

वार्षिक प्रतिवेदन Annual Report 2008-09



केन्द्रीय उपोष्ण बागवानी संस्थान

रहमानखेड़ा, लखनऊ

Central Institute for Subtropical Horticulture
Rehmankhara, Lucknow



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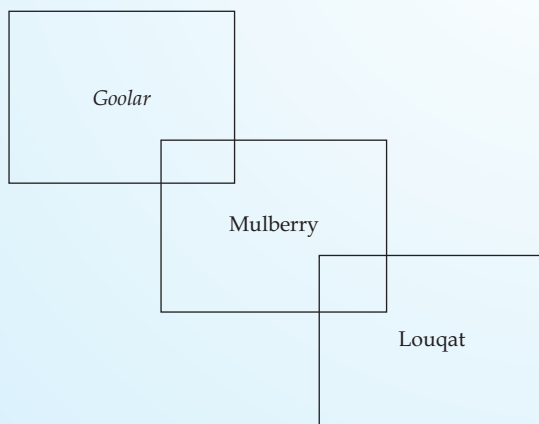
Correct Citation
CISH Annual Report, 2008-2009
Lucknow, India

Published by :
Dr. H. Ravishankar
Director
Central Institute for Subtropical Horticulture (ICAR)
Rehmankhera, Lucknow-227 107 (U.P.), INDIA

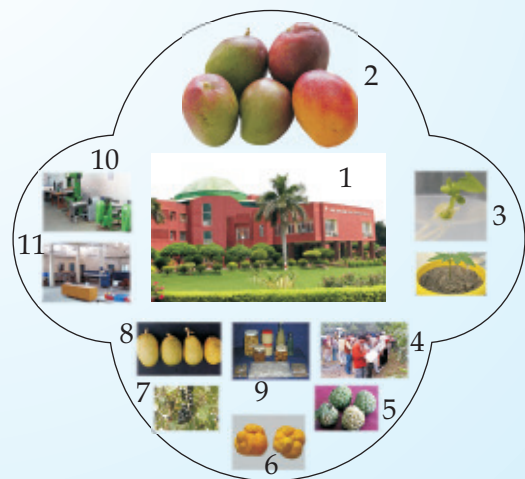
Compiled and Edited by :
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Cover Design and Photographs by :
Prem Kumar and H. Rehman

Back Cover



Front Cover



1. Laboratory cum Administrative complex, 2. Mango variety-Arunika 3. Transgenic papaya developed against PaLcv, 4. Technology dissemination through field visit, 5. Custard apple, 6. Barhal (Lakuch), 7. *Jamun*, 8. Bael-CISH B-1, 9. Aonla products, 10. Processing Hall, 11. Packaging Hall

PREFACE

Owing to rapid pace of industrialization especially during the century gone by, climatic scenario in conjunction with declining arable land versus population the world over, has witnessed the unprecedented irreversible shifting patterns, impacting the crop productivity linked factors in a negative mode. Accumulation of carbon credit points in a variety of eco-systems and their percolation down the food web, elevation as well as extension of thermal degree co-efficient over temporal/ spatial scale and relatively lower precipitation rates being experienced currently, has largely resulted in degradation of soil fertility, declining water productivity potential, phenomenal emergence of certain new pests/diseases and above all the erosion and even extinction of invaluable genetic wealth of the country.

Agri-horticultural scientists are actively engaged in confronting the emerging challenges with broader scientific vision and tackling the issues through holistic approaches for evolving and refining the viable technologies with angular societal aspirations for ensuring sustainable livelihoods and better economic options for different economic strata.

The work carried out during the period and reported herein represents the strategic planning exercises in the mandate crops of the Institute comprising of conservation of germplasm and their effective utilization for crop improvement through conventional as well as biotechnological interventions. It is envisaged for developing and meeting various domestic as well as international market requirements. Collection and conservation of germplasm in mandate crops especially mango has led to the development of improved mango variety 'Arunika' through sustained efforts and its release during the period. Canopy engineering, water productivity, fertigation, substrate dynamics, integrated pests and diseases management options have been pursued vigorously and experimented upon in view of obtaining better utilization of dwindling natural resources for maximization of productivity potential. Curtailment of post-harvest losses through pre-harvest management programme has been addressed and development of variety of products coupled with waste/ by-product utilization is in sharp focus. Technology dissemination and its refinement strategies have been attended through farmers-scientists interaction, farm visits, training programmes and technology impact assessment approaches. The Institute endears itself to bring about strategies for improving the livelihood options of farmers through sustainable approaches of integrated horticultural development in the coming years.

The contributions of all the concerned Divisions, administration, accounts, other staff and especially the publication committee headed by Dr. D.K.Tamdon and Dr. R.M.Khan and Shri Dhiraj Sharma in shaping this publication are gratefully acknowledged.

October 2009


(H. RAVISHANKAR)
DIRECTOR

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1. कार्यकारी सारांश

अनुसंधान उपलब्धियाँ

फसल सुधार

इस अवधि के दौरान आम के तीस अभिगमनों को भुवनेश्वर एवं राँची से संकलन किया गया तथा साठ अभिगमनों का संस्थान के प्रक्षेत्र जीन बैंक में रोपण किया गया। आम के पाँच सौ अट्टावन अभिगमनों तथा 600 से ज़्यादा संकर नस्ल के पौधों का उनकी विभिन्न विशेषताओं के आधार पर मूल्यांकन किया गया। 150 अभिगमनों की विशेषताओं के आँकड़ों के आधार पर आम के डी. यू. एस. दिशा-निर्देश तैयार किये गये। आम के 100 अभिगमनों के पत्तों एवं बौर के आधार पर द्वितीय तालिका विकसित की गयी। डेटाबेस संरचना तथा मापदंड में सुधार किया गया। आई. सी. नम्बर के विकल्प या नाम के आधार पर सर्व माडयूल विकसित की गयी।

आम के 150 किस्मों को 20 एस. टी. एस. एस. द्वारा अभिलक्षित किये जाने पर 18 माइक्रोसैटेलाइटों के विश्लेषण से 144 किस्मों में पॉलीमार्फिज्म द्वारा विश्लेषित आँकड़ों को डेंडोग्राम द्वारा निरूपित करने पर यह पाया गया कि कि 150 जनन द्रव्यों को तीन बड़े समूहों में बाँटा जा सकता है। एच. एम. आई. डी. 016 द्वारा सर्वाधिक तथा एच. एम. आई. डी. 2041 द्वारा न्यूनतम स्तर का पॉलीमार्फिज्म पाया गया।

अमरुद के 12 अभिगमनों को उत्तर प्रदेश के विभिन्न क्षेत्रों तथा शिर्डी (महाराष्ट्र) से दो अभिगमनों का संकलन किया गया। संस्थान के प्रक्षेत्र जीन बैंक में सिडियम की छह प्रजातियों सहित एक सौ तेईस अभिगमनों का रखरखाव किया गया। अस्सी अभिगमनों को पत्तों में व्याप्त विशेषताओं के आधार पर जबकि 40 अभिगमनों को फलों में व्याप्त विशेषता के आधार पर अभिलक्षित किया गया।

120 अभिगमनों के जननद्रव्यों संबंधी सूचना को अभिलक्षित कर उनकी संहिता तैयार की गयी तथा तालिका का अद्यतन किया गया।

आँवला के इक्कीस अभिगमनों को मध्य प्रदेश के विभिन्न हिस्सों से संकलित कर उन्हें उनके वृद्धि के मानदण्डों के मूल्यांकन हेतु प्रक्षेत्र में रोपित किया गया। दो बीजरहित जामुन के अभिगमनों सहित पाँच अभिगमनों को गुजरात एवं उत्तर प्रदेश से संकलित किया गया। फल के दैहिक-रसायनिक मानदण्डों के आधार पर आठ सर्वोत्तम जननद्रव्यों को फल भार, बीज एवं भार गूदा की मात्रा टी. एस. एस., टाइटेबल एसिडिटी एसकॉर्बिक एसिड, ऐथोसियानिनस टैनिन आदि के आधार पर मूल्यांकित किया गया। सी. आई. एस. एच.-जे-34 में सर्वाधिक

ऐंटीऑक्सिडेंट वैल्यू (53.29 एम. जी. ए.ई. ए.सी. ग्रा.-1) पाया गया।

संस्थान के प्रक्षेत्र जीन बैंक में जामुन (5), खिरनी (17), महुआ (20), इमली (17) तथा केप गूजबेरी (3) को लगाया गया।

फसल उत्पादन

आम के गुणन (पॉलीथीन बैग में) के लिये प्रयोग किये गये विभिन्न सम्मिश्रणों में मृदा, बालू एवं एफ.वाई.एम. (1:1:1) वाले कोकोपीट (10%) को मीडिया में मिलाने पर बेहतर पादप वृद्धि देखी गयी।

आम के दशहरी किस्म का मध्यम सघनता वाले रोपण (400 पौध प्रति हेक्टेयर) से परम्पराण रोपण (100 पौध प्रति हेक्टेयर) की तुलना में अधिक फल उत्पादन (15.12 टन प्रति हेक्टेयर) रिकार्ड किया गया।

मल्लिका आम के पेड़ों के किनारों की कटाई से उत्पादन (75.5 कि.ग्रा. प्रति पेड़) तथा 'ए' ग्रेड वाले फलों की संख्या (41%) में कटाई रहित पेड़ों की तुलना में बेहतर परिणाम देखने को मिला।

आर्गेनिक खाद या मल्लिंग ने मृदा में आर्गेनिक कार्बन तथा एवं पी.के. मात्रा में सुधार किया। मृदा में नमी का अवधारण वहाँ अधिक था जहाँ 50 प्रतिशत कम पानी से सिंचाई के पश्चात् मल्लिंग किया गया। आम के जिन पेड़ों में लीटर पत्तों से मल्लिंग की गयी तथा फलों की वृद्धि की अवस्था पर सिंचाई की गयी उन वृक्षों में अन्य सामान्य वृक्षों की अपेक्षा अधिक फल उत्पादन प्राप्त रिकार्ड किया गया। ड्रिप सिंचाई अकेले (6.57 टन प्रति हेक्टेयर) या एन.पी.के. के साथ लंगड़ा किस्म के फल का उत्पादन (7.21 टन प्रति हेक्टेयर) बेसिन सिंचाई (5.32 टन प्रति हेक्टेयर) की तुलना में वृद्धि देखी गयी। पैक्लोब्यूट्राजोल का प्रयोग जिन पेड़ों के कैनापी पर किया गया उनमें सामान्य वृक्षों की तुलना में वृद्धि अधिक पुष्पन देखा गया।

मल्लिंग के साथ पैकब्यूट्राजोल (1.6 मिली) का प्रयोग किये जाने पर अधिक मात्रा में उत्पादन एवं फल प्राप्त हुआ। दशहरी आम के रिजोफियर में मिथोनायन (100 पी.पी.एम.) तथा ट्राइकोडर्मा हर्जियानम के प्रयोग से प्रकाश संश्लेषण की दर तथा स्टोमेटल कंडक्शन में वृद्धि हुई। 'लंगड़ा' एवं 'दशहरी' आम के पेड़ों में पैकब्यूट्राजोल का प्रयोग जैसे-जैसे बढ़ता गया वैसे-वैसे प्रकाश संश्लेषण की दर में कमी देखी गयी।



फसल संरक्षण

मौसम तथा कृत्रिम न्यूरोल नेटवर्क तकनीक के आधार पर विकसित किये गये भविष्यवाणी प्रारूप से 15 दिन पूर्व ही आम में होने वाले फल मक्खी तथा हॉपर की जनसंख्या के आक्रमण को बताया जा सकता है। फल मक्खी एवं हॉपर की सर्वाधिक जनसंख्या क्रमशः अप्रैल से मई तथा अक्टूबर से अप्रैल के दौरान देखी गयी। आम के बगीचे में थ्रिप्स की असामान्य घटना की वृद्धि नये कोपलों की उत्पत्ति के दौरान देखी गयी। एसीफेट, स्पाइनोसेड, थाइमेथोक्सेम तथा इमिडाक्लोप्रिड को हॉपर की जनसंख्या को शत-प्रतिशत नियंत्रित करने में प्रभावकारी पाया गया। इमिडाक्लोप्रिड में उच्च मात्रा में व्याप्त विषाक्तता के कारण इस कम विषाक्त एसिफेट से परिवर्तित किया जा सकता है। जिससे कि मधु-मक्खियों पर इसका बुरा प्रभाव नहीं पड़े।

‘इलाहाबाद सफेदा’ नामक अमरुद में इथोफेनोप्रोक्स (0.05%) को 15 दिनों के अन्तराल पर डालने पर बोरर के आक्रमण को पूर्णतया प्रभावकारी पाया गया। कारटैप हाइड्रोक्लोराइड (0.05%), नमी एक्सेल (0.2%) तथा कारबारिल (0.2%) का प्रयोग करने पर प्रयोग रहित की तुलना में क्रमशः 1.26, 2.66 तथा 4.66 प्रतिशत कम आक्रमण देखा गया। इसी प्रकार से इलाहाबाद सफेदा में होने वाले बार्क इटिंग कार्टरपिलर के प्रभाव को मनुष्य द्वारा जालों को साफ कर एवं डिंभकों खत्म कर प्रभावी दंड नियंत्रित किया जा सकता है। पाइन तेल (0.1%), कस्टर तेल (2%) एक्सेल प्लस (1%), क्लोरोपिरीफॉस (0.05%) तथा नीम के तेल (0.15%) के इस्तेमाल से फरवरी के अंतिम सप्ताह में स्वैबिंग को प्रभावी ढंग से प्रबंधित किया जा सकता है। पाइन तेल (1%) तथा कस्टर तेल (1%) के प्रयोग से डिंभक समूह में शत-प्रतिशत कमी पायी गयी। इसके बाद कस्टर के तेल से 75.5 प्रतिशत, नीम के तेल से 75 प्रतिशत तथा क्लोरोपिरोफॉस से 60.25 प्रतिशत डिंभक समूह में कमी देखी गयी। गौल मेकर का आक्रमण आँवला की पौधशाला एवं बगीचे में देखी गयी। पौधशाला में गौल मेकर की घटना तुलनात्मक रूप से कम (0.5 प्रति पौध) थी। सभी किस्मों के परिपक्व पेड़ में शूट गौल देखा गया। इसका सर्वाधिक प्रभाव (प्रति पेड़ 6.08 गौल) अक्टूबर के पहले पखवाड़े से मार्च के पहले पखवाड़े तक देखा गाय। इसी प्रकार फ्रूट बोरर के प्रभाव को अगस्त के पहले पखवाड़े से नवम्बर के पहले पखवाड़े तक देखा गया जिससे कि 2.65 प्रतिशत फल की हानि हुई। बैसिलस सबटीलियस से पृथक किये गये चार जीवाणु को बायोडायनमिक की तैयारी में प्रयोग नहीं किये जाने पर उनमें गोलकृमि की विषाक्तता को अधिक नहीं देखा गया क्योंकि कम उम्र में मृत्यु दर मात्र 0.12 प्रतिशत थी। अलग किये गये जीवाणु में कम मात्रा में गौल कृमि विषाक्तता का कारण कम तापमान (20-22° से०) रहा।

एफ.वाई.एम. के साथ मस्टर्ड केक के औसत (25:75) को ट्राइकोडर्मा हर्जियानम की जनसंख्या का मुख्य कारण पाया गया। मार्च के महीने में तुलनात्मक रूप से कम तापमान (300 से कम) तथा उच्च

नमी (72-98%) के कारण आम में फ्लोरल पाउड्री मिल्ड्यू एपिफिटोटिक अनुपात में प्रभावी व्याप्त नहीं हो सका। इसी प्रकार अनुकूल तापमान एवं नमी के कारण आम में होने वाले ऐनथ्रेक्नोज, ब्लॉसम ब्लाइट सूटी मोल्ड तथा डाइ बैक रोगों का प्रभाव व्यापक नहीं हो सका।

‘एन.बी.-5’ तथा ‘एन.बी.9’ किस्मों के पेड़ों तथा पौधों में ट्रिबग डाइ बैक तथा गम्मोसिस के रोग लक्षण पाये गये। कार्बेन्डाजिम (0.05%) एवं गर्म पानी घोल बनाकर तुड़ाई उपरान्त आम के फल पर लगाने पर परिवेशी वातावरण में उन्हें 8 दिनों तक भंडारित करने में प्रभावी पाया गया। परिवेशी वातावरण में फ्लोक्लोराज एवं ठंडे पानी के प्रयोग को प्रभावहीन पाया गया।

तुड़ाई उपरान्त प्रबन्धन

फल को पकड़ कर उसको काटने के सिद्धान्त पर लॉपर प्रकार के बेल तोड़क यन्त्र का डिजाइन कर निर्माण किया गया। आम के फाँको एवं टुकड़े करने वाले मशीन के ब्लेड में सुधार किया गया तथा मशीन की क्षमता बेहतर करने के लिए उसके सामने के हिस्से में सुधार किया गया।

आम के निर्यात तथा पैकजिंग के लिए ट्रे प्रकार के बक्सों को बनाया गया। आम के लंगड़ा एवं चौसा किस्मों तथा अमरुद के इलाहाबाद सफेदा तथा सरदार किस्मों को निर्यात हेतु श्रेणीकरण कर उनका मानकीकरण किया गया। आम की नौ किस्मों/संकर किस्मों को तेल वाले अचार तथा बारह किस्मों को गूदा/पेय पदार्थ के लिये मूल्यांकित किया गया ताकि उनकी स्वीकार्यता बनी रहे। बथुयी को अचार के लिये सर्वाधिक स्वीकार्य किस्म पाया गया। इसके बाद पऊ, काटेकी बिहार तथा एच.1886 को भी क्रमबद्ध रूप में स्वीकार किया गया। अफीम तथा ब्लैक ऐंड्रू किस्मों से सर्वाधिक पेय पदार्थ पाया गया। इसके पश्चात शोहराब पसन्द किस्म का स्थान आता है जिसे 6 महीने तक भण्डारित किया जा सकता है।

आम के दशहरी किस्म पर तुड़ाई उपरान्त प्यूट्रोसिन (0.01) के प्रयोग गुणवत्ता कायम रखने वाला पाया गया। एल. डी. पी. ई. बक्सों में रखकर (12.2 °C तथा 90.5% RH) कम तापमान पर भण्डारित करने पर वर्ष 2008 के दौरान लखनऊ के बाजार में आने वाली आम की कुल मात्रा (71.6 हजार मीट्रिक टन) विगत वर्ष की तुलना में कम थी। बाजार में सबसे पहले आने वाली आम (अप्रैल में) बैगन पल्ली था। देश के विभिन्न बाजारों में कुल 51.58 हजार मैट्रिक टन आम के फल भेजे गये। वर्ष के दौरान अमरुद के कुल 1639.5 मैट्रिक टन तथा पपीता के 5581.7 मैट्रिक टन फल बाजार में आया। वर्ष 2007-08 के दौरान आम का निर्यात 79.06 से घटकर 54.35 मैट्रिक टन हो गया जबकि आम के गूदा का निर्यात बढ़कर 166.75 हजार टन हो गया।



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 अनुसार, संस्थान 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।

बैठकें

डॉ. आर.एस. राठौर, पूर्व कुलपति, सी.एस.के. हिमाचल प्रदेश कृषि विश्वविद्यालय, पालमपुर की अध्यक्षता में संस्थान की तेरहवीं आर.एस.सी. बैठक 18-19 जून, 2008 तक आयोजित की गयी।

डॉ. बी.एम.सी. रेड्डी निदेशक की अध्यक्षता में दो आई.एस.सी. की बैठकें (20वीं एवं 19वीं) 21 मई 2008 तथा 4 मार्च 2009 को आयोजित की गयी।

संस्थान की चौबसवीं एवं पच्चीसवीं आई.आर.सी. की बैठकें 14 से 16 जुलाई 2008 तथा 16-17 मार्च 2009 को डॉ.बी.एम.सी. रेड्डी, निदेशक की अध्यक्षता में आयोजित की गयी।

शिक्षा एवं प्रशिक्षण

संस्थान के बारह वैज्ञानिकों एवं एक तकनीकी अधिकारी को वैज्ञानिक एवं तकनीकी क्षेत्र में मानव संसाधन के 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। एक वैज्ञानिक को प्रतिनियुक्ति पर विदेश (अमेरिका) भेजा गया।

पुरस्कार एवं सम्मान

तीसरे भारतीय बागवानी सम्मेलन-2008 के दौरान संस्थान के एक प्रधान वैज्ञानिक प्रतिष्ठित डॉ. जे.सी. आनन्द गोल्ड मेडल प्रदान किया गया। जबकि एक अन्य प्रधान वैज्ञानिक को महाराष्ट्र के सिर्डी में आयोजित राष्ट्रीय अमरुद संगोष्ठी में माननीय कृषि मंत्री, भारत सरकार द्वारा अमरुद पंडित पुरस्कार प्रदान किया गया। दू वैज्ञानिकों को हार्टिकल्चर सोसाइटी ऑफ इंडिया तथा इंडियन सोसाइटी फॉर प्लांट

पैथोलोजी द्वारा फेलोशिप भी प्रदान किया गया। संस्थान की राजभाषा पत्रिका को नगर राजभाषा कार्यान्वयन समिति की 60वीं बैठक के दौरान द्वितीय पुरस्कार प्रदान किया गया।

संस्थान के निदेशक/वैज्ञानिकों ने विभिन्न संगोष्ठियों/परिसंवादों/सम्मेलनों/बैठकों

कार्यदल /पाठ्यवृत्त/अनुवीक्षण समितियों तथा जरनलों के संपादन मंडलों में अध्यक्ष, सह-अध्यक्ष, समन्वयक, रैपोटियर तथा सदस्य के रूप में कार्य किया।

अनुबंध एवं सहयोग

केन्द्रीय उपोष्ण बागवानी संस्थान द्वारा अपेडा, डी.बी.टी., डी.एस.टी., कॉली एवं साल्ज पर इण्डो-जर्मन कार्यक्रम, कृषि मंत्रालय, आई.सी.ए.आर. के नेटवर्किंग मोड, नयी दिल्ली, यू.पी.सी.एस.टी., लखनऊ, उपकार, लखनऊ, इग्नू, नयी दिल्ली, एस.ए.यूज. (पंतनगर, फैजाबाद, कानपुर) राजकीय विश्वविद्यालयों (रीवा, लखनऊ, झांसी) तथा केन्द्रीय विश्वविद्यालयों (बी.बी.ए.यू., लखनऊ) विभिन्न राष्ट्रीय वैज्ञानिक निकायों के सहयोग से विभिन्न अनुसंधान, विकास तथा शैक्षिक कार्यक्रम जारी हैं।

अन्य गतिविधियाँ

संस्थान द्वारा 20 जून 2008 को राष्ट्रीय कृषक मेला एवं प्रदर्शनी-2008 का आयोजन किया गया। इस अवसर पर विकसित की गयी संकर किस्में अंबिका, अरुणिका, सी.आई.एस.एच.-एम-2, एच-949 आदि नयी संकर किस्में अन्य उपलब्ध विदेशी किस्मों के साथ प्रदर्शित की गयी। राष्ट्रीय कृषक मेला एवं प्रदर्शनी में 500 किसान संस्थान में सम्मिलित हुए। संस्थान के प्रक्षेत्र जीन बैंक में उपलब्ध।

प्रदर्शनी के एक सत्र के दौरान किसानों एवं वैज्ञानिकों के बीच बागवानी से संबंधित प्रासंगिक मुद्दों पर परिसंवाद हुआ। सत्र के दौरान किसानों ने बागवानी संबंधी समस्याएँ उठाई जिनका समाधान विशेषज्ञ वैज्ञानिकों द्वारा किया गया। किसानों ने आम में थ्रिप्स कीट के आक्रमण की रोकथाम संबंधी प्रबंधन की जानकारी प्राप्त की। इस अवधि के दौरान एक आम की प्रदर्शनी लगायी गयी। हाल ही में विकसित संकर किस्में अंबिका, सी.आई.एस.एच.-एम-2 तथा एच.39 आगंतुकों के बीच आकर्षण का केन्द्र रहीं।

संस्थान में आयोजित हिन्दी चेतना मास के दौरान अनेक प्रतियोगिताओं तथा कार्यशालाओं का आयोजन किया गया। प्रतियोगिताओं के विजेताओं को बाद में पुरस्कृत भी किया गया।



2. EXECUTIVE SUMMARY

Research Accomplishments

Crop Improvement

Thirty accessions of mango from Bhubneswar and Ranchi were collected and sixty accession were planted in the field gene bank during the period.

Five hundred and fifty eight accessions and over 600 hybrid seedlings of mango were evaluated for various traits. DUS parameters for mango were worked out by using characterization data of 150 accessions. Second volume of catalogue was developed on the basis of leaf and panicle characters of 100 mango accessions. An improvement was affected in the database structure and modules. Search module was also developed with option for IC number or name based search.

Out of 20 STMS markers used for characterization of one hundred and fifty mango cultivars, 18 microsatellites detected polymorphism in 144 cultivars. The dendrogram realized from microsatellites data grouped the 150 genotypes into 3 broad groups. Highest level of polymorphism was detected by HMID 016 and lowest by HMID 2041.

Twelve accessions of guava from different parts of Uttar Pradesh and two from Shirdi (Maharashtra) were collected. One hundred and twenty three accessions including six *Psidium* species were maintained in field gene bank. Eighty accessions were characterised for leaf, while 40 for fruit characteristics. Information on characterization of germplasm (120 accessions) were coded and updated for cataloguing.

Two cross- combinations ('Lalit' x 'Purple Guava' and 'Purple Guava' x 'Lalit') were attempted to incorporate genes responsible for anthocyanins synthesis in pulp. A population of 60 genotypes was developed for exploiting half-sib segregating population with desirable characters.

Nineteen cultivars of guava were studied for diversity and heterozygosity. Eight primers yielded 66 alleles at an average of 8.25 alleles per primer. Discrimination of cultivars was feasible through unique fingerprints of ISSR.

Papaya cultivars 'A 3', 'Pusa Delicious', 'Pusa Dwarf' and 'Red Lady' performed well in terms of yield

(63.33, 54.28 48.66 and 48.33 kg fruits⁻¹, respectively) and quality. The cultivar 'A 3' recorded the highest average fruit weight (2.20 kg) followed by 'A-7' (2.00 kg). The quality in terms of TSS (12.0° B) was better in 'Pusa Delicious' and 'CO-7'.

Six cross combinations of papaya parents having desirable characters were used and 70 crosses were made. Forty four fruits were obtained from successful crosses whose seed weight varied from 1.01 to 7.40 g fruit⁻¹. Highest germination(92%) was recorded in 'CO-7' x 'Pusa Delicious' as compared to the lowest (58%) in 'CO-7' x 'Lady Red'.

Somatic embryos of papaya 'Pusa Delicious' were targeted for *Agrobacterium tumefaciens* carrying dual gene. The antibiotic Cefotaxime (500 mg l⁻¹) was most effective in controlling *Agrobacterium* from tissue surface, while the additions of acetosyringone (100 µm) and spermidine (1.0 mM during co-culturing enhanced the survival of Kenamycine resistant plant (11.20%) increased the transformation efficiency), respectively. *Npt II* and *cp* genes were detected in transformed plantlets by PCR with primers specific to *Npt II* (480 bp) and *cp* (410 bp).

Three sets of oligonucleotide primers were used for predicting the sex of papaya. Primers F1 and F 2 (provided by University of Hawaii produced no bands in male, whereas H 1 and H 2 produced bands in hermaphrodites only on PCR based sex diagnostics.

Seven varieties of litchi, which came into bearing, were evaluated. Highest fruit yield (37.78 kg tree⁻¹) was recorded in 'Large Red' followed by 'Pickling' (35.36 kg⁻¹). The least fruit cracking (7.50%) was observed in 'Kasailiya'. Cultivar rose scented recorded highest (20.6° B) TSS followed by 'Ajhauli' (20.2 °B).

Twenty one accessions of aonla were collected from different parts of Madhya Pradesh and planted in the field for evaluation of their growth parameters. Five accessions of jamun including two seedless were collected from Gujarat and Uttar Pradesh. Physio-chemical parameters of fruits of eight elite genotypes were assessed on the basis of fruit weight, seed weight, pulp content, TSS, titrable acidity, ascorbic acid, anthocyanins, tannis, etc. Maximum antioxidant value (53.29 mg AE AC g⁻¹) was observed in accession CISH-J-34.



A number of elite genotypes in jamun (5), khirnee (26), mahua (20), wood apple (17), tamarind (17) and cape gooseberry (3) were established in the field gene bank.

Crop Production

Among various combinations tried for mass multiplication of mango in polyethylene bags, addition of cocopeat (10%) to the media comprising soil, sand and FYM (1:1:1) resulted in better plant growth.

Higher fruit yield (15.12 t ha⁻¹) of mango 'Dashehari' was recorded in medium density planting (400 plants ha⁻¹) as compared to 4.15 ha⁻¹ in conventional planting (100 plants ha⁻¹).

The crown thinning treatment in 'Mallika' mango resulted in maximum yield (75.5 kg tree⁻¹) and number (41%) of A grade fruits as compared to untreated ones (56.5 kg tree⁻¹ and 22.5%).

