# वार्षिक प्रतिवेदन
# Annual Report
## 2010-11







भाकृअनुप
ICAR

## केन्द्रीय उपोष्ण बागवानी संस्थान
रहमानखेड़ा, लखनऊ
## Central Institute for Subtropical Horticulture
Rehmankhera, Lucknow

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रहमानखेड़ा, लखनऊ -227 107 (उ.प्र.), भारत
**Central Institute for Subtropical Horticulture**
**Rehmankhera, Lucknow-227 107 (U.P.), India**

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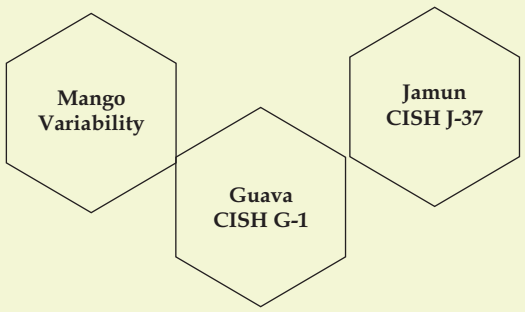
**Front Cover**




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

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# PREFACE

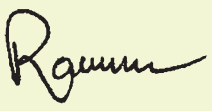
Horticulture sector has been growing to meet the surging demands of the population and has attained the production level of 234.5 million tonnes. In the background of the changing scenario of urbanization, growing awareness about healthy and functional food sources has been the key drivers of increased demand from consumers in India and abroad for quality horticulture produce. To meet the growing demand, 340 million tonnes of horticultural produce have to be produced by the latter part of this decade from declining land, labour and water resources and the emerging scenario of climate change. This will undoubtedly require paradigm shifts in the research arena to address the issues of providing technological back-up for augmented production and quality. To face the challenges, the weaknesses have to be converted into opportunities through use of scientific advances and focused attention on prioritized areas of research.

The subtropical horticulture has been contributing to the food, nutritional security and livelihood of a vast majority of the farming community in the northern Indian plains for a long time. The scenario while presenting variety of opportunities also poses diverse challenges and constraints. The prevailing agro-climates and edaphic factors across this zone though limit culture of many horticulture crops with high outputs of quality, has not deterred the zeal of horticulturists and entrepreneurs to embark upon diversification in this sector in order to augment sustainability and profitability.

The institute is concentrating on mango, guava, aonla, bael, papaya and some underutilized fruits and targets to strive towards integrated farming system. The research programmes of the institute emphasize profitability to the growers through genetic resources management and crop improvement, developing sustainable crop production modules incorporating improved water and nutrient use efficiency, integrated pests and diseases management strategies, integrated pre-harvest protocols with post-harvest management strategies and value addition.

The annual report of the institute for 2010-11 provides comprehensive information on its multifarious activities and achievements in research and development, transfer of technology and human resource development, an outcome of the collective wisdom of qualified and skilled human resource which I feel proud to present. Stakeholders' Consultative Meetings, detailed deliberations of Institute Research Committee (IRC) and Research Advisory Committee (RAC) and Priority Setting, Monitoring and Evaluation (PME) initiatives and responsiveness of the institutes' scientists have been instrumental in reorienting research activities, infuse focus, undertake midcourse corrections and ensure team approach. The scientists of the institute ably supported by technical, administrative, supporting and auxiliary staff deserve appreciation for executing the outlined programmes with commitment. I gratefully acknowledge their inputs and sincerely thank all of them. I am confident that the institute will endear to continue its march to be the 'knowledge centre' and strengthen its linkages with the growers' community through outreach programmes, hand hold them for addressing key production, productivity, profitability and quality constraints. The publication committee has undertaken painstaking and dedicated efforts of compiling, editing and bringing out this document in a presentable form for which I extend my wholehearted appreciation and compliments.

The encouragement and suggestions received from Dr. S. Ayyappan, Director General, ICAR and Secretary, DARE, Dr. H. P. Singh, Deputy Director General (Horticulture) and Dr. S. Rajan, Assistant Director General (Horticulture-I) ICAR, New Delhi from time to time have been the guiding force for the institute in its march towards progress and the institute joins me in gratefully acknowledging their sustained support and guidance.



Lucknow
November 9, 2011

**(H. Ravishankar)**
**Director**

# CONTENTS

# 1. कार्यकारी सारांश

## आनुवंशिकी संसाधन प्रबंधन

उत्तर प्रदेश, गोवा एवं बिहार से आम के पैंतीस अभिगमनों का संकलन कर संस्थान के आम जननद्रव्य इकाई में संरक्षित किया गया जिससे कुल संकलन बढ़कर 732 हो गया। आम के सकल जननद्रव्य संकलन से 190, 150 तथा 45 अभिगमनों के फल, पत्तियों तथा बौर एवं डस (DUS) मानक का मूल्यांकन किया गया। आम के मातृखंड में रोपित आम के किस्मों जैसे मल्लिका, दहानी, लंगड़ा एवं आम्रपाली के पौधों में आनुवंशिक समानता जाँचने हेतु आर.ए.पी.डी. एवं एस. आर. मार्कर की सहायता ली गयी। मातृ वृक्षों के मध्य समानता स्थापित करने में तीन प्राइमर FMID073, HMID074 एवं FMID2007 ने प्रमाणित किया कि मातृ वृक्ष की किस्मों में विभेद नहीं था। आम की उत्तर भारत की व्यावसायिक किस्मों में जीन प्ररूपी विभेद जाँचने के लिए बारकोडिंग की सहायता ली गयी जो 18 एस.एस.आर. लोसाई की मदद से संपन्न हुआ। आम में नियमित फलन, बौर, गुम्मा रोग प्रतिरोधकता एवं छिलके के रंग हेतु 19 संकरण की 11600 पुष्प गुच्छों पर 4543 फुलों की मदद से संयोजित कराया गया। 2008-09 में 20 काम्बीनेशन से उत्पन्न आम के 187 संकर पौधों को परखने के लिए बाग में रोपित किया गया। 2009-10 में ये प्रयास 21 क्रास काम्बीनेशन में किया गया हाँलाकि इसमें सिर्फ एक संकर पौध ही उत्पन्न हो पाया। फल लक्षण मूल्यांकन हेतु 870 आम के संकर पौधों में संकर 949, 1084 एवं 2803 ही उपरोक्त विशेषताओं में उपयुक्त पाये गये। पौधशाला में आम की बहुभ्रूणीय किस्म को अंकुरित कराकर न्यूसेलर एवं जाइगोटिक पौधों को अलग किया। सर्वाधिक अंकुरण कुरूक्कन में एवं इसके बाद पीच किस्म में पाया गया।

अमरूद के 14 नये अभिगमनों का संकलन इलाहाबाद, बैंगलोर तथा मालदा से किया गया। कुल 652 संकर पौधे जो 5 संकरण तथा एक को खुले परागण द्वारा प्राप्त हुए उन्हें प्रक्षेत्र में लगाया गया ताकि फलों में गुलाबी रंग की पहचान की जा सके। एक सौ बीस संकर पौधों का मूल्यांकन उनके बीज की सख्तता के आधार पर किया गया। 8 आर.ए.पी.डी. तथा 5 एस.एस.आर. प्राइमर के इस्तेमाल से *इन विट्रो* से तैयार की गयी ललित पौधों की आनुवंशिक एकरूपता की पुष्टि की गयी। पपीता के 16 अभिगमनों में पूसा डेलीसियस, सी.ओ.-7 तथा अभिगमन एम-1 ने उत्पादकता एवं गुणवत्ता के अनुसार बेहतर नतीजा दिया जबकि पूसा नन्हा में 0.3 मी. की ऊँचाई तथा पूसा डेलिसियस में 0.6 मी. की ऊँचाई पर फसल प्रारंभ हुई। नियंत्रित स्थिति में एक समान परिणाम पाने के लिए 405 सिबमेटेड फूल से 236 फल की प्राप्ति हुई। वाँछित गुणों के विकास हेतु चार संयोजन से 113 संकरों से 76 फल प्राप्त हुए।

पूसा डेलिसस x सी.ओ.-7 के संकर पौधों से सर्वोत्तम उत्पादन वाले बड़े आकार के फल पाये गये। जीन बैंक में संरक्षित किये गये 35 लीची के अभिगमनों में से 7 अभिगमनों में पुष्पन देखा गया। कसैलिया में यद्यपि समय पूर्व परिपक्वता देखी गयी किन्तु बौर प्रारंभ तथा पुष्पन की शुरूआत (39 दिनों) थोड़े अधिक समय में देखी गयी। 20 आर.ए.पी.डी. मारकर का प्रयोग करते हुए लीची के 12 चयनित किस्मों की आनुवंशिक विविधता जाँची गयी तो 15 प्राइमरों द्वारा पुनरूत्पाद के प्रकृति के विशिष्ट एमप्लीकॉन का उत्पादन किया गया। NJ तथा 4 पी.जी.एम.ए. का प्रयोग करते हुए समूह विश्लेषण करने परशाही, देहरारोज तथा रोज सेंटेड को एक ही समूह में रखा गया। मध्य प्रदेश से संकलित आँवला के 22 अभिगमनों जिनको 2007 में रोपण किया गया उनमें से 7 अभिगमनों में फलन प्रारंभ हुआ। सी.आई.एस.एच. ए-13 में सर्वाधिक उत्पादन देखा गया तथा सी.आई.एस.एच. ए-2 में सर्वाधिक ऐस्कार्बिक अम्ल (528 एम.जी. /100 ग्रा-1 गूदा) पाया गया।

उत्तर प्रदेश, बिहार तथा झारखण्ड से संकलित एवं स्थापित किये हुए 8 वर्ष के बेल के पौधों में आकृति संबंधी विभिन्नता देखी गयी। जामुन के सात अभिगमनों का दैहिक-रसायन विशेषता का मूल्याकंन किया गया। मेसर्स नैचुरल रेमेडीस, बैंगलोर के सहयोग से जामुन के बीजे में विद्यमान मिथेनोलिक अर्क की पहचान जीव सक्रीयता के आधार पर की गयी ताकि उसका मूल्यांकन आगे किया जा सके। आकृति तथा दैहिक-रसायनिक गुण विशलेषण के आधार पर खिरनी के सीआईएसएच10 एवं सीआईएसएच-11, करौंदा के सीआईएसएच-11, महुआ के सीआईएसएच एम-8, कैथे के सीआईएसएच वअ-17 तथा चिरौंजी के सीआईएसएच-3 की पहचान उत्तम अभिगमनों के रूप में की गयी।

## उन्नत फसल उत्पादन प्रौद्योगिकियाँ

18 वर्षीय पुराने सघन बागवानी के प्रयोग में वृक्षों की सर्वाधिक ऊँचाई (5.40 मी.) 1600 पौधे/हेक्टेयर की सघनता में पायी गयी जबकि सर्वाधिक उत्पादकता 15.55 मेट्रिक टन प्रति हेक्टेयर की सघनता में पायी जो परंपरागत विधि वाले 100 वृक्ष प्रति हेक्टेयर में 4.60 मेट्रिक टन प्रति हेक्टेयर थी। विकीर्ण विकीरण की मात्रा सर्वाधिक (1097 माइक्रोमील/सेकेण्ड) परम्परागत पद्धति में पायी गयी जबकि यह मात्रा 989 माइक्रोमोल प्रति सेकेण्ड 400 पौधे प्रति हेक्टेयर की सघनता

में पायी गयी। विकीर्ण विकीरण की मात्रा 135-180° दिगंश कोर में सर्वाधिक (94.29 माइक्रोमोल) पायी गयी। लीफ एरिया सूचकांक मध्यम सघनता (400 पौधों) के पौधों में न्यूनतम पाया गया। दक्षिण-पूर्वी भाग अन्य भागों की तुलना में ज्यादा उत्पादक पाया गया। सघन बागवानी के प्रयोग में मृदा एवं पत्तियों के विश्लेषण से पता चलता है कि मृदा पोषण मान वांछित स्तर से कम था जबकि पत्तियों में जस्ता तत्वों की कमी थी। दशहरी में सघन बागवानी में डब्ल हेज से पद्धति ने सर्वाधित उत्पादन (8.15 मैट्रिक टन प्रति हेक्टयर) दिया जबकि वर्गाकार (परांपरागत) विधि में 4.80 मैट्रिक टन प्रति हेक्टेयर था। 24 वर्षीय मल्लिका आम के पेड़ में थिनिंग एवं रिडवशन विधि द्वारा कैनोपी प्रबधन करने पर क्रमशः 88.4 तथा 80.5 कि.ग्रा. प्रति वृक्ष फलत पायी गयी।

सल्स्ट्रेट में FYM, NPK, *एजोटोबैक्टर, ट्राइकोडर्मा* और PSM के माध्यम से परिवर्तन करने पर आर्गेनिक कार्बन की मात्रा 0.32 प्रतिशत से बढ़कर 0.44 प्रतिशत हो गयी। जहाँ पर FYM और/ कृमि खाद और NPK बिछावन के साथ प्रयोग किया गया वहाँ पर सूक्ष्म और मुख्य पोषक तत्वों की मात्रा बढ़ गयी। परंपरागत विधियों की तुलना में उन उपचारों में जैविक, NPK एवं बायोफर्टिलाइपर्स का प्रयोग किया गया तो मृदा डिहाइड्रोजिनेज की सक्रियता बढ़ गयी।

सितम्बर और मई के दूसरे सप्ताह में फर्टिगेशन (NPK) से दशहरी एवं लंगड़ा के बागों में फास्फोरस, पोटैशियम, जस्ता, कापर, मैंगनीज और लोहा की उपलब्धता बढ़ गयी। टपक सिंचाई पद्धति से दशहरी और लंगड़ा की उत्पादकता परंपरागत विधि की तुलना में बढ़ गयी। पैक्लोब्यूट्राजोल के प्रयोग से चौसा और लंगड़ा के उत्पादन में अनियमित फलन की समस्या में काफी कमी देखी गयी किन्तु पूर्णरूपेण निराकरण नहीं हुआ। पैक्लोब्यूट्राजोल से भूमि में कुल सूक्ष्म जीवों की संख्या और डिहाइड्रोजिनेज सक्रियता बढ़ गयी। पैक्लोब्यूट्राजोल का असर भूमि में प्रयोग के दो वर्ष बाद तक देखा गया। 8 बहुभ्रूर्णिय आम की प्रजातियों में से केवल नककारे और बप्पाकाई की लवण प्रेरित तनाव सहने की क्षमता सर्वाधिक पायी गयी जो उच्च तनाव की स्थिति में (2 डी/मीटर) 50 दिनों तक सहन किया। जैसे-जैसे लवणता बढ़ी वैसे-वैसे मेमबरेन परत स्थिरता सूचकांक घटी। नक्कारे ने लवण प्रेरित तनाव में सहनशीलता दिखायी। आम की ललित प्रजाति के पौधे सोमेटिक इम्ब्रियोजेनेसिस विधि से तैयार किये गये जो *फ्यूजेरियम सोलोनाई* के 100 प्रतिशत कल्चरल फिल्ट्रेट में उद्भेदित किये गये, ने 14 दिन के अन्दर भी पत्तियों में भूरापन और सूखने के लक्षण प्रकट किये और समय के साथ-साथ लक्षणों की तीव्रता में बढ़ोत्तरी पायी गयी।

अन्य पौधे जो 50 और 75 प्रतिशत फिल्ट्रेट पर रखे गये थे 14 दिन के अन्दर भूरापन दिखाया जबकि पत्तियों का गिरना 21वें दिन देखा गया। सब्सट्रेट में FYM, NPK, *अजोटोबैक्टर, ट्राइकोडर्मा हरर्जियानम*, PSM तथा जैविक मल्च के द्वारा बदलाव से अमरूद की प्रजाति श्वेता के दूसरे फल जैविक में उच्च उपज 33.05 कि.ग्रा. प्रति वृक्ष पायी गयी तथा फलों का आकार भी बड़ा पाया गया। PSM छोड़कर अन्य सभी निवेश के उपयोग छोड़कर भूमि में मृदा डिहाइड्रोजेनिक की सक्रियता सर्वाधिक पायी गयी। इसी प्रकार से आँवला में भी सब्सट्रेट के बदलाव से भूमि में जैविक कार्बन की मात्रा तथा वृक्षों की वृद्धि बढ़ गयी।

## नाशीकीट तथा रोग प्रबंधन

*इडियोस्कोपस क्लाइपेलिस* हॉपर का पहला प्रकोप 5 मार्च 2011 को देखा गया जब तापमान 12 से 29° सें. ग्रे. तथा सापेक्ष आर्द्रता 33 से 81 प्रतिशत के बीच था। हॉपर की तीनों प्रजातियों (*आई. क्लाइपेलिस, आई.निटिड्यूलस* तथा *एमरिटोडस ऐटकिन्सोनी*) की संख्या मार्च से अप्रैल के बीच अधिक पायी गयी जिसे उसपिनोसॉड 45%, एस.सी. (1 मि.ली./ली.), एसीफेट 75%, एस.पी. (1.5 ग्रा./ली.) के या थायोमेथोक्जाम (0.2 ग्रा./ली.) छिड़काव से नियंत्रित किया जा सकता है। गुझिया कीट, थ्रिप्स तथा फल मक्खी की संख्या क्रमशः जनवरी, अप्रैल-मई तथा जून में सर्वाधिक देखी गयी। सब्जी/फसलों की मृदा से पृथक किये गये 40 जीवाणु समूहों में से केवल 4 समूह ही नीमाटोड रूटनौट के युवाओं को प्रभावित करने वाले पाए गए। पेनोबेसिलस पॉलिमिक्सा जीवाणु के सेंट्रीफ्यूज्ड तथा अल्ट्रा फिल्ट्रड कल्चर फिल्ट्रेट ने 48 से 72 घंटों में कम परिवेशी तापमान (12.5 से 17.50 से.ग्रे.) पर युवाओं (60%) पर नकारात्मक प्रभाव दिखाया।

यूक्लीयान डिस्टेंस आधारित ऐन्थ्रेक्नोज (*कोलेटोट्राइकम ग्लोस्पोराइड्स*) के 30 आइसोलेट्स का विविधता विश्लेषण करने पर उन्हें दो समूहों में पाया गया - समूह I (उत्तर भारतीय आइसोलेट्स) तथा समूह II (उत्तर-पूर्वी आइसोलेट्स)। मल्टीप्लेक्स पी.सी.आर. तकनीक को कोलेट्रोट्राइकम ग्लोस्पोराइड्स के चार प्राइमर सेट द्वारा इष्टम किया गया।

235, 380, 531 तथा 560 बी.पी. आकार की चार विशिष्ट पट्टियाँ जो ग्लूटामीन सिंथेटेज, *सी. ग्लूस्पोराइड्स* की विशिष्ट प्रजातियों तथा पेक्टेट लाइएज बी. जीन यूनिवर्सल ITSI-4 विशिष्ट प्राइमर के लिए ITSr DNA जीन को व्यक्त करने पर एक ही मल्टीप्लेक्स में समान वृद्धि को दर्शाया। अमरूद में उकठा रोग कारक *फ्यूजेरियम ऑक्सीपोरम* को ITS तथा PCR RFLP आधारित आण्विक लक्षण द्वारा वर्णन नहीं किया जा सकता है। *फ्यूजेरियम* सप का विशिष्ट ITSIF तथा ITSIR के प्राइमर समूहों द्वारा 230 बी.पी. पर प्राप्त किया गया। *ट्राइकोडामा हर्जियानम* को नीम की पत्तियों एवं केला के तने के अर्क में अधिक भाग में उपजाया जा सकता है।

## तुड़ाई उपरांत प्रबन्धन

आम को पकाने हेतु एक कम कीमत का पोर्टेबेल चेम्बर विकसित किया गया है। दशहरी आम को बायोएजेन्ट (*सेकेरोमाइसिस सेरेवेसी*) से उपचार कर पोलीथीन बैग (200 गेज, 0.2% छिद्र) में रखने पर उनमें केरोटिनाएड विकास की प्रक्रिया धीमी पाई गई है। आम की संकर किस्मों 1184, 1750 एवं 1795 को तेल का अचार हेतु उपयुक्त पाया गया। आम की ग्यारह किस्मों का गूदे एवं पेय हेतु मूल्यांकन किया गया और एच-1090, एच-1091 एवं पूसा अरूनिमा उत्तम पायी गयी। दहशरी एवं तोतापरी आम की फाँके कैल्सियम क्लोराइड के घोल में डुबाने के उपरांत पोलीथीन बैग में 8° से.ग्रे. पर 11 एवं 10 दिन तक भण्डारित की जा सकती हैं।

आम की दशहरी एवं तोतापरी किस्मों को तुड़ाई उपरांत 5 दिन तक भण्डारित करने पर उन से प्राप्त फाँकों को आस्मो-फ्रीज ड्राइंग तकनीक से सुखाने पर उनकी गुणवत्ता उपयुक्त पायी गयी। आम के गूदे से अच्छी गुणवत्ता की कुकीज बनायी गयी। आम की दशहरी, लंगड़ा एवं चौसा किस्मों को वाइन (10% अल्कोहल) बनाने हेतु उपयुक्त पाया गया। लंगड़ा आम की वाइन में एसकारबिक अम्ल (21.8 मि.ग्रा./100 मि.ली.) एवं टेनिन (72 मि.ग्रा./100 मि.ली.) की मात्रा सबसे अधिक पायी गयी। आम के छिलके को *सेकेरोमाइसिस सेरेवसी* में किण्वित करने पर उच्च कोटि का बायो-इथेनोल (96 ग्रा./ली. घनत्व 41° से.ग्रे. फ्लैश पाइंट, 56 प्रूफ अल्कोहल एवं 0.30 मि.ली. पास्कल लसीलापन 30° से.ग्रे. पर) प्राप्त किया गया। आम की गुठली को पेपर एवं प्लाईबोर्ड बनाने हेतु प्रयोग किया जा सकता है। उपयोग की दृष्टि से कार्बोसल्फान स्प्रे के 84 दिन उपरांत आम को सुरक्षित पाया गया।

अमरूद तोड़क यंत्र का मूल्यांकन किया गया जिसकी क्षमता 250 फल प्रति घंटा पायी गयी। अमरूद की पांच किस्में/संकर को प्रसंस्करण उपयोगिता हेतु मूल्यांकित किया गया एवं स्पियर एसिड किस्म को पेय हेतु सबसे उपयुक्त पाया गया। आस्मो-फ्रीज ड्राइंग तकनीक द्वारा आठ घंटे सुखाने पर अमरूद की ललित किस्म से उच्च गुणवत्ता युक्त फांके तैयारी की जा सकती है। जिनमें एसकार्बिक अम्ल एवं लाइकोपीन की 849 मि.ग्रा./100 ग्रा. एवं 22.73 मि.ग्रा./100 ग्रा. मात्रा क्रमशः प्राप्त हुई। अमरूद की गुलाबी किस्मों से तेल, पेक्टिन, रेशा एवं लाइकोपीन निष्कासन हेतु एकीकृत प्रोटोकाल विकसित किया गया जिसमें लाइकोपीन की 4.2 मि.ग्रा./100 ग्रा. मात्रा प्राप्त हुई। अमरूद एवं बेल के गूदे के इस्तेमाल से कुकीज भी विकसित की गयीं।

स्प्रे ड्राइड आँवले के पाउडर को चुकन्दर से प्राप्त एन्थ्रोसाइनेन द्वारा समृद्ध किया गया। आँवले के अपशिष्ट से एक हर्बल पेय तैयार किया गया।

## बाजार विश्लेषण एवं निर्यात

वर्ष 2009-10 के दौरान पिछले 5 वर्ष में सबसे ज्यादा 68.86 हजार मैट्रिक टन आम लखनऊ क्षेत्र से बाहर भेजा गया। लखनऊ के बाजार में बिक्री के लिए आये आम से ज्ञात हुआ कि पिछले वर्ष के व्यापार 35.02 हजार टन की तुलना में इस वर्ष (2010) आम का कुल व्यापार 86.70 हजार मैट्रिक टन हुआ। देश के सभी बाजारों में दशहरी, लंगड़ा, चौसा, बैंगनपल्ली तथा तोतापरी आम का कुल व्यापार क्रमशः 175.94, 21.70, 82.8, 172.7 तथा 47.75 हजार मैट्रिक टन था। भारत ने 200.54 करोड़ रुपये का 74.76 हजार मैट्रिक टन आम का निर्यात किया। पिछले वर्ष की तुलना में जब निर्यात 83.70 हजार मैट्रिक टन सर्वोत्तम रहा, वास्तव में 11 प्रतिशत निर्यात कम हुआ। आम निर्यातक देशों की संख्या में वृद्धि के बावजूद आम उत्पादों में भी विगत वर्ष के 314.41 हजार मैट्रिक टन की तुलना में 236.34 हजार मैट्रिक टन निर्यात हुआ जो 25 प्रतिशत कम था।

बाजार में कुल 12.71 हजार क्विंटल अमरूद बिक्री हेतु आया जो पिछले वर्ष की तुलना में 9% ज्यादा था। देश से कुल 11.34 करोड़ रुपये का 0.52 हजार मैट्रिक टन अमरूद का निर्यात किया गया जबकि विगत वर्ष 30.44 करोड़ रुपये का 1.69 हजार मैटिक टन निर्यात किया गया था। भारत से अमरूद के दो मुख्य पदार्थ जेली एवं पेय का निर्यात किया गया। वर्ष के दौरान लखनऊ के बाजार में कुल 8.35 हजार टन पपीता आया।

## प्रौद्योगिकी हस्तान्तरण

अधिदेशित फसलों में महसूस किये जा रहे नानाविध समस्याओं से संबंधित अनुसंधान कार्यों के अलावा, संस्थान द्वारा किसानों तक प्रौद्योगिकियों को पहुँचाने पर भी जोर दिया जा रहा है। कार्यक्रम के अनसुार, सस्थान ने एक गोष्ठी का आयोजन किया जिससे 500 किसान लाभान्वित हुए।

प्रौद्योगिकियों को प्रदर्शनियों, वैज्ञानिक-उत्पादक परस्पर संवाद, किसानों, प्रसार कार्यकर्ताओं/विद्यार्थियों के लिए लाभकारी भ्रमण, परामर्श, डॉक द्वारा जानकारी, किसानों की हेल्पलाईन कॉल, प्रशिक्षण कार्यक्रम तथा टी.वी./रेडियो वार्ता द्वारा बताया गया।

संस्थान के वैज्ञानिकों, प्रशासनिक एवं तकनीकी अधिकारियों को मानव संसाधन के क्षेत्र में विशिष्ट कौशल को सशक्त करने के लिए राष्ट्रीय स्तर पर विभिन्न एजेंसियों द्वारा आयोजित विभिन्न कार्यक्रमों में उनके संबंधित क्षेत्र में कौशल उन्नयन के लिए प्रतिनियुक्त किया गया।



वर्ष 2010-2011 के दौरान संस्थान द्वारा कृषकों के लिए 10 प्रशिक्षण कार्यक्रमों का आयोजन किया गया। संस्थान के 1050 किसान, अधिकारी एवं विद्यार्थियों द्वारा भ्रमण किया गया।

## बठैकें

डॉ. डी. एस. राठौर, पूर्व कुलपति, सी. एस. के. हिमाचल प्रदेश कृषि विश्वविद्यालय, पालमपुर की अध्यक्षता में संस्थान की पंद्रहवीं आर. ए. सी. बैठक 28-29 जून, 2010 को आयोजित की गयी।

संस्थान की अठ्ठाईसवीं एवं उन्नतीसवीं आई. आर. सी. की बैठकें 20-22 तथा 25-26 अक्टूबर एवं 13-16, 18 और 20 दिसम्बर, 2010 को आयोजित की गयीं।

## पुरस्कार एवं सम्मान

संस्थान के वैज्ञानिकों को विभिन्न वैज्ञानिक/विकास एजेंसियों द्वारा उनके कार्यो के लिए सम्मान दिया गया। संस्थान की राजभाषा पत्रिका को एच.ए. एल., लखनऊ में सम्पन्न नगर राजभाषा कार्यान्वयन समिति की बैठक के दौरान प्रथम पुरस्कार प्रदान किया गया। इसके अलावा संस्थान को हिन्दी में उत्तम कार्य करने के लिए 6ठा पुरस्कार प्राप्त हुआ।

सस्थान के निदशेक/वैज्ञानिकों ने विभिन्न संगोष्ठियों/परिसंवादों /सम्मेलनों/बैठकों में कार्यदल/पाठ्यवृत्त/अनुवीक्षण समितियों तथा जरनलों के संपादन मंडलों में अध्यक्ष, सह-अध्यक्ष, समन्वयक, रैपोटियर तथा सदस्य के रूप में कार्य किया।

## अन्य गतिविधियाँ

संस्थान द्वारा दिनांक 25-28 जून, 2010 को बायोडायवर्सिटी इन मैंगों फॉर सस्टेनेबल लाइवलीहुड विषय पर राष्ट्रीय सेमिनार का आयोजन किया गया। इस उद्घाटन डॉ. एच.पी. सिंह, उपमहानिदेशक (बागवानी) द्वारा किया गया। इसमें 200 शोधकर्ता सम्मिलित हुए। संस्थान ने दिनांक 4 अक्टूबर 2010 को सहभागी परामर्श बैठक का भी आयोजन किया गया। इसमें 100 किसानों ने सक्रियता से हिस्सा लिया। इस अवसर पर संस्थान के वैज्ञानिकों ने सहभागियों के कृषि संबंधी प्रश्नों का उत्तर दिया। संस्थान ने ख्याति प्राप्त दशहरी गाँव में दिनांक 27 फरवरी 2010 को शोकेसिंग ऑफ एग्रीकल्चर टेकनोलोजीज एण्ड मैंगो गोष्ठी का आयोजन किया जिसमें लखनऊ जिले के माल, मलिहाबाद, काकोरी एवं बक्शी का तालाब ब्लॉक के 400 से ज्यादा सहभागी सम्मिलित हुए। इसमें कृषि उत्पादन, उत्पादकता, तुड़ाई पूर्व एवं उपरान्त प्रबंधन, मूल्य श्रृंखला प्रबंधन, निर्यात, वित्त व्यवस्था आदि विषयों पर विस्तृत चर्चा की गयी।

डॉ. एस अय्यपन, सचिव डेयर तथा महानिदेशक भारतीय कृषि अनुसंधान परिषद, नयी दिल्ली ने दिनांक 19 नवम्बर, 2010 को संस्थान का भ्रमण किया। अपने भ्रमण के दौरान उन्होंने मीडिया संसाधन केन्द्र की स्थापना की तथा संस्थान के प्रयोगशाला-सह-प्रशासनिक भवन का शिलान्यास भी किया। अपने संबोधन में उन्होंने संस्थान में किये जा रहे कार्यों की प्रशंसा की तथा यह भी आशा की कि और अधिक प्रयास किये जाने की आवश्यकता है।

## राजस्व

वर्ष 2010-11 के दौरान दिये गये लक्ष्य से अधिक 52.72 लाख रूपये राजस्व के रूप में एकत्र किये गये।

# 2. EXECUTIVE SUMMARY

## Research accomplishments

### Genetic resources management

Thirty five new accessions of mango were collected from U.P., Goa and Bihar and added in field gene bank raising the total collection to 732. Amongst the germplasm conserved at the institute, 190, 150 and 45 accessions were evaluated for fruit, leaves and panicles and DUS parameters, respectively. The population fingerprinting of mother block of mango cvs Mallika, Dashehari, Langra and Amrapali was undertaken through RAPD and SSR markers. Three primers, *viz*. FMID073, HMID074 and FMID2007, among 6 SSR markers resolved the varietal differences and established homogeneity among the mother block entries. Barcoding, a visual representation of data allowing easy detection of genotypic differences, was carried out for commercial mango cultivars of North India using 18 SSR loci. Ninteen cross combinations involving 45437 flowers on 11600 panicles were effected for the development of recombinations in mango with specific traits like regular bearing, dwarfness, malformation resistance and peel colour. For evaluation of $F_{-1}$ progeny, 187 hybrid seedlings obtained from 20 combinations attempted during 2008-09 were planted in the field. Among 21 cross combinations attempted during 2009-10, fruits from only four cross combinations were obtained. Out of 870 mango hybrids evaluated for fruit characters, hybrid 949, 1084 and 2803 were found promising for the traits in focus. The polyembryonic accessions and varieties of mango were raised in nursery and nucellar and zygotic seedlings were separated and planted. Maximum germination was recorded in Kurukkan followed by Peach.

Fourteen new accessions of guava were collected from Allahabad, Bangalore and Malda. A total number of 652 hybrid progenies from 5 cross combinations and one open pollination were planted in the field for identification of pink pulp colour in fruits. One hundred and twenty hybrid seedlings were evaluated for seed hardiness. Genetic uniformity of guava cv. Lalit plants regenerated *in vitro* was confirmed using 8 RAPD and 5 SSR primers.

Out of sixteen accessions of papaya, Pusa Delicious, CO-7 and accession M-1 (Selection) performed well in terms of yield and quality, whereas the fruiting started at 0.3 m height in cv. Pusa Nanha followed by 0.6 m in cv. Pusa Delicious. Two hundred and sixty-three fruits were obtained from 405 flowers sibmated in different cultivars/accessions under controlled conditions for obtaining homozygosity. One hundred and twelve crosses in papaya were effected in four combinations for developing desirable characters and 76 fruit sets were obtained. The highest yield with bigger fruit size was obtained from the hybrid progeny of Pusa Delicious x CO-7.

Out of 35 litichi accessions conserved in field gene bank, flowering was observed only in 7 accessions. Precocity was observed in Kasailiya though the duration of panicle emergence and flower opening was longer (39 days). Genetic diversity investigated in 12 select litchi cultivars using 20 RAPD markers, prominent amplicons of reproducible nature were produced by 15 primers. Cluster analysis performed using NJ and 4 PGMA methods indicated that cvs Shahi, Dehrarose and Rose Scented were grouped in one cluster. Out of twenty-two accessions of aonla collected from Madhya Pradesh and planted during 2007, seven accessions came into fruiting and CISH A-13 recorded maximum yield and CISH A-2 had maximum ascorbic acid (528 mg $100g^{-1}$ pulp).

Considerable variation in morphological characters in bael was observed in the seedlings raised from the promising germplasm, collected from U.P., Bihar and Jharkhand, after 8 years of planting. Seven promising accessions of jamun were evaluated for physico-chemical attributes. Methanolic extracts of jamun seeds was identified on the basis of bioactivity for further evaluation of diabetes management in collaboration with M/s Natural Remedies, Bangalore. On the basis of morphological and physio-chemical characters CISH K-10 and CISH K-11 of khirnee, CISH Kr-11 of karonda, CISH M-8 of mahua, CISH Wa-17 of wood apple and CISH Ch-3 of chironji were identified as superior accessions.

