भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
Annual Report
2009-10

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

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Central Institute for Subtropical Horticulture
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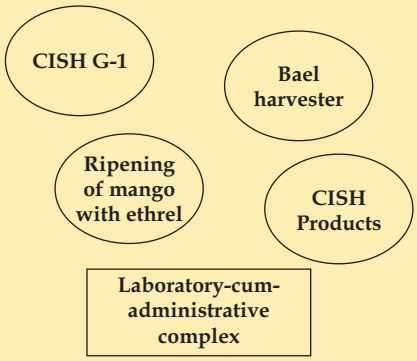

Back Cover : One hundred and fifty years old Horticultural Heritage Dashehari tree, Kakori village, Lucknow accorded G.I. No. 125

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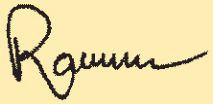
PREFACE

Perpetual scientific quest for augmenting horticultural production coupled with industrialization and its attendant problems through a range of technological innovations though to a greater extent could meet the desired goal but in the process issues of harmonizing the delicate ecological equilibrium to unprecedented climatic upheavals which could derail food and nutrition chain at large appears to be the matter of great concern. Additionally, the phenomenal losses of produce at post harvest stages too cast shadow on the availability scenario. Furthermore, the emergence of market driven forces along with quality and health conscious populace have been posing altogether different set of challenges. The different forces call for a judicious 'nature rescue approach' through pragmatic productivity factor harmonization concept accounting for broader view of ecological processes *vis-a-vis* production practices for ensuring sustainability. Institute through a series of in house exercises and stakeholders meetings, undertook priority setting and research reorientation programmes for fine tuning and addressing the relevant issues.

The research work carried out on different aspects of mandate crops during the period and reported herein is an outcome of well thought out process taking into account the prevailing scenario and emerging signals. Survey, collection and evaluation of trait-specific germplasm of mandate crops especially in mango, guava, papaya and jamun, in harmony with crop improvement programme continued to be in focus. Addressing critical productivity issues of crop canopy architecture, fertigation, substrate dynamics and organic farming during the period through research programmes was an attempt to deal with the challenges arising out of yield plateau, water conservation and environmental safety. Studies undertaken pertaining to seasonal dynamics of pests, diseases and their potential antagonists, molecular characterization, etc., indicate the institutes' incessant efforts to provide the cost effective technologies with minimal usage of chemical(s). Concern for minimization of crop losses at post harvest stage, market economy, farm income enhancement and pesticide residue issues have been addressed. Technology dissemination and capacity building initiatives through variety of programmes including demonstration, scientists-farmers interaction and trainings pursued by the Institute have been widely welcomed. Institute's website www.cishlko.org under the 'media resource file' provides the user with technological information and dynamic information under 'farmers advisory'. There have been sustained efforts of propagating quality planting materials at the Institute's scientific nursery and the concerned were sensitized about critical issues.

The Institute wishes to gratefully place on record, the constant advice, suggestions and guidance received from Hon'ble Director General & Deputy Director General(Hort.), ICAR for fine tuning and improving the outputs. The efforts of scientists in duly getting sensitized to the emerging issues and contributions of technical, administrative and supporting staff during the period are widely appreciated. The keen interest, involvement and commitment of the publication committee of the Institute in bringing out this document in an abridged form is highly commendable.



Place : Lucknow
Date : 14-10-2010

(H. Ravishankar)
Director

CONTENTS

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महाराष्ट्र, पश्चिम बंगाल एवं उत्तराखंड से आम के तीस अभिगमनों का संकलन कर संस्थान के आम जननद्रव्य इकाई में संरक्षित किया गया। आम के सकल जननद्रव्य संकलन से 150, 200 एवं 120 अभिगमनों के फल, पत्तियों के डस (DUS) मानक का मूल्यांकन किया गया। आम कैटलॉग के द्वतीय भाग के विकास हेतु 60 अभिगमनों का उनके पत्तियों एवं पुष्पगुच्छों के लिए मूल्यांकन किया गया। आम के राष्ट्रीय डाटा बेस को विकसित कर समृद्ध किया गया। आम की ऐसी किस्म का विकास करने का प्रयास किया जा रहा है जिसमें नियमित फलत हो, फलों का रंग लाल हो, पौधे छोटे हो एवं गुम्मा रोग के प्रति उनमें प्रतिरोधक क्षमता हो। इस हेतु आम के 60363 फलों के 13766 पुष्पगुच्छों की सहायता से 21 क्रास काम्बीनेशन बनाये गये। आम के 260 संकर पौधों को बाग में उगाया गया जिससे कि उनकी गुणवत्ता, फल के छिलके का रंग, बौनापन, गुम्मा रोग प्रतिरोधकता एवं लवणीय तनाव के प्रति प्रतिरोधकता जैसे कारकों का मूल्यांकन हो सके। आम के 1011 संकर पौधों का मूल्यांकन करने पर संकर 1084 एवं संकर 949 बेहतर पाये गये।

आम की नौ बहुभ्रूणीय किस्मों के मूलवृन्तों पर दशहरी सांकुर शाख को मूल्यांकन किया गया और यह पाया गया कि स्टार्च मूलवृन्त पर रोपित दशहरी पौधे से सर्वाधिक उपज प्राप्त हुई।

अमरूद के 123 अभिगमनों को जिसमें 6 सीडियम स्पीशीस शामिल हैं को संस्थान के प्रक्षेत्र में लगाया गया। अमरूद के चार चयनित किस्मों के मूल्यांकन के बाद पाया गया कि सी. आई. एस. एच.–35, उपज, छिलके का रंग, मुलायम बीज एवं उच्च टी. एस. एस. की दृष्टि से सर्वश्रेष्ठ है। एन्थोसाइनिन निर्माण करने वाले जीन को अमरूद में डालने के लिए ललित को परपल ग्वावा नामक किस्म से एवं परपल ग्वावा को ललित से संकरित कराया गया। ललित एवं परपल ग्वावा के संकरण से उत्पन्न पौधों के ज्यादातर फलों में गुलाबी गूदा पाया गया। साठ संकर पौधों का मूल्यांकन बीज के कठोरीकरण के आधार पर किया गया। अमरूद की अन्तर्जातीय विविधता के मूल्यांकन हेतु mPg CIR 16 प्राइमर सर्वश्रेष्ठ पाया गया।

पपीते की रिंग स्पाट विषाणु बीमारी के लिए प्रतिरोधक पौध बनाने के लिए पपीते के लगभग 50,000 एक्सप्लांटो (भ्रूण) में एग्रोबैक्टीरियम की सहायता से डुअल जीन डाली गयी। प्राप्त निष्कर्ष से मात्र 12 पौधों में ब्च जीन एवं तबच जीन के पी. सी. आर. निष्कर्ष घनात्मक पाये गये। इन 12 पौधों में मात्र 5 पौधे सदर्न हाइब्रीडाइजेशन के लिए घनात्मक पाये गये। इन 5 पौधों को विषाणुओं से संक्रमित किया गया जिसमे से सिर्फ एक पौधे में ही प्रतिरोधक क्षमता दिखायी दी।

आँवला के 15 जननद्रव्यों के मध्य प्रदेश से संकलित किये गये। मध्य प्रदेश से ही संकलित आँवले के 21 जननद्रव्यों का एन. ए.–7, कृष्णा एवं कंचन किस्मों के साथ तुलनात्मक मूल्यांकन किया गया। पूर्वा उत्तर प्रदेश से चयनित बेल के जनन द्रव्यों का मूल्यांकन किया गया। उत्तर प्रदेश के चन्दौली जिले से चयनित जामुन का बीज रहित जननद्रव्य सी. आई. एस. एच. श्र 42, एन्थोसाइनिन एवं ऐंटीऑक्सीडेन्ट प्रचुरता से पाया गया एवं यह प्रसंस्करण हेतु योग्य पाया गया। संस्थान के जीन बैंक में खिरनी के 28, महुआ के 20, कैंथा के 20 एवं इमली के 28 जननद्रव्य संकलित किये गये।

Qly mRiknu

पादप हार्मोन (IAA 0.1 मिग्रा/ली.) संतृप्त पोषक माध्यम में आम के भ्रूण में 86 प्रतिशत अंकुरण पाया गया एवं 28 प्रतिशत भ्रूण पौधों में रूपान्तरित हो गये। परिपक्व काटीलेडनरी भ्रूणों का रूपान्तरण तरल पोषक माध्यम (33 प्रतिशत) में ठोस पोषक माध्यम (25 प्रतिशत) की तुलना में ज्यादा रहा।

आम के पौध प्रवर्धन हेतु यदि सांकुर शाख को 8 दिन पूर्व पर्ण–विहीन कर दिया जाये, वेज कलम बंधन की तकनीक अपनायी जाये एवं पॉलीथीन की टोपी का उपयोग किया जाये तो यह विनीयर कलम बंधन की तुलना में बेहतर है। जनवरी माह में सफलता की दर सर्वाधिक (98.8 प्रतिशत) पायी गयी। ग्रीन हाऊस के भीतर कलम बंधन में यदि पॉलीथीन टोपी का प्रयोग ना किया जाये जो सफलता कम ही रहती है। खुली दशा में कलम बंधन में सबसे कम सफलता प्राप्त हुयी।

आम में परम्परागत बागवानी की तुलना में मध्यम सघन बागवानी उपज की दृष्टि से बेहतर पायी गयी। जिन पौधों की शाखाएँ 30–60^0 कोण पर स्थित थी उनमें सर्वाधिक फलोत्पादन हुआ। क्राउन थिनिंग एवं क्राउन रिडक्शन द्वारा कैनॉपी प्रबंधन से 68.3 किग्रा एवं 60.5 किग्रा उपज प्रति पौधा प्राप्त हुयी। पाया गया कि भूमि पर पैक्लोब्यूट्राजाल

(1.6 मिली/पौध) के छिड़काव, उचित खाद एवं उर्वरक के साथ यदि कटाई–छंटाई की जाये तो 95.5 प्रतिशत नयी शाखाओं पर पुष्पगुच्छ आ जाते है। गोबर की खाद, वर्मीकम्पोस्ट, एन. पी. के., एजोटोबैक्टर, ट्राइकोडर्मा एवं पीसम द्वारा सब्सट्रेट के बदलाव से 53.6 से 60 प्रतिशत कार्बन मृदा में बढ़ गया जबकि प्रारम्भिक दशा में यह केवल 0.32 प्रतिशत था। कार्बनिक मल्च ने ना केवल जल वाष्पोत्सर्जन की दर को कम किया वरन् मृदा के तापमान को भी बढ़ाया। पत्तियों के मल्च द्वारा मृदा की नमी को रोकने में सफलता पायी गयी। गोबर की खाद के साथ हरी खाद (सेसबेनिया) मृदा में डालने से फास्फोरस, पोटाश, जिंक एवं लौह तत्व की उपलब्धता बढ़ गयी।

पैक्लोब्यूट्राजाल के साथ मल्चिंग करने पर आम में उपज काफी बढ़ गयी (98.30 किग्रा/पौध) साथ ही एन्टीआक्सीडेन्ट एन्जाइम (कैटालेस/पराक्सीडेस) की मात्रा भी लंगड़ा एवं आम्रपाली की पत्तियों में ज्यादा दर्ज हुयी।

आम की सात बहुभ्रूणीय किस्मों को लवणीय तनाव की अवस्था में उगाया गया जिसमें सिर्फ 'नेक्कारे ही अत्यधिक लवणीय तनाव सहने में सक्षम पाया गया।

नये एवं पुर्नउधारित बागों के लिए सहफसलों का उगाना आम की दृष्टि से बेहतर पाया गया। सरसों में 1200 की लागत में 19,000 रूपये एवं मटर में 5000 रूपये की लागत पर 10,500 रूपये प्राप्त हुये। अमरूद के 39 एवं 14 पौधों के एस्टीमेट से निष्कर्ष निकाला गया कि अमरूद की किस्म सरदार के उपज का 95 प्रतिशत पूर्वानुमान की एरर 5–10 प्रतिशत है।

वेज कलम बंधन द्वारा आँवला/बेल के पौध प्रवर्धन में जनवरी–फरवरी माह में अच्छी सफलता प्राप्त हुयी। खिरनी में विनियर कलम बंधन द्वारा अगस्त में 75 प्रतिशत सफलता मिली वही करोंदा में क्लेट वुड विधि द्वारा जुलाई में सर्वाधिक सफलता प्राप्त हुयी। CISH J-42 में सर्वाधिक लेवनॉयड एवं CISH J-36 में सर्वाधिक कैरोटिनायॅड प्राप्त हुआ।

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भुनगे की तीन प्रजातियाँ *अमरिटोडस ऐटकिंसोनी इडियोस्कोपस क्लीपीलिस* तथा *आई. निटिड्यूलस थ्रिप्स* और *गॉलमिज* को आम के फसलों को हानि पहुँचाने वाला पाया गया।

ऐटाकेंसोनी की संख्या पूरे वर्ष आम के तने पर पायी गयी किन्तु अक्टूबर के महीने में इसकी संख्या सर्वाधिक देखी गई। आई. निट्यूडूलस को नयी पत्तियों तथा बौर पर पाया गया जबकि इसकी सबसे संख्या मार्च के चौथे सप्ताह में रही।

जुलाई से अक्टूबर के बीच फल–मक्खी का प्रकोप अधिकतम रहा। थ्रिप्स की संख्या सितंबर/अक्टूबर में सर्वाधिक पायी गयी। पाउड्री मिन्ड्यू, ऐन्थ्रेक्नोज, उल्टा सूखा, सूटी मोल्ड तथा ब्लौसम ब्लाइट की घटना क्रमशः 5–15, 12.5, 3–5, 30–35 तथा 5 प्रतिशत रही। एसिफेट (1.5 ग्रा./ली.), थियोमेथोक्जेम (0.2 ग्रा./ली.) तथा स्पीनोसेड (1 मि.ली./ली.) की दर से स्प्रेइंग अच्छा पाया गया।

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नायलान पाऊच युक्त एक क्लिपर युक्त बेल तोड़क यंत्र एवं अमरूद तोड़क यंत्र का विकास किया गया है। कोडेक्सन ऐलिमेनटेरिस के अनुसार आम की दशहरी, लगड़ा और चौंसा किस्मों के निर्यात हेतु भार के आधार पर मानकीकरण किया गया। आम की दशहरी किस्म की भन्डारण अवधि को बढ़ाने के लिए स्पर्मिन (0.01 प्रतिशत) रसायन से उपचार को प्रभावी पाया गया।

आम की लंगड़ा तथा अमरूद की किस्में इलाहाबाद सफेदा की भण्डारण अवधि को बायो एजेन्ट (*सेकेमाइसिस सेरेवेसी*) के उपचार द्वारा क्रमशः 9 तथा 6 दिन तक अनुकूल परिस्थितियों में रखा जा सका। आँवले की चकैया किस्म में सोडियम बायो कार्बोनेट का उपचार प्रभावी पाया गया। ईथरल (2000 पी. पी. एम.) से उपचारित बेल फलों को 24 दिन तक में पकाया जा सका जबकि अनुपचारित फलों में यह अवधि 21 दिन थी।

आम की पांच संकर किस्मों को तेल के अचार हेतु तथा 13 किस्मों को गूदे एवं रस बनाने हेतु मूल्यांकन किया गया। संकर को अचार हेतु तथा संकर–1190 को रस हेतु उपयुक्त पाया गया। हिम–औसमो–फ्रीज ड्राइंग तकनीक द्वारा पके आम की फाकों को सुखाया गया। अमरूद की पाँच किस्में/हाइब्रिड को प्रसंस्करण उपभोगिता हेतु मूल्यांकन किया गया। संकर रस बनाने हेतु उपयुक्त पाया गया। चार माह तक भंडारित ताजे रस से स्प्रे तकनीक से सुखाये गये आँवले की पाउडर को कुल घुलनशील ठोस अम्लता, एस्कोर्बिक अम्ल तथा टैनिन की मात्रा में निरन्तर ह्रास हुआ जबकि नान एन्जाइमेटिक ब्राउनिंग में बढ़ोत्तरी वृद्धि दर्ज की गयी।

बेल के गूदे को 1000 पी. पी. एम. सल्फर डाई आक्साइड के उपचार द्वारा 12 माह तक सुरक्षित रूप से संरक्षित किया जा सका।

कच्चे आम से मसाला युक्त किण्वित पेय विकसित किया गया। आम के प्रसंस्करण उद्योग से प्राप्त अपशिष्ट से उच्च कोटि के खाद्य रेशा युक्त बिस्किुट निर्मित किया गया।

परिपक्व मल्लिका आम की गिरी से 9 प्रतिशत तेल निष्कर्षित किया गया जिसमें प्रचुर मात्रा में स्टिरिक, पामिरिक, ऑलिक, लिनोलिक तथा मैरिस्टिक वसीय अम्ल थे।

ट्राइकोडर्मा स्पी. की किन्वीकरण प्रक्रिया के द्वारा महुआ अपशिष्ट से सैलूलेज एन्जाइम बनाया तथा उसकी के. एम. तथा वी. मैक्स गुणों का निर्धारण किया गया।

दशहरी आम के गूदे तथा छिलके की वृद्धि एवं विकास की विभिन्न अवस्थाओं में *इमिडाक्लोपिड पेस्टीसाइड* के अवशेष का विश्लेषण किया गया। स्प्रे के पचह दिन मि. ग्राम प्रति कि. ग्राम अवशेष गूदे में पाये गये। जो उपयोग की दृष्टि से सुरक्षित है।

वातावरण में असामान्य परिवर्तनों के कारण उत्तर भारत के पूरे आम पट्टी क्षेत्र में आम का उत्पादन वर्ष 2009 में कम हुआ जिसके फलस्वरूप आम का विपणन केवल 51. 58 हजार मीट्रिक टन ही रहा। वर्ष 2008 – 2009 में भारत से आम का निर्यात अकेले बांगला देश को हुआ। कानपुर जनपद में अमरूद की मूल्य वृद्धि श्रंखला के अध्ययन से ज्ञात हुआ कि अधिकतर व्यापार नियमिक मडियों की अपेक्षा स्थानीय बाजारों में ही हुआ। बीज पौधों की अधिकता तथा बागों की नियमित रखरखाव न होने के कारण फलों की गुणवत्ता असमान पाई गयी।

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

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

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

वर्ष 2009–2010 के दौरान संस्थान द्वारा कृषकों के लिए 10 प्रशिक्षण कार्यक्रमों का आयोजन किया गया। संस्थान के 1460 किसान, अधिकारी एवं विद्यार्थियों द्वारा भ्रमण किया गया।

cBd

डॉ. डी. एस. राठौर, पूर्व कुलपति, सी. एस. के. हिमाचल प्रदेश कृषि विश्वविद्यालय, पालमपुर की अध्यक्षता में संस्थान की चौदहवीं आर. ए. सी. बैठक 16–17 जून, 2009 तक आयोजित की गयी।

संस्थान की छब्बीसवीं एवं सत्ताईसवीं आई. आर. सी. की बैठकें 05 से 08 जनवरी 2009 तथा 29–31 मार्च 2010 को डॉ. एच. रविशंकर, निदेशक की अध्यक्षता में आयोजित की गयी।

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संस्थान के वैज्ञानिकों को विभिन्न वैज्ञानिक/विकास एजेंसियों द्वारा उनके कार्यो के लिए सम्मान दिया गया। संस्थान के निदेशक एवं एक अन्य प्रधान वैज्ञानिक को आई. एस. एच. आर. डी. द्वारा फेलो की मानद उपाधि प्रदान की गयी। संस्थान की राजभाषा पत्रिका को नगर राजभाषा कार्यान्वयन समिति की बैठक के दौरान तृतीय पुरस्कार प्रदान किया गया। सस्ंथान के निदेशक/वैज्ञानिकों ने विभिन्न संगोष्ठियों/परिसंवादों/सम्मेलनों/बैठकों में कार्यदल/पाठ्यवृत्त/अनुवीक्षण समितियों तथा जरनलों के संपादन मंडलों में अध्यक्ष, सह–अध्यक्ष, समन्वयक, रैपोटियर तथा सदस्य के रूप में कार्य किया।

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संस्थान में दिनांक 16 जून से 6 जुलाई 2009 तक समर स्कूल का आयोजन किया गया। कीट विज्ञानियों की बैठक जून 10 से 11, 2009 तक आयोजित किया गया। इसमें 50 कीट विज्ञानी सम्मिलित हुए। एन. ए. आई. पी. के घटक II की शुरूआत 25 जून 2009 को संस्थान में हुई।

संस्थान में ही दिनांक 24–25 फरवरी 2010 को शोकेसिंग ऑफ टेकनेलॉजी का आयोजन किया गया। 26 मार्च 2010 को स्टेकहोल्डर मीट का आयोजन किया गया जिसमें किसानों की समस्याओं के समाधान पर चर्चा हुई।

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वर्ष 2009–10 के दौरान को दिये गये लक्ष्य से अधिक 58.11 लाख रूपये राजस्व के रूप में एकत्र किये गये।

2. EXECUTIVE SUMMARY

Research Accomplishments

Crop Improvement

Thirty new accessions of mango, collected from Maharashtra, West Bengal and Uttaranchal, are being conserved in germplasm collection unit. Thirty-two accessions were added to the field gene bank. Amongst the available mango germplasm collections, 150, 200 and 120 accessions were evaluated for fruit, leaves and panicles and DUS parameters respectively. Sixty accessions of mango were characterized in respect of leaf and panicle characters for development of second volume of catalogue. National Database for mango gene bank was updated. Twenty-one cross combinations involving 60363 flowers on 13766 panicles were effected for the development of recombinants in mango with specific traits like red colour, regular bearing, dwarfness, malformation resistance etc. Further, two hundred and sixty-seven hybrid seedlings were raised for evaluation of quality, peel, colour, dwarfness, malformation resistance and salt induced stress resistance**.** Out of one thousand eleven mango hybrids evaluated for fruit characters, hybrid 1084 and 949 were found promising. Among nine poly embryonic varieties used as rootstock in the field using Dashehari as scion, maximum fruit yield was obtained in Starch (45 kg plant^{-1}). One hundred and twenty-three accessions including six *Psidium spp.* are being conserved in the field gene bank. Out of four clonally propagated selections, half-sib population CISH-35 was identified as high yielder with attractive fruit surface colour, soft seeds and high TSS. Cross combinations of Lalit **x** Purple guava and Purple **x** Lalit guava were effected for incorporation of gene responsible for anthocyanin synthesis. Maximum hybrid seedlings with pink pulp were obtained from Lalit **x** Purple guava. Fifty-two hybrid seedlings were evaluated for seed hardiness. Interspecies variability in guava could be best assessed by *mPgCIR* 16 primer and PCR conditions were optimized for SSR markers. Five polymorphic SSR markers were found enough to discriminate guava accessions and *miPg CIR09* and *miPg CIR16* were found useful. Out of 50,000 papaya cv. Pusa Delicious explants targeted for *Agrobacterium* mediated transformation and subjected to kanamycin, 12 plants were found positive for *cp*, *npt*. II and *rep* gene and only five plants were found positive for Southern analysis. Out of these, only one T0 plant showed mild symptoms of PRSV. Fifteen accessions of papaya were evaluated for growth and fruiting behavior and CISH P-1 had higher values for plant height whereas canopy spread was maximum in cv. Sunset Solo. On the other hand fruit yield and TSS were maximum in CO-7 and Red Lady. Seed cavity was minimum in Pusa Nanha. One hundred ninety fruits were obtained from 251 flowers sib-mated in 14 cultivars/accessions for obtaining homozygosity. Fifty-three crosses in papaya were effected in five combinations for developing desirable characters and 43 fruit sets were obtained. Hybrid progeny obtained from Red Lady x CO-7 gave the highest yield. Out of 21 varieties of litchi evaluated, higher yield was recorded in Early Large Red, whereas maximum fruit weight and fruit size were observed in Seedless -1 while they were minimum in Rose Scented. Early panicle emergence was found in Kasiliya while it was late in Seedless-1 and Mandraji. Touch down PCR conditions were optimized for DNA amplification of 28 litchi cultivars using 12 SSR primers. LMLY8 was found to be the most descriptive locus which generated unique profile for Late Bedana, Longia, CHL-7, Dehradun and Dehrarose. Out of 20 primers of OPX series screened for RAPD-PCR of select litchi cultivars, 8 primers produced prominent amplicons of reproducible nature. Cluster analysis performed using NJ and UPGMA methods indicated that cv. Swarnaroopa was an out group by using UPGMA, whereas it was found grouped with Kasba by using NJ method. Fifteen fruit samples of anola accessions collected from five districts of Madhya Pradesh were evaluated for proximate principles. Morphological characterization of 21 anola germplasm accessions was undertaken and maximum plant height was recorded in CISH-A2**.** Physico-chemical variability was recorded in bael germplasm collected from Eastern U.P. Fifty two promising accessions of jamun were evaluated. Seedless type of jamun CISH J-42 selected from Chandauli (U.P.) was found promising in terms of processing potential, antioxidant value and anthocyanins. Superior

accessions of Khirnee (28), Karonda (30), Mahua (20), Wood Apple (20) and Tamarind (28) collected from different parts of the country are being maintained in the field gene bank for evaluation for different physico-chemical attributes. A total number of fifteen accessions of aonla, twelve of bael, nine of jamun and twenty-eight of khirnee were collected and added.

Crop Production

Phytohormone (IAA@0.1 mg l^{-1}) fortified medium influenced 86 per cent germination and 28 per cent conversion of mango embryos. Similarly, advance cotyledonary embryos were found highly amenable to conversion into plants in solid (25%) and liquid medium (33%) as compared to early cotyledonary stage. Wedge grafting of 8 days old defoliated scion stick coupled with polythene capping was found superior (53.3 to 98.8%) over veneer grafting under green house conditions. January was found to be the best month for obtaining maximum success (98.8%). Conversely, grafting under green house conditions without polythene capping could bring only 40 to 89.9 per cent success as compared to grafting under open conditions (9.6-60%). Medium density planting system (400 plants ha^{-1}) provided higher yield (13.14 t ha^{-1}) as compared to 100 plants ha^{-1} **m** traditional system (9.55 t ha^{-1}). Crop productivity was influenced by branch angle of 30°-60° from vertical axis which bore maximum fruits (48.25%). Crown thinning and crown reduction mediated crop canopy architechture management resulted in 68.3 kg and 60.5 kg per tree yield respectively in 23 year old Mallika mango. Pruning along with soil application of paclobutrazol (1.6ml $tree^{-1}$) and recommended dose of fertilizers and manures induced panicles in 95.5 per cent of newly emerged shoots as compared to only 15.5 per cent panicles in trees subjected to only pruning. Substrate manipulation through FYM, vermicompost, NPK, *Azotobacter*, *Trichoderma harzianum* and PSM could cause an increase of 53.6 to 60.0 per cent in carbon contents over an intial level (0.32%). Organic carbon build up was higher (0.492%) following incorporation of vermicompost (10 kg), NPK (100,50,100g per tree), *Azotobacter*, PSM and *Tricoderma harzianum* along with organic mulch (40 cm thick) as compared to untreated also proved effective in minimizing water loss coupled with rise in soil temperature. Application of FYM and green manure (*Sesbania aculeata*) also augmented the availability of phosphorus, potassium, zinc and iron. Mulching along with application of paclobutrazol (1.6 ml $tree^{-1}$) resulted in significant increase in yield (98.30 kg $tree^{-1}$) as compared to untreated (44.40 kg $tree^{-1}$). It also caused an increase in antioxidant enzymes (catalase, peroxidase) in leaves of Langra and Amrapali at flowering stage. Out of seven polyembroynic seedlings subjected to salt induced stress conditions, only Nekkare (33% germination) could withstand higher stress (4 and 6 ds m^{-1}). Intercropping modules with mustard and pea in newly established and rejuvenated orchard were found better options with returns of Rs.19000 and Rs. 10500 over an investment of Rs. 1200 and Rs. 5000 in mustard and pea, respectively. An estimate of 39 and 14 guava plants was found optimum for yield prediction in guava cv. Sardar at 95 per cent probability with an error of 5 and 10 per cent. January and February were identified as the best period for obtaining maximum graft success through wedge grafting (88 to 92.5, 82 to 92%) in aonla and bael as compared to March (61%, 53%). Veneer grafting in khirnee gave 75 per cent success during August, while soft grafting through cleft wood method gave 65 and 60 per cent success in karonda during July and June, respectively. On the other hand 98 and 90 per cent success was achieved during August and July, respectively. In jamun, maximum flavanoid content was recorded in the CISH J-36 where as maximum carotenoid content was in CISH J-42.