The addition of organic manure or mulching improved the organic carbon and available N, P and K contents in soil. Moisture retention in soil was more where irrigation with 50 per cent reduction in water followed by organic mulching (leaf litter or paddy straw) was done. Higher fruit yield (4.6 t ha⁻¹) was recorded in mango trees mulched with leaf litter and irrigated at fruit growth and fruit maturity stages as compared to untreated one (2.1 t ha⁻¹). Drip irrigation either alone (6.57 t ha⁻¹) or in conjunction with NPK enhanced the fruit yield (7.21 t ha⁻¹) in 'Langra' as compared to basin irrigation (5.32 t ha⁻¹).

Maximum flowering (86%) was recorded in 'Dashehari' trees treated with 0.8 ml m⁻¹ canopy diameter of paclobutrazol which received 1.6 ml of paclobutrazol during the last two years as compared to untreated trees (47%). Mulching along with application of 1.6 ml paclobutrazol resulted in higher number of fruits and yield. The rate of photo synthesis and stomatal conductance were increased when methionine (100 ppm) and *Trichoderma harzianum* (10⁸ spores g⁻¹) were applied in the rhizosphere of 'Dashehari' mango. The application of paclobutrazol to 'Langra' and 'Amrapali' mangoes resulted in decreased rate of photo synthesis at (flowering and fruit set) stages as its concentration increased.

The effect of different levels of CO₂ on gas exchange parameters was observed under controlled conditions in regular ('Amrapali') and biennial (Chausa) cultivars at full bloom stage. The rate of photosynthesis increased with increasing

concentration of CO₂ (up to 450 μmol mol⁻¹) in both the cultivars. However, lower rate of photosynthesis was noticed in Chausa.

Thirty five and twelve plants of 'Allahabad Safeda' guava are required for prediction of yield at 95 per cent confidence probability with 5 and 10 per cent error with Tippet's methodology, when the yield of 100 plants was taken as 63.7 kg with a variance of 137.77.

The propagation techniques standardized in mulberry, custard apple, carambola and lasora were mainly found to be governed by prevailing temperature.

Crop Protection

Forecasting model developed on the basis of weather index and artificial Neural Network Technique enabled the prediction for infestation of mango fruit fly and hopper population 15 days in advance. Fruit fly and hopper population attained a peak population build up on mango during April- May and October- April, respectively. An unusually high incidence of thrips infestation was recorded in mango orchards which was found to coincide with the onset of new flesh. Acephate (1 g l⁻¹), spinosade (1 ml⁻¹), thiamethoxam (0.2 g l⁻¹) and imidacloprid (0.3 ml l⁻¹) were found effective in suppressing the hopper population even up to 100 per cent. Imidacloprid, owing to high degree of toxicity, could be replaced with acephate due to its lower degree of toxicity against honey bee.

Two sprays of Ethopphenprox (0.05%) at 15 days interval were highly (100%) effective in controlling borer infestation on guava cv. 'Allahabad Safeda' followed by cartap hydrochloride (0.05%) (1.26% infestation), neem excel (0.2%) (2.66% infestation) and carbaryl (0.2%) (4.66 % infestation) as compared to untreated check (20.40% infestation). Similarly, bark eating caterpillar, *Inderbela* sp., could be effectively managed in guava 'Allahabad Safeda' by mechanical methods (cleaning of webs and collection and killing of the larvae) and swabbing (during the last week of February) with pine oil (1%), castor oil (2%), Excel Plus (1%), chloropyriphos (0.05%) and neem oil (0.15%). Pine oil (1%) and Excel Plus (1%) caused 100 per cent reduction in larval galleries followed by castor oil (75.5%), neem oil (75%) and chloropyriphos (60.25%).

The attack of gall maker (*Betousa stylophora*) in aonla was noticed in nursery as well as in old bearing trees of aonla. Its incidence was considerably low (0.5



galls plant⁻¹) in nursery. However, shoot galls were observed in mature trees of all the cultivars. Its maximum incidence could be noticed (6.8 galls tree⁻¹) from 1st fortnight of October to 1st fortnight of March. Similarly, fruit borer, *Deudorix (Virachola) isocrates*, incidence in aonla started from 1st fortnight of August and continued up to first fortnight of November causing 2.65 per cent fruit loss. Two sprays of cartap hydrochloride (0.05%), carbaryl (0.15%) and neem oil (0.15%) at fortnightly interval during July were highly effective in the management of shoot galls in aonla.

Four bacterial isolates of *Bacillus subtilis*, isolated from certain biodynamic preparations, could not exhibit a perceptibly significant degree of nematotoxicity as the juvenile mortality was found to be only 0.12 per cent. Lower degree of temperature regimen (20-22°C) could be ascribed for lower degree of nematotoxic potential of the isolates.

Mustard cake in combination with FYM (75:25 ratio) was found to support the maximum (19 CFU g⁻¹) population of *Trichoderma harzianum*.

Floral powdery mildew in mango could not attain apiphytotic proportion on account of relatively low temperature (below 35°C) and high humidity (72-98%) prevalent during March. Similarly, congenial temperature and humidity could significantly impact the occurrence and incidence of anthracnose, blossom blight, sooty mould and die back diseases in mango.

Twig die back and gummosis symptoms were observed in seedlings *Aegle marmelos* cultivars 'NB-5' and NB-9.

Hot water supplemented with carbendazim (0.05%) was found effective in controlling post-harvest diseases of mango up to 8 days of storage under ambient conditions while carbendazim (0.1%) could control post harvest diseases up to 10 days. Prochloraz in cold water was found ineffective at ambient temperature.

Postharvest Management

A lopper type bael harvester was designed and fabricated on the principal of holding and cutting of fruit. The blades of mango slicer and cube cutting machines were refined and mango feeding opening were adjusted for better efficiency of machines.

Tray type CFB boxes were developed for packaging and export of mangoes. The grading for export of mango cvs 'Langra' and 'Chausa' and guava

cvs 'Allahabad Safeda' and 'Sardar' were standardized.

Nine mango varieties/hybrids for pickle in oil and twelve for pulp/beverage were evaluated for their acceptability. Sensory evaluation of pickles indicated that 'Bathui' was the most acceptable variety followed by 'Pau', 'Katakee Bihar' and 'H-1886', while best beverage was obtained from cvs 'Afeem' and 'Black Andrew', followed by 'Sohrab Pasand' after six months of storage. Calcium chloride (0.0375M) improved the organoleptic quality of osmo-air dried slices of ripe mango cv. 'Totapuri' when stored up to six months in PET jars.

As the steeping preservation of aonla cv. 'Chakaiya' in water prolonged from 0 to 25 days, the ascorbic acid content decreased in the extracted juice. Blanching of aonla cv. 'Chakaiya' fruits in 0.5 or 1.0 per cent alum resulted into preparation of good quality of segments-in-syrup. Powder prepared from 0, 15, 30, 45 and 60 days stored aonla juice by spray drying showed a continuous decrease in ascorbic acid and polyphenol contents and increase in non-enzymatic browning.

The post-harvest treatment of mango cv. 'Dashehari' with putrescine (0.01%) resulted in better retention of quality when packed in ventilated LDPE bags and stored at low temperature (12±2°C; 90±5% RH). Similarly, 'Chausa' mango fruits treated with spermidine (0.01%) could be stored up to 30 days when packed in ventilated LDPE bags and stored at low temperature (10±2°C; 90-95% RH). Maximum FRAP value in fruits of aonla cv. 'Kanchan' treated with CaCl₂ .2H₂O (2%) + KMnO₄ (0.01%) was observed during 9 days of ambient storage.

Good quality of guava and aonla cider were obtained when tannins concentration in fermentation medium was kept at 0.2 and 0.4 per cent, respectively. Addition of lemon peel or cinnamon were found to enhance the quality of mahua wine. Mahua vermouth could be prepared by fortification with spices. The protocols were developed for the production of pectinase and cellulase enzymes from mango kernel. The budding yeast, isolated from spoiled aonla juice, was found to survive at 100°C for 20 minutes.

The total quantity (71.6 thousand MT) of mango arrived in Lucknow market during 2008 was less than that of last year (85.7 thousand MT). The earliest mango variety, available in the market, was 'Banganpally', which arrived during April. A total of 51.58 thousand MT of mango fruit was sent to different markets of the



country. The total arrival of guava during the year was 1639.5 MT, while that of papaya was 5581.7 MT. The export of mangoes from India declined from 79.06 to 54.35 thousand MT during the year 2007-08, whereas export of mango pulp increased to 166.75 thousand MT.

Technology Transferred

Besides, carrying out research in the sphere regarding gamut of challenges being faced in the mandate crops, the Institute also concentrated on dissemination of technologies to the end users. In pursuance to the programme, the Institute organized one goathi wherein around 500 farmers were benefited. The Institute also participated in a number of state as well as national level events across the country and dealt with the problems faced by farmers through its technology modules. Technologies were also delivered 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.

Meetings

The 13th meeting of RAC of the Institute was held during June 18-19, 2008 under the Chairmanship of Dr. R. S. Rathore, Ex Vice-Chancellor, C.S.K. Himanchal Pradesh Krishi Vishwavidyalaya, Palampur.

Two IMC meetings (20th and 21st) were held on May 21, 2008 and March 4, 2009 under the Chairmanship of Dr. B.M.C. Reddy, Director.

Twenty fourth and twenty fifth Institute Research Committee meetings were held from July 14 to 16, 2008 and March 16-17, 2009 under the Chairmanship of Dr. B.M.C. Reddy, Director.

Education and Training

Twelve scientists and one technical office were deputed to different programmes organized by various national agencies for the development of human resource skills and knowledge in respective fields. One scientist was also deputed to USA for Agribusiness Programme.

Awards and Recognitions

Scientists of the Institute brought laurels and and

got recognition from various scientific/developmental agencies. One Principal Scientist was conferred with the prestigious Dr. J. C. Anand Gold Medal during the Third Indian Horticulture Congress 2008 held at OUA&T, Bhubaneswar, while the other one was bestowed with Amrood Pandit Award by Hon'ble Union Minister for Agriculture, Shri Sharad Pawar at the National Guava Symposium held at Shridi, Maharashtra. One scientist each were honoured with the Fellowship of Horticulture Society of India (HSI) and Indian Society of Plant Physiology (ISPP).

Director/scientists of the Institute also acted as Chairman, Co-chairman, Coordinator, Rapporteur and Member in various seminars/symposia/conferences/meetings, task force, curriculum/monitoring committees and editorial boards, etc.

Udyan Rashmi, Rajbhasha Patrika of the Institute was awarded 2nd prize by the Nagar Rajbhasha Karyanvayan Samiti, Lucknow at its 60th half yearly meeting held at CDRI, Lucknow.

Linkages and Collaborations

Various research, developmental and educational programmes were run at the Institute in collaboration with various national scientific bodies including APEDA, DBT, DST, Indo-German Programme of Kali and Salz, Ministry of Agriculture, Networking Mode of ICAR, New Delhi, UPCST, Lucknow, UPCAR, Lucknow, IGNOU New Delhi, SAU's (Pantnagar, Faizabad, Kanpur), State Universities (Rewa, Lucknow, Jhansi) and Central University (BBAU, Lucknow).

AICRP/Coordination Unit

The Project Coordinator's Cell of All India Coordinated Research Project on Subtropical Fruits is situated at the Institute. The Cell's coordinated research on crop improvement, production and protection (mango, guava and litchi) were carried out at 18 centres located at SAUs and ICAR Institutes.

The Project Coordinator's Cell organized the 18th Group Worker's Meeting of AICRP (STF) at its Rehmankhara campus during June 29 to July 2, 2008. About 200 participants including scientists and professors from seven ICAR Institutes, eleven State Agricultural Universities, one Non-governmental Organization and Presidents/Vice Presidents of crop grower's associations (mango, guava, litchi and grape) participated in the meeting. During the meeting,



progress of research with respect to approved technical programmes of different centers was reviewed and the new programmes for the next biennium were finalized. Besides the achievements made in ad hoc scheme were also discussed. After comprehensive review of programmes in the plenary session, related recommendations were made for further refinement of recommendation/ improvement of the work carried out.

Consultancy, Patents and Commercialization of Technology

Consultancy services were provided to various governmental and non-governmental organizations and entrepreneurs on payment.

Other Activities

Institute organized the Rashtriya Krishak Mela Evam Pradarshini- 2008 on June 20. The newly developed hybrids, Ambika, Arunika, CISH-M-2, H-949, etc., along with other exotic varieties available in the Institute's Field Gene Bank were displayed on the occasion. About 500 farmers participated in the Rashriya Krishak Mela Evam Pradarshini.

A farmer-scientist interaction also took place in one of the sessions of the Pradarshini. During the session, farmers projected their problems which were addressed by the concerned expert related to suitability of varieties and management of irrigation, insect pest

and diseases. The farmers also displayed interest in the management schedule of thrips infestation in mango, a newly emerged phenomenon in the region. A mango exhibition was also organized during the period. Newly developed hybrids, viz. Ambika (Amrapali x Janardan Pasand), CISH-M-2 (Dashehari x Chausa) and H-39 (Amrapali x Vanraj) were the centre of attractions amongst the visitors.

Validation Workshop of the project Technology gap analysis study for food processing industry cluster of Malda', sponsored by TIFAC(DST), Govt. of India, New Delhi, was organized by the Institute at Golden Park Hotel, Malda (W.B.) on January 28, 2009. The workshop was aimed at positioning the fruits and vegetables from Malda and adjoining districts at a higher platform and invite industries/ entrepreneurs render these available to their advantage, thereby strengthening the farmers, industry and traders partnership.

The Institute also organized Hindi Chetna Mass from September 14 to October 12, 2008 wherein various programmes including competitions and cultural activities for the propagation of official language were held and prizes were distributed.

Revenue Generation

A total revenue of Rupees 41.38 lakhs was generated by the Institute during the financial year 2008-09.



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, is serving the nation on different aspects of research on mandated subtropical fruits.

The Institute has two experimental farms, one at Rehmankhara approximately 25 km away from the city and the other at Rai Bareli (R.B.) Road, in the city of Lucknow. The experimental farm at Rehmankhara 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) and R.B. Road campus has an area of 13.2 ha. In order to meet the emerging challenges in frontier lines of research on subtropical fruits, the Institute has modern nursery facilities, well established orchards fully equipped laboratories and persistent endeavours for human resource development for capacity building. A trainees hostel-cum-guest house is located at R.B. Road Campus for accommodating farmers, trainees and experts.

The Institute has in place MoUs to facilitate capacity building avenues with Allahabad Agricultural Institute (Deemed University), Allahabad, APS University, Rewa, 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. National Horticulture Mission has also identified the Institute as nodal centre for imparting training on rejuvenation of old and senile mango orchards and meadow orcharding in guava.

The QRT, while reviewing the progress made by the Institute, has recommended to modify the mandate

and objectives of the Institute to focus on select major and minor subtropical fruit crops.

Mandate

To undertake basic and applied research to enhance productivity and develop value chain for major and minor subtropical fruits.

To act as national repository of above fruit crops.

To act as a centre for human resource development and provide consultancy to stake holders.

To develop linkage with national and international agencies to accomplish the above mandate.

Objectives

Management of genetic resources of mandated fruit crops and their conventional and molecular characterization.

Crop improvement through breeding and genetic engineering.

Enhancing productivity through improving quality and quantity of planting material 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 impact.

Data storage and retrieval on all aspects of mandated crops.

Past Achievements

Crop Improvement

The Institute has the world's largest germplasm collection of mango numbering 721 accessions,



collected from different indigenous and exotic sources.

A promising mango hybrid CISH-M-1 (Amrapali x Janardhan Pasand), which is a regular bearer having yellow colour with red blush, firm flesh and scanty fibres was released as 'Ambika'. It has good potential for domestic and export markets.

The regular mango hybrid H-39 (Amrapali x Vauraj), having yellow colour with red blush, firm flesh, high TSS (240 B) and high, carotenoids content was released as 'Arunika'.

The mango hybrid, 'H-1084', was found promising.

A regular bearing and high yielding clone Dashehari-51 has been released for commercial cultivation. It yielded 38.8 per cent higher than that of the normal 'Dashehari'.

Mango cv. 'Elaiichi' was found free from floral malformation and is being used in breeding programme.

A South Indian mango cv. 'Totapuri' was found regular bearer and good yields under Lucknow conditions. It may be cultivated in Northern India for its pulp consistency and blending purposes.

The Institute has 114 accessions of guava and 7 *Psidium* spp. maintained in its 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' by the Institute for commercial cultivation. Fruits of 'Lalit' are attractive, saffron yellow with red blush, medium sized, firm and pink flesh. It gives 24 per cent higher yield than the popular variety 'Allahabad Safeda'. 'Shweta' has subglobose fruits with few soft seeds, high TSS (14°B) and attractive pink blush. It has good yield potential.

Institute has 54 accessions of bael maintained in the field genebank. Two promising selections 'CISH-B-1' and 'CISH-B-2' have good table and precise qualities.

The Institute has 32 collections of papaya, 35 of litchi, 35 of aonla, 7 of banana, 43 of jamun, 38 of khirnee, 30 of karonda, 24 of tamarind, 30 of mahua, 8 of chironji, 17 of woodapple, 10 of mulberry, 3 of cape gooseberry, 8 of custard apple,

2 of carambola, 3 of lasora and 2 of roseapple in its field gene bank.

Crop Production

Rejuvenation technique for old and unproductive mango and guava trees has been standardized and demonstrated at farmers' field.

Techniques for meadow orcharding and canopy management in guava have been standardized and recommended. Consequently, it has been adopted by farmers in Maharashtra, Haryana, Punjab, Rajasthan and Uttar Pradesh. About 400 ha area related to this technology has come up in different parts of the country.

Mango based cropping system has been developed and cowpea-potato system has been found to give higher monetary returns in 10 years old orchards.

Soil application of paclobutrazol @ 4 g tree⁻¹ (3.2 ml m⁻¹ canopy diameter) has been found to manage irregular bearing problem in mango cv. 'Dashehari' and has resulted in increased flowering and fruiting.

Soil application of 1kg each of N, P and K (tree⁻¹ year⁻¹) to 10 year old Dashehari mango trees increased the yield. Trench application of fertilizers around the tree in July has been found most efficient.

Two sprays of urea (10%) on guava cv. 'Allahabad Safeda' and 20 per cent on cv. 'Sardar' at bloom could cause flower drop and eliminate poor quality rainy season crop.

Planting papaya at a spacing of 2 x 1.8 m in the month of September gave the highest yield and good quality fruits.

Crop Protection

IPM modules for mango insect pests and diseases have been developed, standardized and disseminated amongst the clientele groups.

Entomogenous fungus, *Verticillium lecanii*, egg parasites, *Agrostocetus* spp., *Gomatocerus* sp. and *Polynema* spp., and predators, *Chrysopa lacciperda*, *Mallada boninensis* and *Coccinella septempunctata* were found potential biocontrol agents against hoppers.



Critical levels of weather parameters were identified for forecasting the epidemic of powdery mildew.

Mango bacterial canker disease (MBCD) could be checked by spraying of Streptocycline (200 ppm) at 10 days interval. Antagonists *Bacillus coagulans*, *Pseudomonas* spp. and *Acinetobacter* sp. 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 ($52 \pm 1^\circ\text{C}$) for 15 minutes.

Gliocladium roseum was found associated with guava wilt disease.

Aspergillus niger (AN17), *Trichoderma harzianum*, *T. viride* and *Penicillium citrinum* were found effective in integrated management of guava wilt.

A cross (F_1) between *Psidium molle* x *P. guajava*, identified as resistant rootstock against guava wilt, has been multiplied for large scale demonstration trials.

Four endophytic bacteria and lac based compounds were found effective against root-knot nematode, whereas the potency of entomopathogenic nematode has been demonstrated against insect pests under *in vitro* conditions.

Post-harvest Management

Maturity indices for commercially grown 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, *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 ($52 \pm 2^\circ\text{C}$) 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 dihydrate (2%) at 10 days interval was found to check the jelly 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 acceptable.

Recipe for oil less mango pickle and sweet papaya chutney have been developed which could be stored for nine months safely.

The techniques for preparation of sweetened and brined (salted) aonla segments and cider (aonla and guava) have been standardized.

Methodology has been standardized for the preparation of *mahua* (*Bassia latifolia*) wine through alcoholic fermentation.

A good quality vinegar from mango peel could be obtained by use of *Acetobacter aceti*.

Transfer of Technology

Institute undertook implementation of sponsored training programmes on production, protection and post-harvest management of subtropical fruits for the benefit of orchardists and extension workers of various State Departments. Institute also provided training on different aspects pertaining to cultivation of mango and other fruit crops for scientists and development workers from within the country and abroad.

Library

The library of the Institute is well equipped having books, periodicals, reports, reprints and C.D. ROMS pertaining to relevant aspects of subtropical horticulture along with internet surfing, computer and reprographic facilities. Currently, the library has 3085 scientific and technical books and 7457 back volume of journals and subscribes 111 journals. Out of which



49 foreign journals are being subscribed as printed as well as Internet version. Additionally, 34 M.Sc. and Ph.D. theses related to Institute's mandate crops are also available. About 200 annual reports are received from ICAR Institutes/Universities/International Institutions on exchange basis. The library has also been automated through LS EASE software (Libsys) e-connectivity for accessing e-resources is also in place.

Art and Photo Cell

During the year, 4000 photographs were exposed and edited by image processing software for research and exhibition purposes. One hundred thirty-five charts/graphs, 90 posters and 470 labels/strips/nameplates were prepared depicting various research/

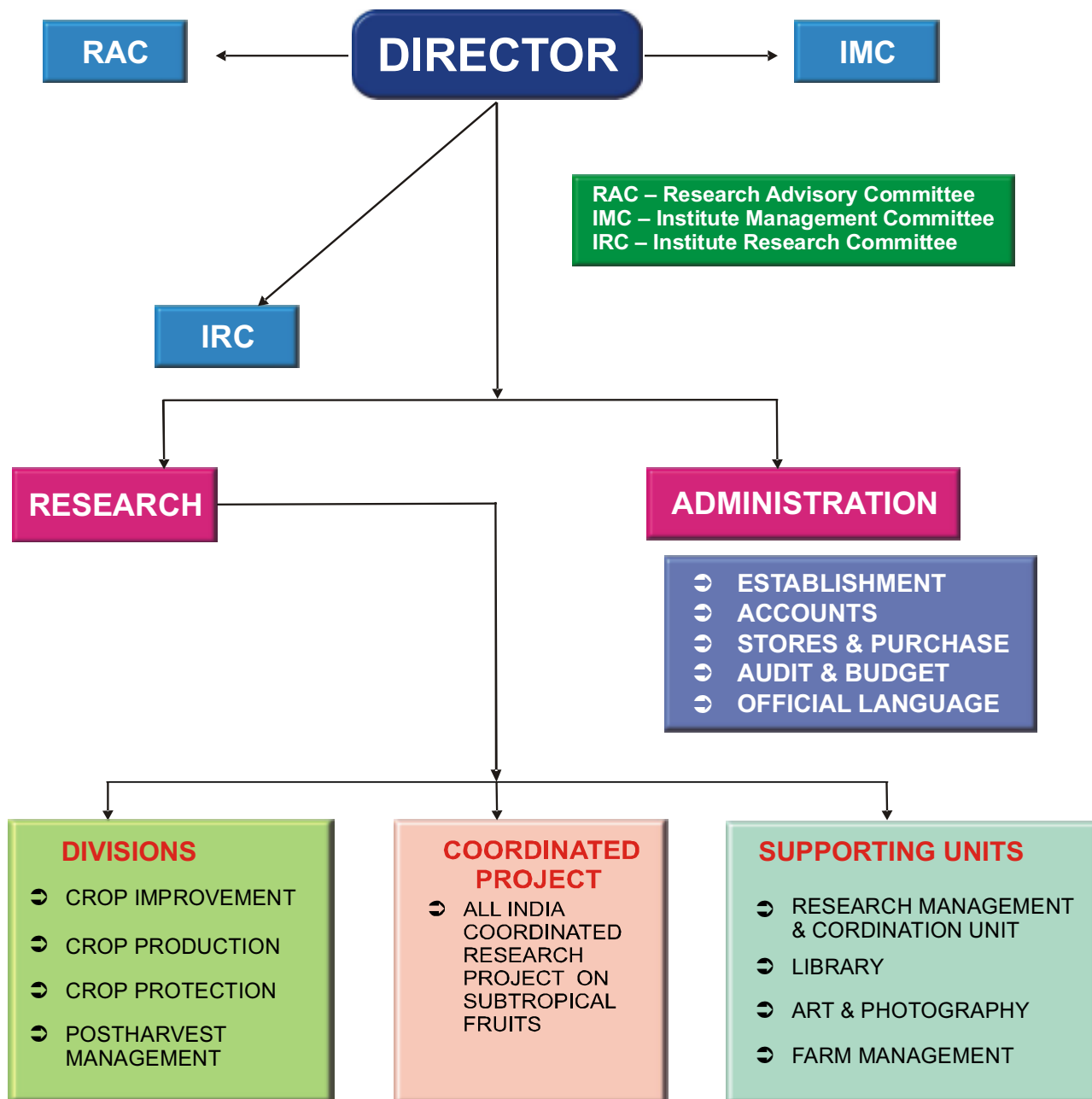
extension activities for publication of papers, technical/ extension bulletins and exhibitions.

Organizational Set-up

The Institute functioning is organized through four Divisions, *viz.* crop improvement, crop production, crop protection and post harvest management. It also houses the headquarters of the All India Coordinated Research Project on Subtropical Fruits. The complete organizational set-up of the Institute is shown in organogram. Apart from working in research specific areas, targeted programmes were also carried out through interdisciplinary approaches cutting across Divisional boundaries.



Organogram



Financial Set-up

Budget Allocation & Expenditure (2008-2009)

(Rupees in lakh)

Sl. No.	Head	Non-Plan		Plan		AICRP(STF)		A.P. Cess Funded Project		Externally Aided Projects		Revolving Fund Scheme	
		Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.
1.	a) Estt. Charges	794.00	794.02	-	-	207.34	207.34	5.25	3.70	56.50	30.20	-	-
	b) Wages	19.00	18.98	-	-	-	-	-	-	-	-	-	-
	c) OTA	0.15	0.15	-	-	-	-	-	-	-	-	-	-
2.	T.A.	6.50	6.50	10.00	10.00	4.31	4.31	2.25	1.50	7.00	5.70	-	-
3.	HRD	-	-	4.25	4.25	-	-	-	-	-	-	-	-
4.	Other charges including Equipments	120.00	120.00	210.75	210.75	38.35	38.35	4.67	2.05	115.07	74.38	26.79	10.70
5.	Minor Works	5.00	5.00	-	-	-	-	-	-	-	-	-	-
6.	Major Works			150.00	150.00	-	-	-	-	-	-	-	-
7.	<u>AR&M</u>												
	a) Residential Buildings	3.00	3.00	-	-	-	-	-	-	-	-	-	-
	b) Office Buildings	30.00	30.00	-	-	-	-	-	-	-	-	-	-
	TOTAL :	977.65	977.65	375.00	375.00	250.00	250.00	12.17	7.25	178.57	110.28	26.79	10.70





Revenue Receipts (2008-2009)

(Rupees in lakh)

1.	Farm Produce	15.66
2.	Sale of Products	1.26
3.	Sale of Publication/Tender Forms etc.	1.92
4.	Guest House charges/License Fee/ Rent	1.73
5.	Training / Consultancy	4.06
6.	Auction of Vehicle/ Other Machine tools	2.01
7.	Interest on 'P' Loans	5.38
8.	Interest on TDR	7.12
9.	Electric/Water/Transport charges	2.05
10.	Misc. Receipts	0.06
11.	Sale of Mango Harvester	0.13
TOTAL		41.38

Staff Position (as on 31.3.2009)

Sl. No.	Category	Sanctioned	Filled
1.	Scientific	47	38
2.	Technical	57	55
3.	Administrative	25	22
4.	Supporting	44	43
TOTAL		173	158

Staff Changes

Promotion

Scientific

- i) Dr. S.K. Shukla, Senior Scientist (Hort.) granted merit promotion to the post of Principal Scientist (Hort.) w.e.f. 01.04.2008.

Technical

- i) Shri Abhay Dixit, T-6 (T.O.) granted merit promotion to the post of T-7-8 (T.O.) (Lab) w.e.f. 01.07.2007.
- ii) Shri Sanjay Kumar, T-6 (T.O.) granted merit promotion to the post of T-7-8 (T.O.) (Lab) w.e.f. 01.07.2007.
- iii) Shri S. K. Arun, T-6 (T.O.) (Lab) granted one advance increment w.e.f. 01.07.2007.
- iv) Dr. Om Prakash, T-6 (T.O.) (Lab) granted one advance increment w.e.f. 01.07.2007.
- v) Shri Ramendra Tewari, T-5 (T.O.) granted merit promotion to the post of T-7-6 (T.O.) (Workshop) w.e.f. 01.01.2003.

