A. delivered lecture on 'Approaches and Achievements of Molecular Breeding Techniques in Fruit Crops' in 'Digital Training Programme on Fruit Science Research: Progress & Prospects (for Students & Researchers)' organized at Department of Horticulture, Post-Graduate College of Agriculture, Dr. Rajendra Prasad Central Agricultural University Pusa, Samastipur, Bihar during September 01-08, 2021.
- Bajpai, A. delivered lecture on 'Functional genomics and its applications in horticulture' in 'Online Professional Development Program (PDP) on Future prospects of Molecular Technologies in Biological Research' organized at Integral University, Lucknow during November 23 – December 08, 2021.
- Bajpai, A. presented Lead Paper on the topic 'Transcriptional roadmap to flowering pathway in mango (*Mangifera indica* L.)' in the 'International Conference on Advances in Agricultural and Food Sciences to Face the Challenges to Environment and Bio-security' organized at Sharda Univ., Greater Noida, Uttar Pradesh during January 16-20, 2021.
- Barman, P. delivered talk as Resource Person on 'Factors affecting growth and production of garden plants (soil condition, pH, moisture retention capacity etc.)' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Barman, P. delivered talk as Resource Person on 'Plant trees, shrubs and herbs (based on location and purpose), digging pits and gap fill' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Barman, P. delivered talk as Resource Person on 'Practice of grafting in mango and budding

in rose' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.

- Barman, P. delivered talk as Resource Person on 'Role of an Assistant Gardener and possibility of vocation' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Barman, P. delivered talk as Resource Person on 'Root-stock and scions' varieties for propagation and raising of rootstocks for grafting and budding' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Barman, P. delivered talk as Resource Person on 'Training and pruning for management of garden plants' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Beer, K. delivered lecture on 'Irrigation schedule, proper spread of water, drainage at various life stages of the crops and occurrence and management of disease due to high moisture' in 'Organic Grower Training Program under ASCI' (QP-AGR/Q1201) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during February 05 to March 07, 2021.
- Beer, K. delivered lecture on 'Post-harvest handling and value-added products of mango, litchi and sapota' organized by Centre for Subtropical Fruits Department of Horticulture, Govt. of Haryana on July 10, 2021.
- Beer, K. delivered lecture on 'Various methods of irrigation, characteristics of good irrigation system, advantages and disadvantages of irrigation channels and micro-irrigation' in 'Organic Grower Training Program under ASCI' (QP-AGR/Q1201) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during February 05 to March 07, 2021.
- Dayal, V. delivered lecture on 'After care of trained and pruned plants in a garden' during 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Dayal, V. delivered lecture on 'Maintenance of garden textures and structures' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Dwivedi, S.K. delivered lecture on 'Stimulation of growth of plants using fertilizers and chemicals' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Dwivedi, S.K. delivered lecture on 'Use techniques to shape garden plants using pinching, training and pruning' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Gundappa delivered lecture on *'Aam Ke Niryat Yogy Utpadan Hetu Keet Prabandhan'* in APEDA seminar held at Varanasi, Uttar Pradesh on July 08, 2021.
- Gundappa delivered lecture on *'Amrud, Aonla, Kela Aura Am Ke Niryat Yogy Utpadan Hetu Keet Prabandhan'* in APEDA seminar held at Prayagraj, on October, 22, 2021.
- Gundappa delivered lecture on 'Barsat Men Amrud Ki Pramukh Keet Evam Niyantran'

in Zoom Meeting on *'Barsat men Amrud ke Uchch Gunvatta ke Fal kee Utpadan Taknik'* organized by ICAR-CISH, Lucknow on June 21, 2021.

- Gundappa delivered lecture on *'Ekikrit Keet Prabandhan'* in Training programme organized by SAMETI, Rehmankhera, Lucknow on October 25, 2021.
- Gundappa delivered lecture on 'Integrated pest management in mango' in Paclobutrozol awareness programme held at Bharawan (Mall) during September 27, 2021.
- Gundappa delivered lecture on 'Pest dynamics under HDP system in mango and guava" in National Webinar on 'Canopy Architecture Management in Perennial Commercial Horticultural Crops' organized by UHS, Bagalkot, Karnataka during July 19-20, 2021.
- Gupta, A.K. delivered a lecture on 'Waste utilization in gardening' in 'Organic Grower Training Program under ASCI' (QP-AGR/Q1201) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during February 05 to March 07, 2021.
- Kumar, G. delivered expert talk on strategies to enhance pesticide degradation through microorganisms on the occasion of Swachhta Pakhwada at ICAR-CISH, Lucknow during 16-31 December, 2021.
- Kumar, G. delivered oral presentation on 'Trichocare bioformulation: for pesticide biodegradation, plant growth promotion and biocontrol action under subtropics' in 'International Conference on Innovative Approaches on Applied Sciences and Technologies' organized by SERS Meerut (U.P.) & BBAU, Lucknow during December 03-05, 2021.
- Kumar, G. delivered oral presentation on topic entitled 'Biodegradation of carbosulfan pesticide by using novel indigenous *Bacillus cereus* strain T_5 under subtropics (2021)' in '3rd International Conference on Global Initiative in Agricultural, Forestry and Applied Sciences for Food Security, Environmental Safety and Sustainable Development (GIAFAS-2021)' during October 17-18, 2021.
- Kumar, G. delivered talk as Resource Person for 'Beneficial microorganisms as biological control of pests' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Kumari, N. delivered lecture on 'Bordeaux mixture and paste preparation and application/tree drenching' in training on 'Pest Management in Sub-Tropical Fruit Crops with Special Reference to Mango, Guava Citrus and Pomegranate' at ICAR-CISH, Lucknow during March 22-24, 2021.
- Kumari, N. delivered lecture on 'Disease identification and their integrated management in citrus, guava and litchi' in training on 'Pest Management in Sub-Tropical Fruit Crops with Special Reference to Mango, Guava Citrus and Pomegranate' at ICAR-CISH, Lucknow during March 22-24, 2021.
- Kumari, N. delivered lecture on 'Management of aonla diseases' in training on *'Aam Amrudh Amla Ka Jeernoddhaar Evam Rakharakhaav'* at ICAR-CISH, Lucknow during January 2021.
- Ravi, S.C. delivered lecture on 'Economics of kitchen gardening' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Ravi, S.C. delivered lecture on 'Marketing systems of mango in India' in a training programme organized by the UP state Horticulture Department on February 22, 2021.
- Ravi, S.C. delivered lecture on 'Undertaking organic farming as business' in 'Organic Grower Training Program under ASCI'

(QP-AGR/Q1201) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during February 05 to March 07, 2021.

- Ravi, S.C. delivered online lecture on 'Farm laws 2020' in the programme organized by KVK, Dakshina Kannada on January 09, 2021.
- Shukla, P.K. delivered Hindi lecture on *'Barsat Men Amrud Ki Pramukh Vyadhi Evam Niyantran'* in Zoom Meeting on 'Barsat men Amrud ke Uchch Gunvatta ke Fal kee Utpadan Taknik' organized by ICAR-CISH, Lucknow during on June 21, 2021.
- Shukla, P.K. delivered Hindi lecture on *'Poudhshala men rog aur keet pahchan evam prabandhan'* in Zoom Meeting on 'Poudhshala Prabandhan' organized by Directorate of Horticulture and Food Preservation, Lucknow for departmental officers and employees on July 13, 2021.
- Shukla, P.K. delivered Invited Lecture on 'Recent advances in management of diseases of mango and guava' in National Symposium on 'Plant health management beyond 2020' at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during May 5-6, 2021.
- Shukla, P.K. delivered Lead Lecture on 'Risk to mango production from newly emerging diseases' in 9th IHC 2021 held at CSAUAT, Kanpur on November 18, 2021.
- Shukla, P.K. delivered lecture on *'Aam Ki Fasal Surksha'* in Webinar organized by Centre for Subtropical Fruits, Ladwa, Kurukshetra, Haryana on September 30, 2021.
- Shukla, P.K. delivered lecture on *'Amrud, Aonla, Kela Aura Am Ke Niryat Yogya Utpadan Hetu Rog Prabandhan'* in Training programme organized by APEDA at Prayagraj on October 22, 2021.
- Shukla, P.K. delivered lecture on 'Dynamics of disease incidents and its management under HDP system in mango and guava' in National webinar on 'Canopy Architecture Management in Perennial Commercial Horticultural Crops' organized by UHS, Bagalkot, Karnataka during July 19-20, 2021.
- Shukla, P.K. delivered lecture on *'Ekikrit Nashijiv Prabandhan Evam Fasal Survekshan'* in Training programme organized by SAMETI, Rehmankhera, Lucknow on October 25, 2021.
- Shukla, P.K. delivered lecture on *'Jalvayu Parivartan Paridrishy Men Uposhn Fal Faslon Ke Rogon Ka Prabandhan'* in Kisan Vaigyanik Sangosthi on *'Jalvayu Anukul Kismen, Prodhyogiki aur Paddhatiyan'* at ICAR-CISH, Lucknow on September 28, 2021.
- Shukla, P.K. delivered lecture on *'Mushroom Utpadan Men Mahilaon Ki Bhumika'* in Training programme organized by SAMETI, Rehmankhera, Lucknow on October 13, 2021.
- Shukla, S. delivered talk as Resource Person on 'Identification and growing of indoor and outdoor plants and their basic requirements' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Shukla, S. delivered talk as Resource Person on 'Maintenance of lawn and turf by mowing, weeding, irrigation and aeration' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Shukla, S. delivered talk as Resource Person on 'Use of fencing in garden' in 'Assistant Gardener' training under ASCI (QP-AGR/Q0804) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.
- Singh, A. delivered lecture on 'Nutrition of family through nutrition garden' at SIMA, Rehmankhera, Lucknow on October 22, 2021.

