वार्षिक प्रतिवेदन
Annual Report
2009-10

भारतीय बागवानी अनुसंधान संस्थान, हेसरघट्टा, बेंगलूर - ५६० ०८९

INDIAN INSTITUTE OF HORTICULTURAL RESEARCH

Hessaraghatta, Bangalore 560 089

Technologies commercialized during 2009 - 10

Sl. No.	Technology	Licensee
1	Chilli CMS Line	M/s Doctor Seeds. Lidhiana
2	Crossandra (Arka Ambara)	Ekalavya Sasya Kshetra Pakegowdana Palya, Bangalore
3	Cost effective eco- friendly Para pheromone trap from effective monitoring of fruit flies belonging to Bactrocera spp. For use in Horticulture	Technology Assigned to NRDC, Licensed from NRDC to M/s. Rainbow Agro vet technologies Cuddapah. M/s. Precision Agro technologies, Bangalore M/s Nandi Agro vet, Bangalore
4	A process for preparation of Crop specific foliar micronutrient formulation for Banana (Musa sp.)	Technology licensed to M/s. Rainbow Agro vet through NRDC

भा.बा.अ.सं.
IIHR

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भाकृअनुप
ICAR

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CONTENTS

PREFACE

Impact of climate change, a global phenomenon, is imminent on agricultural and horticultural productivity in India. There is also a widespread concern regarding diminishing water availability. Under these circumstances, Indian horticulture faces greater challenges in sustaining production, promoting export and achieving nutritional security. Indian Institute of Horticultural Research, Bangalore, a premier national institute of ICAR, has directed its research programmes to meet these challenges. The scientists of the institute are working on well defined research projects on a time scale, seeking to overcome the genetic, physiological and other barriers in obtaining horticultural produce with optimum yield and quality. Work is also being carried out on reducing post harvest losses and value addition. Transfer of technologies developed, through commercialization, demonstrations, farmer- scientist interaction meets and other means ensure that the benefits of research carried out reaches the end user. During the year under report, four of Institute's technologies have been commercialized, twenty three improved varieties identified for release at Institute level and three at State level.

It gives me great pleasure in presenting this Annual Report, which summarizes various research findings and major accomplishments of the Institute during the year. I am thankful to all the members of the Research Advisory Committee (RAC), Institute Research Committee (IRC) and Project Monitoring and Evaluation (PME) Committee for helping us improve our research efforts through their valuable inputs. The scientists of the Institute, ably supported by technical, administrative, supporting and auxillary staff members are worthy of all appreciation for their constant endeavor to achieve targets with dedication and commitment.

The Institute Editorial and Publication Committee has prepared this report. I wish to place on record my sincere appreciation and compliments to the team comprising of Dr. Debi Sharma, Chairperson, Dr. B.N. Srinivasamurthy, Dr. D. Srinivasamurthy, Dr. Hima Bindu, Dr. B. Balakrishna, Shri P.B. Gaddagimath and Shri A. K. Jagdeeshan, Assistant Director (Official Language) for hindi translation of executive summary. I specially thank Dr. M.R. Hegde, Chairman, Research Management and Co-ordination Committee for providing various inputs.

I take this opportunity to gratefully acknowledge the encouragement, guidance and support provided by Dr. S. Ayyappan, Secretary (DARE) and Director-General, Indian Council of Agricultural Research (ICAR), and Dr. H.P Singh, Deputy Director General (Horticulture), ICAR, New Delhi.

Bangalore
7 July, 2010

Amrik Singh Sidhu
Director

१. कार्यकारी सारांश

संस्थान के मुख्य केन्द्र के पास 38 तथा क्षेत्रीय बागवानी परीक्षण केन्द्रों के पास 8 अनुसंधान कार्यक्रम हैं जिनके माध्यम से सहयोगी एवं बहुविषयक अनुसंधान द्वारा दस मुख्य प्राथमिकतावाले क्षेत्र पर ज़ोर दिया जा रहा है। अनुसंधान कार्य मुख्यतः जननद्रव्य संग्रहण, मुल्यांकन एवं लक्षणीकरण, अधिक उपजवाली, गुणवत्तायुक्त, जीवीय एवं अजीवीय प्रतिबल के प्रति सहनशील किस्मों का विकास, मॉलिक्युलर मार्कर एवं ट्रांसजेनिकी का विकास आदि पर केन्द्रित है। अनुसंधान के अन्य महत्वपूर्ण क्षेत्र हैं – वितान प्रबंधन, कीट प्रबंधन, संवर्धन क्रियाएँ, आदानों का सक्षम उपयाग, प्रक्षेत्र यंत्रीकरण आदि के माध्यम से उत्पादकता बढ़ाना, पोषक मूल्यों में सुधार, उत्पाद की सुरक्षा एवं गुणवत्ता, वर्ष भर उत्पादन, उत्पादन की आर्थिकी तथा विभिन्न निवेशकों को प्रौद्योगिकी हस्तांतरण में हो रही समस्याओं को पहचानना आदि।

भारतीय कृषि अनुसंधान परिषद की मार्गदर्शिका के अनुसार भारतीय बागवानी अनुसंधान संस्थान की संस्थान प्रौद्योगिकी प्रबंधन इकाई द्वारा भा.बा.अ.सं. की प्रौद्योगिकियों का व्यावसायीकरण एवं संरक्षण का कार्य किया जा रहा है। इस अवधि के दौरान चार प्रौद्योगिकियों, जैसे – मिर्ची सीएमएस लाइन, क्रोस्सान्ड्रा (अर्का अम्बर), बेक्ट्रोसेरा स्पीशीज की फल मक्खियों के प्रभावी अनुवीक्षण के लिए परिस्थिति अनुकूल फेरोमोन जाल तथा केले के लिए पर्ण पोषण मिश्रण बनाने की प्रक्रिया, का विभिन्न लाइसेन्सों के माध्यम से व्यावसायीकरण किया गया।

फल, सब्जी, शोभाकारी एवं औषधीय फसलों के आनुवंशिक सुधार के लिए निरंतर किए गए प्रजनन कार्यों के परिणामस्वरूप कई किस्मों का विमोचन तथा अधिक उपज, गुणवत्ता एवं जीवीय व अजीवीय प्रतिबल के प्रति सहनशील उन्नत प्रजनन लाइनों की पहचान एवं पृथक्करण किया जा सका।

राज्य स्तर पर विमोचन के लिए पहचानी गई किस्में

मिर्ची की अधिक उपजवाली एफ1 संकर अर्का हरिता, पाउडरी मिल्ड्यु एवं मिर्ची शिरीय चित्तीदार पोटीवाइरस के प्रति सहनशील अधिक उपजवाली गाजर किस्म, अर्का सूरज को दक्षिण कर्नाटक में विमोचन के लिए अनुशंसित किया गया। कार्नेशन किस्म अर्का फ्लेम को राज्य स्तरीय किस्म मूल्यांकन समिति द्वारा अनुमोदित किया गया तथा इसे दक्षिण कर्नाटक में संरक्षित खेती हेतु विमोचन की अनुशंसा की गई।

संस्थान स्तर पर विमोचन के लिए पहचानी गई किस्में

वर्ष 2009–10 के दौरान कुल 23 उन्नत किस्मों की पहचान की गई। एक अर्ध प्रबल पपीता किस्म अर्का प्रभात को कम ऊँचाई में फल लगने, बड़े आकार का फल एवं अधिक टीएसएस सहित गहरे गुलाबी रंग की गूदा आदि विशेषताओं के लिए पहचानी गई। अमरूद में कमसारी ग गुलाबी स्थानीय के संयोजन से अर्का किरण संकर को अधिक उपज, गहरी गुलाबी रंग की गूदा, अधिक टीएसएस एवं लाइसोपीन की अधिक मात्रा के लिए पहचानी गई। प्याज में किण्वित परिरक्षण के लिए दो किस्मों जैसे अर्का उज्ज्वल, प्रवर्धक प्याज एवं अर्का स्वादिष्ट, सफेद प्याज की पहचान की गई। तरबूज़ किस्म, अर्का मुत्तु को अधिक उपज एवं अच्छी गुणवत्तावाले फलों के लिए पहचानी गई। तरबूज की दो अन्य किस्मों जैसे – अर्का आकाश एवं अर्का ऐश्वर्या को अधिक उपज एवं टीएसएस के लिए पहचानी गई। फ्रेंच बीन में अर्का शरत को उच्च गुणवत्तावाली तंतु मुक्त फलियों के कारण विमोचन के लिए पहचानी गई। कुन्दरू में अर्का नीलाचल सबुजा को अधिक गूदा एवं मुदु बीज के फलों सहित अधिक उपज के लिए पहचानी गई। एक अन्य लाइन अर्का नीलाचल कुंखी सलाद के लिए उपयुक्त चयन है जिसमें क्रमिक रूप से फल लगते हैं, अर्का नीलाचल कीर्ति, मज़बूत बीजकोश सहित अधिक उपजवाली एक परवल किस्म है, अर्का नीलाचल श्री अधिक उपजवाला ककोड़ा का चयन है तथा अर्का नीलाचल गौरव जो छोटे काँटे सहित अंडाकार के फलों वाली, गहरे हरे रंग की टीज़ल गार्ड किस्म है, का भी विमोचन के लिए पहचान किया गया। ग्लेडियोलस में संकर चयन अर्का नवीन एवं अर्का गोल्ड की, आकर्षक रंग एवं गुणवत्ता के फूल के कारण विमोचन के लिए पहचान की गई। एक अन्य चयन अर्का अमर को इसके फूलों की गुणवत्ता एवं फ्युसेरियम विल्ट के प्रतिरोध के लिए पहचानी गई। डयान्थस में अर्का तेजस संकर को गमले में उगने वाली शोभाकारी पौधे के रूप में इसकी व्यावायिक क्षमता के लिए पहचाना गया। रजनीगंधा संकर चयन में अर्का निरंतरा, एक अधिक उपजवाली, जल्दी पकने व लंबे समय तक रहनेवाली किस्म, को विमोचन के लिए पहचाना गया। दो क्रोस्सान्ड्रा किस्म, अर्का कनका एवं अर्का अम्बरा को क्रमशः नवीन रंग एवं बड़े आकार के फूल के लिए तथा गुलदाऊदी किस्म अर्का पिंक स्टार को गमले में उगने वाले शोभकारी किस्म के रूप में विमोचन के लिए पहचाना गया। कोंच में दो न खुजली वाले चयन अर्का धन्वंतरी एवं अर्का अश्विनी को क्रमशः अधिक बीज उपज व एल–डोपा मात्रा के लिए तथा जल्दी पकने के कारण पहचाना गया।

आनुवंशिक संसाधनों का प्रबंधन

चौंतीस देशी प्रकार के जननद्रव्यों को मिलाकर भारतीय बागवानी अनुसंधान संस्थान के आम के कुल जननद्रव्य संग्रह 450 हो गया है। 'जैवविविधता अंतर्राष्ट्रीय विवरक' के अनुसार 174 किस्मों का लक्षणीकरण किया गया। केन्द्रीय बागवानी परीक्षण केन्द्र, भुवनेश्वर में 23 खाद्योपगयोगी केले के जननद्रव्यों का, वृद्धि, उपज एवं लक्षण