- vi) Shri A. K. Singh, T-5 (T.O.) granted merit promotion to the post of T-6 (T.O.) (Lab) w.e.f. 24.02.2006.
- vii) Shri Ram Sharan, T-5 (T.O.) granted merit promotion to the post of T-6 (T.O.) (Lab) w.e.f. 01.01.2007.
- viii) Shri Prem Kumar, T-5 (T.O.) granted merit promotion to the post of T-6 (T.O.) (Photo) w.e.f. 24.02.2006.
- ix) Shri Bahadur Singh, T-5 (T.O.) granted merit promotion to the post of T-6 (T.O.) (Workshop) w.e.f. 01.01.2008.
- x) Shri R. P. Mishra, T-4 granted merit promotion to the post of T-5 (T.O.) (Driver) w.e.f. 01.01.2005.
- xi) Shri Ayodhya Prasad, T-4 granted merit promotion to the post of T-5 (T.O.) (Driver) w.e.f. 01.01.2005.
- xii) Shri Mashooq Ali, T-4 granted merit promotion to the post of T-5 (Workshop) w.e.f. 01.01.2005.
- xiii) Shri J.K.Khare, T-4 (Lab) granted two advance increments w.e.f. 01.07.2006.
- xiv) Shri C.P.Dwivedi, T-5 (T.O.) (Lab) granted three advance increments w.e.f. 01.07.2007.
- xv) Shri Chandra Bahar, T-4 (Workshop) granted two advance increments w.e.f. 01.01.2006.
- xvi) Shri Ram Dayal, T-3 (Lab) granted three advance increments w.e.f. 01.07.2007.

Administrative

- i) Shri A. K. Seth, Sr. Clerk promoted to the post of Assistant w.e.f. 01.12.2008.
- ii) Shri Vidya Sagar, Jr. Clerk promoted to the post of Sr. Clerk w.e.f. 22.07.2008.
- iii) Shri Vijendra Singh, Jr. Clerk promoted to the post of Sr. Clerk w.e.f. 01.12.2008.
- iv) Shri Satyawati Verma, Jr. Clerk granted ACP to the next higher grade w.e.f. 15.06.2008.
- v) Shri B. C. Lohani, Sr. Clerk granted ACP to the next higher grade w.e.f. 29.09.2008.

Supporting Staff

- i) Smt. Savitri Devi, S. S. Grade-I granted ACP scale to the next higher grade w.e.f. 17.07.2007.



4. RESEARCH ACHIEVEMENTS

CROP IMPROVEMENT

MANGO (*Mangifera indica* L.)

Germplasm collection, characterization, evaluation and documentation

Collection: Thirty accessions ('Babul Pasand', 'Bage-e-Bahar', 'Bombay Tel', 'Buponix', 'Calcutta Malda', 'Collector', 'Gulabi-1', 'Iturba', 'Mozzerelo Selection', 'Mulgoa Hill', 'Namkum Selection I', 'Namkum Selection II', 'Narsinghpur Collection 1', 'NR-3', 'NR-10', 'Nasik Pasand', 'Navaliasmamdi', 'Papaya Khas', 'Peter', 'Vastora', 'Amir Gola', 'Mohanrah Bhog', 'Gauri Pasand', 'Rani Mir Jaffer', 'Lat Sundari', 'MA-I', 'MA-II', 'MA-III', 'Kalloo' and 'GHM-7 Nellanchal Kesri') were collected from CHES, Bhubaneswar and HARP, Ranchi.

Characterization: Out of 558 accessions of mango, 105, 303 and 150 were characterised with respect to fruit, vegetative (leaves and panicles) and DUS parameters, respectively.

Evaluation for processing potential: Sensory evaluation of pickles indicated that out of eight varieties, 'Hayder Sahib' was the best followed by 'Phulgola', 'Darbhanga' and 'Bathui'. Similarly, amongst nine hybrids and varieties, 'Bathui' was the best variety with respect to sensory evaluation followed by 'Pau', 'Katakee Bihar' and 'H-1886' after 3 months of storage. 'Kharbuja' exhibited maximum acidity (2.79%), followed by 'Bathui' (2.26%), while least acidity was recorded in 'Black Andrew' (0.60%). The moisture content varied from 78.1 to 82.6 per cent.

Documentation: Characterization data (100 accessions) with respect to leaf and panicle characters were assessed for development of second volume of catalogue. A database structure and different modules like data input, validation of data and update after validation, image upload for leaf, panicle and fruit characters were improved. Search module was developed with option for IC number or name based search. Information on the accessions that were catalogued earlier were also added to the database. Algorithms were developed for quantification of similarity between varieties. Information system and interactive database were improved and updated. National database for mango gene bank holdings was

developed and updated. Script developed for update at gene bank level and its confirmation for addition to National Database.

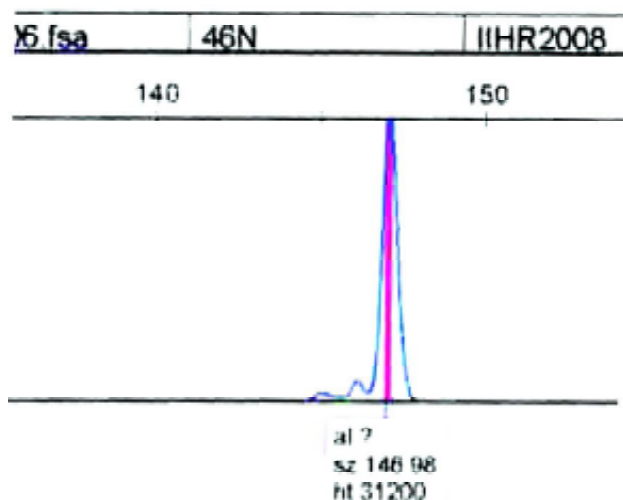
Field gene bank (FGB)

Sixty accessions, *viz.* 'M-30', 'Wild Langol', 'Pratappuri', 'K R Collection', 'Kazoo', 'NR-3', 'PFN-11', 'Villium (Sonti)', 'MN-4(P)', 'ShaiBELa', 'UA Collection-13', 'NR-58', 'K R Collection-10', 'MDCH-1', 'NR-108', 'Machli', 'Karel', 'Bhagwant Khera', 'PPN 11', 'Shelinka', 'NR 1', 'Police', 'PFN 19', 'PFN 18', 'GHM', 'NR 25', 'MNCP', 'NR 65', 'UA Collection 10', 'UA Collection 12', 'UA Collection 7', 'Baramasi 2', 'PFN 20', 'MN-1', 'KR Collection 15', 'PFN 27', 'Litchi', 'Konkan Ruchi', 'Sharanpur Early', 'AN 1', 'Asif Pasand', 'Navneetham', 'Talgnai', 'Mulgoa', 'Jwari', 'Pachrasi', 'Himayuddin', 'Khudad', 'Sonatol', '13-1', 'Rajapuri', 'Malda', 'Khazri', 'Muchhiswania', 'Faluda', 'Khurum', 'Moovandan', 'Himayat Pasand', 'Malai' and 'Shorab', were planted in the field gene bank.

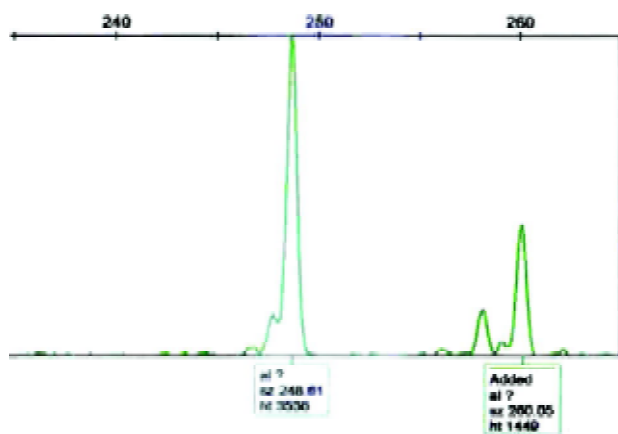
Molecular characterization

One hundred and fifty cultivars of mango were studied for STMS (Sequence Tagged Microsatellite Sites) based polymorphism. Twenty microsatellites (STMS primers) were used in the study, out of which 18 microsatellites detected polymorphism among 144 cultivars (Fig. 1). The alleles detected for each microsatellite were recorded into a data matrix as molecular weight. All recorded loci followed a disomic inheritance. Data for 18 loci was analyzed and the number of alleles detected per locus ranged from 6 to 23 for MiIIHR 12 and MiIIHR 23, respectively. In total 255 alleles were amplified and gene diversity estimates ranged from 0.537 to 0.8673 for individual loci sampled. Heterozygosity levels ranged from 0.3662 to 0.8227 and PIC values averaged 0.7225. The dendrogram realized from microsatellites data grouped the 150 genotypes into 3 broad groups. Highest level of polymorphism was detected by HMID 016, while lowest by F10 primer.

Clones of 'Dashehari', 'Chausa' and 'Himsagar' were selected and DNA amplified with 8 STMS primers. The amplified products were sequence characterized to arrive at correct allele size. The Gene Scan based analysis detected variability among 'Himsagar' clones with FMID 250 (Fig. 2).



A: FMID250 primer depicting allelic configuration of Dashehari at MiiHR 26 locus



B: HMID 019 discriminating Amrapali at MiiHR 24

Fig 1: Typical electrophoretograms of two mango cultivars with STMS markers differing in stutter and amplification characters. A: Dashehari, B: Amrapali

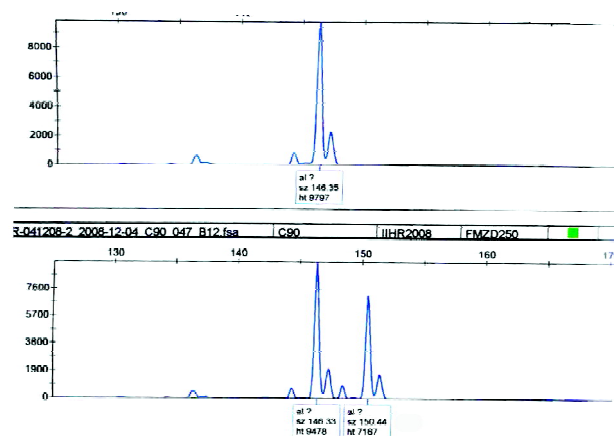


Fig 2: Typical electrophoretograms of Himsagar Clone number 42 and 63 with STMS primer FMID 250

Hybridization and evaluation of hybrids

Hybridization : Hybridization was carried out for evolving varieties having red colour (6 cross combinations), regular bearing, dwarf (7 cross combinations), malformation resistant (one combination) and dwarfing rootstock (6 cross combinations) and abiotic tolerance (Tables 1 and 2).

Table 1: Parental combination involved in hybridization carried out during the year 2008-09

Breeding objective	Cross combination	Panicle	Flower
Quality coloured varieties	Dashehari x 13-1	433	1676
	Dashehari x Arunika	2906	11914
	Dashehari x Sensation	1235	5049
	Dashehari x Tommy Atkins	765	2830
	Dashehari x Van Raj	650	2520
	Arunika x Ambika	50	194
Regular bearing and dwarf stature	Amrapali x Tommy Atkins	100	384
	Amrapali x Arunika	562	2420
	Amrapali x Sensation	170	699
	Amrapali x Ambika	350	1447
	Kensington x Tommy Atkins	200	654
	Mallika x Arunika	300	1138
	Neelum x Arunika	654	2227
Rootstocks imparting dwarfing and abiotic stress tolerance	EC 95862 x 13-1	449	1763
	EC 95862 x Tommy Atkins	350	1173
	EC 95862 x Arunika	314	1061
	Goa x 13-1	112	327
	Starch x Manipur Dwarf	200	811
	Starch x 13-1	100	438
Malformation resistance	Elaichi x Arunika	115	403
Total		10015	39128

One hundred forty nine hybrid seedlings were raised and established in the field.

Establishment of hybrids: Four hundred and eighty five hybrid seedlings were raised in respect of sixteen parental crossed combinations used in hybridization programme during the year 2007-08 (Table 3). Seedlings, however, could not be obtained from six cross combinations.

Evaluation of hybrids: Over 600 hybrid seedlings were evaluated for fruit weight and length, stone weight and length, peel and pulp percentage and TSS. High GCV and heritability accompanied with greater genetic advance as per cent of mean were observed for average



Table 2: Cross combinations tried with different objectives

Cross	Q+C	RB+D	D+AB	MFR
Amrapali x Ambika	+	+		
Amrapali x Arunika	+	+		
Amrapali x Sensation	+	+		
Amrapali x Tommy Atkins	+	+		
Arunika x Ambika	+	+		
Dashehari x Arunika	+	+		
Dashehari x 13-1	+		+	
Dashehari x Sensation	+			
Dashehari x Tommy Atkins	+			
Dashehari x Vanraj	+			
EC 95862 X 13-1			+	
Starch x Manipur Dwarf		+		
EC 95862 X TA	+		+	
Elaichi x Arunika				+
Starch x 13-1			+	
Mallika x Arunika	+	+		
Kensington x Ambika	+			
Kensington x Arunika	+			
Kensington x Tommy Atkins	+			
Goa x 13-1			+	
Neelum x Arunika	+	+		

Q= Quality, C=Coloured Fruits, D= Dwarfing, RB= Regular Bearing AB= Abiotic Stress, MFR= Malformation Resistance.

fruit weight, peel weight, stone weight, stone length and fruit length which revealed that these five characters had additive gene effect. High heritability coupled with low genetic advance for TSS, fruit width, fruit thickness, pulp per cent and stone width suggested the involvement of non-additive gene action in their inheritance, which can be exploited through heterosis breeding.

Owing to regularity in bearing, firm flesh, high TSS (24° B) and high carotenoids content, 'H-39' was found to be the most promising hybrid and was released as 'Arunika'.

Statistical methodology in breeding: The possibility of application of incomplete block designs were tried using combinations of five female and twelve male mango cultivars and treating female parents as treatment and male parents as block. Since all the female parents were not used as female for all the mentioned male parents, the blocks were incomplete. The observations were recorded on fruit weight and TSS.

Table 3: Raising of hybrid seedlings for evaluation from crosses carried out during the year 2007-08.

Breeding objective	Cross combination	Panicles used (No.)	Flowers crossed (No.)	Fruits harvested (No.)	Stones Germinated (No.)
Quality coloured varieties	Dashehari x H-39	1815	6926	85	72
	Dashehari x Ambika	1560	5641	126	114
	Dashehari x Sensation	912	3581	35	23
	Dashehari x Tommy Atkins	1650	4635	78	57
	Dashehari x Van Raj	2685	8032	95	83
	CISH-M-2 x Sensation	58	231	-	-
	Mallika x Tommy Atkins	108	287	6	-
Regular bearing and dwarf stature	Amrapali x Tommy Atkins	1042	4351	110	50
	Amrapali x Vanraj	550	2183	23	11
	Amrapali x Sensation	786	3051	32	26
	Amrapali x Ambika	890	3896	32	18
	Ambika x Sensation	166	447	-	-
	Amrapali x Manipur Dwarf	400	1526	1	1
	Neelum x Ambika	411	1658	13	6
Rootstocks imparting dwarfing and abiotic stress tolerance	Neelum x Tommy Atkins	289	1197	9	1
	EC 95862 x 13-1	85	300	-	-
	EC 95862 x Manipur Dwarf	128	397	3	2
	Kitchner x 13-1	157	598	9	1
	Manipur Dwarf x 13-1	11	31	-	-
	Philipino x Manipur Dwarf	139	493	-	-
Malformation resistance	Starch x 13-1	358	1280	40	10
	Elaichi x Tommy Atkins	250	695	16	10
Total		14450	51436	713	485



The parametric combinations $\{v=5, b=12, r = (3 \text{ to } 9), k = (1 \text{ to } 5), \lambda = 1\}$ did not satisfy the requirement for the existence of Balanced Incomplete Block Design but could be used in incomplete block designs layout with some modifications based on treatments and block composition. The study indicated that, barring some specific values, incomplete block design could not be used for all the size of treatment (v), replication (r) and size of each block (k).

GIS based mapping

Among various climatic models tested, Maximum Entropy Model (Maxent), Genetic Algorithm for Rule Set Prediction (GARP) and BIOCLIM were found suitable for climatic characterization.

GUAVA (*Psidium guajava* L.)

Germplasm collection, characterization and evaluation

Twelve accessions of guava, one, two and nine were collected from Sultanpur, Malihabad and Allahabad, respectively. Seeds of two accessions were also collected from Shirdi.

Field gene bank (FGB)

Evaluation of half-sib selections

CISH-GS-35 was high yielder besides its attractive fruit surface, colour, soft seeds and TSS (14° Brix).

One hundred and twenty three accessions including six *Psidium* species were maintained in the field gene bank. The accessions 'AC-3', 'Sindh', 'AC 8', 'PF-1', 'Citnapur', 'Hybrid 1', 'AC-14', 'Surkha Abu Chittiwala', 'S-1, Jarrya 1', 'Jarrya 2', 'AC-23', 'AS-22', 'AS-10', 'S-12', 'Chittidar', 'Dharwar', 'Gunees', 'Gashekan Sweet', 'Florida Seedling', 'White Fleshed', 'Behat Coconut', 'Red Fleshed', 'HAPSI-46', 'Pear Shaped', 'Nasik', 'Superior', 'Hariza', 'Banarsi', 'Kohir Jam', 'HAPSI 10', 'G-5' were added to field gene bank. Clonal multiplication of 'Surkhee', 'AS-9', 'AC7-14', 'SES 6550', 'Anakapalli', 'Chitti Abuwala', 'AC-6', 'AC-13', 'Sultanpur Local', 'AC-7', 'Supreme Mild', 'Webber' x 'Supreme Ruby', 'Supreme Ruby', 'EC 147036', 'Phulpur 1', 'EC 147037', 'Kesaria', 'Thailand', 'Beaumont', 'EC-147034', 'Pink Pear Shaped', 'Oval Pink', 'Colbourne', 'EC-147039', 'Mundera-1', 'EC-162904', 'Kamsari', 'Nagpur Seedless' and 'Allal Red' was done.

Characterization for vegetative, floral and seed hardness

Eighty seven accessions were characterized for leaf characteristics and forty for fruit characteristics. Seed weight ratio, fruit weight, number of seeds fruit⁻¹, seed hardness and 100 seed weight indicated scope for effective selections. Correlation and path coefficient analysis indicated that 100 seed weight as the most important character for realizing improvement for seed hardness in guava accessions.

Computerization and compilation : Database for converting the data into catalogue was built up and few accessions updated for printing catalogue on guava. Information on the germplasm characterization (120 accessions) was coded and updated. Database input module was used for data update. Performance of majority of the accessions was erratic during winter season as all the accessions had early maturity and quality which varied during different harvest periods.

Molecular characterization

DNA was isolated from the leaf of 19 guava cultivars along with newly developed varieties of the Institute ('CISH-G1', 'Lalit', 'Shweta', 'G5' and 'G6'). Eight primers yielded 66 alleles at an average of 8.25 alleles per primer. Mean gene diversity and heterozygosity was 0.7922 and 0.1304, respectively. Mean of PIC for 19 cultivars was 0.7783. Discrimination of cultivars was feasible through unique fingerprints of ISSR.

Hybridization and evaluation of hybrids

For incorporating genes responsible for anthocyanin synthesis in pulp, following cross combinations *viz.* 'Lalit' x 'Purple Guava' and 'Purple Guava' x 'Lalit' were attempted. Guava hybrid population (4 cross combinations) for developing red pulp and red peel guava varieties were planted and maintained in the field. Heterobeltiosis was recorded for time taken for first flowering. Fruits were obtained in few seedlings with red coloured pulp.

A population of 60 genotypes was developed for exploiting half-sib segregating population with desirable characters.

Clonal multiplication of rootstock

For carrying out field demonstration of interspecific hybrid wilt resistant rootstock of guava,



600 plants were clonally multiplied. These rootstocks were used for the propagation by grafting the scions of different cultivars ('Allahabad Safeda', 'Apple Colour', 'Lalit' and 'Shweta') in the nursery. Hardwood cuttings of wild relatives of *Psidium guajava* L. were rooted in hot bed. The cuttings were grown for field planting and wilt screening. Aneuploid-82 was also clonally multiplied for its evaluation as dwarfing rootstock.

Somatic embryogenesis

Isolated zygotic embryos from 60 days after pollination fruits were incubated in SE induction media containing spermidine in three concentrations (0.5, 1.0 and 2.0 mg l⁻¹). There was marked increase in per cent embryogenesis both for frequency and intensity in case of 'Allahabad Safeda' and 'Lalit'. Genotype specific response was found in 'Allahabad Safeda' as there was higher frequency and intensity (Fig. 3).

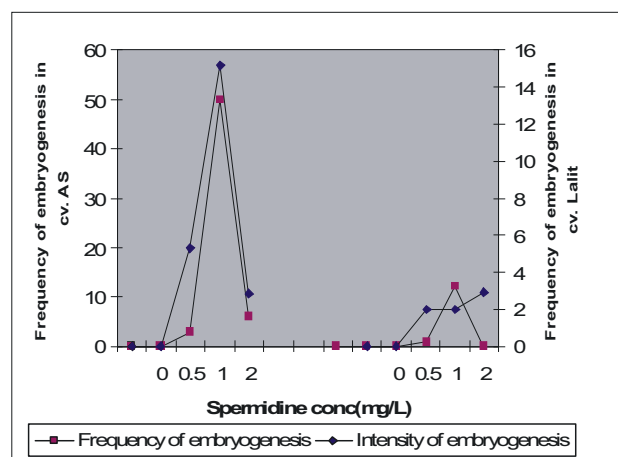


Fig 3: Effect of spermidine concentration on somatic embryogenesis in guava cvs. 'Allahabad Safeda' and 'Lalit'.

Gelrite column fractionation and *in vitro* selection

Gelrite column fractionation was performed to purify crude culture filtrate of *Fusarium solani*. High activity of the toxin was noticed at 280 nm in fraction nos 5 to 12. *In vitro* studies revealed higher mortality of guava shoots in fraction nos 5 to 11 (Fig. 4).

Genetic transformation system was standardised in guava for the first time using *endochitinase* gene derived from *Trichoderma harzianum* in order to develop wilt resistance in guava.

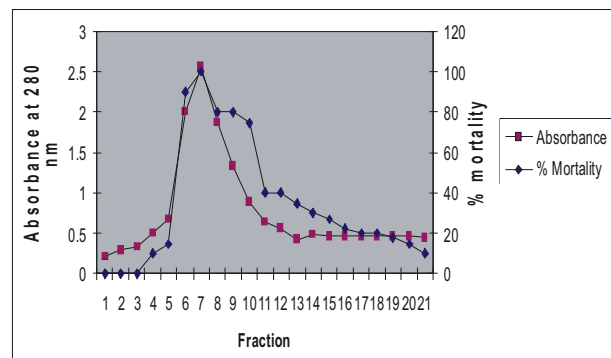


Fig. 4. Effect of toxin fraction (*Fusarium solani* isolate no. 15) on *in vitro* mortality in guava shoots.

Development of transformation system

Better gene integration was found when *in vitro* grown shoot tips were subjected to wounding by ballistic gun (microprojectile bombardment of tungsten particles) with 12 kg cm⁻² helium gas pressure followed by infection with *Agrobacterium tumefaciens*, carrying *endochitinase* gene, for 45 minutes and subsequent coculture for 72 hours (Fig 5). The bacterial culture density of 1 (OD at 600 nm) was optimum for infection. Enhanced culture density of *Agrobacterium* (1.5 OD) led to explants mortality during co-culture phase. Maximum putative transformants (2.96%) were observed when explants were wounded with particle gun. *Agrobacterium* infection time of 45 minutes followed by co-culturing time of 72 hours generated maximum number of putative transformants. However, transformation efficiency was low when the infection time was reduced to 30 minutes. One hour of infection time also generated more number of putative transformants, but it caused maximum mortality of explants. Best control of Agroinfection was observed

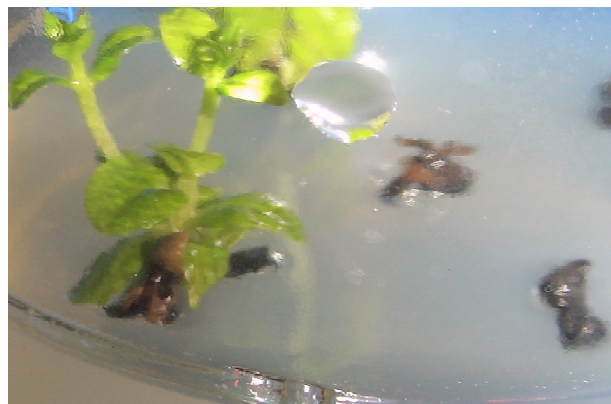


Fig. 5: Survival of putative transformants in selection medium

when the co-culture explants were washed with MS salt solution containing cefotaxime (250 mg l^{-1}) and (250 mg l^{-1}) streptomycin. Higher concentrations of cefotaxime and streptomycin (300 and 500 mg l^{-1} respectively) though resulted in 100 per cent removal of *Agrobacterium*, but it also caused severe mortality of smaller and younger explants. The PCR confirmation of putative transformants showed the bands of *endochitinase* at 1200 bp (Fig. 6).

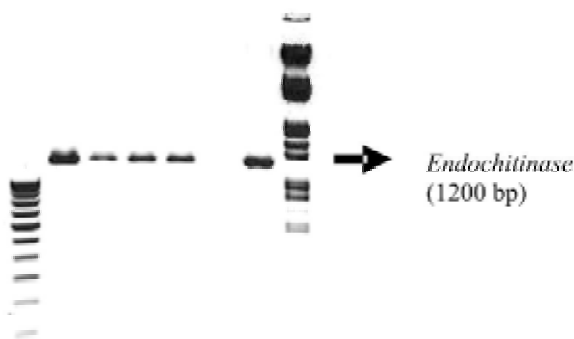


Fig. 6: PCR confirmation of gene integration with gene specific primers

PAPAYA (*Carica papaya* L.)

Germplasm evaluation

Genetic variability: In order to assess the germplasm potential as base material, twenty nine accessions of papaya were evaluated in randomized block design with three replicates of five plants each. Based on variability parameters for quantitative characters (plant height, girth of plant, canopy spread, fruiting height, number of fruits plant⁻¹ and yield plant⁻¹). 'A3' and 'Pusa Delicious' were superior in terms of yield (63.33 and $54.28 \text{ kg plant}^{-1}$) and quality parameters. Pusa Dwarf and Red Lady also performed well (48.66 and $48.33 \text{ kg plant}^{-1}$ fruit yield).

Growth and fruiting behaviour: Nineteen germplasm, viz. 'Red Lady', 'Surya', 'Pusa Delicious', 'Solo', 'Nigeria', 'A1', 'A2', 'A3', 'A4', 'A6', 'A7', 'V1', 'V2', 'V3', 'Kalepura', 'M-1', 'CO-7', 'Pusa Dwarf' and 'Pusa Nanha', were evaluated for growth and fruiting behaviour. The maximum plant height (2.46 m) was recorded in 'A1' followed by 'A3' (2.39 m). However, canopy spread in N-S (2.06 m) and E-W (2.12 m) direction was maximum in 'CO-7' followed by 'A4' with 2.02 m in N-S and 2.09 m in E-W direction. The fruiting started at minimum height from ground level (0.37 m) in 'Pusa Dwarf' followed by 0.39 m in 'CO-7'.

Fruit yield and quality: The average fruit weight was maximum (2.20 kg) in 'A3' followed by 'A7' (2.00 kg), 'Red Lady' (1.75 kg) and 'Pusa Delicious' (1.74 kg). The maximum TSS (12.0° Brix) was recorded in 'Pusa Delicious' and 'CO-7'. The minimum seed cavity was in 'A4' (8.96 cm), while it was maximum in 'A7' (18.24 cm).

Pulp firmness and fruit colour

Red Lady exhibited maximum pulp firmness (2.25 kg cm^2) followed by 'Pusa Delicious' (1.90 kg cm^2) and 'CO-7' (1.80 kg cm^2). It was minimum in 'Pusa Dwarf' (1.75 kg cm^2).

Hunter's 'L' value in fruits found was maximum in 'Red Lady' (46.87) followed by 'Pusa Dwarf' (43.65), whereas it was minimum in 'Pusa Delicious' (40.82). Maximum 'a' value was found in 'Pusa Delicious' (-2.02) followed by 'Pusa Dwarf' (-2.61), whereas minimum 'a' value was observed in 'Red Lady' (-4.62). Maximum 'b' value was noticed in 'Red lady' (25.48) followed by 'Pusa Dwarf' (22.41).

Maximum 'L' value in pulp was observed in 'Pusa Dwarf' (46.14) followed by 'Pusa Delicious' (45.77). 'Red Lady' recorded maximum 'a' value (15.62), while 'Pusa Dwarf' recorded minimum (13.88). Maximum 'b' value was also found in 'Red Lady' (25.64) followed by 'Pusa Delicious' (25.61) and the minimum 'b' (25.13) in 'Pusa Dwarf'. The higher 'a' value in pulp of was 'Red Lady' indicated higher lycopene content, whereas higher 'b' value in 'Red Lady' and 'Pusa Delicious' indicated yellow carotenoids rich pulp.

Maintenance of genetic purity

Papaya seeds were produced by controlled pollination to maintain genetic purity of identified lines. Sixteen cultivars/accessions were sibmated for production of true to type seeds of individual cultivars/germplasm. Two hundred and thirty three flowers were sibmated which produced 178 fruits. The seed weight in fruits varied from 3.14 to 15.314 g fruit⁻¹.

Hybridization

Six combinations of crossed parents possessing desirable characters (fruit weight, colour and flesh firmness) were used and seventy nine crosses were made. Seed weight varied from 1.013 to 7.401 g fruit⁻¹. Germination of seeds took 9 to 12 days in all the crosses. Germination percentage varied from 58 to 92 per cent



{{('CO-7' x 'Pusa Delicious' (92%), 'Red Lady' x 'Pusa Delicious' (86%), 'Farm Selection' x 'Pusa Delicious' (82%) & 'CO-7' x 'Red Lady' (58%))}.