### Improved crop production technologies

Mango tree height was maximum (5.40 m) in the highest planting density (1600 plants $ha^{-1}$), while the yield (15.55 MT $ha^{-1}$) was higher in medium planting (400 plants $ha^{-1}$) as compared to 4.80 m and 4.60 MT $ha^{-1}$, respectively, in the recommended planting (100 plants $ha^{-1}$). Diffused radiation below the canopy was

maximum (1097 µmol$^{-2}$ s$^{-1}$) in 100 plants ha$^{-1}$, while it was 989 µmol $^{-2}$s$^{-1}$ in 400 plants ha$^{-1}$ in 18 years old Dashehari orchard. The diffused radiation below the canopy at 135-180$^{o}$ azimuth angles (S-E quadrant of canopy) was the highest (94.29 µmol$^{-2}$ s$^{-1}$), while LA1 was minimum in medium density planting (400 plants ha$^{-1}$). South-east quadrant of canopy was found more productive as compared to the other quadrants. Soil and leaf nutrient analysis of high density orchard of Dashehari indicated that the soil values were below the critical level of nutrients and leaf samples were Zn deficient. The double hedge row system in high density planting of Dashehari provided highest yield (8.15 MT ha$^{-1}$) as compared to minimum (4.08 MT ha$^{-1}$) in square system. Crown thinning and crown reduction in 24 years old Mallika resulted in 88.4 and 80.5 kg tree $^{-1}$ yield, respectively.

Substrate manipulation through FYM, NPK, *Azotobacter*, *Trichoderma harzianum* and PSM and organic mulch effected an increase in organic carbon content from 0.32 to 0.44 per cent. The contents of macro- and micro-nutrients increased where FYM and/or vermin-compost and NPK with mulching were applied. Total dehydrogenase activity in soil increased under organics, NPK and bio-fertilizers applications as compared to their respective controls. Application of NPK fertigation during September and second week of May in Dashehari and Langra orchards augmented the availability of phosphorus, potassium, zinc, copper, manganese and iron. The drip irrigation system provided higher yields in Dashehrai and Langra (54.4 and 43.4 kg plant $^{-1}$) as compared to basin irrigation (35.84 and 25.84 kg plant $^{-1}$).

The tendency of alternate bearing rhythm in Chausa and Langra could be reduced significantly by the application of paclobutrazol but their bienniality behavior could not be changed. Paclobutrazol also showed promotive effects on total microbiol population and dehydrogenase activity in soil. Persistence of paclobutrazol was observed even after two years of its application. Out of 8 polyembryonic seedlings subjected to salt induced stress conditions, only Nekkare and Bappakai could survive up to 50 days under high stress (2d m$^{-1}$). Membrane stability index and chlorophyll fluorescence reduced drastically as salinity increased. Nekkare indicated tolerance to salt induced stress .

The guava plants cv. Lalit regenerated through somatic embryogenesis incubated in 100 per cent culture filtrate of *Fusarium solani* started expressing leaf browning and wilting occurred within 14 days with an increase in symptoms intensity over time . The plants kept in 50 and 75 per cent culture filtrate also showed browning within 14 days but leaf shedding was observed on 21 days. Substrate manipulation through FYM, NPK, *Azotobacter*, *Tricoderma harzianum*, PSM and organic mulch in guava cv. Shweta resulted in higher yield (33.05 kg tree $^{-1}$) with bigger size fruits in second year of fruiting. The pooled average of dehydrogenase activity in soil was maximum where all inputs except PSM were applied. Similarly, substrate manipulation in aonla resulted in higher growth and organic carbon build up in soil.

## Pests and diseases management

The first emergence of hopper, *Idioscopus clypealis,* was recorded on March 5, 2011 when temperature and relative humidity ranged between 12 to 29$^{0}$C and 33 to 81 per cent**.** The population of all the three species of hoppers, *viz. I. clypealis*, *I. nitidulus* and *Amritodus atkinsoni,* were higher during March-April and could be controlled by the sprays of spinosad 45% SC (1 ml l$^{-1}$), acephate 75%, SP (1.5 g l$^{-1}$) or thiomethaxom 25% WG (0.2 g l $^{-1}$) . The population of mealy bug, thrips and fruit fly exhibited peaks during January, April-May and June, respectively. Out of 40 bacterial colonies isolated from the soil of vegetable/fruit crops, only 4 isolates were found to impact the mortality of juveniles of rootknot nematode. The centrifuged and ultra filtered culture filtrate of bacteria *Paenobacillus polymyxa* showed negative impact on the juveniles (60%) within 48 to 72 hrs of exposure at lower ambient temperature (12.5 to 17.5 $^{0}$C).

Diversity analysis of 30 isolates of anthracnose (*Colletotrichum gloeosporioides*) based on Euclidian Distance, indicated their clustering into two groups, *viz.* Cluster I (North Indian isolates) and Clusters II (North-East isolates). A multiplex PCR with four sets of primer pairs for *C. gloeosporioides* was optimized. Four specific bands of 235, 380, 531 and 560 bp sizes representing glutamine synthetase, *C. gloeosporioides* species specific and pectate lyase B gene along with universal ITS 1-4 fungi specific primers for ITSrDNA genes indicated uniform amplification in a single multiplex PCR. ITS and PCR RFLP based molecular characterization could not differentiate *Fusarium oxysporum,* wilt causing organism in guava, at species level. Specific detection of *Fusarium* spp. carried out with ITS 1F and ITS 1R designed primer pairs indicated its presence as a product of 230 bp. *Trichoderma harzianum* could be mass multiplied on the extracts of neem leaves (10$^{6}$ cfu g$^{-1}$) and banana psuedostem (10$^{6}$ cfu g $^{-1}$).

## Post-harvest management and value addition

A low cost portable type of ripening chamber suitable for 500 kg fruits was designed and developed. Dashehari mango fruits treated with bio-agent (*Saccharomyces cerevisiae,* $10^8$ cells $ml^{-1}$) and packed in 200 gauge LDPE (0.2% vent.) bags had slower development of carotenoids in pulp as compared to fruits treated with bio-agent on the $8^{th}$ day of storage. Based on sensory evaluation, H-1884 was found to be better hybrid followed by H-1750 and H-1759 for pickle preparation. Among eleven mango varieties/hybrids evaluated for pulp and RTS beverage potential, H-1090, H-1091 and Pusa Arunima were found better over others. Totapuri and Dashehari slices, pretreated with $CaCl_2$ and packed in LDPE pouches, could be stored up to 10 and 11 days, respectively, at $8^0$ C. Osmo-freeze dried mango slices prepared from fruits of cvs Dashehari and Totapuri withdrawn after 5 days of storage were better in quality. Mango pulp enriched cookies were developed. Mango wine containing 10 per cent alcohol was prepared from cvs Dashehari, Langra and Chausa. Wine prepared from Langra contained maximum ascorbic acid (21.8 mg 100 $ml^{-1}$) and tannins (72.0 mg 100 $ml^{-1}$). Bio-ethanol having 0.96g $l^{-1}$ density, 41 °C flash point, 56 proof alcohol and 0.30 mPa. viscosity at 30 °C was produced from mango peel using *Saccharomyces cerevisiae.* Mango stone shell was utilized for making paper and plyboard. Waiting period for carbosulfan after pre-harvest spray on mango fruits was found to be 84 days.

A guava harvesting device with harvesting efficiency of 250 fruits $hr^{-1}$ has been developed. Among five guava varieties/hybrids evaluated for processing potential best beverage was obtained from cv. Spear Acid. An yield of 38.4 per cent of osmo-freeze dried guava cv. Lalit slices was obtained after approximately 8 hours of drying time. The dried slices contained 849 mg $100g^{-1}$ of ascorbic acid and 22.73 mg $100g^{-1}$ of lycopene. An integrated protocol has been worked out for extraction of oil, pectin, fibre and lycopene from pink guava. The yield of lycopene was found to be 4.2 mg 100 $g^{-1}$ of pulp. Cookies enriched with guava and bael pulps were developed.

Anthocynin rich spray dried aonla powder was prepared by blending it with beet root powder. A herbal formulation (dip type) was developed using aonla processing waste as major ingredient that could be used as hot beverage.

## Market analysis and export

Mango disposal from Lucknow region touched a 5 year high at 68.86 thousand MT during 2009-10. The arrival pattern of mango in Lucknow market indicated that the total trading in mango in Lucknow region during 2010 was 86.70 thousand MT as against only 35.02 thousand MT during the previous year. The total trading of Dashehari, Langra, Chausa, Banganpalli and Totapuri fruits in all the markets of the country were found to be 175.94, 21.70, 82.8, 172.97 and 47.75 thousand MT, respectively. India exported 74.46 thousand MT of mangoes worth Rs. 200.54 crore. The exports actually declined by 11 per cent over the all time high export of 83.70 thousand MT during the previous year. The country exported 236.34 thousand MT of all mango products as compared to 314.41 thousand MT during the previous year depicting a decline of about 25 per cent, even though the list of countries has expanded. The total arrival of guava during 2010-11 was 12.71 thousand quintals, which was about 9 per cent higher than the previous year arrivals. The country exported only 0.52 thousand MT of guava worth Rs. 11.34 crore as against 1.69 thousand MT of guava worth Rs. 30.44 crore during the previous year. Jelly and RTS beverage were the two major products of guava exported from India. A total of 8.35 thousand MT of papaya was received in Lucknow during the year.

## Technology transfer

Apart from targeted research in the area of crop improvement, crop production, crop protection and post-harvest management, gamut of challenges were encountered in the mandate crops. The institute focused on dissemination of technologies to the end users. Institute organized different theme oriented programmes in which about 500 farmers/trainers were sensitized. The institute also participated in a number of state as well as national level events and addressed the problems of farmers through its improved technology capsules. Technology showcasing through demonstrations, scientists-farmers' interactions, exposure visits for the benefit of farmers, extension workers/students, counseling, postal queries, farmers helpline call, training programmes and TV/radio talks were undertaken. During the year, 1460 farmers and officials were trained through targeted training programmes. A total of 14 thematic training programmes were organized during the period. Scientists, administrative and technical officers of the

institute were deputed to different programmes organized by national agencies for envisaging upgradation of human resource.

## Meetings

Fifteenth meeting of the RAC of the institute was organized under the Chairmanship of Dr. D.S. Rathore, Ex-Vice Chancellor, C.S.K. Himanchal Pradesh Krishi Vishwavidyalaya, Palmpur from June 28-29, 2009. Twenty-eighth and twenty-ninth Institute Research Committee meetings were held from October 20-22 and 25-26 and December 13-16, 18 and 20, 2010 to review the progress made in ongoing research projects and approval of technical programmes for the next year. Need for re-orientaion of research programmes in harmony with emerging needs and team approach was highlighted.

## Awards and recognitions

Scientists of the institute received recognitions from different scientific / developmental agencies. Director/Scientists of the institute also functioned as chairman, co-chairman, coordinator, rapporteurs and members in different seminars/symposia/ conferences/meetings, taskforce, curriculum/ monitoring committees and editorial boards, etc., 'Udyan Rashmi', Rajbhasha Patrika of the institute was awarded 1st prize by the Nagar Rajbhasha, Karyanvayan Samiti, Lucknow at its half-yearly meeting held at HAL, Lucknow. The institute also got 6th prize for carrying out commendable work in Hindi by the Nagar Rajbhasha, Karyanvayan Samiti, Lucknow.

## Linkage and collaboration

During the year, the institute signed two MOUs with Integral University, Lucknow, and Sardar Vallabhbhai Patel University Agriculture & Technology, Meerut besides strengthing the ongoing research, development and educational programmes with Sam Higginbothom Institute of Agriculture Technology and Science, Allahabad, APS University, Rewa, Babasaheb Bhimrao Ambedkar University, Lucknow, Bundelkhand University, Jhansi, and Lucknow University, Lucknow for facilitating capacity building initiatives through pursuing M.Sc. and Ph.D. degrees of students.

## AICRP/PFDC

The Project Coordinator's Cell of All India Coordinated Research Project on Subtropical Fruits is located at the institute. The Cell's activities in coordinating research on crop improvement, production and protection (mango, guava and litchi) were implemented at 18 centres located at SAUs and ICAR institutes. The Precision Farming Development Centre organised Summer School and different training programmes for farmers and orchardists. Two thousand six hundred farmers were trained through these training programmes.

## Other activities

The institute organized the National Seminar on Biodiversity in Mango for Sustainable Livelihood at its Rehmankhera Campus from June 25-28, 2010. The Seminar, inaugurated by Dr. H.P. Singh, DDG (Hort.), was attended by more than 200 researchers. The institute also organized a Stakeholder's Consultative Meet on October 4, 2010. More than 100 farmers actively participated in the Meet. On this occasion the scientists of the institute responded to the queries of the stakeholders. The institute organized a Showcasing of Agricultural Technologies and Mango Gosthi at the famous Dashehari village on February 27, 2011. More than 400 stakeholders from Malihabad, Mall, Kakori, and Bakshi-ka-Talab blocks of Lucknow district interacted among themselves on various pertinent issues of production, productivity, pre- and post-harvest management, value chain management, exports, finance, etc.

Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR visited the institute on November 19, 2010. He inaugurated the Media Resource Centre besides laying down the foundation stone of the extension wing of Laboratory-cum-Administrative Building of the institute. In course of his address to the scientists, technical, administrative as well as supporting staff of the institute, he appreciated the research work being done but firmly believed that plenty still needs to be done. Hindi Chetna Mass was organized from September 14 to October 12, 2010 wherein different programmes including competitions and cultural activities for the promotion of official language were held and prizes distributed.

## Revenue generation

A total of Rupees 52.72 lakhs was generated by the institute during the financial year 2010-11.

# 3. INTRODUCTION

## The institute

The Central Institute for Subtropical Horticulture (CISH) was started as Central Mango Research Station on September 4, 1972 under the aegis of the Indian Institute of Horticultural Research, Bangalore. The Research Station was upgraded to a full-fledged institute and named as Central Institute of Horticulture for Northern Plains on June 1, 1984. The institute later renamed as Central Institute for Subtropical Horticulture (CISH) on June 14, 1995 continues to serve the nation on different research and development aspects of mandated subtropical fruits. In recent years, the institute has started crop diversification strategies with a view to approach integrated farming concept. The institute has two experimental farms located one each at Rehmankhera, approximately 25 km away from the city, and at Rae Bareli (R.B.) Road right in the city of Lucknow. The experimental farm at Rehmankhera has an area of 132.5 ha comprising 4 blocks (block I-15.5 ha, block II-35.5 ha, block III-37.42 ha & block IV-44.08 ha), while R.B. Road campus has an area of 13.2 ha. To meet the emerging challenges in frontier areas of research on subtropical fruits, the institute has modern nursery facilities, well established orchards and fully equipped laboratories. Simultaneously, concerted endeavours for human resource development through capacity building are also going on.

The institute has in place MOUs to facilitate capacity building avenues with Integral University, Lucknow, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad, Babasaheb Bhimrao Ambedkar University, Lucknow, Bundelkhand University, Jhansi and Lucknow University, Lucknow for pursuing M.Sc. and Ph.D. degrees of their students at this institute. Institute has also been recognized by IGNOU, New Delhi as one of the study centres for offering one year Diploma course on Value added products from fruits and vegetables and a Certificate course on Organic farming. National Horticulture Mission has also identified the institute as a nodal centre for imparting training on rejuvenation of old and senile mango orchards and meadow orcharding in guava. The institute has a well established scientific nursery unit producing quality planting material of mango, guava, aonla and bael for supply to farming communities and backstopping Krishi Vigyan Kendra for establishing mother blocks. The institute renders other quality services to the growers, *viz.* responding to queries on orcharding problems through phone-in-live programme (0522-2841082 every Friday from 10.30 am to 4.00 pm), diagnostic services of soil and nutrient constraints, pests and diseases problems, on-farm visits, production and supply of bio-control agents, hand holding of KVKs and other agricultural/horticultural universities including the one in Nagaland and other stakeholders. The institute has been actively partnering with the National Horticulture Mission and National Horticulture Board for its outreach activities of promoting integrated development of horticulture in the region.

During the period under report, two stakeholders consultative meetings were organized and the key issues of stakeholders were integrated in the reoriented research programme which was also reviewed by the Research Advisory Committee.

A National Seminar on Mango biodiversity for livelihood was organized at Rehmankhera campus of the institute from June 25-28, 2010 for the benefit of the stakeholders of the country. Support to the infrastructure and manpower for accomplishing the envisaged targets is also derived from twenty three number of externally aided projects that included ICAR/UPCAR/UPCST/DBT/National Medicinal Plants Board sponsored, NAIP and two foreign aided projects.

## Mandate

The institute has been functioning with the following mandates to:

- Undertake basic and applied research to enhance productivity and develop value chain for major and minor subtropical fruits.
- Act as national repository of above fruit crops.
- Act as a centre for human resource development and provide consultancy to stakeholders.
- Develop linkages with national and international agencies to accomplish the targets.



## Objectives

The mandates of the institute are being targeted through the following objectives :

- Management of genetic resources of mandate fruit crops and their conventional and molecular characterization.
- Crop improvement through breeding and genetic engineering.
- Enhancing productivity through improving quality of planting materials using modern propagation techniques and rootstocks, precision farming practices including mechanization and management of biotic and abiotic stresses.
- Reduction in post-harvest losses through improved post-harvest management practices, value addition and diversification of products.
- Human resource development, transfer of technology and evaluation of its socio-economic impacts.h
- Data storage and retrieval on all aspects of mandate crops.

## Past achievements

### Crop improvement

- The institute is conserving the world's largest germplasm collection of mango numbering 732 accessions collected from different indigenous and exotic sources.
- A regular bearer mango hybrid CISH-M-1 (Amrapali x Janardhan Pasand) was released as Ambika. The fruits have yellow colour with red blush, firm pulp and scanty fibres. It has good potential for domestic and export markets.
- Another regular bearing mango hybrid H-39 (Amrapali x Vanraj) having yellow peel colour with red blush, firm pulp and high TSS (24 $^0$B) and carotenoid gcontents was released as Arunika.
- The mango hybrid H-1084 was found promising which is under evaluation.
- Mango cv. Elaichi, free from floral malformation, is being used as a gene source in trait-specific breeding programme.
- Molecular characterization of 150 mango cultivars indicated that the germplasm accessions could be categorized into 3 broad groups, *viz.* northern, eastern and the other representatives both northern and eastern.
- A South Indian mango cv. Totapuri was found regular bearer and good yielder under Lucknow conditions.
- One hundred and fourteen accessions of guava and 7 *Psidium* spp. are conserved in the field gene bank.
- Two open pollinated seedling selections of coloured guava, CISH-G-3 and CISH-G-4, have been released as Lalit and Shweta for commercial cultivation. Fruits of Lalit are attractive, saffron yellow with red blush in colour, medium size and firm with pink pulp. It yielded 24 per cent higher than the popular variety Allahabad Safeda. Shweta has subglobose fruits with attractive pink blush white pulp, few soft seeds, high TSS (14 $^0$B) and good yield potential.
- Institute has conserved 54 accessions of bael in the field gene bank. Two promising selections CISH-B-1 and CISH-B-2 released by the institute have good table and processing qualities.
- The institute has conserved germplasm accessions of banana (7), papaya (32),litchi (35) and different underutilized fruits representing aonla (35), karonda (30), jamun (43), khirnee (38), tamarind (24), mahua (30), chironji (8), woodapple (17), mulberry (10), cape gooseberry (3), custard apple (8), carambola (2), lasora (3) and roseapple (2).

### Crop production

- The propagation protocols under polyhouse conditions for underutilized fruits were standardized.
- High density planting (400 plants ha$^{-1}$) in Dashehari mango increased the yield by 3 to 4 folds (15 tons ha $^{-1}$) as compared to conventional planting (100 plants ha$^{-1}$).
- Crown thinning in mango resulted in higher yields of 80 kg per plant in Mallika in the following year as compared to 55 kg in control.
- Rejuvenation techniques for old and unproductive mango and guava trees have been standardized and demonstrated in farmers' fields.
- Techniques for meadow orcharding and canopy management in guava have been standardized, recommended and popularised.

- Mango based cropping system has been developed and cowpea-potato system gave higher monetary returns in 10 years old orchard. Soil application of paclobutrazol @ 4 g tree$^{-1}$ (3.2 ml m$^{-1}$ canopy diameter) could manage the problem of irregular bearing in 'Dashehari' resulting in increased flowering and fruiting during off year. Mulching along with application of paclobutrazol (1.6 ml m$^{-1}$ canopy diameter) was also found effective in improving yields.
- Soil application of 1kg each of N, P and K (tree$^{-1}$ year$^{-1}$) to 10 years old 'Dashehari' trees increased the yield. Trench application of fertilizers around the tree in July was found efficient.
- Planting papaya at a spacing of 2 x 1.8 m in the month of September produced highest yields (55 kg per plant) with good quality fruits in 'Pusa Delicious'.

## Crop protection

- IPM modules for mango insect pests and diseases have been developed and standardized. Entomogenous fungus, *Verticillium lecanii*, egg parasites, *Agrostocetus* spp., *Gomatocerus* sp., and *Polynema* spp., and predators, *Chrysopa lacciperda*, *Mallada boninensis* and *Coccinella septumpunctata* were recorded parasiting/ predating on mango hoppers.
- Critical limits of weather parameters (temperature and relative humidity)were identified for forecasting the epidemics of hoppers and powdery mildew.
- Mango bacterial canker disease (MBCD) could be checked by spraying of streptocyline (200 ppm) at 10 days interval. Antagonists *Bacillus coagulans*, *Pseudomonas* spp. and *Acenetobacter* spp. were found potent bio-control agents for MBCD pathogen.
- Post-harvest diseases of mango, *viz*. anthracnose and stem end rot, could be controlled by dipping the fruits in 0.025 per cent carbendazim in hot water (52±1°C) for 15 minutes.
- *Gliocladium roseum* was found associated with guava wilt disease, however, *Fusarium oxysporum* f.spp.psidii was found more potent.
- *Aspergillus niger* (AN17), *Trichoderma harzianum*, *T. viride* and *Penicillium citrinum* were found effective in integrated management of guava wilt.
- A progeny of the cross ($F_1$) between *Psidium molle* x *P. guajava* was identified as resistant rootstock against guava wilt.
- Four endophytic bacteria and lac based compounds were found effective against rootknot nematode, whereas the potency of entomopathogenic nematode has been demonstrated against insect pests under *in vitro* conditions.

## Post-harvest management

- Maturity indices for commercial mango cvs Dashehari, Langra, Mallika, Amrapali and Chausa were worked out.
- A simple low cost mango harvester with a harvesting capacity of 800 to 1000 fruits per hour was fabricated and demonstrated.
- Three temperature gradients for storage, *viz*. 12, 15 and 10 °C, were worked out to enhance the shelf life of Dashehari, Langra and Chausa fruits up to 3, 2 and 3 weeks, respectively.
- Uniform ripening of early harvested mangoes could be achieved by dipping of fruits in 750 ppm ethrel in hot water (52 ± 2 °C) for 5 minutes.
- Corrugated fiber board (CFB) boxes of 2 and 4 kg capacities were fabricated for packaging and transportation of mango and guava fruits.
- Pre-harvest sprays of calcium chloride di-hydrate (2%) at 10 days interval was found effective to reduce jelly seed formation in mango.
- Guava fruits cv. Allahabad Safeda could be stored for 28 days at 5 °C in 0.25 per cent ventilated LDPE bags.
- Methodology for preparation of raw mango squash (panna) has been standardized.
- Mango pulp sterilized at 75 to 78 °C could be stored in glass jars successfully up to 12 months under refrigeration or with 1000 ppm $SO_2$ under ambient conditions.
- Beverages prepared from blends of mango-pineapple (1:1), mango-pear (any ratio) and mango-papaya (2:1) were found organoleptically acceptable.
- Recipe for oil-less mango pickle and sweet papaya chutney have been developed with shelf life of nine months.
- The techniques for preparation of sweetened and brined (salted) aonla segments and cider (aonla and guava) have been optimized.



- Protocols for the preparation of *mahua* (*Bassi latifolia*) and mango wine were optimized.
- A good quality vinegar from mango peel could be obtained by using *Acetobacter aceti*.

## Transfer of technology

A total of 14 sponsored training programmes on production, protection and post-harvest management of subtropical fruits were organized for the benefit of orchardists and extension workers of different State Departments. Institute also provided training on different aspects of improved crop production technology in mango and other mandate fruit crops for scientists and development workers. Specialized training programme on postharvest management and value addition of mango for farm women and rural youth was organized under NAIP project. On and off-farm trainings for the benefit of farmers of Hardoi, Raebareli and Lucknow districts were organised under PFDC, Lucknow. Scientific nursery programmes on different aspects of quality planting material production were organized for target groups. Exposure visits for students and officials/farmers from different parts of the country were organised for their awareness of the technologies developed by the institute.

Technology showcasing through demonstrations, scientists-farmers' interactions, counselling, postal queries, farmers help line call and TV/Radio talks were under taken. Institute also participated in a number of state as well as national level events to disseminate improved technologies developed.

## ARIS cell

The institute has well developed ARIS cell comprising of computers, server, LAN and 4 Mbps leased line internet connection. The institute website (www.cishlko.org) has been developed to provide information about its activities to the public. The website contains detailed information on its organizational set-up, cadre, staff, ongoing research projects, achievements made, facilities available, package of practices developed for nursery management and higher productivity, technologies optimized, services offered, institute functionality and e-governance. Besides general information, it also contains media resource section where CISH technologies, farmers' advisories and alerts, videos on mango technologies and press releases are uploaded for the use of media persons and farmers/ entrepreneurs/students. The website is regularly updated with the latest information.

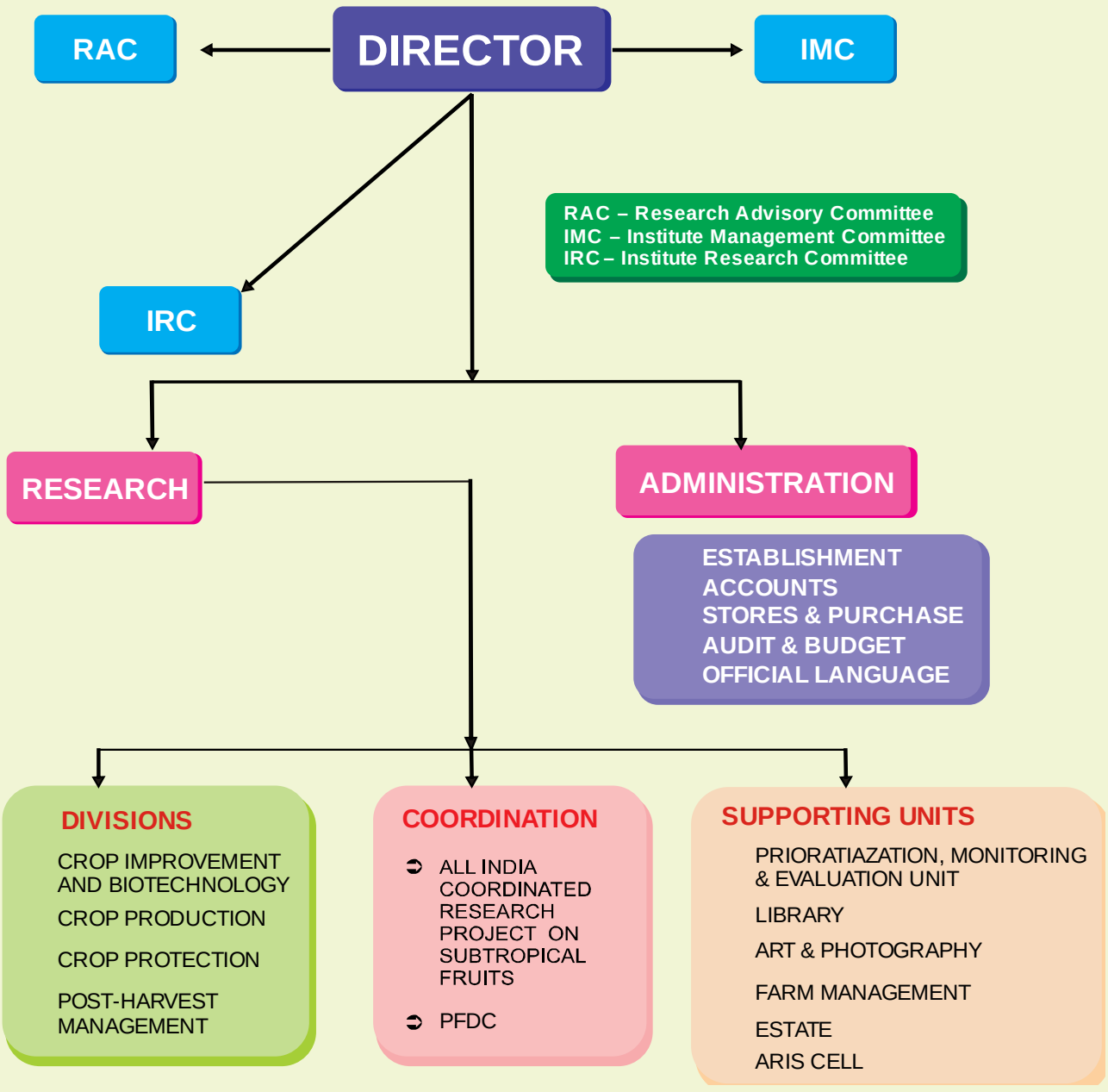
## Library

The library of the institute is catering to the requirements of the scientists, research workers and students of M.Sc./Ph.D. It is well equipped with books, periodicals, reports, reprints and CD ROMs pertaining to different aspects of subtropical horticulture and allied disciplines along with computer, internet surfing and reprographic facilities. The facility for database search has been provided through Hort. CD of CABI, AGRIS, etc., and has been automated through LSEASE software of Lybsis. The existing collection (3217) of scientific and technical books was further enriched by the addition of 177 books during the period. Apart from this, 98 books in Hindi language were also procured. The institute subscribed 62 national and 49 international journals both in printed as well as in internet version. More than 200 annual reports are received from ICAR institutes/universities/ international institutes on exchange basis which are documented.

## Organizational set-up

The institute's functioning is organized through four Divisions, *viz.* Crop Improvement and Biotechnology, Crop Production, Crop Protection and Post-harvest Management. It houses the headquarters of the All India Coordinated Research Project on Subtropical Fruits and facilitate its activities. The institute also has a Precision Farming Development Centre for promoting aspects of high-tech horticulture. (The organizational set-up of the institute is shown in organogram). Besides focusing on thematic research areas, interdisciplinary/ inter institute collaboration team approach is being harmonized for optimizing outputs.

# Organogram


RAC
DIRECTOR
IMC
RAC – Research Advisory Committee
IMC – Institute Management Committee
IRC – Institute Research Committee
IRC
RESEARCH
ADMINISTRATION
ESTABLISHMENT
ACCOUNTS
STORES & PURCHASE
AUDIT & BUDGET
OFFICIAL LANGUAGE
DIVISIONS
CROP IMPROVEMENT AND BIOTECHNOLOGY
CROP PRODUCTION
CROP PROTECTION
POST-HARVEST MANAGEMENT
COORDINATION
ALL INDIA COORDINATED RESEARCH PROJECT ON SUBTROPICAL FRUITS
PFDC
SUPPORTING UNITS
PRIORATIAZATION, MONITORING & EVALUATION UNIT
LIBRARY
ART & PHOTOGRAPHY
FARM MANAGEMENT
ESTATE
ARIS CELL

## Financial set-up

### Budget allocation & Expenditure (2010-2011)

(Rupees in lakh)

| S. No. | | Non-Plan | | Plan | | AICRP(STF) | | AP Cess Fund Projects | | Externally Aided Projects | | Revolving Fund | | NAIP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head | Budget | Expn. | Budget | Expn. | Budget | Expn. | Budget | Expn. | Budget | Expn. | Budget | Expn. | Budget | Expn. |
| 1 | a) Estt. Charges | 995.00 | 994.81 | 0.00 | 0.00 | 241.61 | 241.61 | | | | | | | | |
| | b) Wages | 23.00 | 23.00 | 0.00 | 0.00 | | | | | | | | | | |
| | c) OTA | 0.15 | 0.15 | 0.00 | 0.00 | | | | | | | | | | |
| 2 | T.A. | 6.00 | 6.00 | 14.00 | 13.99 | 4.30 | 4.30 | | | | | | | | |
| 3 | HRD | 0.00 | 0.00 | 6.00 | 5.95 | | | | | | | | | | |
| 4 | Other Charges (incl. equipment) | 97.50 | 96.65 | 237.00 | 236.68 | 54.09 | 54.07 | 2.54 | 2.19 | 240.06 | 142.20 | 40.91 | 16.88 | 110.37 | 75.41 |
| 5 | Minor Works | 0.30 | 0.29 | 0.00 | 0.00 | | | | | | | | | | |
| 6 | Major Works | 0.00 | 0.00 | 110.00 | 109.29 | | | | | | | | | | |
| 7 | AR&M | | | | | | | | | | | | | | |
| a) | Residential Buildings | 5.70 | 5.66 | 0.00 | 0.00 | | | | | | | | | | |
| b) | Office Buildings | 12.50 | 12.45 | 8.00 | 8.00 | | | | | | | | | | |
| | **Total** | 1140.15 | 1139.01 | 375.00 | 373.91 | 300.00 | 299.98 | 2.54 | 2.19 | 240.06 | 142.20 | 40.91 | 16.88 | 114.62 | 77.58 |

## Revenue receipts (2010-2011)

(Rs. in lakh)

| S. No. | Particulate | Target | Achievement |
|---|---|---|---|
| 1 | Farm Produce | | 24.45 |
| 2 | Sale of Products | | 1.18 |
| 3 | Sale of Publication/Tender Form etc. | | 1.36 |
| 4 | Guest House Charges/Licence fee/Rent | | 3.14 |
| 5 | Training/Consultancy | **37.00** | 1.95 |
| 6 | Interest of 'P' Loans | | 4.88 |
| 7 | Electric Water/Transport Charges | | 14.78 |
| 8 | Misc. Receipts | | 0.06 |
| 9 | Sale of Mango Harvester | | 0.92 |
| | **Total** | **37.00** | **52.72** |
| | **Interest on TDR** | 3.00 | 4.92 |

## Staff position (as on 31.03.2011)

| Sl.No. | Category | Sanctioned | Filled | Vacant |
|---|---|---|---|---|
| 1. | RMP | 1 | 1 | - |
| 2. | Scientific | 46 | 39 | 7 |
| 3. | Technical | 57 | 53 | 4 |
| 4. | Adminstrative | 24 | 22 | 2 |
| 5. | Skilled Supporting Staff | 44 | 35 | 9 |
| | **Total** | **172** | **150** | **22** |

## Staff changes

### Promotion

#### Administrative

1. Smt. Annapurna Gupta, SS Grade-I appointed to the post of Lower Division Clerk w.e.f. 27.04.2010.
2. Smt. Jyoti Gyanchandani, Sr. Clerk promoted to the post of Assistant w.e.f. 31.03.2011.
3. Smt. Satyawati Verma, Jr. Clerk promoted to the post of Sr. Clerk w.e.f. 31.03.2011.
4. Shri K.K. Maurya, Sr. Clerk promoted to the post of Assistant w.e.f. 31.03.2011.

### Joining

#### Scientific

1. Km. Pushpa K., Scientist (Foods and Nutrition) joined on 23.04.2010.
2. Shri Umesh Hudedamani, Scientist (Plant Breeding) joined on 23.04.2010.
3. Dr. Barsati Lal, Sr. Scientist (Agri. Extension) joined on 14.05.2010.
4. Dr. Sridhar Gutam, Sr. Scientist (Plant Physiology) joined on 27.12.2010.
5. Shri. H. Kesava Kumar, Scientist (Nematology) joined on 24.01.2011.