के लिए मूल्यांकन किया गया। समग्र कार्यनिष्पादन एवं गुणवत्तायुक्त उपज के आधार पर सीएचबी–5 (बतीसा बंथल) खाद्योपयोगी केला जीनोटाईप के रूप में उन्नत पाया गया। अमरूद में दो और एक्सेशन जैसे – रानी पसन्द एवं एसपी नं. 7, सहित कुल जननद्रव्य संग्रह 79 हो गया है। साठ किस्मों का कड़क बीज के लिए मूल्यांकन किया गया तथा 6 किस्मों का मानक विवरकों के उपयोग के द्वारा लक्षणीकरण किया गया। केन्द्रीय बागवानी परीक्षण केन्द्र, भुवनेश्वर में झारखण्ड, पश्चिम बंगाल एवं उड़ीसा तथा उड़ीसा के कांधमाल व कोरापुट जिलों से कटहल के 25 जीनोटाईप (सीएचजे–1 से सीएचजे–25) का संग्रहण किया गया। प्यूमेलो जाति, देवनहल्ली तथा रामबूटान चयन सीएचईएस 27 उन्नत पाया गया। गुजरात के कच्छ एवं भुज क्षेत्रों से एकत्रित किए गए मशरूम स्पीशीज़, सवृन्त पफ़बॉल (लाइकोपरडॉन स्पीशीज़) एवं केलोसाइब स्पीशीज का संवर्धन एवं शुद्धीकरण किया गया। अश्वगंधा के 190 एक्सेशनों के संपूर्ण जननद्रव्य समूह का 48 मात्रिक एवं गुणात्मक विशेषता के उपयोग द्वारा आकारिकीय लक्षणीकरण किया गया।

फसल सुधार में जैवप्रौद्योगिकी

विभिन्न फसलों में महत्वपूर्ण लक्षणों के लिए मॉलिक्युलर मार्कर एवं ट्रांसजेनिकी के विकास का कार्य किया जा रहा है। पपीते में पीआरएसवी से संबंधित मॉलिक्युलर मार्कर पर अध्ययन ने दर्शाया है कि सी. पपीता किस्म सूर्या एवं वी. कॉलीफ्लोरा में से 2 एसएसआर प्राइमर, 11 आईएसएसआर प्राइमर एवं ओ, डी, जी, आर. व एस. सीरीज़ के 16 आरएपीडी प्राइमर ने उच्च बहुरूपी एवं पुनरुत्पादन योग्य बैंड का विकास किया। अनार में बैक्टीरियल ब्लाइट से संबंधित मॉलिक्युलर मार्कर पर किए गए कार्यों में 40 आरएपीडी प्राइमर एवं एक आईएसएसआर प्राइमर ने दाताएँ जैसे गणेश एवं दारु के लिए बहुरूपता दिखाई। इकतालीस मार्करों से प्रवर्धित 80 एफ$_2$ (गणेश ग दारु) में से 35 को सुव्यवस्थित किया गया तथा 8 संपर्क समूहों का रूप धारण कर 6 असंबंधित रहा, लेकिन किसी भी प्राइमर ने बैक्टीरियल ब्लाइट के लिए स्थूल विसंयोजक विश्लेषण में बहुरूपता नहीं दर्शाई। अमरूद में मृदु बीज के लिए मॉलिक्युलर मार्कर पर किए गए अध्ययन पर ओपीक्यु, ओपीएम, ओपीएच, ओपीए सीरीज़ के 25 आरएपीडी प्राइमर ने एफ1 के समूहों एवं दाताओं में अनुकूल परिणाम दिया। एफ1 संकरों में प्रत्येक के और अधिक परीक्षण का कार्य प्रगति पर है। अमरूद के ताज़ा रंग के लिए मॉलिक्युलर मार्कर के विकास में 8 आरएपीडी प्राइमर एवं 8 आईआईएसआर प्राइमर ने विशेष रूप से या तो लाल या सफेद प्रकार के लिए प्रवर्धन दर्शाया। पान में माता एवं नर डीएनए समूहों के परीक्षण के दौरान तीन लिंग संबंधी आईआईएसआर प्राइमर की पहचान की गई तथा 65 जननद्रव्य लाइनों तक वैधीकरण किया गया।

पपीता पीआरएसवी के प्रतिरोधी ट्रांसजेनिक के विकास के दौरान टी1 पौधे से प्राप्त 24 पौध, जिनी गूदा पीला है, ने पूर्ण प्रतिरोध दर्शाया जबकि 40 नियंत्रित पौधे, जब विषाणुधर ऐफिडों से चुनौती मिली तब, संवेदनशील पाए गए। प्रतिरोधी पौधे रोपण के तीन महीने बाद से निरंतर प्रतिरोध दिखाया। बैक्टीरियल विल्ट प्रतिरोधी अनार प्रजाति भगवा के विकास के दौरान एग्रोबैक्टीरियम माध्यम के अंतरण द्वारा एएमपी जीन से बीजपत्र एवं बीजपत्राधर के अंतरण में सफलता मिली तथा तीन गहरे पुंधानी रूपांतरज प्राप्त हुए। टमाटर में जल्दी मुरझाने के प्रतिरोधी ट्रांसजेनिक पर अध्ययन के दौरान पहले से ही पहचानित टी2 पीढ़ी में ट्राइकोडर्मा हरजियानम चिटिनेस जीन सहित ट्रांसजेनिक टमाटर प्रजाति अर्का विकास की दो समयुग्मजी स्थायीकृत लाइनों को टी3 पीढ़ी में पीसीआर विश्लेषण द्वारा पुनः सुनिश्चित किया गया। अर्का मेघली की एक ट्रांसजेनिक लाइन ने चैलेंज इनोकुलेशन करने पर पीबीएनवी के प्रति अधिक प्रतिरोध दर्शाया तथा यह अत्यधिक वर्षा की स्थिति में आल्टरनेरिया के प्रति भी प्रक्षेत्र–प्रतिरोधी पाई गई। टी3 टमाटर अर्का सौरभ अनुवृत्त 130–13, टी3 अर्का मेघली अनुवृत्त 227–14 एवं 231–12, टी3 अर्का विकास अनुवृत्त 225–7–5 तथा टी3 पूसा रूबी अनुवृत्त 138–4 पीबीएनवी एवं टीएलसीवी के संयोजी प्रतिरोध के लिए उदीयमान पाए गए। अजीवीय प्रतिबल के प्रतिरोधी ट्रांसजेनिक टमाटर के विकास पर अध्ययन के दौरान सात दिन तक पानी देने को रोककर ड्रेब1ए अंतरण कारक से अंतरित टी2 पीढ़ी के टमाटर पौधों पर कम नमी प्रतिबल आरोपित किया गया। डी–27 लाइन में आरडब्ल्युसी में जल प्रतिबल के दौरान कम बून्द थी। ज्वार एम–35–1 की सूखा प्रतिरोधी भू–वंशावली से सूखे के प्रति सहनशीलता दर्शाने के लिए अनुमानित एक नई जीन का क्लोनिंग की गई, जिसका अनुक्रम किया गया तथा यह जीन बैंक के ज्वार ड्रेब2 क्रम से चार अमीनो अम्ल के लिए विभिन्न थी। इस अनुक्रम को एनसीबीआई जीन बैंक में जमा किया गया। बैंगन के टहनी व फल छेदकों के प्रतिरोध के लिए ट्रांसजेनिक बैंगन के विकास के दौरान अर्का केशव किस्म में क्राई2ए की टी0 व टी2 अवस्थाओं में बीटी ट्रांसजेनिक बैंगन लाइनों का विकास किया गया तथा मॉलिक्युलर रूप में विश्लेषण किया गया।

उत्पादकता बढ़ाना

वर्तमान वर्ष में बागवानी फसलों की उत्पादकता बढ़ाने पर किए जा रहे अनुसंधान में वितान संरचना एवं प्रबंधन, कटाई की अवधि बढ़ाना, जल उत्पादकता एवं पोषण प्रबंधन को अनुकूल बनाना, फल के रोग की कार्यिकी की जाँच, असली व रोगमुक्त पौध सामग्री का प्रवर्धन तथा बृहत् उत्पादन, फसल प्रणाली अध्ययन, संरक्षित खेती, जैविक खेती, परागण अध्ययन आदि विभिन्न पहलुएँ सम्मिलित हैं।

आम के 'वेल्लईकुलम्बन' एवं 'ओलूर' प्रकन्दों के बीच 'अल्फोन्सो' की विभिन्न रोपण सघनता सम्मिलित प्रक्षेत्र परीक्षण में, ओलूर प्रकन्द का 3 मी. x 3 मी. की दूरी में उपयोग से, पेक्लोबूट्राज़ोल की प्रयोग करने या न करने पर दसवीं बागान वर्ष के दौरान 6. 74 टन/हे. की अधिकतम उपज प्राप्त हुई तथा 10 मी. ग 10 मी. की दूरी में नियंत्रण की तुलना में पेक्लोबूट्राज़ोल की दर कम थी। पेक्लोबूट्राज़ोल के प्रयोग ने फूलने के प्रतिशत को प्रभावित किया

तथा अक्तूबर के अंतिम सप्ताह में किए गए 5 ग्रा. ए.आई के प्रयोग से 93.3% फूलन सहित अधिक सुनिश्चित प्रभाव था जबकि तोतापुरी आम में नियंत्रण ने फूलने की प्रतिशत केवल 35% दर्शाया। आम बागान की मृदा की पोषक–स्थिति को समझने के लिए किए गए अध्ययन से पता चला है कि पत्तों की पोषक–मात्रा तथा सठियाव के दौरान पोषकों का पुन–शोषण ऐसी बारहमासी फसल प्रणाली में पोषकों की मृदा में वापस जाने वाली मात्रा को निर्धारित करता है। स्पंजी टिशू, अल्फोन्सो आम की एक मुख्य बीमारी, और बीज के अंकुरित स्थिति में बदलने तथा कई कार्यिकीय एवं जैवरासायनिक लक्षणों के आधार पर नमी एवं समीपस्थ मध्यफल–भित्ति से अन्य संसाधनों के अनुवर्ती बहाव का पता लगाया गया है। इसलिए स्पंजी टिशू के विकास को रोकने की रणनीति परिस्थिति अनुकूल मिश्रणों के द्वारा बीज–प्रसुप्ति को प्रेरित करने/बीज उपापजयी क्रियाशीलता को कम करने/भ्रूण–अक्ष के नाश पर ज़ोर दिया गया है तथा इनके परिणाम बहुत ही प्रेरणादायक रहे। आम की सात किस्मों पर परागणकर्ता स्पीशीज़ की विविधता अभिलिखित की गई तथा विभिन्न चारा स्पीशीज़ों में ऐपिस फ्लोरी प्रमुख पाया गया (3.86/पुष्प गुच्छ/मिनट)।