Hybrids planted in the field were evaluated for quality. 'A3' x 'V2' hybrid had the maximum yield (50.60 kg plant⁻¹) fruit size and with good optimum fruit quality attributes like TSS 10° Brix. All six hybrids were sibmated and backcrossed.

Genetic transformation

Agrobacterium mediated transformation : Somatic embryos of papaya 'Pusa Delicious' were targeted for *Agrobacterium tumefaciens* carrying dual gene. The explants after infection (30 min) with *Agrobacterium* were blotted on sterile filter paper, transferred to agarified regeneration medium for co-culturing and incubated for 72 hours in dark (Fig. 7). Cefotaxime 500 mg l⁻¹ was found highly effective in controlling *Agrobacterium* from tissue surface (Fig. 8). Addition of acetosyringone (100 μM) during co-culturing enhanced the survival of kanamycin resistant plant (Fig. 9). Spermidine (1.0 mM) increased the transformation efficiency when used during co-

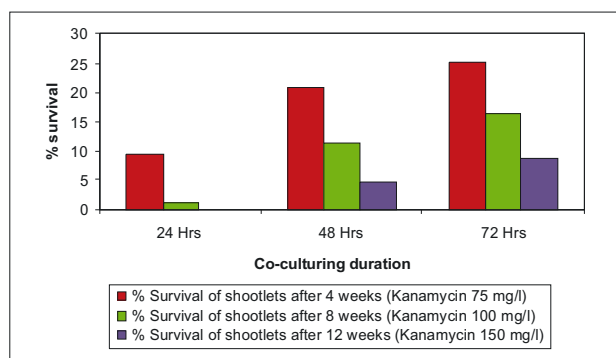


Fig. 7: Effect of co-culturing periods on transformation efficiency

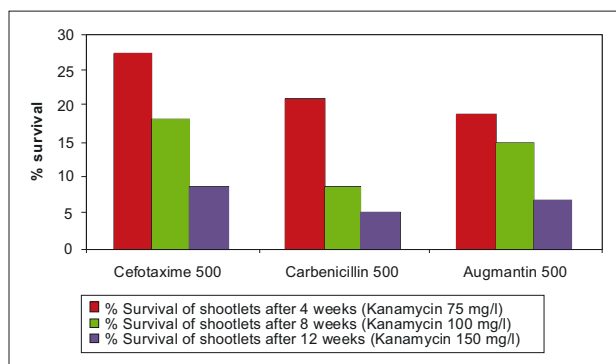


Fig. 8: Effect of antibiotics on control of Agrobacterium

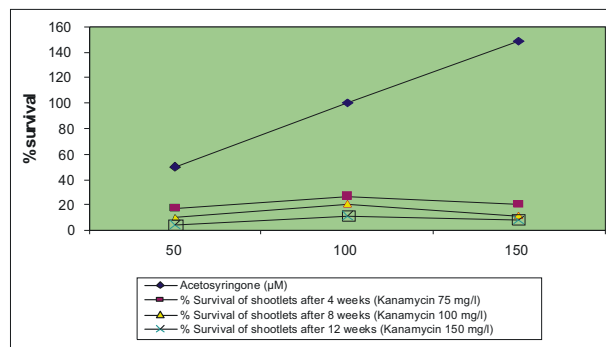


Fig. 9: Effect of acetosyringone on transformation efficiency

culturing. Out of three osmoticum used to dehydrate embryos, polyethylene glycol (45 mg l⁻¹). It also enhanced embryos conversion to microshoots (81 shoots culture⁻¹). Transformed shoots (1-2 cm long) subjected to IBA (2.0 mg l⁻¹) in the absence of Kanamycin produced more roots (3.0 roots culture⁻¹). The plants were acclimatized on vermiculite under ventilated culture vessels. Approximately, 250 ng of genomic DNA was used as template for PCR, in order to show the integration of T_L-DNA and T_R-DNA of Ti plasmid in the transformed plantlets. *Npt-II* gene and cp gene were detected by PCR with primers specific to *npt II* (480 bp) and cp (410 bp) (Fig. 10).

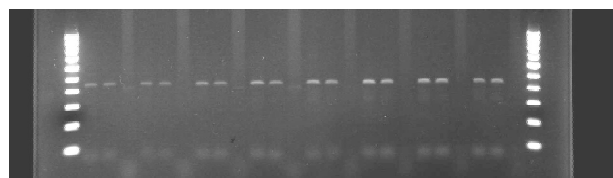


Fig. 10: PCR confirmation of *npt-II* gene (480 bp) with gene specific primers

Microprojectile transformation : Around 50,000 somatic embryos were bombarded with dual gene construct. Microprojectile suspension containing 50μl tungsten in an eppendorf tube, having 50μl plasmid DNA (1μg μl⁻¹), 50μl CaCl₂ 2.5m and 20μl filter sterilized spermidine (0.1M) was shot on embryos with the help of Gene gun. The helium gas pressure was kept at 12 kg cm⁻² and tissue was kept at 9 cm distance from the micro holder on sliding tray. Plasmid suspension (4 μl) was loaded onto the micro-holder. The microprojectile suspension was shot at 600 Hg initial pressure. Each plate bombarded at least twice. Bombarded cultures were transferred on the kanamycin medium. None of the embryos survived under kanamycin (100 mg l⁻¹).



Molecular diagnostics for sex identification :

Improvement of methodology by designing a protocol for mini-prep of plant genomic DNA extraction from papaya plantlets was carried out. The DNA thus obtained was found fit enough to perform multiplex PCR reactions for detection of both the sex and diseases (Geminiviral infections) diagnostics. In predicting the sex of papaya, mix and match of the three sets of oligonucleotide primers as shown below :

F1: 5'GTCTCTCGTATAGTTCTCGT3'

F2: 5'ACGTCTCCACTCGCTTCCAT3'

M1: 5'GCACGATTTAGATTAGATGT3'

M2: 5'GGATAGCTTGCCAGGTCAC3'

H1: 5'ATCTCGGTGTGCGTAGTC3'

H2: 5'TCATCTACTAGTGCCTAGTC3'

CR1: 5'GCC(CT)AT(GA)TA(TC)AG(AG)AAGCC
(AC)AG 3'

CR2: 5'GG(AG)TT(ATG)GA(GA)GCATG(TCA)
GTACATG 3'

Primers F1 and F2 (primer sequence provided by the University of Hawaii) produced a 1.3 kb PCR product in both females and hermaphrodites and no band in males. Primers M1 and M2 amplified 225 bp fragment only in male and hermaphrodite individuals suggesting it as male and hermaphrodite specific marker. Primers H1 and H2 produced a 0.8 kb PCR product in hermaphrodites only (hermaphrodite specific marker) without any band in females or males. Detection of Geminiviral infections was done by using degenerate Geminivirus group specific primers from coat protein gene. Primers CR1 and CR2 produced a 580 bp PCR product in PaLCuV infected seedlings only PaLCuV and other Geminiviral specific diagnostics and no bands in healthy females / males/ hermaphrodites. Successful attempts were made to standardize the PCR conditions for multiplexing both the sex and disease specific primer so that both the diagnostics could not be undertaken in a single PCR reaction. Primers were designed by using web-primer and other primer designing tools for accomplishing sex and disease diagnostics in one reaction.

LITCHI (*Litchi chinensis* Sonn)

Germplasm evaluation

Twenty five varieties of litchi were evaluated for tree growth characters. The 'Dehradun' exhibited more

vigour followed by 'Ajhauri' and 'Rose Scented'.

Seven varieties that came into bearing were evaluated for yield and fruit quality parameters. Maximum fruit yield was recorded in 'Early Large Red' (37.78 kg tree⁻¹) and 'Pickling' (35.36 kg tree⁻¹), where as maximum fruit weight (23.0 g) and fruit size (length- 4.36 cm) and diameter (4.04 cm) were noticed in Kasailiya followed by 'Ajhauri' (fruit weight- 22.8g, length- 3.5cm and dia.- 3.46 mm.). Sun burn in fruits could not be noticed in any variety. Fruit cracking was also found relatively low, which may be attributed to frequent rains during fruit growth/maturity period. Fruit cracking percentage was the highest (12.58%) in 'Rose Scented' followed by 'Early Large Red' (11.8%) and 'Pickling' (11.7%) and least (7.50%) in 'Kasailiya'. Similarly, seed percentage was the highest (18.7%) in 'Rose Scented' followed by 'Pickling' (17.8%) and 'Early Large Red' (17.5%) and minimum (14.6%) in 'Mandraj'. Highest (74.2%) aril percentage was in 'Kasailiya' and minimum (68.9%) in 'Pickling'. TSS varied from 16.8 to 20.6 °B, highest in 'Rose Scented'.

Variability in flowering pattern

Early panicle emergence (24.12.08) was recorded in 'Early Large Red', 'Pickling' and 'Maharaj Singh' and late (02.03.09) in 'Dehradun' and 'Calcuttia'. Flower opening (06.03.09) was early in 'Early Large Red', 'Ajhauri' and 'Rose Scented'. 'Maharaj Singh' took maximum number of days from panicle emergence to flower opening as compared to minimum 31 days in 'Serguja Sel.-I'. The complete flower opening period in a panicle was only 9 days for 'Dehradun', while it was 23 days for 'Early Seedless-1'.

AONLA (*Emblca officinalis* Gaertn.)

Germplasm collection and evaluation

Twenty one accessions of aonla collected from Madhya Pradesh different parts of were planted in the field along with along with four commercial varieties('NA-7', 'Krishna', 'Kanchan' and 'Lakshmi-52'). Maximum plant height (1.64 m) was recorded in accession CISH-A-4 as compared to minimum in CISH-A- (0.34 m). 28. The maximum plant circumference (12.3 cm) and plant spread in both the directions (1.13 and 1.16 m) were recorded in CISH-A-12 while minimum in CISH-A-11.



BAEL (*Aegle marmelos* Correa)

Germplasm collection and evaluation

Eighteen accession of bael were identified collected and multiplied from Uttar Pradesh, Madhya Pradesh, Bihar and Jharkhand. Data on initial growth parameters exhibited non significant differences. Seedling progeny of promising bael genotype was maintained in the field gene bank for creating genetic variability and subsequent selection.

JAMUN (*Syzigium cumini* Skeel)

Germplasm collection and evaluation

Five accessions were collected from Uttar Pradesh and Gujarat. Out of these, two seedless accessions collected from Varanasi, were multiplied vegetatively and planted for field evaluation. Fruits of eight accessions of elite genotypes were evaluated for physico-chemical attributes. Observations were recorded in respect of fruit weight (5.91 to 18.65 g), length (2.24 to 3.56 cm), diameter (2.18 to 3.06 cm), length: diameter ratio (1.01 to 1.22), pulp weight (4.11 to 17.08 g), pulp content (69.54 to 97.88%), seed weight (0.141 to 1.846 g), seed content (2.11 to 30.46 per cent), pulp: seed ratio (2.28 to 46.38), TSS (11.00 to 18.20° Brix), titrable acidity (0.669 to 0.892%), TSS : acid ratio (13.30 to 27.20), total sugar (4.71 to 6.74 per cent), sugar : acid ratio (5.44 to 9.90), tannins (0.137 to 0.245 per cent), anthocyanin (0.70 to 1.60%) and ascorbic acid (29.31 to 41.58 mg 100 g⁻¹).

Antioxidant values were estimated in different jamun accessions. The maximum antioxidant value (53.29 mg AEAC g⁻¹) was observed in accession CISH-J-34, whereas minimum (0.81mg AEAC g⁻¹) in CISH-J-44. The total carotenoids were maximum in CISH-J-43 (24.30 µg g⁻¹) and minimum (4.36 µg g⁻¹) in CISH-J-40. The phenol content range from 52.43 to 18.18 mg g⁻¹. Similarly, the flavonoid content varied from 1.19 to 2.01 mg g⁻¹.

KHIRNEE (*Manilkara hexandra* Toxb.)

Germplasm collection and evaluation

Twenty six elite genotypes were established in

field gene bank. Survey was carried out at Lalitpur, Lucknow and Ashok Nagar (M.P.). The fruits of superior accessions (12) were analyzed for fruit weight (1.66 to 4.25 g), length (1.39 to 2.18 cm), diameter (0.77 to 1.58 cm), length : diameter ratio (1.04 to 2.83), pulp weight (1.28 to 3.33 g), pulp content (77.10 to 91.20), seed weight (0.21 to 0.92 g), seed content (7.97 to 21.62%), pulp : seed ratio (3.62 to 10.86), seed per fruit (1.00 to 4.00), TSS in (26.20 to 31.8°B), titrable acidity (0.108 to 0.160%), TSS : acid ratio (176.25 to 288.89), vitamin C content (9.84 to 19.68mg 100g⁻¹) reducing sugar (4.15 to 6.06%), non-reducing sugars (4.88 to 10.46%), total sugars (10.25 to 14.92%), sugar : acid ratio (69.87 to 131.30) and tannins (0.145 to 0.257%).

The antioxidant value was found to be maximum (52.39 mg AEAC g⁻¹) in CISH-K-38 and minimum (27.73mg AEAC g⁻¹) in CISH-K-40. The total carotenoids were maximum (68.69 µg g⁻¹) in CISH-K-32 and minimum (3.66 µg g⁻¹) in CISH-K-42. The phenol content was maximum (63.88 mg g⁻¹) in CISH-K-33 and minimum (36.59 mg g⁻¹) in CISH-K-35. The flavonoid content varied from 2.03 to 0.79 mg g⁻¹.

MAHUA (*Madhuca latifolia* Roxb.)

Germplasm collection and evaluation

Twenty elite genotypes of mahua collected from different places in the country were planted in field gene bank for evaluation of growth and fruit quality.

WOOD APPLE (*Ferronia limonia* L.)

Germplasm collection and evaluation

Seventeen superior accessions were multiplied (vegetative propagation) and planted in field gene bank (FGB) for evaluation of growth, flowering and fruiting pattern.

TAMARIND (*Tamarindus indica* L.)

Germplasm collection and evaluation

Fruits of seventeen superior accessions were collected from Ashok Nagar (M.P.) and Lalitpur (U.P.) and twenty eight accessions were planted in the field gene bank. The pod shape was observed to range from



curved to straight. The colour of pods ranged from light brown to deep brown while pulp colour varied from light to redish brown. Similarly, the physiochemical parameters like pod weight (5.88-21.84 g), length (7.30-13.87 cm), breadth (1.83-3.12 cm), pulp weight (0.68-8.19 g), pulp per cent (9.16-42.63), number of seeds pod⁻¹ (3.33-8.33), seed weight (1.68-6.11 g), seed per cent (18.85-33.34), shell weight (1.53-5.27 g), shell per cent (17.89-33.40), fibre (1.66-3.97 g), TSS (50.00-74.67° B), titrable acidity (5.27-11.37%), TSS : acid ratio (4.46-13.52), reducing sugars (18.90-29.00%), total sugars (37.17-57.63%), sugar: acid ratio (3.54-10.44) and ascorbic acid (17.07-24.91 mg 100⁻¹ g) exhibited variations.

The antioxidant value was maximum (35.22 mg AEAC g⁻¹) in accession 'CISH-T-36' and minimum (4.34 mg AEAC g⁻¹) in 'CISH-T-33'. The total carotenoids were maximum (44.39 µg g⁻¹) in 'CISH-T-28' and minimum (14.41 µg g⁻¹) in 'CISH-T-44'. The phenol content ranged from 15.61 mg g⁻¹ in 'CISH-T-32' to 56.77 mg g⁻¹ in 'CISH-T-36'. The flavonoid content varied from 0.26 mg g⁻¹ to 19.58 mg g⁻¹.

CHIRONJI (*Buchanania lanzan Spreng.*)

Germplasm collection and evaluation

Survey was done in Bundelkhand region of Uttar Pradesh. Variation in fruit size and colour could not be recorded. The seedling plants were planted in field gene bank for *in situ* grafting.

CAPE GOOSEBERRY (*Physalis peruviana L.*)

Germplasm collection and evaluation

Three genotypes of cape gooseberry were raised and planted in field gene bank for evaluation of growth and fruiting pattern. Mature fruits of two elite accessions were collected and analyzed for fruit colour, weight, length, diameter, panicle length, thickness and TSS. The individual fruit weight ranged from 12.81 to 12.84 g, length from 2.26 to 3.19 cm, diameter from 2.55 to 3.05 cm and TSS from 16.4 to 17.0 °Brix.

CROP PRODUCTION

MANGO (*Mangifera indica L.*)

Micropropagation

Micropropagation system has been developed in mango using nucellus embryogenesis. However, none of the plants could be acclimatized. In order to develop good root system, somatic embryos as well as shoot explants were infected with *Agrobacterium rhizogene* to produce adventitious roots in mango. However, so far none of the Kanamycin explants could be regenerated.

Mass multiplication

Different combinations of soil, sand, FYM, single superphosphate, neem cake, *Trichoderma* and cocopeat were used for raising mango seedlings. Pond soil mixed with FYM and cocopeat was also used as one of the treatments for raising mango seedlings. One month old mango seedlings raised in beds were transplanted in polythene bags. Data were recorded on various parameters like height of plants, number of leaves and stem thickness. Mango seedlings attained maximum plant height (21.2 cm), stem diameter (8.6 mm) and number of leaves (17.4 plant⁻¹) in case of pond soil (60%) used with FYM (30%) and cocopeat (10%) after eight months of planting. It was closely followed by the plants grown in pond soil and FYM mixture (3 : 2), which exhibited non significant differences. Graftable seedlings of mango were obtained from both the media even after eight months. Problem of water stagnation and disturbed air water relations was observed in above media due to poor media porosity. Use of cocopeat significantly improved the plant growth in terms of plant height, diameter and number of leaves. The growth of plants with cocopeat (10%) even in the media comprising soil, sand and FYM (1:1:1) was better as compared to without cocopeat. Minimum growth of plants in terms of plant height (12.7 cm), stem diameter (4.5 mm) and number of leaves (9.2 per plant) was recorded in soil and FYM mixture prepared (1 : 1).

Scion defoliated on the day of grafting covered with a white polythene cap had better success of grafts (80-95% in green house and 70-90% in open field conditions). The temperature (22-28%) with relative humidity (75-80%) were most conducive for maximum bud take.



Standardization of planting system- cum- density

Planting density: In a 16 year old 'Dashehari' orchard planted at different densities, *viz.* 1600, 800, 400, 266, 178 and 100 plants ha⁻¹, maximum tree height (5.20 m) was observed in higher density planting (1600 plants ha⁻¹) followed by 5.15 m in density of 800 plants ha⁻¹ and minimum (4.50 m) in traditional planting density (100 plants ha⁻¹). Maximum canopy spread in north-south and east-west directions (5.47 m and 5.43 m) was recorded in the density of 178 plants ha⁻¹, whereas it was least with 3.29 m and 3.22 m in density of 1600 plants ha⁻¹. Maximum fruit yield (15.12 t ha⁻¹) was recorded in medium density planting (400 plants ha⁻¹), whereas minimum yield (4.15 t ha⁻¹) was recorded in traditional planting (100 plants ha⁻¹).

Effect of branch angle on fruit production: Branch angle and its relationship with bearing was studied in 'Dashehari' mango. The most productive branch angle was 31-60° from vertical axis as there were maximum fruits (49.33%) on these branches. Least fruit production (6.88%) was recorded from narrow angled branches of less than 30°. The maximum fruits weight (228.70 g) was recorded from the branches with angle of 31-60° followed by 211.15 g from narrow angled (< 30°) branches. There was no significant effect of angle on TSS of fruit.

Effect of pruning

Heading back: Heading back operations were performed in 'Dashehari' and 'Amrapali' trees at two levels (1.0 and 1.5 m above ground) during December 2005. After three years of growth in 'Dashehari', average plant height was 1.61 and 1.85 m and fruit yield per tree was 9.41 and 12.50 kg in 1.0 and 1.5 m height, respectively. In 'Amrapali', average plant height was 1.75 and 1.90 m in 1.0 and 1.5 m headed back trees, respectively. No flowering and fruiting in 'Amrapali' was observed as plants were severely affected by frost during December, 2007.

Canopy management

Canopy modifications: Three treatments for crop modifications, *viz.* control, crown thinning and crown reduction, were applied to twenty two years old 'Mallika' orchards and fruit yield was recorded. Maximum fruit yield (75.5 kg tree⁻¹) was noted in crown thinning treatment and lowest (56.5 kg tree⁻¹) in control. Maximum (41.0%) 'A' grade fruits were obtained in

crown thinning treatment followed by 38.75 per cent in crown reduction and only 22.5 per cent in control. TSS of fruits was also affected by treatments and it was higher (23.80° B) in crown thinning treatment followed by 22.80° B in crown reduction treatment and 20.60° B in control.

Canopy height in 'Mallika' was divided into three vertical grids (0 – 2.0, 2.1 – 4.0 and above 4.0 m for control). Fruit yield was higher in lower grid (52% in crown reduction and 56% in crown thinning) as compared to upper grids (48% in crown reduction and 44 in crown thinning). In control, higher fruit yield (49%) was recorded from middle grid followed by 44 per cent from lower grid and only 7 per cent from upper grid.

Panicle emergence: Final fruit retention in early and timely emerged, with about 20 days time gap, was observed in 'Mallika', 'Dashehari' and 'Amrapali' trees. The fruit retention was quite low (5.25%) in early emerged panicles as compared to timely emerged panicles (24.22%).

Training systems: Young plants of 'Mallika' were trained to different tree training systems (open centre, palmette and control) by pruning and bending of emerged shoots at desired angles. In six years of growth, minimum plant height (2.55 m) was recorded in open centre system followed by 2.65 m in palmette system and 3.50 m in control. The canopy spread was higher in control with 2.65 and 2.71 m as compared to open centre system with 2.35 and 2.46 m (EW and NS directions, respectively). Fruit yield was 5.5 kg tree⁻¹ in control and 4.0 kg tree⁻¹ in open centre and palmette system of training.

Substrate dynamics for IPNM

The experiment on 'Dashehari' conducted with 18 treatment combinations comprising FYM, vermicompost, *Azotobacter*, phosphorus solubilizing microorganisms, *Trichoderma harzianum* and NPK fertilizers was in the third year. Data were recorded on plant height, stem diameter, spread and nutrient status of soil and leaf. Plant height and stem diameter varied from 108.5 to 148.6 cm and 2.30 to 3.67 cm, respectively. Plant spread in north - south direction was from 59.1 to 110.5 cm and in east-west direction from 58.4 to 112.3 cm. Organic carbon and available N, P and K contents (0.214% and 34.8, 8.8 and 33.3 ppm, respectively) in soil were the lowest in the treatments without any addition of organic manure or mulching. DTPA extractable Fe, Mn, Zn and Cu contents were



also lowest in the treatments where no organic matter was added in the soil (4.05, 3.53, 0.65 and 0.32 ppm, respectively). Macro and micro-nutrient contents increased in the treatments comprising FYM and/or vermicompost and NPK fertilizers, however, differences due to various treatments were non-significant. The analysis of leaf samples showed no significant differences in N, P, K, Fe, Mn, Zn and Cu contents. However, the level of all the nutrients in the leaves were well above their respective critical limits.

Soil-water-plant relationship

Increasing water use efficiency through mulches: A field experiment comprising twenty treatments of irrigation and mulches is in progress since April, 2004. Irrigation with 50 per cent reduction in water followed by organic mulches continued to show a noticeable difference in soil moisture retention. Mulching with leaf litter had shown maximum moisture retention (18.70%) at all stages of growth followed by paddy straw (18.30%) and polyethylene mulch (16.90%). Minimum soil moisture retention (8.50%) was observed in control (basin).

The maximum soil organic carbon (0.545%), available P(15.50 ppm), K (81.30 ppm), Zn(1.47 ppm), Mn(5.24 ppm) and Fe (5.11 ppm) were recorded in the basin receiving leaf litter as mulch followed by paddy straw and polythene mulch. Maximum uptake in N (2.96%), P (0.142%), K (0.66%), Zn (25.30 ppm), Mn (181.0 ppm) and Fe (52.2ppm) were recorded in the treatments where leaf litter was applied. Mango trees mulched with leaf litter and irrigated at fruit growth (marble size) and fruit maturity stages gave the highest fruit yield (4.6 t ha⁻¹) followed by paddy straw (3.68 t ha⁻¹) and polyethylene mulch (3.17t ha⁻¹). The percentage increase in the fruit yield with leaf litter was 54.8 per cent over unmulched control.

Fertigation techniques: The fruit yield of 'Langra' was higher (6.57 t ha⁻¹) under drip irrigation than the basin irrigation (5.32 t ha⁻¹). Drip irrigation followed by fertigation with N P K at fruit set stage had given the highest yield (7.21 t ha⁻¹) as compared to conventional use of water and fertilizers (5.32 t ha⁻¹). The maximum availability of organic carbon (0.623%), phosphorus (20.30 ppm), potassium (135.00 ppm) and Zn(1.74 ppm) were recorded in the soil of the treatment which received N P K fertigation from September to second week of May. The concentrations of organic carbon, phosphorus and potassium were higher in surface soil (0-0.25 m) which decreased with the increase in depth

of the soil. Similar trend was observed in the availability of Zn and Cu. On the contrary, increase in Mn (15.86 ppm) and Cu (5.38 ppm) was observed in basin system of irrigation.

Nutrient management

A field experiment on nutrient management in 'Dashehari' comprising 24 treatments of FYM, green manure, nitrogen fixing and phosphorus solubilizing microorganisms, micronutrients (Zn, B, Mn and Cu) and NPK fertilizers is in progress since July, 2006. Ninety six composite soil samples (surface and subsurface) and 48 leaf samples were collected, processed and analyzed for their nutrient contents. The contents of Fe, Mn, Cu and Zn in leaves ranged from 137.56 to 230.00, 51.75 to 81.66, 17.66 to 42.00 and 21.00 to 27.00 ppm, respectively. Since the treatments were incorporated in July, 2006, no significant effect of the treatments were observed on fruit yield, though improvement in vigour of plants and micronutrient status were observed. Higher fruit yield was recorded in the treatment which received NPK + FYM+ *Azotobactor* + *Aspergillus awamori* (14.92 t ha⁻¹) followed by NPK + Mn + B (14.61 t ha⁻¹) as compared to control (12.46 t ha⁻¹).

Management of irregular bearing

Effect of paclobutrazol with mulching: On the basis of results obtained during previous years, a large scale trial of paclobutrazol (PP₃₃₃) with plastic mulch in 'Dashehari' was conducted. Eight set of treatments were imposed, in the first set 0.8 ml m⁻¹ canopy diameter of PP₃₃₃ was applied in those trees which were treated with 1.6 ml of PP₃₃₃ per tree during preceding years (2006-07 and 2007-08), in the 2nd set, trees were treated similarly as in 1st set but with mulching, in the 3rd set, 1.6 ml PP₃₃₃ + mulch was applied in those trees which were treated with the same dose in 2006-07 and 2007-08, in the 4th set, 1.6 ml PP₃₃₃ was applied in the trees which were treated with the same dose during previous years. In the 5th set, 1.6 ml PP₃₃₃ was applied in trees which received 3.2 ml PP₃₃₃ during the last year. In the 6th set, 3.2 ml PP₃₃₃ was applied during current years. The other two sets were control with and without mulch. The maximum flowering (86.0%) was recorded in 5th and 2nd set of treatments followed by 3rd (83.0%) and 1st (81.0%) set of treatments. The control trees showed only 47.0 per cent flowering. The retention of fruits at marble stage was maximum (5 panicle tree⁻¹)



in the trees which received PP₃₃₃ @ 1.6 ml m⁻¹ canopy diameter continuously for the last two years and 0.8 ml during the current year along with mulching.

The total number of fruits and yield per tree increased significantly in majority of the treatments and maximum fruit number (623.5) and yield 124.70 kg tree⁻¹ were recorded in the trees which received paclobutrazol @ 1.6 ml m⁻¹ canopy diameter with mulching continuously for three years as compared to minimum number of fruits (257.25 fruits tree⁻¹) and yield (51.45 kg tree⁻¹) in control. Residual level of paclobutrazol in soil was also monitored at different periods. Efficient utilization of paclobutrazol (2.0 g tree⁻¹) by the trees was recorded where plastic mulching was done as indicated by minimum residue (0.210 mg kg⁻¹ soil) remained in the soil after three months as compared to maximum available paclobutrazol (0.354 mg kg⁻¹) in soil without mulching.

In another trial, paclobutrazol doses, viz. 0.5, 1.0, 1.5 and 2.0 g tree⁻¹, were applied to the soil in the orchard of Amrapali (5 year old) for observing the flowering and fruiting behaviour. Maximum number of fruits number (1014 fruits tree⁻¹) and yield (154.0 kg tree⁻¹) were recorded in trees treated with 2.0 g of paclobutrazol as compared to control (390 fruits and 50.5 kg yield tree⁻¹).

Response of methionine: Methionine (0, 100, 200 and 400 ppm) either alone or in combination with *Trichoderma harzianum* (10⁸ spores g⁻¹) were applied in the rhizosphere soil of 15 years old orchard of 'Dashehari'. Flowering was significantly enhanced in majority of the treatments and maximum flowering (90%) was obtained in the trees treated with methionine (100 ppm) and *Trichoderma harzianum* followed by methionine (100 ppm) alone (83%). Maximum (19.70%) hermaphrodite flowers were recorded in trees treated with methionine (100 ppm) followed by methionine (200 ppm) and *Trichoderma harzianum*. However, the sex ratio was maximum (39.01%) in trees treated with methionine (200 ppm) and *Trichoderma harzianum* as compared to control (27.4%). The number of fruits per panicle, counted at marble stage, also improved (3 – 5 fruits panicle⁻¹) in the treated trees as compared to control (1.20 fruit panicle⁻¹).