Crop Protection

Three species of hoppers *viz. Amretodus atkinsoni, Idioscopus clypealis* and *I. nitidulus,* thrips and leaf gall midge were recorded infesting mango crop at different stages**.** Population of *A. atkinsoni* prevailed throughout the year mainly on trunk and attained a peak during October while the population of *I. nitidulus* was prevalent on younger leaves and panicles and peaked during the fourth week of March. Fruit fly population exhibited peaks during July and October and had significant and positive correlation with maximum and minimum temperature, evapotranspiration and wind velocity. Population of thrips was low during first week of March and September/October and peaked during second week of March. Population of

leaf gall midge was higher during first week of September to last week of January. Incidence of powdery mildew, anthracnose, die back, sooty mould and blossom blight was 5-15, 12.5, 3-5, 30-35 and 5 per cent, respectively. Spray of acephate (1.5g l^{-1}), thiamethoxam (0.2g l^{-1}) and spinosad (1 ml l^{-1}) were found effective up to three weeks resulting in 98 per cent reduction in hopper population during flowering season. Around 95 per cent population of mealy bug was effectively managed by carbosulfon (0.05%), acephate (1.5g l^{-1}) and lastraw (5 ml l^{-1}). Molecular characterization of twelve isolates of *Colletotrichum gloesporioides* collected from different agro-climatic zones of mango belt could not reveal distinct variation amongst isolates. However, restriction digestion of ITS-PCR products by PCR-RFLP using Msp-1 could discriminate *C. gloesporiodes* from *C. capsici* and *C. falcatum*. Similarly, restriction pattern of *Fusarium* isolates using *Tag 1* exhibited variation between *Fusarium oxysporum* and *F. solani*. Gall maker and fruit borer were major pests of aonla. Maximum temperature and shoot gall incidence were found negatively correlated. Varying degrees of incidence of rust, die back, stalk end rot, leaf blight and leaf spot diseases were recorded on aonla, bael, jamum, custard apple, jackfruit, khirnee, mulberry and lasoda. Population of entomopathogenic nematode *Steinernema carpocasae* collected from mango and guava orchards failed to multiply on fruit fly maggots collected from mango.

Post Harvest Management

Small farmer-friendly guava harvesting device having mild steel finger with plastic tube and nylon pouch attached to a MS frame was designed and fabricated. A clipper type bael harvester was also developed. Grading protocols for export of mango cvs Dashehari , Langra and Chausa were standardized on the basis of *Codex Alimentarius*. Post harvest treatment of mango cv. Dashehari with spermine (0.010) resulted in better quality retention when packed in LDPE bags and stored at low temperature (12± 2°C; 90±5%RH). Shelf life of 9 days in mango cv. Langra and 6 days in guava cv. Allahabad Safeda was observed when treated with a bioagent, developed by the institute under ambient conditions. Aonla fruits cv. Chakaiya treated with 4 per cent $NaHCO_3$ exhibited minimum browning after 12 days of storage at room temperature. Bael fruits cv. CISH B-2 could be ripened uniformly with 2000 ppm ethrel treatment by 14 days as compared to 21 days in control. Five mango hybrids for pickle in oil and thirteen varieties/hybrids for pulp/ beverage were evaluated for their acceptability. Sensory evaluation of pickles indicated that hybrid H-935 was the most acceptable while the best beverage was obtained from hybrid H-1190 followed by H-896, H-2530 and HVB-2. Effective protocols for osmo-freeze drying of ripe mango slices were optimized. Five guava varieties/hybrids were evaluated for their processing potential. Best beverage was obtained from hybrid HPSI-6. Progressive decrease in the contents of TSS, acidity, ascorbic acid and tannins with a concomitant increase in NEB values were recorded in the spray dried powder prepared from fresh and stored aonla juice (cv. Chakaiya) until 4 months. Bael pulp could be preserved with 1000 ppm SO_2 in glass jars for 12 months without much deterioration in quality. A fermented raw mango beverage, amended with spices, was developed. Creamy coloured dietary fibre was extracted from mango pulp processing waste of finisher stage which could be used for value additions to biscuits. Nine per cent oil was recovered from mango (cv. Mallika) kernel having stearic, palmitic, oleic, linoleic and myristic acids with potential for use of cosmetics. The production protocols of cellulases from Mahua pomace using *Trichoderma spp*. was optimized and their K_m and V max values were evaluated. Imidacloprid residues were analyzed in peel and pulp of Dashehari mangoes during growth and development. The residues (0.09 mg kg^{-1}) were found below MRL value in pulp after 75 days of spraying and found safe. Market analysis indicated that the production in mango belt of North India during the year 2009 was low owing to unusual weather parameters. Consequently, disposal of mango was only 51.58 thousand MT during the year. The export of mango from India was the highest (83.7 thousand MT) during 2008-09, Bangladesh being the leading importer accounting for 54 per cent of the total exports from India. Study of value chain for domestic market in guava in Kanpur district indicated that the fruit was traded mostly in local markets rather than the regulated mandis. Quality of fruits was also not found uniform as majority of the orchards in that area were of seedling origin and orchards don't receive optimal cultural care.

Technology Transfer

Apart from targeted research in the area of crop improvement, crop production, crop protection and post harvest management, gamut of challenges were encountered in the mandate crops. The institute focused on dissemination of technologies to the end-users. Institute organized different theme oriented programmes in which about 500 farmers/trainers were sensitized. The institute also participated in a number of state as well as national level events and addressed the problems of farmers through its improved technology capsules. Technology showcasing through demonstrations, scientists-farmers' interactions, exposure visits for the benefit of farmers, extension workers/students, counseling, postal queries, farmers helpline call, training programmes and TV/radio talks was undertaken. During the year, 1460 farmers and officials were trained through targeted training programmes. A total of 10 thematic trainings programmes were organized during the period. Scientists, administrative and technical officers of the institute were deputed to different programmes organized by national agencies for envisaging up-gradation of human resource.

Meetings

Fourteenth meeting of the RAC of the Institute was organized under the Chairmanship of Dr. D.S. Rathore, Ex-Vice Chancellor, C.S.K. Himanchal Pradesh Krishi Vishwavidyalaya, Palmpur during June 16-17, 2009. Twenty-sixth and twenty-seventh Institute Research Committee meetings were held from January 5 to 8, and March 29 to 31, 2010 to review the progress made in ongoing research projects and approval of technical programmes for the next year. Need for re-orientaion of research programmes in harmony with emerging needs and team approach was highlighted.

Awards and Recognitions

Scientists of the Institute received recognitions from different scientific/developmental agencies. The Director, CISH and one Principal Scientist were conferred with the Fellowship of the Indian Society of Horticultural Research and Development during the National Symposium on Conservation Horticulture held at Uttaranchal. Director/Scientists of the institute also functioned as chairman, co-chairman, coordinator, rapporteurs and members in different seminars/symposia/conferences/meetings, task-force, curriculum/monitoring committees and editorial boards, etc., 'Udyan Rashmi', Rajbhasha Patrika of the Institute was awarded 3rd prize by the Nagar Rajbhash, Karyanvayan Samiti, Lucknow at its half-yearly meeting held at CDRI, Lucknow.

Linkage and Collaboration

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

AICRP/PFDC

The Project Coordinator's Cell of All India Coordinated Research Project on Subtropical Fruits is located at the institute. The Cell's activities in coordinating research on crop improvement, production and protection (mango, guava and litchi) were implemented at 18 centres located at SAUs and ICAR institutes. The Project Coordinator's Cell organized the Nineteenth Group Workers Meeting of AICRP (STF) at Balasahab Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra from December 14 to 17, 2009 at BSKKV, Dapoli. A total number of 117 participants from all the cooperating centres, including ICAR institutes, SAUs, state government, fruit growers, private agencies, principal investigators of ad-hoc schemes and industries participated. During the meeting, progress of research with respect to approved technical programmes of different centres were reviewed and the new programmes for the next biennium were finalized. Besides, the achievements made under ad hoc schemes were also discussed. After comprehensive review in the plenary session, recommendations were made for refinement of the

work. The Precision Farming Development Centre organised Summer School and different training programmes for farmers and orchardists. Two thousand six hundred farmers were trained through these training programmes.

Consultancy, Patents and Commercialization of Technology

Consultancy services were provided to various governmental and non-governmental organization and entrepreneurs on payment in accordance with ICAR guidelines.

Other activities

The institute organized a two-day interaction meet of Entomologists at CISH, Lucknow under the Chairmanship of Dr. H.P. Singh, DDG (Hort.) from June 10 - 11, 2009 for developing an innovatively synchronized action plan for effective management of pests affecting horticultural crops across the country. Fifty entomologists working on horticultural crops at different institutes under ICAR system discussed the strategies for management of pests participated in discussion and interaction. The subproject on "A value chain on mango and guava for domestic and export markets" under Component – II of the National Agricultural Innovation Project (NAIP) was launched by Dr. J.P. Mittal, National Coordinator on June 25, 2009. A two-day programme on "Showcasing of Agricultural Technologies" and scientists-farmers interface in connection with acquisition of Geographical Indicator Status by 'Dashehari' mango was also organised under the National Agricultural Innovative Project (NAIP) at R B Road Campus of the Institute from February 24-25, 2010. Stakeholders' meet was organized by the Institute on March 26, 2010 with a view to take stock of prevailing and contextual issues pertaining to different aspects of production and post harvest management, supply chain management problems in mandate crops and set research agenda. Hindi Chetna Mass was organized from September 14 to October 12, 2009 wherein different programmes including competitions and cultural activities for the promotion of official language were held and prizes distributed. A Hindi translation software was procured and installed in order to facilitate use of official language in day to day work.

Revenue Generation

A total of Rupees 58.11 lakhs was generated by the institute during the financial year 2009-10.

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 research and development aspects on mandated subtropical fruits.

The Institute has two experimental farms, located each at Rehmankhera approximately 25 km away from the city and at Rae Bareli (R.B.) Road, right in the city of Lucknow. The experimental farm at Rehmankhera has an area of 132.5 ha comprising 4 blocks (block I-15.5 ha, block II-35.5 ha, block III-37.42 ha & block IV-44.08 ha) while R.B. Road campus has an area of 13.2 ha. To meet the emerging challenges in frontier areas of research on subtropical fruits, the Institute has modern nursery facilities, well established orchards and fully equipped laboratories. Simultaneously, concerted endeavours for human resource development through capacity building are also going on.

The Institute has in place MOUs to facilitate capacity building avenues with Integral University, Lucknow, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad, 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 and a certificate course on organic farming. National Horticulture Mission has also identified the Institute as a nodal centre for imparting training on rejuvenation of old and senile mango orchards and meadow orcharding in guava. The Institute also has a well established scientific nursery unit producing quality planting material of mango, guava, aonla and bael for supply of farming communities and backstopping Krishi Vigyan Kendra for establishing mother blocks.

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 linkages with national and international agencies to accomplish the above mandate.

Objectives

- Management of genetic resources of mandate fruit crops and their conventional and molecular characterization.
- Crop improvement through breeding and genetic engineering.
- Enhancing productivity through improving quality of planting 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 mandate crops.

Past Achievements

Crop Improvement

- The Institute has the reputation of conserving world's largest germplasm collection of mango numbering 732 accessions, collected from different indigenous and exotic sources.
- A promising mango hybrid CISH-M-1 (Amrapali x Janardhan Pasand), which is a regular bearer, fruits having peel yellow colour with red blush, firm pulp and scanty fibres was released as 'Ambika'. It has good potential for domestic and export markets.
- The regular mango hybrid H-39 (Amrapali x Vanraj) having peel yellow colour with red blush, firm pulp, high TSS (24°B) and 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 yield than that of the normal Dashehari.
- Mango cv. Elaichi continues to be free from floral malformation and is being used in trait specific breeding programme.
- Molecular characterization of 150 mango cultivars indicated that the germplasm accessions could be categorized into 3 broad groups.
- A South Indian mango cv. Totapuri was found regular bearer and good yielder under Lucknow conditions, has good potential for processing to important instant pickles and pulp.
- One hundred and fourteen accessions of guava and 7 *Psidium* spp. are conserved in the field gene bank of the Institute.
- 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 cv. Lalit are attractive, saffron yellow with red blush in colour, medium size and firm with pink pulp. It yielded 24 per cent higher yield than the popular variety Allahabad Safeda. Shweta has sub-globose fruits with white pulp and few soft seeds, high TSS (14°B) and attractive pink blush and the traits and good yield potential.
- Institute has 54 accessions of bael conserved in the field genebank. Two promising selections 'CISH-B-1' and 'CISH-B-2' have good table and processing qualities.
- The Institute has conserved 32 germplasms accessions of underutilized fruits in field gene bank representing papaya, 35 of litchi, 35 of aonla, papaya (32), karonda (30), 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.

Crop Production

- The propagation techniques under polyhouse conditions for underutilized fruits were standardized.
- High density planting (400 plants ha^{-1}) in Dashehari mango was found to increase the yield by 3 to 4 folds as compared to conventional planting (100 $plants^{-1}$).
- Crown thinning in mango resulted in higher yield.
- Rejuvenation techniques for old and unproductive mango and guava trees have been standardized and demonstrated in farmers' fields.
- Techniques for meadow orcharding and canopy management in guava have been standardized, recommended and popularised. These have been adopted by farmers in Maharastra, Andhra Pradesh, Haryana, Punjab, Rajasthan and Uttar Pradesh. The demand for Lalit guava has increases manifold as it was found highly responsive.
- Mango based cropping system has been developed and cowpea-potato system gave higher monetary returns in 10 years old orchards.
- Soil application of paclobutrazol @ 4 g $tree^{-1}$ (3.2 ml m^{-1} canopy diameter) was found to manage the problem of irregular bearing in mango cv. Dashehari resulting in increased flowering and fruiting. Mulching along with application of paclobutrazol (1.6 mlm^{-1} canopy diametre) was also found effective in improving yield.
- 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 was found efficient.
- 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 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 septumpunctata*, were found potential bio-control agents against hoppers.
- Critical limits of weather parameters were identified for forecasting the epidemic of hoppers and powdery mildew.
- Mango bacterial canker disease (MBCD) could be checked by spraying of Streptocyline (200 ppm) at 10 days interval. Antagonists *Bacillus coagulans*, *Pseudomonas spp*. and *Acenetobacter* 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±1°C) for 15 minutes.

- *Gliocladium roseum* was found associated with guava wilt disease and a revised technical programme .
- *Aspergillus niger* (AN17), *Trichoderma harzianum*, *T. viride* and *Penicillium citrinum* were found effective in integrated management of guava wilt.
- A cross (F1) 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 rootknot nematode, whereas the potency of entomopathogenic nematode has been demonstrated against insect pests under *in vitro* conditions.

Post-harvest Management

- Maturity indices for commercial mango cvs Dashehari, Langra, Mallika, Amrapali and Chausa were worked out.
- A simple low cost mango harvester with a harvesting capacity of 800 to 1000 fruits per hour was fabricated and demonstrated.
- Three temperature gradients for storage, *viz.* 12, 15 and 10°C, were worked out to enhance the shelf life of Dashehari, Langra and Chausa fruits up to 3, 2 and 3 weeks, respectively.
- Uniform ripening of early harvested mangoes could be achieved by dipping of fruits in 750 ppm ethrel in hot water (52 ± 2 oC) for 5 minutes.
- Corrugated fiber board (CFB) boxes of 2 and 4 kg capacities were fabricated for packaging and transportation of mango and guava fruits.
- Pre-harvest sprays of calcium chloride di-hydrate (2%) at 10 days interval was jelly seed found effective to reduce 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 with shelf-life of nine months.
- The techniques for preparation of sweetened and brined (salted) aonla segments and cider (aonla and guava) have been optimized.
- Protocols for the preparation of *mahua* (*Bassia latifolia*) and mango wine through alcoholic fermentation were optimized.
- A good quality vinegar from mango peel could be obtained by using *Acetobacter aceti* fermentation.

Transfer of Technology

Institute implementated sponsored training programmes on production, protection and post-harvest management of subtropical fruits for the benefit of orchardists and extension workers of different State Departments. Institute also provided training on different aspects of improved crop production technology in mango and other mandated fruit crops for scientists and development workers. A scientific nursery programme is being pursued and target groups were sensitized about different aspects of quality planting production.

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 3217 scientific and technical books and 7535 back volume of journals and subscribes 111 journals. Out of which 49 foreign journals are being subscribed as printed as well as in Internet version. 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.

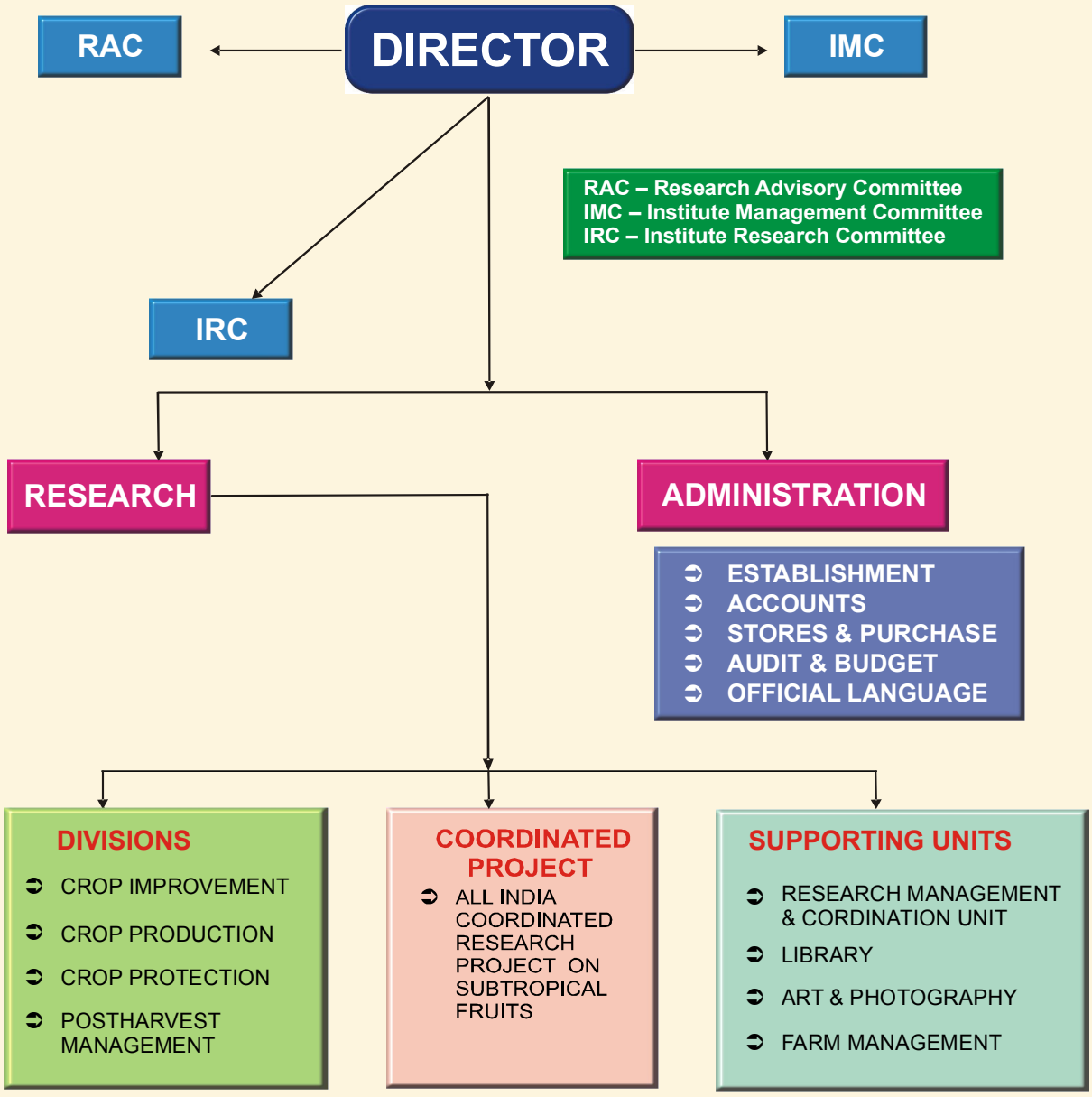
Art and Photography Cell

During the year, 3500 thematic photographs were generated and edited by image processing software for research and exhibition purposes. One hundred charts/graphs, 125 posters and 300 lasers/strips/ nameplates were prepared highlighting different research/ extension activities for publication of papers, technical/ extension bulletins and exhibitions.

Organizational Set-up

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

Organogram



Financial Set-up

Budget Allocation & Expenditure (2009-2010)

(in Rupees lakh)

Sl. No.	Head	Non-Plan		Plan		AICRP(STF)		A.P. Cess Fund Project		Externally Aided Project		Revolving Fund		NAIP	
		Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.	Budget	Expn.
1.	a) Estt. Charges	1120.96	1120.95	-	-	220.99	220.99	5.15	4.84	39.95	37.92	-	-	11.11	11.65
	b) Wages	25.10	24.92	-	-	-	-	-	-	-	-	-	-	-	-
	c) OTA	0.09	0.09	-	-	-	-	-	-	-	-	-	-	-	-
2.	T.A.	5.44	5.44	12.00	11.99	4.80	4.80	0.11	0.07	6.50	5.61	-	-	3.50	1.68
3.	HRD	-	-	3.00	3.00	-	-	-	-	-	-	-	-	-	-
4.	Other charges including Equipments	98.05	98.05	217.00	216.70	54.21	54.18	2.35	1.29	153.80	86.61	32.64	14.58	115.23	56.02
5.	Minor Works	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	Major Works	-	-	128.00	128.00	-	-	-	-	-	-	-	-	-	-
7.	AR&M														
a)	Residential Buildings	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b)	Office Buildings	0.86	0.85	-	-	-	-	-	-	-	-	-	-	-	-
	TOTAL :	1250.50	1250.30	360.00	359.69	280.00	279.97	7.61	6.20	200.25	130.14	32.64	14.58	129.84	69.35

Revenue Receipts (2009-2010)

(in Rs. lakh)

1.	Farm Produce	17.50
2.	Sale of Products	1.90
3.	Sale of Publication/Tender Forms etc.	1.05
4.	Guest House charges/License Fee/ Rent	5.27
5.	Training/Consultancy	1.42
6.	Auction of Vehicle/Other Machine tools	0.76
7.	Interest on "P" Loans	5.54
8.	Interest on TDR	6.40
9.	Electric/Water/Transport charges	16.78
10.	Misc. Receipts	0.13
11.	Sale of Mango Harvester	1.36
	TOTAL	58.11

Staff position (as on 31.03.2010)

Sl. No.	Category	Sanctioned	Filled
1.	RMP & Scientific	46	39
2.	Technical	57	52
3.	Administrative	25	23
4.	Supporting	44	41
	Total	**172**	**155**

Staff Changes

Promotion

Scientists

1. Dr. (Smt.) Anju Bajpai, Scientist (SS) granted merit promotion to the post of Senior Scientist(Biotech.) w.e.f. 25.07.2004.
2. Dr. Achal Singh, Scientist (SS) granted merit promotion to the post of Senior Scientist w.e.f. 28.09.2007.

Joining

1. Dr. A. K. Shukla, Principal Scientist joined on 09.06.2009.
2. Dr. P.K. Shukla, Senior Scientist joined on 19.08.2009.
3. Dr. H.C. Verma, Scientist (S.S.) (Computer Appl.) joined on 04.08.2009.
4. Miss Nimisha Sharma, Scientist (Bio-Tech) joined on 19.08.2009.

Superannuation

1. Dr. Bankey Lal, Principal Scientist superannuated on 31.05.2009.
2. Kailash Chandra, Assistant superannuated on 31.08.2009.
3. Shri. Manohar Lal, Skilled Support Staff superannuated on 31.12.2009.
4. Shri Sahib Deen, Skilled Support Staff superannuated on 31.01.2010.
5. Shri Radhey Lal, Field Technician superannuated on 28.02.2010.

Obituary

1. Shri S. K. Saxena, T (7-8) T. O. (Lib.) expired on 30.09.2009.

4. RESEARCH ACHIEVEMENTS

CROP IMPROVEMENT

MANGO (*Mangifera indica* L.)

Germplasm collection, characterization, evaluation and documentation

Collection **:** Thirty accessions, *viz.* Jhumkya, Kaonba, Amari, Belia, Bunch Type, Madragi, Jhapya, Aswina, Arajanma, Lakshman Bhog, Babul Dofala, Gopal Bhog, No. 10, Chini Dofala, Kuopahar, Mulayam Jam, HM 09-5, HM 09-6, Hm 09-1, Hm 09-2, HM 09-3, RH/SM 09-7, RH/SM 09-8, HM 09-7, HM 09-8, HM 09-9 , HM 09-10, HM 09-11, RH/SM 09-1 and RH/Sm 09-2, were collected from Nandubar, Jalgaon, Malda, Pantnagar and Bihar.

Characterization: Among the available accessions in field gene bank 150, 200 and 120 accessions were characterized for fruit characteristics, vegetative (leaves and panicles) and DUS parameters, respectively.

Evaluation: Three varieties, *viz*. Sawan (HVB2), RKS Early and Langra Ilham Pasand, were evaluated for their processing potential beverage. The variety Sawan had the highest TSS (23.4°B), while RKS Early had the highest carotenoids (5.82 $mg100g^{-1}$). Beverage prepared from Sawan was the most acceptable.

Documentation: Characterization data (60 accessions) for development of second volume of catalogue was collected with respect to leaf and panicle characters. Search module was developed with option for IC number or name based search. Information on the accessions catalogued earlier were also added to the database. Information system and interactive database were improved and updated. National database for mango gene bank holdings was developed and updated.

Field gene bank

Thirty two accessions namely Abu Saeed Wali Kakran, Oliveira-Neto, *Mangifera odorata,* Lat Sundari, Vastara, Itruiba, Bag-e-Bahar, Kalua, Babul Pasand, Tamancha, Buponix, M-30, Chinkhu MY, PFN-19, NR-10, Bombay Tel, Xavier, Garacharma, Tenneru, Sona Tol, Nasik Pasand, NR-4, Calcutta Malda, NR-40, Calcutta, UA SELL-2, MA III, Maharaj Bhog, Pacharasi, Malda Khajari, Paiyur - 1, Navaliasmadi and Gauri Bhog were integrated into the field gene bank.

Molecular characterization

Characterization and marker development

One hundred and fifty accessions were characterized with a set of 18 SSR primers.Cultivar specific markers were developed with the help of SSR genotyping which are under validation. Genetic analysis of 18 microsatellite loci was undertaken to test Hardy Weinberg Equilibrium for determining proper selection of markers to carry forward MAS. Genetic using Power Marker V3.25 software was adopted to calculate expected (HE) and observed (HO) levels of heterozygosity and to test Hardy-Weinberg equilibrium (HWE). PIC values to measure diversity values indicated moderate to high range from 0.436 to 0.855 for the analyzed loci suggesting existence of appreciable variability. Heterozgosity ranged from 0.366 to 0.993 for HO and from 0.537 to 0.867 for HE. P values of seven loci showed significant deviation from HWE ($P<0.05$) in this population and showed heterozygote deficiency, which can be accounted by unequal allele distribution probably arising due to selection of horticultural traits and further clonal propagation.

Diversity analysis

Molecular diversity study in the population of cultivars from North and East India based on SSR markers recorded gene diversity estimates varying from 0.537 to 0.867. This was further substantiated by structure analysis which revealed that the population comprised of admixture of two subpopulations, corroborating the derivation of accessions from North and Eastern parts of India being contiguous.

Clonal variability in Dashehari

Molecular variability was studied among 13 Dashehari clones and 1 Mother Dashehari (collected from Dashehari village, Kakori, Lucknow), with 8 SSR primers. For 8 primers screened, amplification was obtained in 7 primers, and confirmed by agarose gel electrophoresis. (Fig.1)

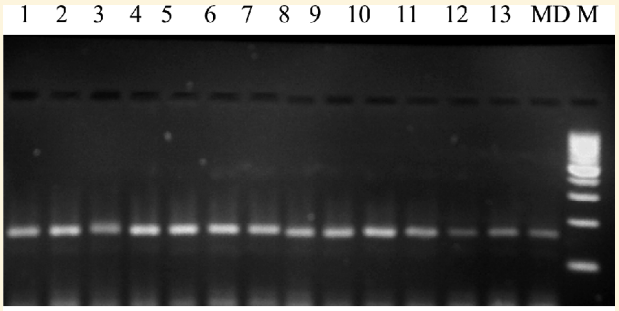


Fig.1 : Agarose gel profile of SSR products amplified using FMID06 for 13 Dashehari clones and Mother Dashehari. 1 -13: Clones, MD: Mother Dashehari, M: Marker.

Hybridization

Hybridization was carried out for developing varieties with red peel colour, regular bearing, dwarf, malformation resistance and tolerance using 21 cross combinations and 60363 flowers were crossed on 13766 panicles (Tables 1 and 2).

Table 1 : Parental cross combinations in hybridization (2009-10).