### Technical

Shri Neresh Chandra Verma, T-3 (Lib.) joined on 02-08-2010.

### Administrative

1. On promotion to the post of Senior Administrative Officer, Shri Firoz Khan, Section Officer, ICAR, Krishi Bhawan, New Delhi joined the post of SAO on 07.10.2010.
2. On deputation to the post of AAO, Shri A.M. Srivastava, Assistant, IISR, Lucknow joined the post of AAO on 20.10.2010.
3. On promotion to the post of Finance and Accounts Officer, Shri G. D. Amola, AF & AO, IVRI, Bareilly joined the post of F&AO on 28.03.2011.

## Superannuation

### Scientific

1. Shri R. B. L. Srivastava, Scientist(S.G.) superannuated on 30.06.2010.
2. Dr. S.R. Bhriguvanshi, Principal Scientist superannuated on 31.07.2010.
3. Shri Shashi Sharma, Principal Scientist superannuated on 31.12.2010.
4. Er. M.D. Singh, Principal Scientist superannuated on 31.01.2011.

### Administrative

1. Shri S.S. Arora, AAO superannuated on 31.07.2010.
2. Smt. K. Swarnakumari, AO superannuated on 30.09.2010.

### Supporting

1. Shri Kamta Prasad, Skilled Support Staff (Group-D) was superannuated on 22.12.2010.
2. Shri Shiv Raj, Skilled Support Staff superannuated on 31.12.2010.
3. Shri Chhotay Lal, Skilled Support Staff superannuated on 31.01.2011.
4. Shri Sadhari, Skilled Support Staff superannuated on 31.03.2011.
5. Shri Babu Lal, Skilled Support Staff superannuated on 31.03.2011.

## Voluntary retirement

### Scientific

1. Shri A. K. Shukla, Principal Scientist voluntarily retired from service on 01.08.2010.

### Administrative

1. Shri A. K. Talwar, Assistant retired voluntarily from service on 06.07.2010.

### Supporting

1. Shri Radhay Lal, Skilled Support Staff voluntarily retired from service on 28.02.2011.

# 4. RESEARCH ACHIEVEMENTS

## Crop improvement and biotechnology

### Mango (*Mangifera indica* L.)

#### Germplasm collection, characterization, evaluation and documentation

***Collection*:** Thirty five accessions, *viz*. Faizabad Safeda, Bhelnika and Bhari from Faizabad, Sadabahar from Lucknow, Cardozo Mankurad from Goa and thirty from Bihar, were collected during the year.

***Characterization*:** One hundred and ninety accessions of mango were evaluated for fruit characteristics. One hundred and fifty accessions were evaluated for old and new leaves and panicle characters and 45 accessions were characterized from DUS point of view.

***Evaluation*:** One hundred and fifteen hybrids were screened against mango anthracnose (*Colletotrichum gloeosporioides*). The size of lesion pathogen varied between 10 to 25 mm on the fruit surface in a large population of $F_1$ progeny of hybrid mango. Twenty mango hybrids/varieties were evaluated for their processing potential for pickle in oil and RTS beverage. After six months of storage of pickle in oil H–1884 and H-1250 were found best in quality. Similarly, best RTS beverage was obtained from the six months stored pulp of hybrids H- 1090 and H-1091.

#### Molecular characterization

***Population fingerprinting*:** Plants of cvs Mallika, Dashehari, Langra and Amrapali mother blocks were bulked and used individually for confirming the uniformity and suitability of RAPD and SSR markers for population fingerprinting. Out of 16 RAPD primers of OPA and OPX series screened, eight primers, *viz*. OPA1, 2, 3 and 4 and OPX 2, 7, 14 and 17, produced 117 scorable bands out of a total of 159 bands with an average of 8 bands per primer. Though RAPD is non-reproducible across laboratories, very stringent conditions were employed to obtain reproducible and distinct patterns for molecular characterization of mother block candidates in mango (Fig.1). Among 6 SSR markers, three primers, *viz*. FMID 073, HMID 074 and FMID 2007, resolved the varietal difference and at the same time established homogenity among the mother block entries. Since microsatellites showed a high level of polymorphism, they are informative markers that could be used for clone identification of closely related species.

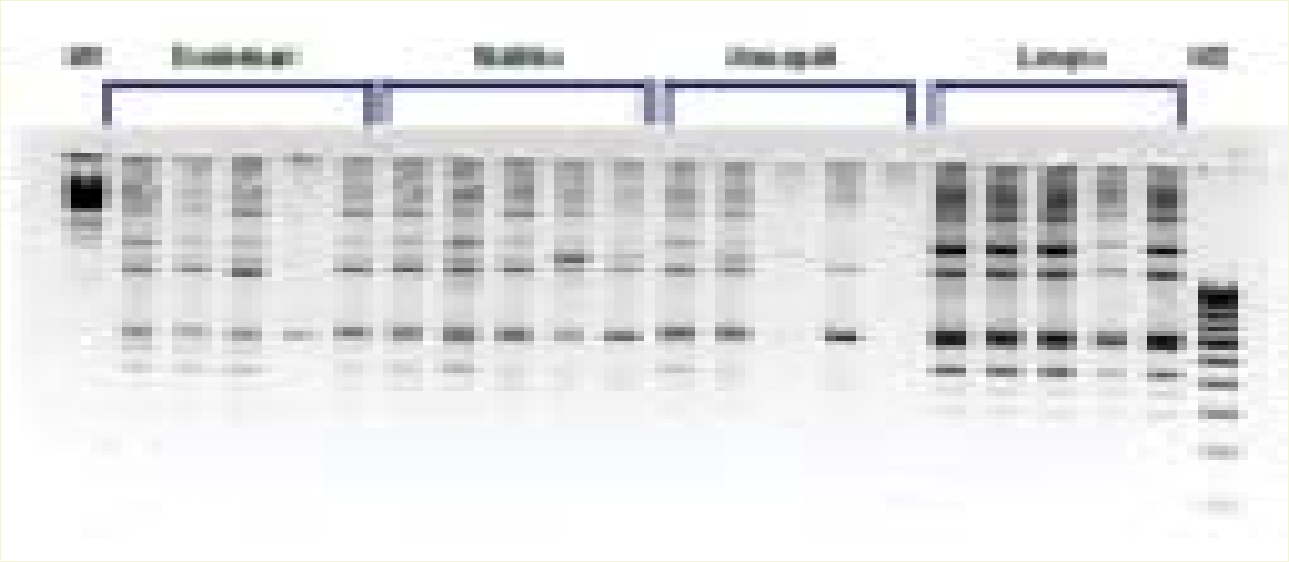


**Fig.1: Typical agarose gel profile of RAPD fragments generated by OPA 3 primer in cvs Dashehari, Mallika, Amrapali and Langra. M1- lDNA/*Eco*R I/*Hin*d III double digest, M2- 100 bp ladder**

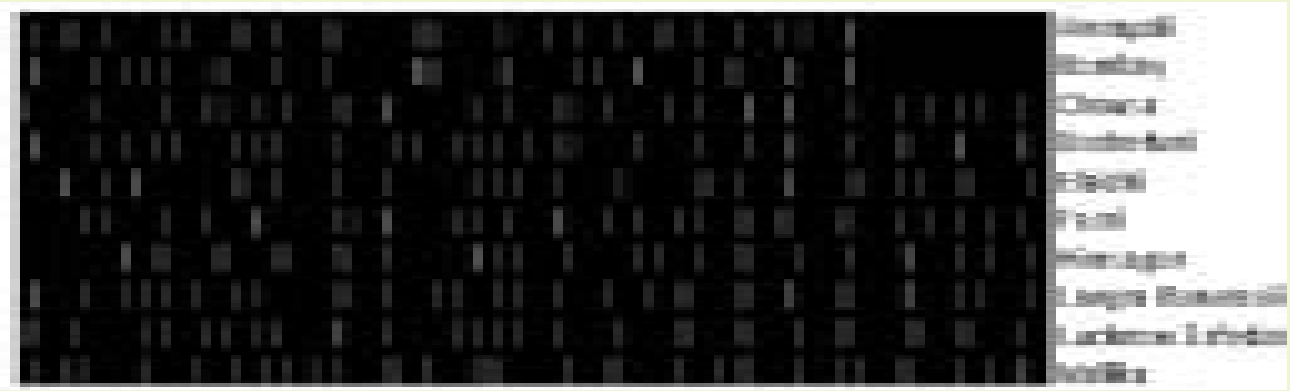


Fig.2. SSR based barcodes for selected commercial cultivars from north India.

***Development of microsatellite based barcodes*** : Important commercial cultivars from North India were used for generating microsatellite based barcodes with 18 SSR loci. The individual discriminative microsatellite bands at these loci were converted into binary matrix using Crop DNA Fingerprint Database (NBPGR, New Delhi) followed by barcode representation (Fig.2). The barcode is a visual representation of the data allowing easy detection of genotypic differences.

## Hybridization and evaluation of hybrids

***Hybridization*:** A total number of 45437 flowers were crossed on 11600 panicles using 19 cross combinations for developing varieties with regular bearing, malformation resistance, dwarfing and peel colour (Table 1).

***Establishment of hybrids*** **:** Out of 267 stones germinated from 20 hybrid combinations attempted in 2008-09, 182 hybrid seedlings were planted in field for evaluation of $F_1$ progeny, targeting improvement in few traits, *viz.* quality, peel colour, dwarfing and abiotic resistance in rootstock and malformation resistance. Four hundred and forty three progenies were obtained from 21 hybrid combinations attempted during 2009-10 (Table 2). Fruits from four cross combinations could be obtained.

***Evaluation of hybrids*** **:** Eight hundred seventy hybrid seedlings evaluated for weight, length, width and thickness of fruit, peel weight, pulp per cent, stone weight, length, width and thickness and TSS revealed that H-1084, H-2803 and H-949 were found promising. Around 400 mango hybrid seedlings produced fruits averaging 200g during the year. TSS ranged between 20-25 $^{o}$Brix in the seedlings.

Table 1: Parental combination involved in hybridization carried out during the year 2010-11.

| Sl. No. | Cross Combination | Panicles (No.) | Flowers (No.) |
|---|---|---|---|
| 1. | Amrapali x Arunika | 0530 | 2325 |
| 2. | Amrapali x Sensation | 1055 | 4915 |
| 3. | Amrapali x Tommy Atkins | 0245 | 1114 |
| 4. | Arunika x Chausa | 0304 | 1265 |
| 5. | Dashehari x Ambika | 0409 | 1884 |
| 6. | Dashehari x Arunika | 2353 | 9578 |
| 7. | Dashehari x Sensation | 1206 | 4371 |
| 8. | Dashehari x Tommy Atkins | 1590 | 5422 |
| 9. | Dashehari x Vanraj | 1600 | 6292 |
| 10. | Elaichi x Arunika | 0753 | 2571 |
| 11. | Elaichi x Tommy Atkins | 0197 | 0640 |
| 12. | Mallika x Arunika | 0236 | 0958 |
| 13. | Mallika x Tommy Atkins | 0151 | 0584 |
| 14. | Neelum x Sensation | 0200 | 0757 |
| 15. | Neelum x Tommy Atkins | 0200 | 0873 |
| 16. | Neelum x Vanraj | 0174 | 0711 |
| 17. | Totapuri x Vanraj | 0077 | 0235 |
| 18. | Totapuri x Arunika | 0170 | 0472 |
| 19. | Totapuri x Tommy Atkins | 0150 | 0470 |
| | **Total** | **11600** | **45437** |

Table 2 : Raising of hybrid seedlings for evaluation from crosses carried out during the year 2009-10.

| S.N. | Cross combination | Panicles used (No.) | Flowers crossed (No.) | Fruit harvested (No.) | Stones germinated (No.) |
|---|---|---|---|---|---|
| | Amrapali x Ambika | 666 | 3246 | 13 | 10 |
| | Amrapali x Arunika | 1980 | 8936 | 45 | 24 |
| | Amrapali x Sensation | 691 | 3280 | 88 | 73 |
| | Amrapali x Tommy Atkins | 704 | 3021 | 48 | 38 |
| | Arunika x Ambika | 106 | 433 | 1 | 0 |
| | Dashehari x 13-1 | 200 | 776 | 0 | 0 |
| | Dashehari x Ambika | 1209 | 5710 | 40 | 20 |
| | Dashehari x Arunika | 1349 | 6332 | 38 | 22 |
| | Dashehari x Sensation | 745 | 3502 | 72 | 45 |
| | Dasheharix Tommy Atkins | 2081 | 8994 | 123 | 95 |
| | Dashehari x Vanraj | 813 | 3713 | 76 | 32 |
| | EC 95862 x 13-1 | 80 | 290 | 3 | 0 |
| | EC 95862 x Tommy Atkins | 200 | 666 | 5 | 1 |
| | Elaichi x Arunika | 283 | 924 | 17 | 14 |
| | Goa x 13-1 | 132 | 534 | 0 | 0 |
| | Kensington x Tommy Atkins | 190 | 699 | 6 | 4 |
| | Mallika x Ambika | 100 | 347 | 1 | 1 |
| | Mallika x Arunika | 532 | 1989 | 6 | 4 |
| | Neelum x Arunika | 1395 | 5873 | 107 | 53 |
| | Starch x 13-1 | 160 | 554 | 12 | 2 |
| | Starch x Chinkhu | 150 | 544 | 14 | 5 |
| | Total | **13766** | **60363** | **715** | **443** |

## Rootstock standardization

The observations on growth and flowering were recorded in 7 years old Dashehari on nine polyembryonic rootstocks, *viz*. 13-1, Turpentine, Sabre, Peach, Starch, Phillipino, Kensington, Kitchnar and EC 95862, and one monoembryonic rootstock Rumani. Maximum plant height (3.83 m) and canopy spread in E-W (4.81 m) and N-S (4.55 m) directions were recorded in rootstock Starch followed by 13-1 {plant height (3.75 m) and canopy spread E-W (2.90 m) and N-S (3.08 m)}. The polyembryonic accessions collected from NBPGR, Thrissur and polyembryonic varieties (Peach, Kurukkan, Mylepelian, Olour and Nekkare) collected from Bangalore were raised in nursery. The nucellar and zygotic seedlings arising from single stone were separated and planted in separate pots and data were recorded on germination. Maximum germination was recorded in Kurukkan (70%) followed by Peach (66%), Mylepelian (55%), Nekkare (55%) and Olour (46%).

## Guava (*Psidium guajava* L. )

## Germplasm collection, characterization and evaluation

Based on earlier survey, fourteen accessions were collected, 3 from Bangalore, one from Malda and 10 from Allahabad. Ten accessions of guava were planted in the field gene bank. Fifteen accessions were multiplied for planting in 2010.Thirty accessions were characterized for fruit characteristics, while five guava varieties were evaluated for processing potential. Cultivar Puerto Rico-2 had maximum ascorbic acid (259 mg $100g^{-1}$), whereas maximum lycopene content (4.0 mg $100g^{-1}$) was recorded in Waikea. The beverages prepared from all the five varieties though were found organo leptically acceptable the best beverage, however, was obtained from Spear Acid.

## Molecular characterization

Ninteen varieties/selections (G1, G3, G4, G5, G6, Sardar, Allahabad Safeda, Coconut, Chittidar, Phoolpur, PFS1, Nasik, PF1, Pant Prabhat, Seedless, HPSI 16, HPSI 20, Phillipine Guava and Hongkong) were characterized using 8 SSR primers. Only 5 primers gave good pattern in PAGE. Suitability of mPgCIR16 and 09 were confirmed and have been recommended for fingerprinting of closely related accessions.

***Genetic uniformity*** **:** Genetic uniformity of six *in vitro* regenerated plants of cv. 'Lalit' was confirmed by 8 RAPD and 5 SSR primers. Among the primers screened, 5 RAPD and 3 SSR markers were found monomorphic, indicating high degree of genetic homogeneity of the plants (Fig.3).

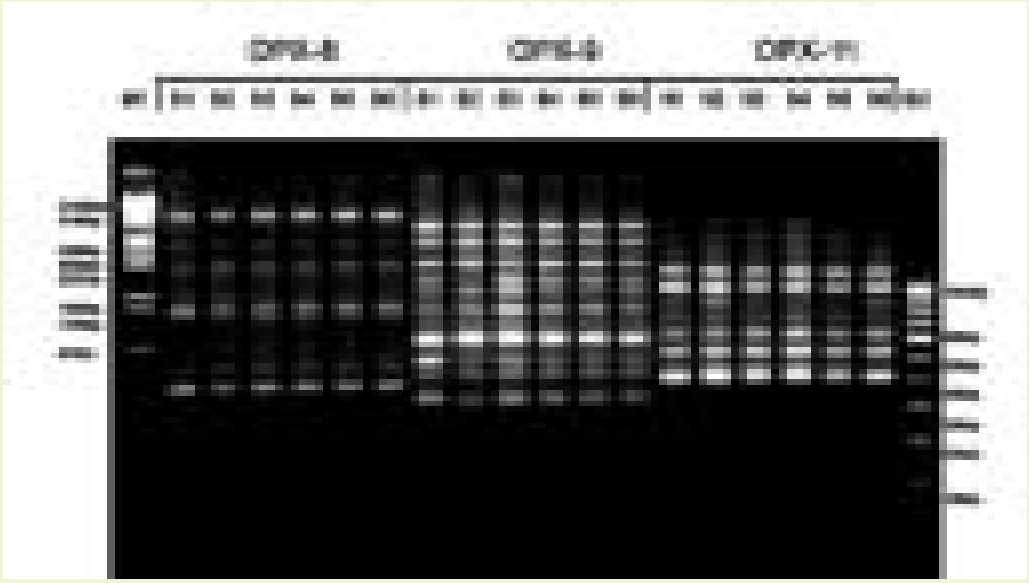


Fig.3: Genetic uniformity of *in vitro* regenerated plants of cv. Lalit Hybridization and hybrid evaluation. M1 : ADNA/EcoR I/HinD III double digest, M2: 100 bp Ladder S1-S6 : *in vitro* regenerated guava cv. Lalit samples

## Hybridization and hybrid evaluation

A total number of 652 hybrid progenies from cross combinations of Gomti Seedling x Lalit (16), Lalit x Purple Guava (241), Purple Guava x Lalit (122), Shweta x Lalit (117) and Shweta x Purple Guava (144) and open pollination of Malaysia Seedling (12) were planted in the field. Purple Guava and Lalit were identified as gene sources for pink pulp colour, one of the essential characteristics for processing varieties due to lycopene. Three hundred and twenty two hybrids were evaluated for fruit pulp colour. Lalit and Purple Guava produced majority of the hybrid seedlings having pink pulp colour. Since pulp colour is linked with seed hardiness, 120 hybrid seedlings were evaluated for hardiness.

# Papaya (*Carica papaya* L.)

## Germplasm evaluation and characterization

***Growth and fruiting behavior*:** The cultivars Red Lady, CO–7, Pusa Delicious, Pusa Nanha, Solo, Pusa Dwarf, Pusa Majesty and Nigeria and accessions A-1, A-2, A-3, A- 7, V-1, V-2, V-3 and M-1, planted in randomized block design with three replications of five plants each were evaluated. The maximum plant height (2.85 m) was recorded in accession A-3 followed by cv. Solo (2.55 m) and maximum plant girth (0.47 m) was recorded in accession M-1 followed by accession A-3 (0.42 m). The canopy spread in N–S (2.30 m) and E–W (2.20 m) directions were maximum in accession A-2. The fruiting started at 0.30 m height from the ground level in cv. Pusa Nanha followed by 0.60 m in cv. Pusa Delicious.

***Fruit yield and quality*:** Maximum fruit yield (55.58 kg plant$^{-1}$) was recorded in cv. Pusa Delicious followed by 51.75 and 50.82 kg plant $^{-1}$ in cv. CO–7 and accession M-1, respectively. The average fruit weight (2.82 kg) was maximum in accession A–3 followed by Pusa Delicious (2.58 kg) and CO–7 (2.11 kg). The maximum TSS (12.6 $^{0}$B) was recorded in fruits of cv. Pusa Delicious followed by Pusa Nanha (12.0 $^{0}$B).

***Genetic purity*** : Four hundred and five flowers from cultivars/accessions were sib mated under controlled pollination conditions and 263 fruit set were obtained. Seed weight varied from 3.356 to 13.494 g per fruit.

## Hybridization and hybrid evaluation

***Hybridization*** : Four parental entries possessing desirable characters like fruit weight, colour and pulp firmness were used in different cross-combinations including reciprocals. A total number of 112 crosses were made with 76 fruit sets. The observations on average number of seeds and seed weight per fruit were recorded. Seed weight per fruit was found to vary from 7.498 to 13.926 g.

***Evaluation of hybrids*** :Maximum yield (41.62 kg plant$^{-1}$), bigger fruit size and higher TSS (10.8 $^{0}$Brix)

were recorded in hybrid Pusa Delicious x CO-7 followed by hybrid A–3 x V–2 having yield (38.82 kg plant$^{-1}$), big fruits and TSS (10.0 $^{0}$B). All the four hybrids were sibbed and backcrossed.

## Litchi (*Litchi chinensis* Sonn)

### Germplasm evaluation

***Growth characters*** **:** Out of thirty five accessions conserved in field gene bank, twenty nine were evaluated for tree growth characters. Maximum tree girth (142.0cm) and height (6.68m) were recorded in Dehradun, whereas Rose Scented exhibited maximum tree volume (271.99 m$^3$) followed by Ajhauli (207.07 m$^3$) and Dehradun (202.43m$^3$). Moderate flowering was recoded in seven varieties during the period but fruit set was very poor due to unfavourable weather conditions.

***Flowering behaviour*****:** Flowering was recorded only in seven varieties. Early preococity (February 2, 2010) was observed in Kasailiya and late (February 28, 2010) in Seedless- I. Opening of flowers was early (March 12, 2010) in Deshi and Kasailiya and late (March 20, 2010) in Rose Scented, Longia, Early Seedless, Calcuttia, Early Large Red and Maharaj Singh. The duration of panicle emergence to flower opening was longer in Large Red (41 days), Kasailiya (39 days), Pickling (39 days) and Rose Scented (38 days) and shortest in Mandraji (13 days). Duration between first to last flower opening was 22 days in Shahi and 12 days in Early Seedless-II and Large Red.

### Molecular characterization

Genetic diversity was investigated in Shahi, Swarna Roopa, Purbi, Dehradun, China, Bedana, Ajhauli, Dehrarose, Elaichi, Kasba, Rose Scented and Longia using 20 RAPD markers. High quality genomic DNA was extracted by newly developed DNA isolation protocol involving modified CTAB method (3.5% CTAB) followed by purification in HiPura kit. Out of twenty primers screened, 15 RAPD primers yielded reproducible results. Hundred per cent polymorphism was generated by primers OPA-03, OPB-13, OPX-05 and OPX-09 followed by 94.1 per cent polymorphism by OPA-05 primer. A typical agarose gel profile generated by primer OPA1 in 11 litchi cultivars has been shown in Fig.4. The Jaccard's similarity coefficients ranged between 0.52 to 0.85. Cluster analysis was performed using NJ and UPGMA methods, which presented almost similar type of clustering patterns. In the UPGMA tree, the cultivars Shahi, Dehrarose and Rose Scented formed one cluster, while others formed the second cluster. Distinctly, Bedana, China and Longia groups were formed as they are expected to have varying morphological characters,

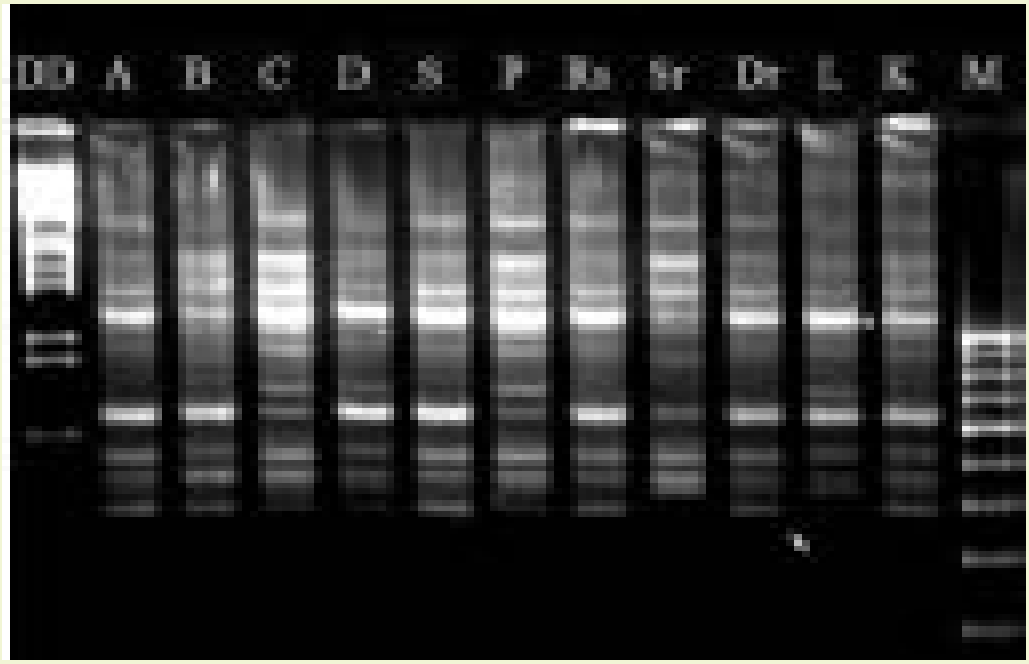



**Fig. 4: Typical agarose gel profile of DNA amplification pattern generated by primer OPA1 in 11 litchi cultivars. DD-Double digest-λDNA/*Eco*RI /*Hin*D III double digest, A- Ajhauli, B-Bedana, C-China, D-Dehradun, S-Shahi, P-Purbi, Rs- Rose Scented, Sr- Swarna Roopa, Dr- Dehrarose, L- Longia, K- Kasba, M:100bp marker.**

however, Bedana occupied the bottom end. Swarna Roopa, Kasba, Purbi and Longia were in the same cluster.

## Aonla(*Emblica officinalis* Gaertn.)

### Germplasm management

Twenty two accessions collected from different parts of Madhya Pradesh were planted in field along with four known commercial varieties, *viz.* NA-7, Krishna, Kanchan and Lakshmi-52, as check during 2007. The observations on growth data showed that maximum plant height (4.05m) was obtained in Lakshmi-52 followed by CISH A-12 (4.00m). Minimum plant height (1.55m) was recorded in accession CISH A-28. The maximum plant girth (41.5cm) was recorded in accession CISH A-13 followed by CISH A-30 (40.5 cm), while minimum (10.1cm) was recorded in CISH A-5. Maximum plant spread (NS-4.18 and EW-4.57m) was recorded in accession number CISH A-13, while the spread was minimum (NS-1.20 and ES-1.15m) in accession CISH A-5. Out of twenty two accessions, seven accessions came into fruiting for the first time. Maximum fruit yield (1.41 kg tree$^{-1}$) was recorded in accession CISH A–13, while minimum yield (0.92 kg tree$^{-1}$) was noted in NA-6 after third year of planting.

Data on quality characters, *viz*. TSS (8.2 to 11.2 $^{0}$B), acidity (1.65 to 2.97%), total sugars (6.42 to 7.19%), reducing sugars (2.50 to 3.39%), ascorbic acid (291 to 528 mg 100g $^{-1}$ pulp), tannins (3.28 to 4.26%) and antioxidant activity (73.23 to 103.84 mg g$^{-1}$ fresh weight) showed variation among different accessions analyzed. Maximum ascorbic acid content (528 mg 100 g$^{-1}$ pulp) was recorded in CISH A-2 followed by CISH A-13(513 mg 100 g$^{-1}$ pulp), while minimum content (291 mg 100 g$^{-1}$ pulp) was recorded in cv. Kanchan.

## Bael (*Aegle marmelos* Correa)

### Germplasm management

Thirty six clonally multiplied bael accessions were planted in the field gene bank for evaluation. Data on growth parameters showed variations in plant height (1.66 to 3.70 m), stem girth (14.0 to 39.0 cm) and plant spread 1.32 to 2.72m (E-W) and 1.20 to 2.80m (N-S). Out of thirty six accessions, eight accessions came into bearing this year. Seedlings raised from promising bael germplasm collected from UP, Bihar and Jharkhand and planted in the field during the year 2002-2003, were evaluated for their growth characteristics. The plant height, girth and tree volume varied from 1.50 to 6.40, 9.0 to 61.0 cm and 5.19 to 164.0 m$^{3}$, respectively . Twelve accessions came to fruiting this year for the first time.

## Jamun (*Syzigium cuminii* Skeel)

### Germplasm collection and evaluation

Observations on physico-chemical attributes of seven promising accessions were recorded. A large variation in the characters, *viz*. fruit weight (4.27 to 22.15 g), length (1.78 to 3.37 cm), diameter (1.52 to 2.64 cm), length: diameter ratio (1.13 to 1.56), pulp weight (2.81 to 9.81g), pulp content (65.81 to 80.74%), seed weight (1.46 to 2.74g), pulp: seed ratio (1.92 to 4.19), total soluble solids (4.60 to 13.80 $^{0}$B), titrable acidity (1.54 to 1.98%), TSS: acid ratio (2.32 to 8.96), total sugars (5.79 to 8.06%), reducing sugars (4.75 to 6.14), sugar: acid ratio (2.92 to 5.23), anthocyanin (62.5 to 110.7 mg 100g$^{-1}$ and ascorbic acid (28.70 to 37.67 mg 100g$^{-1}$) was obtained in the diversity.

Methanol and successive water extracts prepared from pulp and seeds of different accessions were evaluated in protocols of *in-vitro* inhibition assays relevant to diabetes management in collaboration with M/s Natural Remedies, Bangalore under PPP mode. On the basis of bioactivity obtained in different bioassays, methanolic extract of seeds was chosen for bioactivity guided fractionation, which is being further evaluated.

## Khirnee (*Manilkara hexaandra* Toxb.)

### Germplasm collection and evaluation

Seventeen accessions were established in the field gene bank. Out of 37 accessions, CISH K–10 and CISH K–11 were identified as superior and promising type based on different physic-chemical parameters.

## Karonda (*Carissa carandas* L.)

### Germplasm collection and evaluation

On the basis of the variability in fruit type, *viz.* green, purple, pink and bicolour, thirty accessions were established in the field gene bank. One acession CISH Kr-11 was identified having superior fruit quality.

## Mahua (*Bassia latifolia* Roxb.)

### Germplasm collection and evaluation

Twenty four promising accessions have been identified, collected, multiplied and established in field gene bank for evaluation of growth and fruiting pattern. The flowers from these selected accessions were analyzed for flower weight flower (1.10 to 2.63g), length (1.53 to 2.60 cm), diameter (1.46 to 1.90cm) TSS (14.53 to 26.0 $^0$B). The juice content in the accessions varied was from 44.25 to 64.90 per cent. On the basis of these characters CISH M – 8 was found to be superior type.

## Wood apple (*Ferronia limonia* L.)

### Germplasm collection and evaluation

Seventeen promising accessions have been collected, multiplied and established in field gene bank for evaluation of growth and fruiting pattern. Out of these 17 accessions, CISH Wa-17 was found promising.

## Chironji (*Buchanania lanzan* Spreng.)

### Germplasm collection and evaluation

Out of ten promising accessions collected, three accessions were established in field gene bank for evaluation of growth and fruiting pattern. Significant variation in fruit characters was not observed. However, the performance of CISH Ch-3 was better.

# Crop production

## Mango (*Mangifera indica* L.)

### Planting density

***Effect of planting density on vegetative growth and fruiting:*** In 18-year old Dashehari orchard, planted at different densities (1600, 800, 400, 266, 178 and 100 plants ha$^{-1}$), observations on vegetative growth parameters showed maximum tree height (5.40 m) in the highest planting density (1600 plants ha$^{-1}$) followed by 5.30 m in 800 plants ha$^{-1}$ and minimum (4.80 m) in recommended density (100 plants ha$^{-1}$). The highest fruit yield (15.55 MT ha$^{-1}$) was recorded in medium density (400 plants ha$^{-1}$) followed by 10.68 MT ha$^{-1}$ in density of 267 plants ha$^{-1}$ and the lowest yield (4.60 MT ha$^{-1}$) in recommended density (100 plants ha$^{-1}$).

***Effect of planting density on availability of radiation:*** Diffused radiation below the canopy was maximum (1097 µ mol m$^{-2}$ s$^{-1}$) 100 plants ha$^{-1}$ and it was 989 µ mol m$^{-2}$ s$^{-1}$ in 400 plants ha$^{-1}$, while minimum (888 µ mol m$^{-2}$ s$^{-1}$) in 1600 plants ha$^{-1}$ in 18-years old Dashehari orchard (Fig. 5). There was a high degree of negative correlation (r = -0.703) between LAI and total radiation below canopy. Direct radiation level above the canopy was higher (450-600 µ mole m$^{-2}$ s$^{-1}$) than below the canopy throughout the year in medium density (400 plants ha$^{-1}$).

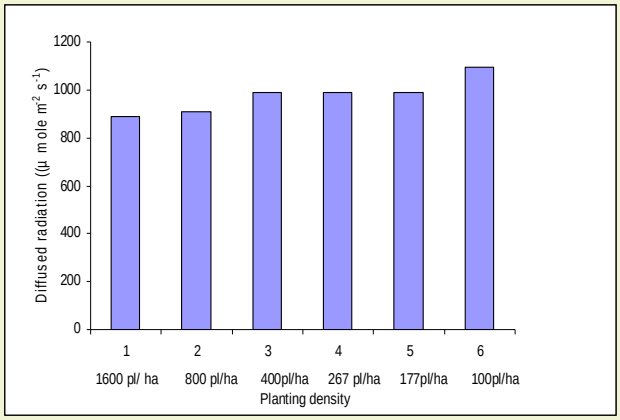



**Fig. 5: Diffused radiation below canopy in different planting densities in mango**

***Light availability at different angles within the canopy:*** Diffused radiation below canopy at different zenith and azimuth angles under medium density (400 plants$^{-1}$ ha) planting of 18-years old Dashehari orchard was recorded and production potential of canopy quadrants was correlated with gap fraction. It was observed that diffused radiation below canopy was the highest (94.29 µ mol m$^{-2}$ s$^{-1}$) and LAI was minimum at 135-180$^o$ azimuth angles (S-E quadrant of canopy). South-East quadrant of canopy was found more productive (31.5 to 33.33 % of total production) as compared to the other quadrants (N-W 18.0 to 19.5 ; S-W 24.5 to 25 and N-E 23.9 to 24.2 %). Production potential of canopy quadrants was correlated with gap fraction and it was observed that diffused radiation below canopy was the highest and LAI was the lowest at 135-180 $^o$ azimuth angles.