- Singh, A. delivered lecture on 'Role of women in processing and preservation of fruits and vegetables' at SIMA, Rehmankhera, Lucknow on January 05, 2021.
- Singh, A. delivered talk as Resource Person on 'Safety measures and precautions during agricultural field' in 'Organic Grower Training Program under ASCI' (QP-AGR/Q1201) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during February 05 to March 07, 2021.
- Singh, H.S. delivered online lecture on 'Agro-ecosystem cleanliness–do we have alternatives of pesticides?' in special Swachhta Campaign at ICAR-CISH, Lucknow during October 02 -31, 2021.
- Singh, H.S. delivered online lecture on 'IPM in horticulture for safe food production' in 'XV Agricultural Science Congress' organized by National Academy of Agricultural Sciences at Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh during November 13-16, 2021.
- Srivastava, K.K. delivered Guest Lecture on 'Advance cultivation practices of mango and litchi' at Fruit Expo Event at Centre for Sub Tropical Fruits, Ladwa, Kurukshetra, Haryana on July 10, 2021.
- Srivastava, K.K. delivered Guest Lecture on 'Chat Per Phalon Ki Bagwani' during National Training Programme for Horticulture for Urban and Peri-urban Area, at Krishi Vigyan Kendra, Ujwa, New Delhi on June 24, 2021.
- Srivastava, K.K. delivered Guest Lecture on 'Container gardening for income generation' in Technological Interventions for Rural Entrepreneurship & Farmers Prosperity in Eastern India at ICAR-Indian Institute for Wheat Barley Research, Karnal, Haryana on July 30, 2021.
- Srivastava, K.K. presented a Lead Paper on 'Container gardening: an alternate farming practice' at the National Seminar on Horticulture for Next Generation in Eastern India, organized by Bihar Agriculture, University, Sabour, Bihar on August 6, 2021.
- Trivedi, A.K. delivered a lecture on 'Control of soil erosion' in 'Assistant gardener' training under ASCI (QP-AGR/Q0804) at ICAR-CISH, Lucknow during March 01-31, 2021.
- Trivedi, A.K. delivered a lecture on 'Critical stages of plant growth for water requirement in garden plants' in 'Assistant Gardener training under ASCI (QP-AGR/Q0804)' at ICAR-CISH, Lucknow during March 15-20, 2021.
- Trivedi, A.K. delivered a lecture on 'Management of physiological disorders in garden plants' in 'Assistant Gardener training under ASCI (QP-AGR/Q0804)' at ICAR-CISH, Lucknow during March 15-20, 2021.
- Trivedi, A.K. delivered a lecture on 'Water requirement and management in garden plants' in 'Assistant Gardener training under ASCI (QP-AGR/Q0804)' at ICAR-CISH, Lucknow during March 01-31, 2021.
- Trivedi, A.K. delivered an Invited Lecture on 'Research methodologies, practices and their management in crop physiology and agriculture' in scientific online training on 'Research Methodologies, Practices and their Management in Crop Physiology and Agriculture' organized by Samagra Vikas Welfare Society (SVWS) and College of Horticulture & Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh during October 04-24, 2021.
- Trivedi, A.K. delivered Lead Lecture on 'Potential and prospects of underutilized tropical and subtropical fruit crops in the food and nutrition security under climate change scenario' in the 'International Conference on Advances in Agricultural & Foods Sciences to face the Challenges to Environmental and Biosecurity' organized by School of Agricultural Sciences, Sharda University, Greater Noida during January 16–21, 2021.

- Trivedi, A.K. delivered lecture in 'National Conference of Plant Physiology (NCPP–2021) on Frontiers of plant physiology for climate smart agriculture' organized by Indian Society for Plant Physiology, New Delhi in collaboration with ICAR – National Institute of Abiotic Stress Management, Pune during December 09 – 11, 2021.
- Yadav, A. delivered talk as Resource Person on 'Approaches for Multi Cropping' in 'Organic Grower Training Program under ASCI' (QP-AGR/Q1201) organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during February 05 to March 07, 2021.
- Yadav, A. delivered talk as Resource Person for 'Propagation of plants through cuttings' in 'Assistant Gardener training under ASCI (QP-AGR/Q0804)' organized by ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow during March 01 to 31, 2021.

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-110003 for (i) Development of national database on mango. (ii) Project on management of *Fusarium* wilt in NER banana using ICAR-FUSICONT Technology.
2. 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, Opp-Todapur Village, New Delhi-110012 for development of morphological descriptors and DUS test guidelines for mango, guava, jamun, aonla and bael.
3. Council of Science and Technology U.P. (UPCST), Vigyan Bhawan, 9-Nabiullah Road, Lucknow, Uttar Pradesh-226018 for research funding.
4. UP Council of Agricultural Research (UPCAR), 8th Floor, Kisan Mandi Bhawan, Vibhuti Khand, Gomtinagar, Lucknow, Uttar Pradesh-226010 for research in priority areas established with special reference to Uttar Pradesh.
5. 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 -110001; for project on 'Integrated Bee Development Centre (IBDC)'.
6. Mission for Integrated Development of Horticulture (MIDH)-National Horticulture Mission, NHM 248A, Krishi Bhawan, Dr. Rajendra Prasad Road, New Delhi - 110001; for development of Hi-Tech Nursery for Public Sector.
7. Bayer Crop Science Limited, Khasra No. 563, Amar Shaheed Path, Lucknow, Uttar Pradesh 226002; for Evaluation of bio-efficacy and phytotoxicity of Flupyram and Trifloxystrobin against anthracnose, powdery mildow and leaf spot and Tebuconazole against anthracnose, powdery mildew and post harvest diseases in mango.
8. Agriculture Skill Council of India (ASCI) 6th Floor, GNG Building, Plot No. 10, Sector -44, Gurugram, Haryana-122004; for providing the farmers centric training.
9. Department of Science and Technology-Science and Engineering Research Board 5 & 5A, Lower Ground Floor Vasant Square Mall Sector-B, Pocket-5 Vasant Kunj New Delhi-110070; for supporting research projects.
10. Palvi Industries, Sangli, Maharashtra C/o Sudarshan Agro Engineering, Plot No-H/18-1, Behind Latthye Polytechnic College, Sangli, Maharashtra-413436, India; signed MoU for five years w.e.f January 01, 2020 for Prototype development of solar light based insect traps having electrified killing mechanism and other associated prototype development works.
11. National Bank for Agriculture and Rural Development, Plot C-24, G Block, Bandra Kurla complex, BKC Road, Bandra East, Mumbai, Maharashtra-400051; for Technology interventions for quality mango production for doubling income of mango growers in Malda District, West Bengal.
12. National Institute of Agricultural Extension Management (MANAGE), Rajendranagar Hyderabad, Telangana signed MoU for three years w.e.f. February 02, 2019; for providing support in training program (ACABC, Certified Farm Advisor Programme and

Diploma in Agricultural Extension Services for Input Dealers (DAESI) at KVK, Malda by SAMETI & MANAGE.

13. Crop Life India, 2nd Floor, Ansal Chambers II 6 Bhikaji Cama Place, New Delhi signed MoU for three years w.e.f. March 27, 2019; for providing training on organic cultivation.
14. Bundelkhand University, Kanpur Road, Jhansi, Uttar Pradesh signed MoU for three years w.e.f. March 12, 2019; for facilitating student training/ post graduate dissertation/ research work.
15. Green care Hydroponics Private Limited, Lucknow, signed MoU for three years w.e.f. April 06, 2019; for crop specific hydroponics nutrient management technology.
16. Rama University, Kanpur, signed MoU for three years w.e.f April 18, 2019; for facilitating students' training/postgraduate research.
17. Awadh Aam Utpadak Evam Bagwani Samiti, Malihabad, Lucknow signed MoU for three years w.e.f. April 22, 2019; for sustainable development and extension of mango orchard-based poultry farming.
18. M/s. Agrarian Development Consultant Private Limited, 441.L-IV/08 Purana Topkhana, Bari Road Balaganj, Lucknow signed MoU for three years w.e.f. June 10, 2019; for carrying out the technical support/ guidance towards export of mango.
19. SRIJAN, 4, Community Shopping Centre, Saidullajab, New Delhi signed MoU for three years w.e.f. June 27, 2019; for betterment of farmers and knowledge sharing.
20. Satvik Biotech Kela Utpadak Nursery, Lucknow signed MoU for three years w.e.f. July 04, 2019 for technology transfer of ICAR- Fusicont to control Fusarium wilt.
21. G.L.A. University, Mathura signed MoU for three years w.e.f. November 20, 2019; for promotion of Inter-institutional research collaboration, staff and students' training/ post graduate research.
22. M/s Parashar Agrotech Bio Pvt. Ltd., Varanasi signed MoU for five years w.e.f. November 11, 2020; for licensing CISH Trap container.
23. ICAR-Directorate of Poultry Research, Rajendra nagar, Hyderabad, signed MoU for two years w.e.f. November 17, 2020; for Introduction/ evaluation of suitable backyard poultry farming in the schedule caste populated village/block, district of west Bengal.
24. M/s Ranaji Biotech India Pvt. Ltd., Kanpur signed MoU for five years w.e.f. November 30, 2020; for licensing CISH glue trap.
25. Shri Rai Rampati Rai, Raipur village block Maal,Tehsil, Malihabad, U.P signed MoU for one year w.e.f. December 15, 2020; for rejuvenate old unproductive mango orchard and record related data.
26. Jan evam Krishi Vikas Sansthan, 607 A, Transport Nagar, Prayagraj signed MoU for one years w.e.f. December 17, 2020; for providing training to enable farmers to earn maximum profit by growing fruit crops.
27. 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).
28. 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.
29. 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.
30. M/s Saavi Industries Sangli Maharashtra signed MoU for five years w.e.f. January 19, 2021; for licensing CISH Pest Hammer.
31. G H Raisoni University, Chhindwara, MP signed MoU for five years w.e.f. February 04, 2021; for facilitating Students Training/ Postgraduate research.
32. ICAR-NINFET, 12, Composite Housing

Estate, Regent Park, Kolkata, West Bengal-700040, signed MoU for five years w.e.f. August 08, 2021; to promote and enhance research interests, sharing scientific knowledge, methodology.

33. Amity University, Lucknow signed MoU for five years w.e.f. August 09, 2021; for facilitating students' training/postgraduate research.
34. Ch. Charan Singh Meerut University, Meerut signed MoU for five years w.e.f. September 08, 2021; for facilitating students' training/ postgraduate research.
35. 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).
36. M/s Balaji Agro Foods, Lucknow signed MoU for five years w.e.f. October 26, 2021; for mango based immunity booster products.
37. RML Avadh University, Ayodhya signed MoU for three years w.e.f. November 20, 2021; for facilitating students' training/ postgraduate research.
38. 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.
39. NABARD, Kolkata signed MoU for three years w.e.f. November 30, 2021; for promoting NABARD FPO.

Linkages of RRS, Malda with different agencies

1. National Bee Board, Ministry of Agriculture & Farmers Welfare, Govt. of India.
2. Protection of Plant Variety and Farmers Right Authority, Ministry of Agriculture & Farmers Welfare, Govt. of India.
3. Department of Agriculture, Government of West Bengal.
4. Directorate of Horticulture, Dept. of FPI & Horticulture, Govt. of West Bengal.
5. Ramakrishna Mission Ashrama, Sargachi, Murshidabad.
6. National Bank for Agriculture and Rural Development (NABARD), Regional Office, Kolkata.
7. Agricultural Technology Management Agency, Malda.
8. Department of Agriculture, Cooperation and Ministry of Agriculture and Farmers, Welfare, Govt. of India.
9. Crop Life India Ltd, New Delhi.
10. National Seed Corporation, Malda office.
11. South Asian Biotechnology Center, New Delhi.