Cross combination	Panicles (No.)	Flowers (No.)
Amrapali x Ambika	666	3246
Amrapali x Arunika	1980	8936
Amrapali x Sensation	691	3280
Amrapali x Tommy Atkins	704	3021
Arunika x Ambika	106	433
Dashehari x 13-1	200	776
Dashehari x Ambika	1209	5710
Dashehari x Arunika	1349	6332
Dashehari x Sensation	745	3502
Dashehari x Tommy Atkins	2081	8994
Dashehari x Vanraj	813	3713
EC 95862 x 13-1	80	290
EC 95862 x Tommy Atkins	200	666
Elaichi x Arunika	283	924
Goa x 13-1	132	534
Kensington x Tommy Atkins	190	699
Mallika x Ambika	100	347
Mallika x Arunika	532	1989
Neelum x Arunika	1395	5873
Starch x 13-1	160	554
Starch x Chinkhu	150	544
Total	**13766**	**60363**

Table 2 : Parental cross combinations tried for different objectives in focus.

Cross	Q+C	RB+D	D+SIS	MFR
Amrapali x Ambika	+	+		
Amrapali x Arunika	+	+		
Amrapali x Sensation	+	+		
Amrapali x Tommy Atkins	+	+		
Arunika x Ambika	+	+		
Dashehari x 13-1	+	+		
Dashehari x Ambika	+	+		
Dashehari x Arunika	+			
Dashehari x Sensation	+			
Dashehari x Tommy Atkins	+			
Dashehari x Vanraj	+	+		
EC 95862 x 13-1			+	
EC 95862 x Tommy Atkins	+	+		
Elaichi x Arunika				+
Goa x 13-1			+	
Kensington x Tommy Atkins	+	+		
Mallika x Ambika	+			
Mallika x Arunika	+			
Neelum x Arunika	+			
Starch x 13-1			+	
Starch x Chinkhu			+	

Q= Quality, C=Peel colour, D= Dwarfing, RB= Regular bearing SIS=Salt induced stress, MFR= Malformation resistance.

Table 3: Raising of hybrid progenies for evaluation (2008-09).

Cross combination	Panicles used (No.)	Flowers crossed (No.)	Fruits harvested (No.)	Stones germinated (No.)
Amrapali x Ambika	350	1447	7	7
Amrapali x Arunika	562	2420	14	14
Amrapali x Tommy Atkins	100	384	-	-
Amrapali x Sensation	170	699	5	5
Arunika x Ambika	50	194	4	4
Dashehari x 13-1	433	1676	47	38
Dashehari x Van raj	650	2520	15	11
Dashehari x Arunika	2906	11914	65	40
Dashehari x Sensation	1235	5049	111	88
Dashehari x Tommy Atkins	765	2830	75	40
EC 95862 x 13-1	449	1763	-	-
EC 95862 x Arunika	314	1061	-	-
EC 95862 x Tommy Atkins	350	1173	6	5
Elaichi x Arunika	115	403	8	6
Goa x 13-1	112	327	2	2
Kensington x Tommy Atkins	200	654	-	-
Neelum x Arunika	654	2227	6	4
Mallika x Arunika	300	1138	-	-
Starch x Manipur Dwarf	200	811	3	2
Starch x 13-1	100	438	1	1
Total	**10015**	**39128**	**369**	**267**

Establishment of hybrids: Two hundred and sixty seven hybrid progenies were obtained from 20 hybrid combinations attempted in 2008-09, targeting improvement in few traits, *viz*. quality, peel colour, dwarfing and salt induced stress in rootstock and malformation resistance (Table 3). However, fruits could not be obtained from five cross combinations.

Evaluation of hybrids: Among one thousand and eleven hybrids evaluated for fruit characteristics, *viz*. fruit weight, length, width, and thickness, peel weight, stone weight, pulp per cent, stone length, width, thickness and TSS, H-1084 and H-949 were found promising.

Five mango hybrids were evaluated for pickle in oil. Sensory evaluation of pickles indicated that H-935 had the best potential.

Rootstock standardization

The plants of nine polyembryonic varieties, *viz*. 13-1, Turpentine, Sabre, Peach, Starch, Philippino, Kensington, Kitchnar and EC 95862, and one monoembryonic Rumani, as rootstocks were planted in the field with Dashehari scion. The difference in growth pattern at initial stage of plants was non-significant. Five varieties (rootstocks) flowered during the year. Maximum fruit yield (45.0 kg plant^{-1}) was recorded in Starch followed by Peach (28.0 kg plant^{-1}).

GUAVA (*Psidium guajava* L.)

Germplasm collection, characterization and evaluation

One hundred and twenty three accessions including six *Psidium* species were maintained in field the gene bank. Accessions have been clonally propagated for integration in field gene bank. Eleven accessions, one from Malda and 10 from Allahabad, were collected which had been identified during earlier surveys but could not be established successfully at CISH, Lucknow. Fifteen accessions, maintained in FGB, were multiplied for field planting.

Evaluation

Clonally multiplied selections, *viz*. CISH-G-1, CISH-G-5, CISH-G-6 and CISH-GS-35, were evaluated for their yield and TSS In half-sib population CISH-GS-35 indicated high yield with attractive fruit peel, colour, soft seeds and TSS (14°B). Thirty accessions were evaluted for fruit characteristics. Five guava varieties were evaluated for their processing potential and the best beverage was obtained from HPSI-6.

Hybridization

For incorporating genes responsible for anthocyanin bio synthesis in the pulp, the parental cross combinations of Lalit x Purple Guava and reciprocal cross were attempted. Hybrid population (5 cross combinations) targeted towards developing red peel and red pulped varieties, 206 hybrid seedlings were planted in the field. Lalit x Purple Guava produced majority hybrid seedlings with pink pulp. Since red pulp colour was found linked with seed hardiness, 52 hybrid seedlings were evaluated for seed hardiness and segregation.

Molecular characterization

Nineteen cultivars were characterized by 8 nuclear SSR loci based on (GA)n and (GT)n enriched microsattelite library developed and reported at CIRAD, France. Good discriminatory power was evidenced by these markers in respect of the accessions tested. Interspecies variations were assessed in *Psidium molle*, *Psidium cattleianum*, *P. cujavillis*, *P. friedrischthalianum*, *Phillipine guava(P. guajava)*, *P. guineense*, *P. acutangula*, *P. chinensis* and *P. guajava* (Allahabad Safeda) using 6 SSR markers(reported earler)which amplified 20 alleles. Interspecies variability assessed best by *mPgCIR* 16 primer with allelic weight in range of 250-300bp.Genetic relationships among species could be defined using this marker data, which is important for carrying out interspecific hybridization and molecular breeding. Primers mi*Pg*CIR 09 and mi*Pg*CIR 16 were found more informative for discrimination (Fig.2).

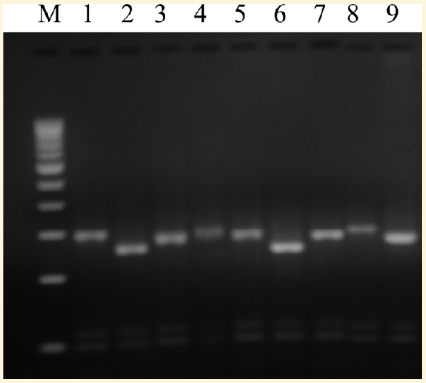


Fig.2 : Agarose gel profile of SSR products amplified by mi*Pg*CIR 16 for guava species. 1 - 9: Guava species, M: Marker.

PAPAYA (*Carica papaya* L.)

Germplasm evaluation and characterization

Growth and fruiting behaviour: Fifteen accessions were evaluated for growth and fruiting behaviour. Maximum plant height (3.10 m) was recorded in CISH P-1 followed by cv. Sunset Solo (2.86 m). Canopy spread in N-S (2.41 m) and E-W (2.54 m) directions were maximum in cv. Sunset Solo followed by CO-6 with 2.55 m in N-S and 2.53 m in E-W directions. The fruiting started at minimum height (0.25 m) from ground level in cv. Pusa Nanha followed by 0.41 m in Red Lady.

Yield and quality : Maximum fruit yield was recorded in cv. CO-7 (54.25 kg plant^{-1}) followed by Red Lady (53.62 kg plant^{-1}), Innivet - 2000 (52.15 kg plant^{-1}) and Pusa Nanha (51.27 kg plant $^{-1}$). The average fruit weight was maximum in cv. Red Lady (2.25 kg) and Innivet - 2000 (2.25 kg) followed by Farm Selection (2.00 kg), CO-7 (1.87 kg) and Pusa Nanha (1.75 kg). The maximum TSS (11.80°B) was recorded in CO-7 followed by Red Lady (11.6°B) and Farm Selection (11.6°B).

Maintenance of genetic purity

Papaya seeds were produced by controlled pollination to maintain genetic purity of identified lines. A total number of 14 cultivars/accessions were sib mated for production of true to type seeds of individual cultivars/accessions. Two hundred fifty one flowers were sib mated and 190 fruit sets were recorded. The seed weight varied from 1.129 to 6.352 g fruit $^{-1}$ in different cultivars.

Hybridization

Five parental entries possessing desirable characters like fruit weight, colour and firm pulp were used in different cross-combinations including reciprocals. A total number of 53 crosses were made with 43 fruit sets. The seed weight varied from 1.385 to 6.143 g fruit $^{-1}$. Germination of seeds took 9 to 12 days in all the crosses. Germination percentage varied from 60 to 90 per cent in Pusa Delicious x CO-7 (90%), CO-7 x Pusa Delicious (85%), A-3 x Kalepura (80%) and A-1 x A-2 (60%). Hybrids progenies planted in the field showed that Red Lady x CO-7 recorded the highest yield (48.96 kg plant^{-1}), fruit size and TSS (11.20°B). All the five hybrids were sibbed and backcrossed.

Genetic transformation for PRSV resistance

A total number of 50,000 explants were targeted for *Agrobacterium* mediated transformation. The explants were selected under different levels of kanamycin (50,100 and 150 mg l^{-1}) for 4-5 months. Kanamycin resistant plantlets were further rooted and shifted in cocopeat based medium. Out of 12 plants which showed PCR positive for *cp*, *npt-II* and *rep* gene, only 5 plants were found positive for Southern analysis (Fig.3). These plants were then shifted to soil under containment conditions and challenged 4 times with PRSV in different months. Out of these, only one T0 plant showed mild symptoms of PRSV disease so far. Five such T0 plants were developed and kept under containment (Fig.4) for evaluation.

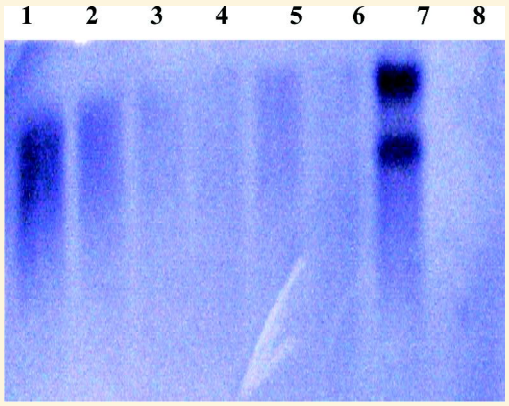


Fig.3: Southern analysis of transformants of papaya

1 to 6= Transformants

7 = Plasmid pBinAR

8 = Negative Control (DNA of non transformed papaya)

Fig 4. T0 plants in containment facility

LITCHI (*Litchi chinensis* Sonn)

Germplasm evaluation

Yield and quality : Out of twenty one varieties that came into bearing, higher yield was noted in Early Large Red (58.0 kg tree^{-1}) followed by Green (50.7 kg tree^{-1}). Maximum fruit weight (30.0 g) and fruit size (length- 4.1 cm and diameter- 3.8 cm) were recorded in Seedless- 1 and minimum (fruit weight 18.4g, length 3.3 cm and diameter 3.1 cm) in Rose Scented. Maximum aril (83.3%) and minimum (3.3%) seed were recorded in Seedless–1, while maximum (27.0%) seed and minimum (53.4%) aril were obtained in Calcuttia. Maximum (20.0%) peel content was recorded in Kasba, while it was minimum (10.0%) in Early Large Red. Maximum TSS (22.0 °B) was observed in Ajhauli followed by Kasailiya (21.4°B), Shahi (21.0°B), Pickling (21.0°B) and Large Red (21.0°B), whereas it was minimum (18.6°B) in Early Large Red.

Flowering behaviour: 26-day variation (February 2 to 28, 2010) was observed in panicle emergence among different varieties. Early panicle emergence was recorded in Kasailiya and late in Seedless-1 and Mandraji. Flower opening started early in Deshi, Kasailiya and Mandraji while it was late in Rose Scented, Longia, Early Seedless, Calcuttia, Early Large Red and Maharaj Singh. Large Red, Kasailiya, Pickling and Rose Scented took more days (38 to 41) from panicle emergence to flower opening, whereas Mandraji took minimum period (13 days).

Molecular characterization

Twelve SSR primers were used and touch down PCR conditions were optimized for DNA amplification of 28 litchi cultivars collected from NRC Litchi, Muzaffarpur. Out of twelve SSR primers screened, six SSR primers detected reproducible profiles. A total of 31 bands were detected with an average of 5.1 bands per SSR. Allele frequencies ranged from 0.307 to 0.5, with a mean of 0.435. Heterozygosity estimates were very low (0.0385 to 0.0769). Cultivar Shahi was characterized by allelic configuration of 87/92, while China by 88/93. Population variability within cv. China was recorded by LMLY8, which however needs additional verification. LMLY8 was most descriptive locus which generated unique profiles for Late Bedana, Longia, CHL-7, Dehradun and Dehrarose. LMLY3 could discriminate CHL-3 and Bombay No.1. The banding pattern indicated presence of indels in litchi SSR.

Twenty primers of OPX series were screened for RAPD-PCR of 12 selected litchi cultivars from CISH FGB. Out of 12, 8 primers (OPX-01, OPX-02, OPX-05, OPX-06, OPX-14, OPX-17, OPX-18 and OPX-19) produced prominent amplicons of reproducible nature in all the cultivars (Fig.5). The number of scorable bands was in the range of 8 to 14 with an average of 11 bands per primer. A total number of 91 bands were scored for which the fragment sizes were determined. The molecular sizes of fragments varied in the range of 234 to 2345 bp. OPX-5 resulted in 100 per cent polymorphism followed by maximum polymorphism generated by primers OPX-17 (87.5%) and OPX-18 (81.3%). RAPD marker OPX-14 produced the least of polymorphism (33.3%).

Cluster analysis was performed using NJ and UPGMA methods. The Jaccard's similarity coefficients ranged between 0.52 to 0.85. The two important cultivars China and Shahi are placed in two different subgroups (Fig.6).

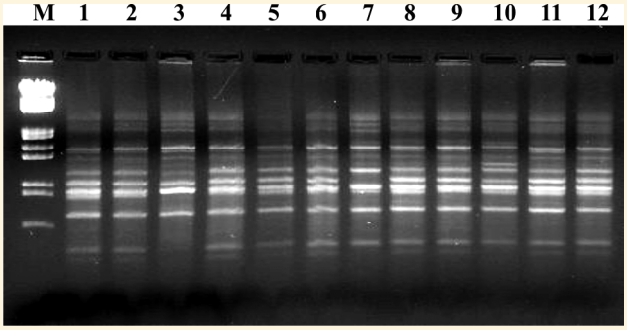


Fig.5 : Agarose gel profile of PCR products amplified by OPX6. M- ëDNA/*Eco*R I/*Hin*D III double digest (Marker), 1-Shahi, 2-Turkolia, 3-Swarnaroopa, 4-Purbi, 5-Dehradun, 6-China, 7-Bedana, 8-Elaichi, 9-Calcuttia, 10-Kasba, 11-Rose Scented, 12-Mandarji.

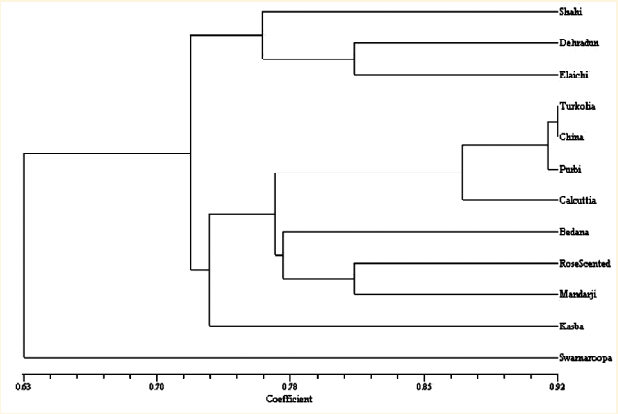


Fig.6 : Dendrogram showing genetic relationship among 12 litchi cultivars using UPGMA cluster analysis calculated from 91 RAPD markers.

AONLA (*Emblica officinalis* Gaertn.)

Germplasm collection and evaluation

Surveys were conducted in Rewa, Katni, Shivini, Mandla and Jabalpur districts of Madhya Pradesh to identify superior seedling type having bigger fruit size, good yield, heavy and regular bearing with high ascorbic acid and phenol contents. A total number of fifteen potential germplasm were marked *in situ* and passport data were collected. Fruit samples were collected and analyzed for fruit weight (9.40 to 46.00g), fruit length (2.31 to 3.32 cm), fruit width (2.61 to 3.85 cm), stone weight (0.78 to 1.42g), TSS (8.2 to 11.3°B), titratable acidity (1.83 to 3.22%), ascorbic acid (266.9 to 412.3mg $100g^{-1}$), total sugars (5.62 to 6.707 %), reducing sugars (3.149-4.55%) and total polyphenols (2.16. to 3.14 %).

Field gene bank

Twenty one accessions of aonla, collected from different parts of MP, were field planted along with four known commercial check varieties, *viz.* NA-7, Krishna, Kanchan and Lakshmi-52, for evaluation during the year 2007. After their establishment, data on morphological parameters was recorded. Maximum plant height (3.70m) was recorded in CISH-A-2, while minimum (1.15m) in CISH-A-3. Maximum plant circumference (13.10cm) was recorded in CISH-A-12, while it was minimum (4.8cm) in CISH-A-11. Maximum plant spread (2.80 and 3.00m) in E-W and N-S directions were recorded in accession number CISH-A-13, while minimum (1.20 and 1.15m) in accession CISH-A-5.

BAEL (*Aegle marmelos* Correa)

Germplasm collection and evaluation

Survey was conducted in the Eastern UP and twelve accessions were collected. Considerable variability was found existing in respect of physico-chemical characteristics among the accessions. The fruits were round to oval in shape from a weight ranging from 0.75 to 2.15 kg and 33-166 number of seeds. TSS of the pulp ranged from 32-35°B, ascorbic acid from 9.0 to 18.9 mg $100g^{-1}$, total sugars from 15.27 to 15.83 per cent and reducing sugars from 8.47 to 15.83 per cent.

Field gene bank

Thirty four clonally propagated bael accessions were planted in the field gene bank for evaluation. Plant height varied from 1.06 to 3.53 m, stem girth from 4.00 to 12.20 cm and plant spread in E-W direction from 0.56 to 1.85 m and N-S direction from 0.53 to 1.87m.

A total number of 146 seedlings raised from promising bael germplasm were planted during the year 2002-2003 were evaluated for growth parameters, *viz.* plant height and girth which varied from 1.60-6.54 m and 5.8-18.2 cm, respectively.

JAMUN (*Syzigium cuminii* Skeel)

Germplasm collection and evaluation

Nine accessions were collected from different parts of UP and Gujarat. Out of these, two seedless accessions were sourced from Varanasi and one accession superior type obtained from CHES, Godhra were vegetatively propagated and planted for field evaluation. Fifty two germplasm accessions were evaluated and 38 promising ones were established in the field gene bank. Fruits of nine promising accessions that came into bearing were evaluated for physico-chemical attributes. Observations were recorded in respect of fruit weight (5.77 to 19.73 g), length (2.06 to 3.81 cm), diameter (1.94 to 2.98 cm), pulp weight (4.34 to 17.79g), pulp content (75.22 to 97.88 %), seed weight (0.14 to 1.94 g), pulp: seed ratio (3.03 to 46.38), TSS (12.1 to 17.23 °B), titratable acidity (0.524 to 0.737 %), TSS: acid ratio (16.36 to 32.96), total sugars (5.44 to 11.10 %), tannins (0.709 to 0.903 %), anthocyanins (112.84 to 156.23mg $100gm^{-1}$) and ascorbic acid (30.40 to 44.37mg $100g^{-1}$).

Superior type: Seedless germplasm accessions of jamun CISH J-42, selected from Chandauli district of UP (Fig.7), was multiplied by soft wood grafting and planted at CISH field gene bank during 2009. *In situ* evaluation indicated that one accession was precocious under Lucknow conditions. Fruits were ovoid, seedless with good taste. Fruit length (2.57 cm), breadth (2.18 cm), average fruit weight (6.87g), pulp (97.88%), TSS

Fig.7 : CISH J-42

(13.5°B), ascorbic acid (32.26mg100g^{-1}), tannins (0.735%) and anthocyanins (135.42mg 100g^{-1}) were recorded. Total antioxidant value of this accession was 69.28 DPPH (% inhibition) and 112.38 FRAP (mg AEAC g^{-1} FW). It also recorded a total phenol content (256.29 mg g^{-1}) and flavonoids (0.50 mg g^{-1}). The selected accession has good processing potential due to absence of seed.

KHIRNEE (*Manilkara hexandra* Toxb.)

Germplasm collection and evaluation

Twenty eight elite accessions were established in the field gene bank. Survey was carried out in Lucknow and adjoining areas, Bundelkhand region of Lalitpur and Ashoknagar, MP to identify accessions having bold fruits with low seed content. The mature fruits of 8 superior accessions were analyzed for fruit weight (1.49 to 2.05 g), length (1.66 to 2.24 cm), diameter (1.15 to 1.35 cm), pulp weight (1.35 to 1.85g), seed weight (0.13 to 0.18 g), number of seeds per fruit (1.00 to 1.58), TSS (31.3 to 35.8 °B), titratable acidity (0.23 to 0.33 %), ascorbic acid (10.17 to 19.72 mg 100g $^{-1}$), reducing sugars (3.75 to 4.47 %) and total sugars (11.94 to 14.36 %) (Fig. 8).

Fig. 8 CISH J-42

KARONDA (*Carissa carandas* L.)

Germplasm collection and evaluation

Thirty superior accessions were planted in field gene bank for evaluation of growth and fruiting pattern. Four new accessions, collected from CHES, Godhra and central parts of UP, were added to the field gene bank.

MAHUA (*Bassia latifolia* Roxb.)

Germplasm collection and evaluation

Twenty elite accessions of mahua, collected from different places, were planted in the field gene bank for evaluation in 2006-08. Fourteen accessions were added from adjoining areas of Lucknow in 2009 to the collection.

WOOD APPLE (*Ferronia Limonia* L.)

Germplasm collection and evaluation

Twenty superior genotypes were vegetatively propogated by soft wood grafting and planted in the field gene bank in 2006.

TAMARIND (*Tamarindus indica* L.)

Germplasm collection and evaluation

Twenty-eight accessions including varieties of tamarind were planted in the field gene bank during 2005-08. Fruits of seventeen superior accessions collected from Ashoknagar (MP) and Lalitpur (UP) were appraised for different physio-chemical parameteres.

The shape of pod was curved and straight with colour ranging from light to deep brown. Pulp colour varied from light to redish brown. The other attributes recorded were pod weight (13.14 to 19.68 g), length (11.03 to 19.73 cm), breadth (2.37 to 2.69 cm), pulp weight (3.92 to 7.39 g), pulp percentage (24.67 to 37.55%), number of seeds per pod (4.67 to 8.33), seed weight (3.15 to 5.14 g), shell weight (6.03 to 8.42 g), fibre (2.16 to 4.18 g), TSS (49.8 to 69.5°B), titratable acidity (4.97 to 10.16 %), reducing sugars (18.22 to 28.13 %), total sugars (37.56 to 46.87 %) and ascorbic acid (17.8 to 21.0 mg 100 g^{-1}).

CHIRONJI (*Buchanania lanzan* Spreng.)

Germplasm collection and evaluation

Survey was carried out in Bundelkhand region (UP) in 2008. Not much variation in fruits (size and colour) was recorded. The seedlings raised were planted in the field gene bank.

CAPE GOOSEBERRY (*Physalis peruviana* L.)

Germplasm collection and evaluation

Seedling population of five accessions of cape gooseberry were raised and planted in the field gene bank in 2009. Mature fruits of two elite accessions were analyzed for fruit weight (12.81 to 12.84 g), length (2.26 to 3.19 cm), diameter (2.55 to 3.05 cm), panicle length (3.21 to 3.51 cm) and TSS (16.4 to 17.0 °B).

CROP PRODUCTION

MANGO (*Mangifera indica* L.)

Micropropagation

***Evaluation of PGPR activity in micro propagated plantlets*:** Four PGPR cultures sourced from IIHR, Bangalore were evaluated. Colony count of different PGPR ranged between $13x10^5$ and 76x105 cfu cm^{-2}. Appropriate cell density of the cultures (OD) at 600 nm for inoculum preparation varied from 0.418 to 1.00401. All these PGPRs are being tried in mango for enhancing survival of micropropagated plantlets.

Somatic embryogenesis

Effect of phytohormones: Somatic embryogenesis system has been developed in mango cv. Dashehari. Different plant growth regulators were fortified in the medium and well developed cotyledonary embryos were transplanted to examine efficacy of bioregulants on conversion. IAA (0.1 mg l^{-1}) helped in germination of 86 per cent embryos and converted 28 per cent embryos into normal plantlets, whereas IAA (0.2 mg l^{-1}) converted 5 per cent embryos into plantlets. None of the other phytohormones, *viz*. kinetin and GA_3, helped in conversion of embryos. Though few embryos germinated in kinetin but failed to convert embryos germinated into plantlets (Fig. 9).

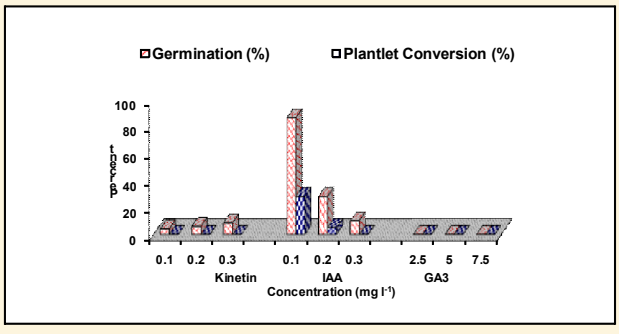


Fig. 9: Effect of phytohormones on plantlet conversion

Size optimization of transplanted embryos: The major problem in mango embryogenesis system is unpredictability of embryos' conversion into plantlets and lack of adventitious root system. The experiments indicated that 2 cm long embryos were optimum in terms of their conversion potential and around 32 per cent of them developed into normal plantlets (Fig. 10), whereas longer (3 cm) embryos had difficulty in conversion and only 18 per cent of them developed into plantlets. The size of embryos however did not influence their germinability.

Fig. 10: Conversion of transplanted embryos

Phenological stage of embryos: Not only the size but also phonological stage of embryos influenced regeneration and ultimate plant production. Three different stages of embryos, *viz*. early cotyledonary, mid cotyledonary and advance cotyledonary, were exposed to solid regeneration medium (modified MS). The data revealed that advance cotyledonary stage embryos were more amenable to conversion than early or mid stage (Fig. 11). Around 25 per cent embryos of advance stage converted into plantlets in solid medium, whereas mid or early cotyledonary embryos did not convert into plantlets. The conversion of same stage of embryos was significantly higher (33%) in liquid medium than solid medium.

Fig. 11: Advance cotyledonary embryo

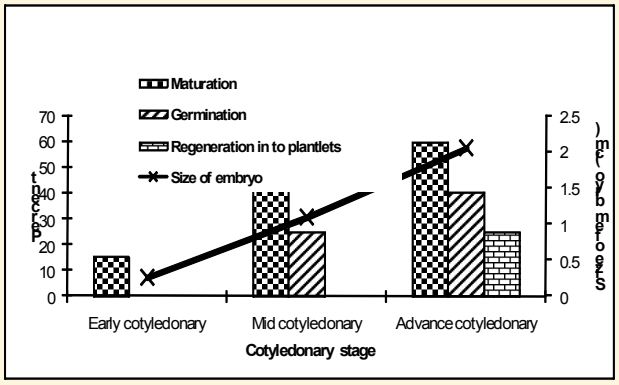


Fig. 12: Effect of phenological stage of embryos on conversion

***In vitro* rooting**: Germinated mango embelings have long black tap root and are brittle and have almost no vascular connection. Hence, the healthy shoots of mango were subjected to IBA, NAA, paclobutrazol, phloroglucinol and putriscein treatments. The treatment with IBA (2 mg l^{-1})+ NAA (1 mg l^{-1}) produced 74.6 per cent roots under *in vitro* conditions (Plate 1.) followed by IBA+NAA (1mg l^{-1} each), which recorded 59.8 per cent roots. Paclobutrazol and putriscein remained at par in terms of root induction. However, these plants failed to survive due to shoot necrosis when shifted to potting mixture.