***Soil health under high density planting:*** Soil and leaf nutrient analysis of high density orchard of Dashehari indicated that bulk density and water holding capacity of soil ranged between 1.32 to 1.62 Mg m$^{-3}$ and 16.64 to 26.06 per cent, respectively. Organic carbon ranged between 0.19 to 0.60 per cent across three soil depths (0-30, 30-60 and 60-90 cm) and it decreased down the

depth. Available N, P and K ranged from 29 to 93, 5.7 to 30.7 and 32.9 to 114 ppm, respectively. DTPA extractable Zn, Cu, Mn and Fe varied from 0.10 to 0.50, 0.6 to 10.16, 2.9 to15.4 and 2.8 to 12.1 ppm, respectively. Majority of the soil samples were below the critical level of nutients. Majority of the leaf samples showed Zn deficiency. Proper nutritional management in high density mango orchard is, therefore, imperative for quality fruit production.

***Effect of planting systems:*** The experiment on high density-cum-planting system in cv. Dashehari with 5 planting systems, *viz*. square, hedge row, double hedge row, paired and cluster system, was in the eighth year of progress. Observations on growth, flowering and fruit yield have shown maximum tree height (2.85 m) in double hedge row system followed by hedge row system (2.75 m), while minimum height (2.60 m) was found in square system. The highest fruit yield (8.15 MT $ha^{-1}$) was obtained in double hedge row system followed by hedge row system (6.46 MT $ha^{-1}$), while minimum (4.08 MT $ha^{-1}$) yield was recorded in square system.

## Canopy architecture management

***Canopy engineering:*** Canopy modifications, *viz*. crown thinning and crown reduction, on 24-years old Mallika showed significant effects on fruit yield. The highest fruit yield (88.4 kg $tree^{-1}$) was recorded in crown thinning treatment followed by 80.5 kg $tree^{-1}$ in crown reduction treatment as against 60.5 kg $tree^{-1}$ in untreated trees.

## Substrate dynamics for IPNM

The experiment on Dashehari comprising 18 treatment combinations of *FYM*, vermicompost, NPK, *Azotobacter, Trichoderma harzianum*, phosphorus solubilizing micro- organisms and mulching was in the fifth year of progress. Plant growth in terms of height, stem girth and canopy spread was maximum in treatment FYM + NPK + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulch (10 cm thick). Plant height and stem girth varied from 1.68 to 2.61 m and 18.5 to 31.0 cm, respectively, in different treatments. Canopy spread in N-S direction ranged from 1.58 to 2.79 m, while in E-W direction it was between 1.68 and 2.68 m. There was no significant effect of different treatments on growth parameters. The flowering percentage ranged between 38.3 and 73.3 among different treatments. There was an increase of 37.5 per cent in organic carbon content over the initial level (0.32%) by the application of substrate treatments. Maximum organic carbon build up (0.44 %) was recorded in treatment FYM + NPK+ *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulch (10 cm thick ) as against 0.32 per cent where no FYM or vermicompost was applied. Available N, P and K were minimum (61.3, 18.2 and 62.7 ppm) in the treatments receiving no N, P or K fertilizers. In general, status of available N was low and available P and K were high in all the treatments. DTPA extractable Fe, Mn, Zn and Cu contents ranged from 6.22 to 10.97, 7.02 to 12.05, 1.25 to 3.55 and 1.34 to 6.49 ppm, respectively. These nutrients were in lower amounts in the treatments where organic matter was not added to the soil. Both macro- as well as micro-nutrient contents increased in the treatments comprising FYM and / or vermicompost and NPK with mulching, however, there was no significant difference due to treatments. The analysis of leaf samples showed no significant difference in N, P, K, Fe, Mn, Zn and Cu contents in different treatments, however, all the leaf nutrient contents in the leaves were above their respective critical limits.

Total dehydrogenase activity in soil increased under organics, NPK and biofertilizers as compared to their respective controls. It was the highest (2.48 $\mu gTPFg^{-1}\ hr^{-1}$) in 0-10 cm soil layer in the treatment combination which received recommended doses of N, P, FYM, all three bioinoculants and organic mulching. The activity decreased with increase in soil depth. N application promoted dehydrogenase activity, while K had detrimental effects on it.

## Water and nutrient management

***Spatio-temporal variations in soil moisture and temperature*:** Soil samples were analyzed for moisture and temperature each month in drip irrigated Dashehari orchard having 5 treatments of NPK fertigation at different crop phenological stages. The moisture content (0-15 and 15-30 cm soil depth) ranged between 15.8 to 22.7, 14.2 to 20.4, 10.6 to 15.6, 10.0 to13.0 and 9.4 to 13.1 per cent (Fig. 6), while soil temperature (0-15 and 15-30 cm soil depth) varied between 21.7 to 23.8, 18.3 to 21.0, 14.1 to 16.5, 18.3 to 21.6 and 22.5 to 24.1 °C (Fig. 7) during November to March, respectively. Soil moisture content decreased with the increase in temperature. The soil temperature was lowest during flowering period.

***Fertigation*** : The organic carbon content ranged between 0.27 and 0.57 per cent, available P between 11.7 and 18.93 ppm and available K between 92.23

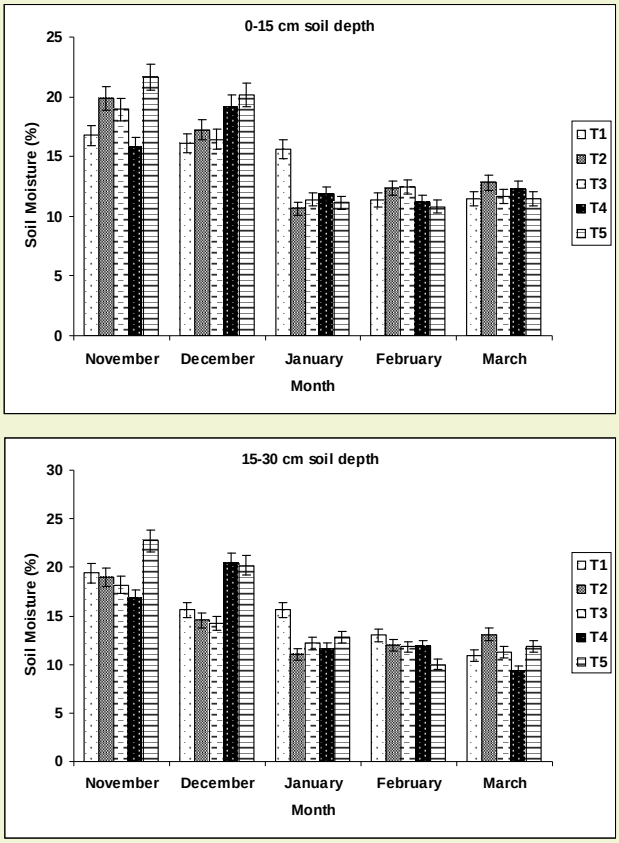



Fig. 6: Spatio-temporal variations in soil moisture (%) in drip irrigated mango orchard (T1-NPK application in basin, T2- NPK Fertigation from the beginning of Sep to the end of October, T3-NPK Fertigation at time of flowering, T4- NPK Fertigation at the time of fruit setting, T5-NPK Fertigation from the beginning of Sept to second week of May)

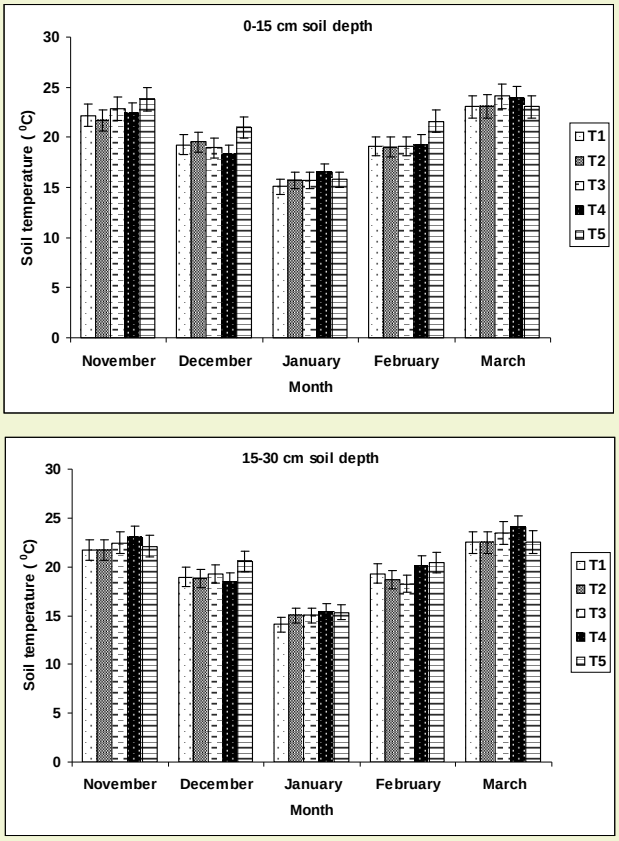



Fig. 7: Spatio-temporal variations in soil temperature ($^0$C) in drip irrigated mango orchard (T1-NPK application in basin, T2- NPK Fertigation from the beginning of Sep to the end of October, T3-NPK Fertigation at time of flowering, T4-NPK Fertigation at the time of fruit setting, T5-NPK Fertigation from the beginning of Sept to second week of May)

and 181.83 ppm in many orchards. The highest availability of organic carbon (0.57%), phosphorus (18.93 ppm), potassium (181.83 ppm), Zn (0.75 ppm), Cu (3.63 ppm), Mn (8.53 ppm) and Fe (11.07 ppm) were recorded in the treatment that received NPK fertigation from September to second week of May in Dashehari, whereas the figures for Langra were 0.51 per cent organic carbon, 22.4 ppm P, 183.67 ppm K, 0.88 ppm Zn, 5.03 ppm Cu, 15.73 ppm Mn and 26.56 ppm Fe. The nutrient content in leaf were 0.25 per cent P, 1.17 per cent K, 15.67 ppm Zn, 20.0 ppm Cu, 55.33 ppm Mn, 306.33 ppm Fe in Langra, while the corresponding values in Dashehari were 0.25 per cent P, 0.94 per cent K, 29.67 ppm Zn, 35.33 ppm Cu, 68.33 Mn and 262.33 ppm Fe.

The maximum fruit yield of Dashehari was obtained under drip irrigation (54.4 kg plant$^{-1}$) as compared to the basin irrigation (35.84 kg plant$^{-1}$) regime. The highest fruit yield (43.4 kg plant$^{-1}$) in Langra was obtained in drip irrigation while it was the lowest in basin irrigation (28.54 kg plant$^{-1}$). The TSS ranged between 18.9 to 19.6 $^0$B in Langra and 19.8 to 20.3 $^0$B in Dashehari fruits.

***Nutrient management*** **:** The experiment on integrated nutrient management in Dashehari with 24 treatments comprising of FYM, green manuring, *Azotobacter*, PSM, NPK and micronutrients (Mn, Zn, Cu and B) was in fifth year of progress. The fruit set was very erratic during the year despite profuse flowering and response of the treatments was not clear on the fruit yield. Ascorbic acid content was the highest (35.5 mg 100g$^{-1}$) in the treatment where ½ dose of NPK + FYM + *Azotobacter* + PSM + Zn + Cu + Mn + B was applied. TSS and acidity varied in a narrow range of

18.2 to 18.9 $^0$B and 0.10 to 0.16 per cent, respectively. Nutrient buildup in soil was significantly higher across different treatments over control. The sub-surface soil (30-60 cm) had lower nutrient level than the top layer (0-30 cm).

## Management of irregular bearing

***Effect of paclobutrazol*:** The rhythm of alternate bearing in Chausa and Langra was evaluated. The alternate bearing index 'I' for each control and treated tree was tested for significance by data re-sampling. All the untreated trees exhibited strict alternate bearing behaviour having alternate bearing index more than one. On the other hand, paclobutrazol treated trees showed very narrow range of alternate bearing index (0.35 to 0.48). In the treated trees, the fruit yield increased manifolds and yield increment year-wise was significant. The lower alternate bearing index in these trees clearly suggested that paclobutrazol application had significantly reduced the tendency of alternate bearing rhythm in Chausa and Langra but could not change the bienniality behaviour.

The variation in strength of a fluorescent signal (Fv) from Fo to Fm, PS II, ETR (electron transport rate) level and non-photochemical quenching (NPQ) were estimated in dark adapted leaves of Langra and Amrapali at fruit-bud differentiation (FBD), full bloom and fruit set (marble) stages. The Fv/Fm ratio varied significantly in both the varieties at different stages of flowering and fruiting. Maximum Fv/Fm (0.81) was recorded at FBD stage, however, it gradually decreased and maximum reduction was obtained at fruit set stage in both the varieties. Amrapali registered higher chlorophyll fluorescence at all the stages as compared to Langra. Similar pattern was also obtained in PS II and ETR with varietal variations.

The response of paclobutrazol on microbial population and enzyme activity in soil showed promotive effects of paclobutrazol on total microbial population (yeast, mould and bacteria) and dehydrogenase activity (3.04 to 5.03 $\mu gTPFg^{-1}hr^{-1}$), however, dehydrogenase activity decreased (0.79 to 1.10 $\mu gTPFg^{-1}hr^{-1}$) with increasing soil depth from 15 to 30 cm.

Paclobutrazol residue was 0.0172 to 0.205 $\mu g\ g^{-1}$ in unripe mango fruits which was below EU MRL value of 0.5 $\mu g\ g^{-1}$, while the same was not detected in ripe fruits. Residue levels of paclobutrazol in soil up to 20 cm depth after harvesting the fruits were in the range of 0.26 to 3.69 $\mu g\ g^{-1}$ and there was an increase in the residue (0.415 to 4.85 $\mu g\ g^{-1}$) in the following year of application at the same dose in the same trees. LC-MS/MS spectra of soil samples were compared with that of paclobutrazol standards by identifying possible mass fragmentation patterns at m/z 70.1, 125.1, 236.0 and 293.5. The results of the analysis confirmed the presence of paclobutrazol in soil even after two years of its application.

## Salt tolerant polyembryonic rootstocks

EC in the range of 1 to 6 dS $m^{-1}$ was created in soil using calibration curves (EC in dS $m^{-1}$=0.539 x + 0.27; $R^2$=0.99, where x = ml of stock salt solution 100g $^{-1}$

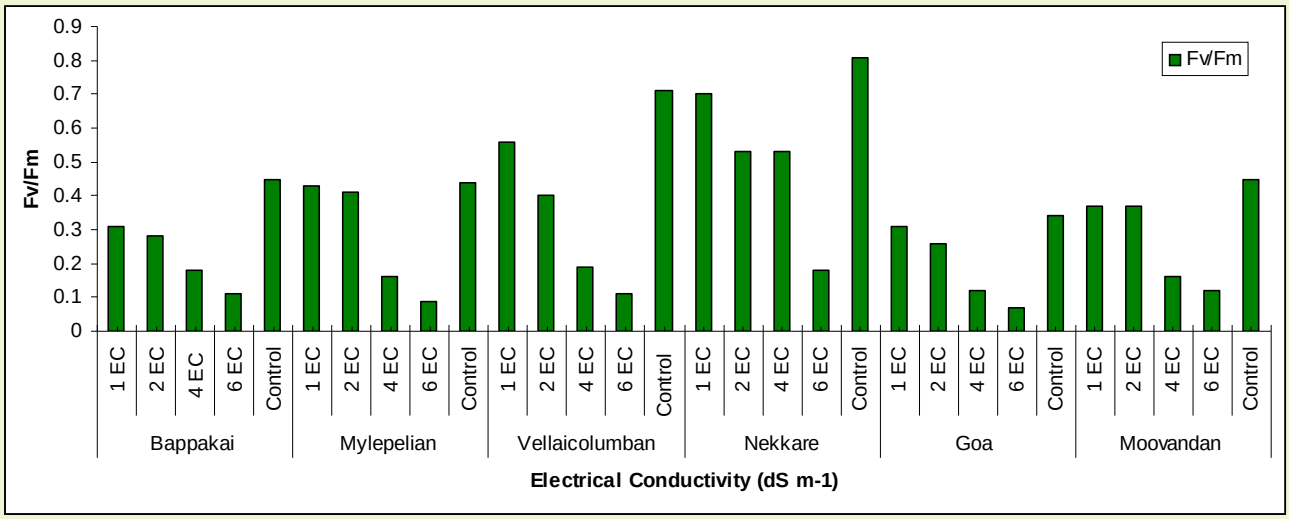



Fig. 8: Variation in ratio of variable chlorophyll fluorescence to maximal fluorescence (Fv/Fm) of polyembryonic mango under various salt conditions

soil). Initial pH and EC of experimental soil were 7.92 and 0.39 dS $m^{-1}$ with macro and micro-nutrients at normal level and organic carbon at 0.487 per cent. Nucellar seedlings of uniform size of polyembryonic mango cultivars Bappakai, Goa, Kurukkan, Mylepellian, Muvandan, Olour, Nekkare and Vellaikulamban were planted in pots having different levels of salinity. The observations on plant growth (plant height, stem, root and leaves dry weight), chlorophyll fluorescence, water potential and membrane stability index were recorded periodically. The salinity symptoms appeared after one month and all the plants died within 50 days, except Nekkare and Bappakai and Kurukkan that survived up to EC of 2 dS $m^{-1}$, and 1 dS $m^{-1}$, respectively. Plant growth decreased significantly with increasing salinity levels and marked decline in dry mass of leaves (9 to 55%), stem (31.43 to 58.75%) and roots (23.2 to 69.7%) was observed as compared to control. The leaf water potential (Øw) gradually decreased with increasing salinity levels. As stress became more severe at 30 days of treatment, the Øw reached the range of – 07.26 to -10.5 MPa from -0.57 MPa in most of the polyembryonic cultivars, except in Nekkare wherein it was -5.60 MPa suggesting the development of less water deficit in this cultivar as compared to others. Membrane stability index (90.83 to 97.33%) and chlorophyll fluorescence (Fv/Fm) reduced drastically as salinity increased (Fig. 8). The reduction rate in Fv/Fm was narrow in Nekkare (0.35 to 0.81) as compared to other cultivars (0.11 to 0.80), which indicated its tolerance to salinity stress. Glycine betaine content increased for short period (15 days) thereafter decreased gradually with increasing salinity levels .

## Guava (*Psidium guajava* L.)

### Somatic embryogenesis

***In vitro* selection** : The plants regenerated through somatic embryogenesis pathway were evaluated for resistance to toxin/ metabolites exuded by *F. solani* isolate No. 40. The plants incubated in 100 per cent culture filtrate (CF) started expressing leaf browning and wilting within 14 days and expression of symptom intensity increased over time (Fig. 9). Leaf browning was high in 75 and 100 per cent, medium in 50 per cent and low in 25 per cent CF. Wilting symptoms such as leaf yellowing, leaf curling, leaf shedding and leaf browning were also observed. Initially, leaf browning masked leaf yellowing as yellowing symptoms were expressed only at low concentrations (25 and 50% CF).

**Fig. 9: Symptoms of wilting in guava cv. Lalit screened *in vitro* against *Fusarium solani* isolate No. 40 after 14 days of growth.**

After 14 days, the plants incubated in 25 per cent CF also displayed initiation of leaf browning along with leaf yellowing and leaf curling. These plants got progressively more affected and showed leaf shedding by 28 days of incubation. Similarly, plants kept in 50 and 75 per cent CF showed leaf browning within 14 days, leading to leaf shedding on 21 days.

### Substrate dynamics for IPNM

The experiment on substrate dynamics for integrated plant nutrient management on Shweta with 18 treatment combinations was in fourth year of progress. Plant height ranged between 2.85 to 3.80 m and stem girth between 23.3 to 33.3 cm. The canopy

spread in N-S was between 3.80 to 4.90 m, while in E-W direction, it ranged between 3.64 to 4.89 m. Plant height and canopy spread were maximum in the treatment where all the substrates were applied. In second year of fruiting, highest yield of guava (33.05 kg tree$^{-1}$) with maximum fruit weight (222 g) was obtained in the treatment FYM + NPK + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulch (10 cm thick ). The highest TSS (12.2 $^0$B), ascorbic acid (235 mg 100g$^{-1}$), total sugars (9.3%) and minimum acidity (0.22 %) were recorded in the same treatment.

Organic carbon and available N, P, and K in soil ranged between 0.331 to 0.448 per cent 60.0 to 81.0, 13.9 to 21.5 and 100.9 to 196.4 ppm, respectively. DTPA extractable Fe, Mn, Zn and Cu contents ranged from 1.83 to 3.39, 4.61 to 6.49, 0.55 to 1.33 and 0.38 to 1.78 ppm, respectively, and were in optimum range in all the treatments. However, there was no significant effect of treatments on the nutrient build up in the soil. The N, P, K and Fe, Mn, Zn and Cu concentrations in leaf varied from 1.81 to 2.76, 0.123 to 0.229, 1.63 to 2.95 per cent and 81.8 to 124.0, 74.3 to 136.5, 19.5 to 24.8 and 6.3 to 20.8 ppm, respectively, and were above the critical levels.

The highest dehydrogenase activity (6.14 µg TPF g$^{-1}$ hr$^{-1}$) at 0-10 cm soil depth was found in the treatment which received all inputs except N, followed by 5.65 and 5.59 µg TPF g$^{-1}$hr$^{-1}$ in the treatments that received all inputs except PSM and all inputs, respectively. In 10 - 20 cm soil depth highest dehydrogenase activity (3.92 µg TPF g-$^{1}$ hr$^{-1}$) was found in the treatment which received all inputs except PSM. Pooled average dehydrogenase activity was maximum (3.54 µg TPF g$^{-1}$ hr$^{-1}$) in the treatment that received all inputs except PSM followed by 2.98 µgTPFg$^{-1}$hr$^{-1}$ in treatment which received all inputs except N.

## Aonla (*Emblica officinalis* Gaertn.)

### Substrate dynamics for IPNM

The substrate dynamics experiment on aonla with 18 treatment combinations was in the third year of progress. Data were recorded on plant growth parameters like plant height, stem diameter and canopy spread and nutrient status of soil. The maximum plant growth was recorded in the treatment FYM + NPK + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulch. Organic carbon and available N, P, and K ranged between 0.324 to 0.487 per cent and 69.6 to 85.8, 12.9 to 21.3 and 102.8 to 194.3 ppm, respectively. DTPA extractable Fe, Mn, Zn and Cu contents ranged from 3.07 to 5.31, 4.72 to 8.69, 0.65 to 1.55 and 0.28 to 1.69 ppm, respectively. All the nutrients, except N, were in the sufficient range. The treatments, however, showed no significant effect on the nutrient buildup in soil. The N, P, K, Fe, Mn, Zn and Cu contents were in optimum levels in aonla leaves but there were no significant differences in nutrient contents among different treatments.

## Crop protection

## Mango (*Mangifera indica* L.)

### Insect pests

#### Hopper

***Population dynamics*** : First emergence of hopper, *Idioscopus clypealis,* was recorded on 5$^{th}$ March, 2011 when minimum and maximum temperatures and relative humidity ranged between 12 to 29.6 $^o$C and 33 to 81 per cent, respectively. Its population was higher during March–April (2 to 8 hoppers panicle$^{-1}$). Population of *Idioscopus clypealis* and *I. nitidulus* were also recorded on new leaves and panicles at weekly intervals. The population of *Idioscopus clypealis* and *I. nitidulus* were low throughout the year (2 to 4 hoppers panicle$^{-1}$ /leaf$^{-1}$). There was no significant effect of directions on the population of these species of hopper. Population of *Amritodus atkinsoni* recorded on tree trunk throughout the year at weekly intervals showed the highest population during March-April (2 to 4 hoppers).

***Management*** : A field trial was conducted during March-April, 2010 on cultivar Dashehari with 7 treatments, *viz.* spinosad 45% SC (1 ml l$^{-1}$), imidacloprid 17.8% SL (0.3 ml l$^{-1}$), acephate 75% SP (1.5 g l$^{-1}$), thiamethoxam 25% WG (0.2 g l$^{-1}$), lamdacyhalothrin 25% EC(1 ml l$^{-1}$), lastraw (5 ml l$^{-1}$) and mycozoal (2 ml l$^{-1}$), and control (water spray). Spinosad (1 ml l$^{-1}$), acephate (1.5 g l$^{-1}$) and thiamethoxam (0.2 g l$^{-1}$) were found highly effective registering more than 90 per cent reduction in hopper population up to 21 days after spray.

#### Mealy bug

***Population dynamics*** : First emergence of mango mealy bug(*Drosicha mangiferae*) was recorded on 17$^{th}$ January, 2011 when temperatures were 3.6 $^o$C (minimum) and 19.7 $^o$C (maximum) and relative humidity was 63 to 80

per cent. Its population was low from February to April (1 to 3 mealy bugs panicle$^{-1}$).

***Management*** : A field trial was conducted during March – April 2010 on cv. Dashehari with 8 treatments, *viz.*, spinosad (1 ml l$^{-1}$), carbosulfan 25% EC(2 ml l$^{-1}$), fipronyl 5% SC (1ml l$^{-1}$), lastraw (5 ml l$^{-1}$), mycozoal 10% SC(2 ml l$^{-1}$), lamdacyhalothrin (1 ml l$^{-1}$), dimethoate 30% EC(2 ml l$^{-1}$) and thiamethoxam (0.2 g l$^{-1}$), and control (water spray). Carbosulfan (2 ml l$^{-1}$) and fipronyl (1 ml l$^{-1}$) were found highly effective registering more than 90 per cent reduction in mealy bug population up to 21 days after spray.

## Thrips

***Population dynamics*** : Thrips (*Scirtothrips dorsalis* Hood) has emerged as new serious insect pests of mango. First emergence of thrips was recorded on 28$^{th}$ March, 2011 when temperatures were 35.5 $^{o}$C (maximum) and 15.8 $^{o}$C (minimum) and relative humidity was 43 to 72 per cent. Its population was higher during April-May (5 to 8 thrips leaf$^{-1}$) and August to October (4 to 10 thrips leaf$^{-1}$).

***Management*** : A field trial was conducted during October, 2010 for control of thrips on cv. Dashehari using spinosad (1ml l$^{-1}$), thiamethoxam (0.2 g l$^{-1}$), imidacloprid (0.3 ml l$^{-1}$), acephate (1.5 g l$^{-1}$), dimethoate (2 ml l$^{-1}$), lamdacyhalothrin (1 ml l$^{-1}$) and carbosulfan (1 ml l$^{-1}$). Spinosad (1ml l$^{-1}$) and thiamethoxam (0.2 g l$^{-1}$), proved highly effective registering more than 96 per cent reduction in thrips population up to 21 days after spray.

## Leaf gall midge

***Management*** : A field trial was conducted during July – August with 7 treatments, *viz.* carbosulfan (2 ml l$^{-1}$), dimethoate (2 ml l$^{-1}$), lamdacyhalothrin (1 ml l$^{-1}$), acephate (1.5 gl l$^{-1}$), imidacloprid (0.3 ml l$^{-1}$), lastraw (5 ml l$^{-1}$) and thiamethoxam (0.2 g l$^{-1}$) for the control of leaf gall midge(*Procantariana mattiana*). Dimethoate (2 ml l$^{-1}$) proved highly effective registering more than 90 per cent control of midge up to 21 days after spray.

## Fruit fly

***Population dynamics:*** Fruit fly (*Bactrocura dorsalis*) population was monitored throughout the year using methyl eugenol wooden block traps. Fruit fly population started increasing from first week of March (Av. 15 flies trap$^{-1}$) and became higher during fourth week of April to first week of September (Av. 114 to 297 flies trap$^{-1}$ week$^{-1}$), the highest being in the 4$^{th}$ week of June.

## Nematode pests

***Evaluation of toxic potential of bacterial flora against second stage juveniles of root-knot nematode (Meloidogyne incognita):*** Forty soil/root samples were collected from fruit trees (mango, guava and aonla) and vegetable crops (brinjal and okra) located in Rehmankhera, RB Road Farm and Mallihabad during May to December. Based on their saprophytic nature, forty bacterial colonies were isolated. Prevalence of colonies was relatively higher on vegetable crops as compared to fruit crops. Similarly, the periodicity of prevalence was found to be relatively higher during July-August as compared to rest of the period. Maximum bacterial colonies (80%) were isolated from vegetable crops.

Out of these 40 bacterial isolates, only four isolates, tentatively designated as 3A, 3B, 5A and 9A, could impact the juvenile mortality ranging from 15 to 40 per cent over a temporal scale stretched up to 120 hrs. Besides this, another bacterium, *Paenobacillus polymyxa* known to have nemic antagonism, was also tested against the same nemic population. The crude culture of *P. polymyxa* could not effect mortality of the juveniles significantly (15%) even after an exposure of one week. However, the exposure of juveniles to centrifuged culture filtrates could impact the juvenile mortality to a significant level (100%) within 48 hrs of exposure at ambient temperature (23 to 30.5°C). Significant negative impact on juveniles (60%) was observed following their exposure to centrifuged and ultra filtered culture filtrate within 48 to 72 hrs at lower ambient temperature (12.5 to 17.5°C).

## Diseases

## Anthracnose

***Diversity analysis of anthracnose*:** Diversity analysis of 30 isolates of anthracnose (*Colletotrichum gloeosporioides)* collected from different geographical regions of India was carried out. Based on Euclidian Distance, the isolates had clustered into two groups (Cluster I and II). Sixty six point six per cent of the isolates fell in Cluster I and 43.4 per cent in the Cluster II (Fig. 10). Clustering pattern followed the media, pH and temperature optima and sensitivity towards different systemic and non-systemic fungicides and their reaction towards different bioagents. All the

isolates in Cluster I belong to North India, while in Cluster II to North-East.

***Molecular diagnosis*** **:** A multiplex PCR with four sets of primer pairs, *viz.* ITS1-4 universal primers, MKCg6 F&R (species-specific), BKPCgPec F&R (pectate lyase B gene-specific) and BKPCgGS F&R (glutamine synthetase gene-specific), for *Colletotrichum gloeosporioides* was optimized with PCR reaction conditions of 25 ng DNA, 0.2 mM dNTP, 1.5 mM $MgCl_2$, 1 µM primers and 1U Taq polymerase in a multi-cycling profile. This quadruplex PCR technique yielded four specific bands of 235, 380, 531 and 560 bp sizes representing glutamine synthetase, *C. gloeosporioides* species-specific and pectate lyase B gene along with universal ITS1-4 fungi specific primers for ITS rDNA genes, respectively (Fig. 11). Of these primers, the former three represents the newly designed primers using sequence information from database. The results proved that the three sets of designed primers in combination with the universal fungal ITS primers were uniformly amplified in a single multiplex PCR under standardized conditions.

## Wilt

Surveys were conducted in Bareilly, Haridwar, Lakhimpur Kheri, Lucknow, Muzaffarnagar, Saharanpur, Shahjahanpur and Sitapur districts for the incidence and severity of wilt and decline of mango. In Haridwar, Muzaffarnagar and Saharanpur districts sudden wilting of trees was observed and a beetle was found associated with bark. At other places, slow decline combined with dieback was found common. Declining trees had rotten roots and discolouration of central woody portion of roots, stem and twigs. Species of *Fusarium, Phytophthora* and *Sclerotium* were found in roots and stems of wilted trees. Observations were also made on graft rot in nursery. Fungi associated with roots and graft portion were identified as *Fusarium, Sclerotium* and *Drechslera*.

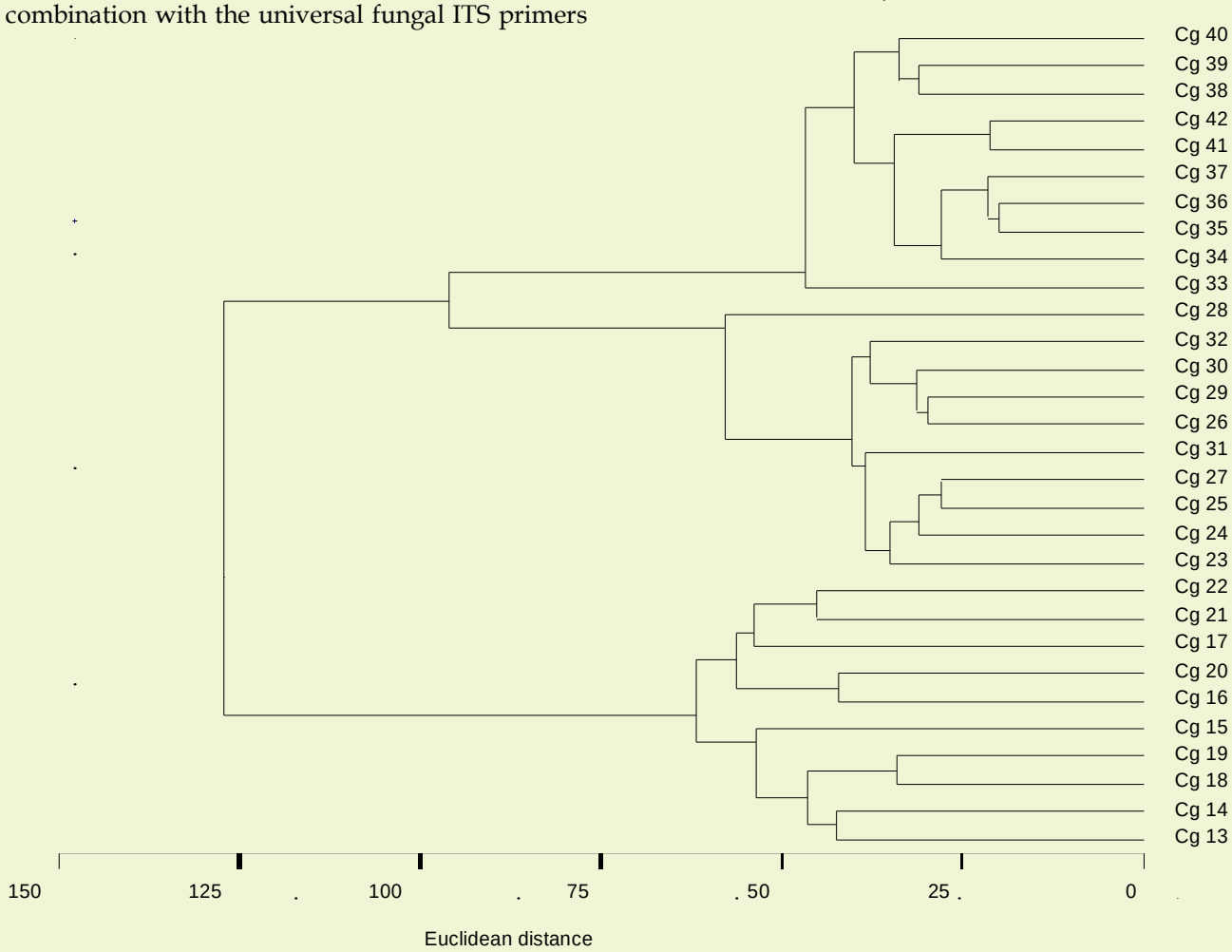



**Fig. 10 : Clustering of different isolates of *Colletotrichum gloeosporioides* based on Euclidian Distance analysis.**

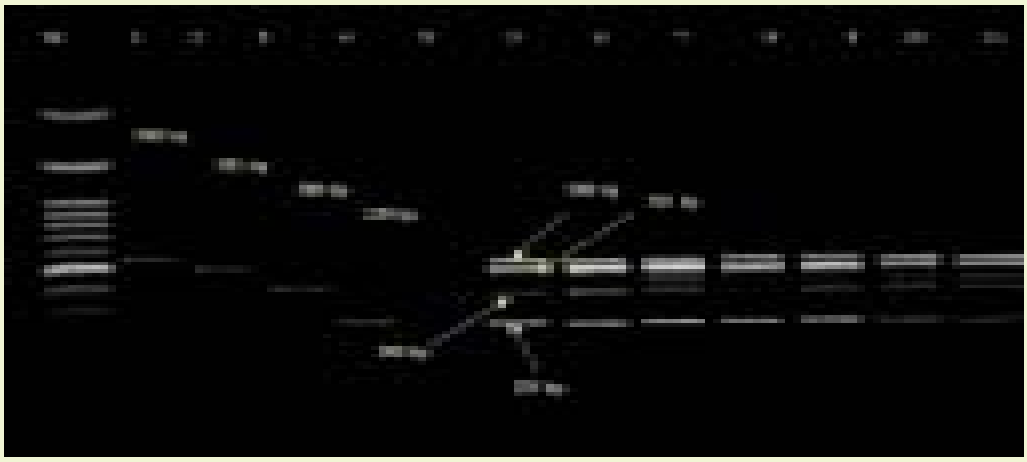


Fig. 11: Multiplex PCR for molecular diagnosis of *C. gloeosporioides*. Lane M- 100 bp DNA Ladder, 1- primer ITS1-4 (universal); 2- *pectate lyase* B gene-specific designed primer ; 3- species-specific designed primer, 4-glutamine synthetase gene-specific primer pair and N – negative control, lane 5-11 *C. gloeosporioides* isolates collected from different mango growing regions showing simultaneous expression of four set of primers in a single multiplex PCR.