Methionine (100 ppm) and *Trichoderma harzianum* also resulted in improvement of stomatal conductance (gs) (4.88 mol m⁻² s⁻¹) and rate of photosynthesis (Pn) (0.12 μ mol m⁻² s⁻¹) as compared to untreated comparative check (gs=1.21 mol m⁻² s⁻¹, Pn = 0.01 μ mol m⁻² s⁻¹).

Large variations in microbial population in terms of fungal, bacterial as well P-solubilizers and N-fixers were recorded in the treated soil. Many fold increase in bacterial (8.25 – 18.35x10⁶) and P-solubilizers (4.90 – 11.15x10⁶) population were recorded after one month of treatment in treated soil as compared to control (2.15 and 2.45x10⁶).

Effect of paclobutrazol on gas exchange

The photosynthetic efficiency and stomatal conductance at flowering and fruit set stages of 'Amrapali' and 'Langra', regular and biennial bearing cultivars, were studied when treated with different doses of pactobutrazol, viz. 0, 0.8, 1.6, 2.4 and 3.2 ml m⁻¹ canopy diameter. The rate of photosynthesis (Pn) at both the stages decreased as the concentration of paclobutrazol increased (Fig. 13). The higher Pn was observed in 'Langra' at both the stages. Similar effect of paclobutrazol was obtained in respect of stomatal conductance in both the varieties.

Variation in fluorescence and associated attributes: Chlorophyll variable fluorescence (Fv) to maximum fluorescence (Fm), PSII and electron transport rate (ETR) were measured in dark adapted leaves of 'Amrapali' and 'Langra' trees at flowering and fruit set (marble) stages. The Fv/Fm ratio was higher (0.760) in 'Amrapali' and lower (0.710) in 'Langra' during flowering. However, reverse trend of Fv/Fm ratio in these varieties was obtained at fruit set stage. Similar pattern of results in PSII and ETR were observed in respective cultivars at two stages.

Effect of CO₂: Effect of different levels of CO₂ (150-500 m mol mol⁻¹) on gas exchange parameters, viz. rate of photosynthesis, transpiration and stomatal conductance, was observed under controlled environment conditions in regular ('Amrapali') and biennial ('Chausa') cultivars at full bloom stage (Fig. 14). In 'Amrapali', the rate of photosynthesis (Pn) increased with increasing concentration of CO₂ up to 450 m mol mol⁻¹ and declined sharply thereafter.

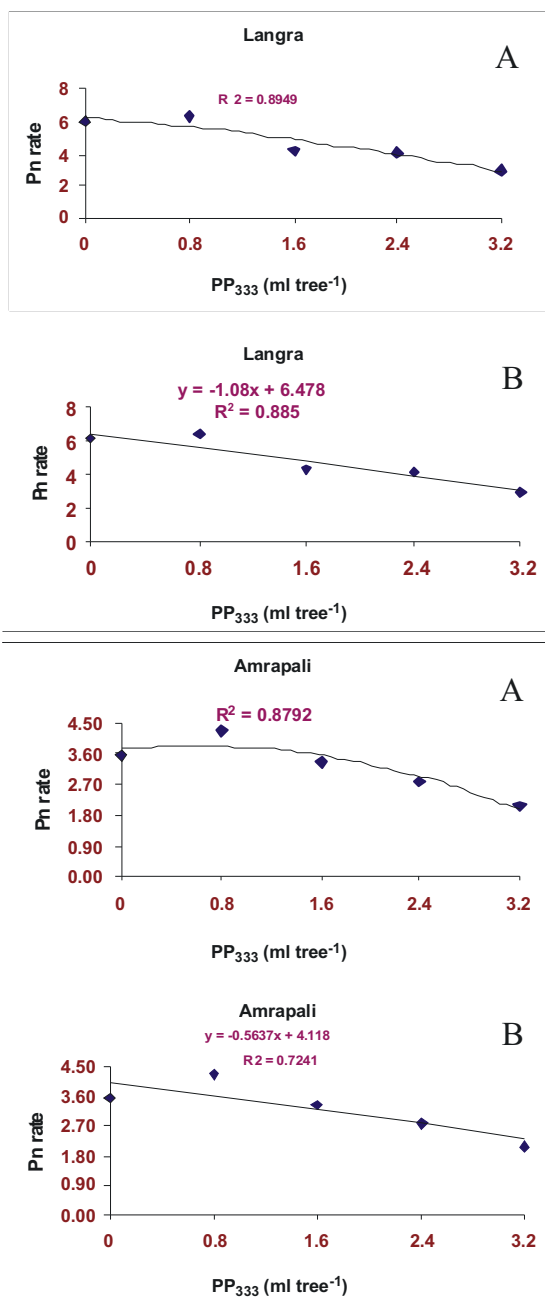
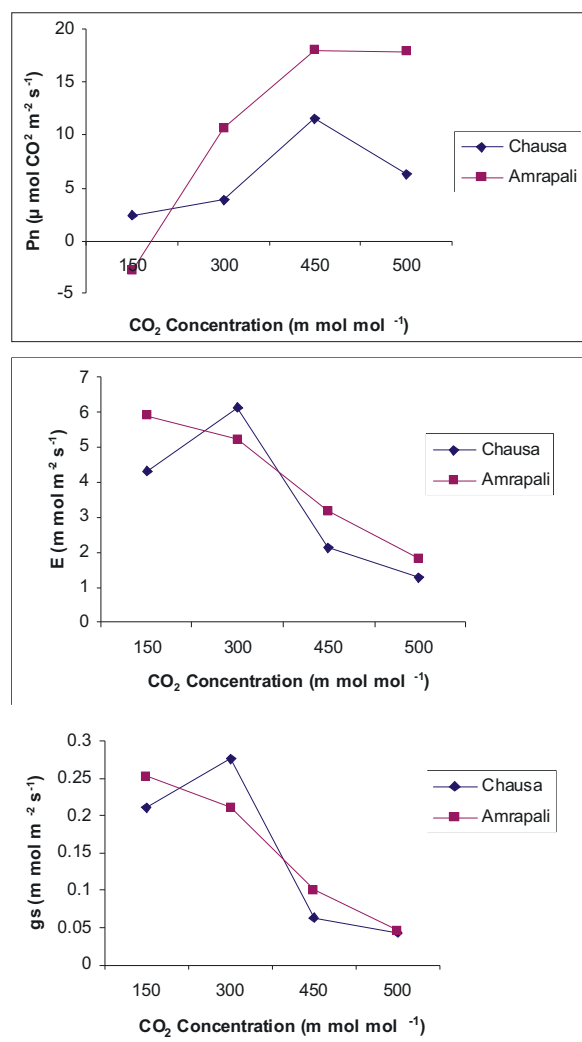


Fig. 13: Correlation between concentration of paclobutrazol (PP₃₃₃) and photosynthesis at flowering (A) and fruit set (B) stages

However, reduction in rate of photosynthesis at higher levels of CO₂ was in case of 'Chausa'. Sharp reduction in stomatal conductance ('gs') and transpiration rate (E) were noticed at higher concentration (300 m mol mol⁻¹) of CO₂ in both the cultivars.



Pn = photosynthetic rate, E = rate of transpiration, gs = stomatal conductance

Fig. 14: Effect of different levels of CO₂ on gas exchange in regular and biennial mango cultivars under control environment conditions of leaf.

Antioxidant capacity of fruits

A wide variation in antioxidant capacity in fruit pulp of different varieties at different growth stages was recorded. Its maximum value, in terms of FRAP, was obtained in 'Mallika' (11.98 mg AEAC g⁻¹ FW) after 50 days of fruit set and minimum in 'Chausa' (3.88 mg AEAC g⁻¹ FW) at juvenile phase (25 days after fruit set). Mature fruits of all the varieties studied exhibited maximum antioxidative activity. Total phenol and tocopherol contents declined gradually



as fruits matured, whereas its maximum value was recorded in 'Langra' at growth phase ($236.82 \mu\text{g AEAC g}^{-1}$ FW) and in 'Chausa' in at late maturity phase ($113.50 \mu\text{g AEAC g}^{-1}$ FW). 'Langra' fruits contained maximum phenol content with the range of $2.57 - 12.55 \text{ mg g}^{-1}$ fresh wt, whereas 'Amrapali' and other cultivars had minimum amount of phenol ($0.94 - 11.17 \text{ mg g}^{-1}$ FW). Significant variation in the contents of carotenoids and flavonoids were recorded among the cultivars at various growth stages of fruit. All the cultivars exhibited higher carotenoids value at maturity stage. But at early stages of fruit growth and development negligible amount of carotenoids were recorded. The maximum carotenoids was obtained in 'Langra' and 'Amrapali' (77.22 and $55.91 \mu\text{g g}^{-1}$ FW) and minimum in 'Dashehari' and 'Mallika'. However, 'Chausa' contained maximum flavonoids (2.90 mg g^{-1} FW), while 'Amrapali' minimum (1.20 mg g^{-1} FW). Narrow difference between FRAP and other contributory compounds at maturity stage depicted the higher antioxidant value.

Insect pollinators

Mass rearing: Efficient pollinators, viz. *Sarcophaga* sp. and *Lucilia*, were reared on beef extract in the laboratory and on fish meat in perforated nylon mesh bags and plastic bottles in the field. *Coccinella septumpunctata* was mass-multiplied on aphids and agar media in the laboratory. Stingless bees, *Trigona* spp., were collected from natural abodes and utilized for pollination purpose.

Correlation of population with fruit set and yield: Average fruit set of 3.5 panicle^{-1} and yield of 9.0 kg tree^{-1} were obtained in 5-6 years old trees of 'Mallika' exposed to different types of pollinators including *Sarcophaga* sp. and *Lucilia* sp. (10,000 nos), *Coccinella septumpunctata* (5000 nos), *Trigona* spp. (6000 nos.), and colonies of *Apis mellifera* (2 nos) as compared to average fruit set of 0.5 panicle^{-1} and fruit yield 2.1 kg tree^{-1} (5-6 years old trees, hybrids) where only 2 colonies of honey bee (*Apis mellifera*) boxes were kept. No fruit set could be recorded in the bagged trees.

GUAVA (*Psidium guajava* L.)

Substrate dynamics for IPNM

The experiment on 'Shewta' of guava comprising of 18 treatment combinations of FYM, vermi compost, *Azotobacter*, phosphorous solubilising microorganisms, *Trichoderma harzianum* and NPK fertilizers

was in the second year. Plant height ranged between 99.7 to 183.7 cm and stem diameter between 2.22 to 3.83 cm. The canopy spread ranged between 94.0 to 185.4 cm in N-S direction and 85.1 to 172.7 cm in E-W direction. Plant height and canopy were maximum in the treatment where all the substrates were applied. Organic carbon and available N, P, and K in different treatments were in the range of 0.307 to 0.486 per cent, 39.5 to 58.3 ppm, 26.8 to 45.7 ppm and 81.4 to 111.7 ppm, respectively. DTPA extractable Fe, Mn, Zn and Cu contents in soil ranged from 4.05 to 5.63, 10.26 to 16.38, 0.43 to 0.69 and 0.14 to 0.60 ppm, respectively. The treatments, however, showed no significant effect on the nutrient buildup in the soil. The N, P, K, Fe, Mn, Zn and Cu concentrations in leaves did not differ significantly.

Estimation of sample size for yield prediction: It was estimated that 35 and 12 plants of 'Allahabad Safeda' guava are required for prediction of yield at 95 per cent confidence probability with 5 and 10 per cent error through Tippet's methodology, when the yield of 100 plants was taken as 63.7 kg with a variance of 137.77. The predicted yield varied from 61.37 to 68.32 kg when 35 plants were used at 95 per cent confidence probability with 5 per cent error, while the range of 55.42-69.87 kg was wider when 12 plants were used at 95 per cent confidence probability with 10 per cent error. The more reliable data was obtained when 35 plants were used for yield prediction having 0.093 information function value.

AONLA (*Emblca officinalis* Gaertn.)

Substrate dynamics for IPNM

The substrate dynamics experiment on 'NA-7' aonla was replanted with 18 treatment combinations comprising FYM, vermicompost, *Azotobacter*, phosphorus solubilizing microorganisms, *Trichoderma harzianum* and NPK fertilizers. Data were recorded on initial plant growth and nutrient status of soil. Initial plant height ranged between 65.0 to 71.2 cm and stem diameter varied from 1.05 to 1.17 cm in different treatments. The soil pH and electrical conductivity ranged from 7.75 to 8.06 and 0.07 to 0.16 ds m^{-1} , respectively. Organic carbon and available N and K ranged from 0.350 to 0.505 per cent, 72.3 to 97.7 ppm and 90.9 to 143.4 ppm, respectively. DTPA extractable Fe, Mn and Zn contents in soil ranged from 2.33 to 4.23, 1.15 to 1.95 and 0.367 to 0.507 ppm, respectively, while DTPA extractable Cu was in traces. The experimental soil was poor in micronutrients.



MULBERRY (*Morus rubra* L.)

Propagation: The propagation of mulberry accessions by hard wood cuttings revealed the survival percentage of 62.5, 12.5, 37.5 and 50.0 per cent in MI-0118, MI-0171, MI-0249 and MI-0512, respectively during July under polyhouse conditions. Propagation through hard wood cuttings was difficult in some accessions inspite of using Rootex-3 powder, while others could be multiplied easily (87.5-100% survival) under polyhouse conditions (25-35% and 75-80% RH). None of the cuttings of the accessions could produce root and shoot properly when planted in bed under open conditions.

CUSTARD APPLE (*Annona squamosa* L.)

The graft success per cent was the highest (83.32%) under polyhouse conditions after 30 days of grafting. The graft success per cent was the highest (88.32%) when done on 15th February, 2008. Cleft and veneer grafting methods gave higher success per cent, i.e., 81.66 and 81.65 per cent, after 30 days of grafting. Interaction of time and method of grafting showed 91.66 per cent graft success when done on 15 February, 2008 by cleft grafting. Interaction of three factors environment, time and method of grafting, showed highest graft success (93.33%) when coupled with cleft grafting under polyhouse conditions on 15 February, 2008.

CARAMBOLA (*Averrhoa carambola* L.)

Carambola was successfully multiplied during spring season by wedge grafting on rootstocks raised in polybags having size 25 x 10 cm filled with soil and FYM mixture in 1: 1 ratio. The wedge grafted plants were kept in polyhouse for 20-25 days before transferring them to 50 per cent shaded agronet house. The success ranged between 88 and 100 per cent.

LASORA (*Cordia myxa* Roxb.)

Grafting was performed at intervals to standardize the best time of cleft grafting in lasora. Data were recorded on success and growth of grafts kept under polyhouse conditions. Hundred per cent success and survival were recorded during December to March under polyhouse conditions. The success and survival reduced to 80.33 per cent during April and May due to rise in temperature.

Other crops

Three accessions of Rose apple/Gulab jamun (*Syzygium jambos*) and three accessions of phalsa (*Grewia subinaequalis*) have also been maintained in field gene bank.

CROP PROTECTION

MANGO (*Mangifera indica* L.)

INSECT PESTS

Fruit fly

Forecasting: Correlation based weather index for forecasting of fruit fly population was validated. The observed and expected values matched well and forecasting was feasible 15 days in advance for population at critical weeks and peak population. The r^2 values were 0.75 and 0.88, respectively.

Population dynamics: Fruit fly population was monitored throughout the year at two locations (R.B.Road Campus of the Institute and Rehmankhara Block II and III) using wooden block impregnated methyl eugenol traps. The population started increasing from last week of April and peaked during May to first week of July (39.60 to 85.25 flies trap⁻¹ week⁻¹) on mango.

Hopper

Forecasting: Model for prediction of mango hopper, *Amritodus atkinsoni*, on trunk was validated. Correlation based weather index model and artificial Neural Network Technique were found suitable for critical weeks and epidemics and prediction was feasible 15 days in advance. The r^2 values were 0.68 and 0.78, respectively.

Population dynamics: The population of hopper, *Amritodus atkinsoni* was prevalent throughout the year on trunk having a peak during October to April.

Management: Among 8 insecticides/biopesticides evaluated, acephate (1.5 g l⁻¹), spinosad (1ml l⁻¹), thiamethoxam (0.2 g l⁻¹) and imidacloprid (0.3 ml l⁻¹) were found effective in reducing population 100 per cent after 21 days of spraying. Owing to relatively lower degree of toxicity of acephate and spinosad against beneficial insects, especially the honey bee, replacement of imidacloprid could be considered.



Thrips

Incidence: Incidence of leaf thrips during April, 2008, was negligible (0.001) at Institute's farm. Thrips attack coincided with new flush and was seen on panicles and mustard size fruits. During March, 2009 very low incidence (0.01) of thrips was seen on new flush at Institute's farm. However, heavy attack (5-25%) of thrips was recorded on new flush in farmers orchards. In some of the trees whole new flush was infested resulting in complete leaf mortality.

DISEASES

Malformation

Evaluation of resistance sources: Out of one hundred and ninety nine varieties were screened for floral/vegetative malformation disease at Rehmankhea and RB Road Campus of the Institute 143 varieties were found infected with floral malformation.

Powdery mildew

Prevalence: Floral powdery mildew (*Oidium mangiferae*) did not assume epiphytotic proportion menace in the mango belt of Malihabad. The low disease incidence (5-10%) was observed during March as the temperature remained below critical limit (35°C) and relative humidity remained higher (72-98%).

Anthracnose

Prevalence: Foliar anthracnose (*Colletotrichum gloeosporioides*) was first noticed with the onset of rains in July but the disease incidence was low (10%). Its incidence increased up to 15 per cent in the second fortnight of August when temperature ranged between 23.5 to 32.5°C. It could be inferred that high RH (83-95%) and variation in maximum of 24.1-34.2 °C and minimum of 21.6-25.7°C temperatures are conducive for the disease development.

Blossom blight

Prevalence: Blossom blight caused by *Colletotrichum gloeosporioides* and *Alternaria alternata* was observed on panicles during March at Kakori and Malihabad area of Lucknow. However, disease incidence was less than 5 per cent.

Sooty mould

Prevalence: Sooty mould was found prevalent in orchards through out in Malihabad and Mal blocks of Lucknow and disease incidence ranged from 10-15 per cent during March - April. The incidence affected market appeal of fruits.

Die-back

Prevalence: Surveys were conducted for prevalence of (*Lasiodiplodia theobromae*) inciting die-back disease in Kakori and Malihabad blocks of Lucknow. Incidence of die-back disease ranged between 2-6 per cent in November. During this period maximum temperature varied from 28.2-31.6°C, while the minimum temperature was between 12.5-15.2°C.

Mango Bacterial Canker Disease (MBCD)

Twenty six cultures of the MBCD pathogen (*Xanthomonas campestris* pv. *mangiferaeindicae*), collected from different mango cultivars, were preserved.

Post-harvest diseases

Effect of chemicals: There was no development of anthracnose up to 4 days in all the treatments except control (31.25%). Hot water supplemented with carbendazim (0.05%) was found effective in controlling post-harvest diseases of mango up to 8 days of storage under ambient conditions, while carbendazim (0.1%) could control post-harvest diseases up to 10 days. Prochloraz treatments in cold water was found ineffective at ambient temperatures. Disease incidence and disease index were 8.33 and 3.23 and 9.38 and 5.25 per cent in fruits treated in hot water supplemented with carbendazim (0.05%) and Prochloraz (0.1%), respectively, in comparison to 62.50 and 36.21 per cent in control. Treatment with carbendazim (0.1%) in hot water could be recommended for the control of post-harvest diseases of mango under ambient conditions. Prochloraz (0.01%) in hot water was found effective in controlling the diseases up to 2 weeks of fruit storage at low temperature, while fruits treated with carbendazim in hot water could be stored up to 3 weeks without any disease incidence. However, none of the treatments were found effective in controlling diseases up to 4 weeks at low temperature of storage though hot water supplemented with carbendazim (0.1%) was found effective in minimizing the disease incidence and



disease index to 6.25 and 3.25 per cent as compared to 81.25 and 43.76 per cent, respectively, in control.

Effect of botanicals on *Colletotrichum gloeosporioides*:

Out of thirteen botanicals (*Mentha indica*, *Allium sataiva*, *Tagetes erecta*, *Cannabis sataiva*, *Ocimum sanctum*, *Morus alba*, *Allium ceepa*, *Lantana camara*, *Calatropis gigantean*, *Euphorbia hirta*, *Carica papaya*, *Ricinus communis* and *Azadirachta indica*) at three concentrations (10, 50 and 100 ppm) tested under *in vitro* conditions, *Morus alba* and *Ocimum sanctum* were found effective in checking the radial growth of *Colletotrichum gloeosporioides* as it was 4.97 and 5.11 cm at 10 ppm, 5.90 and 5.89 cm at 50 ppm and 6.86 and 6.72 cm at 100 ppm of *Morus alba* and *Ocimum sanctum*, respectively, in comparison to control (7.84 cm).

GUAVA (*Psidium guajava* L.)

INSECT PESTS

Fruit borer

Management: Two sprays of various insecticides and neem oil were conducted at 15 days interval on guava 'Allahabad Safeda' for the control of fruit borer (*Deudorix isocrates*). Ethopphenprox (0.05%) was highly effective in controlling borer infestation followed by cartaphydrochloride (0.05%) (1.26% infestation), neem excel (0.2%) (2.66% infestation) and carbaryl (0.2%) (4.66 infestation) as compared to control (20.40% infestation).

Bark eating caterpillar

Management: Bark eating caterpillar, *Inderbela* sp., could be effectively managed by mechanical methods (cleaning of webs and collection and killing of the larvae) and swabbing (during the last week of February) with pine oil (1%), castor oil (2%), Excel Plus (1%), chlorpyriphos (0.05%), neem oil (0.15%). Pine oil (1%) and Excel Plus caused 100 per cent reduction in larval galleries followed by castor oil (75.5%), neem oil (75%) and chlorpyriphos (60.25%).

PAPAYA (*Carica papaya* L.)

NEMATODE PESTS

Survey and collection of bacterial antagonist: Surveys conducted in the fruit crops comprising of aonla,

banana, bael and vegetable crops including cabbage and tomato revealed a varying number of distinct bacterial colonies from the rhizosphere/ rhizoplane ranging from two to six. Colonies were found to be characteristically quite distinct in terms of colour and growth pattern. Furthermore, their growth pattern exhibited suppressive growth features – absolutely marked and qualitative parameters for their saprophytic nature which could be gainfully explored and exploited for the management of nematode populations. Second stage juveniles of root-knot nematode, *Meloidogynye incognita* used as a test candidate against the representative bacterial colonies, though exhibited varying levels of juvenile mortality but it was largely found to be relatively insignificant. Even four bacterial isolates of *Bacillus subtilis*, isolated from certain biodynamic preparations could not exhibit a perceptibly significant degree of nemato-toxicity as the juvenile mortality was found to be only 0.12 per cent. Lower degree of temperature regimen (20-22 °C) could also be ascribed as a factor responsible for lower degree of nemato-toxic potential of the isolates.

Response of bacterial isolates against antibiotics:

Bacterial isolates recovered from the rhizoplane (R₁, R₂) and rhizosphere (S₁, S₂) of tomato/ brinjal crop pathosystem and exposed to 16 antibiotics responded varyingly in terms of their growth pattern *vis-à-vis* antibiotics. Ciprofloxacin could not exert a negative impact on the growth of all nematode antagonists (R₁, R₂, S₁, S₂) as the bacterial growth was 18.00, 18.33, 30.33 and 13.33 mm, respectively. On the other hand, six antibiotics (Amoxicillin, Gentamycin, G-10, G-30, Penicillin, P-10, Kanamyein, K-30 and Streptomycin, S-10) to varying degree could impact the growth patterns of all the antagonists to a significant level.

Survival of entomopathogenic nematodes: Currently, the soil inhabiting entomopathogenic nematodes are being increasingly deployed as the management tools against the insect pests. However, majority of the species of entomopathogenic nematodes appear to lack moisture tolerance feature. In order to test the moisture tolerance potential, nematode populations (*Steinernema carpocapsae*) collected from guava fields, was subjected to six different treatments comprising of 7 watering treatments including daily, alternate day, 3rd day, 1 week, 4 week and 8 week watering (5ml) interval. Juveniles of *Steinernema carpocapsae* were



found to survive even in the soil watered once in 8 weeks. The pathogenic potential, however, of the nematode, owing to lower populations (1404) was found reduced as compared to other treatments.

Response of *Trichoderma harzianum* against organic sources : With a view to develop of bioagent based management system, 3 organic sources (neem cake, mustard cake, powdered FYM and press mud) either alone or in combination were evaluated for the survival and multiplication of *T. harzianum*. Mustard cake in combination with powdered FYM (75:25 ratio) was found to support the maximum population of *Trichoderma harzianum* (19 cfu g⁻¹) as compared to other treatments.

AONLA (*Emblia officinalis* Gaertn.)

Gall maker

Incidence : Gall maker (*Betousa stylophora*) attack was recorded in nursery as well as in old bearing trees. The incidence was very low (0.5 galls plant⁻¹). Shoot galls were observed in mature trees of all the cultivars and the incidence started from the fortnight of April. The maximum incidence was noticed (6.8 galls tree⁻¹) during the first fortnight of October. The incidence continuing up to March (6.5 galls tree⁻¹ I fortnight and 5.3 galls tree⁻¹ II fortnight) and the incidence varied from 1.4 galls tree⁻¹ (July II fortnight) to 6.8 galls tree⁻¹ (October I fortnight).

Fruit borer

Incidence : Fruit borer (*Deudorix isocrates*) incidence started from I fortnight of August and continued up to I fortnight of November causing 2.65 per cent fruit loss. There was an increase in the incidence from II fortnight of August. The maximum fruit borer incidence was observed in II fortnight of October.

Management : Two sprays of cartap hydrochloride (0.05%), carbaryl (0.15%) and neem oil (0.15%) at fortnightly intervals during July were highly effective in the management of shoot galls. No gall formation was observed in treated trees in comparison to control (3.4 galls tree⁻¹).

BAEL (*Aegle marmelos* Correa)

Die-back and gummosis

Twig die-back and gummosis symptoms were observed in seedlings as well as trees of *Aegle marmelos* cultivars (NB-5 and NB-9). Two isolates of *Fusarium oxysporum* were obtained from the affected plants. Initial die-back symptoms appeared in the form of slow drying up of leaves and twigs of upper region of canopy followed by its gradual spread to the lower portion. Serial laboratory isolations from the affected leaves and twigs largely yielded *Fusarium oxysporum*.

POST-HARVEST MANAGEMENT

MANGO (*Mangifera indica* L.)

Mechanization

Evaluation of mango slicer and cube cutting machines: The blades of mango slicer and cube cutting machines were refined and mango feeder openings adjusted to increase their efficiency and quality of the product. Consequently, smooth slices and cubes could be cut for processing into pickles and performance efficiency was increased from 60 to 70 per cent.

Grading: The grades for 'Langra' and 'Chausa' on weight basis were standardized. Only 30 and 40 per cent of fruits 'Langra' and 'Chausa' were above 300 g for export purposes.

Packaging

Development of tray type CFB boxes: A 4-kilogram carton was designed on the basis of weight and size specifications for the required market that could accommodate 8, 10, 9, 12, 14 or 16 fruits weighing 500, 400, 450, 330, 230 and 250 g, respectively (Fig. 15). The ventilation (0.5% of surface area) provided movement of air freely. Individual labels could be attached to the fruit for appearance and recognition/traceability. Eight to ten number of trays could be stacked in one column with the upper most provided with a lid.

Storage

Assessment of safe chemicals: Mature 'Dashehari' fruits treated with 0.01 per cent putrescine, packed in 200 gauge ventilated LDPE bags and stored under cold conditions (12±2°C and 90±5% RH) were analysed for



Fig. 15: Tray type CFB boxes

quality at regular intervals. With the advancement of storage period, the firmness and titratable acidity decreased, while TSS and Ferric Reducing Antioxidant Power (FRAP) value increased. The fruits treated with putrescine and packed in LDPE bags exhibited better quality retention up to 3 days of ripening after withdrawal from cold storage after 21 days duration.

Similarly, 'Chausa' fruits treated with 0.01 per cent spermidine packed in ventilated LDPE bags (MAP) and stored under low temperature conditions ($10 \pm 2^\circ \text{C}$ and $90 \pm 5\% \text{RH}$) showed better retention of firmness and lower physiological loss in weight after 30 days of storage.

Value addition

Evaluation of varieties/hybrids for pickle: Nine varieties and hybrids were evaluated for pickle in oil. The analysis of fresh mature fruits indicated average variation of 119.6-437.9 g in weight, 78.3-82.6 per cent in moisture, $35.8-73.0 \text{ mg}100\text{g}^{-1}$ in ascorbic acid and 0.60-2.79 per cent in titratable acidity. The maximum acidity was obtained in 'Kharbuja' (2.79%) followed by 'Bathui' (2.26%) and 'Pau' (2.07%), while the least acidity was noticed in 'Black Andrew' (0.60%). The pickle prepared from these varieties/hybrids was analysed at 0, 3 and 6 months of storage under ambient conditions. A decrease in moisture and acid contents, and increase in the contents of salt and reducing sugars of pickles were recorded after six months of storage. Sensory evaluation of pickles indicated that 'Bathui' was the best variety followed by 'Pau', 'Akhadya' and 'Katakee Bihar' after six months of storage.