Plate 1. *In vitro* rooting

Quality planting material production

Substrate and growth condition: Efforts were made to standardize substrate for raising mango seedlings in polythene bags using different combinations of soil and FYM (1:1) and soil : FYM : cocopeat (5 : 4: 1 and 10: 9: 1). Water soluble fertilizer containing N (19 %), P (19 %) and K (19 %) @ 0.4 per cent, was used for spray at monthly intervals. Data recorded at 180 days after transplanting revealed the range of plant height from 20.4 to 35.6 cm, stem diameter from 0.42 to 0.63 cm and number of leaves from 4.8 to 11.4. Non-significant differences were observed in respect of different substrate combinations.

***Wedge and veneer grafting*:** Two methods of vegetative propagation, *viz.* wedge and veneer grafting, were compared. The scion shoots defoliated at 0, 4 and 8 days prior to grafting were used. Grafts were kept in green house and open conditions with or without polythene capping. Among methods of grafting, wedge grafting gave better success over veneer grafting in all the months under both green house and open conditions. The graft success varied from 53.3 to 98.8 per cent during different months in green house with polythene capping and with scion shoots defoliated 8 days prior to grafting. Maximum (98.8%) success rate in wedge grafting was obtained in the month of January. Graft success ranging from 40 to 89.9 per cent was recorded without polythene capping in green house, while it was reduced to 9.6 to 60 per cent under open conditions with polythene capping. In case of veneer grafting, graft success of 38.4 to 53.33 per cent was recorded during May to September, while it was reduced to 10.7 to 40.5 per cent during October to January.

Planting density

Planting density: In an established 17 year old Dashehari orchard, planted at different densities, *viz.* 1600, 800, 400, 266, 178 and 100 plants ha^{-1}, observations on vegetative growth parameters and yield were recorded. Maximum fruit yield (13.15 t ha^{-1}) was observed in medium density planting (400 plants ha^{-1}) followed by 9.55 t ha^{-1} in 266 plants ha^{-1} and the lowest (4.00 t ha^{-1}) in traditional planting (100 plants ha^{-1}).

Canopy architecture

***Canopy engineering*:** Canopy modifications were effected by crown thinning and crown reduction on 23 year old Mallika plantation. Fruit yield was the highest (68.30 kg $tree^{-1}$) in crown thinning treatment followed by 60.5 kg $tree^{-1}$ in crown reduction treatment. The lowest fruit yield (45.55 kg $tree^{-1}$) was recorded in untreated. Fruits with weight range of more than 350 g, 300 to 349g and less than 300g were classified as A, B and C grades. Maximum A grade fruits (37.0 %) were obtained from crown thinning treatment followed by 33.75 per cent in crown reduction and 20.5 per cent in control. TSS and total sugars content observed in fruits were 23.50, 22.80 and 22.6 ^{0} B and 17.50, 16.50 and 16.25 per cent in crown thinning, crown reduction and control, respectively.

Canopy heights in cv. Mallika were divided into two vertical grids (0 to 2.0 and 2.1 to 4.0m), while there were three grids for control (0 to 2.0, 2.1 to 4.0 and above 4.0m). Higher fruit yield was recorded in lower grid (53 % in crown reduction, 58 % in crown thinning) as compared to upper grid (47 % in crown reduction, 42 % in crown thinning). In control, higher fruit yield (50 %) was observed in middle grid (2.1 to 4 m) followed by 44 per cent in lower grid (0 to 2.0m).

Heading back: Heading back operations were performed at 1.0 and 1.5 m from the ground level in high density plantation (1600 plants ha^{-1}) of cvs Dashehari and Amrapali during December 2005. After four years of growth, average plant height were 2.10 and 2.35 m and 2.05 and 2.10 m in 1.0 and 1.5 m headed back Dashehari and Amrapali trees, respectively. Fruit yield in Dashehari and Amrapali were 8.65 and 10.20 kg $tree^{-1}$ in 1.0 m and 10.15 and 12.25 kg $tree^{-1}$ in 1.5 m headed back trees respectively.

Effect of branch orientation on fruit production: In mango cv. Dashehari, the most productive branch orientation was identified as 30-60 ^{0} from vertical axis as there were maximum fruits (48.25 %) on these branches. Least fruit production (9.35 %) was recorded from narrow oriented (<30^0) branches.

***Pruning*:** In cv. Dashehari, where July, 2009 pruning was coupled with paclobutrazol application @ 1.6 ml $tree^{-1}$ along with recommended dose of fertilizers and manures, 95.5 per cent newly emerged shoots produced panicles during February, 2010, whereas in treatment where July, 2009 pruning alone was carried out 15.50 per cent newly emerged shoots produced panicles and rest remained vegetative.

Substrate dynamics for IPNM

The experiment on mango cv. Dashehari, conducted with 18 treatment combination comprising *FYM,* vermicompost, NPK, *Azotobacter, Trichoderma harzianum and phosphorus solublizing micro organisms,* was in the fourth year. Plant height and stem girth in different treatments varied from 1.31 to 1.98 m and 11.5 to 29.7 cm, respectively. Canopy spread in N-S direction ranged beween 0.79 to 1.37 m, while in E-W direction it was between 0.75 to 1.42 m. No significant effect of various treatments on these growth parameters was observed. There was an increase of 53.6 - 60.0 per cent in organic carbon content over the initial level (0.320 %) by the application of different substrates. Maximum organic carbon build up (0.492 %) was recorded in treatments amended with 10 kg vermicompost, NPK (100, 50, 100g $tree^{-1}$ $year^{-1}$ of age), *Azotobacter*, PSM and *Trichoderma harzianum* along with organic mulch (10 cm thick) as against 0.320 to 0.390 per cent where neither FYM nor vermicompost was applied. Available P and K were minimum (16.6 and 52.5 ppm) in the treatments which received no P or K fertilizers. In general, status of available N and K were low and available P was high in all the treatments. DTPA extractable Fe, Mn, Zn and Cu contents (4.9 to 5.4, 5.40 to 5.65, 0.63 to 0.78 and 0.87 to 1.29 ppm, respectively) were also lower in the treatments where no organic matter was added. Both macro and micro nutrient contents increased in the treatments, FYM and / or vermicompost and NPK, however, differences due to various treatments were non significant. The analysis of leaf samples showed no significant differences in the contents of N, P, K, Fe, Mn, Zn and Cu in various treatments, however, nutrient concentrations in the leaves were well above their respective critical levels.

Water and nutrient management

Water use efficiency: A field experiment comprising twenty treatments of irrigation and mulches is in progress since April, 2004. Irrigation regime with 50 per cent reduction in water along with organic mulch application showed an increase in retention of soil moisture and reduction in soil temperature. Mulching with leaf litter had maximum moisture retention (19.10 %) and minimum soil temperature (26.5^{0}C) followed by paddy straw (17.10 % and 27.4^{0}C) and polythene mulch (14.15 % and 28.1^{0}C) throughout the growth period. Minimum soil moisture retention (11.30 %) and higher soil temperature (30.0^{0}C) were observed in control.

Maximum organic carbon (0.448 %) and available K (87.20 ppm), Zn (1.40 ppm) and Mn (3.64 ppm) contents were recorded in soil where leaf litter was used as mulch. Uptake of N, P, K, Zn, Mn and Cu increased in the treatments where organic mulches were applied. Maximum uptake of N (2.96 %), P (0.142 %), K (0.660 %), Zn (25.30 ppm), Mn (181.0 ppm) and Fe (52.2 ppm) was recorded in the treatments where leaf litter was applied as mulch. The trees were in off-year of fruiting and yield was very low. Mango trees mulched with paddy straw and irrigated at flowering, fruit set, fruit growth (marble size) and fruit maturity stages resulted in the highest fruit yield (3.8 t ha^{-1}) followed by polythene mulch (2.07 t ha^{-1}).

Fertigation: The fruit yield of mango cv. Dashehari was higher (7.2 t ha^{-1}) in drip irrigation followed by

fertigation with NPK from the beginning of September to second week of May, while in basin irrigation it was 4.3 t ha^{-1}. The highest values of organic carbon (0.519 %), P (18.99 ppm), K (181.83 ppm), Zn (0.74 ppm), Cu (3.66 ppm) and Mn (9.99 ppm) were recorded in the treatment which received N, P and K fertigation from September to second week of May. The distribution of organic carbon, P, K, Zn and Cu in the drip irrigation system was fairly good and increased with depth up to 75 cm, while in basin system Zn and Cu were low. The distribution pattern of Mn and Fe in the profile now ever was erratic.

Nutrient management: Field experiment on nutrient management in mango cv. Dashehari comprising 24 treatments of FYM, green manure, nitrogen fixing and phosphorus solubilizing microorganisms (PSM), micronutrients (Zn, B. Mn and Cu) and NPK fertilizers is in progress since July, 2006. Composite soil (surface and subsurface) and leaf samples were collected, processed and analyzed for their nutrient contents. Organic carbon content ranged from 0.457 to 0.642 per cent, available P from 12 to 23.20 ppm, Zn from 0.35 to 1.40 ppm, Cu from 1.77 to 5.57 ppm, Mn from 7.93 to 16.32 ppm and Fe from 3.39 to 13.81 ppm in soil, while in leaf samples P ranged from 0.141 to 0.177 per cent , K from 0.530 to 0.902 per cent, Zn from 19.25 to 30.50 ppm, Cu from 15.33 to 62.00 ppm, Mn from 57.50 to 80.00 ppm and Fe from 175.25 to 283.66 ppm. The application of FYM and green manure augmented the soil organic carbon and available P, K, Zn and Fe. Green manuring with dhaincha (*Sesbania aculeata*) resulted in higher availability of P. Maximum contents of organic carbon, P, K, Zn and Fe were observed in surface (0 to 25 cm) as compared to sub surface (25 to 50 cm) soil.

Highest fruit yield (22.35 t ha^{-1}) was recorded in the treatment which received NPK, Zn and Cu followed by the treatment NPK, Mn and B (21.5t ha^{-1}). No significant differences were noted in the fruit quality parameters.

Management of irregular bearing

Effect of paclobutrazol (PP_{333}): As per previous year's observations, it was noticed that half of the standardised dose of paclobutrazol (1.6 ml m^{-1} canopy diameter) along with black plastic mulch was as effective as full dose of paclobutrazol (3.2 ml m^{-1} canopy diameter) for flowering and fruiting in cv. Dashehari. The data revealed significant increase in fruit yield (98.03 kg $tree^{-1}$) in the trees treated with paclobutrazol @ 1.6 ml m^{-1} canopy diameter along with mulch as compared to control (44.40 kg $tree^{-1}$). Non significant differences in CPLW, TSS and pH of the fruit pulp were found.

A demonstration trial of paclobutrazol (1.6 ml m^{-1} canopy diameter) with plastic mulch was laid out during the year. Six set of treatments, *viz.* 0, 0.8 and 1.6 ml paclobutrazol (m^{-1} canopy diameter) without mulch, 0.8 and 1.6 ml paclobutrazol m^{-1} canopy diameter with polythene mulch, and polythene mulch alone, were applied to Dashehari mango tree. The results showed that half of the standardised dose of paclobutrazol (1.6 ml m^{-1} canopy diameter) along with plastic mulch was as effective as full dose of paclobutrazol (3.2 ml m^{-1} canopy diameter) for inducing flowering in mango and maximum flowering (90 %) was obtained in the treated tree as compared to control (50 %).

The status of macro and micronutrients in soil of paclobutrazol treated and untreated trees were also assessed. There was no significant change in organic carbon content among the treatments, however, available P and K increased significantly in paclobutrazol treated soil with mulch. Among the micronutrients, no significant change was recorded in the contents of Cu, Mn and Fe but the level of Zn increased significantly (0.32 ppm) in paclobutrazol + mulch treated trees as compared to control (0.28 ppm).

Chlorophyll fluorescence, variation in strength of a fluorescent signal (Fv) from Fo to Fm, PSII and ETR level, was measured from dark adapted leaves of cvs Langra and Amrapali at flowering and fruit set stage (marble stage). Among the cultivars, the Fv/Fm (variable fluorescence to maximum fluorescence) was maximum (0.83) in Langra treated with 1.6 ml m^{-1} canopy diameter of paclobutrazol during flowering, however, reverse trend of Fv/Fm in these varieties were obtained at fruit set stage. Similar pattern of results was also obtained in PSII and electron transport rate (ETR) with cultivar variation.

Paclobutrazol enhanced the activities of antioxidative enzymes, *viz.* catalase and peroxidase, in the leaves of Langra and Amrapali at flowering stage. The rate of enhancement was found higher in Langra (10.5-19.0 unit mg $protein^{-1}$) as compared to Amrapali (4.8-9.0 unit mg $protein^{-1}$), however among the untreated cultivars, Amrapali showed higher activities of above than Langra.

Persistence of paclobutrazol in soil and fruits: Residue levels of paclobutrazol in soil at 90 and 270 days after its application were estimated in Dashehari and Langra orchards. Its level was found in the range of

0.260 to 3.689 and 0.012 to 0.760 mg kg $^{-1}$ soil at 90 and 270 days respectively in Dashehari. However, Langra orchard had residue in the range of 0.345 to 2.245 mg kg^{-1} soil at 270 days of application. In fruits, residue was detected only at higher concentration of paclobutrazol (3.2 ml m^{-1} canopy diameter) and Dashehari contained residue in the range of 0.017 to 0.205 mg kg^{-1} of fruit and Langra contained 0.2275 to 0.433 mg kg^{-1} at harvest. It is much less than the MRL value (0.510 EU).

Protein profile: Protein profile in regular and biennial mango cultivars at various stages of flower development was estimated. A wide range of protein 3.0 to 205 KD was found. More number of low molecular weight proteins (3.0 to 20.1 KD) were found in Amrapali (regular bearing) than Dashehari, Chausa and Langra (irregular bearing) during flower bud differentiation. Similarly, more number of low molecular weight proteins were found in the leaves of paclobutrazol treated trees as compared to control. Increasing trend in soluble protein content of flower bud was found up to first week of January whereas corresponding trend in leaves was found up to November. Thereafter, a gradual reduction in its content in both cultivars was noted. However, marked reduction in soluble protein content in the leaves of paclobutrazol treated tree was found which may be due to enhanced mobilization towards fruitlets.

Evaluation of polyembryonic rootstocks for tolerance to salt

Salt stress (EC in the range of 2-10 dS m^{-1}) was created in soil with NaCl in the pots. Initial pH and EC of experimental soil were 7.92 and 0.39 dS m^{-1}. Major and minor nutrients were at normal level, however, organic carbon was 0.487 per cent. Stones of eight polyembryonic mangoes, *viz.* Bappakai, Goa, Kurukkan, Mylepellian, Muvandan, Olour, Nekkare and Vellaikulamban, were evaluated for germination under different salt stress conditions. At higher EC (4 and 6 dS m^{-1}) only Nekkare seed germinated (33%). Nucellar seedlings of uniform size were also planted in pots and observations on root weight and chlorophyll fluorescence were recorded. Maximum root weight was found in Nekkare and Vellaikulamban (11.50 g FW per seedling) and minimum in monoembryonic 'Dashehari' mango (3.50 g FW per seedlings). Nekkare and Olour exhibited maximum level of chlorophyll fluorescence (0.81), while it was minimum in Kurukkan (0.72).

Antioxidant Value

The antioxidative activity of associated compounds in mango pulp of different cultivars at different growth stages were estimated. There was wide variation in antioxidant capacity in the fruit pulp of different varieties. Fruits of cvs Langra, Dashehari, Amrapali, Mallika and Chausa showed total antioxidant values of 6.73, 5.34, 3.69, 2.14 and 1.90 mg AEAC g^{-1} FW in terms of FRAP value. Mallika fruits contained maximum (4.81 mg g^{-1} FW) whereas Chausa fruits had minimum amount (0.09 mg g^{-1} FW) of polyphenols. The maximum carotenoids in fruits were obtained in Langra (77.28 µg g^{-1} FW) followed by Amrapali (55.91 µg g^{-1} FW). However, Dashehari fruits contained maximum flavonoid (0.22 mg g^{-1} FW), while Mallika had minimum (0.11 mg g^{-1} FW).

Development of growth and yield models: In developing growth and yield model for mango rootstock, average values of characters for 24 rootstocks for four years (2000 – 2004) were utilized for principal component analysis. On the basis of canopy spread (N-S) the rootstocks Rumani (16.07), Mundappa (15.97), Willard (15.40) and Pahutan (15.63) were found promising under Lucknow conditions. These rootstocks, on the basis of canopy spread (N-S) scores, were almost equal and had the uniform canopy spread in N-S direction. This study has relevance to HDP systems.

Economic analysis

***Mango based inter-cropping*:** A survey was undertaken in the mango belt of Lucknow, comprising Kakori, Malihabad and Mal blocks, for working out the profitability of inter-crops in mango orchards. The orchardists cultivating inter-crops in new orchards (up to 10 years of age) and in rejuvenated orchards under irrigated conditions were selected. The canopy of these orchards was not fully developed consequently there was sufficient light penetration in the interspaces. It was observed that about 60 to 70 per cent of the orchard area was available for cultivating the intercrops. The monsoon during the year 2009 was very erratic, which hampered cultivation of maize, sorghum, paddy, etc., as the crops dried up due to scanty and ill-distributed rainfall. Only pigeon pea was sown under rainfed conditions. Mustard crop was cultivated during the winter season. The farmers invested Rs. 12,000 per ha and received a return variable cost of Rs. 19,000^{-1} ha.

Pea was extensively cultivated by the farmers for green pods as well as mature seeds. The farmers received a return of Rs. 10,500^{-1} ha over variable cost against an investment of Rs. 5,000^{-1} ha. Wheat was the most preferred crop as it supplemented the family requirements of food grains and generated market surplus. The straw was utilized as cattle feed. The return over variable cost was estimated as Rs. 18,000^{-1} ha including the gross returns from the by-products. Some of the orchardists in the vicinity of the city cultivated marigold for sale as loose flowers. The marigold cultivation was found to be labour intensive, particularly the operation of flower plucking. The total expenditure for cultivation of marigold was estimated as Rs. 38, 000^{-1} ha against a return of Rs.22,000^{-1} ha over variable cost. The cultivation of the flower was found to be a risky proposition due to fluctuations in the demand.

GUAVA (*Psidium guajava* L.)

Substrate dynamics for IPNM

The experiment on substrate dynamics for integrated plant nutrient management on guava cv. Shweta with 18 treatment combinations was in third year of progress. Plant height ranged between 1.92 to 2.65 m and stem diameter between 15.2 to 22.2 cm. The canopy spread in N-S and E-W directions ranged between 2.50 to 3.72 m and 2.30 to 3.45 m, respectively. Plant height and canopy spread were maximum in the treatment where all the substrates were applied. The highest yield of guava (11.6 kg tree^{-1}) was obtained in the treatment of 10 kg FYM + 100, 50,100 g N, P, K tree^{-1} year^{-1} of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulch (10 cm thick). The effect of different treatments on growth parameters and fruit yield were however, non-significant. Organic carbon and available N, P, and K in different treatments were in the range of 0.323 to 0.432 per cent, 58.0 to 73.5, 16.3 to 30.1 and 81.4 to 111.7 ppm, respectively. DTPA extractable Fe, Mn, Zn and Cu contents were in optimum range in all the treatments, however, there was no significant effect of treatments on the nutrient buildup in the soil. The N, P, K, Fe, Mn, Zn and Cu concentrations in leaves were above the critical level but did not differ significantly among various treatments. Higher dehydrogenase activity (3.15 – 6.62 µg TPF g^{-1}hr^{-1}) was noticed in the treatments having organics, N, P and bio-fertilizers as compared to their respective controls (2.38 – 3.53 µg TPF g^{-1}hr^{-1}).

Organic farming

Package of practices: Seven treatments of different organic inputs were applied during the month of September to 15 years old guava cv. Allahabad Safeda. Maximum number of fruits and yield (398 and 40.13 kg tree^{-1}) were recorded with *Rishi Krishi* package of practice followed by biodynamic compost (292 and 37.73 kg tree^{-1}) and minimum (256 and 23.09 kg tree^{-1}) in untreated plants. Maximum TSS (11.7 °B) in fruits was obtained with biodynamic, while maximum ascorbic acid (216 mg 100g^{-1}) and reducing sugars (3.08%) were found with *Panchgavya* package of practices. The disease recorded in stored fruits on 0-5 scale, revealed no disease incidence on 3rd day, while 12.75 per cent disease was observed in control with 4 per cent disease index on 5th day. *Colletotrichum psidii* was isolated from the diseased fruits.

Microbial assay of organic/biodynamic preparations: The microboial population in organic/biodynamic preparations, generated at the Institute, were assessed. The highest population of *Azotobacter* sp. (15.0 x 10^5 cfu g^{-1}) was found in CPP, while (0.01 x 10^5 cfu g^{-1}) in cow horn silica (BD-501). The considerable population of *Azotobacter* sp. recorded in other preparations were BD-505 (9.0 x 10^5 cfu g^{-1}), BD-507 (5.4 x 10^5 cfu g^{-1}), *Jeevamrit* (3.7 x 10^5 cfu g^{-1}), *Amrit Pani* (3.6 x 10^5 cfu g^{-1}), *Panchagavya* (2.8 x 10^5 cfu g^{-1}), BD-506 (1.01 x 10^4 cfu g^{-1}), and cow horn manure (0.8 x 10^5 cfu g^{-1}). Similarly, highest number of *Azospirillum* sp. (13.0 x 10^5 cfu g^{-1}) was found in CPP. No *Azospirillum* sp. was found in cow horn silica and *Jeevamrit*. Results indicated that presence of both *Azotobacter* and *Azospirillum* in higher numbers in biodynamic preparation CPP, BD-507, *Amrit Pani, Panchagavya* and cow horn manure could be utilized as one of the approaches to improve the soil health.

Estimation of sample size for yield prediction: It was estimated that 39 and 14 plants of Sardar guava are required for predication 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 50.77 kg with a variance of 100.33. The predicted yield varied from 48.87 to 53.92 kg when 39 plants were used at 95 per cent confidence probability with 5 per cent error, while the range of 49.24-59.13 kg was wider when 14 plants were used at 10 per cent error. The sample size of 39 plants with information function value of 0.12 was more reliable for predicting yield as against 14 plants size with 0.098 information value.

PAPAYA (*Carica papaya* L.)

Suitability of substrate for growth of *Trichoderma harzianum*

Greater emphasis is being laid on the role of organic matter vis-à-vis rhizospheric microbes, with twin objectives of enriching the soil rhizosphere and promoting antagonistic microbes for suppressing the pathogenic microbes for sustainable yield. In view of this, leaves of different plants available locally were tested for their potential in supporting the growth of T. harzianum.

Leaves of five plants (bael, banana, cauliflower, neem and radish) and pseudo stem of banana were tested in different forms (green, dry and rotten). Maximum radial growth (90.0 mm) of T. harzianum was recorded on dry partially rotten and green leaves of banana followed by green leaves of bael (89-33 mm), dry and partially rotten mid rib of banana leaves (89.33), green neem leaves (89.0 mm). Fungal growth was minimum (15.33 mm) on green leaves of radish.

Evaluation of soil, FYM and mixture of soil and FYM for the growth of the fungus was done. Data revealed that the growth of fungus (cfu-1) was more on unsterilized garden soil(35 cfu-1) as compared to FYM (7.75 cfu g-1).

AONLA (*Embilica officinalis* Gaertn.)

Plant propagation

Wedge grafting: Wedge grafting was tried in aonla using containerized and bare rooted seedlings at four different periods from January to March. Graft success was 88 to 92.3 per cent, when grafting was done during January to February in containerized rootstocks and kept in greenhouse till complete sprouting and therafter shifting to shade net house (50% shade). However, success was reduced to 64 per cent when grafting was done in March. Similar success in grafting was achieved when grafts were capped with polythene tubes and kept directly in net house after grafting. Bare rooted aonla seedlings, when grafted and kept in polyhouse and net house, gave 84-96 per cent success until last week of February but success reduced to 52 per cent when grafted in the first week of March. Bare rooted seedlings gave good success (88.3 to 96.6 %) when kept directly in shade net house and under tree shade using poly caps.

Substrate dynamics for IPNM

The substrate dynamics experiment on aonla with 18 treatment combinations was in the second year of progress. The plant height ranged between 1.03 to 1.70 m, while stem girth varied from 8.17 to 14.90 cm in different treatments. The canopy spread in N-S and E-W directions ranged between 0.93 to 1.98 m and 0.87 to 1.80 m, respectively. Organic carbon and available N, P, and K ranged between 0.338 to 0.467 per cent, 67.3 to 82.0, 12.6 to 22.3 and 106.7 to 151.0 ppm, respectively, in different treatments. DTPA extractable Fe, Mn, Zn and Cu contents in soil varied from 1.75 to 3.41, 1.56 to 2.45, 0.23 to 0.69 and traces to 0.19 ppm, respectively. Though all the nutrients, except P and K, were in the deficient range no significant effect of treatments on nutrient build up was observed in the soil. However, the contents of N, P, K, Fe, Mn, Zn and Cu in leaves were at optimum level.

BAEL (*Aegle marmelos* Correa)

Plant propagation

Wedge grafting: Wedge grafting gave 82 to 92 per cent success during January to February when grafts were kept in greenhouse till sprouting and thereafter shifting to shade net house. But success reduced to 53 per cent when grafting was done in the first week of March. A success rate of 89 to 94 per cent was achieved in grafts using polythene caps . Bare rooted seedlings grafted and kept in polyhouse coupled with shifting to net house after sprouting gave maximum success (68 %) when grafting was done in the last week of January. Better success (82 to 94.3%) was achieved in second week of February when grafting was done during to first week of March using polythene caps and kept in the shade net house (50% shade).

Underutilized fruits

JAMUN (*Syzigium cuminii* Skeel)

Plant propagation: Soft wood grafting was standardized using cleft method. Seedlings of jamun were raised in the nursery for rootstock and after 8-10 months of growth seedlings attained graftable thickness. Grafting was performed at monthly intervals using 12 to 15 days defoliated scion. The time taken for bud sprout in the months of June and September (16 and 15 days) were minimum. Maximum success rate was recorded in the months of March (75 %) and February (70 %).

High density planting: The plants of CISH J-37 were planted at a distance of 2.5 x 2.5 m (1600 plants ha^{-1}) for evaluation of canopy management, flowering and fruiting pattern. The observations were made on plant height (1.19 to 1.35 m), trunk girth (0.7 to 0.8 m) and plant spread E -W (1.00 to 1.01m) and N– S (0.89 to 0.95 m) at initial stage of plant growth.

Canopy management: The plants of CISH J- 37 were planted at a distance of 5x5 m (400 plants ha^{-1}) for studies on canopy development, flowering, fruiting pattern and yield. Two systems of initial training, i.e., open centre and palmette system, were adopted for canopy management.

Flower biology and fruit development: Studies on the flower biology in jamun during 2009 revealed floral activity initiation in last week of February, which continued up to first week of April. The terminal and axillary inflorescence having hermaphrodite (bisexual) flowers were borne from February to April from the eastern direction. In west direction, panicle emergence was recorded in first week of March, a delay by ten days. Maximum number of panicles per shoot (14) was observed in eastern direction of tree followed by north and south (10 each). However, the minimum number of panicles per shoot (7) was observed in west. Each inflorescence had 40 - 50 flowers, which were initially club shaped. Anthesis started from 5:30 a.m. and continued till 7:30 a.m., subsequently in evening from 4:00 to 7:00 p.m. Maximum anthesis was recorded from 4:00 to 5:00 p.m. in all the directions. Anther dehiscence initiated at 5:30 a.m. and continued till 9:30 a.m. Average number of anthers ranged from 60 to 65 per flower. Stigma receptivity was found maximum on day prior to anthesis and remained receptive up to 2 to 4 days after anthesis. Selfing by bagging resulted in good fruit set. Fruit set period was from 12th April to 10th May. Fruit set studies showed that 45 to 50 per cent fruit set by self pollination and 30 to 40 per cent by cross pollination.

Anti-diabetic activity guided fractionation and associated attributes

Evaluation of germplasm: The mature fruits of nine elite genotypes were collected and evaluated. The weight of fruit ranged from 5.91 to 18.65 g, pulp from 4.11 to 17.08 g, seed from 0.141 to 1.846 g, TSS from 11.0 to 18.2 °B, titratable acidity from 0.669 to 0.892 per cent, total sugars from 4.71 to 6.74 per cent, tannins from 0.137 to 0.245 per cent, anthocyanins from 0.70 to 1.60 per cent and ascorbic acid from 29.31 to 41.58 mg 100 g^{-1}. The antioxidant values ranged from 584.87 to 3077.75 mg AEAC g^{-1} in seed and 10.07 to 258.88 mg AEAC g^{-1} in pulp. The maximum FRAP activity (3077.75 mg AEAC g^{-1}) was observed in CISH J-37 and minimum (584.87 mg AEAC g^{-1}) in CISH J-34 in seeds of respective accessions. However, FRAP values in pulp were maximum (258.88 mg AEAC g^{-1}) in CISH J-43 and minimum (10.07 mg AEAC g^{-1}) in CISH J-40. The DPPH activity ranged from 46.77 to 72.44 (% inhibition) in seed and 10.51 to 36.37 (% inhibition) in pulp.