गुच्छे के अच्छे आकार के लिए अंगूर में लगभग सभी बीज रहित प्रजातियों में मुख्य रैकिस की छँटाई की गई है। फ्लेम सीडलेस प्रजाति में मुख्य रैकिस के दूरस्थ अग्र भाग के 25% एवं 50% छँटाई सहित एक परीक्षण प्रारंभ किया गया। एक अन्य परीक्षण में, पश्च भाग में परिवर्तनशील हल्की प्रवृत्ति पाने के लिए, फल की बेहतर गुणवत्ता के लिए, बढ़ने वाले टहनीवाहक गुच्छों को गुच्छे के आगे से 5–13 तक पत्तों को रखकर काट दिया गया। अधिक पत्तोंवाली टहनियों की अपेक्षा सात पत्तों तक रखकर टहनियों को काट दिये जाने से फलों को गहरा रंग प्राप्त हुआ। केन्द्रीय बागवानी परीक्षण केन्द्र, चेट्टहल्ली में एक फसल प्रणाली परीक्षण किया गया जिसमें कॉफी एवं काली मिर्ची के साथ उगाए गए एरिथ्रीना पर अनुवर्धित कूर्ग मंडारिन के मुकुलित पौधों (चेक प्रजाति के रूप में पौध) ने दर्शाया है कि छोटे पौध की फल–उपज मुकुलित पौधों की उपज की अपेक्षा कम थी।

जलवायु परिवर्तन की वर्तमान परिदृश्य में, विपरीत परिस्थितियों के अधीन उत्पादकता बढ़ाने पर अध्ययन का महत्व पूर्वाधिक है। ग्लाईसिनबीटेन के प्रयोग से मिर्ची में जल की कमी होने पर पौधे की वृद्धि में सुधार करते पाया गया। प्याज की प्रजाति अर्का कल्याण पर उन्नत कार्बन डायोक्सइड (सीओ2) के प्रभाव के अध्ययन से पता चला है कि उन्नत कार्बन डायोक्सइड (550 पीपीएम) ने समग्र वृद्धि, जल उपयोग दक्षता एवं कुल जीव मात्रा को प्रभावित किया है। कुल जीव मात्रा, नियंत्रण (13.4 ग्रा./पौधा) की अपेक्षा रोपण के 90 दिन बाद (18.6 ग्रा./पौधा) अधिकतम थी। उन्नत कार्बन डायोक्साइड स्तर पर विभिन्न बढ़वार अवस्था में इसकी प्रतिशत 52 से 81% तक रहा।

भारतीय बागवानी अनुसंधान संस्थान में सब्जियों की बेमौसम खेती के लिए संरक्षित खेती का विस्तृत अध्ययन किया जाता है। भिंडी की अनुकूलतम उत्पादकता के लिए शीतकाल में फसल की धीमी वृद्धि मुख्य रूप से बाधक है। अर्का अनामिका एवं यूएस 7109 जैसी भिंडी की दो प्रजातियाँ मौसमी बाधाओं को पार करने के लिए शीतकाल के दौरान स्वाभाविक रूप से हवादार पॉलीहाउस में उगाया गया। भिंडी की उपज नवंबर के मध्य लगाई गई फसलों (21.5 टन/हे.) की अपेक्षा अक्तूबर के मध्य लगाई गई फसलों (28.1 टन/हे.) में अधिक पाई गई।

टमाटर में टिकाऊ उत्पादन के लिए बढ़वार एवं पोषक उद्ग्रहण को बढ़ावा देने के लिए रोगाणुवीय सहजीविता पर अध्ययन प्रारंभ किया गया। एक सौ बहत्तर पौधों में से बढ़वार को बढ़ावा देने वाले, कर्नाटक के विभिन्न टमाटर उगाने वाले कृषि पारिस्थितिकी क्षेत्र से पृथक्कृत एज़ोस्पिरिल्लुम (40), एज़ोटोबेक्टर (36), फोस्फोरस घुलनशील बैक्टीरिया (62) एवं फ्लूरसेन्ट स्यूडोमोनास (34) जैसे पृथक्कृतों में से निम्नलिखित पृथक्कृत जैसे – एज़ोस्पिरिल्लुम, एज़ोटोबेक्टर, फोस्फोबेक्टीरिया एवं स्यूडोमोनास राइज़ोस्फियर सक्षमता, बढ़वार बढ़ावा एवं पौध पोषक उद्ग्रहण में अन्य पृथक्कृतों की अपेक्षा उत्कृष्ट पाए गए।

केन्द्रीय बागवानी परीक्षण केन्द्र, भुवनेश्वर में आम की प्रजाति मल्लिका में जीवीय एवं अजीवीय उपचार में पौधों के बढ़वार प्रतिरूप में कोई मुख्य अंतर नहीं था। इसी प्रकार पपीता प्रजाति सूर्या में गोबर की खाद, जैवउर्वरक एवं वर्मीकम्पोस्ट सहित 12 पोषक संयोजनों सहित जैविक क्रियाओं पर किए गए प्रक्षेत्र परीक्षण में पाया गया कि रोपण के छः महीने बाद उपचार में वानस्पतिक प्रतिमान का कोई विशेष महत्व नहीं था। रोपण के 12 महीने बाद केवल पौधों की घेर में विशेष अंतर पाया गया तथा अधिकतम घेर (51.9 से.मी) उर्वरक की 50% अनुशंसित मात्रा गोबर की खाद + एज़ो + फोस्फोरस घुलनशील बैक्टीरिया + वर्मीकम्पोस्ट से प्राप्त हुई तथा कम घेर (39.9 से.मी) उर्वरक की 100% अनुशंसित मात्रा से उपचार से प्राप्त हुई। फिर भी फल–उपज एवं फल–गुणवत्ता प्रतिमान अप्रभावित रहा। पत्तागोभी प्रजाति उन्नति पर किए गए एक अन्य अध्ययन में पौध–वृद्धि प्रतिमान विभिन्न जैविक उपचार से प्रभावित नहीं रहा।

कीट प्रबंधन एवं कीटनाशी अवशेष

आम के एन्थ्रेक्नोज़ तना सड़न को नियंत्रित करने के लिए एज़ोक्सीस्ट्रोबिन के बाद थायोफनेट मीथाईल एवं कार्बेन्डाज़िम का प्रयोग अत्यधिक प्रभावी पाया गया। हल्दी, नीम सत्त, वी. नीगुण्डो पत्तों का सत्त एवं लहसुन से भी एन्थ्रेक्नोज़ को एक हद तक नियंत्रित किया जा सका। चीकू के बीज छेदक, टी. मार्गेरिस, के नियंत्रण के लिए अन्य उपचारों जैसे डायमेथॉट, बीटी, नीम साबुन, करंज साबुन की अपेक्षा डेल्टामेथ्रिन से उपचार चौथी कटाई के बाद भी उत्कृष्ट पाया गया। अमरूद के फेरीसिया विरगेटा के नियंत्रण में मेटारज़ियम एनीसोप्ली कीटरोगवाहक प्रभावी पाया गया जबकि लाम्डा–साइहलोथ्रिन, एसेटामिप्रिड एवं बी. बेसियाना से किए गए उपचार ने छिड़काव दूसरे सप्ताह से ही

चाय के मच्छर कीट द्वारा की जा रही फलों की हानि को प्रभावी रूप से कम किया। पॉली हाउस में चूर्णी कीट का प्रकोप क्रिप्टोलीमस सूँडी को छोड़ने से नियंत्रित किया जा सका। मृदा में नीम की खली के प्रयोग के बाद नीम साबुन एवं एनएसपी से छिड़काव खरीफ़ में पत्ती छेदकों के नियंत्रण में प्रभावी रहा, लेकिन गर्मी में कीटों का प्रकोप ज्यादा होने से मध्यम प्रभावी रहा। बैंगन की टहनी एवं फल छेदकों के नियंत्रण के लिए राइनाक्सीपीर (0.3 मि.ली.) का प्रयोग अन्य कीटनाशी उपचार से उत्कृष्ट पाया गया तथा जिसके परिणामस्वरूप फलों की औसत हानि नियंत्रण की 45.35% की तुलना में 8.36% रहीं फुहारे से सिंचाई करने से कीटनाशक के छिड़काव के बिना मिर्ची के थ्रिप्सों की संख्या में कमी पाई गई जबकि ब्लाप्टोस्टेथस पैलेसीन्स को 1/पौधा की दर से हफ्ते में एक बार छोड़ने के बाद 0.01% की दर से सूरजमुखी तेल के साथ 1 x 109 बीजाणु/मि.ली. की दर से एम. एनीसोप्ली से सप्ताह में एक बार छिड़काव करने से मिर्ची एवं शिमला मिर्ची में थ्रिप्सों की संख्या में काफी कमी पाई गई।

खरीफ़ के दौरान प्याज के पर्ण बीमारियों के नियंत्रण में मेन्कोजेब की 15 दिनों की छिड़काव–तालिका प्रभावी रही, जिससे अनुपचारित नियंत्रण में 45 पीडीआई एवं 16.67 टन/हे. की उपज की अपेक्षा प्रकोप का प्रतिशत 35 एवं उपज 30.0 टन/हे. प्राप्त हुई। अन्य रासायनिक/वानस्पतिक उपचारों एवं नियंत्रण (19.15% से 33. 66%) चारे के छिड़काव (डेल्टामेथ्रिन 0.1% + गुड़ 1% + क्युल्युर जाल 10/एकड़ की दर से लगाना) से समेकित कीट प्रबंधन ने करेले की तरबूज कीट से होने वाली हानि (12.66%) को प्रभावी रूप से कम किया।

रोपण के समय तथा 6 महीने के अंतराल में स्यूडोमोनास फ्लोरसेन्स (109 सीएफयु/ग्रा.) एवं ट्राइकोडर्मा हरजियानम (106 सीएफयु/ग्रा) से संवर्धित गोबर की खाद के 2 कि.ग्रा. प्रति पौधे के प्रयोग द्वारा केले में सूत्रकृमियों के प्रबंधन को मानकीकृत किया गया। पपीता, भिंडी, गाजर एवं ग्लैडियोलस के लिए भी सूत्रकृमि प्रबंधन प्रणाली तैयार की गई।