Evaluation of varieties/hybrids for pulp: The pulp of fruits obtained from five mango varieties and seven hybrids, ripened uniformly with ethrel, were evaluated for their physico-chemical characters. The average weight of fruits varied from 246-518 g, while pulp percentage in ripe fruits varied from 60-71. Based on organoleptic parameters, fruits of 'H-2079' were rated the highest followed by 'H-193' and 'Almas'. The fruits of 'Hanuman Bhog' exhibited highest TSS (20.0°B) followed by 'H-2094', while it was the lowest in 'Black Andrew' and 'H-193' (15.4°B). The ascorbic acid content was low in all the varieties/hybrids except 'Black Andrew' ($50.0 \text{ mg}100\text{g}^{-1}$). The fruits of 'Almas', 'Hanuman Bhog', 'H-2079' and 'H-2035' contained higher carotenoids ($4.11-4.89 \text{ mg}100\text{g}^{-1}$). The analysis of pulp prepared from these varieties/hybrids, preserved in glass jars and stored for 6 months, showed an increase in reducing sugars and decrease in yellowness index and total carotenoids. The organoleptic quality of RTS beverage prepared from varieties and hybrids (except 'H-2075', 'H-2079' and 'H-2094') was acceptable at the time of preparation. The most acceptable quality of RTS beverage was obtained from 'Afeem' and 'Black Andrew' after six months of pulp storage.

Calcium fortified osmo-air dried slices: The ripe mango slices of 'Totapuri' pre-treated with 2 per cent salt solution, dipped in 50°B sugar syrup containing three different concentrations each of calcium chloride and calcium saccharate, osmo-air dried and stored up to six months in PET jars exhibited a decrease in the acidity and carotenoids content and an increase in reducing sugars in the slices after six months of storage. The organoleptic quality of the slices was



improved by the addition of calcium chloride (0.0375M), while the slices treated with calcium saccharate were found unacceptable.

Pectinase production for peel: Protocol for purification of pectinase (obtained through microbial fermentation of mango peel) by ion exchange chromatography was standardised using DEAE-cellulose column (1.1 x 40 cm) as matrix, 50 mM acetate buffer (pH 5.5) as equilibration buffer and 0.1M NaCl gradient in 50 mM acetate buffer (pH 5) as elution buffer, sixty six fold purification was obtained with 159.7 per cent recovery (Fig. 16).

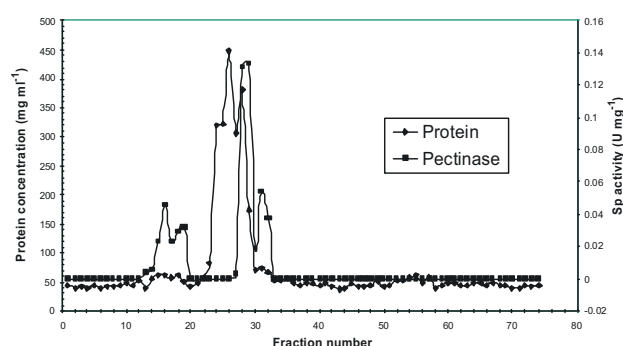


Fig 16: Purification of pectinase produced by *A. fumigatus* using DEAE-cellulose column

Cellulase production from peel: Cellulobiose (13.98 U mg⁻¹) was found best for cellulase production from mango peel using *Bacillus* spp. followed by cotton (11.33 U mg⁻¹) and carboxy methyl cellulose (10.67 U mg⁻¹). Protocol was standardized for purification of cellulase by affinity chromatography using agarose column (1.5 x 26 cm) as matrix 50 mM acetate buffer (pH 5) as equilibration buffer and 50 mM acetate buffer (pH 5) as elution buffer. Purification to the extent of 28.24 fold was achieved with 1.99 per cent recovery (Fig 17).

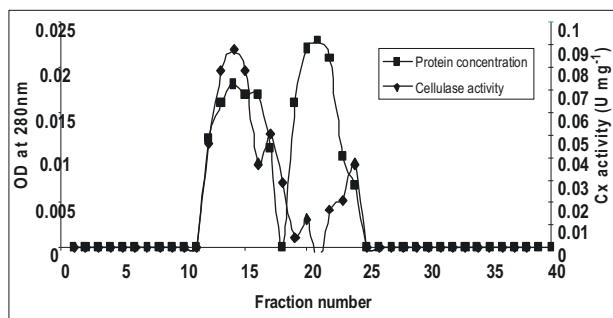


Fig 17: Purification of cellulase produced by *Bacillus* sp. using agarose (affinity) column

Amylase production from kernel: Protocol for amylase production, obtained by fermentation of mango kernel by *Fusarium* spp. using DEAE-cellulose column (1.1 x 40 cm) as matrix, 50 mM acetate buffer (pH 5) as equilibration buffer and 0.1M NaCl gradient in 50 mM acetate buffer (pH 5) as elution solution. Ninety five fold purification of amylase was obtained with 171.62 per cent recovery (Fig. 18).

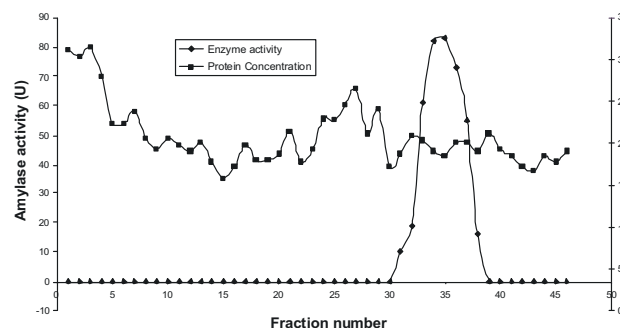


Fig 18: Purification of amylase produced by *Fusarium* sp. using DEAE-cellulose column.

Pesticide residue analysis

Carbendazim : The initial residues of carbendazim in whole fruit (peel + pulp) were 3.13 and 6.07 mg kg⁻¹ at 0.05 and 0.1 per cent concentrations, whereas the corresponding values in pulp were 0.78 and 1.83 mg kg⁻¹, respectively. Residues of carbendazim in whole fruit degraded to 0.92 and 2.06 mg kg⁻¹ in 0.05 and 0.1 per cent treatments after 10 days of storage at ambient temperature (30 ± 2°C; and 80 – 90% RH) and followed first order rate kinetics. Carbendazim concentration in fruit pulp reached maximum after 4 days and came down to 0.51 and 1.05 mg kg⁻¹ after 10 days of storage. Three and seven days waiting period for consumption of ripe 'Chausa' fruits treated with 0.05 and 0.1 per cent carbendazim, respectively, could be considered safe. The residual half-life value of carbendazim in whole fruit was statistically calculated as 3 days at both the concentrations.

Market analysis

Disposal: A total of 51.58 thousand MT of the fruits were sent to different markets around the country and to Nepal markets during 2008 out of which about 79.62 per cent during June, 2008 followed by about 11.81 and 8.57 per cent during July and May, 2008, respectively, were disposed of. The corresponding figures for June, 2008 accounted for 87.77 per cent of



the total disposal during 2007 followed by 7.66 and 5.43 per cent in July and May, 2007, respectively.

About 68.25 per cent of the total disposal from Lucknow was traded outside Uttar Pradesh during 2008 as against 77 per cent during the previous year. The rest was traded in the markets located within the state. Delhi, the main assembly market in North India, received about 37.35 per cent of the total disposal in 2008 as against 33 per cent during the previous year.

About 75.86 per cent of mangoes disposed during July, 2008 were traded in the state and rest was traded outside. The situation was in contrast to the disposals during July 2007, when the disposals within and outside the state accounted for 48.39 and 51.61 per cent, respectively.

About 77.41 per cent of the produce was disposed of during three week period starting from May 30, 2007, while the peak of 22.76 per cent was recorded in the week starting from June 13, 2007. Significant quantities of mangoes (85.6%) from Lucknow were traded in the markets outside the state during early and mid season, while it was only 56.65 per cent during the period in the markets within the State.

Arrival and prices : The total arrival of mango in Lucknow during 2008 was 71.6 thousand MT which was less than the 85.7 thousand MT registered during 2007. Although arrivals in Lucknow were from March to August, about 99 per cent of the total arrival was concentrated during May to July itself, which coincided with the production season of 'Dashehari'. June alone accounted for about 79 per cent of the total arrival. The average price during the season was Rs. 823 quintal⁻¹ because of discolouration/blotch of the fruits caused by excessive and persistent rains during the harvesting season, leading to poor external appearance. The market arrivals, hence, were found lowest during the last 6 years in the region.

Variety-wise perusal concerning arrival and price pattern indicated that 'Banganpalli' was the first to arrive from Andhra Pradesh and other south Indian states during March lasting up to mid June with total arrival of 1577 MT, which dwindled upon the arrival of Dashehari from Lucknow district. Owing to non-availability of other varieties during the period, its price was the highest. The total arrival of Dashehari was found maximum at 9298 MT. However, its price realization was the least *vis-à-vis* 'Langra' and

'Chausa'. The model price of 'Dashehari' was Rs. 1078 quintal⁻¹, while that of 'Chausa' was the highest amongst North Indian cultivars as their arrival was late.

Export performance : The export of mango from India declined to 54.35 thousand MT worth Rs. 127.4 crores during 2007-08 as against all time high at 79.06 thousand MT worth Rs. 141.94 crore during 2006-07. It depicted a decline of 31.25 and 10.24 per cent in quantity and value of exports, respectively, over and above the previous year. In fact, over all growth during 1999-2000 to 2006-07 was 57 and 78 per cent in quantity and value, respectively, of exports from India. The linear regression function for trend alone explained 78.7 per cent variation in the quantity of exports. The coefficient was significant at 1 per cent level of probability. The trend, however, could not explain sufficient variation in value of export. The export to Bangladesh declined drastically from 42.9 thousand MT during 2006-07 to 17.06 thousand MT during 2007-08, depicting a sharp decline of 60 per cent both in terms of quantity as well as value. The main reason for this trend could be attributed to the trading on credit and default payments by the traders from Bangladesh in the previous years. Even the mango exports to United Arab Emirates have been fluctuating, with a slow growth pattern, while the exports to other Gulf States has been stagnating or even declining. This could be attributed to stiff competition from Pakistan, which is nearer and could export through the land route. Consequently, the landed price of Pakistani mangoes is lower *vis-à-vis* Indian mangoes. However, exports to U.K. increased from 1.88 thousand MT worth Rs. 11.41 crores to 2.58 thousand MT worth Rs. 19.82 crores.

The Indian export of mango pulp has maintained an increasing trend with an all time high of 166.75 thousand MT worth Rs. 509.69 crore during 2008-09, which was 6.3 and 0.76 per cent higher than the previous year. The over all growth in the quantity and value of pulp export during 1999-2000 to 2007-08 was 130.4 and 159.3 per cent, respectively.

Saudi Arabia continued to be the most dependable importer of Indian mango pulp having a growth rate of about 133.4 per cent during 1999-2000 to 2006-07, though it declined marginally during 2007-08. It accounted for 27.5 per cent of the total pulp export of 72.38 thousand MT and 21 per cent of total value of



pulp export of Rs. 196.53 crores during 1999-2000, however, its share increased to about 27.8 per cent of 166.75 thousand MT of total pulp export and about 23.22 per cent of Rs. 509.69 crores of value of pulp exports during 2007-08. Netherlands has now emerged as dependable importer of mango pulp from India. It could serve as the window for European Union Markets. Development of appropriate market and linkage of production with emerging markets could provide further fillip to expansion of production area and improved livelihood of farmers in mango belt.

Constraints in export: State supported export ventures from Uttar Pradesh were not found sustainable. It participated in mango shows in Dubai and Europe but the experiences were not shared with the participating farmers and no follow up measures were taken. The Mandi Samiti procured the best quality fruits from the farmers and left the rest for the local markets. This has not found favours with the orchardists as they felt that their reputation and brand value, not only for the current year but also for the future, got affected and they could not get the reasonable price for their produce. Although infrastructure facilities for fresh mango exports, *viz.* packing line, cool chain facilities, have been created in Agri-Export Zones, they have not become popular amongst the farmers.

Lack of interest on the part of established exporters was another reason hampering exports of mango and its products from the northern belt. The referral laboratories, vapour heat treatment plants and irradiation facilities are yet to be established in various Agri-Export Zones for promoting exports to developed countries, which needs priority attention.

GUAVA (*Psidium guajava* L.)

Packaging

Commercial varieties of guava ('Allahabad Safeda' and 'Sardar') were graded on packaging line and analyzed on the basis of CODEX standards. It was found that on weight basis majority of the fruits were below the code range of 3(251-350 g and 86-95 mm dia.) and were falling between code 4-9(201 to <350 g and 76-85 to < 30 mm dia.). Therefore, following standard grades for different markets were suggested for 'Allahabad Safeda' and 'Sardar' (Table 4).

Table 4 : Standard grades for guava on weight basis

Weight (g)	'Allahabad Safeda'	'Sardar'
> 200	10% for export	20% for export
151 – 200	30% for export	40% for export
100 – 149	20% for metro Cities	10% for metro cities
< 100	30% for local markets	20% for local markets
Discards	10%	10%

Value addition

Development of cider: Out of four concentrations (0.1, 0.2, 0.3 and 0.4%) of tannins, 0.2 per cent was found optimum for guava cider having 4 per cent alcohol. Guava blended with aonla (1:0.5) was found organoleptically better (average score 8 out of 10) over the other treatments. Four phenolic compounds, *viz.* chlorogenic acid, caffeic acid, catechin and 4-hydroxybenzaldehyde, were detected in stored guava cider.

Market analysis

Arrival and prices: The total arrival of guava during 2008-09 was significantly higher (1639.5 MT) than the arrivals during the past two years. The arrival of guava during 2008 was late as it virtually started during August and peaked during January, 2009. The arrival during January, 2009 was 7248 quintals (44.21% of total arrival), the highest in recent years. The monsoon from August and September, 2007-08 received 20.97 per cent of total arrival of 1639.5 MT, while the winter, *i.e.* November, 2008 to January, 2009 had 68.41 per cent of the total arrival. The lowest price of guava stood at Rs. 281 quintal⁻¹ in December followed by November, August and February, 2009.

PAPAYA (*Carcica papaya* L.)

Market analysis

Arrival and prices: A total of 5581.7 MT of papaya was received during the April to December, 2008. The arrival of papaya fluctuated drastically over the months. The lowest arrival (14.1 MT) was during January, 2009 due to peak winter month, followed by 124 MT during June, 2008. It was the highest (968.3 MT) during March followed by 811.1 and 680.1 MT during September and November, 2008, respectively. In fact the arrival was concentrated during September



to December, 2008 and February and March, 2009, which accounted for about 47 and 26.66 per cent of total arrivals, respectively. The average price of the fruit during 2008-09 was Rs. 395 quintal⁻¹, which was higher than the previous year.

AONLA (*Emblica Officinalis Gaertn.*)

Storage

Effect of chemical treatments: Effects of post-harvest treatments comprising $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ (2.0%), KMnO_4 (0.01%) and their combinations along with untreated control were observed on mature green fruits of 'Kanchan' stored under ambient conditions ($18 \pm 2^\circ\text{C}$ and $57 \pm 5\%$ RH). Minimum browning was found in KMnO_4 treated fruits after 9 days of storage as compared to other treatments. Fruits treated with $\text{CaCl}_2 \cdot 2\text{H}_2\text{O} + \text{KMnO}_4$ had maximum ascorbic acid content after 9 days of storage (Fig. 19). Polyphenols were maximum under KMnO_4 . The maximum Ferric Reducing Antioxidant Power (FRAP) values were observed on the 9th day of storage.

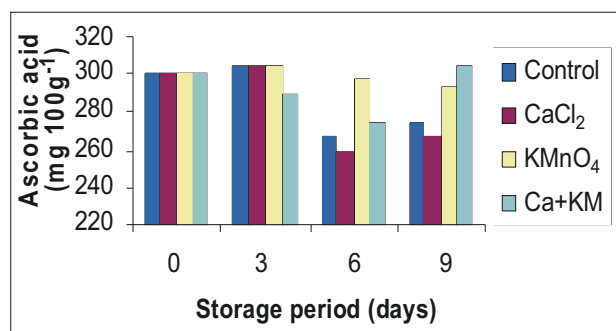


Fig. 19: Changes in ascorbic acid content in 'Kanchan' aonla during storage.

Value addition

Steeping preservation of fruits on juice quality: Fruits of 'Chakaiya' were steeped in tap water and juice was extracted at 0, 5, 10, 15, 20 and 25 days of preservation. A continuous decrease in TSS, titratable acidity, ascorbic acid and tannins was observed in fruits as the duration of steeping preservation prolonged. The content of ascorbic acid declined from 292.0 to 36.5 mg 100g⁻¹ in stored fruits. The yield of juice was highest (58.8%) after 5 days of storage. As the steeping period of fruits in water prolonged, the quality of juice extracted also declined in terms of ascorbic acid and tannins. The deterioration in juice quality was more

pronounced when it was extracted from preserved fruits after 15 days of storage.

Pre-treatments for segments-in-syrup: Fruits of aonla 'Chakaiya' were blanched in boiling water containing 0, 0.5 and 1.0 per cent alum. The segments were separated from the fruits and the product was prepared by dipping the segments in increasing concentration of sugar syrup. The product segments-in-syrup was packed in PET jars and stored under ambient conditions. The sensory quality of the product was found better when prepared from fruits treated with alum.

Spray drying of juice: Spray dried powder was prepared from aonla juice stored for 0, 15, 30, 45 and 60 days under ambient conditions. A slight decrease in the contents of ascorbic acid (390 to 318 mg 100g⁻¹) (Fig. 20) and polyphenols (4.17 to 4.07%) and an increase in non-enzymatic browning (NEB) (0.066-0.115 OD at 440 nm) were observed in stored juice. The ascorbic acid (Fig. 21) and polyphenol contents were

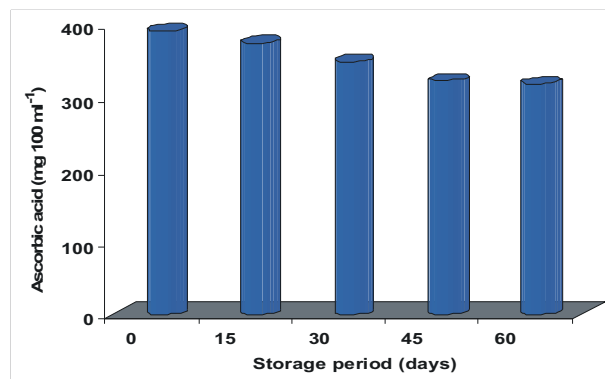


Fig. 20: Changes in ascorbic acid content of aonla juice during storage.

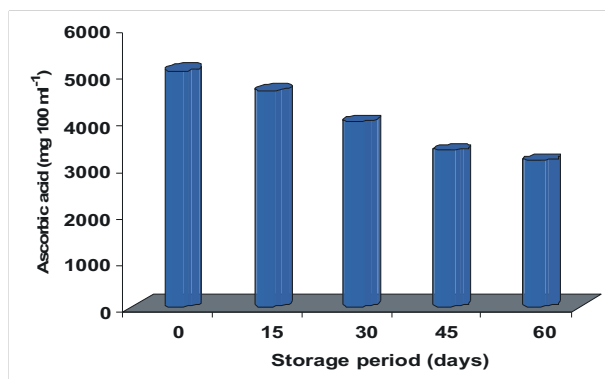


Fig. 21: Changes in ascorbic acid content of spray dried aonla powder prepared from stored juice.



5069 mg100g⁻¹ and 39.59 per cent in the powder prepared from fresh juice, which decreased to 3135.7 mg100g⁻¹ and 32.94 per cent, respectively, when prepared from 60 days stored juice. The browning in powder also increased from 0.036 to 0.061 OD when prepared from 60 days stored juice.

Heat resistance study of spoilage yeast: Heating temperature from 80-100° C resulted in four log reduction in microbial population of the yeast (*Saccharomyces cerevisiae*) isolated from spoiled juice. This budding yeast survived boiling at 100° C for 20 minutes. An increase in sugar concentration in the medium (1.0-5.0%) affected heat resistance, 10 times more population survived at 5.0 per cent as compared to 1.0 per cent sugar concentration. A further increase in heat resistance (about 20 times more population) was noticed following treatment with 5.0 per cent sugar and 2.0 per cent acidity.

Development of cider: Tannins concentration of 0.4 per cent was found optimum for aonla cider. Cider having 4 per cent alcohol was found organoleptically better as compared to aonla blended with guava (1:0.5 ; 1:1) and apple (1:1). Six phenolic compounds, *viz.* chlorogenic acid, caffeic acid, *p*- coumaric acid, catechin, epi-catechin and 4-hydroxybenzaldehyde, were detected in stored cider.

BAEL (*Aegle marmelos* Correa)

Mechanization

Design and fabrication of harvester: A lopper type bael harvester was designed and fabricated on the principal of holding and cutting of fruit (Fig. 22). Initial trials revealed that around 50 to 60 fruits could be harvested in one hour.



Fig. 22. Bael harvester

MAHUA (*Bassia latifolia* Roxb.)

Value addition

Development of wine and vermouth: A sugar acid ratio of 20° B and 0.5 per cent acidity was found optimum for preparation of mahua wine. Improvement in taste and aroma could be brought about by additives like lemon peel or cinnamon. Mahua vermouth was prepared by fortifying the young wine with traditional Indian herbs, *viz.* black pepper, cinnamon, clove, cumin, fenugreek, large cardamom, small cardamom, nutmeg, mace, aniseed and *tejpatta*. After one year of ageing, mahua vermouth had 6.4° B TSS; 0.57 per cent titratable acidity, 1.19 mg 100⁻¹ ml ascorbic acid, 0.11 per cent tannins, 0.27 per cent reducing sugars, 0.33 per cent total sugars and 8.0 per cent alcohol. The vermouth was found organoleptically better as compared to wine. Five phenolic compounds, *viz.* chlorogenic acid, caffeic acid, *p*-coumaric acid, catechin and 4 hydroxyben-zaldehyde, were detected in mahua wine and vermouth.



5. TECHNOLOGY ASSESSED AND TRANSFERRED

Impact Assessment of Institute Technologies

Leaf webber infestation was found severe in mango orchards. Surveyed through PRA, beneficiaries and non beneficiaries both found affected, while 63% beneficiaries used Institutes device and proper dose of chemicals for leaf webber controlling. However 21 per cent non beneficiaries also followed neighbour of beneficiaries.

The average yield of mango at the orchards beneficiaries for the demonstrations was 110.6 kg per tree with gross return of about Rs.1106/- against an average yield of mango 71.0 kg per tree and a gross return of Rs. 710/- at non-beneficiaries as per survey.

Only 19 per cent farmers followed our recommendations in the neighborhood of adopted orchards. The adopted farmers fully adopted our recommendations.

Approximately 76 per cent farmers adopted the polythene banding of mango trees for the control of Mealy Bug in Mohan area. They wrapped polythene sheet around the mango tree stem during December .

About 89 per cent farmers used self-made mango harvester for harvesting the fruits while only 11 per cent farmers used improved harvester developed by the CISH.

About 33% orchards are old and dense. For overcoming from this problem, rejuvenation technology evolved by this Institute is very vital. But this is not

being adopted by the orchardists mainly due to administrative clearance, lack of power chain saws inadequate support from the state department and financial constraints ,etc.

It is found that farmers did not use ethereal for the ripening of mango due to complexity

Extension Intervention for Technology Change

Gosthi: Institute organised a gosthi at village Bhatoya, Malihabad (Lucknow) on November 15, 2008 for providing the information pertaining to latest developments in cultivation technologies of mandate fruit crops in which about 400 farmers participated. The scientists of the institute delivered lectures on various aspects such as establishment of orchards, nursery management, rejuvenation of old/ unproductive mango orchards, high density planting, nutrient management, intergated insect, pests and disease management, organic farming and post-harvest management of fruit crops.

Besides, the Institute also participated in various gosthi organised by other agencies within and outside the state.

The Institute also participated in different State and National Level exhibitions and displayed the achievements and technologies on mandate crops as per details given below in the table.

Sl	Event/Occasion	Place	Organiser	Participants (No.)	Date
1.	Virat Kisan Mela evam Krishi Pradarshini	SIMA, Rehmankhhera, Lucknow	NAFED, New Delhi & Directorate of Agriculture, Govt. of U.P.	8000	May 8-12, 2008
2.	All India Litchi Show and Kisan Gosthi	NRC, Litchi, Mushehari, Muzaffarpur	NRC Litchi, Muzaffarpur	1000	June 8-11, 2008
3.	Rastriya Krishak Mela evam Pradarshini-2008	CISH, Rehmankhhera, Lucknow	CISH, Rehmankhhera, Lucknow	500	June 20, 2008
4.	Second Green Revolution Summit and Agro. Protech - 2008	Science City, Kolkata	Indian Chamber of Commerce & Govt. of West Bengal	4000	September 24-26, 2008
5.	Kisan Mela	KVK, Dhaura, Unnao	KVK, Dhaura, Unnao	5000	November 8, 2008
6.	National Farmers Fair and Vegetable Exhibition	IIVR, Varanasi	IIVR, Varanasi	5000	January 29-30, 2009
7.	Farmers Fair	KVK(IIVR), Sargatia, Kushinagar	IIVR, Varanasi	2000	March 01, 2009



Demonstrations, Growers-Scientists Interaction/Meet:

Rejuvenation technology of mango was demonstrated in unproductive mango orchard at Saidpur Mehari village, Kakori. Four interaction/grower-scientists meet were arranged during the visits in the mango and guava growing belts of Lucknow, Barabanki and Unnao districts (U.P.).

Exposure visit: About 2340 farmers and 61 students from across the country visited the Institute. They were taken around the experimental farms and different laboratories and technical information centres of the Institute to acquaint them about the technologies developed and on-going research activities.

Counseling: Thirteen farmers and extension functionaries visited the Institute from different. They were apprised of the advanced scientific cultivation technologies of different subtropical fruit crops and their queries were responded.

Farmer's Helpline and Postal Queries: Growers' queries related to different aspects of subtropical fruits were attended through correspondence. Farmers' queries (107 calls) attended and provided with solutions through Kisan Call Centre. The queries of the farmers were primarily pertaining to nursery, insect pests and diseases management in mango. Extension folders and bulletins related to scientific cultivation of mango,

aonla, guava, bael and papaya were provided to the farmers.

Trainings: Fourteen training programmes sponsored by NHB Gurgaon, Horticulture Technology Mission of U.P. and Uttarakhand, Federation and Samaritan Social Service Society, Madhya Pradesh on production, protection and post harvest technology of fruits, were organized by the Institute and 325 farmers from Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Uttarakhand, Tamil Nadu, Orissa and Pondicherry were trained. Thirty-five officials, sponsored by IFFCO Foundation, New Delhi, from all over the country were trained on establishment of scientific nursery/ programme.

A three-day training programme sponsored by Directorate of Extension & Training, Ministry of Agriculture and Cooperation, Government of India, New Delhi on Rejuvenation and Canopy Management of mango, guava and aonla was organised at the Institute for fourteen development workers from all over the country.

An international training (4 days), sponsored by Afro-Asian Rural Development Organisation, on 'Care of mango' tree was organised at the Institute for scientists from Sultanate of Oman.



6. EDUCATION AND TRAINING

Training

India

Dr. R.P. Shukla, Principal Scientist and Incharge, RCMU was deputed to attend Management Development Programme of PME for Agricultural Research held at IIM, Lucknow, July 7-11, 2008.

Dr. S. Rajan, Pr. Scientist was deputed to attend Management Development Programme on Data mining and GIS for decision support in agriculture at IIM, Lucknow August 25 - September 5, 2008.

Dr. (Mrs.) Anju Bajpai, Scientist (Sr. Scale) was deputed to attend training on Molecular methodologies for assessing and applying genetic diversity in crop breeding at ICRISAT, Hyderabad, November 17 - 28, 2008.

Dr. Tarun Adak, Scientist attended a winter school on Recent advances in diagnostic technologies and management of poor quality water/soils at CSSRI, Karnal, November 18 - December 8, 2008.

Drs. R.M.Khan, A.K.Singh, D. Pandey, Ram Kumar and S.K.Shukla, Principal Scientists were deputed to attend ICAR Training-cum-workshop on IP and technology management held at NBFGR, Lucknow, December 18 - 20, 2008.

Shri Vikram Singh, Scientist was deputed to attend training on *In vitro* techniques in plantation crops held at CPCRI, Kasargod, Kerala, January 15 -24, 2009.

Dr. S.R.Bharguvanshi, Head, Division of Crop Production attended management development programme on Leadership for innovation in agriculture held at NAARM, Hyderabad, January 19 - 23, 2009.

Shri M. Muthukumar, Scientist was deputed to attend Summer School on Application of RAPD and AFLP markers in horticultural crops held at University of Agricultural Sciences, GKVK, Bangalore, February 17- March 9, 2009.

Dr. Ram Kumar, Principal Scientist was deputed to attend management development programme on IPR : Protection of plant varieties - procedures and methodologies held at NAARM, Hyderabad, February 23 - 26, 2009.