The maximum (395.79 mg g^{-1} FW) phenol content in seed was observed in CISH J-36, while minimum (201.86 mg g^{-1} FW) in CISH J-34. Similar pattern of phenol content was recorded in pulp of these two accessions; however, its level was less (2.56 to 70.56 mg g^{-1} FW) as compared to seed. The flavonoid content in seeds ranged from 0.53 to 1.54 mg g^{-1} fresh weight, whereas in pulp it ranged fron 0.02 to 0.15 mg g^{-1} fresh weight. The maximum flavonoid content in seeds was recorded in CISH J-40 and minimum in CISH J-23. In pulp, maximum flavonoid content was noted in CISH J-36 and minimum in CISH J-42. The total carotenoids in pulp was maximum (22.34 mg $100g^{-1}$) in CISH J-23 and minimum (12.38 mg $100g^{-1}$) in CISH J-49.

KHIRNEE (*Manilkara hexandra* Toxb.)

Two methods of propagation *viz.* soft wood grafting and veneer grafting, were used for standardization. Seedlings of khirnee were raised in the nursery for rootstock. Seedlings attained graftable thickness after 12-18 months of age. Soft wood grafting was performed using cleft method in each calendar month. The minimum period for bud sprout was 18 days in the month of September, while in the months of January and February it took 35 days. Maximum success of 80 per cent was observed during August. Similarly in veneer grafting, the success was 75 per cent in the month of August.

KARONDA (*Carissa carandas* L.)

Soft wood grafting of seedling rootstocks of 12-18 months was performed using cleft method in each calendar month. Minimum period taken for bud sprout was noted in the month of July (15 days), while in the month of January it was 29 days. The maximum success of 65 per cent was recorded during July followed by June and August (60 %).

MAHUA (*Bassia latifolia* Roxb.)

Soft wood grafting of seedlings rootstocks of 10-12 months was performed using cleft method in each calendar month. A cut of 3-5 cm on the soft wood portion of the seeding was made. The scion of same diameter and wedge length of was inserted into the cut and tied firmly with polyfilm strip. The minimum period (16 days) for bud sprout was noted in the months of August and September. Seventy per cent success was recorded in the month of July followed by August (65 %).

WOOD APPLE (*Ferronia Limonia* L.)

Soft wood grafting of seedling rootstocks of 10-15 months was performed using cleft method in each calendar month. The minimum period (13 days) for bud sprout was recorded in the months of April and September followed by July (15 days). Ninety eight per cent success was achieved in the month of August followed by 95 per cent in the month of July.

TAMARIND (*Tamarindus indica* L.)

Soft wood grafting of 10 months old seedlins rootstocks was performed using cleft method in each month of the year. A cut of 3-5 cm on the soft wood portion was made. The same diameter and wedge length of scion was inserted into the cut and tied firmly with polyfilm strip. The minimum period (19 days) for bud sprout was recorded in the month of September with a success rate of 30 per cent.

CROP PROTECTION

MANGO (*Mangifera indica* L.)

INSECT PESTS

Hopper

***Population dynamics*:** Population of *Amritodus atkinsoni* was recorded on tree trunk throughout the year while that of other species, *Idioscopus clypealis* and *I. nitidulus*, however was recorded only on younger leaves and panicles. Population of *Amritodus atkinsoni* was higher during the month of October on trunk (av. 4 to 12 hoppers). Population of *I. nitidulus* started building up from the first week of March (av. 5 hoppers panicle^{-1}) which attained a peak during 4th week of March (av. 42 hoppers panicle^{-1}). *I. nitidulus* population could not be recorded during October to second week of February. No definite relationship between hopper population and size of panicle could be established.

***Management*:** Eleven foliar treatments including 8 new molecules / biopesticides, *viz.* spinosad (1 ml l^{-1}), imidacloprid (0.3 ml l^{-1}), thiamethoxam (0.20 g and 0.25 g l^{-1}), acephate (1.0 and 1.5 g l^{-1}), organic salt (Lastraw 5 ml l^{-1}), *Beauveria bassiana* (Mycozal 2 ml l^{-1}), azadirachtin 300 ppm (Neembaan 2 ml l^{-1}) and carbosulfan (1.0 and 1.5 ml l^{-1}) were evaluated on cv. Dashehari against mango hopper during (February-March) flowering and after fruit harvest (July-August). Among these molecules, acephate (1.5 gl^{-1}), thiamethoxam (0.2 gl^{-1}) and spinosad (1 ml l^{-1}) were found highly effective against hopper registering more than 98 per cent reduction in its population up to 21 days after spray during flowering season. Acephate (1.5 g l^{-1}) was the most effective in controlling the population of hoppers up to 21 days after spray during July-August.

Fruit fly

***Population dynamics*:** Fruit fly population started increasing from the first week of April (av. 63 flies trap^{-1} week^{-1}) and reached a peak during first week of July (av. 722.47 flies trap^{-1} week^{-1}). During the period of higher population, maximum and minimum temperatures ranged between 20.9 - 41.9^{0}C and 9.3 - 27.7 ^{0}C respectively, and RH from 77 - 95.3 ^{0}C. Following a lean period of a fortnight from 4th week of August it again started increasing (Av. 124 flies trap^{-1} week^{-1}) and gained a peak during 4th week of October (av. 132.08 trap^{-1} week^{-1}). Higher population was mainly attributed to the host mango from April to 3rd week of August and guava from 4th week of August to October. Population was significantly and positively correlated with maximum (r = 0.50) and minimum temperature (r = 0.56), evaporation (r = 0.48) and wind velocity (r = 0.31), whereas it was significantly and negatively correlated with RH (r = -0.42).

Mealy bug

Management: Nine foliar treatments including 6 new molecules / biopesticides, *viz.* thiamethoxam (0.2 g l^{-1} and 0.25 g l^{-1}), acephate (1.0 and 1.5 g l^{-1}), organic salt (Lastraw 5 ml^{-1}), *Beauveria bassiana* (Mycozal 2 ml l^{-1}), azadirachtin 300 ppm (Neembaan 2 ml l^{-1}) and carbosulfan (1.0 and 1.5 ml^{-1}), were evaluated under field conditions on cv. Dashehari against mealy bug. Carbosulfan (0.05%), acephate (1.5 gl^{-1}) and lastraw (5 ml l^{-1}) were found highly effective registering more than 95 per cent reduction in mealy bug population up to 21 days after spray.

Thrips

***Population dynamics*:** Low thrips population was recorded during last week of September (av. 2 thrips leaf $^{-1}$) to last week of October (av. 4 thrips leaf $^{-1}$). Higher population (av. 8 thrips panicle^{-1} leaf^{-1}) was recorded from second week of March to first week of April. Incidence (0.63 panicle^{-1}) was low on new flush during March.

Leaf gall midge

Population dynames: The population of leaf gall midge was low during August (av. 3 galls leaf^{-1}) while it increased from first week of September to last week of January (av. 8 galls leaf^{-1}).

Diseases

Malformation

Prevalence: Floral malformation incidence ranged from 5-10 per cent in commercial mango cultivars (Langra, Chausa, Bombay Green and Malika). However, incidence was 30-35 per cent in Lucknow Safeda, and Amrapali. *Fusarium subglutinans* was isolated from malformed panicles. Among 199 genotypes / varieties screened for floral malformation, symptoms could not be noticed in 14 germplasm accessions / varieties. Fifty six germplasm accessions / varieties showed malformation below 10 per cent, sixty four between 11 to 40 per cent and rest above 40 per cent.

Powdery mildew

***Prevalence*:** Powdery mildew (*Oidium mangiferae*) did not assume epiphytotic proportion in mango belt comprising Malihabad, Mal and Kakori blocks of Lucknow during the period under report. The low disease incidence (5-15 %) might be due to higher RH (85.6%) during the first fortnight of March.

Anthracnose

***Prevalence*:** The anthracnose (*Colletotrichum gloeosporioides*) disease was recorded throughout the year having maximum incidence (12.5%) on newly emerged leaves in the second fortnight of July, when temperature ranged from 23.8 to 36.7 ^{0}C, with an average temperature of 34.7 ^{0}C and RH 83 to 97 per cent. Its incidence increased to 15 per cent in the second fortnight of August.

***Molecular characterization*:** Genomic DNA of 12 isolates of anthracnose (*Colletotrichum gleosporioides*), collected from different agro-climatic regions of UP, MP, Bihar, Assam, Tamil Nadu and Andhra Pradesh, were carried out using boiling process. PCR reactions for amplification of ITS + 5.8S rDNA region were standardized using the programme consisting of following steps: initial denaturing at 94^{o}C for 1 min, followed by 30 cycles of 60 sec at 94^{o}C, 2 min at 58^{o}C and 60 sec at 72^{o}C, and a final extension step of 5 min at 72^{o}C. Distinct variation among the 12 isolates of *C. gloeosporioides* however could not be ascertained. Restriction digestion of ITS-PCR products by PCR-RFLP using *Msp* I discriminated *C. gloeosporioides* from other species, *viz. C. capsici and C. falcatum.*

Blossom blight

***Prevalence*:** Low incidence (5%) of blossom blight (*Colletotrichum gloeosporioides* and *Alternaria alternata)* was observed on panicles of Dashehari during February, 2010 at Kakori and Malihabad blocks. However, owing to sudden increase in temperature (40^{0}C) during the second fortnight of March the disease incidence increased to 15-20 per cent.

Die-back

Prevalence: Low incidence (3 to 5%) of die-back disease caused by *Lasiodiplodia theobromae* observed in old orchards of Dashehari and Langra during first fortnight of July 2009 in Malihabad, Mal and Kakori blocks of Lucknow district.

Sooty mould

Prevalence: Sooty mould was noticed on old leaves in different orchards of Ramnagar (Mawana), Bazargoan, Piperigoan, Saidpur, Raghunathpur, Manji and Madwana in Mal, and Kasmoura, Kasmandi Kala, Hafizkhera, Bednanagar Nala, Nabihpana and Kana in Malihabad and Kakori blocks of Lucknow district during 2009-10. The disease incidence ranged from 30-35 per cent in March.

GUAVA (*Psidium guajava* L.)

INSECT PESTS

Fruit borer

Management: Traps using aonla cider, white vinegar and water (1:1:2), guava cider, white vinegar and water (1:1:2), mahua cider, white vinegar and water (1:1:2)

and plain water (control) were used for trapping guava fruit borer. Traps prepared with guava cider, white vinegar and water showed attraction (1 adult trap $^{-1}$) to moths of guava borer, while other traps exhibited no attraction.

Bark eating caterpillar

***Management*:** The pest could be managed by mechanical (cleaning of webs and insect entry holes and collection and destruction of larvae) or injecting pine oil, neem oil, chlorpyriphos or dichlorvos. Significant reduction in larval galleries was observed by injecting 2 per cent pine oil (0.12 live galleries plant $^{-1}$) or 2 per cent neem oil (0.09 live galleries plant $^{-1}$) in comparison to 0.55 live galleries per plant with chlorpyriphos (0.5 %) and 0.52 live galleries per plant with dichlorvos (0.5%).

NEMATODE PESTS

Distribution of Steinernema carpocapsae in guava rhizosphere

Soil samples collected at monthly intervals from three soil stratification levels (0, 15 and 30 cm), two directions (East and West) and two distance levels from the tree trunk (50 and 100 cm) of mango and guava were kept in 100cc plastic containers. Last instar of guava fruit borer, greater wax moth and *corcyra* were kept in the container having soil collected from aforementioned orchards and data were recorded on the mortality of instar and population catch of EPN. All the trap insect yielded varying population of *Steinernema carpocapsae* throughout the year. It, however, was found to be dictated by the soil strata mainly on account of prevailing moisture regimen. Population was largely found to be very low during the period of moisture stress particularly during the months of April, May and June.

Evaluation of EPN population against fruit fly

Maggots of fruit fly infesting guava were exposed to different inoculum levels of *Steinernema carpocapsae* (100, 500, 1000, 5000 and 10000) populations of infective juveniles collected from guava and mango orchards. Data were recorded on final population density and mortality of maggots at five intervals (1 day, 2 day, 1 week, 2 week and 1 month). Nematode population from either of the locations (mango and guava orchards) could not multiply on the maggots. Similarly, the mortality of maggot could not be noticed at any innoculum level as well as time period. Study indicated that the isolates of S. carpocapsae used in the study were not pathogenic on fruit fly population infesting guava orchards.

DISEASES

Guava wilt

Molecular characterization of *Fusarium*, causal agent of guava wilt : Genomic DNA of 20 isolates of *Fusarium*, collected from different agro-climatic regions of UP, MP, Bihar, Assam, TN and Andhra Pradesh, were carried out by boiling process. ITS primers screened did not show any variability among the isolates. PCR-RFLP of the ITS regions using enzymes *Alu* I, *Hae* III, *Msp* I, *Rsa* I and *Taq* I produced distinct variations for the isolates screened. For all *Fusarium* isolates, DNA fragments of approximately 570 bp were amplified using ITS1 and ITS4 primer pair. No length variation was observed for the amplified ITS regions. The ITS of all the *Fusarium* isolates were digested using *Eco* RI and *Taq* I which indicated that isolates contain recognition sites for these enzymes. The restriction patterns of *Fusarium* isolates using *Taq* I showed variation between *F. oxysporum* and *F. solani* (Fig.13).

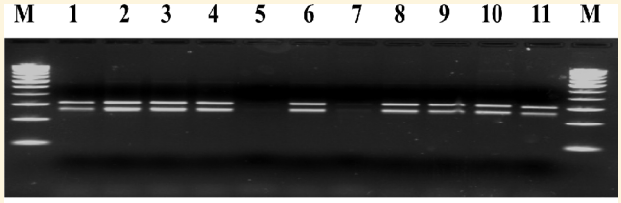


Fig. 13 : Restriction patterns of ITS regions of *Fusarium* isolates *Fusarium* isolates with Taq I. Lane 1-10: *F. oxysporum spp.*, Lane 11: *F. solani.*, Lane M: 100 bp DNA Ladder.

PAPAYA (*Carica papaya* L.)

Nematode Pests

Soil samples (75) were collected from brinjal, bottlegourd, tomato, okra and guar fields located in Sisaundi village, brinjal, onion and radish fields located in Guara village and brinjal, cauliflower, chilli, mustard, pea and tomato fields located in Kahunkhera village and around 156 bacterial colonies were isolated.

Screening of bacterial isolates:

One hundred second stage juveniles were exposed to twenty five bacterial colonies selected on the basis of growth pattern. Out of twenty five colonies, fourteen colonies could bring about 26-66 per cent juvenile mortality within 24 hours of exposure. Further extension of exposure period (72 hr.) could cause 100 per cent mortality. On the other hand, four colonies could effect only 32-40 per cent juvenile mortality within an exposure period of 96 hr. Extension of exposure period up to 12 days could not cause further increase in juvenile mortality.

Pot culture experiments were conducted to evaluate the potential of bacterial isolates screened under *in vitro* conditions. Seedlings of brinjal inoculated with fifteen bacterial isolates (10 ml crude suspension) and 500 juveniles of root knot nematode revealed that out of 15 bacterial isolates final nematode population was found to reduce (1120, 1469, 1288 and 1360) to certain extent only in four isolates (1 A, 1 B, 4 A and 5 C) as compared to 1586 in uninoculated plant. In rest of the treatments, population build up trend could not exhibit any marked difference from the untreated check.

AONLA (*Embilica officianlis* Gaertn.)

Insect Pests

Gall maker

***Incidence*:** The data was analysed to determine the weather parameters (maximum and minimum temperature, RH and rainfall) conducive for incidence of shoot gall maker (*Betousa stylophora*). Minimum temperature (4.5 to 23.8^{0}C) was found to be negatively correlated with the shoot gall incidence (r = 0.66). Similarly, the correlation coefficient between maximum temperature (26.5 to 43.5 ^{0}C) and shoot gall incidence too were found negatively correlated (r = 0.63). Regression analysis using weather data showed satisfactory R^2 value (0.68).

Fruit borer

***Incidence*:** Fruit borer, *Deudorix* (*Virachola*) *isocrates*, incidence (1.39 per fruit) started from the second fortnight of August and reached its peak from September to second fortnight of November (4.25 per fruit). The incidence of borer ranged from 2.5 to 5.88 per fruit in dropped fruits.

***Management*:** *In vitro* testing of castor oil (1.0%), soapnut extract (1.0%) and pine oil (1.0%) showed 100 per cent mortality of fruit borer. Traps using aonla cider, white vinegar and water (1:1:2) showed attraction to moths of aonla fruit borer (2 per trap).

Diseases

Severe incidence (88-93 %) of rust was observed on cv. NA-7 during September and October followed by shedding of infected leaves. Leaves also had light brown lesions caused by *Drechslera spp*.

BAEL (*Aegle marmelos* Correa)

Diseases

Die-back and stalk end rot, caused by *Fusarium oxysporum*, were observed in severe form in nursery and occasionally in orchards. Light brown blight coupled with severe yellowing was observed on light green thinner leaves. Anthracnose symptoms were noticed on dark green thicker leaves. *Alternaria* leaf spots and *Phytophthora* leaf blight caused severe defoliation in the month of November in seeding under poly house conditions. Symptoms of gummosis were recorded on main trunk and thick branches in orchards during the month of March.

Underutilized fruits

JAMUN (*Syzigium cuminii* Skeel)

Diseases

Severe incidence (85 to 95%) of leaf spot disease was observed, irrespective of variety or selection. Symptoms appeared in the form of black tiny spots on lower surface of leaves during rainy season which turned into dark tan spots during winter. Both the diseases jointly caused over 50 per cent leaf necrosis, followed by gradual shedding of infected leaves. Seedlings in poly house suffered from *Phytophthora* leaf blight followed by stem infection and death.

CUSTARD APPLE (*Annona squamosa* L.)

Diseases

Incidence (30%) of anthracnose and blight caused by *Colletotrichum gloeosporioides* and *Phytophthora spp*. was observed on leaves during rainy season, which increased to 60 per cent followed by shedding of infected leaves. Anthracnose incidence on fruits was over 50 per cent.

Diseases

Incidence of leaf spot disease ranging from 5 to 27 per cent was noticed on jackfruit, khirnee, mulberry and lasoda. However, the disease severity was higher in mahua (25 to 30%), phalsa (45 to 95%) and tamarind (25 to 50%).

POST-HARVEST MANAGEMENT

MANGO (*Mangifera indica* L.)

Packaging

***Standardization of grades on packaging line*:** The commercial varieties of mango (Dashehari, Langra and Chausa) were selected for standardization of 4 grades on packaging line harmonizing the *Codex Alimentarius* standards (Table).

Table: Weight grades of commercial cultivars of mango.

Name of Cultivar	Grade	Fruit weight	Percentage fruit
Dashehari	A	> 300	20
	B	250-299	30
	C	200-249	30
	D	<199	15
Langra	A	> 300	30
	B	250-299	30
	C	2150-249	25
	D	<150	10
Chausa	A	> 300	40
	B	250-299	35
	C	2150-249	10
	D	<150	10

Storage

Evaluation of chemicals on storage behaviour: Mature Dashehari mangoes treated with spermine (0.01%) and packed in MAP (ventilated 200 gauge LDPE bags), apart from control, were stored at low temperature (12 ±2 °C and 90±5 % RH). Maximum firmness was recorded in fruits treated with spermine in comparison with MAP on the 15th day of storage. The activity of Poly Galacturonage (expressed as % change 2.8ml extract^{-1} 10 min^{-1}) was lower in spermine as combination with MAP treated fruits and PME activity was also suppressed. Maximum total carotenoids was found in fruits treated with spermine + MAP after 21 days of cold storage followed by 3 days at ambient conditions contributing to higher antioxidant value. After 21 days of cold storage, the post harvest life of fruits deteriorated following infection of stem end rot and anthracnose.

***Efficacy of bio-agent*:** Mature Langra fruits were dipped in the solution of $NaHCO_3$ (2%) or bio-agent (*Saccharomyces cereviceae* @ 10^8 cells ml^{-1}) for 10 minutes and stored under ambient conditions. With the advancement of storage duration the firmness and acidity of fruits decreased with increased TSS, carotenoids and FRAP value. Fruits treated with bio-agent showed maximum firmness and least colour development (yellowness index) after 9 days of storage. The bio-agent treated fruits exhibited minimum disease incidence after 9 days of storage.

Value addition

Evaluation of hybrids for pickle: Five hybrids were evaluated for processing to pickle in oil. The analysis of fresh fruits indicated a variation of 85 to 177 g (average fruit weight), 6.9 to 8.9 °B (TSS), 0.44 to 2.23 per cent (titratable acidity) and 49 to 92 mg 100g $^{-1}$ (ascorbic acid). The hybrid H-7661 contained the maximum (2.23%) acidity while H-3071 the minimum (0.44%). The pickle prepared from these hybrids was stored under ambient conditions and analysed at 0, 3 and 6 months of storage. The pickles prepared from all the hybrids were highly acceptable organoleptically, the best being from hybrid H-935.

Evaluation of varieties/hybrids for pulp: Thirteen mango varieties/hybrids, ripened uniformly with ethrel, were evaluated for their physio-chemical characters and pulp and beverages were prepared. The average weight of fruits ranged between 167 to 418 g, while pulp content ranged from 62.3 to 75.6 per cent. The fruits of cv. Langra, Ilham Pasand and H-1190 recorded higher organoleptical scores, while H-790 and H-788 showed the least acceptability. Fresh fruit analysis showed a variation of 13.2 to 23.4°B (TSS), 0.14 to 0.54 per cent (titrable acidity), 14 to 87 mg 100g^{-1} (ascorbic acid), 1.99 to 4.62 per cent (reducing sugars) and 1.60 to 7.42 mg 100g^{-1} (total carotenoids). The beverage obtained from hybrid H-1190 recorded highest score followed by H-896, H-2530 and HVB-2. The beverage from Langra, Ilham Pasand and H-2529 had low organoleptical scores.

Osmo-freeze drying of slices: Ripe mango slices of cvs Dashehari and Totapuri were dipped in sugar syrup strength of 30, 40, 50 or 60° B containing 0.3 per cent acid and 0.05 per cent postassium metabisulphite for 1, 2 or 4 hr. The osmotically dried slices were freeze dried for a period of 5 to 6 hr. The best incubation period was 2 hr which resulted in an acceptable product.

***Development of raw mango cider*:** A partially fermented beverage having distinct flavour and taste was developed from ameliorated raw mango pulp using *Saccharomyces cerevisiae*. The siphoned beverage obtained after 15 days of fermentation was rendered with flavour enhancement treatments using fennel or mint or combination of other spices. The storage studies indicated no significant changes in TSS, acidity and alcohol content up to 6 months of storage. However, ascorbic acid content decreased significantly (91-93%) after 6 months of storage. Similarly, initial anti-oxidant value (FRAP) of 18.8 to 20.0 $mMml^{-1}$ came down to a level of 8.7 to 9.3 $mMml^{-1}$. There was slight increase in reducing sugars and Non Enzymeatic Brewing values. The sensory evaluation of product at different storage intervals indicated that treatments containing fennel and spices combinations scored consistently higher, while in others, the organoleptic scores varied (Fig. 14). Based on consistency in score, the beverage flavoured with fennel and spices combinations was the best.

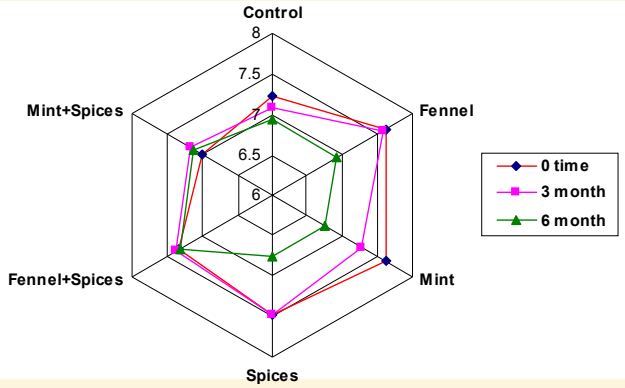


Fig. 14: Sensory scores of raw mango cider

Waste utilization

***Extraction of fibre from processing waste*:** Solid waste at finisher stage was collected from mango processing industry and a low energy method for extraction of fibre was developed. Steps used to produce the product included microbial fermentation followed by acid, alkali and alcohol treatments. The product has IPR issues and patent application is in process.

***Development of fibre enriched biscuits*:** Mango fibre (particle size 50 mesh) extracted from mango finisher pulp was incorporated into biscuits for enhancing the dietary fibre content. The fibre enriched biscuits were low in calories and high in dietary fibre. Biscuits prepared also have acceptable taste and a shelf life of more than 180 days.

***Production of Bioethenol from mango kernel through alcoholic fermentation*:** Mango kernel, being available as voluminous waste from processing industry and a source of starch was used as bio substrate for ethanol production. Preliminary study has indicated that seventy-seven per cent fermentation efficiency using coculture fermentation involving fungus *Aspergillus niger* and yeast *Saccharomyces cerevisisae* was obtain.

Oil extraction from kernel: Fruits of cv. Mallika were harvested at different stages of maturity, *i.e.*, from second week of June to last week of July. With the advent of maturity total oil content increased from 6 to 9 per cent with increases in stearic acid from 65.14 to 67.41 and oleic acid from 18.98 to 19.06 per cent. However, decreases in palmitic acid from 8.72 to 6.97, linoleic acid from 3.68 to 2.71 and myristic acid from 0.08 to 0.04 per cent were observed. Owing to the presence of these fatty acids, the kernel oil of all stages of development may have good potential for cosmetic purpose.

***Development of cosmetic products from processing waste*:** Face packs were developed for all types of skin (dry, oily and normal) using mango peel/kernel/kernel oil the basic ingredients. Face packs will be subjected to climatological testing.

Food safety

Pesticide residue analysis

Imidacloprid : Imidacloprid was sprayed on Dashehari @ 0.3 ml l^{-1} of water during tree-bloom stage with 6-8 cm panicle size (last week of February) to control hoppers. Residues were analysed in peel, pulp and peel + pulp at different stages of fruit development and maturity. The dissipation of imidacloprid was very slow in both peel and pulp but it followed first order rate kinetics in whole fruit (peel + pulp) (Fig. 15). The residues were 1.54 and 0.59 mg kg^{-1} in peel and pulp, respectively, after 30 days of spraying. The residues in peel and pulp of fruits (75 days after spraying) were 0.65 and 0.09 mg kg^{-1}, while in fruits (85 days after spraying) 0.58 mg kg^{-1} of the insecticide was detected in peel but the residue was below detectable limit (0.01 mg kg^{-1} by HPLC) in pulp. The maximum residue limit (MRL) of imidacloprid in mango (peel + pulp) is 0.2 mg kg^{-1} (fixed by EU).

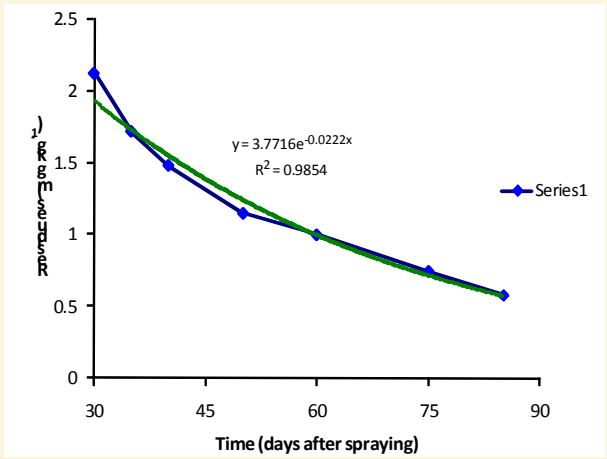


Fig. 15. First order exponential curve of dissipation of imidacloprid residues in whole mango fruits after pre harvest spray.

Market analysis

***Arrival, disposal and prices*:** The production in the entire mango belt of Lucknow district during the year 2009 was found to be very low owing to unusual weather resulting into drought like conditions. The flowering was also very low. This could be attributed to heavy monsoon season during the previous season which allowed retention of fruits over longer period. Consequently, the disposal of mango during the entire season was only 31.48 thousand MT as against 51.58 thousand MT during the previous year, depicting a significant drop of about 39 per cent. In fact, the disposal was the least in the last 5 years. The disposal to the markets outside Uttar Pradesh was 72 per cent as against only 28 per cent in the markets within the State in contrast to 68 and 32 per cent in the previous year, respectively. The disposal of mangoes to Delhi market was the highest and it accounted for 32 per cent of the total mango disposed from Lucknow. A perusal of weekly disposal pattern of mango from Lucknow indicated about 67.89 per cent of the disposals concentrated during the three weeks starting from June 6, 2009 as against 77.41 per cent during the previous year. The peak disposal of 26 per cent was recorded between June 13-19, 2009. Thereafter, the disposal got reduced drastically so much so that July did not have any significant disposals from Lucknow as the season ended. On the other hand, disposal during the previous year continued up to the third week of July. The total arrival of mango in Lucknow wholesale market during 2009 was around 35 thousand MT, which was less than the correspondingly arrival during the previous year by about 51 per cent. Arrival started in Lucknow during February, 2009, picked up during April and May as the Banganpalli started arriving from the production areas of Andhra Pradesh. The arrival of Bangapalli dropped with the beginning of Dashehari arrivals from the local belt. The average price realization recorded was also high at Rs. 1246 per quintal during 2009 as against Rs. 823 per quintal in the previous year, attributable to low arrivals.