Publications

1. Adak, T. and N. Babu (2021). Soil and air permeability - A key factor for soil processes and productivity. *Current Advances in Agricultural Sciences* (*An International Journal*) 13(1): 13-18. 10.5958/2394-4471.2021.00003.4.
2. Ahmad I., M. Muthukumar and S. Rajan (2021). In-silico mining and characterisation of TIFY genes in mango. *Research Journal of Biotechnology* 16: 24–28.
3. Babu, N., Adak, T., Arvind, K. and V. K. Singh (2021). Scientific analysis of drought assessment and its management strategies for food security. *Current Advances in Agricultural Sciences* (*An International Journal*) 13(1): 1-6. 10.5958/2394-4471.2021.00001.0.
4. Bajpai Y., M. Trivedi, M. Muthukumar and A. Bajpai (2021). Novel insights into biochemical and hormonal factors regulating floral transition in mango (*Mangifera indica* L.) *Indian Journal of Biotechnology* 20: 54-64.
5. Baradevanal G., R.P. Srivatsava and K.M. Kumarnag (2021). Mango stem borers: new threat to mango in India. *Journal of Eco-friendly Agriculture* 16(1):1-9.
6. Baradevanal G., S. Chander, P.K. Jayanthi, H.S. Singh and D.S. Reddy (2021). Assessing the risk of mango quarantine pest *Deanolis sublimbalis* Snellen under different climate change scenarios. *Journal of Plant Diseases and Protection* 128(3): 853-863.
7. Bhatt P., E.R. Rene, A.J. Kumar, S. Gangola, G. Kumar, A. Sharma, W. Zhang and S. Chen (2021). Fipronil degradation kinetics and resource recovery potential of *Bacillus* sp. strain FA4 isolated from a contaminated agricultural field in Uttarakhand, India. *Chemosphere* 276: 130-156.
8. Bhattacherjee A.K. and A. Dikshit (2021) Phenolic components, ascorbic acid and organic acids profiling of six guava varieties grown under subtropical region of Lucknow, Uttar Pradesh. *Journal of Eco-friendly Agriculture* 16(1): 77-82.
9. Chander S., M. Husain and G. Baradevanal (2021). Thermal energy requirement for tobacco caterpillar *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) development on artificial diet. *Journal of Agrometeorology* 23(2): 236-241.
10. Chaudhary P., A. Chaudhary, H. Parveen, A. Rani, G. Kumar, R. Kumar and A. Sharma (2021). Impact of nanophos in agriculture to improve functional bacterial community and crop productivity. *BMC Plant Biology* 21(1): 1-12.
11. Chaudhary P., Khati, P., Chaudhary, A., Maithani, D., Kumar, G. and A. Sharma (2021). Cultivable and metagenomic approach to study the combined impact of nanogypsum and *Pseudomonas taiwanensis* on maize plant health and its rhizosphericmicrobiome. *PloS One* 16(4): p.e0250574.
12. Damodaran T., K. Yadav, K. Dutt, A. Singh, M. Muthukumar, S. Rajan, R. Gopal and P.C. Sharma (2021). Mapping Bioactive metabolite potential of rhizobacterium *Bacillus licheniformis* CSR D4: an effective biocontrol agent against banana *Fusarium* wilt tropical Race 4. *Rhizosphere* 18: 100341.
13. Garg N., A.K. Bhattacherjee, P.K. Shukla and B. Singh (2021). Influence of imidacloprid on bacterial community diversity of mango orchard soil assessed through 16S rRNA sequencing-based metagenomic analysis. *Environmental Monitoring and Assessment*. 10.1007/s10661-021-08885-7.
14. Garg N., B. Singh, S. Vaish and S. Kumar (2021). Enzyme production from different fruit and vegetable waste using lactic

acid fermentation. *Journal of Ecofriendly Agriculture* 16(1): 74-76.

15. Garg N., B. Singh, S. Vaish, S. Kumar and S. Arora (2021). Exploring microbial community diversity of mango leaf compost. *Current Horticulture* 9(1): 27-35.
16. Garg N., S. Kumar and P. Yadav (2021). Indian goose berry fortified, anti-oxidant rich bael (*Aegle marmelos*) fermented beverage. *Journal of Food Science and Technology* 58(11): 4437-4441.
17. Garg N., S. Kumar, K.K. Srivastava, B. Singh and S. Vaish (2021). Development of value added products from subtropical peach. *Journal of Eco friendly Agriculture* 16(1): 83-86.
18. Garg N., S. Kumar, S. Vaish and B. Singh (2021). Utilization of sugar syrup waste of aonla processing industry for flavored spicy beverages. *Journal of Eco-friendly Agriculture* 17(1): 177-179.
19. Joshi K., J.C. Jeeva, A. Singh and P. Joshi (2021). Need of mechanized intervention in selected farm operations in finger millet cultivation in tribal hills of Odisha. *Journal of Community Mobilization and Sustainable Development* 16 (3): 781-786.
20. Kumar D., G. Pandey, K.K. Srivastava and V.K. Singh (2021). Response of micro-nutrients on yield, fruit quality and nutrient status of mango cv. Dashehari. *Indian Journal of Horticulture* 78(4): 405-409.
21. Kumar D., S. Rajan, and K.K. Srivastava (2021). Response of phenological manipulation through planting time for productivity of banana under subtropics. *Indian Journal of Agricultural Sciences* 91(11): 1592-1596.
22. Kumar G., A. Suman, S. Lal, R.A. Ram, P. Bhatt, G. Pandey, P. Chaudhary and S. Rajan (2021). Bacterial structure and dynamics in mango (*Mangifera indica*) orchards after long term organic and conventional treatments under subtropical ecosystem. *Scientific Reports* 11(1): 1-13.
23. Kumar G., S. Lal, P. Bhatt, R.A. Ram, Bhattacherjee, A.K., Dikshit, A. and S. Rajan (2021). Mechanisms and kinetics for the degradation of paclobutrazol and biocontrol action of a novel *Pseudomonas putida* strain T7. *Pesticide Biochemistry and Physiology* 175: 104846.
24. Kumar G., S. Lal, S.K. Maurya, A.K. Bhattacherjee, P. Chaudhary, S. Gangola and S. Rajan (2021). Exploration of *Klebsiella pneumoniae* M6 for paclobutrazol degradation, plant growth attributes, and biocontrol action under subtropical ecosystem. *PloS one* 16(12): p.e0261338.
25. Kumar R., H. Krishna, S. Rajan, M. Alizadeh and P. Barman (2021). Understanding Phenological Stages of Pomegranates Flowering and Fruiting Regulation. *Journal of Horticultural Research*. 10.2478/johr-2021-0013.
26. Kumar S., A. Sharma, K.G. Rosin, V.K. Sharma, S.K. Sinha, D. Kumar, N. Dwivedi and Vishwanath (2021). Medium term impact of organic and microbial fertilization on production efficiency and fertility of soil in an apple production system under north west Himalayan region. *Communication in Soil Science and Plant Analysis*. 10.1080/00103624.
27. Kumari N., P.K. Shukla, H. Singh, T. Fatima and A. Bajpai (2021). Development of species specific PCR based detection assay for *Ceratocystis fimbriata*, mango wilt pathogen *Indian Phytopathology*. 10.1007/s42360-021-00438-9.
28. Kumari N., S. Chaudhary, S. Dhiman, P.K. Shukla (2021). Biological management of horticultural crop diseases using phyllosphere-, rhizosphere-, and endosphere-derived biocontrol agents. *Innovative Approaches in Diagnosis and Management of Crop Diseases*, 179-200.
29. Kushwaha A., A. Kumar and R.R. Khan (2021). A comparative assessment of non-destructive and destructive methods

for precise volume estimation of mango (*Mangifera indica*) trees. *Journal of Applied and Natural Science* 13 (1): 183-190.

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32. Rathore A.C., H. Mehta, S. Islam, P.L. Saroj, N.K. Sharma, J. Jayaprakash, A.K. Gupta, R.K. Dubey, B.N. Ghosh, R. Prasad, D. Kumar and A. Raizada (2021). Biomass, carbon stocks estimation and predictive modeling in mango based land uses on degraded lands in Indian Sub-Himalayas. *Agroforestry Systems* 95: 1563-1575.

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2. Bajpai, A. and Muthukumar, M. (2021). Mango malformation disease phyllosphere associated microbiome, PRJNA759061 dated August 28, 2021.
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Research Projects

Institute's Projects (upto 30.11.2021)

Title	Name of Scientists
Research Programme	
Conservation and utilization of genetic resources for improvement of subtropical fruits for higher productivity and quality	Dr. S. Rajan (upto 30.11.2021), Dr. A. K. Singh, Dr. D. Pandey, Dr. Maneesh Mishra, Dr. Anju Bajpai, Dr. H.C. Verma, Dr. Muthukumar M, Dr. Israr Ahmad, Dr. Ashish Yadav, Dr. Anshuman Singh, Dr. Vishambhar Dayal, Dr. Antara Das, Dr. Swosti Suvadarsini Das, Mr. Amar Kant Kushwaha (w.e.f. 11.2.2021), Dr. Dipak Nayak, Dr. Ashok Yadav (upto 6.2.2021)
Integrated nutrient, water, space and canopy management for improving productivity of subtropical fruits	Dr. Ghanshyam Pandey (upto 30.9.2021), Dr. R.A. Ram, Dr. S.K. Shukla, Dr. Dinesh Kumar, Dr. K.K. Srivastava, Dr. S.R. Singh, Dr. A.K. Trivedi, Dr. Ashok Kumar, Dr. Dushyant Mishra, Dr. Tarun Adak, Dr. Govind Kumar, Dr. Prannath Barman, Dr. Sharad Kumar Dwivedi
Diagnosis of new and emerging biotic stresses, development of prediction models and devising integrated management schedules for higher productivity	Dr. H.S. Singh, Dr. S.K. Singh (upto 30.6.2021), Dr. P.K. Shukla, Shri H.C. Verma, Dr. Gundappa, Dr. Nidhi Kumari
Devising technologies for minimizing postharvest losses, value added products and marketing of subtropical fruits	Dr. Neelima Garg, Dr. A.K. Bhattacherjee (up to 20.11.2021), Dr. Abha Singh, Er. A.K. Verma, Dr. Bharati Killadi, Dr. Ravi S.C., Dr. Alok Kumar Gupta, Dr. Karma Beer (w.e.f. 1.2.2021)
Improving knowledge and skill of stakeholders for improving production of subtropical fruits	Dr. Naresh Babu
Flagship Project	
Integrated management of guava wilt	Dr. S. Rajan (upto 30.11.2021), Dr. H.S. Singh, Dr. P.K. Shukla, Dr. Maneesh Mishra, Dr. Israr Ahmad, Dr. Muthukumar M, Dr. Gundappa, Dr. Nidhi Kumari, Dr. Govind Kumar
Inter-Institutional Flagship Project	
Survey, identification and management of the banana *Fusarium* wilt caused by *Fusarium oxysporum* f.sp. *cubense* tropical race 4 in Uttar Pradesh, Bihar, West Bengal and Odisha	Dr. S. Rajan (upto 30.11.2021), Dr. T. Damodaran, Dr. Muthukumar M, Dr. P.K. Shukla, Dr. Maneesh Mishra, Dr. Israr Ahmed, Dr. Dinesh Kumar, Dr. Govind Kumar, Dr. Nidhi Kumari, Dr. Deepak Nayak, Dr. Ashok Yadav (upto 6-2-2021)

Restructured Projects (w.e.f. 1.12.2021)