Shri S.K. Saxena, T7-8 (Library) was deputed to attend Krishi Prabha : Indian Agricultural

Doctoral Dissertations Repository-cum-training at Nehru Library, CCSHAU, Hisar, February 24-25, 2009

Abroad

Dr. Gorakh Singh, Principal Scientist was deputed for Agribusiness Programme Module-I at Goa(May 25-30, 2008) and for Module-II at Ithaca, New York (June 18-26, 2008) under the aegies of Cornell University, New York, USA and Sathguru Management Consultants, India.

Lectures Organized

Under lecture series programme following scientists/experts delivered lectures on emerging scientific areas:

Dr. (Mrs.) Anju Bajpai, Scientist (SS) –“Molecular techniques for assessing genetic diversity in fruit crops” April 30, 2008.

Mr. B.K. Singh, Regional Manager (North) of Labindia Instruments Pvt. Ltd., Lucknow – ‘Application and Technology of LCMS/MS’ May 6, 2008.

Dr. Achal Singh, Scientist (SS) – “Roles of statistical analysis in agricultural research” May 15, 2008.

Dr. A.K. Singh, Principal Scientist – “Neutraceutical value of underutilized fruits” May 30, 2008.

Dr. A.K. Singh, Sr. Scientist –“Mushroom production in India – an overview” August 30, 2008.

Er. Anil Kumar Verma, Scientist (SG) – “Tools and equipments for Horticulture” September 15, 2008.

Shri Atul Singha, Scientist –“Bioremediation : a credible technology” October 30, 2008.

Dr. B. Lal, Principal Scientist –“High density orcharding in mango” December 30, 2008.

Shri Prem Narain, Registrar General, Protection of Plant Varieties & Farmers’ Rights Authority – DUS guidelines for mango February 21, 2009.

Dr. B.P. Singh, Emeritus Scientist –“Maturity indices and harvesting methods in relation to shelf-life of fruits” March 31, 2009.

Dr. A.K. Misra, PC (STF) –“Variability in guava pathogen and their distribution” February 28, 2009 on the occasion of National Science Day.



7. AWARDS AND RECOGNITIONS

AWARDS

Dr. J C Anand Gold Medal

Dr. D.K. Tandon, Principal Scientist received the prestigious Dr. J. C. Anand Gold Medal for his contributions in the field of Post-harvest Technology of Horticultural Crops for the year 2008. The award was presented to him at the Inaugural Session of the 3rd Indian Horticulture Congress – 2008 held at Orissa University of Agriculture and Technology, Bhubneswar.

Amrood Pandit Award

Dr. Gorakh Singh, Principal Scientist was bestowed with the prestigious Amrood Pandit Award by Hon'ble Union Minister for Agriculture, Shri Sharad Pawar at the National Guava Symposium held at Shridi, Maharashtra. The award was conferred on him for his outstanding contributions in the sphere of guava.



Dr. Gorakh Singh receiving Amrood Pandit Award from Hon'ble Union Minister for Agriculture, Shri Sharad Pawar Ji

Rajbhasha Patrika Award

Udyan Rashmi, the Rajbhasha Patrika of the Institute, was given the second prize by the Nagar Rajbhasha Karyanvayan Samiti, Lucknow at its 60th half yearly meeting held at Central Drug Research Institute, Lucknow.



Dr. B.M.C. Reddy, Director (in the middle), Dr. D.K. Tandon (left) and Shri Dhiraj Sharma along with the shield

Best Paper Award

Dr. Ramesh Chandra and Dr. Maneesh Mishra were awarded judged best poster entitled, 'Studies on genetic transformation of guava (*Psidium guajava* L.)' Third Indian Horticulture Congress – 2008 held at Orissa University of Agriculture and Technology, Bhubaneswar, November 6 to 8, 2008.

Dr. Neelima Garg was awarded 2nd prize for the poster entitled, 'Production and characterization of extracellular cellulases from a cellulolytic *Bacillus* sp using mango peel as substrate' presented at National Conference on Eco-friendly Approaches in Sustainable Agriculture and Horticulture Production held at Amity University, Lucknow, November 28 to 30, 2008.

Fellowship

Dr. Ramesh Chandra, Head, Crop Improvement Division was conferred Fellowship of Horticulture Society of India (HSI).



Dr. V. K. Singh, Principal Scientist was conferred Fellow of Indian Society of Plant Physiology (ISPP).

RECOGNITIONS

Member Editorial Board/Executive Committee of Journals/Society

Dr. D. K. Tandon was nominated as an Executive Councillor (2009-2011), HSI, New Delhi.

Dr. D. K. Tandon was nominated as Member, Editorial Board (2008-2010), Indian Journal of Horticulture, HSI, New Delhi.

Seminars/Symposia/Meetings

Dr. Ram Kishun acted as Chairman of the Technical Session-VI of the 18th AICRP Workshop held at Institute's Rehmankhara Campus from June 29 to July 2, 2008.

Dr. B.M.C. Reddy acted as a Co-chairman of the Plenary Session of the 18th AICRP Workshop held at Institute's Rehmankhara Campus from June 29 to July 2, 2008.

Drs. R. P. Shukla, A. K. Mishra, Ghanshyam Pandey, S. Rajan, V. K. Singh, Devendra Pandey, A. K. Singh and S. K. Shukla acted as a Rapporteur of the different Sessions of the 18th AICRP Workshop held at Institute's Rehmankhara Campus from June 29 to July 2, 2008.



8. LINKAGES AND COLLABORATION

Linkages were developed with Sultanate of Oman and other organizations including APEDA, ICAR-APCESS, DBT, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India, NHB, New Delhi, NMPB, UPCAR, UPCST, Directorate of Horticulture and Food Processing, U.P., ICAR Institutes (Networking Mode Project), SAUs

(Pantnagar, Faizabad & Kanpur), Lucknow University, Allahabad Agricultural Institute (Deemed University), APS University, Rewa, BBAU, Lucknow, Bundelkhand University, Jhansi, A total and Kali and Salz, New Delhi (Indo-German Programme). The externally funded projects in operation at the Institute are listed below :

Sl. No.	Title of project	Funding agencies
1	Clonal multiplication of interspecific wilt resistant rootstock (<i>P. molle</i> x <i>P. guajava</i> L.) for grafting guava cultivars.	ICAR-APCESS
2	Multiplication and sale of commercial and elite clones of mango, guava, aonla and bael.	Revolving fund scheme
3	National integrated fruit fly surveillance programme.	APEDA
4	Characterization and assessment of genetic diversity in mango cultivars using DNA markers: Sequence Tagged Microsatellite Site (STMS) and Random Amplified Polymorphic DNA (RAPD).	DBT
5	Development of genetic resource database and information system for mango.	DBT
6	Studies on use of potassium for improving yield and fruit quality of mango grown in Uttar Pradesh.	Indo-German Programme of Kali and Salz
7	Hi-tech horticulture for efficient utilization of resource through precision farming.	DAC, NCPAH, Ministry of Agriculture, GOI
8	Network project on wilt of crops with special reference to cultural, morphological, molecular characterization and pathogenic variability of isolates.	ICAR
9	Nutritional and physiological disorders in mango.	ICAR
10	National network project on underutilized fruits.	ICAR
11	Seed production in agricultural crops and fisheries.	ICAR
12	Network project on transgenics in crops (papaya).	ICAR
13	Mass sex screening of papaya for improved production.	UPCST
14	Organic/biodynamic cultivation of horticultural crops in N.E. Region including Sikkim.	Technology Mission, GOI
15	Physiological and nutritional studies associated with the softening of tissues around stone in Dashehari mango and develop control measures.	UPCAR
16	Survey, collection, evaluation and conservation of germplasm of underutilized fruits.	UPCAR
17	Establishment of leaf/ tissue analysis laboratory.	UPCAR
18	Establishment of model nursery for fast multiplication of elite clones and new varieties of mango, guava, aonla and bael.	UPCAR
19	Establishment of bio-control laboratory and production of bio-agents.	UPCAR
20	Management studies for irregular bearing in mango.	UPCAR
21	Application of microorganisms in agriculture and allied sectors	AMAAS, Mau
22	Intensification of research on bael (<i>Aegle marmalos</i> Corr.) with reference to medicinal value.	National Medicinal Plants Board
23	Anti-diabetic activity guided fractionation and associated attributes in potential germplasm of jamun (<i>Syzygium cumini</i> Skeels).	National Medicinal Plants Board
24	Mango Tree Encyclopedia Project.	Sultanate of Oman



9. AICRP (STF) / COORDINATION UNIT

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 governmental 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, Mandsoor (M.P.), 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.

Genetic stocks of mango, guava and litchi were collected, evaluated and maintained at nine regular and three voluntary centres for selection of potential cultivars/varieties for different regions and for using them for further crop improvement and production programmes. Cataloguing of genetic stocks of different subtropical fruits was done using various descriptors. A total number of 58 trials, divided into 6 sections related to crop improvement, crop production and crop protection aspects of mango, guava and litchi, were conducted. Besides, work is also in progress in four ad hoc schemes under AICRP (STF) programme.

CROP IMPROVEMENT

MANGO (*Mangifera indica* L.)

Germplasm collection and evaluation

Collection: Out of 78 seedling germplasm of mango collected during the period, 31 at BAC Sabour, 14 at RFRS, Vengurle, 3 at BCKV, Mohanpur, 5 at FRS, Rewa, 8 at IARI, New Delhi, 7 at FRS, Sangareddy and 10 at HC&RI, Periyakulam, respectively, were added. Additionally, out of 15 superior clones of leading varieties of different regions, two of 'Banganpalli' at FRS, Sangareddy, one of 'Langra' at BAC, Sabour, one of 'Alphonso' at AES, Paria, two of 'Dashehari' at GBPUA&T, Pantnagar, three of 'Chausa' at FRS, Rewa and two each of 'Himsagar' and 'Alphonso' at BCKV, Mohanpur and RFRS, Vengurle were also collected.

Three variants comprising of one each in 'Neelam', 'Kalepad' and 'Salem Bangalora' were also identified at HC&RI, Periyakulam.

Evaluation: Out of 273 germplasm accessions, 31 at BAC, Sabour, 28 at GBPUA&T, Pantnagar, 4 at AES, Paria, 12 at FRS, Sangareddy, 64 at RFRS, Vengurle, 20 at IARI, Bangalore, 88 at FRS, Rewa and 15 at IARI, New Delhi were evaluated. Yield of cultivar 'Bangalora' was maximum (115.80 kg tree⁻¹) followed by 'Dholikothi Maldah' (110.20 kg tree⁻¹) at BAC, Sabour. However, maximum fruit yield was recorded in cv. Mallika (70.50 kg tree⁻¹) followed by 'Zafrani Gola' (66.75 kg tree⁻¹), while yield efficiency was maximum in 'Banarsi Betali' (1.24 kg/m³) followed by 'Amrapali' (1.14 kg/m³) at GBPUA&T, Pantnagar. Yield of 'Suvarnarekha' was maximum (75.00 kg tree⁻¹) at RFRS, Vengurle.

Clonal selections, 'Pedda Baneshan' and 'Allahabad Baneshan', were promising with respect to bigger fruit size at FRS, Sangareddy. However, clones of 'Himsagar' (T 22 & T 23) were found promising in respect of yield (83.33 and 86.83 kg tree⁻¹) and good quality at BCKV, Mohanpur. 'Chausa' clone No.2 was found promising in terms of yield (65.67 kg tree⁻¹) at FRS, Rewa.

Mango 'Mallika' gave higher yield at majority of the centres, while 'Mallika' and 'Langra' were good yielders at BAC, Sabour. On the other hand, 'Bangalora', 'Mallika', 'Langra' and 'Baneshan' were promising at FRS, Rewa.

Evaluation of hybrids

Hybrid-311 ('Alphonso' x 'Neelam') having good yield and quality was free from spongy tissue at RFRS, Vengurle. Five hybrids, viz. H-1-1 ('Amrapali' x 'Lal Sundari'), H-1-6 ('Amrapali' x 'Sensation') and H-2-6 ('Amrapali' x 'Sensation'), H-4-12 ('Dashehari' x 'Sensation') and H-8-11 ('Amrapali' x 'Sensation'), were promising owing to dwarf stature, less incidence of floral malformation and red peel colour. Mango hybrids, viz. 'Neeleshan', 'Mallika' and 'Mehmood Bahar', 'Neeleshan' and 'Mallika' and 'Amrapali' and 'Mallika' provided maximum yield along with good quality fruits, at FRS, Sangareddy, BAC, Sabour, AES, Paria and FRS, Rewa, respectively.



GUAVA (*Psidium guajava* L.)

Germplasm collection and evaluation

Five accessions each were collected at FRS, Sangareddy and FRS, Rewa. Maximum yield was recorded in 'Sardar' (77.73 kg tree⁻¹) followed by 'Pant Prabhat' (72.77 kg tree⁻¹) at GBPUA&T, Pantnagar. Cultivar 'Guthneewala', 'Safeda' (J-2), 'Surkhee', 'Chittaeneptune' and 'Portugal' gave higher yield at FRS, Rewa. The performance of 'Kohir Safeda' was better in terms of yield and fruit quality at FRS, Sangareddy followed by 'Allahabad Safeda', while cultivars 'Sardar', 'MPUA' & 'T-S-2' and 'MPUA' & 'T-S-1' performed better in terms of yield and quality at RCA, Udaipur and 'Allahabad Safeda' and 'Safed Jam' at BAC, Sabour.

Six progenies were identified at IIHR, Bangalore from cross combination of 'Kamsari' x 'Purple guava' having dark pink (4) and pink (2) flesh.

LITCHI (*Litchi chinensis* Sonn)

Germplasm collection and evaluation

Two clones of Bombai were collected at BCKV, Mohanpur. Evaluation of germplasm revealed that 'Rose Scented' (50.78kg tree⁻¹) out yielded other cultivars at GBPUA&T, Pantnagar, while 'Bombai' (48.71kg tree⁻¹) and 'Muzaffarpur' (46.88kg tree⁻¹) yielded better at BCKV, Mohanpur.

CROP PRODUCTION

MANGO (*Mangifera indica* L)

Evaluation of rootstocks

Rootstock 'Latra' imparted maximum dwarfness to 'Bombai' scion, whereas maximum fruit yield was recorded on rootstock 'Puttu' (50.41 kg tree⁻¹) followed by 'Mylepellian' (48.00 kg tree⁻¹) at BAC, Sabour. The maximum cumulative yield (101.28kg tree⁻¹) was recorded in 'Banganpalli' when grafted on 'Nekkare' rootstock at FRS, Sangareddy, while rootstock 'Olour' and 'Kurukkan' imparted least yield on scion 'Langra' at FRS, Rewa.

Planting system-cum-high density planting

Double hedgerow system of planting produced significantly higher yield in 'Amrapali' (943.88 kg

plot⁻¹) at BAC, Sabour and (291.5 kg plot⁻¹) at FRS, Rewa, 'Neelam' at HC&RI, Periyakulam and 'Kalepad' (212.18 kg plot⁻¹) at Killikulam. On the other hand, square system of planting gave maximum yield in 'Dashehari' (33.68 kg tree⁻¹) at GBPUA&T, Pantnagar.

Pruning

Maximum fruit yield was recorded in the trees pruned at alternate limbs after harvest followed by paclobutrazol application (10 g a.i. tree⁻¹) at most of the centres. However, thinning of crowded branches after fruit harvest along with paclobutrazol application gave maximum yield at BCKV, Mohanpur. Heading back of branches at 50cm level on alternate limbs without application of paclobutrazol gave maximum yield (6.380 kg tree⁻¹) at RFRS, Vengrulu, while heading back of branchlet on the entire tree at 50cm level resulted in maximum yield (37.683kg tree⁻¹) at AES, Paria.

Rejuvenation

Heading back of crowded branches along with centre opening coupled with the application of paclobutrazol (10g a.i. tree⁻¹) during rest period resulted in maximum fruit yield of 49.06, 38.67, 85.50 and 62.90 kg tree⁻¹, at FRS, Sangareddy, AES, Paria, GBPUA&T, Pantnagar and FRS, Rewa, respectively.

Integrated plant nutrient management

Cultivar 'Himsagar' gave maximum fruit yield (12.9kg tree⁻¹), fruit weight (215.7g) and fruit length (9.22cm) following application of NPK (100g each) tree⁻¹ year⁻¹ along with foliar spray of Zn (0.2%), B (0.2%) and Mn (0.1%) at BCKV, Mohanpur, whereas 'Langra' produced maximum yield (101.01kg tree⁻¹) with the application of 200g N, 100g P₂O₅ and 100g K₂O tree⁻¹ year⁻¹ at FRS, Rewa. On the other hand, maximum fruit yield (3.97kg tree⁻¹) and fruits (8.67 tree⁻¹) were recorded in five years old plantation of 'Banganpalli' at FRS, Sangareddy following the application of recommended dose of NPK fertilizers (200, 100 and 100g tree⁻¹, respectively).

Effect of bio-regulator

Pre harvest application of KH₂PO₄ (1%)+ KNO₃ (1%) before bud break stage produced more number of panicles per square meter area and total yield (51.59 kg tree⁻¹) along with good quality fruits in 'Banganpalli' at FRS, Sangareddy.



GUAVA (*Psidium guajava* L)

Effect of fertilizers

Maximum fruit yield (47.17 kg tree⁻¹) was recorded in 'Pant Prabhat' at GBPUA&T, Pantnagar following treatment with the half recommended dose of fertilizers along with 25 kg FYM and 5 kg vermicompost. However, application of 500:200:500g NPK tree⁻¹ along with spray of Zn (0.5%) + B (0.2%) + Mn (1%) twice during the months of August and October gave maximum yield (73.74kg tree⁻¹) in 'Sardar' at FRS, Sangareddy, whereas application of 200:100:250g NPK along with 10 kg FYM enriched *Trichoderma* gave maximum yield (25.28kg tree⁻¹) in 'Sardar' at RCA, Udaipur.

LITCHI (*Litchi chinensis* Sonn)

Planting system-cum-high density

Double hedgerow system of planting resulted in higher yields at RAU, Pusa, GBPUA&T, Pantnagar and BCKV, Mohanpur. Modified central leader system gave maximum yield (121.37kg tree⁻¹) at RAU, Pusa.

Harvesting

Fruit harvesting with 50cm long branches followed by removal of new flushes during November-December at RAU, Pusa effected maximum yield in 'Shahi'. Conversely, maximum yield in 'Bombai' (1134.77kg tree⁻¹) could be obtained following harvesting along with 50 cm long branches only at BCKV, Mohanpur.

Substrate dynamics

Irrigation and sprinkling of water significantly reduced fruit cracking in 'Shahi' and 'Rose Scented' at RAU, Pusa and GBPUA&T, Pantnagar. Similarly, maximum fruit yield (70.49kg tree⁻¹) was obtained in 'Shahi' with the application of half of the recommended dose of fertilizers along with 50kg FYM and 5 kg vermin-compost at RAU, Pusa.

Diagnostic surveys conducted in litchi orchards of Murshidabad revealed maximum yield ('Bombai') in the orchard having soil N (179.44kg ha⁻¹), P₂O₅ (123.15kg ha⁻¹) and K₂O (299.44kg ha⁻¹) and leaf N (1.78%), P (0.34%) and K (0.92%).

Girdling of (50%) of primary branches with 1mm diameter to a 1mm depth of ring resulted in significant

increase in the yield and fruit quality of 'Rose Scented' at GBPUA&T, Pantnagar. Application of 4 foliar sprays of KNO₃ (10g l⁻¹) from September to December significantly increased the fruit size, fruit weight and total yield at GBPUA&T, Pantnagar.

CROP PROTECTION

MANGO (*Mangifera indica* L.)

INSECT PESTS

Surveillance: Hopper population was relatively high during the second fortnight of January-February, February- April, April, II fortnight of January to I fortnight of March-April and October-March, respectively, at FRS, Sangareddy, BAC, Sabour, GBPUA&T, Pantnagar, AES, Paria, BCKV, Mohanpur and RFRS, Vengurle.

Peak incidence of fruit fly was noticed in cv. Banganpalli during May, June-July, I fortnight of June to II fortnight of July, respectively, at FRS Sangareddy, BAC, Sabour and GBPUA&T, Pantnagar, RFRS, Vengurle and BCKVV, Mohanpur. Methyleugenol trap (4 acre⁻¹) were effective in monitoring the fruit fly population.

IPM : Spray of Imidacloprid (0.05%) at panicle emergence followed by two sprays of Endosulfan (0.07%) after 21 days of first and 15 days of second spray were most effective in managing the hopper population and avoidable crop loss at FRS, Sangareddy, BAC, Sabour, BCKV, Mohanpur and RFRS, Vengurle.

Out of different IPM modules tested for management of hopper on the commercial cultivars in different regions Module I (Imidacloprid-Azadirachtin-Endosulfan) was better at AES, Paria, GBPUA&T, Pantnagar and RFRS, Vengurle, while Module II (Thiamethoxam-Azadirachtin-Ethofenprox) was superior at FRS, Sangareddy, BAC, Sabour and BCKV, Mohanpur.

DISEASES

Germplasm evaluation : About 301 accessions including standard varieties, hybrids and seedling/clones were screened against floral malformation of mango at FRS, Sangareddy (73), AES, Paria (29), RFRS, Vengurle (78), BAC, Sabour (46) and BCKV, Mohanpur(75). Cultivar Meghlantan was found free from malformation at BCKV, Mohanpur.



Epidemiology: The appearance of powdery mildew was noticed during the 2nd week of January to 3rd week of February at FRS, Sangareddy on inflorescence and fruitlets of 'Dashehari' and 'Baneshan'. The mean minimum temperature (11-15° C), maximum temperature (28-30° C) and low relative humidity (42-50%) was prevalent during the period. On the other hand, its maximum incidence was recorded in the 3rd week of March on 'Alphonso' and 'Himsagar' at RFRS, Vengurle and BCKV, Mohanpur.

Management: Chlorothalonil (0.2%), Thiophenate methyl (0.1%), Saaf (0.2%) and carbendazim (0.1%) sprays significantly reduced anthracnose at FRS, Sangareddy, RFRS, Vengurle, BCKV, Mohanpur and BAC, Sabour, respectively. Similarly, application of Thiophenate methyl (0.1%) and Saaf (0.2%) reduced the incidence of mango blossom blight (composite infection of anthracnose and *Alternaria*) at RFRS, Vengurle, BAC, Sabour and BCKV, Mohanpur.

GUAVA (*Psidium guajava* L.)

DISEASES

Survey and surveillance: Fruit spot, anthracnose, *Phytophthora* fruit rot and canker were found important at BCKV, Mohanpur during rainy season while incidence of wilt and dieback were more pronounced in post-monsoon season.

Management: Soil application of bioagent *Trichoderma viride* was found effective in controlling guava wilt at BCKV, Mohanpur.

LITCHI (*Litchi chinensis* Sonn.)

INSECT PESTS

Survey and surveillance: Inflorescence webber, leaf roller, fruit borer and litchi bug were the key pests at GBPUA&T, Pantnagar. Though inflorescence webber caused mild damage but litchi bug infestation was higher (>50%) in young trees as compared to old ones. Litchi mite was the major pest prevalent in litchi growing areas of Bihar and higher infestation was recorded during May. Similarly, fruit borer and litchi leaf roller also caused considerable damage. Incidence of leaf roller was low up to June and increased gradually during July and peaked in October-November at BCKV, Mohanpur. Three species of fruit borer, viz. *Conogethes punctiferalis*, *Platyepela* sp. and *Conopomorpha cramerella*, caused serious damage to crop throughout the year (except December-March). Infestation of *C. cramerella* during the colour break stage affected the fruit quality.

Management: Two sprays of Endosulfon (0.07%), 1st at peanut and 2nd at colour break stage, were effective at GBPUA&T, Pantnagar and BCKV, Mohanpur, while spray of Carbaryl (0.1%) was the best at RAU, Pusa.



10. LIST OF PUBLICATIONS

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11. LIST OF APPROVED ONGOING PROJECTS

1.0 THEME : MANAGEMENT OF GENETIC RESOURCES

Programme

- 1.1 Collection, evaluation, characterization, conservation and documentation of germ-plasm of subtropical fruits

Programme Leader : B.M.C. Reddy

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 : B. Lal

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 : B. Lal

- 2.2.4 Planting density and canopy management in guava, aonla and bael

Project Leader : Dr. Gorakh Singh

- 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

- 2.2.7 Bio-ecology and management of insect pollinators of mango

Project Leader : S. Sharma

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. Bhriuvanshi

Projects

- 4.1.1 Integrated water management for increasing water use efficiency in mango

Project Leader: S.R. Bhriuvanshi

- 4.1.2 Nutrient management in mango

Project Leader: S.R. Bhriuvanshi

- 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

- 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 Epidemiology, ecology and management of mango bacterial canker disease (MBCD)

Project Leader: A.K. Singh

- 6.2.3 Management of post-harvest diseases of mango

Project Leader: B.K. Pandey



6.2.5 Epidemiology, ecology and management of diseases of underutilized fruits

Project Leader : B.K.Pandey

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

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

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

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

1. Dr. D. K. Tandon, Principal Scientist and Shri Abhay Dixit, T.O. provided consultancy sponsored by Micro, Small and Medium Enterprises (GoI), Allahabad on aonla processing to farmers and entrepreneurs of Pratapgarh (May 5-6, 2008).
2. Dr. Ramesh Chandra, Head, Division of Crop Improvement and Dr. Manish Mishra, Senior Scientist provided consultancy on establishment of plant tissue culture laboratory for fruit crops to U. P. Bio Energy, Lucknow for establishment of plant tissue culture laboratory and development of tissue culture protocol of fruit crops (May 14, 2008).
3. Dr. D. K. Tandon, Principal Scientist and Shri D. K. Shukla, T.O. provided consultancy to Abdullah Fresh Fruit Pvt. Ltd., Lucknow on uniform ripening of mango using ethrel, for export to Malaysia on (June 11, 2008).
4. Dr. R. P. Shukla, Principal Scientist and Dr. A. K. Singh, Senior Scientist provided consultancy to Bharat Petroleum Corporation Limited, Mumbai for testing of bioefficacy of minimal oil "MAK ALL SEASON HMO" against mealy bug and sooty mould of mango (February 10, 2009).
5. Dr. Gorakh Singh, Principal Scientist provided consultancy to IFFCO Foundation, New Delhi on establishment of mother block, pruning operation and propagation techniques for nursery management (September, 2009).
6. Dr. B. M. C. Reddy, Director, Er. M. D. Singh, Principal Scientist, Dr. D. K. Tandon, Principal Scientist, Dr. Ajay Verma, Principal Scientist, Dr. A. K. Bhattacharjee, Senior Scientist, Er. Anil Kumar Verma, Scientist (SG) and Sri Ramendra Tiwari, T.O. provided consultancy to Technology Information, Forecasting and Assessment Council (TIFAC), Govt. of India, New Delhi on technology gap analysis study for food processing industry cluster of Malda (July 2008).

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

Research Advisory Committee (RAC)

The 13th meeting of the Research Advisory Committee of the Institute was held under the Chairmanship of Dr. D.S. Rathore, Ex-Vice Chancellor, C.S.K. Himachal Pradesh Krishi Vishwavidyalaya, Palampur at CISH, Rehmankhera, Lucknow during June 18-19, 2008. The following members attended the meeting:

1.	Dr. K.K. Jindal	Member
2.	Dr. Gajendra Singh	Member
3.	Dr. R.D. Rawal	Member
4.	Dr. A.K. Bakshi	Member
5.	Dr. K.R. Kaundal	Member
6.	Dr. S.N. Pandey	Member
7.	Dr. B.M.C. Reddy	Member
8.	Dr. R.P. Shukla	Member Secretary

Significant Decisions

Core collections of the genetic resources of mango and guava should be identified.

Research interventions should be intensified in

mango, viz. 'Dashehari', 'Langra' and Chausa by screening and using superior clones to increase productivity of commercial varieties.

The major thrust should be given on medium density plantation of mango, guava and other important fruit crops of the Institute with proper pruning and fertigation schedule through experimentation with selected cultivars.

There is a need to survey and evaluate dwarfing rootstocks available indigenously. Polyembryonic and dwarfing species from East, especially Indo-Burma border, should be surveyed extensively. Simultaneously, exotic dwarfing rootstocks from the mango and guava growing countries of the world may be procured in stages through NBPGR.

Transgenic research on papaya and guava should be strengthened to deliver the product at the earliest. Efforts should also continue for mango transformation using different strategies.

Study on molecular markers should be directed to identify the suitable markers for variety identification of mango and crop improvement breeding by associate mapping.

Good work done on surveillance and prediction models of fruit fly and hopper should be continued leading to their refinement and testing based on the field data.

Strengthening of production and use of bioagents against fruit fly, scale insects and mealy bug.

Bio-intensive management of nematode pests of subtropical fruits to be continued.

It is important to compare observed values with the predicted values for validation of epidemiological experiments. For more



Dr. D.S. Rathore, Chairman RAC along with other members of the committee



refinement of prediction models, the weather factors like sunshine, number of rainy days, evaporation and vapour days may be included. The method should be worked out to reduce the residues in the end product. In case of mango residue studies, analyse the pesticide residues separately in pulp and peel.

The Institute should collaborate with IIHR, Bangalore for molecular diagnosis of pathogens.

A compendium of all post-harvest research work and protocols developed should be prepared.

Scientists should interact closely with industries and exporters so that need based research work could be undertaken.

Institute should strengthen itself with latest facilities and work as an incubator unit to integrate production into value chain and provide a platform for further expansion of rural and processing industries and exporters.