Export: India accounted for 21 per cent of the world export of mango, worth US$ 1.64 million, surpassing all the other major mango exporting countries. Netherlands, which imported mangoes from different countries, became the major exporter and realized better prices than other major mango exporting countries. Export of mango from India touched a all time high to 83.7 thousand MT worth Rs. 170.7 crores during 2008-09. It was higher by 52.8 per cent in terms of quantity and 33.9 per cent in terms of value against the previous year. Bangladesh reemerged as the leading mango importer from India by accounting for 54 per cent of the total exports from India but only 24 per cent in terms of value. This indicated that the price realization for mangoes was quite low in Bangladesh. The extent of mango exports to Bangladesh increased from 43 per cent during 2007-08 to 54 per cent. United Arab Emirates continued to import considerable quantities of mangoes from India and it accounted for 46 per cent of the total value of mango exports. Major non-tariff barriers to mango international trade included stringent plant quarantine procedures including zero tolerance for insect pests. Restrictions on import of Indian mangoes due to presence of 14 fruit flies and stone weevils, protocol for the export to some of the countries to be finalized yet, delay in finalization of protocols on phyto-sanitary measures and certification procedures based on pest risk analysis (PRA) and high cost of certification. Alphonso was the major cultivar exported from India. Mexico, the major competitor has the larger production season ranging from April to December, as compared to the one prevailing in the country.

GUAVA (*Psidium guajava* L.)

Mechanization

Design and development of harvester: Since guava fruits do not mature at one point of time, it requires human

judgment and selective harvesting. Pedicel of guava being shorter in length, it becomes very difficult to hold it in a nylon woven pouch comfortably. In this background, a guava harvesting device having mild steel fingers (6 nos and 4 mm diameter) and 40 mm height covered with plastic tube and a nylon pouch attached to the frame of the harvester to collect the fruits was developed. (Fig. 16). Field per formance will be tested in the coming season.

Fig. 16 : Guava harvester

Storage

***Assessment of bio-agent*:** Mature hard green fruits of guava cv. Allahabad Safeda subjected to post harvest treatments, *viz.* $NaHCO_3$ (2 or 4%) and bio-agent (*Saccharomyces cereviceae* @ 10^8 cells^{-1} ml $^{-1}$) for 10 minutes, were packed in brown paper bags and stored under ambient conditions (18 ±2 °C and 57±5 % RH). Quality attributes, like TSS, acidity and ascorbic acid, were higher in bio-agent treated fruits in comparison to control during storage. These fruits were good in appearance, quality and taste with attractive yellow colour development. The fruits treated with bio-agent had maximum FRAP value over control.

Value addition

Evaluation of varieties/hybrids for processing: Five guava varieties/hybrids were evaluated for processing potential. Hybrid HPSI-16 recorded highest ascorbic acid (221 mg100g^{-1}) content, while Spear Acid had the lowest (55 mg100g^{-1}). The highest lycopene (4.0 mg 100g^{-1}) content was recorded in HPSI-16, while it was the lowest (0.63 mg100g^{-1}) in Spear Acid. The hybrids/ varieties were however found suitable for beverage preparation; the best being HPSI-6.

Market analysis

***Value chain for domestic and export market*:** A survey-cum-participatory appraisal discussion of the existing system of production and marketing was held with the beneficiaries of the NAIP subproject in Kanpur district. The yield of guava in the rainy season was only about 2 to 15 per cent of the production during winter season. Since majority of the plantations were seedling based, the orchards are heterogeneous and varied fruit parameters comprising size, appearance, taste, etc. The orchardists were found not adopting improved package of technologies and this adversely impacted health of the trees leading to poor fruit quality. High incidence of guava wilt and bark eating caterpillar was recorded. The guava in entire Kanpur region was traded in local market rather than the regulated mandi of Chakarpur. Trading of the fruit was facilitated by the commission agents charging Rs. 10 per basket (20 kg) or crate (25 kg capacity) from the purchaser of the produce i.e wholesaler or vendor. A wide variability in the quality of produce was observed, which deterred the purchasers from outside the region and distant markets. Majority of the orchardists of the village Shivdeenpurwa, Kanpur preferred to dispose the produce in the village itself. In fact, the traders from distant markets of Ghaziabad, NOIDA, Agra, etc., distribute the plastic crates to the farmers at a pre-settled price, almost the same as that of the nearby wholesale market.

AONLA(*Embilica officinalis* Gaertn.)

Storage

***Effect of treatments*:** Different concentrations of $NaHCO_3$ (1, 2 or 4%) as post harvest treatment, for enhancing the shelf-life of aonla cv. Chakaiya were tried. Minimum browning was noticed in $NaHCO_3$ (4%) treated fruits even after 12 days of storage as compared to other concentrations used. Aonla fruits treated with 4 per cent $NaHCO_3$ had maximum ascorbic acid content and FRAP value on the 8th day of storage and thereafter it decreased.

Value addition

***Spray drying of juice*:** Spray dried powder was prepared from aonla juice (cv. Chakaiya) stored for 4 months under ambient conditions. Decrease in TSS (8.0 to 6.0°B), titratable acidity (1.59 to 1.16%), ascorbic acid (375 to 245 mg 100ml^{-1}) and tannins (1.59 to

1.45%) and a slight increase in non enzymetic browning were observed in stored juice. The TSS, ascorbic acid and tannins contents were 95.8°B, 3176 mg100g^{-1} and 13.5 per cent, respectively, in the powder prepared from fresh juice. The ascorbic acid content in powder decreased slightly to 3114 mg100g^{-1}, when prepared from 4 months stored juice.

BAEL (*Aegle marmelos* Correa)

Mechanization

***Development of harvester*:** A manually operated bael harvester was designed and developed using spring loaded clipper to sharply slash the pedicel of the fruit and to collect into nylon pouch safely without mechanical injury. The efficiency of the harvester was 65 fruits per hour (Fig. 17).

Fig. 17: Clipper type bael harvester

Storage

***Uniform ripening*:** The mature fruits of bael cv. CISH-B-2 were dipped for 10 minutes in 0, 1000 or 2000 ppm of ethrel solution and stored up to 29 days under ambient conditions. The uniform ripening in fruits treated with 2000 ppm ethrel was achieved after 14 days, while it took 21 days in control fruits stored under ambient conditions. TSS increased from 25.3 to 33.8° B in fruits treated with 2000 ppm ethrel after 25 days of storage, while in control it increased to 33.2°B after 29 days of storage. The anthocyanin content increased from 0.52 to 1.93mg100g^{-1} up to 21 days and then decreased in fruits treated with 2000 ppm ethrel.

Packaging: The mature fruits of bael cv. CISH-B-2 were packed in gunny bags, plastic crates and CFB cartons and stored at room temperature for 32 days. TSS increased progressively in fruits of all the packaging. The fruits packed in CFB boxes ripened in 18 days and did not show any spoilage until storage, while fruits packed in gunny bags were of dull yellowish green colour with bruises on the surface and few fruits also spoiled.

Value addition

Preservation of pulp: The pulp of bael cv. CISH B-2 was preserved with potassium metabisulphite or sodium benzoate or their combinations in glass jars under ambient conditions up to 12 months. A slight increase in reducing sugars and decrease in titratable acidity and anthocyanin content were recorded as the storage period prolonged. The browning in the pulp also increased with increase in the storage period but it was minimum in pulp preserved with 1000 ppm SO_2. No microbial spoilage was noticed in the pulp preserved with any of the treatments. The pulp preserved with 1000ppm SO_2 was the best in quality.

***Microbial analysis*:** Two spoilage fungi, *viz. Syncephalastrum racemosum* and *Penicillium sp.*, were isolated from spoiled bael squash. These were found to be osmo-tolerant.

MAHUA(*Bassia latifolia* Roxb.)

Value addition

***Production and characterization of cellulases*:** Maximum production of CMCase was obtained at pH 4 and 30 °C temperature on 7th day, while that of â-glycosidase on 5th day at pH 5 and 40°C temperature when 10 per cent mahua pomace was incubated with *Trichoderma spp*. Maximum FPase production was observed at 5 per cent substrate concentration, pH 5 and 30° C on 5th day of incubation using *Trichoderma sp*. CMCase production was enhanced by addition of mineral nutrients (Mo^{3+}, Mn^{2+} and Zn^{2+}) in the growth medium. Similarly, Mo^{3+}, Ca^{2+}, Mn^{2+}, Fe^{2+} or Zn^{2+} enhanced â-glycosidase production, while Mg^{2+}, Ca^{2+} and Fe^{2+} augmented FPase production. Moreover, combined effects of basal and mineral medium increased CMCase and â-glycosidase production up to 1.75 and 4 times, respectively. Maximum activity of CMCase was at 40°C and pH 5.5, while 30°C temperature was the best for â-glucosidase and FPase activities at pH 5.5 and 4.5, respectively. K_m for CMCase, â-glucosidase and FPase were 1.67, 0.31 and 175 mg ml^{-1}, respectively, and V_{max} values were 0.011, 0.16 and 0.667 µmole min^{-1} respectively.

5. TECHNOLOGY ASSESSMENT AND TRANSFER

Impact Assessment

Forty farmers from the villages of Bhatoya and Masheera, Lucknow were adopted and complete technologies of mango cultivation were provided to them. Survey revealed that adopted farmers fully followed the recommendations. Only seventeen per cent of the non-beneficiaries followed the recommendations for orchard management. The average yield of mango at the beneficiaries orchards was 93.5 kg per tree with a gross return of about Rs. 1122.00 against an average yield of 64.4 kg per tree with a return of Rs. 772.00 per tree in non-beneficiaries orchards. Only 8 per cent of the orchardists adopted CISH mango harvester. The rejuvenation technology developed by the Institute was not adopted due to financial and inadequate administrative support despite the willingness of the farmers to rejuvenate their old and senile mango orchards. The farmers faced the problems of non-availability of quality planting material particularly of new varieties, improved machines and tools, genuine pesticides and water and electricity during critical periods.

Extension Intervention

***Gosthi-cum-Field day*:** Institute organized a gosthi-cum-field day at village Kanar, Malihabad, Lucknow on December 30, 2009 to update the knowledge of farmers on the scientific methods of cultivation of mango and other mandate fruit crops in which 60 farmers participated. Scientists of the Institute delivered thematic talks on high density planting, rejuvenation of senile mango orchards and integrated pests and disease management. The scientific cultivation of mushroom for supplementary incomes was also demonstrated.

Exhibitions: Institute participated in various State as well as National level exhibitions and displayed Institute's achievements and technologies on mandate crops as per the following details.

Sl. No.	Event/Occasion	Place	Organiser	Date
1.	Inter-State Horti-Fair (Horti-Sangam-2009)	Pragati Maidan, New Delhi	NHB & Ministry of Agriculture, Govt. of U.P	May 22-24,2009
2.	Swadesh Prem Jagrati Sangosthi - 2009	Mahmada, Pusa, Samastipur, Bihar	Lt. Amit Singh Memorial Foundation, Mahmada, Samastipur	May 28 – 31,2009
3.	National Farmers Fair	U.P College, Varanasi	U.P College, Varanasi	October 15 – 16, 2009
4.	Farmers Fair	KVK, Dhaura, Unnao	KVK, Dhaura, Unnao	November 04 ,2009
5.	National Farmers Fair and Vegetable Exhibition	CISH, Lucknow	CISH, Lucknow	December 08, 2009.
6.	27th Foundation Day Celebration of NBFGR	NBFGR, Lucknow	NBFGR, Lucknow	December 12, 2009
7.	Northern India International Trade Fair	Motijheel Ground, Kanpur	India International Trade Event Organization	January19-26, 2010
8	State Flower, Fruit & Vegetable Show	Governor House, Lucknow	Directorate of Horticulture & Food Processing, Lucknow	February 20-21, 2010
9	Showcasing of Agricultural Technologies	CISH, Lucknow	CISH, Lucknow	February 24 – 25, 2010
10	Agricultural Fair	SVPUA&T, Meerut	SVPUA&T, Meerut	March 10 – 12, 2010

Scientist-Growers' Interaction/Meet: Five interactions/meet(field visits and small growers' meetings) of scientists-growers' were organised. Discussions were held on scientific cultivation of subtropical fruit crops in mango growing belts of Lucknow and Unnao districts.

***Exposure visit*:** About 1685 farmers/ officials including 75 students from different states of the country visited the Institute. They were shown scientif nursery facilities, experimental farms, processing and packaging laboratories and technical information centre to make them aware about the research activities and technologies developed.

***Farmers' helpline*:** Growers' queries relating to aspects like rejuvenation, high density planting and insect pest management of subtropical fruits were attended to through correspondence. Extension folders and bulletins related to scientific cultivation of mango, aonla, guava and papaya were provided to the orchardists. Farmer's queries (118 calls) particularly related to availability of plants and insect and disease management were attended and their solutions were provided through telephonic conversations on Kisan Call Centre.

***Trainings*:** Ten training programmes on production, protection and post-harvest management of fruit crops, sponsored by UPDASP, Lucknow, NHB, Gurgaon, ATMA, Bihar and Mahila Chetna Manch, Bhopal were organised by the Institute in which 219 farmers including twenty three women participated. Seventeen officials, sponsored by Directorate of Extension, New Delhi and 48 officials, sponsored by IFFCO Foundation, Unnao were trained on establishment of scientific nursery, rejuvenation and post-harvest management. MPCON Ltd. Bhopal sponsored 53 farmers for training on processing and value addition in fruit crops. Fifty entrepreneurs from Malda and Kanpur sponsored by TIFAC (DST), New Delhi and NAIP Subproject, Lucknow were trained on post-harvest management and processing of fruits. Additionally, two training programmes were organised for 123 non-matric Group D Staff of the Institute for upgradation of their skills and career advancement opportunities.

Fifteen trainings were organized by the PFDC, CISH, Lucknow in twelve districts of U P. A total number of 2500 farmers/ officials were trained. Besides off-farm trainings, the on-farm interactive programmes were also conducted. The farmers and officials were taken to the ongoing research and demonstration activities of the PFDC at CISH, Lucknow highlighting the use of plastics in nursery and improved propagation techniques, high density planting and meadow orcharding, drip irrigation and plastic mulching in cultivation of fruits and vegetables.

Training in progress on drip irrigation and plastic mulching under PFDC at Chandauli, U.P.

6. EDUCATION AND TRAINING

Training

India

- Dr. Tarun Adak was deputed for 15 days training programme on Enhancing Water Productivity in Agriculture under XIth Plan Scheme on "Scaling up Water Productivity for Livelihood in Agriculture through Training and Demonstration: Training of Trainers and Farmers" during at Water Technology Centre, IARI, New Delhi June 02-15, 2009.
- Dr. S. Rajan participated in the regional workshop on good practices related to traditional knowledge (TK) documentation, community biodiversity register and farmer's descriptors at Telang Usan Hotel, Kuching and Kampung Kiding, Padawan, Malaysia from October. 8 to 14, 2009.
- Dr. S. K. Shukla attended a 5-day Management Development Programme on "Technical Aspects of Agricultural Communication and Knowledge Management for ICAR Executives" organized by IIM, Lucknow during November 16 to 20, 2009.
- Muthukumar, M. was deputed to attend a winter school on Bioinformatics and its Applications in Agriculture at Kerala Agricultural University, Thrissur December 1 to 21, 2009.
- Dr. S. Rajan, was deputed to attend National level training cum interactive discussion on Off Season Mango Production organized by NAIP at Kanyakumari, December 7, 2009.
- Dr Dushyant Mishra attended "Scientists and Administrators Interface Training Programme" held at Lal Bahadur Shastri National Academy of Administration, Mussoorie, December 21-25, 2009.
- Ms Nimisha Sharma was deputed to attend Rajbhasha training at CDRI, Lucknow, December 23, 2009.
- Dr. S. K. Shukla attended Management Development Programme on "Leadership for Innovation in Agriculture" held January 18-22, 2010.
- Dr. R. Chandra was deputed to attend the programme on Geographical Indication and Patent organized by Technology Information Forecasting and Assessment Council (TIFAC) at Malda, March 3, 2010.
- Muthukumar, M. was deputed attend training on Fundamentals of IPR at UPCAR, Lucknow, March 5 to 6, 2010.
- Dr. Dushyant Mishra attended a training program on "IT based DSS for Rural Livelihood Assessment" at National Institute for Rural Development, Hyderabad during March 11-20, 2010.

7. AWARDS AND RECOGNITIONS

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केन्द्रीय उपोष्ण बागवानी संस्थान, लखनऊ की राजभाषा पत्रिका उद्यान रश्मि के वर्ष 2010 के अंक 1 और 2 के संस्करण को लखनऊ स्थिति नगर राजभाषा कार्यान्वयन समिति की अर्धवार्षिक बैठक के दौरान तष्तीय पुरस्कार प्राप्त हुआ। यह पुरस्कार नराकास के 159 कार्यालयों के मध्य प्रतिस्पर्धा के उपरान्त प्राप्त हुआ। ध्यातव्य है कि पूर्व में भी संस्थान की राजभाषा पत्रिका को गणेष षंकर विद्यार्थी एवं नराकास के पुरस्कार प्राप्त होते रहे हैं।

Fellowship

- Dr. H. Ravishankar, Director, CISH and Dr. Ghanshyam Pandey, Principal Scientist were awarded with the prestigious Fellow Award of the Indian Society of Horticultural Research and Development during the National Symposium on Conservation of Horticulture held at Dehradoon from March 21 to 23, 2010.
- Dr. H. P. Singh, DDG (Hort.) awarding the ISHRD Fellow to Dr. H. Ravishankar
- Dr. Achal Singh was awarded for best poster entitled "Determination of canopy volume in different cultivars of mango (*Mangifera indica*)" in National Symposium on Conservation Horticulture held at Dehradun, March 21-23, 2010.
- Dr. Dushyant Mishra acted as a Jury for the event GEOFEST INTERNATIONAL, organized by CMS, Lucknow on November 8, 2009.
- Dr. V. K. Singh acted as a Rapporteur during National Seminar on Production, Post Harvest Technology and Marketing of Mango in Session VI, Post harvest handling and value addition, held at TNAU Horticultural College and Research Institute, Periyakulam during September 23-25, 2009.
- Dr. V. K. Singh acted as a Rapporteur during the 19th AICRP-STF Group Workers Meeting in Session IV, Use of bio regulators to increase productivity and quality, held at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharastra, during 14-17, 2009.
- Dr. RA Ram was appointed as Programme Incharge of IGNOU Study Centre on Organic farming (PGCOF) (Code 27158 (P).

Best Paper Award

- Dr. Neelima Garg, Devendra Kumar, Mohd. Ashfaque and Muthukumar M. were awarded third prize for the oral presentation of paper entitled, "Production of cellulase from mango peel residue left after pectin extraction using *Aspergillus niger*" in National Seminar on Production, Postharvest Technology and Marketing of Mango held at TNAU, Periyakulam, September 23-25, 2009.
- Devendra Kumar, Mohd. Ashfaque, Abhishek Shukla, Preeti Yadav, Jyoti Bajpai, Muthukumar. M and Neelima Garg were awarded for best poster entitled, "Optimization of condition for carboxymethyl cellulase production from mahua pomace using *Trichoderma* sp." in National Seminar on Food Security and Economic Prosperity through Processing and Preservation of Food held at CIAE, Bhopal, February 4-5, 2010.
- Devendra Kumar, Mohd. Ashfaque, Abhishek Shukla, Muthukumar. M and Neelima Garg were awarded for best poster entitled, "Production, purification and characterization of â-amylase

by *Fusarium* sp. using mango kernel as potential substrate" in National Symposium on Conservation Horticulture held at Dehradun, March 21-23, 2010.

Recognitions

Seminars/Symposia/Meetings

- Dr. H. Ravishankar acted as Chairman of the Technical Session-IV of AICRP(STF) group discussion held at KAU, Thrissur from November 15-19, 2009.
- Dr. H. Ravishankar acted as Chairman of the Technical Session-I of IXth AICRP(STF) Workshop held at KVK, Dapoli from December 14-17, 2009.
- Dr. H. Ravishankar acted as Co-Chairman of the Technical Session on Current Status of Seeds and Planting Material of National Conference on Production on Quality Seeds of Planting Material-Health Management in Horticultural Crops held at New Delhi from March 11-14, 2010.
- Dr A.K. Mishra, Project Coordinator (STF) acted as a member of the Institute Management Committee of NRC, Citrus, Nagpur.
- Dr A.K. Mishra, Project Coordinator (STF) acted as an Advisor, Screening Committee ASRB, New Delhi.
- Dr A.K. Mishra, Project Coordinator (STF) acted as Co-Chairman, Session-I in National Symposium on Modern Approaches to Insect Pest Management held at Zoology Department, Lucknow University, March 27, 2010.
- Dr A.K. Mishra, Project Coordinator (STF) was nominated as an Editor, Journal of Eco-friendly Agriculture.

8. LINKAGE AND COLLABORATION

The Institute has in place MOUs to facilitate capacity building avenues with Integral University, Lucknow, SVPUA&T, Meerut, Sam Higginbottom Institute of Agricultures, Technology and Science, 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 and a certificate course on organic farming. 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.

Externally –aided projects in operation

Sl.No.	Project Title	PI	Period
	DAC, NCPAH, Ministry of Agriculture, GOI, New Delhi		
1.	Hi-tech horticulture for efficient utilization of resource through precision farming (PFDC).	Dr. V.K. Singh	May 2002 - Continue
	Indo-German Programme of Kali & Salz, Germany and AERO, New Delhi		
2.	Use of potassium for improvement of yield and fruit quality of mango.	Dr. V.K. Singh	Oct. 2001-Sept.2010
	AMAAS, MAU (ICAR), New Delhi		
3.	Utilization of mango processing waste for obtaining value added products through fermentation.	Dr. (Smt.) Neelima Garg	April 2007 – March 2010
	APCESS (ICAR), New Delhi		
4.	Multiplication and sale of commercial and elite clones of mango, guava, aonla and bael. **(Revolving Fund Scheme)**	Dr. R.A. Ram	April 2001 – March 2010
	Networking Project ICAR, New Delhi		
5.	Seed production in agricultural crops and fisheries. (**Mega Seed Project**)	Dr. S.Rajan	March 2006 - continue
6.	National network project on underutilized fruits.	Dr. A.K. Singh	Sept.2005 - Aug. 2010
7.	Network project on transgenics in crops (Papaya).	Dr. Ramesh Chandra	Oct. 2005 - March 2012
9.	Network project on Assessment of gender issues and identification and refinement of selected women specific technologies in horticultural crops.	Dr. S.K.Shukla Co-PI	2009- 2012
	Outreach Programme in Network Mode (ICAR), New Delhi		
10.	Outreach programme on *Phytophthora*, *Fusarium* and *Ralstonia* diseases of horticultural and field crops. Sub Project : *Fusarium* (Guava)	Dr. B.K.Pandey	2009- 2012

Sl.No.	Project Title	PI	Period
11.	Outreach programme on Management of sucking pests on horticultural crops. Sub Project : Mango hopper	Dr. R.P.Shukla	2009- 2012
12.	Outreach programme on Diagnosis and management of leaf spot diseases of field and horticultural crops. Sub Project : *Colletotrichum* (Mango)	Dr. B.K.Pandey	2009- 2012
	DBT, Ministry of Science & Technology, Govt. of India, New Delhi		
13.	Characterization and assessment of genetic diversity in mango cultivars using DNA markers: Sequence Tagged Microsatellite Site (STMS) and Random Amplified Polymorphic DNA (RAPD).	Dr. (Smt.) Anju Bajpai	Dec. 2004 – March 2010
14.	Development of genetic resource database and information system for mango.	Dr. S. Rajan	Dec. 2006 – Dec. 2009
	UPCST, Ministry of Science & Technology, Lucknow (U.P.)		
15.	Mass sex screening of papaya for improved production.	Dr. Maneesh Mishra	July 2006 – July 2009
	UPCAR, Ministry of Agriculture, Govt. of U.P., Lucknow		
16.	Survey collection, evaluation and conservation of germplasm of underutilized fruit crops.	Dr. S.K. Shukla	Aug. 2006 – Aug. 2009
18.	Establishment of model nursery for fast multiplication of elite clones and new varieties of mango, guava aonla and bael.	Dr. S. Rajan	Dec. 2006 – Dec. 2009
19.	Establishment of bio-control laboratory and production of bio-agents.	Dr. A.K. Singh	June 2007 – Sept. 2009
20.	Management studies for irregular bearing in mango.	Dr. V.K. Singh	Oct. 2008 – Oct. 2011
	National Medicinal Plants Board, Ministry of Health and Family Welfare, New Delhi		
21.	Intensification of research on bael (*Aegle marmalos* Corr.) with reference to medicinal value.	Dr. Devendra Pandey	April 2008 – March 2011
22.	Anti-diabetic activity guided fractionation and associated attributes in potential germplasm of jamun (*Syzgium cumini* Skeels).	Dr. A.K. Singh	2008-2011
	Technology Mission, Ministry of Agriculture, Govt. of India, New Delhi		
23.	Technology Mission for integrated development of horticulture in North-Eastern State Sub Project – Organic/ biodynamic cultivation of horticultural crops in N.E. region including Sikkim.	Dr. R.A.Ram Co-PI	April 2003 – March 2012

Sl.No.	Project Title	PI	Period
	Sultanate of Oman		
24.	Mango Tree Encyclopedia Project.	Dr. S. Rajan	Nov. 5, 2008 - Nov.4, 2010
	UNEP/GEF-PDF-B		
25.	Conservation and sustainable use of cultivated and wild tropical fruits diversity: Promoting sustainable Livelihoods, food security and ecosystem services.	Dr. S. Rajan	2009 - 2014
	NAIP		
26.	Understanding the mechanism of off season flowering and fruiting in mango under different environmental conditions.	Dr. S. Rajan Consortium PI	2008-2011
27.	A value chain on mango and guava for domestic and export markets.	Dr. S.K.Shukla Consortium PI	2009-2012
28.	Mobilizing mass media support for sharing agro-information	Dr. S.K.Shukla CCPI	2009-2012
29.	Holistic approach fro improving livelihood security through livestock based farming system in Barabanki and Raebareli district of U.P.	Dr. R.A. Ram CCPI	2009-2012

9. AICRP (STF)/ PFDC

ALL INDIA COORDINATED RESEARCH PROJECT

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 government agency. Two ICAR based centres are regular centres, while 3 are co-opted centres. The research on grapes is being carried out at 4 centres under the supervision of NRC on Grapes, Pune. A new centre on grape at JNKVV, Mandsore(M.P.), was also added in the 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 in nine regular and three voluntary centers of AICRP (STF) for selection of suitable cultivars/varieties for different regions and for using them for further crop improvement and production programme along with different traits. The germplasm were evaluated for their qualitative and quantitative traits. Cataloguing of genetic stocks of different subtropical fruits was done using different descriptors. A total of 68 trials divided into 6 sections related to crop improvement, crop production and crop protection aspects of mango, guava and litchi were conducted.

Crop Improvement and Genetic Resources

MANGO (*Mangifera indica* L.)

A total number of 48 seedling germplasm of mango were collected and characterized. Out of these, 4 from RFRS, Vengurle, 11 from HC&RI, Periyakulam, 10 from AES, Paria, 18 from FRS, Sangareddy and 5 from GBPUA&T, Pantnagar were introduced. Apart from these, 12 superior clones of leading varieties *viz.* of 3 of Langra from BAC, Sabour, 2 of Alphonso from RFRS, Vengurle, 2 of Dashehari from GBPU&T, Pantnagar, 3 of Banganpalli from FRS, Sangareddy and 2 of Alphonso from AES, Paria were collected.

A total number of 273 germplasm accessions were evaluated. These indicated 31 at BAC, Sabour, 28 at GBPUA&T, Pantnagar, 4 at AES, Paria, 12 at FRS, Sangareddy, 64 at RFRS, Vengurle, 20 at IIHR, Bangalore, 88 at FRS, Rewa and 15 at IARI, New Delhi. Hybrid 10/1 recorded maximum number of fruits (416) and yield (102kg tree^{-1}) at RFRS, Vengurle. Maxiumum number of fruits tree^{-1} was recorded by the CISH M-1, whereas maximum fruit yield was recorded by cv. Arka Kiran (66.22kg tree^{-1}) at FRS Sangareddy. Cultivar Dudhia Maldah produced maximum fruit yield (56kg tree^{-1}) followed by cv. Surajgarh Maldah (53kg tree^{-1}) at BAC, Sabour, whereas cv. Bombay Green recorded maximum fruit yield (150kg tree^{-1}) followed by cvs Kesar and Langra (100kg tree^{-1}) at RCA, Udaipur. In clonal selection, maximum fruit and pulp weight (621g and 470g, respectively) was recorded in cv. Banganpalli clone-2 at FRS, Sangareddy. Among two superior clones of Dashehari tested at FRS Sanngareddy, maximum number of fruits and yield (137.7 and 16.8kg tree^{-1}) were recorded in Dashehari local (control) than Dashehari-35.