S.N.	Name of proposed activity	Principal Investigator	Co-Principal Investigator
1.	Genetic resource management and improvement of mango	Dr. AshishYadav	Dr. Anshuman Singh, Dr. Vishambhar Dayal, Dr. Amar Kant Kushwaha, Dr. P.K. Shukla, Dr. Gundappa
2.	Genetic resource management and improvement of guava	Dr. Anshuman Singh	Dr. Ashish Yadav, Dr. Vishambhar Dayal, Mr. Amar Kant Kushwaha, Dr. Nidhi Kumari, Dr. Gundappa
3.	Genetic mapping and development of genomic tools to accelerate molecular breeding in fruits	Dr. Anju Bajpai	Dr. Muthukumar M, Dr. Israr Ahmad, Dr. H.C. Verma, Dr. Bharati Killadi, Dr. Ashish Yadav, Dr. Devendra Pandey, Dr. Anshuman Singh, Dr. P. K. Shukla
4.	Improvement of aonla and bael for higher yield and nutraceutical value	Dr. D. Pandey	Dr. Anju Bajpai, Dr. A.K. Bhattacherjee (upto 20-11-2021), Mr. Amar Kant Kushwaha
5.	Genetic resource management and improvement of jamun	Dr. A.K. Singh	Dr. Anju Bajpai, Dr. Anshuman Singh
6.	Development of tissue culture system of fruit crops though bioreactor	Dr. Maneesh Mishra	Er. Anil Kumar Verma
7.	Development of ICT tools for advisories on subtropical fruit crops	Dr. H.C. Verma	
8.	Canopy management for improving productivity in mango and guava	Dr. K.K. Srivastava	Dr. S.K. Shukla, Dr. D. Mishra, Dr. Dinesh Kumar, Dr. A.K. Trivedi, Dr. S.K. Dwivedi, Dr. P. Barman, Dr. Govind Kumar
9.	Enhancing input use efficiency for higher productivity of subtropical fruits	Dr. Dinesh Kumar	Dr. R.A. Ram, Dr. S.K. Shukla, Dr. K.K Srivastava, Dr. S.R. Singh, Dr. Naresh Babu, Dr. A.K. Verma, Dr. Tarun Adak, Dr. S.K. Dwivedi, Dr. P. Barman, Dr. Govind Kumar
10.	Crop diversification in fruit production system for enhanced productivity and farmer profitability	Dr. S.K. Shukla	Dr. D. Mishra, Dr. S.R. Singh, Dr. Naresh Babu, Dr. K.K. Srivastava, Dr. A.K. Trivedi, Dr. P. Barman, Dr. Israr Ahmad, Dr. Govind Kumar, Dr. Ravi S.C.
11.	Development and evaluation of nano formulations for enhancing productivity and quality of horticultural crops	Dr. Dushyant Mishra	Dr. A.K. Trivedi, Dr. S.K. Shukla, Dr. Dinesh Kumar, Dr. Israr Ahmad, Dr. Bharati Killadi, Dr. P. Barman, Dr. Govind Kumar

12.	Management of abiotic stress and physiological issues in subtropical fruit crops	Dr. A.K. Trivedi	Dr. S.K. Shukla, Dr. Dinesh Kumar, Dr. Dushyant Mishra, Dr. Israr Ahmad, Dr. S.K. Dwivedi, Dr. P. Barman, Dr. Govind Kumar, Dr. Alok Kumar
13.	Improving knowledge and skill of stakeholders for increasing production and productivity of subtropical horticultural crops	Dr. Naresh Babu	Dr. S.K. Shukla, Dr. K.K. Srivastava, Dr. S. R. Singh, Vishambhar Dayal, Dr. Ravi S.C.
14.	Development of soilless culture technology for high value fruits and vegatable crops	Dr. S.R. Singh	Er. A.K. Verma, Dr. Ashok Kumar
15.	Exploring possibilities of non-traditional fruit crops for extended market availability of fresh fruit in subtropics	Dr. Ashok Kumar	Dr. Naresh Babu, Dr. S.R. Singh
16.	Evaluation of stress under different moisture/temperature regimes in subtropical fruit orchards	Dr. Tarun Adak	Dr. Naresh Babu, Dr. Ashok Kumar
17.	Identification, dynamics, loss assessment and devising management tools and schedules for prevailing and emerging insect pests of subtropical fruit crops	Dr. H.S. Singh	Dr. Dinesh Kumar, Dr. S.K. Shukla, Dr. P.K. Shukla, Dr. Gundappa, Dr. S.K. Dwivedi, Dr. Govind Kumar
18.	Disease diagnosis, devising detection tools and management practices for diseases of subtropical fruit crops	Dr. P.K. Shukla	Dr. Nidhi Kumari
19.	Developing protocols for value added products of fruits and vegetables	Dr. Abha Singh	Dr. Neelima Garg, Dr. Bharati Khilladi, Dr. A.K. Gupta, Dr. Karma Beer
20.	Development of protocol for shelf life extension of sub-tropical fruits and vegetables	Dr. Bharati Killadi	Dr. Alok Gupta, Dr. Neelima Garg, Dr. Abha Singh
21.	Handling, storage and transport studies in mango for minimized losses	Dr. Karma Beer	Er. A.K. Verma, Ravi S.C.
22.	Identification of constraints and opportunities for improving efficiency of mango and guava value chain in subtropics	Dr. Ravi S.C.	Dr. Karma Beer, Er. A.K. Verma

Externally Aided Projects

S.N.	Project Title	PI/Nodal Officer	Period
AMAAS, MAU			
1.	Network project on Micro organisms in agriculture and allied sectors Sub-Project: Microbial interventions for production of enzyme supplement for animal feed from fruit and vegetable mandi waste	Dr. Neelima Garg	2017-2021
DST-SERB			
2.	Genomics assisted identification of resistance genes from wild relatives of guava against *Meloidogyne enterolobii* causing wilt	Dr. Muthukumar M	2018-2022
3.	Micro biome analysis and their application for pesticide biodegradation and plant growth promotion in subtropical horticultural crops	Dr. Govind Kumar	2019-2022
4.	Genome wide SNP markers associated with fruit traits for developing climate smart mango hybrids using genome selection	Dr. Anju Bajpai	2020-2023
DBT			
5.	Management of *Fusarium* wilt in NER banana using ICAR-FUSICONT Technology	Dr. S. Rajan / Dr. T. Damodaran (Project Coordinator) Dr. Maneesh Mishra, Co-PI Dr. Ashish Yadav, Co-PI	2021-2024
UPCST			
6.	On-farm production of bio-enhancers, isolation, characterization, molecular identification and development of beneficial microbial consortium for organic farming	Dr. R.A. Ram	2018-2021
7.	Development of integrated package for management of fruit drop of beal (*Aegle marmelos* Correa)	Dr. P.K. Shukla	2021-2024
UPCAR			
8.	Design and development of ergonomically efficient fruit harvesters for mango, guava and bael	Er. Anil Verma	2020-2023
PPV & FRA			
9.	Developing national repository and facilities for DUS testing in guava (*Psidium guajava*) and litchi (*Litchi chinesis*)	Dr. S. Rajan (upto 30-11-2021)	2012-2022
10.	Characterization of aonla varieties for developing DUS test guidelines	Dr. Devendra Pandey	2012 -2022
11.	Validation of DUS descriptors of bael (*Aegle marmelos* Correa)	Dr. Devendra Pandey	2012 -2022
12.	Development of morphological descriptors and DUS test guidelines for jamun	Dr. A.K. Singh	2012 -2022
13.	National DUS centre for mango crop	Dr. S. Rajan (upto 30-11-2021)	2012 -2022

ICAR Networking Project			
14.	Network project on transgenics in crops (Functional genomics of mango)	Dr. Anju Bajpai	2015 -2021
15.	National Agriculture Innovation Fund: Component-I IP&TM	Dr. Ravi S.C.	2008 - 2022
16.	National Agriculture Innovation Fund: Component-II ABI	Dr. Maneesh Mishra	2019-2022
Extramural fund research project			
17.	Generation of bio-efficacy and toxicological data for commercialization of bio-formulation ICAR-Fusicont towords the management of banana wilt caused by *Frusarium oxysporum* f.sp. *cubense* tropical race 4.	Dr. S. Rajan	2019-2021
RKVY			
18.	Advance centre for establishment of value chain and food processing of agri-horticultural crops to empower rural youth, self-help groups and processing entrepreneurs	Dr. Dipak Nayak	2018-2021
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
MIDH			
20.	Hi-Tech Nursery Public Sector (4 ha)	Dr. Dipak Nayak	2020-2023
Farmer FIRST Programme of KVK scheme			
21.	Enhancing livelihood and profitability index of Malihabad farmers through diversified horti-enterprise modules	Dr. Maneesh Mishra	2016-2022
Mandi Parishad, U.P. (Contract Service)			
22.	Preparation of work plan and its implementation for GI patenting of Langra, Chausa and Rataul mango of U.P.	Dr. S. Rajan (upto 30.11.2021) / Dr. Ashish Yadav (w.e.f. 1.12.2021)	2020-2022
Seed Hub Project			
23.	Seed Hub Project at KVK Malda	Dr. Dipak Nayak	2017-2022
National Bee Board, New Delhi			
24.	Integrated Bee Development Centre (IBDC)	Dr. Dipak Nayak	2018-2021
Crop Life India			
25.	Responsible use of Crop Protection products in mango and litchi for farmers safety, pollinators conservation and enhancing yield of the crops in West-Bengal and Bihar under crop life	Dr. Dipak Nayak	2019-2022
Palvi Industries, Sangli, Maharashtra			
26.	Prototype development of solar light based insect traps having electrified killing mechanism and other associated prototype development works.	Dr. H.S. Singh	2019-2023

NABARD			
27.	Technology interventions for quality mango production for doubling income of mango growers in Malda Districts, West Bengal	Dr. Dipak Nayak	2020-2023
Bayer Crop Science Limited (Contract Research)			
28.	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
Inter-Institutional Collaborative project (ICAR-CISH and CSIR-NBRI, Lucknow)			
29.	Application of whitefly-trap-cum death sink cotton to protect vegetables and horticultural crops from whitefly vectored viral diseases in India	Dr. Manessh Mishra, PI and Dr. Nidhi Kumari, Co-PI	2021-2026
Tribal Sub Plan			
30.	Tribal Sub Plan	Dr. Dipak Nayak	2018-2022
Scheduled Caste Sub Plan			
31.	S.C. Sub Plan	Dr. Ashok Kumar/ Dr. Vishambhar Dayal	2018-2022

AICRP-Fruits experiments executed at ICAR-CISH, Lucknow

S.No.	Code No.	Name of experiments	PI/CO-PI
1.	1.2.1 G	Augmentation and evaluation of germplasm in guava	Dr. S. Rajan/ Dr. Ashish Yadav
2.	1.2.5 G	Testing the performance of new promising hybrids and selections of guava (MLT-3)	Dr. S. Rajan/ Dr. Ashish Yadav
3.	1.2.7 G	Testing the performance of new promising hybrids of guava (MLT-5)	Dr. S. Rajan/ Dr. Anshuman Singh
4.	3.2.4 G	Enhancing input use efficiency in guava under HDP	Dr. K.K. Srivastava
5.	6.2.3 G	Integrated management of guava wilt	Dr. PK Shukla
6.	1.1.1 M	Augmentation and evaluation of germplasm in mango	Dr. S. Rajan/ Dr. Ashish Yadav
7.	1.1.13 M	Improvement of mango through half-sibs	Dr. S. Rajan/ Dr. Ashish Yadav
8.	1.1.14 M	Scion breeding in mango	Dr. S. Rajan/ Dr. Ashish Yadav
9.	1.1.15 M	Root stock breeding in mango	Dr. S. Rajan/ Dr. Ashish Yadav
10.	1.1.17 M	MLT (II) for mango hybrids	Dr. S. Rajan/ Dr. Ashish Yadav
11.	3.1.5 M	Fertilizer scheduling for high density planting in mango	Dr. Dinesh Kumar
12.	3.1.6 M	Effect of micronutrients on yield and quality of mango	Dr. Dinesh Kumar