सुरक्षित उत्पाद प्राप्त करने के लिए कटाई पूर्व अंतराल की अनुशंसा के लिए कई फसलों में रासायनिक कीटनाशक उपचार की सुरक्षा का मूल्यांकन किया गया। अनार में क्लोरपाइरिफॉस एवं थायमेथॉक्सम के पर्णीय छिड़काव से बीजचोल में कोई भी हानिकारक अवशेष नहीं पाया गया, लेकिन फल के सतह पर जमे अवशेष के आधार पर 35 दिनों की तुड़ाई पूर्व अंतराल की अनुशंसा की गई थी। फलों को धोने से फल की सतह से क्लोरपाइरिफॉस की 65–75% एवं थायमेथॉक्सम की 38–46% तक अवशेष साफ हुआ। अनार में क्लोरपाइरिफॉस एवं काबेन्डज़िम के संयुक्त मृदा मज्जन प्रयोग से पौधों में कार्बेन्डाज़िम का धीमा उद्ग्रहण एवं पत्तों में इसके धीरे–धीरे संचयन हुआ। अनार के फलों के छिलके में हरी अपरिपक्व अवस्था में कार्बेन्डाज़िम का अवशेष 0.44 एवं 0.64 पीपीएम, बीजचोल में 0.08 एवं 0.07 था, लेकिन यद्यपि मृदा में अवशेष 100 दिनों से ज्यादा रहे फिर भी क्लोरपाइरिफॉस अवशेष मृदा से पत्तों या फलों में पहुँचे नहीं। खेत में उगे टमाटर की तुलना में पॉली हाउस में उगे टमाटर में, फल लगने की अवस्था में एक ही मौसम में चार प्रयोग करने पर आईप्रोडियोन एवं क्लोरोथालोनिल का प्रारंभिक अवशेष अधिक पाए गए। खेत में उगे टमाटर की अपेक्षा पॉलीहाउस में आईप्रोडियोन एवं क्लोरोथालोनिल अवशेष का अपव्यय–दर मन्द है तथा टमाटर की सुरक्षित तुड़ाई के लिए पॉलीहाउस में 4 दिनों का एवं खेत में एक दिन का तुड़ाई पूर्व अंतराल अनुशंसित था।

सस्योत्तर हानि को कम करना तथा मूल्य संवर्धन

आम की प्रजातियों जैसे अल्फोन्सो एवं बंगनपल्ली (मोम लेप सहित या बिना) की भण्डारण आयु को 8° से. में बिना किसी द्रुतशीतन घाव के अर्ध पारगम्य फिल्म (सूक्ष्म छिद्रित डी–955 फिल्म) से संशोधित वातावरण पैकिंग द्वारा बढ़ाया जा सका। चीकू (क्रिकट बॉल प्रजाति) की भण्डारण आयु को, जब फलों की संशोधित वातावरण में सूक्ष्म छिद्रित एलडी फिल्म से पैकिंग हुई है, बिना किसी द्रुतशीतन घाव के 10° से. में तीन सप्ताह तक बढ़ाया जा सका। पकने के लिए अनुकूल परिस्थिति में रखे जाने पर फल साधारणतया तीन दिन में पक गए। इस प्रकार जब फफूँदनाशक से उपचारित फलों को सूक्ष्म छिद्रित फिल्म डी–955 (0.125% वायुसंचार) संशोधित वातावरण में पैकिंग करने से तथा कम कचरे (5%) सहित 18° से. में (75–80% आनुपातिक आर्द्रता) में भण्डारण करने से पपीता (ताइवान रेड लेडी प्रजाति) की भण्डारण आयु एक महीने तक बढ़ाया जा सका। बिना पैकिंग के फल की तुलना में संशोधित वातावरण में पैकिंग किए गए तथा भण्डारित पपीता की सतह पकने पर बिना किसी झुर्री के एवं केरोटिन व लाइसोपीन की अधिक मात्रा सहित चमकीले पीले रंग की हुई। फलों को 100 गेज पीई अथवा पीडी–961 फिल्म से संशोधित वातावरण पैकिंग करने से सीताफल (बालनगर प्रजाति) की भण्डारण आयु को बिना किसी द्रुतशीतन घाव के 12° से. में 2 सप्ताह तक बढ़ाया जा सका। पकने के लिए अनुकूल परिस्थिति में रखे जाने पर फल साधारणतया 4 दिनों में पक गए। फलों को अधिक कड़क एवं गुणवत्ता को अनुरक्षित करते हुए 6 घंटे तक 250 पीपीबी 1–एमसीपी तक अनावरण द्वारा सीताफल (अर्का सहन संकर) की भण्डारण आयु को, अनुपचारित फलों की 2 सप्ताह की तुलना में 15° से. में 3 सप्ताह तक बढ़ाया जा सका। अनुकूल तापमान (24–30° से.) में, गुणवत्ता को प्रभावित किए बिना, निधानी आयु को 3 से 4 दिनों तक बढ़ाया जा सका। आँवला 15° से. से नीचे भण्डारित करने पर द्रुतशीतन के प्रति संवेदनशील होते हैं। फलों के चारों ओर पीई लाइनिंग (100 गेज) के उपयोग द्वारा गुणवत्ता को अनुरक्षित करते हुए भण्डारण आयु को 15° से. तक बढ़ाया जा सका। 15° से. में 3 सप्ताह तक रखने के दौरान आँवला में पीई लाइनिंग ने वज़न में होने वाली कमी (नियंत्रित फलों की 8ः की तुलना में 2%) को विशेष रूप से कम किया तथा दृढता को अनुरक्षित किया। यह अनुशंसित है कि भण्डारण के समय के समय बेहतर गुणवत्ता प्रतिधारण के लिए परासरणीय निर्जलीकृत आँवला

में अंतिम नमी की मात्रा को 12–13% के आसपास रखी जाए जबकि टमाटर एवं करेला में 250 पीपीबी सांद्रण में 1–एमसीपी (एक ईथाइलीन क्रिया निरोधक) या 1–एमसीपी वाले मिश्रण के लिए 18 घंटे तक के सस्योत्तर अनावरण से पकने में देरी हुई, इसने अधिक दृढ़ता बनाए रखी तथा इन फलों की भण्डारण आयु को बढ़ाया।

मानकीकृत प्रसंस्करण क्रियाओं का उपयोग करते हुए अल्फोन्सो, दशहरी, तोतापुरी एवं अर्का अनमोल किस्मों की परासरणीय रूप से निर्जलीकृत कतलियाँ तैयार की गई। इन कतलियों को 12–15% के नमी स्तर तक सुखाया गया तथा पनेट में पैकिंग किया गया जिन्हें एक वर्ष तक सुरक्षित रखा जा सका। स्वर्णिम रंग की, मोहक खुशबू वाली, 11 प्रतिशत एल्कोहॉल एवं 0.5 से कम अवशेषी शक्कर सहित केले की रोबस्टा प्रजाति से तथा 10–11.5% एल्कोहॉल, 0.44–0.57% अम्लीयता एवं 0.26–0.28% अवशेषी शक्कर सहित चीकू से वाइन बनाने की प्रक्रिया को मानकीकृत किया गया। अनार से उपयोग के लिए तैयार ज्यूस बनाया गया तथा 25% ज्यूस, 18° ब्रिक्स एवं 0.30% अम्लीयता वाला उत्पाद उत्कृष्ट पाया गया। सम अनुपात में आँवला, आम, पैशन फ्रूट एवं सीताफल के गूदा/ज्यूस को मिश्रित कर फल पंच एवं पेय पदार्थ तैयार किए गए। इस उत्पाद का टीएसएस 58.5 से 61.0° ब्रिक्स तथा अम्लीयता 2.37 से 2.83 तक रहा। समग्र रूप से स्वीकार्यता में आँवला, आम एवं पैशन फ्रूट के फल पंच इनकी बेहतर रुचि एवं खुशबू के कारण उत्कृष्ट पाए गए।

बागवानी उत्पादों की पैंकिंग एवं परिवहन हेतु बेहतर तकनीक के विकास पर भी अध्ययन किया गया। पूर्ण परिपक्व चीकू (किकट बॉल किस्म) को पाँच परत वाले 400 x 300 x 150 मि.मी. आकार के सीएफबी बक्सों में कागज़ के टुकड़ों को कुशन के रूप में बनाकर पैकिंग करने तथा आँवले को इसी प्रकार के बक्सों में बीच में विभाजन सहित पैकिंग करने से ये सड़क द्वारा परिवहन के लिए उत्कृष्ट पाई गई जबकि 6° से. की पूर्वशीतीकृत चमेली की गुणवत्ता 13° से. में पूर्वशीतीकृत फूलों से अच्छी थी। बाँस के बक्सों में रखे फूल सफेद बने रहे तथा इनका खिलना (75%) भी अधिक था जबकि थर्मोकॉल के बक्से में रखे फूल फीके पड़ गए। बागवानी अपशिष्टों के उपयोग पर कार्य प्रारंभ किया गया है। तीन भाग पेट्रोलियम ईथर एवं 2 भाग एसेटॉन सहित मिश्रण का उपयोग करते हुए आम के प्रसंस्करण अपशिष्ट से कुल कैरोटिनॉइड को निकालने की प्रक्रिया को मानकीकृत किया गया। फल प्रसंस्करण अपशिष्ट से इथनॉल के उत्पादन की प्रक्रिया को भी मानकीकृत किया गया। आईसी इंजिन में उपयोग हेतु पेट्रोल में मिश्रित करने के लिए इथनॉल की जाँच की जाएगी।

प्रक्षेत्र यंत्रीकरण

पेड़ में उगने वाली फल फसलों के लिए ट्रैक्टर चलित हाइड्रॉलिक तुड़ाई प्लेटफार्म की परिकल्पना की एवं विकास किया गया। इसके एक प्रचालक प्लेटफार्म, कैंची ऊपर उठाने एवं घसीटने की मशीन आदि होते हैं। आम के पेड़ के पाँचवें क्रम की शाखा की छँटाई के लिए उपर्युक्त प्लेटफार्म से लंबी दूरी तक पहुँचनेवाली आरी का परीक्षण किया गया। निरीक्षित क्षमता 8 मी. तक की ऊँचाई में एक घंटे में एक पेड़ है। अनार के बीजचोल निकालने के लिए पहले से विकसित हस्तचलित मशीन को बिजली चलित यंत्र के रूप में संशोधित किया गया। अनार के दोनों भाग को काटने के लिए पश्चाग्र हाथ में दो आघात स्थान लगाए गए हैं। पश्चाग्र हाथ मोटर एवं गियर बॉक्स से प्रचालित किया जाता है। निकाले गए बीजचोल को छलनी या शूट में एकत्रित किया जाता है। सपाट क्यारी के लिए एक छः पंक्ति वाले ट्रैक्टर चलित प्याज प्रतिरोपक की भी परिकल्पना की गई तथा विकास किया गया।