## Guava (*Psidium guajava* L.)

### Nematode pests

***Spatial distribution of*** entomopathogenic nematode ***Steinernema carpocapsae :*** The most preferred habitat stratum of *Steinernema carpocapsae* revealed that its populations were higher at 15 cm depth and at a distance of 100 cm from the trunk in west side location (560 to 810 trap$^{-1}$). Population was largely found to be low at the surface. Population contours at different soil stratum were by and large found to be governed by the soil moisture. Dry spell of the year (April to June) exerted a negative pressure on population particularly at surface and at 15 cm depth. Conversely, the moisture build up followed by rain water accumulation could bring about a relative uniformity in the population density at different soil strata.

***Effect of Steinernema carpocapsae on fruit fly (Bactrocura dorsalis)*:** The nematode population collected from guava orchard was tested against fruit fly. Maggots of fruit fly of guava exposed to five population densities of *S. carpocapsae* (500, 1000, 5000, 10000 or 100000 infective juveniles) revealed that nematode failed to multiply on the maggots at either level of population density. Similarly, survival of the test insect was also not affected. Nematode population exhibited a gradual decline over period of one week. It was, however, very sharp during subsequent weeks.

### Diseases

#### Guava wilt

***Molecular diagnosis*:** Internal Transcribed Spacer (ITS) and PCR RFLP based molecular characterization of *Fusarium oxysporum* causing wilt in guava was not able to differentiate *Fusarium* at species level. Hence, a metagenomic approach was adopted, which also served as a culture independent (ciPCR) assay for the identification of the pathogen. Community DNA extracted from soil samples using Fast DNA soil


Fig. 12: 18S rDNA PCR amplification of uncultured fungi, Lane M: 100 bp DNA Ladder, 1-8 soil samples (community DNA), 9: positive control, N: negative control.

Fig. 13: PCR amplification of 230 bp with community DNA, Lane M: 100 bp DNA Ladder, 1-8: soil samples, 9: positive control and 10: negative control.

extraction kit yielded a highly pure 18S rDNA region of the fungus, which was amplified by 18S F & 18S R primer-pair (Fig. 12). Specific detection of *Fusarium* spp. was carried out with ITS 1F and ITS 1R designed primer pair. The presence of *Fusarium* spp. as a product of 230 bp was recorded in all the samples (Fig. 13).

### Mass multiplication of *Trichoderma harzianum*

In view of developing a suitable medium for culturing *Trichoderma harzianum*, five different organic sources, *viz*. extracts of banana psuedostem, neem leaves, mango peel, mango kernel and mango leaves, were evaluated. Significant growth of the fungus was observed on neem leaves ($10^6$cfu $g^{-1}$) and banana psuedostem ($10^6$cfu $g^{-1}$). On the other hand, fungal growth was relatively poor on the medium having the extracts of mango kernel and mango peel. Mango leaf extract was found to be unsuitable for the growth of fungus.

## Post-harvest management

## Mango (*Mangifera indica* L.)

### Mechanization

***Development of on-farm fruit ripening chamber***: A low-cost foldable and portable type ripening chamber made of 400 micron polyfilm measuring 3 x 1.5 x 1.2 meters (LxBxH) was designed and developed having a capacity for 5 quintal fruits. The cost of this structure comes around Rs. 2000. This ripening chamber was tested for ripening of banana and mango fruits. The cost of ripening of banana and mango fruits using ethylene gas.

### Storage

***Effect of bio-agent and MAP on storage behaviour***: Mature, hard green Dashehari mango fruits were harvested, washed thoroughly with tap water and given dip treatments with *Saccharomyces cerevisiae* ($10^8$ cells $ml^{-1}$) for 10 minutes. The fruits were surface dried, packed in brown paper bags or MAP (LDPE 200 gauge bags, 0.2% vent.) and stored under ambient conditions (30 ± 2 °C and 85 ± 5% R.H.). Fruits were analyzed for different physico-chemical attributes and assayed to isolate the population and interaction of *S.cerevisiae* after 0, 4, 6, 8 and 10 days of storage. The disease incidence (stem end rot and anthracnose) was 4.0 per cent and 12.9 per cent in fruits treated with *S. cerevisiae* and both bio-agent and MAP, respectively at 10th day of storage. Fruits treated with bio-agent and MAP had 58 per cent yellowness in peel, while in control values were 62 per cent on 8th day of storage. The development of carotenoids in pulp was the slowest in fruits treated with yeast and MAP (3.96 mg 100 $g^{-1}$) as compared to fruits treated without MAP (6.31mg 100 $g^{-1}$) on the 8th day of storage.

### Value addition

***Evaluation of varieties/hybrids for pickle*:** Nine varieties/hybrids were evaluated for pickle in oil. The analysis of fresh fruits indicated a variation of 125 to 226 g in average weight, 77.4 to 88.0 per cent in moisture, 13.3 to 22.0 mg100$g^{-1}$ in ascorbic acid and 0.70 to 2.84 per cent in titratable acidity. Crude fibre ranged between 5.5 to 8.2 per cent in fruit samples. The maximum acidity was obtained in H-1759 (2.84%) followed by Bathui (2.24%), while least acidity was noticed in H-1700 (0.70%). A decrease in acid content and increase in the content of salt and reducing sugars of pickles were recorded after six months of storage. Sensory evaluation of pickles indicated that H-1884 was the best hynrid followed by H-1750 and H-1759.

***Evaluation of varieties/hybrids for pulp:*** Eleven mango varieties/hybrids, ripened uniformly with ethrel, were evaluated for their physico-chemical characters and pulp and beverage were prepared. The average weight of fruits varied from 155 to 279 g, while pulp in ripe fruits varied from 58.3 to 72.8 per cent. The pulp of fruits of Pusa Arunima were liked organoleptically the most followed by H-1090 and H-1912, while H-1084 showed the least liking. The fruits of H-1090 recorded

highest TSS (25.7 $^0$B) followed by H-1895 (22.0 $^0$B), while it was the lowest in Black Andrew and H-1084 (17.2 $^0$B). The ascorbic acid content ranged from 25.8 to 59.0 mg 100g$^{-1}$, the highest being in H-1090. The fruits of H-1090, H-1091 and H-2530 contained high amount of carotenoids (7.31 to 7.46 mg100g$^{-1}$). The pulp prepared from these varieties/hybrids, preserved in glass jars and stored until 6 months, was evaluated for quality. An increase in reducing sugars and decrease in total carotenoids were recorded in pulp over 6 months of storage. The organoleptic quality of RTS beverage prepared from varieties/hybrids was found acceptable at 0 day, except those from H-1901, H-2530 and H-1895, which reduced upon storage. The most acceptable RTS beverage prepared from six months stored pulp was obtained from H-1090, H-1091 and Pusa Arunima.

***Development of fresh cut ripe mango slices:*** Fresh cut slices from cvs Dashehari and Totapuri fruits, ripened uniformly with ethrel, were evaluated. The slices were pretreated with $CaCl_2$ and stored at 8 ± 2 °C temperature in LDPE pouches. The Dashehari slices could be stored up to 11 days, while Totapuri for 10 days.

***Osmo-freeze dried slices*:** Osmo-freeze dried slices of mango were prepared from cvs Dashehari and Totapuri. In one experiment the mature fruits of cv. Dashehari were withdrawn after 3 or 5 days of storage and slices were dipped for two hours in syrup containing 40 per cent sugar,1.0 per cent NaCl, 0.3 per cent acid and 0.05 per cent KMS and freeze dried. The slices prepared from fruits withdrawn after 5 days of storage were better in quality with higher carotenoids, sugar and less titratable acidity. The freeze dried slices could be stored in pouches up to 8 months. The organoleptic quality of the freeze-dried slices declined with prolonged storage. The slices pretreated with sugar solution were found better organoleptically than control throughout the storage period. In another experiment, the fruits were withdrawn after 5 days of storage and grouped on the basis of pulp pressure (0.5 and 1.33 kg cm$^{-2}$) and freeze dried slices prepared and stored up to 8 months. The slices prepared from fruits having average pressure of 0.5 kg cm$^{-2}$ showed higher carotenoid content as compared to the fruits having higher pressure. The slices prepared from fruits having less pressure were acceptable organoleptically up to eight months of storage, whereas slices prepared from fruits having higher pressure were acceptable only up to four months. Similarly, the slices prepared from Totapuri fruits withdrawn after 12 days of storage of mature fruits were better in quality as compared to fruits withdrawn after 10 days.

***Screening of mango varieties for wine preparation*:** Mango wine with10 per cent alcohol was prepared from three commercial north Indian varieties, *viz.* Dashehari, Langra and Chausa. Zero time analysis of wines revealed that wine prepared from Langra variety contained maximum ascorbic acid (21.8 mg 100 ml$^{-1}$) as well as tannins (72.0 mg 100 ml$^{-1}$). Slight decrease in TSS and acid contents were observed in wines prepared from all the cultivars of mango after six months of storage. Ascorbic acid content of wine, however, declined significantly.

## Waste utilization

***Production of bio-ethanol*:** Bio-ethanol was produced from mango processing waste (peel) using *Saccharomyces cerevisiae*. The ethanol produced from mango peel had density 0.96g l$^{-1}$, flash point 41 °C, alcohol 56 proof and viscosity 0.30 mPa at 30 °C. The residual peel could be used as protein enriched supplement for animal feed.

***Development of paper and plyboard*:** Mango stone shell were utilized for making paper and ply board.

## Food safety

### Pesticide residue analysis

***Carbosulfan:*** Carbosulfan was sprayed @ 2.0 ml l$^{-1}$ of water to the trees of mango hybrid (H-1000) during fruit development stage (first week of May) to control

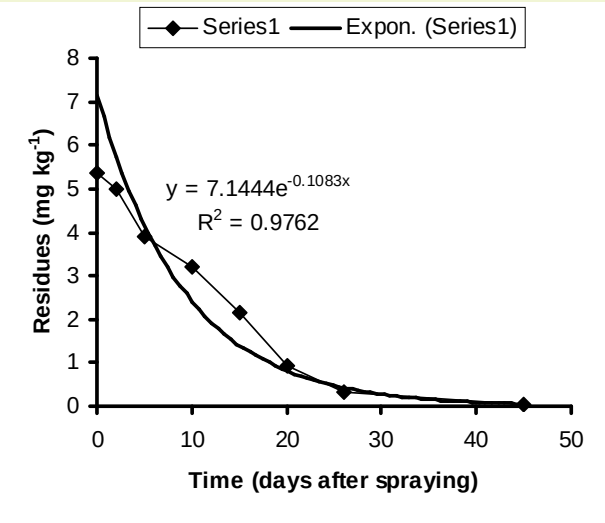



**Fig. 14: First order exponential curve of dissipation of carbosulfan residues in whole mango fruit after pre-harvest spray.**

mealy bug infestation. Carbosulfan dissipated in fruits from 5.38 mg $kg^{-1}$ after 1hr of spraying to 0.05 mg $kg^{-1}$ after 45 days of spraying at harvest. Carbosulfan residue was initially very less in pulp (0.08 mg $kg^{-1}$) after 1hr of spraying, which increased gradually to 0.9 mg $kg^{-1}$ after 10 days and finally came down to below detectable limits at harvest. The dissipation of carbosulfan in whole fruit (peel + pulp) followed first-order kinetics (Fig. 14). The residual half-life value was calculated as 7.0 days in whole mango fruit. A pre-harvest interval of 46 days after spray was suggested according to its MRL value of 0.05 mg $kg^{-1}$ in mango.

***Imidacloprid:*** Imidacloprid @ 0.3 ml $l^{-1}$ of water was sprayed during flowering stage (last week of February) in Dashehari mango trees of NAIP adopted Au-mau village to manage hopper infestation. Some fruits were bagged during first fortnight of May to observe whether there was any masking effect of bagging on degradation of imidacloprid in fruits. After harvesting, 0.49 mg $kg^{-1}$ of imidacloprid was detected in bagged fruits as compared to 0.43 mg $kg^{-1}$ in non-bagged fruits. It indicated that bagging did not have any masking effect on degradation of imidacloprid.

## Market analysis

***Disposal, arrival and price*:** The mango disposal from Lucknow region touched a 5 year high at 68.86 thousand MT during 2009-10 owing to the current year being the 'On year'. The production during the current year was 119 per cent higher than the previous year. The disposal to the markets outside Uttar Pradesh was found to be 60.36 per cent as against only 39.64 per cent in the markets within the State. This was in contrast to 72 and 28 per cent in the previous years, respectively. The disposal of mangoes to Delhi market was the highest as it accounted for 23.65 per cent of the total mango disposed from Lucknow as against 32 per cent during 2009. However, net disposal to Delhi market remained higher than the previous year owing to increased overall disposal. The disposal to Maharastra accounted for 12.01 per cent, while Punjab and Madhya Pradesh received 8.23 and 7.11 per cent of the disposals from Lucknow region, respectively. A perusal of weekly disposal pattern of mango from Lucknow indicated that about 60 per cent of the disposals were concentrated during the three week period from June 6 to 26, 2010 as against 67.89 per cent during the previous year. However, maximum disposal of 25.46 per cent was recorded during June 6 to 12, 2010. Thereafter, the disposal got reduced drastically, so much so that the second fortnight of July did not have any significant disposal from Lucknow.

The total arrival of mango in Lucknow market during 2010 was 86.7 thousand MT as against only 35.02 thousand MT of mango during the previous year. This depicted an increase of about 148 per cent over the previous year. The arrivals during the current year were highest during the last six years, i.e., 2004-2010. The arrival of mango in Lucknow started during March, 2010 which picked up in April and continued up to the first fortnight of May. Banganpalli was the main variety. June was the main period of the arrival of Dashehari as about 80 per cent of the total arrivals during the year were concentrated in this month. July accounted for about 12 per cent of the trading of mangoes in Lucknow. The average price of mango was Rs. 1153 per quintal during 2010 against Rs. 1246 per quintal during 2009. Highest price of Rs. 1737 per quintal of mango was recorded in the month of March due to meagre supply after which it came down to Rs. 1286 per quintal. Increase in price during July and August was observed due to dwindling supplies. A total of 175.94 thousand MT of Dashehari mangoes were traded in all the markets around the country. The Delhi market alone received about 55 per cent of the total Dashehari mango during May to July. It was followed by Ahmadabad, which received about 9 per cent of the total Dashehari trading in the country. The market also received significant quantities of fruit during April ( about 3.33 thousand MT) most probably from Andhra Pradesh at a very high price of Rs. 12.06 thousand per quintal. The price realization reduced sharply in the ensuing months owing to larger arrivals. Kanpur, Lucknow and Jaipur were the other important markets for Dashehari trading. The price structure indicated that there was definite price advantages in Ahmadabad market. Kolkata was another market which could be harnessed.

A total of 21.70 MT of mango cv. Langra was traded over all markets of the country during the year 2010. The fruit was traded from June to August but July received maximum amount. Kolkata was the major market which received fruits from Uttar Pradesh, Bihar and Malda and Murshidabad districts of West Bengal. The market accounted for about 52 per cent of the total langra mangoes traded in the country. Jaipur, Guwahati and Chandigarh were the other important markets for Langra as they accounted for about 18, 9, and 6 per cent of total Langra traded in the country. About 82.8 MT of Chausa was traded in different markets of the country during 2010. It was mainly traded in July and August. Delhi was the single largest

market of Chausa. It accounted for about 86 per cent of the total Chausa trading in the country. On the other hand, Kolkata received about 7 per cent of the Chausa fruits, had definite price advantage as it ranged from Rs. 8.5 to 8.8 thousand per quintal.

Banganpalli was the most traded cultivar of mango after Dashehari, as about 171.97 thousand MT of the cultivar was traded during the year 2010 in different markets of the country. This cultivar was the first one to arrive in the markets and consequently attracted premium price. Its peak arrival time was from April to June, although the arrivals started from March. The cultivar had the distinction of being traded in maximum market centres. Delhi and Nagpur were the most important markets as they accounted for about 22 and 21 per cent of the total trading in the cultivar. Hyderabad, Kolkata and Bangalore were the other important market centres for the cultivar. Chennai, Jammu, Raipur, Srinagar and Delhi paid higher price for the cultivar as the price during April was more than Rs. 3.3 thousand per quintal, whereas in other markets it was below Rs. 2.8 thousand. Totapuri was another commercial cultivar of mango which was traded in many markets around the country. Its peak arrival time was from May to July. Its total trading was restricted to 47.75 thousand MT. Hyderabad was the major market accounting for about 49 per cent of its trading around the country. Nagpur, Bangalore and Chennai were the other important markets accounting for 15, 7 and 4 per cent, respectively. The price of the cultivar ranged from Rs. 0.93 to 2.72 thousand per quintal.

***Export*** **:** India exported 74.46 thousand MT of mangoes worth Rs. 200.54 crores to 55 countries. The exports declined by 11 per cent over the all time high export of 83.70 thousand MT during the previous year. However, price realization was 17 per cent higher than the previous year. The exports to Bangladesh also declined by about 26 per cent in comparison to the previous year. An increase in the export of mango to UAE was observed both in terms of quantity (4%) and value (33%) of the exports.

India exported mango pulp and jam to 72 and 62 countries, respectively. Juice was another product which was exported to 30 countries. The country exported 236.34 thousand MT of all mango products *vis-à-vis* 314.41 thousand MT during the previous year depicting a decline of about 25 per cent, eventhough the list of countries has expanded. On the other hand, value of mango products increased from Rs. 1003.25 to 1013.62 crore. India exported 186.2 thousand MT of pulp worth Rs. 744.61 crore followed by export of 44.90 thousand MT of jam worth Rs. 245.89 crore. Squash, slice (dried), slice (brine and juice) were the other products exported. Export of mango kernel and flour has become negligible.

Saudi Arabia and UAE continued to be a dependable importers of pulp from India by receiving 34 and 9 per cent of the total pulp exports from the country although the exports of the former increased by 19 per cent, while in the case of later it has declined by 22 per cent. The export of pulp to The Netherlands decline during the current year by about 17 per cent. The year witnessed decline in export during the current year by about 17 per cent, while a 219 per cent increase in the imports of mango and its products from different countries was recorded.

***Import***: India imported 0.36 MT of mangoes worth Rs. 33 lakhs from Pakistan during the current year. It imported 2.6 thousand MT of mango juice worth Rs. 6.86 crores from 14 countries. Bangladesh emerged as single largest exporter of juice to India by accounting for 88 per cent of total juice imports by India. Mango pulp was another product,which India imported from unspecified sources. Mango squash was imported from Bangladesh. Jam was mainly sourced from The Netherlands and U.K, but its quantity was meager at 9.66 MT worth Rs. 11.96 lakhs.

## Guava (*Psidium guajava L.*)

### Mechanization

***Development of harvester:*** The developed harvesting device was evaluated for harvesting guava fruits cv. Sardar. About 250 fruits could be harvested in 1 hr. using this device as against 300 fruits by local hook type harvester. However, the percentage of bruised fruits was more (21%) in fruits harvested with local harvester than CISH harvester (2%).

### Storage

***Assessment of bio-agent:*** Mature, hard green fruits of guava cv. Allahabad Safeda were subjected to post-harvest dip treatment of bio-agent (*Saccharomyces cereviceae*) @ 0, $10^2$, $10^4$, $10^6$ or $10^8$ cell $ml^{-1}$ for 10 minutes. The fruits were surface dried, packed in brown paper bags and stored under ambient conditions (18 ± 2 °C and 575 %RH). Quality parameters such as TSS, acidity and ascorbic acid were higher in fruits treated with *Saccharomyces cereviceae* @ $10^8$ cells $ml^{-1}$ in comparison to other treatments during storage. These fruits were

good in general appearance, quality and taste with proper yellow coulur development during storage. The disease in guava fruits was the least in fruits treated with bio-agent of $10^8$ cell $ml^{-1}$ while fruits of control showed disease development on the 8th day of storage. The culture isolates showed that the fruits treated with concentration of $10^8$ cell $ml^{-1}$ had minimum colony, while the control fruits had maximum colony of other microbes.

## Value addition

***Evaluation of varieties*:** Five guava varieties/hybrids were evaluated for their processing potential. The fresh fruits of hybrid cv. Puerto Rico-2 recorded highest ascorbic acid content (259 mg $100\ g^{-1}$), whereas least was found in Spear Acid (50.5 mg $100g^{-1}$). Lycopene content ranged between 0.17 to 4.2 mg $100\ g^{-1}$, highest being in Patillo, whereas Spear acid showed the least content. Carotenoid content ranged between 1.21 to 4.10 mg $100g^{-1}$, highest was in Waikea. There was a decrease in chemical composition of pulp prepared from fresh fruits. The beverage prepared from all the hybrids/varieties were found suitable, however, the best obtained was from cv. Spear Acid.

***Osmo-freeze dried slices*** : A trial was conducted to prepare freeze dried guava slices from cv. Lalit. The slices were pretreated with salt solution and then dipped in $60\ ^0B$ sugar syrup overnight. The slices were freeze dried and a yield of 38.4 per cent was obtained after approximately 8 hours of drying time. The dried slices contained 849 mg $100g^{-1}$ of ascorbic acid and 22.73 mg $100g^{-1}$ of lycopene.

## Waste utilization

An integrated protocol was worked out for extraction of four value added products including oil, pectin, fibre and lycopene from pink pulped guava. The yield of lycopene obtained was 4.2 mg $100g^{-1}$ of pulp.

## Market analysis

***Arrival and price*:** The total arrival of guava was 12.71 thousand quintals during 2010-11, which was about 9 per cent higher than the previous year. Winter season of guava, which produced quality fruits had a good fruiting as about 83 per cent of the guava was produced during the months of November to January. About 47 per cent of total arrival of guava during the year 2010-11 was received during December month alone. The monsoon guava was mainly received during August 2010 (about 5 per cent). The average wholesale price during the year 2010-11 was Rs. 417 per quintal as against Rs. 358 per quintal during the last year, even though the arrivals have increased. The highest price of guava, i.e., Rs. 500 per quintal was realized during August, September and November, 2010. On the other hand, lowest price of guava at Rs. 215 per quintal was observed in January, 2011 followed by Rs. 349 per quintal during February, 2011.

***Export*:** The export of guava from India suffered a severe setback as only 26 countries received Indian guava during 2009-10 as against 31 countries during the previous year. The country exported only 0.52 thousand MT of guava worth Rs. 11.34 crore as against 1.69 thousand MT of guava worth Rs. 30.44 crore during the previous year. This depicted a decline of about 69 and 63 per cent in quantity and value of total guava exports from India, respectively. Oman and Nepal accounted for 15 and 12 per cent of the total guava exports from India. The price realization of guava in Nepal was found to be lower *vis-à-vis* other major importers of the fruit. The export of guava to Saudi Arabia and UAE also showed a declining trend.

A total of 5.56 thousand MT of guava products worth Rs. 158 crores was exported to different countries. Jelly was the single largest item as it accounted for about 98 per cent of the total guava product exports and 97 per cent of the total value of the guava product exports. The Netherlands and U.K. accounted for 22 and 13 per cent of jelly exports from India. On the other hand Saudi Arabia imported about 12 per cent of guava jelly from India. Minor quantities of RTS were imported by Nepal (57 %), Saudi Arabia and The Netherlands.

# Papaya (*Carica papaya* L.)

## Market analysis

***Arrival and price*:** A total of 8.35 thousand MT of Papaya was received during the April 2010 to March 2011. The arrival of papaya was throughout the year, although it fluctuated over the months. The arrival was 84 per cent higher than the previous year. April, may 2010 and March 2011 were the peak arrival months of papaya in the Lucknow market as the supplies exceeded 950 MT in each of the months and these months accounted for 11.5 to 15 per cent of total arrivals. On the other hand, August and September

were the lean months as only 3.13 and 3.37 per cent of the total arrivals of papaya during the year were received, respectively. The average price of the fruit was Rs. 417 per quintal during 2010-11, which was the highest amongst last four years.

## Aonla (*Emblica officinalis* Gaertn.)

### Value addition

***Pigment rich spray dried powder.*** Aonla, beet and carrot juices were prepared and preserved in pet bottles. The aonla juice was blended with carrot and beet juice. The maximum FRAP value (188.3 µmol $ml^{-1}$) was obtained in aonla juice, whereas carrot and beet juice had 2.66 and 9.99 µmol $ml^{-1}$ value, respectively. The spray dried powder was prepared either from pure aonla juice or its blend with 10 per cent carrot and/or beet juice and packed in laminated aluminum foil pouches with an aim to enrich aonla powder with β-carotene and anthocyanins. Blending powders of aonla and beet showed an increase in anthocyanin content from 0.47 to 14.25 mg $100g^{-1}$ but when aonla was blended with both beet and carrot the anthocyanin content decreased to 12.97 mg $100g^{-1}$. Carotenoid content in powder increased to 4.69 mg $100g^{-1}$ from 0.27 mg $100g^{-1}$ when aonla was blended with carrot but when aonla was blended with beet along with carrot showed a slight increase in carotenoid content (5.09 mg $100g^{-1}$). The maximum (0.113 OD) NEB was noted in powder prepared from blended aonla and beet juice.

### Waste utilization

A herbal formulation (dip type), developed using aonla processing waste as major ingredient, could be used as hot beverage alternative to tea. Four phenolics, *viz.* gallic acid, coumaric acid, caffeic acid and kaempferol were identified in aonla based herbal beverage through HPLC analysis.

# 5. TECHNOLOGY ASSESSMENT AND TRANSFER

## Impact assessment

The institute has developed several farmer friendly technologies of mandate subtropical fruit crops. To assess the impact of these technologies a survey was conducted in Khalishpur and Rahimabad villages of Malihabad block of Lucknow. It was revealed that the average yield of mango in the orchards of adopted farmers was 89.5 kg tree$^{-1}$ with gross return of Rs.984.50 against average fruit yield of 65.8 kg tree$^{-1}$ and gross return of Rs. 723.80 in the orchards of non-adopted farmers. The adopted farmers fully followed CISH technologies, however, only 21.0 per cent of non-adopted farmers followed these technologies. Approximately, 61 per cent of farmers adopted the polythene banding of mango trees for the control of mealy bug in Khalispur and Rahimabad villages. They wrapped polythene sheet around the mango tree stem during December. Morover, only 6 per cent of farmers used improved harvester developed by the CISH, while 94 per cent of them used self-made mango harvester. The heavy weight, longer time and trained labour requirement were the main reasons for non-adoption of the mango harvester developed by the institute. A number of mango orchardists have shown their interest for adoption of the rejuvenation technology developed by the institute but due to inadequate financial and administrative support from the government the technology could not be adoped on large scale.

## Extension interventions

***Mango gosthi*** : The institute organised three programmes on mango cultivation and post-harvest management in the districts of Saharanpur, Muzaffarnagar and Haridwar during March 23-25, 2011 wherein 350 farmers participated. Scientists of the institute delivered thematic talks on quality planting materials, high density planting, rejuvenation of old and senile orchards, post-harvest management, marketing and exports.

***Exhibitions*** : Institute participated in various state as well as national level exhibitions and displayed its achievements and technologies on mandate crops as per following details.

| Sl. No. | Event / Occasion | Place | Organizer | Date |
|---|---|---|---|---|
| 1. | National Seminar on Mango Biodiversity for Livelihood | CISH, Lucknow | CISH, Lucknow | June 25 – 28, 2010 |
| 2. | Mango Festival | Dilli Haat, New Delhi | Delhi Tourism and Transportation Development Corporation, New Delhi | July 01-03, 2011 |
| 3. | Mango Show | NASC Complex, New Delhi | CISH, Lucknow | July03, 2010 |
| 4. | Kisan Mela | IVRI, Barielly | IVRI, Barielly | November 01-03, 2010 |
| 5. | Bharat Nirman Jan Soochna Abhiyan Programme | B. P. Shukla Inter College, Trilokpur, Barabanki | Ministry of Information & Broadcasting, Govt. of India & PIB Office, Lucknow | December 11-12, 2010 |
| 6. | Science Expo-2011 | Regional Science Centre, Lucknow | Regional Science Centre, Lucknow | January 19 – 23, 2011 |

| Sl. No. | Event / Occasion | Place | Organizer | Date |
|---|---|---|---|---|
| 7. | State Level Farmers Gosthi, Fair & Exhibition | NTPC Campus, Tanda, Ambedkar Nagar | District Agriculture Office, Ambedkar Nagar | January 29-31 , 2011 |
| 8. | Tenth Agricultural Science Congress | NBFGR, Lucknow | NAAS, New Delhi | February 10 - 12, 2011 |
| 9. | Farmers Fair | IISR, Lucknow | IISR, Lucknow | February 16, 2011 |
| 10. | State Flower, Fruit & Vegetable Show | Governor House, Lucknow | Directorate of Horticulture & Food Processing, Lucknow | February 19 -20, 2011 |
| 11. | North India Regional Farmers Fair | NIT Campus, Hamirpur | Dr. Y. S. Parmar University of Horticulture & Forestry, Solan | February 23 – 26, 2011 |
| 12. | Showcasing of Agricultural Technologies | Village Dashehari, Lucknow | CISH, Lucknow | February 27, 2011 |
| 13. | National Farmers Fair | KVK, Sargatia, Kushinagar | KVK(IIVR), Sargatia, Kushinagar | March 27, 2011 |

***Exposure visit*** **:** More than 1000 farmers/ officials from different parts of the country and 50 students from University of Horticultural Sciences, Bidar, Karnataka visited the institute. During their visit they were shown scientific nursery facilities, experimental farms, processing and packaging lines, laboratories and technical information centre to make them aware about the research activities and technologies developed by the institute.

***Trainings*** **:** A total number of 14 training programmes on production, protection and post-harvest management of fruit crops and mango production and rejuvenation, sponsored by UPDASP, Lucknow, SHM, Hyderabad, SHM, Patna, ATMA, Balrampur, ATMA, Darbhanga, Muzaffarpur, Patna and Saharsa and ATMA Sagar were organized by the institute wherein 124 farmers including 16 gardeners from Chaubatia, Uttrakhand participated. Sixteen officials sponsored by Central Institute of Horticulture, Medziphema, Nagaland and 20 officials sponsored by UPDASP, Lucknow were trained on high density planting and canopy management of horticultural crops and improved scientific cultivation of fruits, respectively. Directorate of Horticulture, Guwahati sponsored 20 farmers for training on organic farming and nursery management in subtropical fruit crops. Twenty farmers, sponsored by SHM, Patna trained on improved cultivation of mango, guava and canopy management. UPDASP, Lucknow sponsored 30 farmers for training on biodynamic farming in fruit crops.

Twenty-five participants comprising 18 farm women and 7 rural youths from Au Mau and Sultanpur villages of Mal block, Lucknow participated in the training on post-harvest management and value addition of mango organized under NAIP sub-project at CISH, Lucknow during July 20-22, 2010.

The Precision Farming Development Centre (PFDC) of the institute organized three training programmes on drip irrigation, plastic mulching and protected cultivation in horticultural crops at Hardoi, Raebareli and Bakshi-Ka-Talab, Lucknow. One hundred fifty progressive farmers and 25 officers/extension workers were trained during April to September, 2010. Besides off-farm training, the on-farm interactive programmes were also conducted.

***Farmers helpline*** **:** Keeping in view the usefulness of farmers helpline/ Kisan Call Centre, institute established a new facility of Phone-in-live programme and Media Resource Centre. A group of subject matter specialists sit together on each Friday between 10 AM to 4 PM and provide farmers queries in an interactive mode. In this programme, growers' queries related to disease and insect pest management (36% ) like midge, hopper, gummosis, stem borer and leaf webber in



mango. physiological disorders (16.7%) like late and irregular flowering, alternate bearing, burning/ redness of inflorescence and rejuvenation, fruit setting, and export and marketing ( 13.9%) were attended. Export quality of papaya and mango, container capacity for export, etc., were dealt separately by the scientists. A total number of 5.5 per cent of farmers queries were based on farm machinery, power and processing. About 8.3 per cent farmers enquired about training on mango, guava and aonla cultivation. Farmers' queries (112 calls) related to production, management, plant protection, high density planting in mango and guava, processing and export were attended by the scientists and provided their solution through telephonic conversation on Kisan Call Centre. Postal queries related to various aspects of production of subtropical fruits were attended through correspondence. Extension folders and bulletins related to scientific cultivation of mango, aonla, guava and papaya were provided to the orchardists.

***Field days*** **:** Two field days on Harvesting, post-harvest handling packaging and marketing of mango at village Au-Mau, Lucknow on June 4, 2010 and Insect pest management in guava at Shivdeenpura, Kanpur on August 23, 2010 were organized under the NAIP subproject on Value Chain on Mango and Guava for Domestic and Export Markets in which 260 farmers participated.

# 6. EDUCATION AND TRAINING

Under human resource development programme following scientists were deputed on training in the country and abroad.

## India

Ms. Nimisha Sharma (Scientist) was deputed to attend the training programme on Viral genomics and transgenic development held at IARI, New Delhi from September 8-28, 2010.

Dr. Achal Singh (Senior Scientist) was deputed to attend the training programme on Data analysis using SAS held at IASRI, New Delhi, October 25-30, 2010.

Dr. Barsati Lal (Senior Scientist) was deputed to attend the training programme on Capacity building course for the frontline project staff held at IIHR, Bangalore, November 6-9, 2010.

Dr. Tarun Adak (Scientist) was deputed to attend a short course on Carbon stabilizing, saturation and sequestration : evolving concepts, mechanisms and approaches held at IISS, Bhopal, November 23 - December 2, 2010.

Ms. Pushpa K. (Scientist) was deputed to attend a winter school on Nutraceuticals: challenges and opportunities in 21st century held at UAS, GKVK, Bangalore, November 29- December 19, 2010.