13.	4.1.4 M	Assessing the effect of climatic aberration on mango flowering and yield	Dr. Dinesh Kumar
14.	5.1.5. M	Survey and surveillance for new and emerging insect pest of mango	Dr. Gundappa
15.	5.1.6. M	Management of mango hoppers and thrips on mango by oil-based formulation of *Metarhizium anisopliae*	Dr. Gundappa
16.	5.1.7 M	Model based pest management in mango	Dr. Gundappa
17.	5.1.8 M	Evaluation of different botanical formulations for management of sucking pest complex in mango	Dr. Gundappa
18.	5.1.9 M	Management of mango stem borer (*Batocera rufomaculata*) using 'Arka Borer Control'	Dr. Gundappa
19.	5.1.10 M	Slow release pheromone formulation for the management of fruit fly in mango	Dr. Gundappa
20.	5.2.2 G	New and emerging insect pests in guava	Dr. Gundappa
21.	5.2.5 G	Slow release pheromone formulation for the management of fruit fly in guava	Dr. Gundappa

AICRP on Biological Control

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

RAC/IMC/IRC Meetings

Research Advisory Committee (Rac)

Twenty-fifth RAC meeting of ICAR-CISH was held virtually on July 22, 2021. It was attended by:

i.	Dr. N. Kumar, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore	:	Chairman
ii.	Dr. (Mrs.) Chandish Balal, Ex. Director, ICAR-NBAIR, Bengaluru	:	Member
iii.	Dr. A.N. Ganeshmurthy, Dean, College of Agriculture, Central Agricultural University, Imphal Manipur & Former Principal Scientist and Head, Division of Soil Science &Agril. Chemistry, ICAR - Indian Institute of Horticultural Research, Bangalore	:	Member
iv.	Dr. Jai Singh, Ex. Director, ICAR-CIPHET, Ludhiana	:	Member
v.	Dr. (Mrs.) Ambika B Gaikwad, Principal Scientist, Division of Genomic Resources, Bio-Technology (Plant Science), ICAR-NBPGR, New Delhi	:	Member
vi.	Dr. B.K. Pandey, ADG (HS-II), ICAR-Hqr., KAB-II, New Delhi-110012	:	Ex-Officio Member
vii.	Dr. S. Rajan, Director, ICAR-CISH, Lucknow	:	Ex-Officio Member
viii.	Dr. Maneesh Mishra, Chairman, PME, ICAR-CISH, Lucknow	:	Member Secretary
	Following members could not be present owing to their pre-occupation	:	
ix.	Shri. Jaswant Saini, Village- Azampur, Post- Rampur, Maniharan, Saharanpur Non-Official member nominated by Hon'ble AM	:	Non-Official Member
x.	Shri Suvrat Pathak, Mohalla Patkana Kannauj Non-Official member nominated by Hon'ble AM	:	Non-Official Member

General Recommendations

- The emphasis must be placed on the utilization of industrial processing wastes and residues, as well as the conversion of raw produce into value-added products (food, feed, nutraceuticals, pharmaceuticals, industrial franchisee, etc.) at the rural level / in the production catchment in the MSME mode for income and employment generation.
- Inter-institutional collaboration with ICAR–CIAE, Bhopal, and ICAR–CIPHET, Ludhiana, for need-based mechanization and the development of new post-harvest appliances and structures, as well as the use of existing ones.
- The institute's website should be kept up to date in terms of the development of new technologies/processes, etc.

Technical Recommendations

Division of Crop Improvement & Biotechnology

- Institute should collect dwarfing rootstocks of mango maintained at Kolar and Bangalore.
- Molecular characterization of mango requires infusion of more markers and it should not be done in a staggered way.
- Bael germplasm having seeds in core should be identified and promoted.
- Co-PI should be included in the project on 'Improvement of aonla and bael for higher yield and nutraceutical value'.
- Low hypoglycemic mango variety should be developed.

Division of Crop Production

- A specific fertigation schedule for mandated fruit crops should be developed for high density planting systems.
- Mango and guava plant yield should always be correlated with planting density.
- NICRA work should be taken in to account for developing non destructive C sequestration methodology.
- In mango, drip irrigation with partial root wetting should be tried.

Division of Crop Protection

- Non-pesticide IPM tools may be tested against the emerging lepidopteron mango pest and efforts are to be made that non-targeted pests/ parasites are not trapped in the Insect Trapping Technology developed by the Institute.
- Pesticide application technology using drones should be developed, and its efficacy should be documented.
- It is necessary to develop IDM for the guava *Fusarium-Meloidogyne* complex.

Division of Post-Harvest Management

- The institute must prioritize value-added products in terms of market feasibility and commercialize high-value products.
- Priority must be given to mango harvesting, latex / sap flow damage control, cleaning, and in-orchard sorting - grading appliances.

Regional Research Station, Malda

- System productivity of various IFS module developed at RRS, Malda should be studied.
- RRS should demonstrate technologies and varieties developed by CISH through its KVK in West Bengal.

Institute Research Committee (IRC)

Forty-fifth meeting of Institute Research Committee was held on October 12, 13 & 18 and December 13, 2021 to review the progress made in ongoing research projects and approval of structured/new projects as per the Agricultural Research Management System. Twenty two projects were approved.

General comments

- It was decided to include government mission, PM's vision, Aatmnirbhar Bharat and Vocal for Local in the newly proposed research projects.
- Research on Drone led agriculture, Nano-technology, artificial intelligence should be initiated.
- Project must envisage Intellectual Property Right protection arising out of projects.
- Five new crops viz., Banana, Papaya, Avocado, Strawberry and Blueberry have been added in the mandate of the institute.

Crop Improvement & Biotechnology

- Genetic resource of mango and guava should be carved out in to two projects from the main project and led by Individual PIs. Improvement of aonla and bael for higher yield and neuraceutical value and genetic resource management and improvement of jamun will be two separate projects with already approved technical program.
- There will be a separate biotechnology project on Genetic mapping and development of genomic tools to accelerate molecular breeding. One project on bioreactor tissue culture technology and one on ICT tools will be included in ARMS.

Crop production

- Out of two projects being run in the division, separate projects on canopy management, input use efficiency, crop diversification, evaluation of nano formulations, management of abiotic stress, Development of soilless culture technology, exploring possibilities of non-traditional fruit crops for extended fruit availability will be submitted to ARMS.

- A separate project with modified technical programs should be developed and submitted on Improving knowledge and skill of stakeholders for increasing production and productivity of subtropical fruit crops. Evaluation of stress under different moisture/ temperature regimes in mango should be submitted with detailed technical program for its inclusion in ARMS.

Crop protection

- Project on identification, dynamics, loss assessment and devising management tools and schedules for prevailing and emerging insects pests of subtropical fruits should be included in ARMS. Another project on disease diagnosis, devising detection tools and management practices for diseases of subtropical fruit crops should be included in ARMS.

Post Harvest Management

- Four separate projects on developing protocols for value added products of fruits and vegetables, development of protocols for shelf life extension, minimization of post harvest losses, export promotion and export competitiveness and identification of constraints and opportunities for improving efficiency of mango and banana value chain in subtropics should be included in ARMS.

Regional Research Station, Malda

- Genetic Resource Management of Mandated Crops for Eastern India will be reported in respective main projects of the Institute.
- RRS will take up project on Refinement of horticultural technologies for eastern region.

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

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

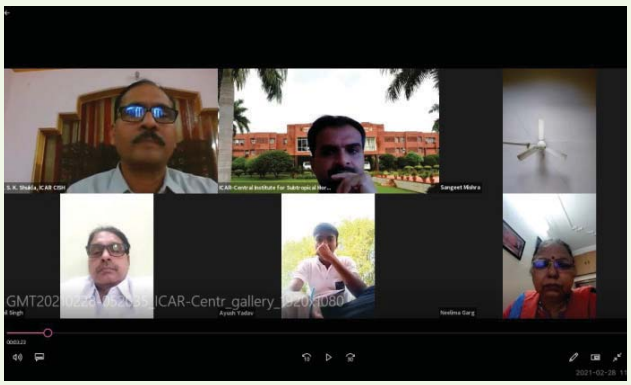
1. WEBINARS /SEMINARS ORGANIZED

Webinar on Boosting Horti-preneurship in India

ICAR-CISH, Lucknow conducted a panel discussion on 'Challenges and Approaches for Boosting Horti-preneurship in India' on January 12, 2021. The objective of the event was to impart the knowledge of horti-preneurship development and capacity building to the potential enthusiastic youth for boosting the startups in horticulture. The programme was conducted in association with Society for Development of Subtropical Horticulture (SDSH). In the event, 102 incubators, founders, innovators, investors, entrepreneurs, women entrepreneurs, scientists, academicians, stakeholders and students participated in the programme from all over the country.

Webinar on Prospects of agricultural education and skill development

On the occasion of National Science Day, ICAR-CISH, Lucknow organized a webinar on 'Prospects of Agricultural Education and Skill Development' for the students of Captain Manoj Kumar Pandey, UP Sainik School, Lucknow on February 28, 2021. This year, National Science Day was focused on education and skill development. The purpose of this programme was to make aware the students for future prospects in agricultural education. The programme was attended by scientists of the institute, students, teachers and family members of the prestigious school of Lucknow.



Webinar on Technology for production of high quality rainy season guava

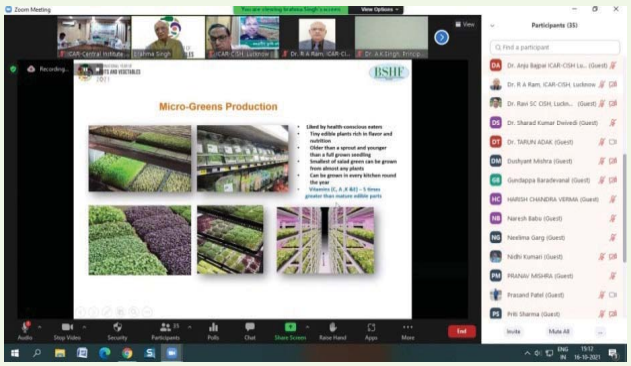
ICAR-CISH, Lucknow organized one day webinar on 'Technology for production of high quality guava fruit in rainy season' on June 21, 2021 through Zoom meeting. A total of 38 participants including Scientists, Researchers, Farmers, Extension workers, etc., from Uttar Pradesh and other states participated. Scientist delivered about pest control, water and nutrient management, bagging, harvesting and packing, etc., for production of high quality fruits.

Webinar on Role of Fruits and Vegetables in Food & Nutritional Security

Institute organized a webinar on 'Role of Fruits and Vegetables in Food and Nutritional Security' on the occasion of National Nutrition Week. The purpose of this programme was to create awareness amongst masses about the nutritional and health benefits of fruits and focus was given for consuming more fruits and vegetables. The programme was attended by scientists, research scholars and academicians from various ICAR institutes and Universities of India.