आर्थिकी, विपणन, व्यापार एवं प्रभाव

कर्नाटक में खुले खेत के अनार, संरक्षित खेती की शिमला मिर्ची एवं पॉलीहाउस की जर्बेरा क्रमशः 220, 70 एवं 31 प्रतिशत के उच्च आईआरआर सहित आर्थिक रूप से व्यवहार्य पाए गए। किसानों की बढ़ती आय में उच्च क्षमता को सूचित करते हुए छूट दिए शुद्ध लाभ मूल्य एवं लाभ–लागत अनुपात तक अधिक थे। पोषण, वृद्धि होर्मोन एवं फफूँदनाशक अनार की खेती को प्रभावित करने वाले मुख्य कारक बन गए। कर्नाटक में अमरूद में तुड़ाई के तुरंत बाद खेत में ही 9.17 प्रतिशत की एवं खुर्दरे स्तर पर 4.12 प्रतिशत की हानि सहित सस्योत्तर हानि 13.29 प्रतिशत थी। हानि के मुख्य कारण थे – अधिक पके फल, पुष्पाग्र विगलन एवं केंकर, ढेर लगाने से होने वाली हानि तथा परिवहन के दौरान फलों का टूटना। अनार में बाज़ार समाकलन अध्ययन ने सूचित किया है कि बेंगलूर बाज़ार के भाव का कानपुर बाज़ार के भाव से गहरा संबंध है, जिसके बाद कोलकत्ता, चेन्नई, दिल्ली, मुम्बई एवं नागपूर के बाज़ार से हैं। अनार के निर्यात में, गुणवत्ता में 14.12: एवं मूल्य में 21.63%, की वृद्धि पाई गई तथा संयुक्त अरब अमीरात, यू.के एवं ओमान सकारात्मक, अधिक एवं महत्वपूर्ण वृद्धि अभिव्यक्त करनेवाले मुख्य आयातकर्ता थे।

भारतीय बागवानी अनुसंधान संस्थान की प्रौद्योगिकियों के प्रभाव ने सूचित किया है कि केले में पर्ण–पोषण को अपनाने से गुच्छे का वज़न बढ़ने तथा 24 प्रतिशत अधिक शुद्ध आय के कारण 10 प्रतिशत अधिक उपज प्राप्त हुई। यह प्रौद्योगिकी कर्नाटक, तमिलनाडू एवं आंध्र प्रदेश के लगभग 400 हेक्टेयर क्षेत्र में फैली हुई है। भारतीय बागवानी अनुसंधान संस्थान की रजनीगंधा किस्म, अर्का प्रज्वल, को कर्नाटक एवं तमिलनाडू के किसानों ने अपनाया है जिन्होंने 15 टन/हे. तक की अधिक उपज ली है। रजनीगंधा में कर्नाटक के लगभग 12 प्रतिशत क्षेत्र में तथा तमिलनाडू के 4 प्रतिशत क्षेत्र में यही किस्म उगाई जा रही है।

कम्प्यूटर अनुप्रयोग

टीआईजीआर टीसी डाटाबेस का उपयोग करते हुए जीवसांख्यिकी अनुप्रयोग के माध्यम से, परासरणी प्रतिबल के प्रति सहनशीलता के लिए उत्तरदाई एराबिडोप्सिस थालियाना एबीए1 के जीन एटी5जी67030 की पहचान की गई तथा एबीए जैवसंश्लेषण में

महत्वपूर्ण एन्ज़ाइम ज़ीक्सेन्थिन इपोक्सिडेस की तुलना की गई। ज़ीक्सेन्थिन इपोक्सिडेस एन्ज़ाइम के लिए कोड बनाए गए जीन, जो जीवीय प्रतिबल के प्रति पौधों की अनुक्रिया को नियंत्रित करने वाला एक मुख्य अणु है, का पता लगाया गया है। सीएमएस विशेषताओं सहित वेब 2.0 तकनीक का उपयोग करते हुए संस्थान के लिए नई वेबसाइट विकसित की गई है। बाज़ार सूचना सेवा पर एक नई डाटाबेस का समाकलन किया गया है जो कीमतों एवं आगमन प्रवृत्ति की ऑनलाईन ग्राफिकल चार्ट प्रदान करती है। अखिल भारतीय समन्वित उष्णीय फल अनुसंधान परियोजना के लिए सूचना प्रणाली का भी विकास किया गया है जिसमें इसके अधीन कार्यरत केन्द्रों, उगाई जा रही फसलों, विमोचित किस्मों एवं विकसित प्रौद्योगिकियों की विस्तृत जानकारी प्राप्त होती है।

प्रौद्योगिकी हस्तांतरण

भारतीय बागवानी अनुसंधान संस्थान द्वारा विकसित टेक्नो–एजेंटों ने सहभागी प्रदर्शनों एवं संपर्क बैठकों के बाद समेकित पोषण प्रबंधन, समेकित कीट प्रबंधन एवं समेकित रोग प्रबंधन जैसे प्रौद्योगिकी कारकों में अधिक ज्ञान स्तर दिखाया है। सहभागी अनुसंधान नीति के माध्यम से पॉलीहाउस एवं नेटहाउस की संरचनात्मक न्यूवता एवं इनका ख़राब अनुरक्षण, कीट व रोगों के लिए मानक पैकेज का अभाव, अनुशंसित फसल चक्र मापदण्ड की अनुपलब्धता, कीटनाशकों का अव्यवस्थित उपयोग तथा गुणवत्तायुक्त जैवकारकों एवं जैविक कीटनाशकों, तेल, पर्ण–मिश्रण की अनुपलब्धता आदि को सब्जियों की पॉलीहाउस में खेती के लिए मुख्य बाधाओं के रूप में पहचान की गई। भारतीय बागवानी अनुसंधान संस्थान की टमाटर में समेकित कीट प्रबंधन प्रौद्योगिकी पर कर्नाटक में किसानों की सहभागिता प्रदर्शन से 17.6 प्रतिशत अधिक बेचने योग्य उपज प्राप्त हुई तथा फल छेदकों का प्रकोप 4.9 प्रतिशत कम हुआ। भारतीय बागवानी अनुसंधान संस्थान द्वारा उन्नत किस्मों जैसे अर्का अनूप एवं अर्का सुविधा का किसानों की खेत में प्रदर्शन किया गया जिससे 18.3 टन से 20.1 टन/हे. तक अधिक उपजप्राप्त हुई। ■

1. Executive Summary

The Institute has 38 research programmes in its main centre and another 8 in its regional horticultural experimental stations, focusing on ten major thrust areas with a collaborative, multidisciplinary approach. The research work aims mainly at germplasm collection, evaluation and characterization, evolving varieties with higher yield, quality, tolerance to biotic and abiotic stress, development of molecular markers and transgenics. Other important areas of research are, enhancing productivity through canopy management, pest management, cultural practices, efficient use of inputs, farm mechanization, improvement in nutritive value, safety and quality of produce, round the year production, economics of production and identification of gaps in transfer of technology to various stakeholders.

As per ICAR guidelines, an Institute Technology Management Unit (ITMU) at IIHR has facilitated commercialization and protection of IIHR technologies. During the year under report four technologies viz. Chilli CMS line, crossandra (Arka Ambara), eco friendly para pheromone trap for effective monitoring of fuit flies belonging to *Bactrocera spp*. and a process for preparation of foliar micronutrient formulation for banana were commercialized through various licensees.

Consistent breeding efforts in the areas of genetic improvement of fruit, vegetable, ornamental and medicinal crops has resulted in release of many varieties and identification and isolation of advanced breeding lines for high yield , quality and for biotic and abiotic stress tolerance.

Varieties identified for release at state level

Chilli high yielding F_1 hybrid Arka Harita, tolerant to powdery mildew and chilli veinal mottle potyvirus and high yielding carrot variety, Arka Suraj have been recommended for release in Southern Karnataka. Carnation variety Arka Flame was approved by State Level Variety Evaluation Committee and recommended for release in Southern Karnataka under protected cultivation.

Varieties identified for release at Institute level

A total of 23 improved varieties were identified during the year 2009-10. A semi vigorous papaya variety Arka Prabhat was identified for its bearing at lower height, bigger fruit size and deep pink colour pulp with high TSS. In Guava, hybrid Arka Kiran from the combination Kamsari x Purple Local was identified for high yield, deep pink pulp, high TSS and high lycopene content. In Onion two varieties were identified namely Arka Ujjwal, multiplier onion and Arka Swadista, white onion for fermented preservation. Watermelon variety, Arka Muthu has been identified for high yield and good quality fruits. Two other watermelon hybrids Arka Akash and Arka Aishwarya have also been identified for high yield and high TSS. In French bean, Arka Sharath, has been identified for release for high yield of good quality string less pods. In Ivy gourd , Arka Neelachal Sabuja was identified for high yield with fruits containing high pulp and soft seeds. Another line Arka Neelachal Kunkhi is a selection for salad purpose with sequential fruiting habit. Arka Neelachal Kirti, a high yielding pointed gourd variety with solid core, Arka Neelachal Shree, a spine gourd selection with very high yield and Arka Neelachal Gaurav a soft seeded teasel gourd variety having dark green, oval fruits with small spines were also identified for release. In Gladiolus, hybrid selection Arka Naveen and Arka Gold were identified for release for their attractive flower colour and quality. Another selection Arka Amar was identified for its flower quality and *Fusarium* wilt resistance. In Dianthus, hybrid Arka Tejas has been identified for its commercial potential as an ornamental pot plant. In Tuberose hybrid selection Arka Nirantara a high yielding, early and prolonged blooming variety has been identified for release. Two crossandra varieties, Arka Kanaka for novel colour and Arka Ambara for bigger size of flowers, a chrysanthemum, Arka Pinkstar as ornamental pot variety have also been identified for release. In Velvet bean two non itchy selections were identiifed, Arka Dhanvantri for high seed yield and L-dopa content and Arka Aswini for earlieness.

Management of genetic resources

The total mango germplasm collection of IIHR stands at 450 with the addition of 34 indigenous types. One hundred seventy varieties were characterized as per 'Bioversity International Descriptor'. Twenty three culinary banana germplasms were evaluated for growth, yield and characters at CHES, Bhubaneshwar. Based on overall performance and quality yield, CHB-5 (Batisa Banthal) has shown promise as culinary banana genotype. In guava, The total collection stands at 79 with two additional accessions viz., Ranipasand and SP No.7. Sixty varieties were evaluated for seed hardiness and six varieties were characterized using standard descriptor. Twenty five genotypes of jackfruit (CHJ-1 to CHJ-25) have been collected from Jharkhand, West Bengal and Orissa and from Kandamal and Koraput districts of Orissa at CHES, Bhubaneshwar. Pummelo cultivar, Devanahalli and rambutan selection CHES 27 showed promise. Mushroom species, Stalked puffball (*Lycoperdon sp.*) and *Calocybe sp*. collected from Kutch and Bhuj regions of Gujarat were cultured and purified . The entire germplasm set of 190 accessions of ashwagandha, were morphologically characterized using 48 quantitative and qualitative traits.

Biotechnology in crop improvement

Development of molecular markers and transgenics for important traits in different crops are being carried out. In Papaya studies on molecular markers linked to PRSV showed that among *C. papaya* var. Surya and *V. cauliflora* 2 SSR primers, 11 ISSR primers and 16 RAPD primers of O, D, G, R and S series generated highly polymorphic and reproducible bands. In the work on molecular markers linked to bacterial blight in pomegranate 40 RAPD primers and one ISSR primer showed polymorphism for the parents Ganesh and Daru. In 80 F_2 (Ganesh X Daru) amplified with 41 markers, 35 were mapped and 6 remained unlinked forming eight linkage groups but none of the primers showed polymorphism in Bulk Segregant Analysis (BSA) for bacterial blight. In guava studies on molecular markers for soft seeds, 25 RAPD primers belonging to OPQ, OPM, OPH, OPA series gave consistent results in bulk of F1s and parents. Further screening of individual F1s with these primers is underway. In the development of molecular markers for flesh color of guava, eight RAPD primers and eight IISR primers showed amplification specific to either red or white type. In betelvine three sex linked ISSR primers, were identified from screening of female and male DNA bulks and validated across 65 germplasm lines.