Dr. H. C. Verma (Scientist, SS) was deputed to attend the management development programme on Data mining and GIS for decision support in agriculture held at NAARM, Hyderabad, January 10-22, 2011.

Dr. (Mrs.) Anju Bajpai (Senior Scientist) was deputed to attend the second training programme on Cyber laws and information security for women scientists and technologists held at IIPA, New Delhi, February 14 - 20, 2011.

Shri Umesh Hudedamani (Scientist) was deputed to attend a national training on Apomixis in horticultural crops held at IIHR, Bangalore, March 8 - 21, 2011.

Dr. Tarun Adak (Scientist) was deputed to attend a national training on Quantifying impact of climate change on agriculture held at NCAP, New Delhi, March 21 - 25, 2011.

## Abroad

Dr. (Mrs.) Anju Bajpai (Senior Scientist) was deputed to attend training on Marker assisted selection in horticulture plants at Clemson University, USA under NAIP, April 7 - July 7, 2010.

Dr. (Mrs.) Bharti Killadi (Scientist) was deputed to attend training on Sensor based applications including bio-indicators at University of Georgia-Tifton, USA under NAIP, August 23 - November 21, 2010.

Dr. S. Rajan (Principal Scientist) was deputed to attend the Regional Workshop on Good practices of conservation and sustainable use of cultivated and wild tropical fruit tree diversity of the UNEP/ GEF project held at Chiang Mai, Thailand, February 22-26, 2011.

## Lectures organized

Under lectures series programme following scientists of the institute and experts from outside delivered lectures on emerging scientific areas:

- Dr. Kailash Kumar, Principal Scientist delivered a talk on Problem soils of India and their management, July 30, 2010.
- Shri Shashi Sharma (Principal Scientist) delivered a talk on Diversity, conservation and management of insect pollinators in fruit crops, October 1, 2010.
- Prof. K.N.Tiwari, IIT Kharagapur delivered a lecture on Water resources available in Uttar Pradesh, November, 2010.
- Ms. Pushpa K. (Scientist) delivered a talk on Nutraceuticals : challenges and opportunities in 21st century", February 28, 2011.

# 7. AWARDS AND RECOGNITIONS

## नराकास पुरस्कार

केन्द्रीय उपोष्ण बागवानी संस्थान, रहमानखेड़ा, लखनऊ की राजभाषा पत्रिका ''उद्यान रश्मि'' के वर्ष 10 के संयुक्तांक को हिन्दुस्तान ऐरोनॉटिकल लिमिटेड में आयोजित नगर राजभाषा कार्यान्वयन समिति की बैठक के दौरान प्रथम पुरस्कार प्राप्त हुआ।

राजभाषा अनुभाग के संयुक्त सचिव डॉ. डी. के. पाण्डे से पुरस्कार ग्रहण करते श्री धीरज शर्मा

यह पुरस्कार भारत सरकार के गृह मंत्रालय के राजभाषा अनुभाग के संयुक्त सचिव, डॉ. डी. के. पाण्डे द्वारा प्रदान किया गया। संस्थान की ओर से यह पुरस्कार श्री धीरज शर्मा, सहायक निदेशक (राजभाषा) ने ग्रहण किया। लखनऊ की नराकास में 160 से ज्यादा सरकारी कार्यालय हैं।

नराकास द्वारा प्रदत्त छठे पुरस्कार के साथ
डॉ. एच. रविशंकर, निदेशक (बीच में) एवं अन्य

नराकास की 64वीं बैठक के दौरान हिन्दी में सर्वोत्तम कार्य करने के आधार पर संस्थान को 6ठा पुरस्कार प्रदान किया गया। यह पुरस्कार किसी भी कार्यालय/संस्थान द्वारा विगत छमाही में किये गये कार्यों के सत्यापन उपरान्त प्रदान किया जाता है। संस्थान द्वारा प्रेषित आँकड़ों का सत्यापन नराकास के सदस्य सचिव डॉ. विजय नारायण तिवारी द्वारा किया गया।

## Award

Rajan S., L.P. Yadava, M. Abdul Nizar and S. N. Gohil, received best poster award on paper entitled Mango livelihood security of tribals in Nandubar district of Maharshtra in National Seminar on Mango Biodiversity for Livelihood June 25-28, 2010, CISH, Lucknow.

Ram R.A. and Atul Singha received second prize for poster presentation on paper entitled On-farm production of quality organic inputs for soil and plant health management in mango cultivation in National Seminar on Mango Bio-diversity for Livelihood June, 25-28, 2010, CISH, Lucknow.

Singh, Achal and S., Rajan, Application of incomplete designs in different crossing populations of mango for better utilization of planting maretial in National Seminar on Mango Biodiversity for Livelihood June 25-28, 2010, CISH Lucknow.

Chandra, R., Anju Bajpai and Muthukumar M. received second prize for poster presentation on paper entitled Genetic conformity of *in vitro* generated guava plantlets using DNA markers in National Seed Congress : Quality Seeds for Prosperity, January 29-31, 2011, Pune.

Bajpai Anju, Muthukumar M., Nimisha Sharma, Umesh Hudedamani, R. Chandra and S. Rajan received best poster award for paper entitled 'Microsatellite based genome analysis in mango (*Mangifera indica* L.) in Xth Agricultural Science Congress on Soil, Plant and Animal Health for Enhanced and Sustained Agricultural productivity. February10-12, 2011, NBFGR, Lucknow.

## Exhibition

The Institute bagged second prize for best exhibition among ICAR institutes in National Farmers Fair' organized by Indian Institute of Vegetable

Research, Varanasi at KVK, Sargatia, Kushinagar, U.P. on March 27, 2011.

## Recognitions

Dr. A.K. Misra was elected Vice President of the Indian Society of Plant Phytopathologist, Ludhiana.

## Seminars/ Symposia/Meetings

Dr. Kailash Kumar acted as Convener of the technical session – V Resource management for sustainable production through system approach and soil health in the National Seminar on Biodiversity in Mango for Sustainable Livelihood held at CISH, Lucknow, June, 25-28, 2010.

Dr. V. K. Singh acted as Convener of the technical session – VI Production physiology in the National Seminar on Biodiversity in Mango for Sustainable Livelihood held at CISH, Lucknow, June 25-28, 2010.

Dr. V. K. Singh acted as Rapporteur in Thematic Annual Workshop – 2011 on Basic and Strategic Research on Frontier Areas of Plant Science held at IIHR, Bangalore, March 07, 2011.

# 8. LINKAGE AND COLLABORATION

The institute has in place MOUs to facilitate capacity building initiatives with Lucknow University, Lucknow; Babasaheb Bhimrao Ambedkar University, Lucknow; Integral University, Lucknow; Sam Higginbotham Institute of Agriculture, Technology and Science, Allahabad; Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut and Bundelkhand University, Jhansi for pursuing research as part of M. Sc. and Ph. D. degrees of their students. Institute is also recognized by IGNOU, New Delhi as one of the study centres for offering one year Diploma on value added products from fruits and vegetables and a Certificate course on organic farming. National Horticulture Mission has identified the institute as nodal centre for imparting training on rejuvenation of old and unproductive mango orchards and meadow orcharding in guava. Linkages were also developed with the Sultanate of Oman and other organizations including APEDA, DBT, UPCAR, etc., to achieve the research targets.

The externally and foreign aided projects in operation at the institute are listed below :

| Sl.No. | Project Title | PI | Period |
|---|---|---|---|
| | **DAC, NCPAH, Ministry of Agriculture, GOI, New Delhi** | | |
| 1. | Hi-tech horticulture for efficient utilization of resource through precision farming (PFDC) | Dr. V.K. Singh | May, 2002 – Continue |
| | **Technology Mission, Ministry of Agriculture, GOI, New Delhi** | | |
| 2. | Technology mission for integrated development of horticulture in North-Eastern State<br>Subproject – Organic/ biodynamic cultivation of horticultural crops in N.E. region including Sikkim | Dr. R.A. Ram | 2003 –2012 |
| | **DBT, Ministry of Science and Technology, GOI, New Delhi** | | |
| 3. | Development of genetic resource database and information system for mango | Dr. S. Rajan | December, 2006 – Continue |
| | **National Medicinal Plants Board, Ministry of Health and Family Welfare, GOI, New Delhi** | | |
| 4. | Anti-diabetic activity guided fractionation and associated attributes in potential germplasm of jamun (*Syzgiumcumini*Skeels) | Dr. A.K. Singh | 2008-2011 |
| 5. | Intensification of research on bael(*Aeglemarmalos* Corr.) with reference to medicinal value | Dr. Devendra Pandey | 2008 –2011 |
| | **PPV & FRA, Ministry of Agriculture, GOI, New Delhi** | | |
| 6 | Developing national repository and creating facilities for DUS testing in mango (*Mangiferaindica*L.), guava (*Psidiumguajava*L.) and litchi (*Litchi chinesis*Sonn) | Dr. S. Rajan | June, 2010 - 2013 |
| | **UPCST, Ministry of Science & Technology, Government of U.P., Lucknow** | | |
| 7. | Genetic transformation of guava (*Psidiumguajava* L.) for wilt resistance | Dr.Maneesh Mishra | March, 2010 – 2013 |

| Sl.No. | Project Title | PI | Period |
|---|---|---|---|
| | **UPCAR, Ministry of Agriculture, Government of U.P., Lucknow** | | |
| 8. | Management studies for irregular bearing in mango | Dr. V.K. Singh | October, 2008 – October, 2011 |
| 9. | Establishment of model nursery for organic production of quality planting materials of mango, guava, aonla and bael with modern techniques | Dr. R.A. Ram | 2010-2013 |
| | **NAIP, ICAR, New Delhi** | | |
| 10. | Understanding the mechanism of off-season flowering and fruiting in mango under different environmental conditions | Dr. S. Rajan Consortium PI | 2008-2011 |
| 11. | A value chain on mango and guava for domestic and export markets | Dr. S.K.Shukla Consortium PI | 2009-2012 |
| 12. | Mobilizing mass media support for sharing agro-information | Dr. H. Ravishankar CCPI | 2009-2012 |
| 13. | Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raebareli districts of U.P. | Dr. R.A. Ram CCPI | 2009-2012 |
| | **AMAAS, Mau, U.P.** | | |
| 14. | Utilization of mango processing waste for obtaining value added products through fermentation | Dr. (Smt.) NeelimaGarg | April, 2007 – Continue |
| | **ICAR Networking Project, New Delhi** | | |
| 15. | National network project on underutilized fruits | Dr. A. K. Singh | September, 2005 – August, 2010 |
| 15. | Network project on transgenics in crops (Papaya) | Dr. Ramesh Chandra | October, 2005 – March 2012 |
| 16. | Seed production in agricultural crops and fisheries (Mega Seed Project) | Dr. S. Rajan | March, 2006 – Continue |
| 17. | Network project on assessment of gender issues and identification and refinement of selected women specific technologies in horticultural crops | Dr. S.K. Shukla Co-PI | 2009- 2012 |
| 18. | Intellectual property management and transfer/ commercialization of agriculture technology scheme | Dr. (Smt.) NeelimaGarg | 2008- Continue |

| Sl.No. | Project Title | PI | Period |
|---|---|---|---|
| | **Outreach Programme in Network Mode(ICAR), New Delhi** | | |
| 19. | Outreach programme on management of sucking pests on horticultural crops<br>Sub project : Mango hopper | Dr. R.P. Shukla | 2009- 2012 |
| 20. | Outreach programme on *Phytophthora*, *Fusarium* and *Ralstonia* diseases of horticultural and field crops<br>Sub project : *Fusarium* (Guava) | Dr. B.K. Pandey | 2009- 2012 |
| 21. | Outreach programme on diagnosis and management of leaf spot diseases of field and horticultural crops. Sub project : *Colletotrichum* (Mango) | Dr. B.K. Pandey | 2009- 2012 |
| | **The Sultanate of Oman** | | |
| 22. | Mango tree encyclopedia project | Dr. S. Rajan | November 5, 2008 - November 4, 2011 |
| | **UNEP/GEF-PDF-B** | | |
| 23. | Conservation and sustainable use of cultivated and wild tropical fruits diversity: Promoting sustainable livelihoods, food security and ecosystem services. | Dr. S. Rajan | 2009 - 2014 |

# 9. AICRP /PFDC

## AICRP (STF)

All India Coordinated Research Project on Subtropical Fruits (AICRP, STF) with its headquarters located at Central Institute for Subtropical Horticulture (CISH), Lucknow has 18 centres working on mango, guava, litchi and grapes. Out of these 5 centres are based at different ICAR institutes, 12 in SAUs and one in a non-government agency. Two ICAR based centres are regular centres, while 3 are co-opted centres. The research on grapes is being carried out at 4 centres under the supervision of NRC on Grapes Pune. A new centre on grape at JNKVV, Mandsore (MP) was also added in XIth Plan. Research activities on mango, guava and litchi are implemented under the guidance and supervision of AICRP (STF) headquarters situated at CISH, Lucknow. A total number of 68 trials divided into 6 sections related to crop improvement, crop production and crop protection aspects of mango, guava and litchi were conducted at various centres.

Genetic stocks of mango, guava and litchi were collected, evaluated and maintained in nine regular and three voluntary centres of AICRP (STF) for selection of suitable cultivars/varieties for different regions and for using them for further crop improvement and production programme. These germplasm were evaluated for their quantitative and qualitative traits. Cataloguing of genetic stocks of different subtropical fruits was undertaken using different descriptors.

## Crop improvement and genetic resources

### Mango (*Mangifera indica* L.)

A total number of 36 seedling mango germplasm were collected and characterized. Out of these, 18 from FRS, Sangareddy, 5 from FRS, Rewa, 5 from AES, Paria, 4 from RFRS, Vengurle and 2 each from RCA, Udaipur and BCKV, Mohanpur were collected. Apart from these, 15 superior clones of leading varieties under different agro-ecological regions were also collected. These were 2 of Hapus (Alphonso) from Vengurle, 1 each of Sunderja and Langra from Rewa, 3 of Banganpalli from Sangareddy, 1 of Langra from Sabour, 5 each of Neelum, Rumani and Banganpalli and 1 of Alphonso from Periyakulam and 2 of Dashehari from Pantnagar.

A total number of 158 mango accessions were evaluated. These were 12 from Sangareddy, 67 from FRS, Rewa and 89 from RFRS, Vengurle. Apart from above, a total number of 49 accessions were augmented by different centres (gene bank which consisted of 27 at IIHR, Bangalore, 4 at AES, Paria, 15 at Pantnagar and 3 at RCA, Udaipur). CISH-M2 recorded maximum number of fruits (448) and yield (108.37 kg tree$^{-1}$) at FRS, Sangareddy. Cultivar Bangalora produced maximum fruit yield (91kg tree$^{-1}$) followed by Surajgarh Maldah (83 kg tree$^{-1}$) at BAC, Sabour. Cultivar Maharaja Pasand recorded maximum (1330g) fruit weight followed by Hybrid 7/15 (1058g) and Tella Gulabi (1010g) at IIHR, Bangalore. Similarly, highest fruit weight was recorded by cvs Vanraj (380g) followed by Totapuri (306.7g) and Maldah (250.7g) at FRS, Rewa. In general, cvs Totapuri and Amrapali recorded consistent economic yield at most of the centres. Dashehari-35 performed better at FRS, Sangareddy.

A total number of 833 flowers were crossed in sixteen cross combinations and 41 fruits were harvested at AES, Paria, whereas 11007 flowers were crossed involving Alphonso, Vanraj, Amrapali and Arka Puneet at IIHR, Bangalore. Amongst the $F_1$ populations available at IIHR, one promising hybrid $R_1 P_2$ from Amrapali x Arka Anmol was selected based on field and laboratory evaluation and the hybrid possessed optimum fruit size and perceptible fruit quality along with shelf life of 14 days under ambient conditions. At RFRS, Vengurle a total number of 1310 crosses were made and 115 fruits were harvested. Finally, 100 $F_1$ hybrid progeny obtained were planted in pots for initial establishment.

Screening of mango germplasm against important insect pests and diseases showed highest infestation of stone weevil (10 to 42%) under unmanaged orchards in Chitoor and Nuzividu districts of Andhra Pradesh. The popular cultivars, *viz*. Neelum and Banganpalli of AP, were found free from infestations. Apart from above, 110 varieties screened at Sangareddy showed negligible infestation (0 to 3%) commercial varieties, *viz*. Suvarnrekha, Vanraj, Totapuri, Banganpalli, Cherukurasam and Himayat, were free from infestations. One hundred and one varieties were also screened for hoppers, thrips, scales, mealy bug and fruit borer. Thirty nine accessions of mango germplasm were screened for mango hoppers and thrips at AES, Paria. Maximum hopper population was recorded in Ratna (22.45 panicle$^{-1}$),

whereas minimum in Zardalu (2.15 panicle$^{-1}$) followed by Hybrid-13-3 (2.20 panicle$^{-1}$), Kishen Bhog (2.45 panicle$^{-1}$) and Fernandin (2.60 panicle$^{-1}$). At RFRS, Vengurle, Alphonso, Hy 7/1, Neelum, Neelum x Himayaaddin, Sabja and Sindhu were found free from stone weevil infestation. However, none of the cultivars were found free from fruit fly infestation, Creeping and Dilpasand were the most susceptible varieties.

### Guava (*Psidium guajava* L.)

A total number of 7 new accessions of guava, 3 at FRS, Rewa and 4 at RCA, Udaipur, were augmented to field gene bank. Apart from these, 14 accessions of guava were also established at PAU, Ludhiana, being the new centre for guava. A total number of 160 accessions of guava were evaluated at different centres, *viz*. 50 at FRS, Rewa, 25 at FRS, Sangareddy, 4 at IIHR, Bangalore, 11 at HC&RI, Periyakulam, 14 at PAU, Ludhiana, 26 at RCA, Udaipur and 4 at RFRS, Vengurle.

Under varietal trial with six guava varieties, cv. Sardar recorded maximum number of fruits (61) and yield (8.81kg tree$^{-1}$) at FRS, Sangareddy though maximum fruit weight (160g) was recorded in cv. Red Flesh. At RFRS, Vengurle maximum number of fruits and yield were recorded in Sardar (66.8 and 12.6kg tree$^{-1}$) followed by Allahabad Safeda (66 and 11.8kg tree$^{-1}$).

A total number of 7314 hybrid progenies of 36 cross combinations of guava were planted in field for evaluation at IIHR, Bangalore. Maximum fruit weight (279.8g) was recorded in $F_1$ hybrid progeny $R_2$ $P_{15}$ followed by $R_{18}$ $P_7$ (272.2g) although seed hardiness varied between 6.35 to 12.75 kg cm$^{-2}$.

Maximum fruit weight (185g) and TSS (12.2 $^0$B) were recorded in hybrid Arka Mridula at IIHR, Bangalore, whereas maximum fruit weight and TSS were recorded in hybrid Shweta and Arka Mridula at RCA, Udaipur.

### Litchi (*Litchi chinensis* Sonn)

A total number of 82 accessions of litchi were maintained in field gene bank at different centres, *viz*. NRCL (L), Muzaffarpur (40), BCKV, Mohanpur (11) and GBPUA&T, Pantnagar (31). Out of 16 germplasm of litchi evaluated, cv. Rose Scented showed higher yield and better quality followed by Dehradun and PHS-1 at GBPUA&T, Pantnagar.

In varietal trial of litchi, a set of 12 varieties was laid out at 4 locations. Maximum fruit weight (20.80g) and pulp weight (15.02g) were recorded with minimum seed weight (2.40g), TSS (18.60 $^o$B) and TSS: acid ratio (66.00) in cv. Bedana at BCKV, Mohanpur though maximum fruit yield was obtained in cv. Bombai. At GBPUA&T, Pantnagar, maximum fruit yield (45.0 kg tree$^{-1}$), fruit weight (20.35g) with minimum acidity (0.49%) was recorded in cv. Rose Scented.

## Crop production

### Mango (*Mangifera indica* L.)

Maximum fruit weight (436.0g) was recorded in Banganpalli on Vellaikolumban rootstock although the cumulative yield (2004-10) was the highest on Nekkare rootstock at FRS, Sangareddy. Maximum fruit yield was recorded in double hedge row system of planting at FRS, Rewa, GBPUA&T, Pantnagar and BCKV, Mohanpur. Under pruning trial for high density planting, maximum fruit weight (488.3g) was recorded by heading back of the terminal shoots biennially at 20 cm immediately after harvest in cv. Banganpalli at FRS, Sangareddy, whereas maximum number of fruits (188 ) and total yield (50.5 kg tree$^{-1}$) were recorded by heading back of the terminal shots at 10 cm biennially at RFRS, Vengurle. Similarly, maximum number of fruits (65) and yield (32.7 kg tree$^{-1}$) were recorded at GBPUA&T, Pantnagar. At FRS, Rewa maximum yield (87.27 kg tree$^{-1}$) in pruning trials was recorded where paclobutrazol was applied.

Heading back of overcrowded branchlets and centre opening in bearing trees, planted at normal distance, just after fruit harvest with application of paclobutrazol ($M_3$ $T_1$ $P_1$). Maximum number of fruits (227.33) and yield (54.17kg tree$^{-1}$) were recorded at HC&RI, Periyakulam. Similar results were recorded at FRS, Rewa and BCKV, Mohanpur.

In IPNM of mango, recommended dose of fertilizers gave maximum yield (401.98 kg tree$^{-1}$) at FRS, Sangareddy, whereas treatment of half dose of recommended fertilizer +*Azotobacter* (250g) + 50 kg FYM recorded maximum yield (59.11kg tree$^{-1}$) at BCKV, Mohanpur. Spraying of Zn (03%) + B (0.2%) + Mn (1%) + Ca (0.6%) along with 10 cm thick organic mulching was found most effective in enhancing the yield and number of fruits at RFRS, Vengurle.

In order to understand the effect of different chemicals on regulation of flowering and fruiting in mango, maximum number of fruits and cumulative yield were recorded in treatment $KH_2PO_4$ (1%) +

$KNO_3$(1%) at FRS, Sangareddy, GBPUA&T, Pantnagar and BAC, Sabour, whereas spraying with $KH_2PO_4$ alone recorded highest yield at RFRS, Vengurle.

Spraying of $CaCl_2 6H_20$ (6%) along with mulching increased the fruit set (5.86), fruit weight (401.3g) and storage life (13.5 days) of mango at FRS, Sangareddy. Mulching + $CaCl_2 6H_20$ (4%) registered highest yield (33.44 kg tree$^{-1}$) and fruit weight (299.0 g) at HC&RI, Periyakulam, whereas spraying of borax (1%) + mulching recorded maximum yield (29.95 kg tree $^{-1}$) and fruit weight (175g) at Pantnagar. At AES, Paria, pre-harvest spraying of 1per cent $K_2S0_4$ along with mulching was found quite effective in harvesting of maximum number of fruits (59.44) and yield (41.94 kg tree$^{-1}$) with improved fruit quality, whereas maximum yield (89.2 kg tree$^{-1}$) was recorded by spraying borax (1%) alone at BAC, Sabour.

The spraying of boric acid and sorbitol significantly enhanced the yield, number of fruits, average fruit weight and fruit set at FRS, Sangareddy and GBPUA&T, Pantnagar. However, at HC&RI, Periyakulam, spraying of Ca $(NO_3)_2$ (6%) + sorbitol (2%) was found effective and maximum pollen germination (87.30%), yield (72.87 kg tree$^{-1}$) and fruit weight (245.3g) were recorded. At AES, Paria, spraying of calcium nitrate + boron was found effective in maximizing the yield, whereas spraying of sorbitol (2%) alone rendered maximum flowering, fruit retention, number of fruits and yield at RFRS, Vengurle.

## Guava (*Psidium guajava* L.)

In IPNM trial of guava, maximum yield (159.46 kg tree $^{-1}$) was obtained when ½ of recommended dose of fertilizer + 25.0 kg FYM + *Pseudomonas florescence* (250 g) were applied at FRS, Sangareddy, while at FRS, Rewa, ½ of recommended dose of fertilizer + 25.0 kg FYM +5.0 kg vermicompost recorded maximum yield (50 kg tree $^{-1}$). Application of ½ recommenced dose of fertilizer + 50 kg FYM +250 g *Azospirillum* gave maximum yield (66.34 kg tree$^{-1}$) at GBPUA&T, Pantnagar, whereas maximum yield (50.41 kg tree$^{-1}$) was recorded with the application of ½ recommended dose of fertilizer + 25kg FYM + *Trichoderma* (250g) at BAC, Sabour. Maximum yield (137.63 kg tree$^{-1}$) was recorded when irrigation was provided with 4 drippers plant$^{-1}$ daily at FRS, Rewa. The application of vermi compost (25 kg tree$^{-1}$) + *Azospirillum* culture (250 g tree$^{-1}$) + PSB (250 g tree$^{-1}$) gave maximum yield (153.35 kg tree$^{-1}$) at FRS, Sangareddy under the development of organic package of practices.

## Litchi (*Litchi chinensis* Sonn)

Double Hedge row system of planting in litchi (222 plants ha$^{-1}$) produced maximum yield along with improved quality in cv. Rose Scented at GBPUA&T, Pantnagar and cv. Bombai at BCKV, Mohanpur. Training of litchi with open vase system recorded maximum yield (21.6 kg tree$^{-1}$) and fruit weight (19.3 g) in cv. Bombai at BCKV, Mohanpur. Harvesting of fruit along with 50 cm long branches resulted in maximum yield (42.36 kg tree$^{-1}$) as well as cumulative yield (234.74 kg tree$^{-1}$) with in cv. Bombai at BCKV, Mohanpur, whereas harvesting of fruit with 50 cm long branches along with removal of new flushes during November–December recorded maximum fruit yield (50.35 kg tree$^{-1}$) in cv. Rose Scented at GBPUA&T, Pantnagar. Application of normal dose of fertilizers followed by spraying of Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) resulted in maximum yield in cv. Rose Scented at GBPUA&T, Pantnagar. Soil and leaf nutrient content varied in different litchi orchards under different centres. Under irrigation trial of litchi maximum yield (30.51kg tree$^{-1}$), fruit weight (21.15 g) and TSS (22.3 $^0$B) were recorded at 1.0 V level of irrigation at GBPUA&T, Pantnagar.The controlling of sun light through use of shed net (30% and 50%) was found most effective treatment in delaying harvesting (11 and 10 days) and producing high yield and good quality fruits at GBPUA&T, Pantnagar. Similarly, maximum fruit yield and quality were influenced by girdling (1mm wide and deep) of 25 per cent primary branches in cv. Rose Scented at Pantnagar.

# Crop protection

## Mango (*Mangifera indica* L.)

Peak activity of hopper population (22.2 hoppers panicle$^{-1}$) was noticed during 7$^{th}$ standard week (3$^{rd}$ week of February) in cv. Banganpalli at FRS, Sangareddy. However, the hopper population on trunk was very high throughout year. Population on trunk was positively correlated with temperature and negatively correlated with rainfall and relative humidity. At BAC, Sabour maximum population of hopper was recorded between 5$^{th}$ and 23$^{rd}$ standard week. The peak population of hopper (26.70 hoppers panicle$^{-1}$) was recorded during 9$^{th}$ standard week at AES, Paria. Hoppers activity was seen throughout the year, except in rainy months, and positive correlation of population with maximum temperature and sunshine hours was recorded. However, at Pantnagar,

adult population of mango hoppers was high (12.10 to15.86 hoppers panicle$^{-1}$) in the month of April in most of the commercially growing cultivars of mango, whereas the population of hoppers was present throughout the year except May, August and September. Highest population of hoppers (17.49 hoppers panicle$^{-1}$) was recorded during the first fortnight of February. Maximum fruit fly population was recorded during the second fortnight of May having a positive correlation with temperature and negative with morning hour's relative humidity at FRS, Sangareddy. At AES, Paria, the fruit fly population was active throughout the year, highest being recorded in 27$^{th}$ standard week (769.0 males trap$^{-1}$) showing a significant positive correlation with minimum temperature and wind velocity. Similarly, peak incidence of fruit fly was recorded between 25$^{th}$ to 28$^{th}$ standard week (78, 100, 85 and 100 males trap, respectively), in cv. Himsagar at BCKV, Mohanpur and in 26$^{th}$ standard week (502.75 flies trap$^{-1}$ week$^{-1}$) at MPKV, Rahuri. Hanging of wooden block soaked solutions containing alcohol: methyl eugenol and DVPP in the ratio of 6:4:1 (10 traps ha$^{-1}$) in plastic bottles gave excellent results and trapped maximum flies (196 males trap$^{-1}$) as compared to other treatments.

Different IPM modules were evaluated for control of hopper population in commercial cultivars of mango in different regions. Maximum yield (3.68 MT ha$^{-1}$) was recorded by Module-IV, which was at par with Module-I (2.66 MT ha$^{-1}$) at MPKV, Rahuri. Module-III was most effective as it recorded minimum hopper population (1.2 hoppers panicle$^{-1}$) and maximum yield (216.6 kg tree$^{-1}$) at BAC, Sabour. Maximum yield (120.0 kg tree$^{-1}$) was recorded in Module IV followed by Module III (100.0 kg tree$^{-1}$) at BCKV, Mohanpur. However, the Modules III and IV proved better over other modules in reducing the hopper population (0.20 and 0.45 hoppers 10 panicles$^{-1}$) as well as registering highest yield (322.50 and 303.75 kg tree$^{-1}$) at GBPUA&T, Pantnagar, whereas Module II was found the most effective and significantly superior over other treatments, except Module IV, at RFRS, Vengurle.

Survey and surveillance of pollinators in different agro-ecological regions showed that average population of pollinators was the highest in south direction (3.3 panicle$^{-1}$) followed by east (2.4 panicle$^{-1}$), although highest being concentrated between middle of tree canopy at BAC, Sabour, Similar results were also obtained at AES, Paria and GBPUA&T, Pantnagar.

A total number of 566 accessions of mango, including standard varieties/ hybrids/seedlings/ clones were evaluated against mango malformation at RFRS, Vengurle (112), FRS, Sangareddy (297), BCKV, Mohanpur (72), AES, Paria (42) and BAC, Sabour (43). Approximately 192 accessions were found free from malformation under different agro-ecological regions of the country.

Appearance of powdery mildew was first noticed in 4$^{th}$ week of February (PDI-5.7%), which reached severity during I$^{st}$ week of March (PDI-12.25%) on panicles, second week of February on leaf and twigs at FRS, Sangareddy, I$^{st}$ week of February at AES, Paria and 2$^{nd}$ fortnight of January at RFRS, Vengurle. The mean maximum (32.60 $^{o}$C) and minimum (10.84 to 11.19 $^{o}$C) temperature and relative humidity (50 to 60%) recorded between 5$^{th}$ to 8$^{th}$ standard weeks were found very congenial for the appearance and spread of powdery mildew at RFRS, Vengurle. Pre-harvest spraying of tricyclozole (0.1%), carbendazim (0.1%) and saaf (0.2%) reduced anthracnose incidence significantly at FRS, Sangareddy, RFRS, Vengurle, BCKV, Mohanpur and AES, Paria. Mango blossom blight (combined infection of anthracnose and *Alternaria*) could be controlled by pre-harvest application of tricyclozole (0.2%) at FRS, Sangareddy and RFRS, Vengurle, mancozeb (0.2%) at BAC, Sabour, carbendazim + mancozeb (0.2%) at FRS, Rewa and carbendzim (0.1%) at BCKV, Mohanpur.

Roving surveys conducted by different centres revealed the status of various diseases in their areas. Maximum infection of anthracnose (25.6%) in cv. Beneshan during September, blossom blight (8.2%) and powdery mildew (15.80%) in cv. Dashehari with high PDI (21.6%) and malformation in cv. Baneshan in March was noted at FRS, Sangareddy. Blossom blight (91.2%) on winter flowering flush and sooty mold (47.6%) and anthracnose (31.13%) on new flush of rainy season were recorded at RFRS, Vengurle. At AES, Paria, the disease intensity, *viz*. powdery mildew (2.56 and 13.12%), anthracnose (7.60 and 22.64%) and sooty mold (16.0%) varied along with maximum floral (9.0%) and vegetative (6.00%) malformation. Although, under fixed plot survey maximum powdery mildew (12.60%) was recorded during 2$^{nd}$ fortnight of March. The black banded disease was maximum (25%) during first fortnight of November and maximum red rust incidence (10.20%) was found during first fortnight of September at AES, Paria. Malformation, anthracnose and red rust were graded as major diseases at BAC, Sabour and FRS, Rewa. Similarly, maximum severity of bacterial fruit canker (19.10%), sooty mold (17.15%), black tip (10.50%), blossom blight (8.20%), powdery

mildew (7.50%), anthracnose fruit spot (6.18%) and malformation (3.6%) were recorded at BCKV, Mohanpur.

Pre-harvest spray of carbendazim (0.1%) 30 days prior to harvest was found better in controling anthracnose at FRS, Sangareddy, whereas minimum anthracnose incidence and severity were recorded by pre-harvest spray of carbendazim 30 to 15 days prior to harvest followed by hot water treatment supplemented with carbendazim at BCKV, Mohanpur. On the $10^{th}$ day of storage, treatments of fungicidal spray with post-harvest hot water fruit dip treatments alone or in combination with fungicide were found most effective at RFRS, Vengurle.

## Guava (*Psidium guajava* L.)

Hanging of wooden blocks soaked in solution containing alcohol, methyl eugenol and DDVP in the ratio of 6:4:1 was found highly effective in trapping maximum fruit flies (40.6 and 60 flies $trap^{-1}$ $week^{-1}$) at BAC, Sabour and MPKV, Rahuri, respectively, for successful control of guava fruit fly.

*Trichoderma viride* showed best efficacy in checking guava wilt at BCKV, Mohanpur. However, seasonal occurrence of different diseases of guava showed maximum incidence of wilt (13.50%) and dieback during post-monsoon at BCKV, Mohanpur. Die back, anthracnose, *Phytophthora*, fruit rot, scab and canker were most important and common diseases of guava recorded at FRS, Rewa and BAC, Sabour.

## Litchi (*Litchi chinensis* Sonn)

Surveillance of the pest complex and their natural enemies showed that infestation of leaf roller was relatively low in July (27.5%) and increased gradually to a maximum level in October (55.5%) at BCKV, Mohanpur, while fruit borer (*Conopemorpha cramerella)* was found to appear after 61 days of fruit set and highest infestation was recorded on 67 days after fruit set (>4%). However, at GBPUA&T, Pantnagar the infestation of leaf roller increased with the increase in temperature and highest infestation (42%) was recorded in the month of July. Higher infestations of fruit borer and litchi mid rib borer (>75%) were recorded at maturity, whereas litchi bug (*Tessaratoma javanica*) incidence was high during April-May.
Two sprays of endosulfan (0.07%) were found effective in managing the litchi pest complex with minimum infestation of 10.1 and 16.3 per cent at BCKV, Mohanpur and GBPUA&T, Pantnagar, respectively.