Emphasis should be given to transfer of technologies to fields for enhancing the farmer's income with complete cost benefit ratio.

Feed back information from farmers needs to be given to scientists for further improvement and refinement of technologies for their larger adoption by the farmers.

Institute Management Committee (IMC)

The twentieth and twenty first meetings of IMC of the Institute were held on May 21, 2008 and March 4, 2009 under the Chairmanship of Dr. B.M.C. Reddy, Director, CISH, Lucknow.

Twentieth IMC

1	Dr. S N Pandey	Member
2	Dr. A. K. Singh	Member
3	Er. M. D. Singh	Member
4	Dr. A. K. Misra	Member
5	Dr. Gorakh Singh	Member
6	Shri P. R. Sharna	Member
7	Shri B. P. Ram	Member
8	Shri Ashish Rastogi	Member Secretary

Significant Decisions

The committee members were informed that a

scientist each in the disciplines of Biotechnology and Soil Microbiology has joined. Committee suggested to pursue with the Council for filling up of the remaining vacant posts of the scientists.

The Committee was informed that the approval of the recommendations of QRT for the Institute as well as of AICRP (STF) have been received and are being implemented.

The Committee noted with satisfaction that all the approved equipments have been purchased.

The Committee suggested that concerted efforts should be made to settle the advances paid to CPWD and other government agencies.

The Committee recommended CGHS approved hospitals (3) and diagnostic centers (3) for the treatment and testing of samples for the Institute employees.

Institute Research Committee (IRC)

The twenty fourth and twenty fifth Institute Research Committee meetings were held from July 14 to 16 and 21-23, 2008 and March 16-17, 2009 under the Chairmanship of Dr. B.M.C. Reddy, Director to review the progress made in ongoing research projects and approval of technical programmes for the next year.

Significant decisions (24th IRC)

Elite germplasm / clones having special attributes should only be selected.

Germplasm of mango should be collected from hot spots and IC Number should be obtained from NBPGR.

Some of the hybrid lines from IIHR, Bangalore should be procured for evaluation under Lucknow conditions.

Both rainy and winter seasons data on guava should be recorded.

Varietal trial on aonla and banana should be dropped and only AICRP trial on grape should be conducted.

Mass rearing of efficient pollinators should be done.

Guava pruner should be fabricated.

Bael harvester should be refined.

Aonla harvester should be developed.

Performance of Air Power Carrier sprayer should be evaluated with conventional sprayers in



Dr. B.M.C. Reddy, Director, CISH Chairing the Institute Research Committee meeting

respect of pest / disease control, fruit set and yield.

Uniform material should be used for experimentation in organic farming experiments.

Residue analysis of imidacloprid, thiamethoxam and propanofos should be done on mango.

Efforts should be made to produce pest free guava crop during rainy season.

Studies should be conducted on compatibility of fungicides and insecticides.

Shelf-life of guava cvs 'Shweta' and 'Lalit' should be studied.

APEDA and NHM may be approached for creating CA storage facilities.

Studies should be conducted on effect of precooling on shelf life of mango.

Foldable boxes should be developed for packaging of mango and guava.

Cost of production of cider should be worked out.

Cost benefit ratio of intercropping should be mentioned.

Studies should be conducted on varietal availability of mango in different states from South to North.

Questionnaire of PRA should be finalized.

Significant Decisions (25th IRC)

Collection of polyembryonic varieties of mango should be intensified.

Polytunnel should be utilized to protect the

September planted papaya plants from winter.

Papaya varieties with red pulp should be developed.

Statistical analysis of data should be done in all experiments.

Aonla pricking machine developed by CIAE, Bhopal should be evaluated.

Residues of chlorpyrifos, carbosulfan and acephate should be analysed in mango.

Management trials should be conducted for control of fruit borer of guava at appropriate fields situation.

Before commissioning the pilot plant of aonla and guava ciders, feasibility studies should be conducted.

Detrimental effect, if any, of intercropping in mango with paddy should be worked out.

Intercropping pattern of some farmers for different years should be studied.

Growth patterns in international production and trade in mango and guava should be studied.

Constraints in export of mango should be studied.

Varietal preference and season of various varieties of mango of different countries should be studied.

Internationally traded varieties of mango should be reported.

Impact studies of trainings organized under PFDC should be taken up.



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

Conferences

- Dr. Neelima Garg attended the National Conference on Eco- friendly Approaches in Sustainable Agriculture and Horticulture Production held at Amity University, Lucknow, November 28 to 30, 2008.
- Dr. A.K. Bhattacharjee attended the 6th International Food Convention (IFCON 2008) held at CFTRI, Mysore, December 15 to 19, 2008.
- Dr. B.M.C. Reddy, Director attended the Directors' Conference held at New Delhi, January 15-16, 2009.

Congress

- Drs. R. Chandra, Neelima Garg, D.K. Tandon, S. Rajan, A. K. Singh and Bharati Killadi attended the 3rd Indian Horticulture Congress on New R&D Initiatives in Horticulture for Accelerated Growth and Prosperity held at OUA&T, Bhubaneswar, November 6 to 9, 2008.
- Drs. S.R. Bhargavanshi, Ajay Verma, Vinod Kumar and Shri Abhay Dixit participated in the Science Expo-2009 held at Regional Science City, Lucknow, January 28 to February 1, 2009.

Meetings

- Dr. B.M.C. Reddy, Director attended a review meeting of National Network Project on underutilized fruits held at New Delhi, April 10, 2008.
- Drs. B.M.C. Reddy, Director and S. Rajan attended the task force meeting on development of DUS guidelines for fruit crops held at New Delhi, April 12, 2008.
- Dr. A.K. Misra attended the XXIII IMC meeting of NRC for Citrus, Nagpur, April 17, 2008.
- Drs. Ram Kishun and D. Pandey attended the meeting of ICAR Regional Committee held at NBFGR, Lucknow, April 19, 2008.
- Dr. B.M.C. Reddy, Director attended the meeting to discuss about developing the DUS testing guidelines for litchi held at Ranchi, May 27, 2008.

Drs. B.M.C. Reddy, Director and S.R. Bhargavanshi attended the interactive meeting on nutrient dynamics in horticultural crops held at IIHR Bangalore, June 14 to 15, 2008.

Drs. B.M.C. Reddy, Director and S. Rajan attended a meeting to discuss about biennial work plan of UNEP-GEF project on 'Conservation and sustainable use of cultivated and wild tropical fruits diversity: Promoting sustainable livelihoods, food security and ecosystem services' held at New Delhi, June 16, 2008.

Dr. Ajay Verma attended the meeting of the Inter-Media Publicity Coordination Committee at Directorate of Field Publicity (GOI) held at Lucknow, July 18, 2008.

Dr. R.P. Shukla attended the Krishak gosthi/ meeting with farmers and orchard owners for creating awareness regarding pest management in mango held at Malihabad, Lucknow, July 23, 2008.

Er. M. D. Singh attended the meeting convened by ADM (Development), Malda held at Malda, July 25, 2008.

Dr. D.K. Tandon attended the meeting of School Board of School of Agriculture (IGNOU) held at New Delhi, July 25 and November 11, 2008.

Dr. B.M.C. Reddy, Director attended the Selection Committee meeting of Project Coordinator (STF) at ASRB as a DG's nominee at New Delhi, August 8, 2008.

Dr. R.P. Shukla attended the Selection Committee meeting for the selection of Subject Matter Specialist (Plant Pathology) held at KVK Dhaura, Unnao, August 23, 2008.

Drs. D.K. Tandon and B.K. Pandey attended the interactive meeting on post harvest technology of horticultural crops held at IIHR, Bangalore, August 23-24, 2008.

Dr. B.M.C. Reddy, Director attended the Selection Committee meeting at ICAR Research Complex for Eastern Region Patna for Subject Matter Specialist in KVK held at Buxar, August 25, 2008.

Dr. Ajay Verma attended the meeting of the Heads of



Scientific Institutions for organization of Science Expo-2008 held at Regional Science City, Lucknow, September 6, 2008.

Dr. B.M.C. Reddy, Director attended the meeting of Corporate Style Functioning for production of planting held at IARI, New Delhi, September 29, 2008.

Dr. B.M.C. Reddy, Director attended the 4th Regional Committee meeting of ICAR comprising the states of Uttar Pradesh, Bihar and Jharkhand held at IIVR, Varanasi, November 21-22, 2008.

Dr. B.M.C. Reddy, Director attended the Directors meeting of Horticulture Division held at New Delhi, January 14, 2009.

Dr. D.K. Tandon attended the meeting of Coordinators/ Programme In-charges of IGNOU held at Lucknow, February 25, 2009.

Seminars/Symposia

Drs. A.K. Singh and A.K. Bhattacharjee attended the National Seminar on Sustainable Horticultural Research in India : Perspective, Priorities and Preparedness held at B.B.A. University, Lucknow, April 14-15, 2008.

Dr. R. Kumar attended the National Seminar on Production, Processing, Marketing and Export of Litchi for Economic Prosperity held at Mushari, Muzaffarpur, June 8 to 11, 2008.

Drs. B.M.C. Reddy, A.K. Misra, R.P. Shukla, D.K. Tandon, Ajay Verma, Gorakh Singh and S. Rajan attended the National Guava Symposium on Improvement, Production and Utilization, Guava Grower Association of India held at Shiridi, Maharashtra, November 24 to 26, 2008.

Drs. R Chandra, A. K. Singh and Dr. Maneesh Mishra attended the 2nd International Symposium on Papaya held at Madurai, December 8 to 12, 2008.

Dr. S. Rajan attended the Seminar on Maintenance of Pure Stocks of Genotypes and Reference Varieties held at NASC Complex, New Delhi, February 12, 2009.

Workshop

Dr. B.M.C. Reddy, Director attended the ICAR Special Interactive Workshop on Administrative and Financial Matters at Ludhiana held at New Delhi, April 17, 2008.

Dr. Achal Singh attended the Launching Workshop on Consortium for e-Resources in Agriculture (CeRA) of NAIP project held at New Delhi, April 30, 2008.

Drs. S.R. Bhargavanshi, Gorakh Singh and Dushyan Mishra attended the Interactive Training Workshop on Developing Winning Research Proposal held at NAARM, Hyderabad, September 10-12, 2008.

Dr. B.M.C. Reddy, Director attended the workshop organized by the PPV & FRA Authority held at NASC Complex, New Delhi, September 22, 2008.

Dr. S.R. Bhargavanshi attended the TSI-FAI Regional Workshop on Promotion of Sulphur Fertiliser use in Indian Agriculture held at Hotel Taj Residency, Lucknow, October 17, 2008.

Drs. R.M. Khan, Ram Kumar, A.K. Singh, D. Pandey and Dr. S.K. Shukla attended the ICAR Training-cum-Workshop on IP on Technology Management held at NBFGR, Lucknow, December 18 to 20, 2008.



15. WORKSHOP, SEMINARS, SYMPOSIA, ETC. ORGANISED

Group Worker's Meeting of AICRP (STF)

The Central Institute for Subtropical Horticulture, Lucknow organized the 18th Group Worker's Meeting



Dr. H.P. Singh, DDG (Hort.) addressing during the Group Worker's Meeting of AICRP

of AICRP (STF) from June 29 – July 2, 2008 at its Rehmankhhera campus. It was inaugurated by Dr. H.P. Singh, DDG (Hort.), ICAR, New Delhi. Dr. V.K. Suri, Vice Chancellor, CSAU&T, Kanpur and Dr. Basant Ram, Vice Chancellor, NDUA&T, Faizabad were the guests of honour.

Dr. H.P. Singh, DDG (Hort.), in his inaugural address, complimented the progress made under this project and further emphasized the need to re look into the research programmes in the present day context. In view of rapid pace of urbanization, small land holdings and dwindling water resources, programmes for increasing the fruit productivity, enhanced nutrient use efficiency, mapping of pest scenario in different regions along with development of eco-friendly control measures are required to be reviewed and reoriented. On the occasion, Dr. B.M.C. Reddy,

Director and Project Coordinator presented a brief report on the progress made at different centres during the past biennium (2005-06 & 2006-07).

Dr. P.G. Adsule, Director, NRC for Grapes, Pune presented the Coordinator's report pertaining to grapes. Dr. Basant Ram, highlighting the significance of germplasm maintenance, stressed the need to develop cost effective control measures for mango hopper and powdery mildew and indicated the reasons for poor adoption of high density planting in mango, extending the period of availability of litchi, development of processed products and problem of fruit cracking in litchi. Dr. V.K. Suri presented a brief review of the progress made in horticulture in general and fruit crops in particular and stressed on the needs of technologies for enhancement of productivity of horticultural crops in the country *vis-a-vis* the world average. Dr. S.N. Pandey, ADG (Hort.) emphasised the need to implement the technical programmes in right earnest and also briefed the achievements of the project in developing region-specific technologies.



Dr. H.P. Singh, DDG (Hort.) releasing the publication

Three publications, *viz.* “Commercialization of CISH Technologies”, “Udyan Rashmi” and “CISH Newsletter”, were released on the occasion. The new mango variety ‘Arunika’ (Amrapali x Vanraj) having deep red peel, good quality with high carotenoid content, high yield along with longer shelf-life was released for commercial cultivation. The vote of thanks was proposed by the Organizing Secretary, Dr. Ramesh Chandra.

About 200 participants including scientists and professors from seven ICAR Institutes, eleven State Agricultural Universities, one Non Governmental Organization and Presidents/Vice Presidents of crop grower’s associations (mango, guava, litchi and grape) participated in the meeting. The progress of research on technical programmes of different centres was reviewed and the new technical programmes for the next biennium were finalized during the six technical sessions. The achievements made in ad-hoc scheme were also discussed. During the plenary session a comprehensive review of programmes and related recommendations was carried out.

A mango exhibition was also organized on the occasion wherein participants showed keen interest

in the newly developed hybrids, *viz.* Ambika (Amrapali x Janardan Pasand) (Arunika, Amrapali x Vanraj) and CISH-M-2 (Dashehari x Chausa) and . A field trip was also organized for the benefit of the participants.

Validation Workshop

The Institute organized one day validation workshop of the TIFAC(DST), Govt. of India, New Delhi sponsored project on Technology gap analysis study for food processing industry cluster of Malda on January 28, 2009 at Golden Park Hotel, Malda (W.B.). It was inaugurated by Shri Sailen Sarkar, Minister Incharge, Parliamentary Affairs and Department of Environment, Govt. of West Bengal and attended by members of TIFAC Apex Committee, local MLAs, Director and scientists of CISH, farmers and entrepreneurs. The workshop was aimed at positioning the fruits and vegetables from Malda and adjoining districts at a higher platform, infrastructure and open facilities available and to invite industries/ entrepreneurs to render them available to their advantage, thereby strengthening the farmers, industry and traders partnership and add value for higher returns in a cleaner and healthy environment.



Dignitaries during the Validation Workshop at Malda (West Bengal)



16. DISTINGUISHED VISITORS

Shri K.N. Chaudhary, Under Secretary(A), ICAR, Krishi Bhawan, New Delhi-110 114 (April 5, 2008).

Dr. H.S. Gupta, Director, Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora-263 601 (April 21, 2008).

Shri Mukesh Kumar, Divisional Forest Officer, Avadh Division, Lucknow-226 002 (April 21, 2008).

Dr. Mangla Rai, Secretary, DARE and Director General, ICAR, Krishi Bhawan, New Delhi-110 001 RB Road Campus, Lucknow (April 26, 2008).

Dr. S.N. Pandey, ADG(Hort.), ICAR, KAB-II, Pusa, New Delhi-1100 12 (May 21, 2008).

Dr. A.K. Singh, Head, Division of Fruit & Horticulture Technology, IARI, New Delhi-110 012 (May 21, 2008).

Shri A.K. Upadhyaya, Additional Secretary, DARE and Secretary, ICAR, Krishi Bhawan, New Delhi-110 114 (June 20, 2008).

Dr. H.P. Singh, Deputy Director General (Hort.), ICAR, KAB-II, Pusa, New Delhi-110 012 (June 20, 2008).

Dr. Masood Ali, Director, Indian Institute of Pulses Research, Kanpur-208 024 (June 20, 2008).

Dr. R.L. Yadav, Director, Indian Institute of Sugarcane Research, Lucknow-226 002 (June 20, 2008).

Dr. W.S. Lakra, Director, National Bureau of Fish Genetic Resources, Canal Ring Road, P.O. Dilkusha, Lucknow-226 002 (June 20, 2008).

Dr. D.K. Sharma, Head, CSSRI Research Station, Dr. Ambedkar Maidan, Jail Road, Lucknow-226 002 (June 20, 2008).

Dr. B.L. Jalali, Former Director of Research, 10/ 95, New Campus, CCS Haryana Agriculture University, Hissar-125 004 (July 7, 2008).

Dr. D.P. Singh, Former Member of Parliament (Lok Sabha), A-51, Pandara Road, New Delhi-110 003 (August 1, 2008).

Dr. H.P. Singh, DDG(Hort.), ICAR, KAB-II, Pusa, New Delhi-110 012 (November 28, 2008).

Dr. Gautam Kalloo, Vice-Chancellor, Jawaharlal Nehru Krishi Viswavidyalaya, Krishi Nagar, Adhartal, Jabalpur-482 004 (November 28, 2008).

Dr. C.D. Mayee, Chairman, Agricultural Scientists Recruitment Board, KAB-I, Pusa, New Delhi-110 012 (November 29, 2008).

Dr. R.L. Yadav, Director, Indian Institute of Sugarcane Research, P.O. Dilkusha, Lucknow-226 002 (January 2, 2009).

Dr. H.P. Singh, DDG(Hort.), ICAR, KAB-II, Pusa, New Delhi-110 012 (January 2, 2009).

Dr. T.P. Trivedi, Project Director, Directorate of Information and Publications of Agriculture, ICAR, KAB-I, Pusa, New Delhi-110 012 (January 2, 2009).

Dr. P.K. Joshi, Director, National Centre for Agricultural Economics & Policy Research (NCAP), ICAR, Pusa Campus, New Delhi-110 012 (January 2, 2009).

Dr. W.S. Lakra, Director, National Bureau of Fish Genetic Resources, Canal Ring Road, P.O. Dilkusha, Lucknow-226 002 (January 2, 2009).

Dr. Jitendra Prakash, President, Invitro International Pvt. Ltd., Bangalore (February 11, 2009).

Shri Prem Nath, Registrar General, Protection of Plant Varieties & Farmers Rights Authority, NASC, DPSM, New Delhi-110 012 (February 21, 2009).

Dr. H.P. Singh, Deputy Director General(Hort.), ICAR, KAB-II, Pusa, New Delhi-110012 (February 27, 2009).



17. PERSONNEL

B.M.C. Reddy, Ph.D.
Director
(Retired and re-employed on 31.12.08)

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.)

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.
Scientist (Sr. Scale) (Gen.& Cyto.)

Shri Vikram Singh, M.Sc.
Scientist (Biotech.)

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

Division of Crop Production

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

B.Lal, Ph.D, F.H.S.I.
Pr. Scientist (Hort.)

Gorakh Singh, Ph.D.
Pr. Scientist (Hort.) (up to 31.03.09)

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

Kailash Kumar, Ph.D.
Pr. Scientist (Ag. Chem.)

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

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

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

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

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

Dushyant Mishra, Ph.D.
Scientist (Sr. Scale) (Hort.)

Atul Singha, Ph.D
Scientist (w e f. 16.05.08)

Tarun Adak, Ph.D.
Scientist, (w e f. 07.07.08)

Division of Crop Protection

Ram Kishun, Ph.D., F.P.S.I.
Pr. Scientist (Pl. Path.)
& Head (upto 31.07.08)

R.P. Shukla, Ph.D.
Pr. Scientist (Ag. Ento.) & Head
(w.e.f. 01.08.08)



Shashi Sharma, M.Sc.
Pr. Scientist (Ag.Ento.)

A.K. Misra, Ph.D.
F.P.S.I., F.I.S.M.P.P.
Pr. Scientist (Pl. Path.) (up to 20.08.08)

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

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

A.K. Singh, Ph.D.
Senior. Scientist (Pl.Path.)
(w.e.f. 3.3.2008)

Division of Post Harvest Management

Neelima Garg, Ph.D.
Pr. Scientist (Micro) & Head (w.e.f. 31.01.09)

M.D. Singh, M.E.
Pr. Scientist (FM&P) & Head
(up to 30.1.09)

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

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

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

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

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

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

Project Coordinator Cell (Subtropical Fruits)

A.K.Misra, Ph.D.
F.P.S.I., F.I.S.M.P.P.
Project Coordinator (w.e.f. 21.08.08)

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

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

TECHNICAL

J.P. Singh, M.Sc. (Ag.)
T-9 (T.O.) (Farm Management)
(up to 31.07.08)

S.K.Raghav, Ph.D. (Ag.)
T-(7-8) (T.O.) (Farm Management)
(w.e.f. 01.01.09)

B.P.Kapoor, B.Sc.
T-7-8 (T.O.) (RCMU)
(Expired on 15.06.08)

S.K.Saxena, M.Lib.Sci., D.P.A.
T-7 (T.O.) (Lib.)

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 Dixit, 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. (Commercil Arts)
T-5 (T.O.) (Arts)

Shambhoo Nath
T-5 (T.O.) (Field) (up to 31.10.2008)

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

D.P.Kureel, Inter (Ag.)
T-5 (T.O.) (Field)(up to 31.01.2009)

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 staff)

ADMINISTRATIVE

Ashish Rastogi, P.G.D.C.M.
Administrative Officer
(up to 02.09.2008)

K. Swarnakumari, Matriculation
Administrative Officer
(w.e.f. 23.09.2008)

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

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

Ravi Bhadra,
Assistant Finance & Accounts Officer
(w.e.f. 06.11.2008)

Ram Naresh
Senior Stenographer



18. OTHER INFORMATION

Rashtriya Krishak Mela Evam Pradarshini-2008

The Central Institute for Subtropical Horticulture, Lucknow organized the Rashtriya Krishak Mela Evam Pradarshini- 2008 on June 20, 2008. It was inaugurated by the chief guest, Shri A. K. Upadhyay, Additional Secretary, DARE and Secretary, ICAR, New Delhi. Prior to inaugurating the gooshi, Shri A.K. Upadhyay inaugurated the mango exhibition wherein 675 varieties of mango were displayed. The newly developed hybrids, Ambika, Arunika, CISH-M-2, H-949, etc. along with Alphonso, Tomy Atkins and other exotic varieties available in the Institute's Field Gene Bank were displayed on the occasion. Dr. H.P. Singh, DDG (Hort.), ICAR, New Delhi along with other dignitaries were also present during the mango exhibition.

Speaking on the occasion, Shri Upadhyay asserted that the horticulture sector could attain 4 per cent growth rate provided scientists, farmers, banks, industry and the concerned government organizations adopt integrated approach for creating and managing the infrastructure. He also informed that the ICAR is working on the interface to execute novel approaches in right earnest. Welcoming the distinguished guests and the farmers, Dr. B.M.C. Reddy, Director, CISH

reiterated the commitment of the Institute towards research not merely in the sphere of augmenting productivity but also in effective handling of the produce for reduction in post harvest losses, value addition and generating quality products for the consumers. About 500 farmers participated in the Rashriya Krishak Mela Evam Pradarshini.

Presiding over the deliberations, Dr. H.P. Singh, DDG (Hort.) underlined three major emerging challenges in the form of reduced availability of land for cultivation, reduction in water table and climate change. He exhorted the scientific community to take up systematic programmes to develop suitable technologies for higher productivity and informed the farmers about the benefits of carbon credit accumulation and its conversion for monetary gains. He also cited the example of traditional cow dung manure prepared in villages, which releases lot of methane responsible for global warming and reduction in the accumulation of carbon credits. Conversely, vermicompost and vermiwash besides providing high quality manure, have low methane output resulting in accrual of high carbon credit points. Dr. D.S. Rathore, Former Vice Chancellor, HPKV, Palampur and Chairman, Research Advisory Committee(RAC), CISH impressed upon farmers for adoption of Institute's technologies for higher economic returns.



Shri A.K. Upadhyay, Addl. Secretary, DARE and Secretary, ICAR with Dr. H.P. Singh, DDG (Hort.) and other dignitaries during Mango Exhibition



Dignitaries and participants at Rashtriya Krishak Mela and Pradarshini-2008

The farmer-scientist Interactive Session, presided over by Dr. R.P. Srivastava, Retd. Principal Scientist and attended by a panel of seven scientists of various disciplines *viz.* Er. M.D. Singh, Drs. R.P. Shukla, S.R. Bhriguvanshi, B. Lal, D.K. Tandon, A.K. Misra, V.K. Singh and Dr. Ajay Verma, was organised. After providing a brief introduction of the technologies, the farmers were requested to apprise their problems encountered in respective areas of work. The principal queries of farmers relating suitability of varieties, management of irrigation, insect pest and diseases were addressed. The farmers were keenly interested in the management schedules of mealy bugs and especially thrips infestation in mango - a newly emerged phenomena in the region.

Field Experience Training (FET) for ARS Probationers

The National Academy of Agriculture Research Management, Hyderabad deputed six ARS Scientist Probationers (Dr. Jagesh Kumar, Dr. Indrajit Ganguly, Shri V. Bhaskaran, Shri Harishankar Singha, Shri K. Karthikeyan and Shri Ramkesh Meena) for Field Experience Training (FET) at the Institute from March 18 - April 5, 2008. The major theme of the training was Input and Services Supply Delivery System.

The trainees organized village goathi on April 1, 2008 in which about 50 farmers participated. It was also attended by officers of the State Bank of India and Directorate of Horticulture and Food Utilization, Malihabad, Lucknow. The trainees presented the conclusions of their study and shared their findings and experiences with the scientists of the Institute.

The probationers also studied the functioning of e-Chaupals run by ITC Limited at Hardoi. The system integrates input, marketing and disposal system through computer interface. The probationers were

also attached to Lucknow Milk Producers Cooperative Union producing 'PARAG' brand of milk and its products wherein they made a study on the supply of inputs and technical know-how from veterinary doctors, milk procurement process, milk pricing and processing for fluid milk/milk products.

Meeting of National Integrated Fruit Fly Surveillance Programme

A meeting was held under the Chairmanship of Shri A.S. Dave, Director, APEDA, New Delhi on June 6, 2008 at the Institute to review the progress of project in U.P. and discuss the action plan for organizing the training programmes for Surveillance Inspectors working in the project. The Chairman also took up the exhaustive review of the status report on fruit fly infestation on mango, guava and vegetable crops grown in the region.

Press Meet on Conservation Agriculture and Horticulture

The Institute organized a press meet on Conservation Agriculture and Horticulture on January 2, 2009 under the Chairmanship of Dr. H.P. Singh, DDG (Hort.), ICAR. Dr. T.P. Trivedi, Project Director (DIPA) was also present on the occasion. The following issues formed the broad theme of the press meet.

Modern agriculture practices on account of excessive exploitation of ecological resources have thrown enormous challenges before the agricultural scientists in the form of incessant depletion of resources resulting in soil nutrient depletion, receding water and aberrant climatic patterns and in the process caused the emergence of yield plateau scenario on the agro-productivity horizon. The emerging issues are being challenged by the research institutions with a well



Dr. H.P. Singh, DDG (Hort) replying the questions of the media during the Press Meet on Conservation Agriculture and Horticulture

thought out and strategically planned concepts of conservation agriculture. In view of the popularization of the concept amongst masses, press meet was aimed to bring out a conceptual shift which may go a long way in ushering an attitudinal changes amongst farmers.

National Science Day

The Institute organized 'National Science Day' on February 28, 2009. The experimental farms and laboratory were thrown open for orchardists and students for visits and interaction with the scientists.

Hindi Programmes

The Institute organized quarterly workshops as per the guidelines of the Rajbhasha Anubhag, Ministry of Home, Government of India. In this connection, a play was also organized to mark the 150th year of the



Dr. H.P. Singh, DDG (Hort) blessing the artist

first war of Independence at the Institute's auditorium on June 30, 2008. The artists of the play were from Geet and Natak Prabhag, Song and Division, Lucknow. The function coincided with the Silver Jubilee celebrations of the Institute.

Chetna Mass

The Institute organized 'Hindi Chetna Mass' from September 14 to October 12, 2008. It began with a Hindi Karyashala wherein Dr. B.M.C. Reddy, Director, CISH was the principal orator on September 16, 2008. Dr. Reddy told that formerly Hindi was the *lingua franca* of the Hindi belt but as time went by, it has indeed become the link language of the country. He also briefed the gathering about achievements made in the implementation of official language at CISH, Lucknow.

A Hindi Workshop was also organized by the Institute on October 10, 2008 wherein five noted poets, Shri Dewal Ashish, Shri Ashutosh Srivastava, Smt. Shikha Mishra, Shri Narayan Agnihotri and Shri Ram Kishor Tiwari, through their poetic genre - geet, poems, hasya poems - illustrated the historical, religious, social and familial idiosyncrasies in Hindi language.



Dr. B.M.C. Reddy, Director speaking at the inaugural function of Hindi Chetna Mass

During the Chetna Mass, a number of competitions like Vad-Vivad, Nibandha, Typing, Kavya Path, Shabdavali, Prashnotati, Noting Drafting competitions, etc. were organized. A large number of scientists, technical and administrative officers and staff of the Institute participated in these competitions. The winners of the various competitions were given prizes during the prize distribution ceremony.



19. METEOROLOGICAL DATA

Meteorological Data at CISH Farm, Rehmankhara (2008-09)