In development of transgenic resistant to PRSV Papaya 24 seedlings from a T1 plant which had yellow flesh showed complete resistance while 40 control plants were all susceptible when they were challenged with viruliferous aphids. The resistant plants showed continued resistance 3 months after transplanting. In the development of pomegranate transgenic cv. Bhagwa for bacterial wilt resistance, transformation of cotyledons and hypocotyls with AMP gene through Agrobacterium mediated transformation was successful and three rooted putative transformants were obtained. In Tomato studies on transgenic resistant to early blight, two homozygous stabilized lines of transgenic tomato cv. Arka Vikas with *Trichoderma harzianum* chitinase gene in T2 generation identified previously were confirmed once gain through PCR analysis in T3 generation. One transgenic line of Arka Meghali was highly resistant to PBNV upon challenge inoculation and was also field-resistant to *Alternaria* under heavy rainfall conditions. T3 tomato Arka Saurabh event 130-13, T3 Arka Meghali events 227-14 and 231-12, T3 Arka Vikas event 225-7-5 and T3 Pusa Ruby event 138-4 were found promising for combined resistance to PBNV and TLCV. In studies on development of transgenic tomato for abiotic stress resistance, low moisture stress was imposed on T2-generation tomato plants transformed with a transcription factor dreb1A by withholding watering for seven days. The line D-27 had least drop in RWC during the water stress. A novel gene likely to confer drought tolerance was cloned from a drought tolerant land race of sorghum M-35-1, sequenced and is different from sorghum Dreb2 sequence of the gene bank by four amino acids. The sequence was deposited in the NCBI gene bank. In the development of Bt transgenic brinjal for resistance to brinjal shoot and fruit borer, in Arka Keshav variety, T_0 to T_2 stages of Cry2A Bt transgenic brinjal lines were generated and analyzed molecularly.

Improving productivity

Research on increasing production in horticultural crops during the current year encompassed the facets like canopy architecture and management; extending the harvest period, optimizing water productivity and nutrient management, investigations on physiology of fruit disorders, propagation and mass production of genuine and disease free planting material, cropping system studies, protected cultivation, organic farming, pollination studies etc.

In a field trial involving different planting densities of 'Alphonso' on 'Vellaikulamban' and 'Olour' rootstocks of mango, with or without the application of paclobutrazol, highest fruit yield of 6.74 t / ha during the tenth orchard year was obtained with 3m X 3m spacing using Olour rootstock and lower rate of paclobutrazol compared to control at 10m X 10m spacing. Flowering percentage was influenced by paclobutrazol application and the most pronounced effect was with 5g a.i applied during last week of October, with 93.3 % flowering where as control recorded only 35% flowering in Totapuri mango. In a study undertaken to understand nutrient dynamics in mango orchard soils, it was found that the nutrient content of leaves and nutrient re-absorption during senescence decides the quantity of nutrients returned to the soil under such perennial crop systems. Spongy tissue, an important physiological disorder in Alphonso mango, has been traced to the shift of seed into germination mode and the consequent drain of moisture and other resources from the adjoining mesocarp based on a number of physiological and biochemical attributes. Strategies to prevent spongy tissue formation have therefore been focused on inducing seed dormancy / reducing seed metabolic activity / death of embryonic axis through eco-friendly formulations and results were very encouraging. Pollinator species diversity was recorded on seven varieties of mango and among different foraging species, *Apis florea* was found to be the dominant one (3.86/panicle/minute).

In grapes, to achieve variable light regimes in the gable area, the growing shoot bearing bunches were halted with varying leaves from 5-13 beyond bunch for better fruit quality. Halting the shoots to 7 leaves proved better with deeper fruit colour than those shoots with more leaves. A cropping system trial established at CHES, Chettalli wherein Coorg mandarin budded plants (seedlings as check) were grown with coffee and black pepper trained on *Erythrina* showed that the fruit yield of seedling plants were significantly lower than the budded plants.

In the present scenario of climate change, studies on improving productivity under adverse conditions have assumed greater significance. Application of glycinebetaine was found to improve the plant growth of chilli under water

stress. A study on the effect of elevated CO_2 on onion cv. Arka Kalyan showed that elevated CO_2 (550 ppm) influenced overall growth, water use efficiency and total biomass. The total biomass was maximum at 90 DAP (18.6 g/plant) compared to control (13.4 g/plant), its per cent increment at elevated CO_2 levels varying from 52 to 81 % at different growth stages.

Protected cultivation for off season cultivation of vegetables is widely studied at IIHR. Slow crop growth during winter is the major constraint for optimum productivity of okra. Two cultivars of okra viz. Arka Anamika and US 7109 were grown in naturally ventilated polyhouse during winter months to overcome seasonal barrier in productivity. Okra fruit yield was significantly higher in mid-October planted crop (28.1 t/ha) compared to mid-November planted crop (21.5 t/ha).

To promote growth and nutrient uptake for sustainable production in tomato, microbial consortium studies were initiated. Out of one hundred and seventy two plant growth promoting rhizobacterial isolates *viz*., *Azospirillum* (40), *Azotobacter* (36), phosphorous solubilizing bacteria (62) and fluorescent *pseudomonas* (34) isolated from different agro ecological tomato growing regions in Karnataka, the following isolates viz., *Azospirillum* (AzosH10), *Azotobacter (*Azotbel2*)*, Phosphobacteria (Psbel6) and *Pseudomonas* (Mpf2) were found to be superior in rhizosphere competence, growth promotion and plant nutrient uptake as compared to other isolates.

At CHES, Bhubaneswar, no significant difference in the growth pattern of the plants among the organic and non-organic treatments was noticed in mango cv. Mallika. Similarly in a field trial on organic practices of papaya cv. Surya with 12 nutrient combinations involving FYM , biofertilizers and vermicompost, six months after planting vegetative parameters were found to be non significant among treatments. At 12 months after planting only plant girth was found to be significantly different and maximum girth (51.9 cm) was obtained with 50% RDF FYM +Azo+PSB+vermicompost and least girth (39.9cm) with 100% RDF fertilizer treatment. However, fruit yield and fruit quality parameters remained unaffected. In another study with cabbage cv. Unnathi plant growth parameters were not affected by different organic treatments.

Pest management and pesticide residues

Azoxystrobin application was most effective in controlling anthracnose stem end rot in mango, followed by thiophanate methyl and carbendazim. Use of turmeric, neem leaf extracts, extract of *V. negundo* leaves and garlic could also control anthracnose to a lesser extent. Deltamethrin treatment was found to be significantly superior over other treatments viz. dimethoate, Bt, neem soap and pongamia soap even after fourth harvest for control of sapota seed borer, *T. margarias*. The entomopathogen *Metarhzium anisopliae* was found to be efficient in controlling *Ferrisia virgatta* on guava while treatment with lamda – cyhalothrin, acetamiprid and *B. bassiana* considerably reduced fruit damage by tea mosquito bug from the second week of spraying. In polyhouse, mealybug infestation could be controlled by release of *Cryptolaemus* grubs. Soil application of neem cake followed by sprays of neem soap and NSP were effective for control of leaf hopper in okra during *Kharif*, but only moderately effective during summer when the pest incidence was very high. Rynaxpyr (0.3 ml/l) application was consistently found superior over other insecticidal treatments to control brinjal shoot and fruit borer and resulted in average fruit damage of only 8.36 % (weight basis) as against 45.35 % in control. Sprinkler irrigation was found to significantly reduce the number of chilli thrips without insecticide spray while weekly spraying of *M. anisoplaie* @ $1x10^9$ spores/ml with sunflower oil @ 0.01% followed by weekly release of *Blaptostethus pallescens* @1/plant recorded significant reduction in thrips population in chilli and capsicum.

A 15 day's spray schedule of mancozeb was effective for the management of foliar disease of onion during *Kharif*, recording a per cent disease incidence of 35 and yield of 30.0 tons/ha as against a PDI of 45 and yield of 16.67tons/ha in untreated control. IPM treatment consisting of bait spray (Deltamethrin 0.1 % + Jaggery 1 % + setting up of cuelure traps @ 10/acre) significantly decreased the melon fly damage (12.66%) in bittergourd as compared to other chemical/ botanical treatments and control (19.15 % to 33.66 %).

Management of nematodes in banana was standardized by application of 2 kg of farm yard manure enriched with *Pseudomonas fluorescens* (109 cfu/g) and *Trichoderma harzianum* (106 cfu/g) per plant at the time of planting and at an interval of 6 months. Nematode management strategies were also developed in papaya, okra, carrot and gladiolus.

Safety of chemical pesticide treatments were evaluated in several crops for recommending pre harvest intervals (PHI) to obtain safe produce. In pomegranate foliar application of chlorpyrifos and thiamethoxam did not result in any harmful residues in aril but based on residue deposit on fruit surface, 35 days PHI was recommended. Washing of fruit was found to dislodge 65 -75 % of residues of chlorpyrifos and 38 - 46% of thiamethoxam from fruit surface. Combined soil drench application of chloropyriphos and carbendazim in pomegranate resulted in slow uptake of carbendazim into plant and its gradual accumulation in the leaves. The residue build up of carbendazim was 0.44 and 0.64 ppm in pomegranate fruit peel at greenish immature stage, 0.08 and 0.07 ppm in aril, but there was no movement of chloropyriphos residues from soil to leaves and fruit although the residues persisted in soil for more than 100 days. Higher intial deposits of iprodione and chlorothalonil were found in polyhouse grown tomato as compared to that in field grown tomato following four applications at fruit formation stage in the same season. The rates of dissipation of iprodione and chlorothalonil residues were slower in polyhouse than in field grown tomato and PHI of 4 days in polyhouse and 1 day in open field for safe harvest of tomato was recommended.