IPM module for litchi mite, revealed that burning of pruned infested leaves and shoots during June followed by spraying dicofol at the emergence of new flush reduced the infestation (56.33%) and resulted in good yield (31.33 kg $tree^{-1}$) at GBPUA&T, Pantnagar. Survey and surveillance of pollinators in litchi showed that *Apis* spp. and dipterans accounted for 41 and 42 per cent, respectively, at BCKV, Mohanpur, whereas maximum population of pollinators, *viz. syrphids*(88.4 to112.80 flies 50 $panicles^{-1}$), *Apis* spp. (68.2 to 86.0 bees 50 $panicles^{-1}$) and non *Apis* spp. (28.4 to 40.6 bees 50 $panicles^{-1}$), were recorded at medium height of tree at GBPUA&T, Pantnagar.

## PFDC

The Precision Farming Development Centre (PFDC) was established through National Committee on Plasticulture Application in Horticulture (NCPAH) at Central Institute for Subtropical Horticulture (CISH), Lucknow during 2001-2002. The principal activities of the centre included technology development and refinement in hi-tech horticulture, technology dissemination and validation, plastic mulching and greenhouse technology , publication of scientific literature and information, and organizing workshop and training programmes for state officials and farmers.

## Intercropping in mango

Intercropping in eight years old mango orchard with vegetables such as bottle gourd (cv. Varad), cauliflower (cv. Girja), cabbage (cv. Green Voyager) and brinjal (cvs. Sahana and Rajni) was tried. Differential drip irrigation was undertaken to avoid any adverse

Intercropping of brinjal in mango

Protected cultivation of capsicum in greenhouse

effect on mango flowering and fruiting. Black polyethylene mulch was used around the intercrop for moisture conservation and to contain the root spread.

The best intercrop combination in terms of total economic returns was mango + brinjal that yielded 19.38 MT $ha^{-1}$ of brinjal along with 2.88 MT $ha^{-1}$ of mango. Besides brinjal, bottle gourd (13.54 MT $ha^{-1}$), cauliflower (9.23 MT $ha^{-1}$) and cabbage (8.50 MT $ha^{-1}$) were effective in sustaining additional income especially during pre-production phase and off-years in mango orchards.

## Greenhouse production of coloured capsicum

The performance of coloured capsicum was evaluated under polyhouse conditions. Five varieties of coloured capsicum were used. Capsicum was planted at a spacing of 45 x 30cm. Beds were mulched with black polyethylene film. Irrigation was provided to the plants at weekly intervals through on-line drip irrigation system having a discharge of 2l $h^{-1}$. Young plants were pruned to retain 4 stems per plant.

# 10. LIST OF PUBLICATIONS

## Research Papers


Chandra, R., M. Kamle, A. Bajpai, Muthukumar M. and S. Kalim (2010). *In vitro* selection: A candidate approach for disease resistance breeding in fruit crops. *Asian J. Plant Sci.*, **9**: 437-446.

Chandra, R. and M. Mishra (2010). Towards development of transgenic papaya (*Carica papaya* L.). *Acta Hort.*, **851**:173-178.

Chandra, R., M. Mishra, R. Pati , S. Agarwal and R.K. Jain (2010). Shoot tip transformation in papaya (*Carica papaya* L.). *Acta Hort.*, **851**:219-226.

Gupta, V.K. and A.K. Misra (2010). Relative pathogenicity of *Fusarium* wilt isolates to guava (*Psidium guajava* L.). *J. Mycol. Pl. Pathol.*, **40**(1) : 72-77.

Kumar, Pradeep, A.K. Misra and D.R. Modi (2011). Current status of mango malformation in India. *Asian J. Plant Sci.*, **10** (1): 1-23.

Kumar, R., Omkar and R.P.Shukla (2010). Spatial distribution of different stages of mango fruit fly, *Bactrocera dorsalis* (Diptera Tephritidae). *J. Eco-friendly Agri.*, **5** (2): 176-178.

Kumar, R., Omkar and R.P.Shukla(2010). Effect of temperature on growth, development and reproduction of fruit fly, *Bactrocera dorsalis* Hendel (Diptera Tephritidae), in mango. *J. Eco-friendly Agri.*, **5** (2): 150-153.

Mishra, M., N. Shukla and R. Chandra (2010). Role of polyethylene glycol in maturation and germination of transformed somatic embryos of papaya (*Carica papaya* L.). *Acta Hort.*, **851**:227-230.

Mishra, M., Y. Shree, R. Pati, S. Seal, N. Shukla, M. Kamle, R. Chandra and A. Srivastava (2010). Micropropagation of *Mangifera indica* L. cv. Kurukkan through somatic embryogenesis. *Indian J. Genet.*, **70** (1):1-6.

Pandey, D., V.K. Singh and A.K. Misra (2011). Effect of bud types and their deblossoming on the incidence of malformation and flowering characters in mango (*Mangifera indica* L.). *Prog. Hort.*, **43** (1):89-91.

Ravishankar, H., Kailash Kumar, Atul Singha and Tarun Adak (2010). Integrated nutrient management in mango and guava. *Indian J. Fert.*, **6**(11):12-21.

Sethi, R.R., A. Kumar, S.P.Sharma and H.C. Verma (2010). Prediction of water table depth in a hard rock basin by using artificial neural network. *International J. Water Resources Environ. Engg.*, **2**(4):95-102.

Shukla, N., M. Mishra and R. Chandra (2010). Influence of polyamine on induction of adventive embryony in papaya (*Carica papaya* L.). *Acta Hort.*, **851**:231-234.

Singh, V. K., Achal Singh and S. Rajan (2011). Physiological diversity and its significance in flowering of mango (*Mangifera indica* L.). *Prog. Hort.*, **43** (1): 61-65.

Singh, V.K. and Swati Kumari (2010). Protein based biochemical changes associated with jelly seed in mango (*Mangifera indica* L.) cv. Dashehari. *Indian J. Agri. Sci.*, **81** (6) **:** 563-566.

Srivastava, Navin, Anju Bajpai, Ramesh Chandra, S. Rajan, Manoj K. Srivastava and Muthukumar M. (2010). Parentage and hybridity confirmation in mango hybrids by three DNA marker system combinations. Special Abstracts, *J. Biotechnol.*, **150S**: S1–S576.

Tandon, D.K., S. Kumar, A. Dikshit and D.K. Shukla (2010). Improvement in quality of beverage prepared from Rumani pulp blended with Dashehari and Mallika. *Indian J. Hort.*, **67**(3) : 376-380.

Yadav, S., H.S. Shukla and R. A. Ram (2010). Studies on foliar application of NAA, $GA_3$, boric acid and Ca $(NO_3)_2$ on fruit retention, growth, yield and quality of aonla (*Emblica officinalis* Gaertn.) cv. Banarasi. *Hort. J.*, **23** (2):64-67.


## Popular articles


Garg, N., M. Ashfaq and Preeti Yadav (2010). *Wine ki gunwatta mein phenolics ki bhumika evam swathya par iska asar. Udyan Rashmi*, **11** (1) : 40-42.

Lal, Barsati, Ajay Verma, H. Ravishankar, Subhash Chandra and Kailash Kumar (2010). *Ekikrit bagwani vikas mein sahbhagioan ki bhumika. Udyan Rashmi*, **11** (1): 1-2.

Pathak,R.K., R.A.Ram, N. Garg, R.Kishun, S.R. Bhriguvanshi and S.Sharma (2010).Critical review of indigenous technologies for organic farming in horticultural crops. *Organic farming News Letter*, June 2010: 3-16.

Singh, V.K., Kamini Singh and Anurag Singh (2010). *Polyhouse mein shimla mirch ka utpadan. Udyan Rashmi,* **11**(1): 55-59.

Singh, V.K., M.K Soni, Kamini Singh, Anurag Singh and Anshuman Singh (2010). *Bagwani mein plasticulture. Udyan Rashmi,* **11**(1): 18-24.

Shukla, S. K. and Anuj Awasthi (2010). *Krishi takneekon ke prasar hetu sanchar madhyam. Udyan Rashimi*, **11**(1): 8-13.

Tandon, D.K. and D. Sharma (2010). *Etherel se aam pakane ki taknike. Udyan Rashmi*, **11**(1): 36-39.

Verma, H.C. (2010). *Krishi mein soochna evam sanchar pradyogiki* (ICT) *ka prayog. Udyan Rashmi*, **11** (1) :3-7

## Abstracts

### National Seminar on Mango Bio-diversity for Livelihood held at CISH, Lucknow, June 25-28, 2010.

Ashfaque, Mohammad, Jyoti Bajpai, Muthukumar M. Neelima Garg and H. Ravishankar. Biodiversity, sustainable livelihood options and IP protection. p. 109.

Bajpai, Anju, Ramesh Chandra, Navin Srivastava, S. Rajan, K.V. Ravishankar, Muthukumar M. and Nimisha Sharma. Evaluation of clonal diversity among Dashehari, Himsagar and Chausa clones of mango (*Mangifera indica* L.) by STMS markers. p. 40.

Chandra, S., Achal Singh, R.B.L. Srivastava and Arvind Kumar. Initiative of kisan call centre in solving growers' problems of mango cultivation. p. 558.

Garg, Neelima, Preeti Yadav, D.K.Shukla, Sanjay Kumar, Mohammad Ashfaque, Devendra Kumar and Jyoti Bajpai. Improved protocol for development of mango wine. p. 98.

Kennady, R. R., S. Rajan and J. Prem Joshua. Mango biodiversity with special reference to the off-season production. p. 5.

Killadi, Bharti, Sanjay Kumar, Abhay Dikshit, Preeti Yadav and Neelima Garg. Shelf-life extension studies of mango cv. Langra by use of bio-agent and safe chemicals. p. 103.

Pandey, B.K., Madhu Kamle, Ashutosh Pandey, Rupesh K. Mishra, A. J. Mathew and Mathukumar M. PCR-based detection and characterization of *Collectotrichum gloeosporioides* (Penz.) Sacc-the incitant of mango anthracnose. p. 43.

Rajan, S. GIS application in conversation and utilization of mango diversity. p. 12.

Rajan, S., L. P. Yadava, M. Abdul Nizar and S. N. Gohil. Mango diversity and livelihood security of tribals in Nandurbar district of Maharashtra. p. 6.

Rajan, S., L. P. Yadava, M. Abdul Nizar and S. N. Gohil. Effects of deforestation on mango diversity and livelihood of tribal community- A case study from hills of Satpura Range. p. 27.

Rajan, S. and L.P. Yadava. GIS based characterization of suitable areas for red colour guava cultivation in Indo-Gangetic plains. p. 359.

Rajan, S., R. Singh, L. P. Yadava and J. P. Verma. Influence of environmental factors on the success of mango propagation methods under various geographical conditions of India. p. 63.

Rajan, S., R.B. Ram, Rajesh K. Sharma and Rubee Lata. Study on the relationship between floral and vegetative malformation incidence in mango (*Mangifera indica* L.) seedlings. p. 90.

Rajan, S., T. K. Sahu, L.P. Yadava and S. Shivani. Mango Information System-A knowledge base on *Mangifera* genetic resources, molecular information and IPR. p. 44.

Rajan, S., T.K. Sahu, Mamta Kumari and Gulshan Wadhwa. Plausible anti-microbial and anti-dementia activities of natural and synthetic mangiferin derivatives: a bio-computational study. p. 40.

Rajan, S., Tanmaya K. Sahu, Anita Dubey and Shubhra Shivani. Exploring image analysis for diversity characterization in mango. p. 35.

Ram, R.A. and B.K. Pandey. Development of low cost organic package of practices for mango cv. Amrapali. p. 59.

Ram, R.A., S. R. Bhriguvanshi and Atul Singha. On-farm production of quality organic inputs for soil and plant health management in mango cultivation. p. 59.

Shukla, R.P., A.K. Misra, T.P. Trivedi, S. Upadhyaya, Rajesh Kumar and Priyanka Chaturvedi (2010). Validation of IPM technology in mango in Uttar Pradesh. p.91.

Shukla, R.P., Rajesh Kumar, S.K.S. Rajpoot and Priyanka Chaturvedi. Population fluctuations of fruit flies on mango in relation to abiotic factors

in Uttar Pradesh. p. 88-89.

Singh, Achal and S. Rajan. Application of incomplete block designs in different crossing populations of mango for better utilization of planting material. p. 18.

Singh, Achal and S. Rajan. Discriminant analysis in different crossing population for selection of best population of mango. p.18.

Singh, M.D., D.K. Tandon, and A. Verma. A vision for Malda food processing industry cluster. p. 97-98.

Singh, V. K., A.K. Bhattacherjee and A.K. Srivastava. Paclobutrazol residue in soil and its impact on mango (*Mangifera indica* L.) yield. p. 69-70.

Singh, V.K. and A.K Srivastava. Genetic variability in mango (*Mangifera indica* L.) fruit in respect to antioxidative potential and its contributory compounds. p. 72.

Singh,V.K., M.K. Soni, Anshuman Singh, Anurag Singh and Kamini Singh. Intercropping in mango (*Mangifera indica* L.) for nutritional security and higher profits. p. 61.

Singh, V.K. and Pooja Saxena. Protein profiling and biochemical study associated with paclobutrazol induced fruiting in mango. p. 73-74.

Singh, V.K., R.B. Ram, M. Kalim, M.L. Meena and Rubee Lata. Response of growth regulator on flowering, fruiting and associated physiological changes in mango cultivars. p. 74-75.

Singh, V.K., R.B. Ram, Manoj Kumar, M.L. Meena and Rubee Lata. Effect of different chemicals on regulation of flowering and fruiting in mango (*Mangifera indica* L.). p. 75.

Singh, V.K., S. Rajan, A.K. Singh and Pooja Sexena. Interspecific variation of the photochemical limitation in mango cultivars. p. 73.

Singh,V. K., Tarun Adak, S.R. Bhriguvanshi and A.K Singh. Response of different salinity levels on performance of polyembryonic mango seedlings. p. 60-61.

Srivastava, Navin, Anju Bajpai, Ramesh Chandra, Nimisha Sharma, S. Rajan, Manoj K. Srivastava and Muthukumar M. STMS based genetic diversity assessment of North and East Indian mango accessions. p. 39.

Verma, H.C., B.K. Pandey, R.P. Shukla and R. Chandra. A framework for developing intelligent expert systems for mango. p. 42-43.

## Xth Agricultural Science Congress on Soil, Plant and Animal Health for Enhanced and Sustained Productivity held at NBFGR, Lucknow, February 10-12, 2011

Adak, Tarun, V.K. Singh, Kailash Kumar, Atul Singha, Vinod Kumar Singh, Dushyant Mishra and S. K. Arun. Addressing soil health issues under high density mango and guava orcharding systems. p. 3.

Adak, Tarun, Vinod Kumar Singh and Kailash Kumar. Identifying some soil physical constraints in sustaining mango productivity in Malihabad region of Uttar Pradesh. p. 23.

Almin, Rukaiya, Preeti Yadav, Mohammad Ashfaque and Neelima Garg. Heat survival dyanamics of *Saccharomyces* sp. under different processing conditions. p. 491.

Bajpai, Anju, Muthukumar M., Nimisha Sharma, Umesh Hudedamani, Ramesh Chandra and S. Rajan. Microsatellite based genom analysis in mango (*Mangifera indica* L.). p. 432.

Bajpai, Anju, Muthukumar M., S. Rajan, Navin Srivastava and Ramesh Chandra. Association genetic studies in mango based on SSR loci. p. 433.

Bajpai, Jyoti, Preeti Yadav and Neelima Garg. Utilization of fruit kernel or pomace as source of oil. p. 483.

Damodaran, T., R.B. Rai, B.K. Pandey, V.K. Mishra, D.K. Sharma, R.A.Ram, R. Kannan and Himanshu Dixit. Technology of banana cultivation with subsoil sodicity management and integration with rural poultry- A boon to marginal farmers for sustainable livelihood generation. p. 92.

Killadi, Bharti, Pushpa K., Abhay Dikshit, Preeti Yadav and Neelima Garg. Shelf-life enhancement in mango cv. Dashehari through use of bio-agent. p. 136.

Kumar, Kailash, S.R. Bhriguvanshi, Tarun Adak and Vinod Kumar Singh. Micronutrients status in mango orchards of Uttar Pradesh. p. 60.

Kumar, Ram and Achal Singh. Influence of some weather parameters on yield of litchi (*Litchi chinensis* L.) varieties. p. 358.

Lal, Barsati, Ajay Verma, H. Ravishankar, K. Kumar, S. K. Shukla and Dushyant Mishra. Analysis of stakeholders issue for integrated development of

horticulture in Uttar Pradesh. p. 134-135.

Mishra, Dushyant, H. Ravishankar, S. K. Shukla and Tarun Adak. Impact of weather dynamics on crop phenology and production of guava in Uttar Pradesh. p. 327.

Mishra, Dushyant and H. Ravishankar. Problems and prospects of citrus cultivation in the Bundelkhand region. p. 327.

Muthukumar M., Umesh Hudedamani, Anju Bajpai, S. Rajan and R. Chandra. Quantitative resistance loci mapping: approach towards marker assisted breeding in mango (*Mangifera indica* L.) for biotic stresses. p. 192.

Pandey, B.K., Rupesh K. Mishra, Ashutosh Pandey, Madhu Kamle, Purnima Sareen and Muthukumar M. Culture independent PCR (ciPCR) : A metagenomic tool towards molecular diagnosis of guava wilt. p.195.

Ravishankar, H., Kailash Kumar, Tarun Adak and Atul Singha. Horticulture in assuring human health quality through rehabilitation of soil health. p. 10.

Shukla, S.K., D. Mishra, Kailash Kumar, Deepak Mishra and A.K. Nagar. Identifying constraints and technological gaps in production to consumption chain of mango in Malihabad belt of Lucknow. p. 321-322.

Singh, A.K., Anju Bajpai, V.K. Singh, H. Ravishankar and J.P. Singh. Genetic diversity in karonda (*Carissa carandas* L.). p. 430.

Singh, Achal and V.K. Singh. Evaluation of shape and size of experimental plot with fertility variation of soil for higher yield of guava (*Psidium guajava* L.). p. 148.

Singh, V.K., Achal Singh, H. Ravishankar and S. Rajan. Appraisal of alternate bearing rhythm in mango cv. Mallika under subtropical conditions of Lucknow. p. 139.

Verma, A., H. Ravishankar and D.K. Tandon. Horticulture innovations and infrastructure needs for integrated development of horticulture in Bundelkhand region. p.132-133.

Yadav, Kaushlesh, Neelima Garg, P. K. Shukla, Sanjay Kumar and Preeti Yadav. Preliminary studies on utilization of fruit waste composts for production of oyster mushroom, *Pleurotus Florida* (Mont.) Singer. p. 436.

Yadav, Preeti, Neelima Garg, Sanjay Kumar and Abhay Dikshit. Vitamin-C enrichment of mulberry juice based ready-to-serve beverages through blending of Indian gooseberry juice. p. 437.

## Others

Bhattacherjee, A.K., D.K. Tandon and A. Dikshit (2010). Quality evaluation of spray dried powder prepared from stored aonla juice. 4th Indian Horticulture Congress- 2010 held at NPL, New Delhi, November 18-21, 2010. p. 428-429.

Chandra, R., Anju Bajpai, Muthukumar M. (2011). Genetic conformity of *in vitro* generated guava plantlets using DNA markers. National Seed Congress : Quality seeds for prosperity held at College of Agriculture, Pune, January 29-31, 2011. p. 254-255.

Kumar, Devendra, R. Chandra, Anju Bajpai, Muthukumar M. and Neelima Garg (2010). Immobillization of extracellular amylase from *Fusarium solani* on calcium alginate beads. 51st Annual Conference of Microbiologist of India AMI-2010, International Symposium on Recent Advances in Cross-disciplinary Microbiology: Avenue and Challenges and International Workshop on rRNA Sequencing, Phylogeny and Next Generation Genome Sequencing held at BIT, Ranchi, December 14-17, 2010. p. 191.

Pandey, B.K., Madhu Kamle, Ashutosh Pandey, Rupesh K. Mishra, Purnima Sareen and Muthukumar M. (2010). Development and validation of sequence based specific primers for diagnosis of *Colletotrichum gloeosporioides* causing mango anthracnose. National Seminar on Molecular Approaches for Fungal Diseases of Crop Plants held at IIHR, Bangalore, December 27-30, 2010. p. 84.

Pandey, B.K., Rupesh K. Mishra, Ashutosh Pandey, Madhu Kamle, Purnima Sareen and Muthukumar M. (2010). Designing and validation of primers aided through bioinformatics tools for molecular genetic diversity assessment of guava wilt pathogen. National Symposium on Molecular Approaches for Fungal Diseases of Crop Plants held at IIHR, Bangalore, December 27-30, 2010. p. 159.

Pandey, B.K., Rupesh K. Mishra, Ashutosh Pandey, Madhu Kamle, Purnima Sareen and Muthukumar M. (2010). Molecular characterization of *Fusarium oxysporum* f. sp. *Psidii*: A casual organism of wilt in guava. National Symposium on Molecular Approaches for Fungal Diseases of Crop Plants held at IIHR,

Bangalore, December 27- 30, 2010. p. 83-84.

Rajan, Shailendra, Ram Kumar and L.P. Yadava (2010). Variability pattern in mango (*Mangifera indica* L.) accessions of diverse geographical origins. The 9th International mango Symposium-2010 held at Sanya, Hainan Island, China, April 8-12, 2010. p. 75.

Rajan, S. Tanmaya K. Sahu, Meenakshi Rai and Gulshan Wadhwa (2010). A bioinformatics approach for analysis of disease resistance in *Mangifera indica* L. The 9th International Mango Symposium-2010 held at Sanya, Hainan Island, China, April 8-12, 2010. p. 41.

Rajan, S., Tanmaya K. Sahu and L.P. Yadava (2010). Mango Resources Information System: An open access portrayal of phenotypic, genetic and chemical information on mango. The 9th International Mango Symposium-2010 held at Sanya, Hainan Island, China, April 8-12, 2010. p. 89.

Ravishankar, H., V.K. Singh and Anurag Singh (2011). Physiological and biochemical mechanism of paclobutrazol in induction of off-season fruiting in mango. National level Workshop-cum-Seminar on Off-season Mango Production held at Kanyakumari February 26-27, 2011. p. 86-89.

Singh, Achal and V.K. Singh (2010). Application of probability models for estimation of orchard yield of guava (*Psidium guajava* L.). 4th Indian Horticulture Congress-2010 held at NPL, New Delhi, November 18-21, 2010. p. 271.

Singh, V.K., A. K. Bhattacherjee and A.K. Srivastava (2010). Persistence of paclobutrazol in soil and fruits of mango cv. Dashehari. National Conference of Plant Physiology on Physiological and Molecular Approaches for Crop Improvement under Changing Environment held at BHU, Varanasi, November 25-27, 2010. p.234-235.

Yadav, Preeti, Neelima Garg and Sanjay Kumar (2010). Screening of mulberry verities for wine preparation. 51st Annual Conference of Microbiologist of India AMI-2010, International Symposium on Recent Advances in Cross-disciplinary Microbiology: Avenue and Challenges and International Workshop on rRNA Sequencing, Phylogeny and Next Generation Genome Sequencing held at BIT, Ranchi, December 14-17, 2010. p. 211.

## Bulletins

Misra, A.K. and B.K. Pandey (2010). *Aam mein samekit rog prabandhan,* CISH, Lucknow. 12 p.

Misra, A.K. and B.K. Pandey (2010). Integrated Disease Management Practices in Mango, CISH, Lucknow. 16 p.

Misra, A.K. and H. Ravishankar (2010). *Aam ki bagwani,* CISH, Lucknow. 48 p.

Misra, A.K. and H. Ravishankar (2010). Good Management Practices for Mango Production and Trade, CISH, Lucknow. 46 p.

Rai, R. B., T. Damodaran, R. A. Ram, Shweta Rai, B. Singh, H. Kumar, D. P. Singh, B. Rai and T. Singh (2010). *Ajeevika hetu krishi takneeken*, IVRI, Bareilly. 25 p.

Singh, A.K., Anju Bajpai, V. K. Singh, H. Ravishankar, D. K. Tandon and B. M. C. Reddy (2010). The Jamun (*Syzygium cuminii* Skeel), CISH, Lucknow. 28 p.

## Chapters in books

Ravishankar, H., D.K. Tandon and B.K. Pandey(2010). Subtropical fruit crop research in CISH, Lucknow oriented for enhanced livelihood options for the farming community. In : *Souvenir Xth Agricultural Science Congress on Soil, Plant and Animal Health for Enhanced and Sustained Agricultural Productivity*. Vindhya Mohindra *et al.* (eds), NBFGR, Lucknow, pp.142-149.

Reddy, B.M.C. and R. A. Ram (2010). Emerging technologies in organic farming: Principles, practices and technologies. In: *Organic Horticulture: Principles, Practices and Technologies*. H.P. Singh and George V. Thomas (eds), Westville Publishing House, New Delhi, pp. 106-117.

Shukla, R.P. (2010). Strategies for integrated pest management in mango. In: *Modern Approaches to Insect Pest Management*. Omkar, G. Mishra and K. Singh (eds), Anuj Printers, Lucknow, pp. 44-52.

Verma, A., H. Ravishankar and D.K. Tandon (2010). Integrated development of Bundelkhand region through horticulture interventions. In: *Extension Strategy for Bundelkhand Region*. K.D. Kokate *et al.* (eds), Zonal Project Directorate, Zone IV, Kanpur, pp.18-26.

# 11. LIST OF APPROVED ON-GOING RESEARCH PROJECTS

## 1.0 Theme : Management of genetic resources

### Programme

1.1 Collection, evaluation, characterization, conservation and documentation of germplasm of subtropical fruits

**Programme Leader** : H. Ravishankar

### Projects

1.1.1 Collection, evaluation, characterization, conservation and documentation of mango

**Project Leader** : S. Rajan

1.1.2 Collection, evaluation, characterization, conservation and documentation of guava

**Project Leader** : S. Rajan

1.1.3 Collection, evaluation, characterization, conservation and documentation of papaya

**Project Leader** : A.K. Singh

1.1.4 Collection, evaluation, characterization, conservation and documentation of aonla and bael

**Project Leader** : D. Pandey

1.1.5 Collection, evaluation, characterization, conservation and documentation of litchi and grape

**Project Leader** : Ram Kumar

## 2.0 Theme : Enhancing productivity of subtropical fruits

### Programme

2.1 Evolving high yielding varieties through selection and hybridization

**Programme Leader** : S. Rajan

### Projects

2.1.1 Evolving improved varieties of mango

**Project Leader** : S. Rajan

2.1.2 Evolving improved varieties of guava

**Project Leader** : S. Rajan

2.1.3 Evolving improved varieties of papaya

**Project Leader** : A.K. Singh

### Programme

**2.2** Evolving technologies for increasing productivity

**Programme Leader** : S.R. Bhriguvanshi (up to 30.07.2010) and Kailash Kumar (from 01.08. 2010)

### Projects

2.2.1 Substrate dynamics for integrated plant nutrient management in mango, guava and aonla

**Project Leader** : K. Kumar

2.2.2 Varietal trials of subtropical fruits

**Project Leader** : G. Pandey

2.2.3 Planting density and canopy management in mango

**Project leader** : Dushyant Mishra

2.2.5 Standardization of rootstock in mango

**Project Leader** : A.K. Singh

2.2.6 Studies on biennial bearing in mango

**Project Leader**: V. K. Singh

### Programme

2.3 Propagation and mass multiplication of genuine planting material

**Programme Leader** : Ramesh Chandra

### Projects

2.3.1 Micropropagation of mango, guava and bael

**Project Leader** : M. Mishra

2.3.2 Mass multiplication of genuine planting material

**Project Leader** : S. K. Shukla

## 3.0 Theme : Sustaining productivity under adverse conditions

### Programme

3.1 Studies on abiotic stress in subtropical fruits

**Programme Leader** : V.K. Singh

### Projects

3.1.1 Studies on salt stress physiology in mango

**Project Leader** : V. K. Singh

## 4.0 Theme : Reducing cost of production and increasing profitability

### Programme

4.1 Enhancing input use efficiency (water, nutrients, pesticides, labour and mechanization)

**Programme Leader** : S.R. Bhriguvanshi (up to 30.07.2010) and Kailash Kumar (from 01.08. 2010)

### Projects

4.1.1 Integrated water management for increasing water use efficiency in mango

**Project Leader** : Kailash Kumar

4.1.2 Nutrient management in mango

**Project Leader** : Kailash Kumar

4.1.3 Design and development of farm machinery for fruit orchards

**Project Leader** : A.K. Verma

## 5.0 Theme : Enhancing nutritive value, food and environmental safety

### Programme

5.1 Studies on organic production and food safety

**Programme Leader** : R.A. Ram

### Projects

5.1.1 Development of organic production package of practices for mango and guava

**Project Leader** : R.A. Ram

5.1.2 Analysis and monitoring of pesticide residues in mango

**Project Leader** : A. K. Bhattacharjee

## 6.0 Theme : Sustaining productivity under biotic stress conditions

### Programme

6.1 Bio-ecology and management of insect/ nematode pests in subtropical fruits

**Programme Leader** : R.P. Shukla

### Projects

6.1.1 Bio-ecology and management of insect pests of mango

**Project Leader** : R.P. Shukla

6.1.2 Bioecology and management of insect pests of guava and aonla

Project Leader : S. Sharma (Up to 31.12.2010) and **R. P. Shukla** (from 01.01.2010)

6.1.3 Bio- intensive management strategies for population containment of plant parasitic nematodes

**Project Leader** : R.M. Khan

### Programme

6.2 Epidemiology, ecology and management of diseases in subtropical fruits

**Programme Leader** : R.P. Shukla

### Projects

6.2.1 Epidemiology, ecology and management of anthracnose, die-back and malformation of mango

**Project Leader** : A.K. Singh

6.2.2 Management of post-harvest diseases of mango

**Project Leader** : B.K. Pandey

6.2.3 Epidemiology, ecology and management of diseases of underutilized fruits

**Project Leader** : P.K. Shukla

## 7.0 Theme : Minimization of postharvest losses in subtropical fruits

### Programme

7.1 Standardization of handling, packaging and storage of subtropical fruits

**Programme Leader** : M.D. Singh (Up to 31.01.2011)

### Projects

7.1.1 Shelf-life enhancement of mango, guava and aonla

**Project Leader** : Bharati Killadi

7.1.2 Standardization of packaging line for mango and guava

Project Leader : M.D. Singh (Up to 31.01.2011) and A.K.Verma (from 01.02.2011)

## 8.0 Theme : Product diversification, value addition and enhancement of nutritive value of processed fruit products

### Programme

8.1 Studies on value addition and waste utilization in subtropical fruits

**Programme Leader** : D.K. Tandon

### Projects

8.1.1 Development of value added products from mango, guava and aonla

**Project Leader** : D.K. Tandon

8.1.2 Fermentation of fruits and fruit industry waste for value addition

**Project Leader** : Neelima Garg

## 9.0 Theme : Economics of production of subtropical fruits

### Programme

9.1 Economics of production, marketing and export of subtropical fruits

**Programme Leader** : Ajay Verma

### Projects

9.1.2 Economics of mango-based intercropping system for higher income

**Project Leader** : R.B.L. Srivastava (Up to 30.06.2010) and Ajay Verma (from 01.07.2010)

9.1.3 Market intelligence and export promotion

**Project Leader** : Ajay Verma

## 10.0 Theme : Transfer of technology

### Projects

10.1 Impact assessment of technologies developed by the institute on mango and guava

**Project Leader** : Subhash Chandra

# 12. CONSULTANCY, PATENTS AND COMMERCIALIZATION OF TECHNOLOGIES

## Advisory/Consultancy

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

# 13. RESEARCH ADVISORY COMMITTEE, INSTITUTE MANAGEMENT COMMITTEE/ INSTITUTE RESEARCH COMMITTEE, ETC.

## Research Advisory Committee (RAC)

The 15th meeting of the RAC of the institute was conducted during June 28-29, 2010 under the Chairmanship of Dr. D.S. Rathore, Ex.-Vice Chancellor, CSKHPKV, Palampur at CISH, Rehmankhera, Lucknow. The following members attended the meeting:

| | |
|---|---|
| Dr. K.K. Jindal | Member |
| Dr. Gajendra Singh | Member |
| Dr. R.D. Rawal | Member |
| Dr. A.K. Bakshi | Member |
| Dr. K.R. Kaundal | Member |
| Dr. S. Rajan | Member |
| Dr. H. Ravishankar | Member |
| Dr. R.P. Shukla | Member Secretary |

### Significant decisions

After thorough discussion with the scientists on the achievements of research programmes during the year, following recommendations were made by the Committee.

### Crop improvement and biotechnology

- The institute should focus on both basic and applied research with respect to varietal development on mandate fruit crops.
- Breeding programme to be intensified to evolve efficient varieties in mango, guava and aonla.
- Biotechnological and molecular breeding approaches may be strengthened for biotic and abiotic stresses management.
- More concerted efforts are required in the development of transgenic papaya for viral disease resistance.
- Central Accession Register for Germplasm should be maintained by institute on the guidelines of NBPGR, New Delhi.

### Crop production

- The biodiversity of mango, litchi, guava and papaya in the plains of adjoining Shivallik hills extending from Jammu, lower areas of Himanchal, Punjab and Uttarakhand needs to be explored to look for beneficial traits especially resistance to diseases and pests.
- The routine protein profile and antioxidant enzyme studies should either be defined for logical conclusions or should be abandoned to save time and energy for evaluation of fruit quality traits.
- Residual effects of paclobutrazol in fruits should be worked out rather than in soil. Soil microflora analysis should also be considered.
- Modern technologies like sprinkler irrigation and

15th RAC meeting in progress

foggers should be included in the project proposed for low lying areas to study the effect of weather vagaries like spring frost in fruit crops.

- There is a need to integrate no chemical method treatment in post-harvest disease management of subtropical fruits.

### Crop protection

- During surveys, there is a need to identify the pathogen before reporting in the report.
- Research on the newly emerging problems like blossom blight of mango need to be undertaken.
- Mango waste should be tried for mass multiplication of *Trichoderma harzianum*.
- Bioecology of hoppers and midges should be continued.
- New fungal pathogens may be screened against hoppers.
- Trial should be initiated to rear some important syrphid predators and pollinators.

### Post-harvest management

- Post-harvest management centres should be developed in some model villages for primary and secondary processing.
- Backward and forward linkages should be developed to link farmers producing processed products with export channels and local markets.
- The technologies developed by the Division should be scaled up, validated and commercialized by licensing and signing MOUs with the private sector.
- The metabolites of the pesticides used by mango orchardists should be analyzed.

## Institute Research Committee (IRC)

The twenty-eighth and twenty-ninth IRC meetings of the institute were held during October 20-22 and 25-26 and December 13-16, 18 and 20, 2010 under the Chairmanship of Dr. H. Ravishankar, Director in the Conference Room at Rehmankhera to review the progress made in respect of ongoing research projects during 2009-10 and 2010-11 and approval of the technical programme for the following year.