Webinar on 'Protected Cultivation of Horticultural Crops for Food and Nutritional Security'

A webinar on 'Protected Cultivation of Horticultural Crops for Food and Nutritional Security' was organized on the occasion of World Food Day on 16th October, 2021, in which Padma Shree Dr. Brahma Singh presented the keynote address. He said that protected cultivation of high-value horticultural crops is an innovation-driven sector, which holds immense potential to revolutionize the horticultural production by enhancing productivity and produce quality, extending the harvest season, conserving the natural resources, bringing marginally productive lands under cultivation and generating employment opportunities for women, youth and landless labourers. This Webinar was attended by about 45 stakeholders including scientists and students.



Webinar on Entrepreneurship Development in Horticulture: A New Paradigm

A webinar on 'Entrepreneurship Development in Horticulture: A New Paradigm' was organized by Agri-Business Incubation (ABI) Centre, ICAR-Central Institute for Subtropical Horticulture on 16th November 2021. A total 52 startup, entrepreneur, scientist, academician, students, women entrepreneur and technical staff participated across the country.

2. CELEBRATIONS

International Women's Day

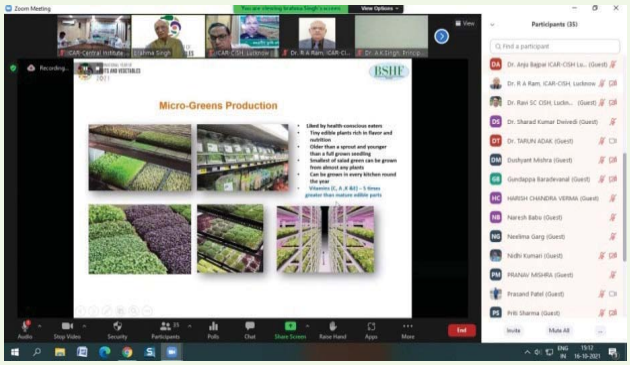
ICAR-CISH, Lucknow celebrated International Women's Day on March 8, 2021. The women leaders of self help groups (SHGs) and women of Institute's staff were the special invitee in the programme. During the programme, Dr. S. Rajan, Director, ICAR-CISH elaborated about equality and empowerment of women through innovative horticulture technologies.

World Water Day

ICAR-CISH, Lucknow celebrated World Water Day on March 22, 2021. On the occasion, a Kisan Gosthi was organized in which 30 farmers from SCSP adopted villages of Kakori and Mall blocks of Lucknow participated. The field visit and interaction meetings were also organized to know the problem faced by farmers for conservation and precise use (drip/sprinkler system) of water for production of horticultural crops.

World Food Day

A webinar on 'Protected Cultivation of Horticultural Crops for Food and Nutritional Security' was organized on the occasion of World Food Day on 16th October, 2021, in which Padma Shree Dr. Brahma Singh presented the keynote address on scope and importance of protected cultivation. This Webinar was attended by about 45 stakeholders including scientists and students.



Vigilance Awareness Week-2021

ICAR-CISH, Lucknow observed Vigilance Awareness Week during October 26- November 1, 2021 with a theme of 'Independent India@75: Self Reliance with Integrity'. On this occasion, pledge was taken by staff of the institute on October 26, 2021. During the week awareness about preventive vigilance was amplified through organization of workshop and essay competition.

National Unity Day-2021

National Unity day was celebrated on the occasion of birth anniversary of Sardar Vallabh bhai Patel at the institute on October 31, 2021. Dr. Shailendra Rajan, Director, ICAR-CISH administered the oath to all employees for protecting sovereignty and observing safety. He briefly highlighted the contribution of Sardar Vallabhbhai Patel in ensuring and strengthening national security, unity and integrity. At this juncture, the children of the employees of the institute, who won the painting competition organized by the institute on October 28, 2021, were also honored with certificates.

Constitution Day

Constitution Day was celebrated on November 26, 2021. On this occasion, Dr. Shailendra Rajan, Director of the institute addressed the staffs and briefed about importance of Indian Constitution. The staff of the Institute also attended online address of our Hon'ble President Shri Ram Nath Kovind, Vice President M. Venkaiah Naidu, Prime Minister Sri Narendra Modi and Lok Sabha Speaker shri Om Birla.

World Soil Day-2021

ICAR-Central Institute for Subtropical Horticulture, Lucknow organized World Soil Day-2021 at Kakrabad village of Lucknow district on December 5, 2021 in which 70 farmers including farm women participated. The theme of the World Soil Day-2021 was 'Halt soil salinization and enhance soil productivity'.

3. PROGRAMMES ORGANIZED UNDER SWACHHTA CAMPAIGN

Special Swachhta Campaign (2-31st Oct 2021)

Swachhta campaignwas carried out in a mission mode manner in campuses of ICAR institute CISH at Rehmankhera, Rae Bareilly Road and RRS, Malda, W.B.under stewardship of its Director Dr. Shailendra Rajan. As this year the country is celebrating Azadi ka Amrut Mahotsav: India @ 75, the banner with Swachhta theme was displayed at all prominent places as per ICAR directives, so that it catches the eye and invokes imagination of all countrymen. The pledge was taken by all staff members reiterating their resolve to fulfil wishes of Mahatma Gandhi for a Clean India.

Webinar during Special Swachhta Campaign

Under Special National Swacchata Campaign, Institute organized Webinar on waste reduction. The lectures were delivered on the topic: Waste Utilization and wealth Generation and Increased relevance of climate change concern and use of Agro ecosystem services provided by nature, use of biological control in an integrated pest system. In this context the use of microbial technologies was advocated for converting postharvest waste into various products that is able to bring additional income for family and processing industry.

Swachhta Pakhwada (16-31st December 2021)

During the fortnight campaign of Swachh Bharat Mission (16-31 December, 2021), the institute organized a Farmer- Scientist interface on 16th Dec in which farmers from Mal and Malihabad blocks participated in a big way. Director CISH Dr. Neelima Garg endorsed the role of organic farming practices in improving soil health and informed about the progress made during last two decades in composting and waste utilization through microbial interventions.

4. PROGRAMMES ORGANIZED UNDER AMRUT BHARAT MAHATSAV

S.N.	Name of Program	Date	No. of participants	Category beneficiaries
1.	Scientist-Farmer Interaction Meeting (Virtual mode)	July 16, 2021	40	Farmers
2.	Dialogue on 'Food and Nutrition for Farmers	August 26, 2021	60	farmers and representatives of SHG/NGO
3.	Scientist-Farmer interaction on 'Food and Nutrition for Farmers'	August 26, 2021	-	SC and ST farmers
4.	Innovator-Farmer Meet on the theme Nutri-sensitive Agriculture'	September 3, 2021	130	Self-Help Group and FPO members, horti-innovators and progressive horticulturists
5.	Webinar on Role of Fruits and Vegetables in Food and Nutritional Security	September 27, 2021	-	Scientists, Research scholars and academicians
6.	Training on 'Entrepreneurship development through Dussehri mango pulp processing'	October 15, 2021	30	Women farmers from SHG '*Swavalamban*' and members of Society for Conservation of Mango Diversity, Kasmandi kalan
7.	Training on Nutritious kitchen garden	October 15, 2021	60	Women farmers
8.	Scientists-Students interaction meet on the theme 'Agriculture and Environment: The Citizen Face	November 1, 2021	200	Students
9.	Scientists-Students interaction meeting on the theme 'Agriculture and Environment: The Citizen Face	November 26, 2021	-	Students
10.	Interaction with school children on "Waste to Wealth Management"	December 3, 2021	100	Students

5. PROGRAMMES ORGANIZED UNDER JAI KISAN JAI VIGYAN

S.N.	Name of Program	Date of events	No. of participants	Category of participants
1.	Farmer-Scientist-Student Interaction meet	December 23, 2021	100	Farmers, students and Institute staff
2.	Talk on Role of Agriculture Fraternity	December 24, 2021	40	Scientific Staff of the Institute
3.	Recent initiatives by ICAR- CISH for developing horti-preneurs	December 27, 2021	80	farmers and Institute staff

6. PROGRAMMES ORGANIZED UNDER RAJBHASHA HINDI

S.N.	Topic/ Title of Program	Starting date of program	Category of participants	Place of Program
1.	Hindi Workshop	June 30, 2021	CISH- Staff	ICAR-CISH, Lucknow
2.	Hindi Workshop	August 21, 2021	CISH- Staff	ICAR-CISH, Lucknow
3.	Hindi week	September 14-20, 2021	CISH- Staff	ICAR-CISH, Lucknow

7. OTHER PROGRAMMES ORGANIZED

S. N.	Topic/ Title of Programme	Date	No. of participants	Place of Programme	Type of programme
1.	Nutri Garden Campaign and Tree Plantation Programme	September 17, 2021	525 Farmers	ICAR-CISH, RRS Malda	Awareness Program
2.	Meditation Camp organized	November 15-16, 2021	50 CISH- Staff	ICAR-CISH, Lucknow	Camp

Programme organized by RRS, Malda

1. Awareness programme on farm mechanization was conducted by Dr. Dipak Nayak at Kendpukur, Habibpur, Malda on 07.01.21 in collaboration with Indian Agricultural Research Institute, Pusa Campus, New Delhi where more than 1000 tribal women participated.
2. Tribal and SC women farmers meet was conducted by Dr. Dipak Nayak and Dr. Antara Das on 12.02.21at Kendpukur, Habibpur, Malda, where around 2000 tribal and SC women participated in the programme. Dr. A. R. Khan graced the programme as Chief Guest in presence of many other dignitaries. Date- 08.03.21.
3. A programme on International Women Day was conducted by Dr. Dipak Nayak and Dr. Antara Das on 08.03.21 at the premises of CISH-RRS-KVK-Malda with participation of 50 women.
4. A series of Mustard Field Days were conducted by Dr. Dipak Nayak and Dr. Antara Das during 04.02.21 to 08.02.21 at Baidypur, Patharbari, Parapur, Begunbari, Hurabari and Mandighi villages of Habibpur block, Malda.
5. A programme was conducted by Dr. Dipak Nayak and Dr. Antara Das on market promotion of jute based products on 25.03.21 in presence of representatives from Malda district administration and jute industry with active participation of 100 women farmers.
6. A meeting was conducted by Dr. Dipak Nayak on formation of Jagriti International FPO on 14.04.21 involving tribal women.
7. A meeting was conducted by Dr. Dipak Nayak on formation of Agrani International FPO on 19.04.21 involving SC women.
8. A meeting was conducted Dr. Dipak Nayak and Dr. Antara Das for membership mobilization of Jagriti International on 10.05.21.
9. A meeting was conducted Dr. Dipak Nayak and Dr. Antara Das for membership mobilization of Jagriti International on 12.05.21.
10. A medical camp along for tribal and SC farmers with blood donation camp was organized on 20.06.21 at Kendpukur, Habibpur, Malda.
11. A programme was organized by Dr. Dipak Nayak on promotion of rice drum seeder among the tribal women on 25.06.21 at Kendpukur, Habibpur, Malda under CISH KVK, Malda.
12. A programme was conducted by Dr. Dipak Nayak and Dr. Antara Das on accelerated jute retting using NINFET Sathi involving SC women farmers on 25.06.21 at Kendpukur, Habibpur, Malda.
13. A programme was conducted by Dr. Dipak Nayak and Dr. Antara Das on accelerated jute retting using NINFET Sathi involving SC women farmers on 15th to 16th July, 2021 at Kendpukur, Habibpur, Malda.
14. A Farmers' Goshthi on Food and Nutrition for Farmers" (Bharat Ka Amrut Mahotsav) was conducted by Dr. Antara Das and Dr. Shailesh Kumar on 26.08.2021 at Khoribari, Habibpur, Malda and also at CISH KVK, Malda.