Minimization of post harvest losses and value addition

Storage life of Alphonso and Banganapalli cultivars of mangoes (with or without wax coating) could be extended without any chilling injury at 8°C by Modified Atmosphere (MA) packing with semi permeable film (micro perforated D-955 film). The storage life of sapota (cv. Cricket ball) could be extended to 3 weeks at 10°C without any chilling injury when the fruits were MA packed with micro perforated LD film. The fruits ripened normally within 3 days when they were shifted to ambient conditions for ripening. Similarly, storage life of papaya (cv. Taiwan Red Lady) could be extended up to 1 month when the fungicide treated fruits were MA packed with micro-perforated D-955 film (0.0125 % ventilation) and stored at 18°C (75-80% RH) with less spoilage (5 %). MA packed and stored papaya fruits were ripened to bright yellow surface colour without any shriveling and with high carotene and lycopene contents when compared to non-packed fruits. The storage life of custard apple fruits (cv. Balanagar) could be extended to 2 weeks at 12°C without any chilling injury when the fruits were MA packed with 100 gauge PE or PD-961 film. The fruits ripened normally within 4 days when they were shifted to ambient conditions for ripening. The storage life of custard apple (Hybrid, Arka Sahan) fruits could be extended to 3 weeks at 15°C by exposing the fruits to 250 ppb 1-MCP for 6 hours with maintenance of higher firmness and quality when compared to 2 weeks in non-treated fruits. At ambient temperature (24-30°C) the shelf life could be extended by 3 to 4 days without affecting the quality. Aonla is susceptible to chilling injury when stored below 15°C. The storage life could be extended to 2 weeks with maintenance of quality at 15°C by using PE lining (100 gauge) around the fruits. PE lining significantly reduced the weight loss (2% when compared to 8 % in control fruits) and maintained the firmness of aonla fruits during 3 weeks of storage at 15°C. It was recommended that final moisture content in osmotically dehydrated aonla should segments be maintained around 12-13% for better quality retention during storage while post harvest exposure of tomato and bitter gourd fruits to 1-MCP (an ethylene action inhibitor) at 250 ppb concentration or formulations containing 1-MCP for 18 hrs delayed the ripening, retained higher firmness and extended the storage life of these fruits.

Osmotically dehydrated mango slices of varieties Alphonso, Dushehari, Totapuri and Arka Anmol were prepared using standard process. These slices dried to a moisture level of 12-15% and packed in punnets could be stored upto one year.

Process was standardized for the preparation of banana wine from *cv*. Robusta with golden colour, pleasant banana aroma, 11 per cent alcohol and less than 0.5 per cent residual sugar and sapota wine with 10-11.5 % alcohol, 0.44- 0.57, % acidity, and 0.26-0.28 per cent residual sugar. RTS juice was prepared from pomegranate and the product comprising of 25% juice, 18 ^{o}Brix and 0.30% acidity was judged best. Fruit punches were prepared by blending pulp/juice of different fruits such as aonla, mango, passion fruit and custard apple in equal proportions and beverage concentrates were prepared. The TSS of the product varied between 58.5 to 61.0^{o}Brix and acidity between 2.37 to 2.83. In over all acceptability the fruit punch comprising of aonla, mango and passion fruit was judged the best due to better taste and flavour.

Studies were also carried out to optimize better techniques to pack and transport horticultural produce. Fully mature sapota (var.Cricket Ball) packed in CFB boxes of size 400x300x150mm, 5-ply rate with paper pieces as cushioning material and fully mature aonla (Var.Krishna) packed in CFB boxes of same with partition in between was superior for road transportation of these produce while quality of 6° C pre cooled jasmine (*Jasminum sambac*) flowers were better over 13° C pre cooled ones. Flowers remained white and opening was higher (75%) in bamboo basket while those in thermocol box exhibited discoloration. Work has been initiated on using horticultural waste. The process of extraction of total carotenoids from mango processing waste (peel and stones) was standardized using mixture containing 3 parts petroleum ether and 2 parts acetone. The process to produce ethanol from fruit processing waste was also standardized. This ethanol will be tested for blending with petrol for use in IC engines.

Farm mechnization

A tractor operated hydraulic harvesting platform for tree fruit crops has been designed and developed. It has an operator's platform, scissors lift mechanism and a trailer. A long reach chain saw was also tested using the above platform for pruning mango trees at 5th order branch. The observed capacity was one tree per hour upto a height of 8 m. The hand operated pomegranate aril remover developed earlier has been modified as motorised aril remover. There are two hitting hubs fitted on reciprocating arms to hit the two halves of pomegranate fruit. The reciprocating arm is operated by a motor and gear box. The removed arils are collected through a sieve and collecting chute. A Six-row tractor operated onion transplanter for flat bed has also been designed and fabricated.

Economics, marketing, trade and Impact

Pomegranate in open filed, capsicum under protected cultivation and gerbera under polyhouse in Karnataka were found economically viable with higher IRR of 220, 70 and 31 per cent, respectively. Even the discounted NPV and BCR were higher indicating the high potential in increasing returns of farming community. Nutrition, growth hormones and fungicides emerged as the major factors influencing pomegranate cultivation. In guava, the post harvest loss was 13.29 per cent in Karnataka, consisting of a loss of 9.17 per cent at field immediately after harvest and 4.12 per cent loss at retail level. The major factors of loss were over ripe fruits, blossom end rot and canker, injury caused due to heaping and crushed fruits during transit. In pomegranate, the market integration studies indicated that the price in the Bangalore market was found to have strong relationship with

Kanpur market followed by Kolkata, Chennai, Delhi, Mumbai and Nagpur markets. Exports of pomegranate, experienced significant growth of 14.12 % in quantity and 21.63 % in value and the major importers which expressed positive, higher and significant growth were UAE, UK and Oman.

Studies on impact of IIHR technologies indicated that in banana, use of foliar nutrition gave 10 per cent higher yield due to increased bunch weight and 24 per cent higher net return. This technology is spread in an area of 400 ha area in Karnataka, Tamil Nadu and Andhra Pradesh. Improved IIHR tuberose variety, Arka Prajwal, was adopted by farmers from Karnataka and Tamil Nadu who realised a higher yield up to 15 t/ha. Nearly 12 per cent area of tuberose in Karnataka and 4 per cent in Tamil Nadu is under this variety.

Computer application

Through bioinformatics application, a gene AT5G67030 of Arabidopsis thaliana ABA1 responsible for tolerance to osmotic stress was identified and Zeaxanthin epoxidase an enzyme important in ABA biosynthesis was compared using TIGR TC database. The gene encodes for Zeaxanthin epoxidase enzyme, a key molecule that regulates plant responses to abiotic stress have been located. A new website of the Institute was developed using web 2.0 technologies with CMS features. A new database on market information service was integrated that provides online graphical charts of price and arrival trend. Information system for AICRP on Tropical Fruits was also developed with detailed information on the centres working under it, crops grown, varieties released and the technologies developed at a centre.

Transfer of Technology

Techno-agents developed by the IIHR have shown significantly higher knowledge levels in technology components like INM, IPM and IDM after participatory demonstrations and interaction meetings. Structural defects in the construction of poly/nethouses and its poor maintenance, lack of availability of standard package for pests and diseases, non availability of recommended crop rotation modules, indiscriminate use of pesticides and non-availability of quality bioagents and bio-pesticides, oils, foliar formulations were identified through PRA as the major gaps/ constraints in polyhouse cultivation of vegetables. Farmers' participatory demonstrations on IIHR technology of IPM in tomato in Karnataka resulted in a 17.6 per cent higher marketable yield and 4.9 per cent less incidence of fruit borer. IIHR demonstrated improved varieties, Arka Anoop and Arka Suvidha in farmer's fields, which resulted in higher yield of 18.3 t to 20.1 t/ha.

■

2. Introduction

The Indian Institute of Horticultural Research (IIHR), a constituent institute of Indian Council of Agricultural Research (ICAR) was established at Council's head quarters, New Delhi on 5th September 1967 with late G.S. Randhawa as founder Director. On 1st February 1968, the institute was shifted to Bangalore and is ideally located at Hessaraghatta, a picturesque setting, 26 kms away from Bangalore. The institute has a sprawling campus of 266 ha experimental land and with excellent state of the art infrastructure facilities for conducting basic as well as applied research on horticultural crops. These facilities coupled with a pool of talented, experienced scientific and technical human resource makes the Institute a premier organization for research, teaching and extension in all branches of horticultural science.

Over the years, the institute nurtured its regional stations to independent institutions such as CISH, Lucknow and NRC for Citrus, Nagpur. Regional stations developed by the institute at Gohdra and Ranchi were merged with other ICAR institutions. At present the institute has three regional horticultural experimental stations, one each located at Chettalli, Kodgu and Hirehalli, Tumkur (both in Karnataka) and Bhubaneswar, Orissa. There is a Krishi Vigyan Kendra under this Institute at Gonikoppal (Kodagu, Karnataka). The Project Co-ordinator's (Tropical Fruits) Cell of All India Co-ordinated Research Project on tropical fruits located at the institute monitors the research activities on citrus, banana, papaya, sapota and jackfruit at 17 centres located all over the country.

The mandate of the institute are (i) To undertake basic and applied research for developing strategies to enhance productivity and utilization of tropical and sub-tropical horticultural crops, (ii) To serve as a repository of scientific information relevant to horticulture, (iii) To act as a centre for training for upgradation of scientific manpower in modern technologies for horticultural production and (iv) To collaborate with relevant national and international agencies in achieving the above objectives.

Considering the significant achievements and progress made by the institute, ICAR has bestowed the Best Institute Award upon IIHR in 1999. In addition, this institute has the recognition by 9 universities for post graduate research in horticulture, main centre for breeders vegetable seed production for supply to seed producing agencies, national and international linkages in horticulture research and education. Centres of excellence in Biotechnology and Post Harvest Management under NATP, Product Development Laboratory for entrepreneurship development and DBT-ICAR National facility for virus diagnosis and quality control of tissue culture plants. The Institute also has an Agriculture Technology Information Centre (ATIC), which is a single window agency for dissemination of information and technologies developed by the Institute. All the technological products and popular publications developed by the Institute are sold to the farmers and interested public through this centre.

The Institute's strategic research of the future aims towards the economic prosperity and nutritional security through all round development of horticulture industry in this country. This will be achieved by focusing on high quality research on development of need based elite varieties, standardizing environmental friendly, cost-effective sustainable production technology, value addition by efficient post harvest management system and effective technology transfer to end users.

Research work carried out during the last four decades with the above objectives has paid rich dividends in the terms of release of more than 170 varieties and hybrids and development of good number of sustainable production, protection and post harvest management technologies. In fruit crops, the institute has released three varieties in papaya, 5 hybrids in mango, 3 varieties in guava, 11 hybrids in grapes, one variety each in pomegranate, annona, ber and passion fruit. Recently released high yielding Pink fleshed Arka Prabhat papaya hybrid, Arka Kiran, a red fleshed hybrid guava and Arka Sahan, a hybrid of annona with large globules and less seeds hold better promise and are gaining more popularity. So far the Institute has developed and released 60 high yielding open pollinated varieties and 15 F1 hybrids in 24 vegetable crops resistant to pests and diseases for commercial cultivation, Arka Manik of Watermelon – triple resistant to pests and diseases, Arka Anamika in okra resistant to Yellow Vein Mosaic Virus and Arka Komal in French bean resistant to rust has spread to the length and breadth of the nation. High yielding varieties of tomato Arka Vikas, Arka Kalyan and Arka Niketan in onion have made significant impacts. Tomato hybrid Arka Ananya, with combined resistant to Tomato Leaf Curl Virus and Bacterial wilt, chilli hybrids Arka Meghana tolerant to thrips and viruses, Arka Harita and Arka Suphal of chilli tolerant to powdery mildew, high yielding male sterility base chilli hybrid Arka Swetha, bacterial wilt resistant brinjal hybrid Arka Anand, high yielding onion hybrids based on male sterility, Arka Lalima and Arka Kirthima are a few which have made significant impact in production and higher economic gains.