## Significant decisions ( 28th IRC)

### Crop Improvement and biotechnology

- Assessment of mango cv. Arunika should be done thoroughly before its distribution to growers.
- DNA barcoding of mango varieties may be undertaken and information documented..
- Since litchi and grape are not the mandate crops of the institute, only AICRP trials should be conducted. The scientific assistance for molecular characterization of litchi may be extended to NRC litchi, Muzaffarpur only after getting budgetary support.
- Analysis of gaps in collection of germplasm needs to be undertaken.
- Sequencing of PRSV of papaya should be done on priority and efforts to increase the number of raised $T_o$ plants in papaya should be made.
- Genetic fidelity of mother plants of the varieties released by the institute should be established.
- Visit to HARP, Ranchi be organized for assessing the performance of guava cv. Lalit, which has shown some variability in the population.
- Registration of improved / elite material of jamun should be undertaken.
- Role of each scientist should be well defined in new or reoriented research project.

### Crop production

- Soil health cards of different blocks of experimental farm should be developed and maintained. Team approach should be followed for addressing soil health issues.
- As a part of diversification of horticulture, ornamental and vegetable crops should be considered as intercrops with economics worked out.
- Research work on rainfed horticulture should be considered keeping in view areas such as Bundelkhand.
- RPF-III of projects on rejuvenation should be submitted. A write up about all aspects of rejuvenation technology should be uploaded on the website of the institute.
- Project on canopy architecture management should be formulated including detailed studies on tree physiology.

- Studies on paclobutrazol residue, its effect on microflora and root physiology should be undertaken.
- More basic studies are required to elucidate the role of root system of irregular bearing mango cultivars in association with the scientists of C.I. Division.
- Physiology of flowering in mango should be studied in detail involving team approach.
- A new project should be formulated on integrated management of water and nutrients.
- Role of calcium and other nutrient interaction in jelly seed formation of mango should be studied systemetically.
- Foliar nutrition in mango should be addressed in complementarity to other modes of nutrition.
- Studies on impact assessment of technologies developed by the institute should be undertaken.
- Farmers Field Schools should be established to facilitate farmer to farmer transfer of technology.
- Impact assessment of training programmes conducted should be undertaken.
- Media resource centre should be developed at institute including phone-in-live programme.
- AICRP trials on fertigation should be undertaken in the Division.

### Crop protection

- Dieback, shoulder browning and wilt in mango and wilt in guava should be studied in detail involving team approach.
- New emerging pest problems, *viz.* shoot gall psylla, thrips and fruit borer in mango should be addressed in totality.
- A flagship project on guava wilt should be formulated involving scientists each from horticulture, pathology, nematology, biotechnology, physiology, soil science and microbiology. Dr. R.M. Khan will be PI of the project.

### Post-harvest management

- Studies on preharvest practices impacting post-harvest shelf life of fruits should be conducted.
- Small farm mechanization is a priority area. A horticulturist should be included in the project on mechanization.
- Work on low cost ripening chambers should be undertaken by Er. Anil Verma in collaboration with Dr. (Mrs.) Bharti Killadi.
- Studies on shelf life enhancement of mandate fruits should be undertaken.
- Work on food safety and environmental safety should be carried out.
- Work on minimally processed products should receive appropriate focus.
- Thermal and freeze-drying technology is required to be used for preparation of products.
- Market intelligence and alternate markets needs to be explored.

## Significant decisions (29th IRC)

### Crop improvement and biotechnology

- Biotechnological approach should be adopted in breeding programmes and outputs should be over time frame.
- Research work on gene silencing for enhancing shelf life in mango, guava and jamun should be carried out.

### Crop production

- Soil information system developed on the lines of NEH region with regards to mango should be carried out.
- Resource mapping of mandate crops need to be undertaken and land use map of U.P. should be developed.

### Crop protection

- Expert system for pest and diseases for farmer advisory should be developed and validated.
- Studies on pest and diseases dynamics in changing climate should be conducted.
- Management of emerging problems should be undertaken in time bound manner.

### Post-harvest management

- Useful machinery for small farmers should be developed.
- Productivity, profitability, value addition and food safety issues need to be addressed.

# 14. PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, SEMINARS, SYMPOSIA, ETC.

## Meetings

Drs. Kailash Kumar and Tarun Adak attended the NASC brainstorming meeting on Soil nutrient depletion and human health held at IIHR, Bangalore, September 7-8, 2010.

Dr. Kailash Kumar attended the second interactive meeting on Nutrient dynamics in horticultural crops held at NRC Citrus, Nagpur, September 27-28, 2010.

Dr. Kailash Kumar attended the brainstorming session on Second green revolution: strategies for agricultural transformation in eastern India held at ICAR Research Complex for Eastern Region, Patna, December 11-12, 2010.

Dr. V. K. Singh attended the interface meeting of Director's / PCs of the Crop Sciences, Horticulture Divisions held at Jabalpur, May 17-18, 2010.

Dr. V. K. Singh attended the CAC meeting of NAIP project entitled Understanding the mechanism of off-season flowering and fruiting in mango under different environmental conditions (Component-4) held at IIHR, Bangalore, March 8, 2011.

Dr. Achal Singh attended the meeting of NAIP project on Strengthening of statistical computing for NARS held at IASRI, New Delhi, June 7-8, 2010.

Dr. H. Ravishankar, Director attended the meeting of Corporation of seed industry-ICAR/ SAU interface held at DSR, Mau, September 20-21, 2010.

Dr. H. Ravishankar, Director participated in XX ICAR Regional Committee Meeting held at Birsa Agriculture University, Ranchi, October 7-9, 2010.

Drs H. Ravishankar, Director, A.K. Misra, PC (STF) and Mrs. Neelima Garg participated in the Horticulture Industry Meet held at IIHR, Bangalore, November 11, 2010.

Dr. H. Ravishankar, Director attended the Annual Review Meeting of NAIP subproject on Mobilizing mass media support for sharing agro-information held at ICAR Research Complex, Barapani, March 4-5, 2011.

Dr. H. Ravishankar, Director attended the Review meeting of mango tree encyclopedia project funded by The Sultanate of Oman held at New Delhi, February 3, 2011.

Dr. H. Ravishankar, Director attended an Interface Meeting of Vice Chancellors, DAC, DADF and Directors of ICAR Institutes/ Bureaus/ NRCs/ Project Coordinators held at New Delhi, February 28, 2011.

Dr. H. Ravishankar, Director attended CSIR Foundation Day Celebration held at NBRI, Lucknow, September 26, 2010.

## Congress/ Conference

Dr. H. Ravishankar, Director attended the Directors' Conference held at NASC Complex, New Delhi, July 15-16, 2010.

Drs D.K.Tandon, A.K.Singh, R.A. Ram, Ram Kumar, A.K. Bhattacherjee, P.K.Shukla, Atul Singha and Umesh Hudedamani attended the 4th Indian Horticulture Congress- 2010 held at NPL, New Delhi, November 18-21, 2010.

Dr. V. K. Singh attended the National Conference of Plant Physiology on Physiological and molecular approaches for crop improvement held at BHU, Varanasi, November 25-27, 2010.

Dr. Ramesh Chandra attended the National Seed Congress: Quality seeds for prosperity held at College of Agriculture, Pune, January 29-31, 2011.

Director and all the scientists of the institute participated in the Xth Agriculture Congress held at NBFGR Lucknow, February 10-12, 2011.

## Symposia/Seminars

Director and all the scientists of the institute participated in the National Seminar on Biodiversity in mango for sustainable livelihood held at CISH, Lucknow, June 25-28, 2010.



## Workshop

Dr. V. K. Singh attended the Review Workshop of NAIP project on Understanding the Mechanism of off-season flowering and fruiting in mango under different environmental conditions (Component-4) held at CISH, Lucknow, April 17, 2010.

Dr. V. K. Singh attended the Thematic Annual Workshop on Basic and strategic research on frontier areas of plant science (NAIP Component-4) held at IIHR, Bangalore, March 7-8, 2011.

Dr. H. Ravishankar, Director attended the International Workshop for Stakeholders on improving productivity and quality of litchi held at NRC Litchi, Muzaffarpur, February 12-13, 2011.

# 15. WORKSHOPS, SEMINARS, SYMPOSIA, ETC., ORGANISED

## National Seminar on Biodiversity in Mango for Sustainable Livelihood

Dr. H. P. Singh, DDG (Hort.) inaugurated the four-day National Seminar on Biodiversity in Mango for Sustainable Livelihood, organized at the institute as part of the International Biodiversity Year on June 25, 2010. In his inaugural address he dealt with the heterozygous nature of mango crop, difficulties in management of genetic resources and crop improvement. He informed that India has immense potential of producing mango almost throughout the year due to diverse agro-climatic zones and prevailing variability with respect to flowering and fruiting in available mango germplasm. The problem of pollination in Dashehari was also highlighted.

Dr. H. Ravishankar, Director delivering speech during the National Seminar

Dr. H. Ravishankar, Director while welcoming the chief guest, dignitaries, delegates and farmers highlighted the achievements of the institute during the past 35 years in the area of mango biodiversity collection, maintenance and technology development for enhancing production and productivity. The indiscriminate exploitation of available genetic resources and rapid pace of urbanization in the country have lead to the erosion of gene pool, he added. He informed that the institute has 732 mango germplasm maintained in its field gene bank.

Dr. J. S. Samra, Chief Executive Officer, National Rainfed Area Authority, Government of India and Special Guest on the occasion, remarked that the diversity of mango is being also maintained by some orchardists in Malihabad. He shared his experience about the mango genotypes especially suitable for marginal lands and waterlogged conditions available in Bihar. Dr. D. S. Rathore, former Vice Chancellor, CSKHPKVV, Palampur appreciated Mr. Kamil Khan for providing his orchard to CISH for validating the mango rejuvenation technology. Mr Inshram Ali, President, All India Mango Growers' Association stressed that farmers and scientists need to work together in order to solve the prevailing problems of mango industry and boost the exports. The Vice Chancellor of Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut and the Chief Guest on the occasion, Dr A. K. Bakshi, informed that India has 8 per cent of the world's biodiversity with only 2.4 per cent of the global area. He suggested that biodiversity available in mango need to be linked with markets in order to maintain the sustainability.

Institute organized a Mango Show on the occasion displaying more than 500 mango varieties from across the country. An exhibition was also organized by the institute wherein more than 15 stalls were put up by different government departments, private agencies and NGOs. More than 300 scientists, officials from different departments and progressive farmers participated in the event.

Dr. H.P. Singh, DDG (Hort.), ICAR, Dr. H. Ravishankar, Director and others during the Mango Show

## Consortium Advisory Committee Meeting

Third Consortium Advisory Committee meeting to review the progress of NAIP subproject on "A value chain on mango and guava for domestic and export markets" was held on September 7, 2010 under the chairmanship of Dr. D.S. Rathore, ex-VC, CSK KPKV, Palampur. The achievements of different co-partners were presented by CPI and CCPIs of the Consortium, namely, CISH, Lucknow(Lead Centre). TNAU, Coimbatore, APHU, Tedepalligudem, NAU, Navasari and a private organization, BAIF Development Research Foundation, Pune. Suggestions were given by the committee for improvement of the project and maximizing quality output. The meeting was also attended by the members of CAC, *viz.* Dr. B. K. Mittal, ex-Head, Food Science and Technology, Mrs. Laxmi Dwivedi, NGO representative, Shri Shailendra Singh, progressive farmer and Dr. H. Ravishankar, Director, CISH and Consortium Leader and Dr. S. K. Shukla, Consortium Principal Investigator.

CAC meeting in progress

## Stakeholders' Consultative Meet

Stakeholders' Consultative Meet was organized by the institute on October 4, 2010 under the chairmanship of Mr. Jagan Mathew, Principal Secretary, Horticulture and Food Processing, Uttar Pradesh to identify the issues and their redressal for integrated development of horticulture in the State. Dr. H. Ravishankar, Director explained the objectives of the meeting as identification and documentation of the issues and problems of stakeholders required for reorientation of institute's research programmes and

Distinguished dignitaries during the Stakeholders' Meet

developing suitable strategies for development departments. Mr. Jagan Mathew, the Chief Guest, highlighted that involvement of stakeholders, *viz.* farmers, processors, market agents and entrepreneurs, was a must for both research institutions and development departments for achieving success in the field of agriculture. Action points need to be developed for enhancing production and productivity of horticulture crops in sustainable manner, strengthening of market links, promotion of processing and value addition through agro-industries and entrepreneurs, he added. All the stakeholders were to be linked with one another for strengthening of production to consumption chain.

Dr. C. Prasad, ex-DDG, ICAR and Dr. R.P. Singh, ex-VC, MPUAT, Udaipur highlighted the need for involving farm women in development of agricultural research programmes and development strategies for effective dissemination of improved technolohies with special focus on social aspects including happiness of faremers besides higher productivity and income. More than 100 participants deliberated on various issues in the interactive meeting which included farmers, representatives from various departments, NGOs, IFFCO, fruit commission agents, exporters, banks, etc.

The specific issues emerged were the short span availability of mango, poor keeping quality of Dashehari fruits, low cost ripening chambers, non-availability of mango varieties for pickles, promotion of late maturing varieties to tap the domestic and world market, promotion of integrated fruit based farming systems instead of monoculture for crops and development of small scale processing modules. Need of soil map of Uttar Pradesh was felt for promoting suitable crops in different areas for enhancing productivity on sustained basis.

# 16. DISTINGUISHED VISITORS

Dr. Vinay Tuli, Senior Value Chain Specialist Sunhara India Project, ASI, Lucknow (April 9 & 10, 2010).

Shri Justice S. B. Deshmukh, Judge, High Court of Bombay, Bench at Aurangabad - 431005 (May 12, 2010).

Dr. Mangala Rai, Former Secretary DARE and Director General, ICAR, New Delhi (May 21, 2010).

Dr. H.P. Singh, Deputy Director General (Hort.), ICAR, Krishi Anushandhan Bhavan, KAB -II, New Delhi 110 012 (June 25 & November 19, 2010).

Dr. D. S. Rathore, Former Vice-Chancellor and Chairman, Institute R.A.C., Flat P, J-1/63, Gupta Colony, Khirki Extension, New Delhi-100 017 (June 28 & 29, 2010).

Dr. A.K.Bakshi, Vice-chancellor, SVBPA&T, Meerut, (June 28, 2010).

Dr. S. Rajan, ADG (Hort I), ICAR, Kushi Anushandhan Bhavan, KAB-II, New Delhi - 110 012 (June 28, 2010).

Dr. A.N. Mukhopadhyay, Ex-VC, AAA, 151, Aakansha Udyan-II, Raebareli Road, Lucknow-226 025 (June 28, 2010)

Dr. D.M. Singh, Additional Director of Agriculture, NFSM, Uttar Pradesh (July 6 & 7, 2010).

Dr. R.P.Singh, ex-VC, MPUA&T, Udaipur, B-5/5, Vinay Khand, Gomti Nagar, Lucknow-226 010 (October 4 & November 19, 2010).

Dr. S. N. Pandey, ex-Director, CPRI, Shimla, Himachal Pradesh (October 4 & November 19, 2010).

Dr. Rajesh Kumar Tiwari, Deputy Director & Head, Amity Institute of Biotechnology, Lucknow, (October 18 to 22, 2010).

Dr. Pitam Chandra, Director, CIAE, Bhopal- 462038, Madhya Pradesh (October 23, 2010)

Dr. K.N. Tiwari, Indian Institute of Technology, Kharagpur -721302, West Bengal (November 2, 2010).

Dr. S. Ayyapan, Secretary DARE and DG, ICAR, Krishi Bhawan, New Delhi- 110014 (November 19, 2010).

Dr. J.K.Jena, Director, NBFGR, Lucknow 226 002, (November 19, 2010).

Dr. S.A.H.Abidi, ex-Member, ASRB, ICAR, New Delhi 110 012 (November 19, 2010).

Dr. Mathura Rai, ex-Director, IIVR, Varanasi (November 19, 2010).

Dr. A.K. Singh, Division of Fruit & Horticulture Technology, IARI, New Delhi - 110012, (November 22 & December 5, 2010).

Dr. Sandeep Prasnis, John Deere India Pvt.Ltd., Pune (December 7, 2010).

Dr. Sanjay Kumar, Department of Applied Science, B.B.A. University, R.B. Road, Lucknow -226025 (January 27, 2011).

Shri Inshram Ali, President, AIMGA, Mango House, Malihabad - 227 110 (27 February, 2011)

Prof. Arun Arya, Maharaja Sayaji Rao University of Baroda, Vadodra - 390002 ( March 3, 2011).

Dr. R.K.Tiwari, Joint Secretary, Government of India, Department of Agriculture & Cooperation, New Delhi - 110 014 (March 3, 2011).

Dr. D.P.Singh, IAS (Retired), Former Secretary to Government of India, 3/243, Vinay Khand, Gomti Nagar, Lucknow - 226 010 (March 17, 2011).

# 17. PERSONNEL

H. Ravishankar, Ph.D.
Director

## SCIENTIFIC

### Division of Crop Improvement

Ramesh Chandra, Ph.D., F.I.S.G.P.B, F.H.S.I.
Pr. Scientist (Eco. Bot.) & Head

Shailendra Rajan, Ph.D.
Pr. Scientist (Hort.)

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

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

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

Maneesh Mishra, Ph.D.
Sr. Scientist (Hort.)

Anju Bajpai, Ph.D.
Sr. Scientist (Gen. & Cyto.)

H.C. Verma, Ph.D.
Computer Appl.
Scientist (SS)

Muththukumar M., M.Sc.
Scientist (Biotech.)

Nimisha Sharma, M.Sc.
Scientist (Biotech.)

Umesh Hudedamani, M.Sc.(Ag.)
Scientist (Plant Breeding) (w.e.f. 23.4.2010)

### Division of Crop Production

S. R. Bhriguvanshi, Ph.D.
Pr. Scientist (Soil Sci.) & Head (up to 31.07.2010)

Kailash Kumar, Ph.D.
Pr. Scientist (Soil Chem./Fert./Microl.) & Head
(w.e.f. 01.08.2010)

V. K. Singh, Ph.D.
Pr. Scientist (Pl. Physiol.)

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

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

Achal Singh, Ph.D.
Sr. Scientist (Ag. Stat.)

Barsati Lal, Ph.D.
Sr. Scientist (Ag. Extension)
(w.e.f. 14.05.2010)

Sridhar Gutam, Ph.D.
Sr. Scientist (Pl. Physiol.)
(w.e.f. 27.12.2010)

R.B.L. Srivastava, M.Sc. (Ag.)
Scientist (SG)(Ag. Eco.) (up to 30.06.2010)

Subhash Chandra, M.A.
Scientist (SG) (Ag. Ext.)

Dushyant Mishra, Ph.D.
Scientist (SS) (Hort.)

Atul Singha, Ph.D.
Scientist (Ag. Micro.)

Tarun Adak, Ph.D.
Scientist (Soil Phy./Water Conserv.)

### Division of Crop Protection

R. P. Shukla, Ph.D.
Pr. Scientist (Ag. Ento.) & Head

S. Sharma, M.Sc.
Pr. Scientist (Ag. Ento.)
(up to 31.12.2010)

R. M. Khan, Ph.D., F.P.S.I.
Pr. Scientist (Nematol.)

B. K. Pandey, Ph.D.
Pr. Scientist (Pl. Path.)

A.K. Shukla, Ph.D.
Pr. Scientist (Pl. Path.) (up to 01.08.2010)

A. K. Singh, Ph.D.
Pr. Scientist (Pl. Path.)

P.K. Shukla, Ph.D.
Sr. Scientist (Pl.Path.)

H. Kesava Kumar, M.Sc.
Scientist(Nematol.)
(w.e.f. 24.01.2011)

## Division of Post Harvest Management

Neelima Garg, Ph.D.
Pr. Scientist (Micro.) & Head

M. D. Singh, M.E.
Pr. Scientist (F.M. & P.) (up to 31.01.2011)

D. K. Tandon, Ph.D., F.H.S.I.
Pr. Scientist (Biochem.)

Ajay Verma, Ph.D.
Pr. Scientist (Ag. Econ.)

A. K. Bhattacherjee, Ph.D.
Sr. Scientist (Ag. Chem.)

Anil Kumar Verma, M. Tech.
Scientist (SG) (FM & P)

Bharti Killadi, Ph.D.
Scientist (Hort.)

Ms. Pushpa K., M.Sc.
Scientist (Food & Nutrition)
(w.e.f. 23.04.2010)

## Project Coordinator (Subtropical Fruits) Cell

A. K. Misra, Ph.D., F.P.S.I., F.I.S.M.P.P.
Project Coordinator

Ghanshyam Pandey, Ph.D.
Pr. Scientist (Hort.)

Rakesh Chandra,
Scientist (SG) (Ag. Stat.)

## TECHNICAL

S.K. Raghav, Ph.D.(Ag.)
T- 7-8 (T.O.) (Farm Management)

R. P. Shankhwar, B.Sc. (Ag.), T.D.C
T-7-8 (T.O.) (Lab.)

Santosh Kumar, M.Sc. (Ag.)
T-7-8 (T.O.) (Farm Management)

Raghubir Singh, Ph.D.
T-7-8 (T.O.) (Farm Management)

Sanjay Kumar, M.Sc.
T-7-8 (T.O.) (Lab.)

Abhay Dikshit, M.Sc.
T-7-8 (T.O.) (Lab.)

S. K. Arun, B.Sc. (Ag.)
T-6 (T.O.) (Lab.)

Om Prakash, B.Ed., Ph.D.
T-6 (T.O.) (Lab.)

Pradeep Kumar Kulshrestha, B.Sc
T-6 (T.O.) (Lab.)

Vinod Kumar Singh, Ph.D.
T-6 (T.O.) (Lab.)

Ramendra Tiwari, B.Tech.
T-6 (T.O.) (Ag.Engg.)

D.K. Shukla, M. Tech.
T-6 (T.O.) (Lab.)

Prem Kumar, D.M. (Mech.)
T-6 (T.O.) (Photography)

Rekha Chaurasia, B.Sc.
T-6 (T.O.) (Lab.)

Anil Kumar Singh, M.Sc.
T-6 (T.O.) (Lab.)

Bahadur Singh, Dip. (Referig. & Aircond.)
T-6 (T.O.) (Lab.)

Ram Sharan, B.Sc. (Ag.)
T-6 (T.O.) (Lab.)

C. P. Dwivedi, M.A.
T-5 (T.O.) (Lab.)

B.P. Shukla, M.Sc., L.L.B., B.J.M.C.
T-5 (T.O.) (Lab.)

Chandra Bhal, B.Sc.
T-5 (T.O.) (Lab.)

H. Rehman, B.F.A. (Commercial Arts)
T-5 (T.O.) (Art)

Braham Pal, Dip. (Ag. Ext.)
T-5 (T.O.) (Field)

Ram Autar, Inter (Ag.)
T-5 (T.O.) (Field)

Anjani Kumar, B.A.
T-5 (T.O.) (Field)

R.P. Misra
T-5 (T.O.) (Driver)

Ayodhya Prasad
T-5(T.O.) (Driver)

Mashooq Ali
T-5(T.O.) (Workshop)

Arvind Kumar, M.Sc.(Ag.)
T-5 (T.O.) (Lab.)

## ADMINISTRATIVE

Shri Firoz Khan, M.Sc. B.Ed.
Senior Administrative Officer
(w.e.f. 07.10.2010)

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

K. Swarnakumari, Matriculation
Administrative Officer (up to 30.09.2010)

Shri G.D. Amola, B.A.,L.L.B.
Finance & Accounts Officer
(w.e.f. 28.03.2011)

S. S. Arora, B.Sc., Dip. (Steno.)
Assistant Administrative Officer
(Retired on 31.07.2010)

Ravi Bhadra, M. Com.
Assistant Finance & Accounts Officer

Shri A.M. Srivastava, B.A.
Assistant Administrative Officer
on deputation(w.e.f. 20.10.2010)

Ram Naresh
Sr. Stenographer

# 18. OTHER INFORMATION

## Export of Mangoes through Sea Transportation

A trial consignment of Dashehari mangoes (10 MT) was sent through land-cum-sea transport to Dubai by an exporter with the financial assistance of NHB, Gurgaon and technical support of the institute. The mangoes were harvested at mature stage, brought to the pack house, treated with cardendazim in hot water, graded and packed in CFB boxes. The cold chain technology developed by CISH for export of mangoes was followed using reefer container. The reefer container reached Dubai enroute Dadri and Mumbai in 15 days. The fruits reached at the destination in sound condition without any mechanical bruising conforming the internationally accepted consumer's preference norms.

## Mango Festival

The institute participated in mango festival organized by DTDC at Delhi Haat during July 2-4, 2010. The festival was inaugurated by Mrs. Sheila Dikshit, Chief Minister of Delhi. On this occasion, she also released institute technical brochure *Ethrel se aam pakane ki taqnikeyan*. After the inauguration, she visited the stall and appreciated the participants for displaying promising varieties.

Mrs. Sheila Dixit, Chief Minister of Delhi visiting CISH Stall during Mango festival at Delhi Haat, New Delhi

## Mango Show

The institute organized a mango show at the NASE Complex, Pusa, New Delhi on July 4, 2010. A number of ICAR dignitaries visited the mango show and took stock of various varieties. A mango eating competition was also held on this occasion.

Distinguished dignitaries sitting on the dais during mango exhibition

## Media Resource Centre

Dr. S. Ayyapan, Secretary DARE and Director General, ICAR, New Delhi inaugurated the Media Resource Centre/CISH Phone-in-live/Visitors' room facility on November 19, 2010. The facility" he expressed

Dr. S. Ayyappan, Secretary DARE & D.G., ICAR inagurating media resource centre

Dr. H. Ravishankar, Director briefing the dignitaries

Dr. S. Ayyappan, DG, ICAR laying the Foundation Stone of extension wing of the Lab-cum-Administrative Building

would cater to the needs of farmers/fruit growers/ stakeholders/entrepreneurs/industry through a direct communication channel with institue's scientists for availing immediate solutions to their problems related to varieties, production technologies, management of insect pests and diseases, use of farm machinery and value added products and marketing of fruits and other problems associated with climatic changes for maximizing fruit crops productivity on sustained basis. The Phone-in-live facility has been made available to all the users on telephone no. 0522-2841082 on every Friday between 10.30 AM and 4.00 PM in an interactive mode in which all the scientists of the institute will be available for addressing growers querries as typical issues.

## Foundation Stone laying of Extension wing of Laboratory-cum-Administrative Building

Dr. S. Ayyapan, Secretary, DARE and Director General, ICAR, New Delhi laid the foundation stone of the extension wing of laboratory-cum-administrative building of the institute at its Rehmankhera Campus on November 19, 2010. He appreciated the achievements made by the institute during the past 38 years and hoped that emphasis may be given to arid horticulture and underutilized fruits in the years to come. He stressed the need for developing profit-prestige-partnership (PPP) in agriculture keeping the interest of farmers in prime focus. Dr. H. P. Singh, DDG (Hort.), Dr. S.A.H. Abidi, ex- Member, ASRB and Dr. J.K. Jena, Director, NBFGR, Lucknow also graced the occasion.

## Showcasing of Agricultural Technologies and Mango Gosthi

Institute organized Mango Gosthi and Showcased the latest agricultural technologies with a view to create awareness amongst the farming community at village Dashehari, Lucknow on February 27, 2011. Shri Manoj Kumar Singh, Secretary, Horticulture, Food processing and Rural Development, Govt. of U.P., the Chief Guest, highlighted the horticultural development schemes of U.P. Government. Mr. Insram Ali, President Mango Growers' Association of India presided over the function and put forth the problems of mango growers and other stakeholders of mango value chain in Malihabad belt which was deliberated in an interactive

Shri Manoj Kumar Singh, Secretary, Food Processing and Rural Development, Govt. of UP inaugurating the exhibition

Distinguished dignitaries and participants during the mango gosthi

mode. Dr. H. Ravishankar, Director welcomed the distinguished guests and outlined the different technologies developed by the institute for the benefit of growers. He also highlighted the media resource file created and updated from time to time with institue's website www.cishlko.org and Media Resource Centre and phone-in-live helpline (0522-2841082) through which farmers and media agencies can source information and interact with the scientists of the institute. Many growers are availing this facility for obtaining solutions to the production problems, it was pointed out.

Farmers-scientists interaction was also organized on the occasion wherein suitable solutions/ suggestions were provided by the scientists of the institute to the problems raised by the growers related to mango production, credit and marketing besides other horticultural crops production.

Exhibition stalls by different ICAR institutes, government departments and private organizations/ entrepreneurs were put up to showcase the latest agricultural technologies available for the benefit of farmers. About three hundred farmers from Mall, Malihabad, Kakori and Bakshi-ka-talab blocks of Lucknow district participated.

Dr. S.A.H. Abidi, ex- Member, ASRB, Dr. A. N. Mukhopadhyaya, ex-VC, AAU, Jorhat, Dr. Mathura Rai, ex- Director, IIVR, Mr. D. K. Sharma, Vice President, MGAI, Mr. Kamil Khan, progressive farmer from Kakori and Mr. M. K. Rawat, Pradhan, Village Dashehari who graced the occasion also expressed their views on the occasion.

## हिन्दी चेतना मास 2010 एवं अन्य राजभाषा गतिविधियां

केन्द्रीय उपोष्ण बागवानी संस्थान, लखनऊ में दिनांक 14 सितम्बर से 12 अक्टूबर 2010 तक हिन्दी चेतना मास का आयोजन किया गया। इसका उद्घाटन हिन्दी दिवस समारोह कार्यक्रम की कार्यशाला के साथ हुआ। हिन्दी कार्यशाला में मुख्य अतिथि डॉ. गौरी शंकर पाण्डेय अध्यक्ष, शिक्षक शिक्षा विभाग, का.सू. साकेत महाविद्यालय फैजाबाद ने व्याख्यान प्रस्तुत किया। उन्होंने हिन्दी का इतिहास, वर्तमान एवं भविष्य

हिन्दी दिवस समारोह के दौरान मुख्य अतिथि डॉ. गौरीशंकर पाण्डेय, डॉ. एच. रविशंकर, निदेशक एवं डॉ. रमेश चन्द्रा

हिन्दी कार्यशाला के दौरान अधिकारियों एवं कर्मचारियों को सम्बोधित करते हुए डॉ. एच. रविशंकर, निदेशक

विषय पर विस्तृत जानकारी देते हुए हिन्दी को भविष्य की भाषा बताया। उन्होंने हिन्दी के बदलते स्वरूप पर भी चर्चा की। इस अवसर पर कार्यकारी निदेशक डॉ. एच. रविशंकर ने हिन्दी के प्रचार-प्रसार पर जोर देते हुए इसकी उपयोगिता की ओर ध्यान आकर्षित किया।

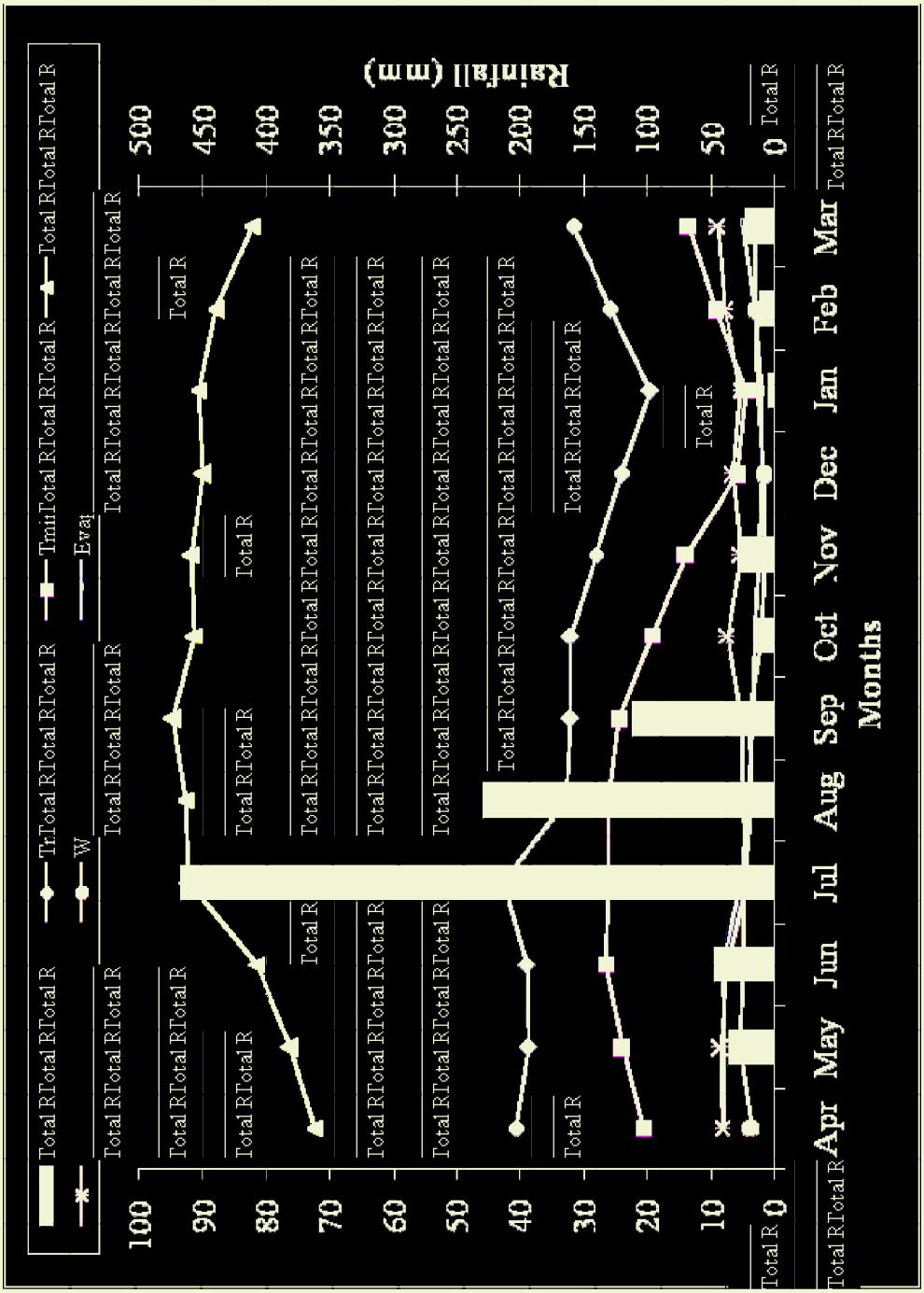
हिन्दी चेतना मास 2010 के दौरान संस्थान के वैज्ञानिकों, अधिकारियों एवं कर्मचारियों के लिए हिन्दी निबंध प्रतियोगिता, टंकण प्रतियोगिता, वाद-विवाद प्रतियोगिता, शब्दावली प्रतियोगिता, प्रश्नोत्तरी प्रतियोगिता आदि का आयोजन किया गया जिसमें सभी ने बढ़चढ़ कर हिस्सा लिया। इसके अलावा संस्थान मे हिन्दी की 4 कार्यशालाओं तथा त्रैमासिक बैठक का समय-समय पर आयोजन किया गया ताकि राजभाषा हिन्दी का प्रगामी प्रसार-प्रचार होता रहे।

यूनिकोड की कार्यशाला पर व्याख्यान देते
डॉ. ए.पी. राय, वरिष्ठ वैज्ञानिक, जी.एस.आई., लखनऊ

हिन्दी चेतना मास 2010 के दौरान
हिन्दी निबन्ध प्रतियोगिता का आयोजन

# 19. METEOROLOGICAL DATA

Meteorological data 2010-11

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