15. A virtual meeting was conducted on promotion of FPO under Chairmanship of Dr. M. V. Rao, Additional Chief Secretary, P&RD Dept. in presence of District Magistrate, Malda.
16. Women Farmers day was organised on 16.10.21 during the auspicious World Food Day at Khoribari, Habibpur, Malda.
17. A program was conducted by Dr. Dipak Nayak and Dr. Antara Das on awareness on nano products in collaboration with IFFCO on 17.10.21 at CISH-RRS-KVK-Malda.
18. A training programme was organised by Dr. Dipak Nayak and Dr. Shailesh Kumar on Scientific Fish Culture on 25.10.21 at Narsinghabati, Habibpur, Malda.
19. A FPO member mobilization programme was organized on 25.10.21 at Kendpukur, Malda.
20. A Prani Mitra programme was organised by Dr. Dipak Nayak and Dr. Shailesh Kumar on 08.11.21 at Kendpukur, Habibpur, Malda.
21. A programme was conducted by Dr. Dipak Nayak on women empowerment in presence of Additional District Magistrate (LR), Malda on 02.11.21 at Kendpukur, Malda.
22. A programme was organised by Dr. Dipak Nayak and Dr. Antara Das on efficient use of fertilizer in collaboration with KRIBHCO at Kendpukur, Malda on 19.11.21.
23. A programme was conducted by Dr. Dipak Nayak and Dr. Antara Das on export promotion of fruits and vegetables from Malda and adjoining districts with support from APEDA Regional Office, Kolkata on 27.11.21.
24. Series of Fish Training Programme was organised by Dr. Shailesh kumar during 04.12.21 to 06.12.21
25. Exposure visit (Farmer's field visit) of DAESI students of CISH Krishi Vigyan Kendra, Malda to adopted villages of ICAR-CISH, RRS, Malda in Habibpur block on 08.12.21
26. A training programme on organic farming was organised by Dr. Dipak Nayak on 16.12.21 in Habibpur block, Malda.

Export oriented capacity development programme for FPOs/FPCs/progressive farmers from SC/ST community

Kisan Goshti on the Occasion of International Women's Day-2021

Personnel

Institute Headquarters, Lucknow (Uttar Pradesh)

Scientific			
S.No.	**Name of the officer**	**Degree**	**Designation**
1.	Neelima Garg	Ph.D.	Director (Acting) (from 01.12.2021)
2.	Shailendra Rajan	Ph.D.	Director (retired on 30.11.2021)
A. Division of Crop Improvement and Biotechnology			
1.	Devendra Pandey	Ph.D.	Principal Scientist (Horticulture) & Head (I/c)
2.	Anand Kumar Singh	Ph.D.	Principal Scientist (Horticulture) (retired on 31.03.2022)
3.	P.L. Saroj	Ph.D.	Principal Scientist (Horticulture)
4.	Maneesh Mishra	Ph.D.	Principal Scientist (Horticulture)
5.	Anju Bajpai	Ph.D.	Principal Scientist (Genetics & Cytogenetics)
6.	Ashish Yadav	Ph.D.	Principal Scientist (Horticulture)
7.	Harish Chandra Verma	MCA	Scientist (SG) (Computer Application)
8.	Muthukumar M.	Ph.D.	Senior Scientist (Biotechnology)
9.	Israr Ahmad	Ph.D.	Senior Scientist (Biotechnology)
10.	Anshuman Singh	Ph.D.	Senior Scientist (Fruit Science)
11.	Vishambhar Dayal	Ph.D.	Scientist (Fruit Science)
12.	Antara Das	Ph.D.	Scientist (Biotechnology)
13.	Swosti Suvardarsini Das	Ph.D.	Scientist (Fruit Science)
14.	Amarkant Kushwaha	M.Sc.	Scientist (Genetic & Plant Breeding)
B. Division of Crop Production			
1.	Ram Awadh Ram	Ph.D.	Principal Scientist (Horticulture) & Head (I/c)
2.	Sushil Kumar Shukla	Ph.D.	Principal Scientist (Horticulture)
3.	Dinesh Kumar	Ph.D.	Principal Scientist (Horticulture)
4.	Naresh Babu	Ph.D.	Principal Scientist (Horticulture)
5.	Kanchan Kumar Srivastava	Ph.D.	Principal Scientist (Horticulture- Fruit Science)
6.	Shyam Raj Singh	Ph.D.	Principal Scientist (Horticulture- Veg. Science)
7.	Ajaya Kumar Trivedi	Ph.D.	Principal Scientist (Plant Physiology)
8.	Dushyant Mishra	Ph.D.	Principal Scientist (Fruit Science)
9.	Ashok Kumar	Ph.D.	Principal Scientist (Environmental Science) (Transferred to ICAR-NRCO, Pakyong on 09.05.2022)
10.	Tarun Adak	Ph.D.	Senior Scientist (Soil Physics/Soil & Water Conservation)
11.	Sharad Kumar Dwivedi	Ph.D.	Scientist (Plant Physiology)
12.	Govind Kumar	Ph.D.	Scientist (Agricultural Microbiology)

C. Division of Crop Protection			
1.	Hari Shankar Singh	Ph.D.	Principal Scientist (Agril. Entomology) & Head (I/c)
2.	Prabhat Kumar Shukla	Ph.D.	Principal Scientist (Plant Pathology)
3.	Gundappa	Ph.D.	Scientist (Agril. Entomology)
4.	Nidhi Kumari	Ph.D.	Scientist (Plant Pathology)
D. Division of Post Harvest Management			
1.	Neelima Garg	Ph.D.	Principal Scientist (Agril. Microbiology) & Head (I/c)
2.	Abha Singh	Ph.D	Principal Scientist (Food & Nutrition)
3.	Bharati Killadi	Ph.D.	Principal Scientist (Hort-Veg. Science)
4.	Anil Kumar Verma	Ph.D	Scientist (SG) (FM&P)
5.	Alok Kumar Gupta	Ph.D	Scientist (Fruit Science)
6.	Karma Beer	Ph.D	Scientist (Fruit Science)
7.	Gopal Carpenter	M.Tech.	Scientist (Farm Machinery & Power)
8.	Ravi S.C.	Ph.D.	Scientist (Agricultural Economics)

Technical

S.No.	Name of the officer	Degree	Designation
1.	Sudhir Kumar Singh Raghav	Ph.D. (Agronomy)	Chief Technical Officer (Field/ Farm Tech.)
2.	Santosh Kumar	M.Sc. (Agronomy)	Chief Technical Officer (Field/ Farm Tech.)
3.	Sanjay Kumar	M.Sc. (Botany)	Chief Technical Officer (Lab. Tech.)
4.	Abhay Dixit	M.Sc. (Chemistry)	Chief Technical Officer (Lab. Tech.)
5.	Vinod Kumar Singh	Ph.D. (Botany)	Chief Technical Officer (Lab. Tech.)
6.	Anil Kumar Singh	M.Sc. (Ag.)	Chief Technical Officer (Lab. Tech (retired on 31.05.2022)
7.	Dharmendra Kumar Shukla	M. Tech. (Food Technology)	Chief Technical Officer (Lab. Tech.)
8.	Arvind Kumar	M.Sc. (Ag.)	Assistant Chief Technical Officer (Lab. Tech.)
9.	Brajendra Kumar	M.Sc. (Hort.)	Assistant Chief Technical Officer (Field/ Farm Tech.)
10.	Priti Sharma	M.Sc. (Botany), M. Phil.	Assistant Chief Technical Officer (Lab. Tech.)
11.	Md. Afroz Sultan	M.Sc. (Agronomy)	Technical Officer (Programme Assistant - Lab. Tech.)
12.	R.K. Mishra	High School, ITI	Technical Officer (Arts)
13.	N.C. Verma	Ph.D. (Library & Information Science)	Technical Officer (Library)
14.	Yamuna Prasad	8th	Technical Officer (Workshop-Driver)
15.	Virendra Pratap Singh	8th	Technical Officer (Workshop-Driver)

16.	Virendra Kumar Yadav	B.A.	Senior Technical Assistant (Workshop-Driver)
17.	Dhurva Kumar	B.A.	Technical Assistant (Field/ Farm Tech.)
18.	Sumit Kumar Soni	Ph.D. (Biotech.)	Technical Assistant (Lab. Technician)
19.	Mohd. Riyaz	B.Sc.	Technical Assistant (Lab. Technician)
20.	Radhey Lal	High School	Senior Technician (Field/ Farm Tech.)
21.	Satyendra Singh	B.A.	Technician (Field/ Farm Tech.)
22.	Alok Shukla	M. Sc. (Biochem.)	Technician (Lab. Technician)
23.	Arvind Kumar Singh	M. Sc. (Biotech.)	Technician (Lab. Technician)
24.	Monika Singh	B. Sc., M.C.A, B.Ed.	Technician (Lab.Computer)
25.	Hemant Kumar Pandey	B.A., M.B.A.	Technician (Field/ Farm Tech.)