A total number of 1350 crosses were made using seven cross combinations and hybrids were raised in pots for final planting at RFRS, Vengurle. At IIHR Bangalore, a total number of 2447 flowers were crossed with three cross combinations involving Alphonso x Vanraj, Arka Puneet x Alphonso and Amrapali X Vanraj resulting in yield of 367 fruits.

A total number of 237 mango cultivars were scored under field conditions against powdery mildew. No powdery mildew initiative was recorded in cvs. Bombey Peda, Himsagar, Navneetham, Nagin Mahmooda Vikarabad and Gulabi at FRS, Sangareddy. None of the accessions were found free from powdery mildew at RFRS, Vengurle. Similarly, 21 accessions of mango were screened for hopper and thrips. Minimum hopper population was recorded in Neeleshwari followed by Neeleshshan Gujarat while minimum thrips population was recorded in Neeleshan Gujarat followed by Vasibadami at FRS, Sangareddy. A total number of 47 accessions of mango screened against different pests at RFRS, Vengurle showed maximum fruit fly population in cvs Creeping, Dil Pasand and Salem, whereas maximum stone weevil infestation was recorded in Chittur, Badami and Mulgoa.

GUAVA (*Psidium guajava* L.)

The accession of guava, namely Dharedar, Arka

Kiran and *Psidium cattleianum,* and 4 accessions namely Hisar Surkha, Hissar Safeda, Black Guava and one kg guava, added to field gene bank at FRS, Sangareddy and GBPUA&T, Pantnagar, respectively. In the evaluation of guava germplasm Lucknow 46-1 and Sabadana Badri recorded maximum number of fruits (1825 tree^{-1}) and fruit yield (231.0kg tree^{-1}) respectively, at FRS, Sangareddy. At BAC, Sabour, cv. Allahabad Safeda gave maximum yield (39.85kg plant^{-1}) and average fruit weight (210g). Cultivar Sardar gave the highest yield (88.16kg tree^{-1}) followed by Pant Prabhat (85.76kg tree^{-1}) at GBPUA&T, Pantnagar. Similarly, cv. Lalit recorded maximum yield at RCA, Udaipur.

LITCHI (*Litchi chinensis* Sonn)

Four new collections of litchi, Bombaiya-I, Bombaiya-2, Surguja-1 and Surguja-2 were added at GBPUA&T, Pantnagar raising the total collection to 35 in field gene bank. Cultivars Shahi and Late Bedana yielded better at RAU, Pusa, cv. Rose Scented at GBPUA&T, Pantnagar and cv. Bombai at BCKV, Mohanpur.

Crop Production

MANGO (*Mangefera indica* L.)

Maximum tree height was recorded in cv. Kensington at RFRS, Vengurle. At FRS, Sangareddy, maximum number of fruits (247 tree^{-1}) and cumulative yield (297kg^{-1}) (based on five years 2004-2009) was recorded in cv. Banganpalli grafted on Nekkare rootstock. Olour and Kurrukan imparted least growth of scion cv. Langra at FRS, Rewa. In pruning trial for high density planting maximum number of fruits (74 tree^{-1}) were recorded in the treatment combination of 10cm. heading back biennially immediately after harvest at RFRS, Vengurle. Under pruning trial for rejuvenation of over crowded Dashehari mango orchards, heading back up to tertiary branches along with application of standard dose of paclobutrazol was found most suitable for obtaining maximum yield at GBPUA&T, Pantnagar. However, maximum number of fruits and yield were recorded in the treatment heading back up to over crowded branchlets and centre opening without application of paclobutrazol at AES, Paria. In the evaluation of substrate dynamics for IPNM in mango cv. Kesar, maximum yield (139.3 kg tree^{-1}) was recorded with recommended dose of fertilizers at AES, Paria.

The spraying of KH_2PO_4 @ 1.0 per cent along with per cent before bud break was found very effective in increasing fruit yield and quality at GBPUA&T, Pantnagar, AES, Paria, and FRS, Sangareddy. At RFRS, Vengurle, maximum number of fruits (248.25 tree^{-1}) and fruit yield (62.06 kg tree^{-1}) were obtained by spraying of 1 per cent KH_2PO_4 and Thiourea.

Pre harvest application of $CaNO_3$ (4%) resulted in maximum number of fruits (206.50 tree^{-1}) at RFRS, Vengurle. At AES, Paria mulching + sparaying of 1 per cent K_2SO_4 gave maximum number of fruits (59.44 tree^{-1}). At GBPUA&T, Pantnagar preharvest spraying of $CaCl_2$ (2%) along with mulching was very effective in increasing the shelf life (12days) of fruits. However, application of 1 per cent borax along with mulching proved better in increasing the yield and fruit quality in mango cv. Dashehari. At FRS, Sangareddy maximum yield, fruit quality and shelf life was recorded with spraying of $CaCl_2.6H_2O$ (6%).

GUAVA (*Psidium guajava* L.)

Under substrate dynamics for IPNM in guava, maximum yield (142.14kg tree^{-1}) was obtained in trees with application of 500g N, 200 g P & 250 g K tree^{-1} along with spraying of Zn (0.5), B (0.2%) and Mn (1%) twice during the months of August and October and mulching with 10cm thick organic mulch below the tree basins at FRS, Sangareddy whereas half of the recommended dose of fertilizers along with FYM and 250g *Azospirillium* provided maximum yield (62.86Kg tree^{-1}) and quality fruits at GBPUA&T, Pantnagar.

LITCHI (*Litchi chinensis* Sonn)

Double hedge row system (222 plants ha^{-1}) gave significantly higher yield and quality on modified central leader system and harvesting of litchi along with 50 cm shoots and removal of new flushes in November-December gave maximum yield at GBPUA&T, Pantnagar.

In irrigation trial, 1.00V level of irrigation was found to be most effective at GBPUA&T, Pantnagar in order to increase yield and improve fruit quality. However, in the trial for extending the harvesting period of litchi cv. Rose Scented, the preharvest application of shade net, gibberellic acid and benzyl adenine was found effective in delaying the harvesting period by a week to fortnight at GBPUA&T, Pantnagar. Girdling (1mm wide and 1mm deep) of 25 per cent primary branches gave maximum yield and fruit quality at Pantnagar. Higher yield along with better fruit quality was recorded with four sprays of KNO_3 (10g^{-1}) at monthly intervals from September to December.

Maintaining the relativehumidity (46.50%) by sprinkling of water with micro sprinkler near tree canopy was the most effective to reduce fruit cracking up to 3.90 per cent as compared to control (21.10%) at RAU, Pusa. Under substrate dynamics for IPMN in litchi, application of 500:200 : 250g NPK + 50kg FYM + 250g *Trichoderma* and *Pseudomonas fulorescens* was the most effective in improving yeld (71.90kg tree^{-1}).

Crop protection

MANGO (*Mangifera indica* L.)

Incidence of hopper population was more (2.64 panicle^{-1}) during the first fortnight of February at RFRS, Vengurle, however, nymphal population was present throughout the year except May, August and September. At GBPUA&T, Pantnagar peak hopper population (14.72 panicle^{-1}) were recorded in the first week of April 2009 and the last week of March, 2010 (18.2 panicle^{-1}) in 30 years old mango tree of cv. Dashehari. The mango cvs Chausa and Langra had higher population as compared to Dashehari. Contrary to this at FRS, Sangareddy, maximum hopper populations were recorded in cvs Dashehari-35, Dashehari -51 and Dashehari— —. At AES, Paria the peak population of mango hopper (11.60 hopper panicle^{-1}) was noticed during 8th standard week, however, the major population of thrips (3.80 panicle^{-1}) was observed during 11th standard week. Peak incidence of fruit fly was recorded in 27th standard week at AES, Paria, 30th standard week at RFRS, Vengurle, 25th to 28th standard week at BCKV, Mohanpur and during June - July at GBPUA&T, Pantnagar. Methyl eugenol trap @ 4 per acre was effective to control fruit fly population at BCKV, Mohanpur and RFRS, Vengurle. Application of imidacloprid (0.05%) at panicle emergence stage followed by two sprays of endosulfon (0.07%) after 21 days of first spray and 15 days of second spray proved most effective at GBPUA&T, Pantnagar, AES, Paria and BCKV, Mohanpur to control hopper population and reduce the avoidable crop loss. Different IPM modules were evaluated for control of hopper population on commercial cultivars of mango in different regions. Module-I (imidacloprid-azadirachtin-endosulfon) proved superior at GBPUA&T, Pantnagar, RFRS, Vengurle and AES, Paria, whereas Module-II (thiomethoxam-azadirachtin-ethofenprox) proved better at BCKV, Mohanpur and FRS, Sangareddy. However, at BAC, Sabour two sprayings of imidacloprid followed by NSKE and endosulfon were found very effective in controlling hopper population.

A total number of 389 accessions including standard varieties hybrids/seedlings/clones were screened against floral malformation of mango at RFRS, Vengurle (61), BAC, Sabour (43), FRS, Sangareddy(250) and AES, Paria (35) and classified into different levels of resistance. Cultivars Alphonso, Bada Gulabi, Bombay Green, Himsagar Peddarasam, Prabhashankar, Khasul-khas, Bombay Peda were free from malformation at FRS, Sangareddy. In epidemiological studies of powdery mildew, the disease appearance was noticed from 2nd fortnight of January to 2nd week of February on new flushes, inflorescences and fruitlets of mango at RFRS, Vengurle and FRS, Sangareddy on commercial cvs Alphonso and Banganpalli. The mean temperature (31.9 to 34.4°C maximum and 16.8 to 27.3°C minimum) and relative humidity between 55.4 to 91.0 per cent between 2nd week of January to 2nd week of February were found congenial for the appearance and spread of powdery mildew at RFRS, Vengurle.

Pre-harvest spraying of chlorothalonil (0.2%), thiaphanate methyl (0.1%), Saaf (0.2%) and carbendazim (0.1%) reduced anthracnose of mango significantly at FRS, Sangareddy, RFRS, Vengurle and AES, Paria. Similarly, for control of mango blossom blight (combined infection of anthracnose and *Alternaria*) pre-harvest application of carbendazim (0.1%)+ mancozeb (0.2%) reduced the disease incidence at RFRS, Vengurle. However, no disease symptoms were observed at AES, Paria and FRS, Sangareddy.

LITCHI (*Litchi chinensis* Sonn)

In the surveillance of pest complex of litchi, leaf roller, fruit borer, midrib borer, litchi bug and litchi leaf curl mite were found most damaging at GBPUA&T, Pantnagar. Leaf roller and mid rib borer caused >50 per cent damage whereas litchi bug and litchi leaf curl mite remained less damaging. Litchi fruit borer and leaf roller infestations reached to 43.50 and 58.90 per cent, respectively at BCKV, Mohanpur. Under IPM for management of litchi fruit borer, two sprayings of endosulfon (0.07%) at peanut and colour break stages were found most effective at GBPUA&T, Pantnagar and BCKV, Mohanpur. However, application of Tricho cards along with *Bacillus thuringiencis* (2g litre $^{-1}$) reduced the infestation up to 9.67 per cent at RAU, Pusa. For litchi leaf curl mite, the pruning and burning of all the affected twigs/leaves just after harvest followed by spraying of dicofol (0.05%) at the time of new flush, reduced the infestation up to 71 per cent at GBPUA&T, Pantnagar.

Survey and surveillance of pollinators in litchi during peak season of flowering showed the presence of *Apis spp*. (79.4%) non *Apis spp*. (3.32%) and syrphids (8.26%) at medium height at GBPUA&T, Pantnagar. However, *Apis dorsata*, A. *mellifera* and *Trigona spp*. and flies *Sarcophaga spp*. and *Lucilia spp*. were the major pollinators at BCKV, Mohanpur.

PRECISION FARMING DEVELOPMENT CENTRE (PFDC)

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

Intercropping of brinjal in mango and guava

Intercropping in mango and guava

Intercropping trials comprising of mango and guava alone, guava + brinjal (cv. Chhaya), mango + bottle gourd (cv. NS-422), mango + cauliflower (cv. Snowball-16), mango + cabbage (cv. Diamond Express) and mango + tomato (cv. Nisha) were tried. Differential drip irrigation was adopted to avoid any detrimental effects on mango during flower bud differentiation, flowering and fruiting. Black polyethylene mulch was used in the intercrops for moisture conservation and to contain the root spread.

The best intercrop combinations in terms of total return was guava + brinjal that yielded 6.35 t ha^{-1} of brinjal and 2.35 t ha^{-1} of guava. Brinjal, bottle gourd, cauliflower, cabbage and tomato were effective in sustaining income especially during pre-production phase and off year in mango.

Greenhouse production of vegetables

The performance of two high value vegetable crops, i.e., capsicum and tomato was evaluated in poly house, net house and open field conditions. Five varieties of coloured capsicum and two varieties of tomato were used. Capsicum was planted at a spacing of 45 x 30cm and tomato was planted at a spacing of 60 x 45cm. The beds were covered with polyethylene mulch. Before transplanting of the seedlings, on-line drip irrigation system having a discharge of 2 lh^{-1} was installed.

Tomato plants were pruned to retain 2 branches per plant, while capsicum plants were pruned to retain 4 branches. Irrigation and fertigation were imposed at weekly intervals. Highest yield of 124.89 t ha^{-1} of tomato and 72.98 t ha^{-1} of capsicum was obtained in greenhouse.

Protected cultivation of tomato in greenhouse

10. LIST OF PUBLICATIONS

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Singh, V. K. and S. Rajan (2009). Changes in photosynthetic rate, specific leaf weight and sugar contents in mango (*Mangifera indica* L.). *The Open Hort. J.*, **2**: 34-37.

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Chandra, Ramesh and Nimisha Sharma (2009). Aam ka itihas. *Udyan Rashmi,***10** (1&2): 34-35.

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Singh, V. K. and A. K. Srivastava (2009). Aam ke phalon main antioxidant aur iske vislashan ki vidhi. *Udyan Rashmi,* **10** (1&2): 26-30.

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Abstracts

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Garg, Neelima, Jyoti Bajpai, Mohammad Ashfaque and Preeti Yadav (2010). Aonla products used for food as well as medicine. National Symposium on Conservation Horticulture held at Dehradun, March 21-23, 2010, p. 276.

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changes with special reference to antioxidant properties in different growth stages of mango fruits. National Conference on Frontiers in Plant Physiology Towards Sustainable Agricultural held at Assam Agriculture University, Jorhat, November 5-7, 2009, p. 89.

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Bulletins

Singh, M. D., R. P. Shukla and D. K. Tandon (2009). CISH Technology for Commercialization, CISH, Lucknow, 30 p.

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Mishra, Maneesh, V. K. Singh and R.K.Pathak (2009).Physiological approaches for enhancing productivity of fruit crops. In: *Physiological and Biotechnological Manupulation for Enhancing Plant Productivity*, G. S. Chaturvedi, P.C. Ram and A. K. Singh (eds), Avishkar Publishers, Jaipur, pp 60-78.

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11. ON-GOING RESEARCH PROJECTS

1.0 Theme : Management of genetic resources

PROGRAMME

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

Programme Leader : B.M.C. Reddy (up to 30.06.2009)
H. Ravishankar (24.09.2009)

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 (up to 31.05.2009)

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 : D. Pandey

2.2.3 Planting density and canopy management in mango

Project leader :

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

Project Leader : V. K. 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. Bhriguvanshi

Projects

4.1.1 Integrated water management for increasing water use efficiency in mango

Project Leader : S.R. Bhriguvanshi

4.1.2 Nutrient management in mango

Project Leader : S.R. Bhriguvanshi

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. Bhattacherjee

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 : A. K. Shukla

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

Advisory/Consultancy

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

Contract Service

A paid up trial for evaluation of MAK ALL SEASON HMO of BPCL, Mumbai was undertaken.

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

Research Advisory Committee (RAC)

The 14th meeting of the RAC of the Institute was held under the Chairmanship of Dr. D.S. Rathore, Ex.-Vice Chancellor at CISH, Rehmankhera, Lucknow during June 16-17, 2009. The following members attended the meeting :

Dr. K.K. Jindal	Member
Dr. Gajendra Singh	Member
Dr. R.D. Rawal	Member
Dr. A.K. Bakshi	Member
Dr. K.R. Kaundal	Member
Dr. S. Rajan	Member
Dr. B.M.C. Reddy	Member
Dr. R.P. Shukla	Member Secretary

Significant Decisions

- Continuous efforts must be made for genetic enhancement through additional collection, selective breeding and evaluation for yield and other traits.
- Possibilities of collaboration must be explored with the world's best institutes known for reputed improvement work on mango and guava.
- Crossing of Totapuri with Neelum to increase the quantum of regular bearing genes in a parent.
- Hybridization work on guava needs to be intensified.
- Hybridization should continue for quality and higher productivity in mango and other mandate crops.
- Preparation of short term and long term improvement programmes for mango and guava with clear cut objectives and time frame.
- Marker Aided Selection (MAS) and molecular breeding should be integral component of crop improvement programme.
- Genetic transformation and development of transgenics should be addressed to those traits which can not be addressed by conventional approach. Work on papaya should be continued to logical end.
- The concept of locating plus trees with better yield and quality especially in minor fruits should be strengthened.
- Identification of the best agro ecological regions for maximum productivity of mango and guava.
- Experimental trials on medium density plantations in mango, guava, aonla and other commercial mandate crops should be laid out and package of cultural practices be developed.
- For dwarfing rootstocks of mango, polyembrayonic mango spp. and cultivars from lndo-Burna border may be procured and tested in collaboration with ICAR Complex for NEH Region, Barapani and its Regional Centres.
- Clear cut recommendation for the application of paclobutrazol to control biennial bearing in mango should be made and be transferred to end users.
- In epidemiological experiments the temperature and humidity at night may be bifurcated. Crop growth stages are also important to develop the prediction model (preferably for two diseases, *viz.* powdery mildew and blossom blight).
- In postharvest studies treatments which have proved effective for long period need not be repeated. Focus should be more on preharvest disease management followed by postharvest treatments.
- Since some of the *Bacillus* sp. isolated from watermelon and banana rhizosphere are ineffective against nematodes, reasons should be worked out for its non-efficacy.
- In disease management experiments, there is a need to incorporate some of the bioagents/plant products along with recommended chemicals especially for powdery mildew and blossom blight.
- Biology of the mango hoppers should be studied in relation to pruning, *i.e.*, canopy management on trees of different age groups planted at different densities.
- Entomo-pathogenic nematodes and other micro-pathogens of larvae of fruit fly, leaf webber and

eggs of mealy bug should be studied along with predators and parasitoids.

- Efficacy of newer insecticidal compounds against hoppers and inflorescence midges should be studied.
- Studies on cool chain /supply chain management are needed in view of increasing fresh retails.
  - (i.) Maturity indices cards for different fruits should be prepared and distributed to farmers.
  - (ii.) Shelf life extension studies standardized by the Institute should be integrated into a value chain from farmer to consumer.
  - (iii.) Month wise activity chart for pre and postharvest treatments should be placed on website of the Institute.
- Fibre and enzyme recovery technologies from by-products / wastes need refinement and commercialization through some industrial collaboration.
- Phytochemicals like phenols, combolian glucosides, gerberesin, gallic acid, psoralins and marmelosins in jamun and bael should be evaluated and reduction on processing should be studied. Since these bind free radicals, their ORAC value should be assessed. The effect of phenolics, pigments and other phytochemicals on human health should be studied in collaboration with medical team.
- Since mango pulp is the largest item of export in aseptic packs, blending technologies of Institute should be tested in export channels through collaboration with APEDA.
- Product development should be need based keeping in mind the gaps in market and brand space. A through process of conceptualization of product attributes, lab scale testing, upscaling using pilot facilities and then testing the product through different market channels should be followed.
- Freeze drying of jamun and the medicinal properties of the pulp as well as stone may be worked out, so that the powder obtained may be used in preparation of extruded products for snacks.
- Fibre obtained from aonla pomace and mango peel may be analyzed for phenolics, ascorbic acid and oxygen radical absorbing capacity for better utilization.

Institute Research Committee (IRC)

Twenty-sixth and twenty-seventh IRC meetings of the Institute were held from January 5-8, and March 29-31, 2010 under the Chairmanship of Dr. H. Ravishankar, Director to review the progress made in ongoing research projects and approval of technical programmes for the next year.

Significant Decisions (26th IRC)

- Trait specific germplasm should be collected.
- Marker Aided Selection should be given priority.
- Central Accession Register of germplasm should be maintained by following guidelines of NBPGR and Director will be the custodian of the register. Register needs be updated periodically.
- Multidisciplinary approach should be followed for addressing the problem of decreasing size of fruits of Dashehari in growers holding for which new project should be formulated.
- Behaviour of malformation tolerant accession reported needs to be verified.
- Finger printing of different varieties need to be undertaken and a compilation needs to be brought out.
- Screening of germplasm against anthracnose and fruit fly is essential.
- Action plan should be developed for collection of pickle varieties of mango and parameters for pickle varieties should be established.
- Extent of variability among Allahabad Safeda guava should be studied.
- Validation of polymorphic primers should undertaken.
- Mother blocks of different varieties for propagation should be established and maintained disease/pest free.
- Mass multiplication protocols developed for wilt tolerant hybrid rootstock needs to be carried forward in collaboration with Dr. Maneesh Mishra.
- Sibmating should be mentioned inplace of controlled pollination. Sibmating and selfing needs to be adopted to ensure purity in seed production of elite types of papaya.
- Collection of germplasm of bael and aonla should only be done which excel in quality. Benchmark information need to be established in this case and focus is needed for improvement of the target traits..
- Status of Elaichi should be reported regarding

resistance to malformation. Molecular aided selection for pericarp colour needs focus.

- Hybrids released by I.I.H.R., Bangalore should be procured and tried.
- The programme on papaya needs relook from the point of view of emerging needs of variety dynamics, production under North Indian belts.
- Rate of organic matter build up and depletion should be studied.
- Role of limiting factors have to be ascertained and soil health issues in totality need to be addressed.
- Basic studies should be integrated with strategic research in all the programmes.
- Land use index should be worked out wherever spacing trials are in progress.
- Research work needs to be focused on identification of rootstocks in mango with histological / anatomical aspects on compatibilities.
- Studies on interaction of paclobutrazol with microflora needs to be carried out in collaboration with soil microbiologist.
- Studies on carbon sequestration in mango system.
- Complete package of sustainable bee keeping merits consideration is needed.
- Use of bee attractants in improving yield of mango orchards needs critical studies.
- Molecular characterization of litchi germplasm in collaboration with NRC Litchi needs attention.
- Studies on gene cloning and RNA gene silencing needs consideration.
- Standards for quality planting materials of mandate crop needs to be outlined should be developed.
- Role of diagnostics, accreditation protocols for scientific nursery programmes need a critical look.
- Water productivity studies should be conducted studies on use of magnetised water for input use efficiency be evaluated.
- Role of micronutrients in the overall nutrition of mandate crops needs to be studied.
- Systematic studies are role of micorhyzae and their association in mango and other mandate fruit crops needs attention.
- Organic farming as a system approach needs to be studied and validated.
- Residue of recommended insecticides *viz.*, imidacloprid, thiamethoxam, chlorpyriphos, carbosulfan and acephate should be analysed in mango.
- Stone weevil is persent in Uttarakhand region. Its presence / absence in the areas contiguous to Uttarakhand needs appraisal.
- PRA of new pest shoot gall psyll and fruit borer needs to be taken up and farmer advisory needs to be put in place.
- Extent of economic loss by each pest should be highlighted.
- Studies on survival of entomopathogenic nematodes in rhizosphere may be intensified.
- Trials for control of fruit borer and shoot gall maker of aonla should be conducted at R.B. Road Campus.
- Management trials should be conducted for control of fruit borer of guava at appropriate fields.
- Role of nematodes in integrated management of guava wilt needs to be delineated.
- Genetics of resistance of malformation should be studied.
- Technical programme should be formulated for integrated management of guava wilt and shoulder browning diseases of mango.
- Pre-harvest management practices needs to be integrated with post-harvest management practices.
- Shink wraping should be tried for packaging. Chemicals may be impregnated in packaging boxes and protocols for long distance transport of produce be evolved.
- Microbial safety of each processed product should be worked out.
- Product diversification with nutraceuticals in foods need attention.
- Economics of enzyme production utilizing waste should be worked out.
- Work on microbial production of ethanol and biomethane be initiated as a part of waste utilization.
- Advisory should be given to farmers regarding intercropping in mandate crops and factor productivity analysis be carried out.
- Programme on Good Agricultural Practices needs attention.

- Comprehensive market intelligence programmes need to be developed. The programme need to bring out farmer advisory services as an approach to empowerment.
- The emphasis needs to be laid on PRA studies. Impact analysis of Institute's technology adoption required.
- Impact of training programmes should also be studied, feed back analysis carried and effective interventions indicated.

Significant Decisions (27th IRC)

- Biotechnologists need to assist in conventional breeding programmes of the Institute.
- Biosecurity, bioinformatics and establishment of mother blocks is a priority.
- Finger printing of new varieties should be done.
- Work on nanotechnology and climate change merits consideration.
- Area covered by the Institute released varieties needs documentation. If the area covered is not satisfactory, then apprise constraints.
- Papaya seed production should be started.
- Rootstock research in mango needs to focus are salt and drought resistance. Physiologist, horticulturist, biotechnologist and soil scientists are to be associated.
- Nutrient budgeting of mandate crops to be carried out.
- Basic studies on water productivity needs focus.
- Site specific nutrient management studies are necessary.
- Under substrate dynamics, micorhyza profiling should be focussed and rhizosphre competence to be established.
- In canopy management trials, geometrical arrangement, growth regulators, physiological implications on productivity, water management and pests and diseases incidence needs to be incorporated.
- Programme on biennial bearing should be revisited and Director desires to be associated in the project. Varieties Dashehari, Langra and Chausa should be included. Physiological and biochemical studies need to be carried out with due focus on the role of root system in regulatory process.
- Integrated farming system research should be initiated.
- Field layout maps, tree record industry yield data needed to be maintained for each of the blocks.
- A new project on Decision Support System should be formulated.
- Emphasis must be laid on the development of weather based forecasting system for major pests and diseases.
- Contingency management plans have to be developed for shoot gall psylla and stone weevil / pulp weevil.
- Efficacy of *Beauveria* sp. along with rational combination of soil moisture may be evaluted.
- Emphasis may be laid on emerging pests and diseases (thrips, wilt) and a team approach may be followed in their management strategy. Before initiation of work in a project mode, a survey may be undertaken for assessing the extent of problem.
- In view of ecofriendly management approaches emphasizing new botanicals need to be tested particularly against post harvest diseases.
- Impact analysis of machines developed at the Institute is necessary.
- All projects should have cost benefit analysis aspects incorporated.

Dr. D.S. Rathore, Chairman, RAC presiding over the meeting

Dr. H. Ravishankar, Director presiding over the IRC meeting

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

Conferences

1. Dr. A. K. Mishra attended the National Conference on Technology Led Economic Development of Horticulture for Rural Upliftment, held at Samastipur, May 29-30, 2009.
2. Dr. V. K. Singh attended the National Conference on Frontiers in Plant Physiology Towards Sustainable Agriculture held at Assam Agricultural University, Jorhat, Assam, November 5-7, 2009.
3. Dr. A. K. Mishra and Dr. V. K. Singh attended the National Conference on Production of Quality Seeds and Planting Material-Health Management in Horticultural Crops, held at New Delhi, March 11-14, 2010

Meetings

1. Dr. V. K. Singh attended a meeting of NAIP project on Understanding the mechanism of off season flowering and fruiting in mango under different environmental conditions held at IIHR, Bangalore, April 4, 2009.
2. Dr. V. K. Singh attended a meeting of PFDC project on Hi-tech horticulture for efficient utilization of resources through precision farming held at New Delhi, August 04, 2009.
3. Dr. A. K. Mishra attended a meeting of IMC, NRC for citrus, Nagpur, September 19, 2009 and January 30, 2010.
4. Dr. V. K. Singh attended the National level interactive training/discussion on off season mango of NAIP project on Understanding the mechanism of off season flowering and fruiting in mango under different environmental conditions held at Kanyakumari, November 7-8, 2009.
5. Dr. H. Ravishankar, Dr. S. Rajan and Dr. V. K. Singh attended CIC meeting of NAIP project on Understanding the mechanism of off season flowering and fruiting in mango under different environmental conditions held at IIHR, Bangalore, November 11, 2009.
6. Dr. V. K. Singh attended the half yearly review meeting of PFDC project on Hi-tech horticulture for efficient utilization of resources through precision farming held at Navsari Agricultural University, Navsari, November 20–21, 2009.
7. Dr. D. Pandey attended the XVth Research Workers Group Meeting of on Arid Zone Fruit held at Horticulture College and Research Institute, Periyakulam, January 28-30, 2010.

Director Meetings

1. Dr. H. Ravishankar, Director and Dr. A.K. Misra, PC (STF) attended the Foundation Day Celebration of CSIR held at Scientific Convention Centre, Lucknow, September 26, 2009.
2. Dr. H. Ravishankar, Director participated in the inaugural programme of UNEP-GEF project held at New Delhi, November 10, 2009.
3. Dr. H. Ravishankar, Director Chaired the CICE Meeting of NEIP projects on off-season flowering in Mango at CISH Lucknow, November 11, 2009.
4. Dr. H. Ravishankar, Director attened the meeting of National Project Steering Committee Members and Thematic Experts of UNEP-GEF TFT Project held at NASC Complex, New Delhi, November 28, 2009.
5. Dr. H. Ravishankar, Director participated in Director's Conference held at NASC Complex, New Delhi, February 15-16, 2010.
6. Dr. H. Ravishankar, Director attended two days National Training on Fundamental of IPR at Uttar Pradesh Council of Agricultural Research, Lucknow, March 5-6, 2010.

Seminars/Symposia

1. Dr Dushyant Mishra, attended "National Seminar on Mango held at Panchkula, July 5, 2009.
2. Dr. V. K. Singh attended the National Seminar on Production, Postharvest Technology and Marketing of Mango held at Horticultural College and Research Institute, Periyakulam, September 23-25, 2009.
3. Dr. Tarun Adak attended the National Symposium on Climate Change and Rainfed Agriculture held at CRIDA, Hyderabad, February 18-20, 2010.
4. Dr. A. K. Mishra attended the National Symposium on Modern Approaches to Insect Pest Management held at Lucknow University, Lucknow, March 27, 2010.

Workshop

1. Dr. V. K. Singh attended the Indo-US sponsored International Congress-cum-Workshop on Intellectual Property Right (IPR) held at Amity University, Noida, October 5-7, 2009.
2. Dr. H. Ravishankar, A. K. Mishra, V. K. Singh, D. Panday , Ghanshyam Panday and Dushyant Mishra attended 19th Workshop of All India Coordinated Research Project on STF held at BSSKKV, Dapoli, December 14- 17, 2009.
3. Dr. D. Pandey attended the Regional Brain Storming Workshop on Perspective Plan for Land Use in the Eastern Region of U.P, held at Varansi, February 22, 2010.
4. Dr. D.Pandey attended the Regional Brain Storming Workshop on Perspective Plan for Land Use in the Central Region of U.P. held at Lucknbow, February 26, 2010.
5. Drs. H. Ravishankar, Ghanshyam Panday, D. Pandey and Achal Singh attended the National Symposium on Conservation Horticulture held at Dehradun, March 21-23, 2010.

15. WORKSHOPS, SEMINARS, SYMPOSIA, ETC. ORGANISED

Interaction Meet of Entomologists

Interaction meet of Entomologists was convened under the chairmanship of Dr. H.P. Singh, DDG (Hort.) from June 10 to 11, 2009 for developing an innovatively synchronized action plan for effective management of pests affecting horticultural crops across the country. Around 50 entomologists working on horticultural crops at different institutes under ICAR system gathered at CISH, Lucknow for in depth discussion and interaction.

An outreach programme on sucking pests and the web site developed by IIHR, Bangalore were launched by Dr. H.P. Singh, DDG (Hort.) on the occasion. Presiding over the meet, DDG (Hort.) spoke on importance of developing holistic management programme for insect pests in action plan mode and the likely output and outcome to be realized. He opined that identification and incorporation of genes controlling specific toxins responsible for insecticidal action against certain targeted pest(s) could be the best option in pest management sphere. He cited an example of native variety of maize expressing resistance against stem borer and hence, stressed the importance of evaluating such germplasm available in specific locale, identification of compound(s) responsible for inhibiting the pest attack and their subsequent exploitation for gainful utilization in pest management programmes.

Speaking on the occasion, Dr. B.M.C. Reddy, Director, CISH highlighted the very purpose of the meet and laid major emphasis on the development of management system having conscious view of quality parameters of crop production. Dr. U.C. Srivastava, ADG (Hort.) emphasized the importance and role of Disease Prediction System for working out dependable and cost effective strategies against the destructive pests affecting horticultural crops.

Exhaustive deliberations on crop infestation level, bioecology and management strategies being followed in major horticultural crops including mango, banana, grape, citrus, papaya, litchi, sapota, black pepper, cardamom, cassava, coconut, cashew nut, brinjal and potato, with reference to coleoplerous and lepidopteron pests, were held. In view of the qualitative degradation of environment and ensuing deleterious impact on biosphere, the role of biotechnological tools and pheromones in tackling the pest population and bio-security aspects were specifically highlighted during the meeting. Accordingly, a work plan was chalked out.

Summer School - 2009

A summer school, sponsored by ICAR, New Delhi, on "Management of canopy architecture for higher productivity in subtropical fruits" was organized at Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow from June 16 to July 6, 2009. Dr. B. M. C. Reddy was the Course Director, Dr. V. K. Singh, Course Coordinator and Dr. Dushyant Mishra, Assistant Coordinator. Twenty-two participants from different states attended this summer school. In the summer school, lectures on different topics including canopy architecture for enhanced yield and quality production, mechanization for tree architecture engineering, management of plant architecture to minimize the climate change impacts, physiological changes with intervention in canopy architecture and genetic basis of canopy architecture

Dr. B.M.C. Reddy, Director and Dr. V.K. Singh, Course Coordinator along with the participants

were delivered by the invited resource persons as well as scientists of the Institute. The summer school also included practical training in the laboratories and the fields. A compendium / training manual was released and distributed to the participants.

Launch Workshop of NAIP subproject

The subproject on A value chain on mango and guava for domestic and export markets under Component – II of the National Agricultural Innovation Project (NAIP) was launched by Dr. J.P. Mittal, National Coordinator on June 25, 2009 at the Lead Centre, Central Institute for Subtropical Horticulture, Lucknow.

Dr. D.S. Rathore, Chairman, CAC and others releasing the publication

Dr B.M.C. Reddy, Director and Consortium Leader of the project welcomed the guests and highlighted the theme of the project. The project, with a total budget allocation of Rs. 443.7565 lakhs, will operate at five centres in consortium mode with CISH, Lucknow as the Lead Centre. Three State Agricultural/ Horticultural Universities, *viz.* Tamil Nadu Agricultural University, Coimbatore, A.P. Horticultural University, Tedepalligudem and Navsari Agricultural University, Navsari, and a private organization, BAIF Development Research Foundation, Pune will be consortium partners in the project in order to achieve the objectives effectively. The project aims to enhance the productivity and quality of mango and guava varieties through technological interventions, better profitability to fruit growers through training, entrepreneurship development in processing sector and marketing linkages for the produce. The Launch Workshop was attended by Dr D. S. Rathore, Chairman, Consortium Advisory Committee (CAC) for the subproject, members of the CAC, Consortium Principal Investigator (CPI), Consortium Co-PIs, representatives from the State Departments, scientists of the Institute and farmers. A brief presentation of the entire project was made by Dr S. K. Shukla, the Consortium PI at the Lead Centre. The objectives and the expectations of the PIU (NAIP) under the project were emphasized by Dr J. P. Mittal. Dr D. S. Rathore, in his remarks, highlighted the practical ways to achieve the targeted objectives. Shri Shailendra Singh and Ms Laxmi Dwivedi, members, CAC shared their expectations from the project.

Group Worker's Meeting of AICRP (STF)

The 19th Group Worker's Meeting of All India Coordinated Research Project on Subtropical Fruits was jointly organized by CISH, Lucknow and Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli from December 14 to 17, 2009 at BSKKV, Dapoli. Dr. H.P. Singh, DDG (Hort.) inaugurated the meeting and delivered the presidential address. Dr. B. B. Jadhav, Director, Research, BSKKV, Dapoli welcomed the dignitaries and participants of group worker's meeting. Dr. A. K. Misra, Project Coordinator, AICRP(STF), presented Coordinator's report pertaining to mango, guava and litchi and brief account of the progress made by different centres during 2007—09. Dr. P.G. Adsule, Director, NRC for Grapes, Pune presented Coordinator's report pertaining to grapes. The guest of honour, Dr. V.B. Mehta, Vice chancellor, Balasahab Sawant Konkan Krishi Vidyapeeth, Dapoli delivered inaugural speech. Dr. H. P. Singh, DDG (Hort.) reviewed the action taken on the recommendations of the 18th Group Worker's Meeting and offered valuable suggestions. Four publications, viz. Mango Plant Protection, Hard Rock Mango Plantation, AICRIP (STF) Annual Report 2008-09 and Biennial Report 2007-09, were released during the occasion by Dr. H. P. Singh. Mango cultivar Suvarna, developed at RFRS, Vengurle was also released and saplings were given to progressive farmers for cultivation.

The progress of research on mango, guava and litchi were discussed in eight sessions, *viz.*, Management of genetic resources and varietal improvement, rootstock, planting density, training and pruning, agro-techniques, use of bio-regulators to

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

increase productivity and quality of fruits, insect pest management, disease managemant, achievements of ad-hoc schemes and planning of time bound achievements. The progress of work on grapes was also discussed in respective sessions during this period. New experiments were separately discussed in detail and finalized for implementation. The work of each research centre was discussed in depth and technical programme was finalized for each session. Old experiments were concluded and centres were advised to submit the final report. A total number of 117 participants from all the cooperating centres, including ICAR institutes, SAUs, state government, fruit growers, private agencies, principal investigators of ad-hoc schemes and industries participated.

Among the important dignities who participated in the meeting included Dr. H P Singh, DDG (Hort.), Dr. Vijay Mehta, V. C., BSKKV, Dapoli, Dr. H. Ravishankar, Director, CISH, Lucknow, Dr. P. G. Adsule, Director, NRC for Grapes, Pune, Dr. K. K. Kumar, Director, NRC for Litchi, Muzaffarpur, Dr. S. K. Mitra, Dean, BCKV, Mohanpur, Dr. B. M. C. Reddy, Ex. Director, CISH, Lucknow, Dr. B. B. Jadhav, Director Research, BSKKV, Dapoli and Dr. S. A. Chavan, ADR, RFRS, Vengurle.

Plenary session was chaired by the Vice Chancellor, BSKKV, Dapoli. Recommendations of different sessions were presented by Chairmen of different sessions and proccedings were finalized.

16. DISTINGHUISHED VISITORS

- Dr. Ajai Kumar, Director, DARE and Chief Vigilance Officer, ICAR, Krishi Bhawan, New Delhi-110 114 (April 10, 2009).
- Dr. D.S. Rathore, Former Vice-Chancellor and Chairman, Institute R.A.C., Flat P, J-1/63, Gupta Colony, Khirki Extension, New Delhi-110 017 (May 16 & 19, 2009).
- Dr. Umesh Srivastava, ADG (Hort.-II), ICAR, KAB-II, Pusa, New Delhi-110 012 (June 10, 2009).
- Dr. H.P. Singh, DDG (Hort.), ICAR, KAB-II, Pusa, New Delhi-110 012 (June 11 & 20, 2009).
- Dr. Prem Mathur, Regional Coordinator, Bioversity International & Dr. Bhuwon Sthapit, Regional Project Coordinator, UNEP-GEF Project, New Delhi-110012 (June 21, 2009).
- Dr. J.P. Mittal, Ntional Coordinator NAIP, ICAR, KAB-II, Pusa, New Delhi-110 012 (June 25, 2009).
- Dr. C.S. Prasad, Professor, Department of Entomology, Sardar Ballabh Bhai Patel University of Agri. & Tech., Roorkee Road, Modipuram, Meerut-250 110 (July 30, 2009).
- Dr. D.S. Rathore, Former Vice-Chancellor and Chairman, Institute R.A.C., Flat P, J-1/63, Gupta Colony, Khirki Extension, New Delhi-110 017(September 25, 2009).
- Shri D.P. Yadav, Former Member of Parliament (Lok Sabha), A-51, Pandara Road, New Delhi-110 003 (September 29, 2009).
- Shri Sudhir Bhargava, Member, Governing Body, ICAR, 25, 2nd Floor, Tardeo A.C. Market, Tardeo, Mumbai-400 034 (October 1, 2009).
- Shri Yogendra Kumar, Senior Regional Manager, Indian Farmers Fertilizer Cooperative Limited, 8, Gokhale Marg, Lucknow-226 001(October 1, 2009).
- Prof. S.W. Akhtar, Vice Chancellor, Integral University, Lucknow (October 19, 2009).
- Er. Mohd. Haris Siddiqui, Chief Worden and Asstt. Prof. (Biotech.), Integral University, Lucknow(October 19, 2009).
- Er. M.Q. Siddiqui, Senior Engineer (Railways), Lucknow (October 19, 2009).
- Dr. Mathura Rai, Director, IIVR, Varanasi (October 30, 2009).
- Shri Mithlesh Kumar, Former Principal Secretary to Governor of Bihar, Patna (October 30, 2009).
- Dr. N.S. Sharma, Former Chief Medical Officer, Pratapgarh (October 30, 2009).
- Dr. Rakesh K. Singh, Professor & Head, College of Agricultural & Environmental Sciences, Department of Food Science & Technology, The University of Georgia, Athens, GA-30602, USA (November 17, 2009).
- Dr. T.P. Trivedi, Project Director, Directorate of Information and Publications of Agriculture, ICAR, KAB-I, Pusa, New Delhi-110 012 (December 8, 2009).
- Dr. B.M. Chattopadhyaya, Chief Nodal Officer, National Agriculture Innovation Project, ICAR, KAB-II, Pusa, New Delhi-110 012 (December 8, 2009).
- Prof. Yasuhiko Mukai, Osaka Kyoiku University, Osaka, Japan (December 24, 2009).
- Dr. M.A. Khan, Director, ICAR Research Complex for Eastern Region, ICAR Parisar, P.O. BV College Campus, Patna-800 014 (January 11, 2010).
- Shri Sanjay Singh, Advisor, TIFAC (DST), Government of India, New Delhi-110018 (January 20, 2010).
- Dr. D. Majumder, Principal Scientific Officer, TIFAC (DST), Government of India, New Delhi-110018 (January 20-22, 2010).
- Dr. Prabeer Banerjee, Joint Secretary (FPICH), Government of W. B., Kolkata-700091 (January 20-22, 2010).
- Shri K. N. Chaudhary, MLA, Golapatti, Malda-732101 (January 22, 2010).
- Dr. H.S. Gupta, Director, IARI, New Delhi-110 012 (February 5, 2010).
- Dr. Umesh Srivastava, ADG (Hort.-II), ICAR, KAB-II, Pusa, New Delhi-110 012 (February 11, 2010).
- Dr. H.P. Singh, DDG (Hort.), ICAR, KAB-II, Pusa, New Delhi-110 012 (February 24, 2010).
- Mr. Hugo A.H. Lamers, Associate Scientist, Bioversity International, National Agricultural Science Centre, New Delhi-110 012 (March 3-4, 2010).
- Dr. D.S. Rathore, Former Vice-Chancellor and Chairman, Institute R.A.C., Flat P, J-1/63, Gupta Colony, Khirki Extension, New Delhi-110 017 (March 26, 2010).

17. PERSONNEL

B. M. C. Reddy, Ph.D.
Director
(On re-employment up to 30.06.09)

Ramesh Chandra, Ph.D., F.I.S.G.P.B, F.H.S.I.
Acting Director (up to 23.09.2009)

H. Ravishankar, Ph.D.
Director
(w.e.f. 24.09.2009)

SCIENTIFIC

Division of Crop Improvement

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

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

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

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

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

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

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

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

H. C. Verma,
Scientist (SS), (Computer Appl.) (w.e.f. 19.08.2009)

Ms. Nimisha Sharma, M.Sc.
Scientist (Biotech.)(w.e.f. 19.08.2009)

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.) (Retired on 31.05.2009)

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.
Pr. 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

Tarun Adak, Ph.D.
Scientist
Division of Crop Protection

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

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

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

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

A. K. Shukla, Ph.D.
Pr. Scientist (w.e.f. 09.06.2009)
A. K. Singh, Ph.D.
Sr. Scientist (Pl.Path.)

P. K. Shukla, Ph.D.
Sr. Scientist (Pl.Path.) (w.e.f.19.08.2009)

Division of Post Harvest Management

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

M. D. Singh, M.E.
Pr. Scientist (FM&P)

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

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

A. K. Bhattacherjee, 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

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

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

TECHNICAL

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

S. K. Saxena, M.Lib.Sci., D.P.A.
T-7 (T.O.) (Lib.)(Expired on 30.09.2009)

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. (Commercial Arts)
T-5 (T.O.) (Arts)

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

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

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

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

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

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

ADMINISTRATIVE

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

K. Swarnakumari, Matriculation
Administrative Officer

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

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

Ram Naresh
Senior Stenographer

18. OTHER INFORMATION

Launching of International Project

Dr. H.P. Singh, DDG (Hort.) and other distinguished dignitaries sitting on the dais during the launching of the International Projects

The project launching ceremony of the International Project entitled Conservation and Sustainable Use of Cultivated and Wild Tropical Fruit Diversity: Promoting Sustainable Livelihoods, Food Security and Ecosystem Services was organized at the Central Institute for Subtropical Horticulture, Lucknow at its Rehmankhera campus on 20 June, 2009. The International Project was inaugurated by Dr. H.P.Singh, Deputy Director General (Hort.), ICAR, New Delhi and the Chairman of the International Project. Dr. B.M.C. Reddy, Director, CISH. is designated as the National Project Director and Coordinator. This is a multinational project involving India, Indonesia, Malaysia and Thailand. The tropical fruit tree (TFT) crops covered under the project are mango, citrus, rambutan and mangosteen. In India, mango, citrus and *Garcinia* are the priority species in this project.

The important objectives of the international project are to improve the livelihoods and food security of target beneficiaries through *in situ* and on farm conservation and sustainable use of tropical fruit genetic resources. This will be achieved by strengthening the capacity of farmers, user groups, local communities and institutions to sustainably apply good practices and secure benefits.

The Project also aims to provide an effective long-term basis for maintaining the genetic diversity and ecosystem functions of both cultivated and wild TFT, a foundation for development of environmental certification schemes to promote marketing and mainstreaming of TFT, generation and exchange of knowledge between institutions, a forum for establishing a regional agenda for TFT and a community-based management model for safeguarding TFT.

The outcome of the project is expected to be, diversity of tropical fruit tree genetic resources is conserved *in situ* and on-farm through improved knowledge of its value, use and sustainable management practices. Besides, there will be additional outcomes like rural communities benefit by using methodologies and good practices for the management and conservation of tropical fruit tree species and intra-specific diversity. Even the stakeholders having the capacity and leadership skills to apply good practices for managing tropical fruit tree diversity for sustainable livelihoods, food security and ecosystem services will be largely benefited.

The project launching ceremony was attended by the officials from GEF, representative from MOEF, officials from Bioversity International, members of the National Project Steering Committee, Thematic Specialists from different parts of the country, State Horticulture Departments Officials, scientists from various State Agriculture Universities of the country.

Showcasing of Agricultural Technologies and Scientists-Farmers Interface

A two-day programme on Showcasing of Agricultural Technologies and scientists-farmers interface in connection with acquisition of

Dignitaries on the dais during the inaugural session of the Showcasing of Agricultural Technologies

Dr. H.P. Singh, DDG (Hort) releasing the CD. Also seen in the picture is Mr. Inshram Ali, President Mango Growers Associations of India and Mr. Kamil Khan

Geographical Indicator Status to Dashehari mango was organised under National Agricultural Innovative Project(NAIP) at R B Road Campus of the Institute on February 24-25, 2010.

About one hundred and fifty farmers from Mall, Mallihabad, Kakori and Bakshi-ka-Talab of Lucknow, Bareilly, Unnao, Bahraich and Maharastra participated in scientist-farmers interaction meet and got problems related to horticulture addressed. Exhibition stalls of different ICAR Institutes, State Agricultural Universities, Govt Departments and private entrepreneurs were also put up for showcasing innovative agricultural technologies for the benefit of farmers. In his welcome address, Dr. H Ravishankar, Director of the Institute, informed the gathering that the objectives of the programme are to promote ICAR brand name in the sphere of agriculture and allied disciplines and provide a platform to the farming community through exhibition and practical demonstrations of agricultural technologies developed under National Agricultural Research System. The programme, inaugurated by Dr. H.P.Singh, DDG(Hort.), ICAR, New Delhi was attended by eminent scientists like Dr. G B Singh, Former DG UPCAR, Dr D S Rathore, Dr. Mathura Rai, Ex. Director, IIVR, Dr. R J Ravindran, Director, NBAII, Shri N C Mistry AMD, NHB, Shri Insram Ali, President, Mango Growers Association of India and Shri Kamil Khan, progressive farmer who shared their views and experiences. Shri Vivek Rastogi, Dhanuka Agritech Ltd., Lucknow explained about the safe use of pesticides for residue free production of fruits to the farmers. Dr. O P Srivastava, Chemtron Escience Laboratory Pvt. Ltd., Navi Mumbai briefed about technologies of uniform ripening of fruits using ethylene.

An interactive discussion on acquiring of GI status to Dashehari mango was also held. An exclusive media meet organized at the occasion was addressed by Dr. H P Singh, DDG(Hort.), ICAR, New Delhi.

Stakeholders' Meet

Stakeholder's Meet was organized by the institute on 26th March 2010 regarding contemporary issues pertaining to aspects of cultivation, production, pest disease and post harvest management problems of mandate crops. The meeting was attended by around fifty farmers from Barabanki, Lucknow, Kanpur, Partapgarh, Sultanpur and Varanasi. It was chaired by D. S. Rathore, Ex. Vice Chancellor, H. P. K. V. V. Palampur (H. P.) and Chairman Research Advisory Council. During the meeting queries were raised about

Dr. H. Ravishankar, Director addressing during the Stakeholders' Meet

the problems of powdery mildew, malformation, marketing of spurious pestides, extended duration of mango, soil salinity *vis-a-vis* crop suitability and market glut were appropriately responded.

fgUnh pruk ekl 2009

केन्द्रीय उपोष्ण बागवानी संस्थान, लखनऊ में दिनांक 14 सितम्बर से 12 अक्टूबर 2009 तक हिन्दी चेतना मास का आयोजन किया गया। इसका उद्घाटन हिन्दी दिवस समारोह कार्यक्रम की कार्यषाला के साथ हुआ। हिन्दी कार्यषाला में मुख्य अतिथि के रूप में लखनऊ विष्वविद्यालय के भाषा विज्ञान विभाग में प्रोफेसर डॉ. श्रीमती ऊषा सिन्हा द्वारा

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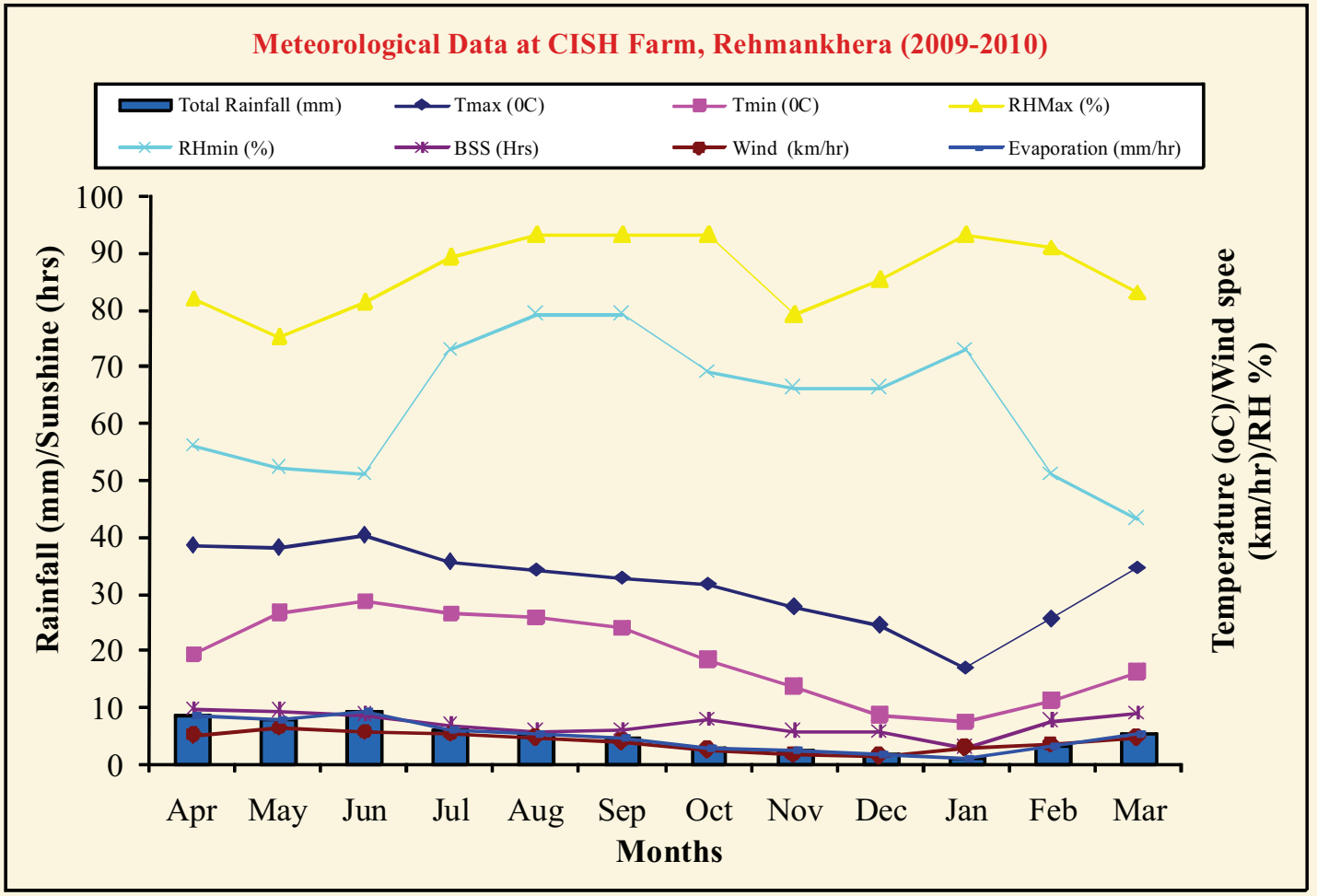
व्याख्यान प्रस्तुत किया गया। उन्होनें भाषा विज्ञान की महत्ता पर प्रकाष डालते हुए कहा कि भाषा के बिना मानव जाति का इतिहास नगण्य है। डॉ. श्रीमती ऊषा सिन्हा ने हिन्दी के बदलते स्वरूप की भी चर्चा की। इस अवसर पर कार्यकारी निदेषक डॉ. रमेष चन्द्र ने भी हिन्दी के प्रचार–प्रसार पर जोर देते हुए इसकी उपयोगिता की ओर ध्यान दिलाया।

हिन्दी चेतना मास 2009 के दौरान भी दिनांक 19 सितम्बर 2009 को कम्प्यूटर हिन्दी कार्यषाला का आयोजन किया गया। इसमें यूनीकोड विषय पर व्याख्यान देने के लिए भारतीय भूवैज्ञानिक सर्वेक्षण, लखनऊ के वरिष्ठ भूवैज्ञानिक, डॉ0 ए. पी. राय को आमंत्रित किया गया था। डॉ. राय ने यूनीकोड विषय पर विस्तष्त जानकारी उपलब्ध करायी। इसी

d- dfork frokjh dfo lEesyu d volj ij dk0; ikB djrh gb

क्रम में दिनांक 06.10.2010 को हिन्दी कवि सम्मेलन का आयोजन किया गया। इस कवि सम्मेलन में श्री आनन्द गौतम, तकनीकी अधिकारी, आई वी आर आई, लखनऊ,श्री राकेष वाजपेयी, आचंलिक कार्यालय, स्टेट बैंक आफ इण्डिया, लखनऊ, श्री रतन तिवारी, गोमतीनगर लखनऊ तथा कुमारी कविता तिवारी, गोमतीनगर लखनऊ उपस्थित थी। इसके अलावा संस्थान के वैज्ञानिकों, अधिकारियों एवं कर्मचारियों के लिए हिन्दी निबंध प्रतियोगिता, टंकण प्रतियोगिता, वाद–विवाद प्रतियोगिता, षब्दावली प्रतियोगिता, प्रष्नोत्तरी प्रतियोगिता आदि का आयोजन किया गया जिसमें सभी ने बढ़चढ़ कर हिस्सा लिया।

19. METEOROLOGICAL DATA



One hundred and fifty years old Horticultural Heritage
Dashehari tree, Kakori village, Lucknow accorded G.I. No. 125

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