Administrative

S.No.	Name of the officer	Degree	Designation
1.	Sujeet Kumar Verma	M.Sc.	Senior Administrative Officer
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
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
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	Skilled Supporting Staff
2.	Maheshwari Devi	Skilled Supporting Staff
3.	Rajesh Kumar	Skilled Supporting Staff
4.	Gyan Wati	Skilled Supporting Staff
5.	Ram Bali	Skilled Supporting Staff
6.	Vishram	Skilled Supporting Staff
7.	Anand Gautam	Skilled Supporting Staff

Regional Research Station, Malda (West Bengal)

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

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

Krishi Vigyan Kendra, Malda (West Bengal)

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

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

Distinguished Visitors

1. Dr. Devendra Thakur, Project Director, H.P. Shiva, Department of Horticulture, H.P. (06.01.2021).
2. Sh. A.P. Singh, Brijesh Pratap Singh, Ranaji Biotech (India) Pvt. Ltd., Kanpur, (07.01.2021).
3. Mr. Shashank Shukla Value Chain Expert, PMU, NHB, Gurgaon (08.01.2021).
4. Mr. Aayush Thakur, Shoolini University, Solan, H.P. (13.01.20221).
5. Mr. Sudarshan Herle, C.E.O. King CATCHER, Palvi Industries, Sangli, Maharashstra (19.01.2021).
6. Mr. Saurabh Shukla, Balaji Agro Food, Lucknow (19.01.2021).
7. Dr. Ravindra Kumar Sharma, Food Agri Specialist, 1168, Vasant Kunj, New Delhi (19.01.2021).
8. Mr. Avnish Chandra, Sr. Manager, (Sales), Dhanuka Agritech Limited, 113/5, 3rd Floor, Navyung Market, Near Urvashi Cinema, Ghaziabad (U.P.) (25.01.2021).
9. Shri Bhupendra Singh, State Présidence Bhartiya Kisan Association, U.P. Kendriya Karyalaya, 43, Pandit Deen Dayal Upadhyaya Marg, New Delhi (28.01.20221).
10. Mr. Manish Yadav, Principal Correspondent, TV9 Bharat Varsh, 302, Shalimar Square, B.N. Road, Lalbagh, Lucknow (29.01.2021).
11. Dr. Naveen Kumar Arora, Professor, Dr. Bhim Rao Ambedkar University, Lucknow, (01.02.2021).
12. Mr. L.D. Pareek, Sales Manager, Boix Machine, India, Pvt.Ltd., Jodhpur (Rajasthan) (09.02.2021)
13. Shri Surya Prakash Shukla, Reporter, Navbharat Times,, Lucknow, M : 9415009900 (10.02.2021).
14. Shri Bhikhari Singh, Ex. Distt. President, BJP, Lucknow (10.02.2021).
15. Dr. Meena Devi, District Horticulture Officer, Lucknow (20.02.2021).
16. Dr. Nutan Kaushik, Director General, Food & Agriculture Foundation, Room No. G-18,Ji Block, Amity University, Sector 125, Gautam Budha Nagar, Noida (U.P.) (22.02.2021).
17. Mr. Rashid Ahmad, Reporter, Hindustan Hindi, Lucknow, M:9336514113 (22.02.2021).
18. Mr. Sanjay Tiwari, Central India Television, Member, Western India Film Producers Association, 502 Vth Floor, B Wing, Rajat Hills Complex, Opp. NBSS & LUP, Amravati Road, Nagrpur (March 4, 2021).
19. Dr. Akhilesh Kumar, Editor in Chief, Eden Horticulture, 1411, Sec.-9, Urban Estate, Karnal (Haryana) (March 6, 2021).
20. Dr. D.B. Shakyawar, Director, NINFET (March 6, 2021).
21. Mr. Devesh Shukla, National Head, VNR Nursery, Private Limted, Corporate Centre, Canal Road Crossing, Ring Road No.1, Raipur Chhattisgarh (March 9, and September 20, 2021).
22. Dr. R.A. Roy, D.G.M. IOC, Indian Corporation, Limited, New Delhi (March 16, 2021).
23. Dr. Sanjay Kumar Singh, Sr. Scientist (Hort.), ICAR-NRC, Litchi, Muzaffarpur (March17, and October 16, 2021).
24. Mr. Anupriya Mohania and Mr. Pushpendra Singh,Veterinary College, DUVASU, Mathura, U.P. (April 12, 2021).
25. Dr. Ram J. Maurya, Dr., H.P. Singh and Dr. K.V. Singh, Shakya, Member UPSC, Prayagraj (June 8, 2021).
26. Dr. Pramod Kumar Gangwar, Dy. Chief Project Officer, Uttarakhand Renewavble Energy Development Agency (UREDA), Energy Park Campus, Industrial Area, Patel Nagar, Dehradun, Uttarakhand (June 9, 2021).

27. Mr. Jyoti Swaroop, Secretary, Samagra Vikas Welfare Society (SVWS), 322/32 Bajrang Nagar, Kanchana Bihari Road, Vikas Nagar, Lucknow (June 11, 2021).
28. Mr. Rohit Mishra, Principal Correspondent Editorial, The Times of India, Bennett, Coleman & Lo. Ltd., Navbharat Times, Prayagpur Tower, 38/22, Meerabai Marg, Lcknow (June 16, 2021).
29. Mr. Rajesh Rawat, Reporter, Rashtriya Sahara, Print Media, Kakori, Lucknow (June 16, 2021).
30. Mr. Vineet Verma, OSD to Deputy Chief Minister, U.P., Luckdnow (June 17, 2021).
31. Mr. D.S. Chauhan, IPS, 1 Gokhle Marg, Lucknow, M : 9454400121 (June 22,2021).
32. Mr. Mohd. Maroof, Reporter, ETV, Bharat, 110 A, First Floor Mahatma Gandhi Marg, Mall Avenue Lucknow, (June 30, 2021).
33. Mr.Sarvesh Kumar Tiwari, Asstt. Director, Hort. (DHO), Bhopal, (July 5, 2021).
34. Mr. Dhidrendra Kuumar Mishra, Garden Superintendent, Rajbhawan, Lucknow, (July 8, 2021).
35. Dr. R. A. Roy, D.G.M. IOC, Indian Corporation, Limited, New Delhi, (July 9, 2021).
36. Mr. Amar Singh Mudtiya, Udhan Vikas Adhikari, Karyalaya Sahayak Sanchalan Udhan, Kuthar Prachetra, Bhopal, (July 12, 2021).
37. Mr. Stayendra Rai, Sr. Exécutive, Sahara T. V. Aliganj, Lucknow, (July 14, 2021).
38. Mr. A. Biswas, Director, AHLLP, Gaziabad, U.P. (July 19,2021).
39. Dr. Sandeep Sharma, SMS Hort. Distt. Mandi, Himachal Pradesh, (July 22,20221).
40. Dr. Sandip Kumar Singh Sr. Scientist cum Head and Dr. Ajit Kumar Srivastav, Specialist (Hort.) Mahayogi Gorakhnath Krishi Vigyan Kendra, ICAR-Agricultural Technology Application Research Institute, Kanpur and Chaukmafi, Peepiganj, Jangal Kaudiya Gorakhpur, U.P. (July 23, 2021).
41. Dr. P.K. Gupta, Director (Acting), NHRD Foundation, Bagwani Bhawan, Plot No. 47, Pankha Road, Institutional Area, Jankipuri, New Delhi (July 26, 2021).
42. Swami Gurukripa Nand and Swami Maneshwara Nand, Divya Jyoti Jagarati Sansthan, Nurmahal, Jalandhar, Punjab (July 27, 2021).
43. Dr. A. Rabbani, Consultant Horticulture, BAU, Ranchi, (August 11, 2021).
44. Mr. Ajay Kumar Rai, SDM Malihabad and Minakshi Dwivedi, Tehsildar, Malihabad (August 12, 2021).
45. Dr. P.K. Singh, Ex. Dean, NDUA&T, Kumar Ganj, Faizabad (August 13, 2021).
46. Shri J. B. Singh, I.A.S. (Retd.), 1/235, Viram Khand, Gomti Nagar, Lucknow, (August 17, 2021).
47. Mr. Deep Singh, Special Correspondent Editorial, Bennett, Coleman & Co. Ltd. 16, Rana Pratap Marg, Lucknow-226001, (August 23, 2021 and August 26, 2021).
48. Mrs. Shefalika Sharma, Founder Froots Technologies Pvt. Ltd., Mumbai, (August 23, 2021).
49. Mr. Dharmendra Kumar Upadhyay, Senior Executive (CSC Scheme), 3rd Floor, Deity 6, CGO Complex, Lodhi Road, New Delhi (August 25, 2021).
50. Mr. Satya Prakash Tirpathi, Senior Agriculture Marketing Inspector Lucknow (September 22, 2021).
51. Dr. T.K. Singh, Scientist (Hort.), JNKVV, College of Agril. Rewa, M.P. (September 24, 2021).
52. Dr. Uttklarsh Shukla, Deputy Director, Lucknow Zoo, (October 12, 2021).
53. Mr. S. Anandasubaramanian, Farm Management, La Ferme De Peter LLP, GKS Estates, No. 76, A/11th Street, Ambattur Indoustrial Estate, Chennai (Tamil Nadu), (October 18, 2021).

54. Dr. Atul Yadav, Asstt. Prof. SHUATS, Pryagraj (October 20, 2021).
55. Dr. Khandewal, Bio-fertilizer, Belgav (Karnataka), (October 20, 2021).
56. Shri Pankaj Kumar Gupta, Vice President, Jila Udyog Vyapar Mandal, Distt. Lucknow, (October 26, 2021).
57. Mr. Aviral Rathi, Microplex, Nagarjuna Agro Chemical Pvt. Ltd,36, Mohata Market, Main Road, Wardha-442001 (M.S.) (November 27, 2021).
58. Mr.S.P. Gautam, Reporter, Swantra Bharat, Lucknow, (November 11, 2021).
59. Mr. B.N. Singh, (IAS), Special Secretary, Rajbhawan, Lucknow (November 11, 2021).
60. Mr. Kanishk Kukreti, MOS Agriculture, New Delhi (November 24, 2021).
61. Dr. R. A. Roy, D.G.M. IOC, Indian Corporation, Limited, New Delhi, (December 04, 2021).
62. Dr. U.K. Behera, Dean College of Agriculture (Kyrdemkulai), Central Agricultural University, CPGS Campus, Umiam, Meghalaya (December 18, 2021).
63. Dr. H.P. Singh, Former Deputy Director Genral, ICAR, Krishi Bhawan, New Delhi (December 23, 2021).

Dr. H.P. Singh, Former DDG (Horticulture) felicited by Director Dr. Neelima Garg

Meteorological Parameters

January to December 2021

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	20.9	6.5	88.3	69.3	5.2	1.5	23.8	0	-	4.5
February	22.6	8.02	91.3	63.8	8.1	1.9	24.1	0	-	6.1
March	33.9	13.9	92.1	64.0	7.8	2.8	24.5	0	-	8.2
April	38.7	16.2	84.1	47.8	8.8	3.0	24.1	0	-	9.7
May	35.6	22.4	87.2	61.1	8.2	3.9	24.2	111.0	5	7.6
June	34.2	25.2	90.6	62.4	7.2	2.7	23.1	208.6	7	6.4
July	34.3	26.2	90.2	65.8	5.5	3.3	23.5	209.4	6	6.9
August	32.9	25.5	95.8	77.7	4.3	3.0	22.9	219.0	6	5.9
September	33.1	24.6	95.4	75.2	7.2	3.7	21.2	226.0	4	5.9
October	32.4	19.6	93.8	74.6	7.7	1.7	22.6	162.0	4	5.4
November	28.0	10.8	91.1	61.4	6.4	0.6	23.0	0	-	5.5
December	23.5	7.5	90.4	63.8	5.4	0.9	22.4	0	-	5.6

Meteorological data recorded during January to December 2021 at the Institute's observatory indicated highest and lowest mean monthly maximum temperature 38.7° C and 20.9° C which were recorded during the month of April and January, respectively. Similarly the highest and lowest mean monthly minimum temperatures were recorded 26.2° C and 6.5° C during the month of July and December, respectively.

Maximum and minimum relative humidity varied between 84.1 to 95.8 per cent and 47.8 to 77.7 per cent, respectively. Average wind speed of 0.6 to 3.9 km/hr and average bright sunshine hours of 4.3 to 8.8 hours were also recorded. Average range of evaporation 4.5 to 9.7 mm recorded in January and April months, respectively. Total annual rainfall of 1136.0 mm received and distributed over 32 number of rainy days during the year 2021. The highest precipitation 226 mm was recorded in September month.

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

स्वच्छ भारत, समृद्ध भारत

स्वच्छ भारत

एक कदम स्वच्छता की ओर

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

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भाकृअनुप ICAR

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