In the area of ornamental crops, the Institute has evolved improved varieties in gladiolus, chrysanthemum, bougainvillea, hibiscus, tube rose, rose, China aster, carnation, gerbera and crossandra. China aster varieties Poornima, Kamini, Vilet cushion and Shashank, tube rose cultivars, Shringar, Suvasini, Prajwal and Vibahv and crossandra variety Arka Ambara have become very popular among the farmers.

In the field of mushrooms, a spore less mutant of oyster mushroom, milky mushroom, Jews ear mushroom and a medicinal mushroom with export potential have been developed.

In the field of production technologies, IIHR has standardized the technology of high density planting of banana and pineapple which are being practiced by all most all growers of these crops. Grape rootstock Dogridge, identified and released by the Institute has revolutionized grape cultivation in dry land and problematic soils. Integrated water and nutrient management schedules like drip irrigation, fertigation, application of fertilizer in the active root feeding zone, etc., for optimum utilization of resources for various fruits, vegetables and ornamental crops have been standardized. The Institute has also standardized leaf and petiole diagnostics for optimum recommendation of fertilizers for respective crops. In the recent years, the institute has standardized technology for foliar nutrition of micro nutrients and has commercially released mango special, banana special, citrus special and vegetable special for higher and quality yields. These technologies have already been commercialized, making these technologies available to cross section of the farming community. The causative factors for occurrence of spongy tissue, a major problem in mango are being established. The Institute has also come out with biofertilizers like PSB, azospirallium, VAM etc.

In the field of plant protection, the Institute has standardized the technology of pest management using trap crops like African marigold for control of tomato fruit borer, mustard for control of DBM in Cole crops, botanicals and plant products like neem soap and pongamia soap for control of major pests. Bio-control agents and micro organisms like *Trichoderma, Pseudonomous fluoroscence, Paecilomyces lilacinus etc.* for control of soil borne diseases and nematodes have been standardized. The mango fruit fly problem, which is a major limiting factor for export has been overcome by standardizing a pheromone trap which has been commercialized by the Institute. Simultaneously, integrated disease management protocols and diagnostic kits for viruses have also been developed.

In the field of post harvest technology, the Institute has standardized technology to extend the storage life at various temperatures, standardized the protocol for MOP and shrink wrapping technology. Value addition through product development has been a priority area, in which the Institute has developed protocols for preparation of osmo-dehydrated products, fruit based beverages like mango squash, passion fruit squash, aonla squash, passion fruit banana blends, various culinary pastes and purees. The Institute has standardized technology for production of tomato, coloured capsicum, cucumbers and melons under protected conditions. The technology for production of nursery seedlings using pro trays has been further refined. In the field of biotechnology, macro propagation protocols for various crops and nucleic acid probes for many viruses have been developed. DNA finger printing techniques have also been developed for characterization and documentation of germplasm.

Transfer of technology, the most important tool for dissemination of information and technologies is being carried out through the Division of Extension and Training through conducting on farm and off farm demonstrations, various media and publicity activities, conducting field days, participating in national and international exhibitions, publication of popular extension literature, imparting training to developmental functionaries, need based training to entrepreneurs and corporate / private agencies and also to the needy farmers

Presently the Institute has a total strength of 554 staff with 134 Scientists, 209 technical staff, 80 Administrative staff and 131 supporting staff. The Institute is headed by the Director supported by 11 Heads of Divisions and 4 Heads of Sections. Expenditure incurred by the institute including regional stations under Plan and Non Plan was Rs.1000 lakhs and Rs.4092.34 lakhs respectively. The revenue generated by the Institute through sale of produce, consultancy services, analytical testing and other means was Rs. 1,09,32,106.

Economic growth, nutritional security and livelihood security through all round development of horticulture sector in the country is the main goal of the institute for which the institute continues to focus on high quality research for developing need based sustainable technologies.

STAFF POSITION

Presently the institute has total staff strength of 555 headed by the Director (including Regional Stations).

Category	Sanctioned			Filled			Vacant		
Director	1			1			-		
	PS	SS	Sci.	PS	SS	Sci.	PS	SS	Sci.
Scientific	12	27	111	11	22	101	1	5	10
Technical	227			209			18		
Administrative	93			80			13		
Supporting	155			131			24		
Grand Total	**626**			**555**			**73**		

Statement showing station-wise expenditure incurred under plan and non plan for the period from 1.4.2009 to 31.3.2010

PLAN Rs. In lakh

Sl. No.	Heads	IIHR B'lore	CHES Chethalli	CHES Hirehalli	CHES B'war	TOTAL
1	Establishment charges	0	0	0	0	0
2	Labour wages	0	0	0	0	0
3	O.T.A.	0	0	0	0	0
4	T.A.	26.76	0.54	0	0.70	28.00
5	Other charges	466.50	14.82	3.63	16.06	501.01
6	Works	205.00	0	0.99	0	205.99
7	H.R.D./ IT	7.73	0.02	0	0.25	8.00
8	Outreach….Leaf spot	225.00	0	0	0	225.00
9	Outreach….Sucking Pest	32.00	0	0	0	32.00
	TOTAL	**962.99**	**15.38**	**4.62**	**17.01**	**1000.00**

NON-PLAN

1	Establishment charges	3151.03	173.99	49.58	120.40	3495.00
2	Labour wages	128.89	29.00	0.00	0.00	157.89
3	O.T.A.	0.20	0.00	0.00	0.01	0.21
4	T.A.	12.55	0.90	0.02	1.65	15.12
5	Other charges	257.92	11.81	16.12	21.75	307.60
6	Works	112.61	0.24	1.87	1.80	116.52
7	H.R.D.	0.00	0.00	0.00	0.00	0
	TOTAL	**3663.20**	**215.94**	**67.59**	**145.61**	**4092.34**

Statement showing station-wise revenue realised for the period from 1-4-09 to 31.3.10

Sl. No	Head of Account	Bangalore	Chettalli	B'war	Hirehalli	Total
1.	Sale of Farm Produce	2356074	1585190	742768	453683	5137715
2.	Sale of Publication	296086	0	0	0	296086
3	a. Licence Fee	429164	131906	0	0	561070
	b. Hostel & Guest House	45900	53642	0	0	99542
4	Interest earned on Loans & Advances	982699	116481	0	0	1099180
5	Analytical Testing fee	279860	9171	0	0	289031
6	Application fee from candidate	89200	0	0	0	89200
7	Receipts from Service rendered	535966	0	0	0	535966
8	Income generated from Internal resources					
	a. Consultancy Fee	200000	0	0	0	200000
	b. Others	75000	10800	0	0	85800
9	Misc. receipts					
	a. Sale of Other Products	238184	0	0	0	238184
	b. Charge for use of Transport	483362	0	0	0	483362
	c. Sale of unserviceable stores	5500	0	2280	0	7780
	d. Sale of Tender Paper	75400	10400	8800	1800	96400
	e. Water charges	8572	0	0	0	8572
	f. Misc. receipts	1556506	17926	0	129786	1704218
	Total	**7657473**	**1935516**	**753848**	**131586**	**10932106**

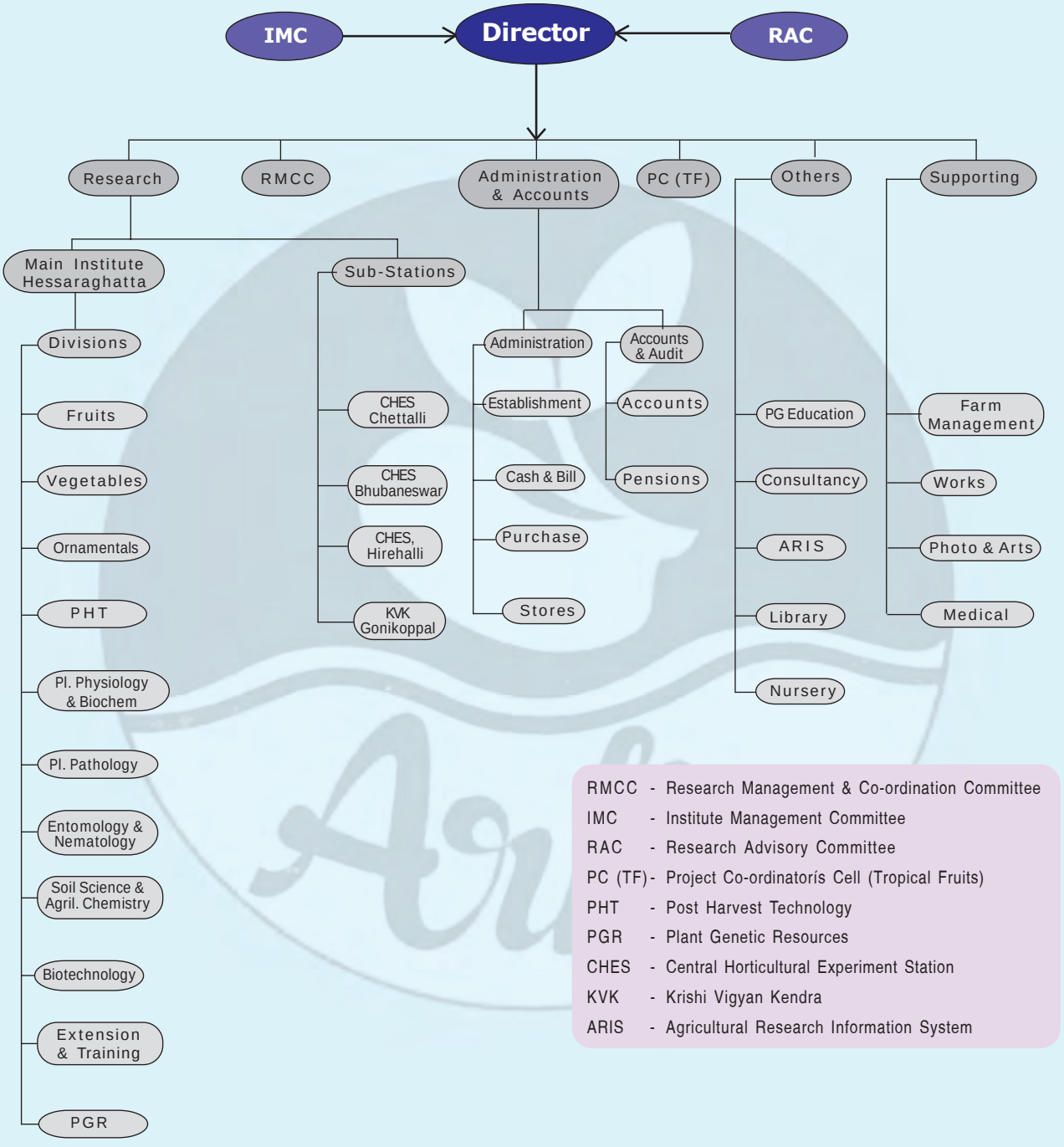


Fig.1 : Organisational set up

3. Research Achievements

3.1 Crop genetic resources

3.1.1 Collection and evaluation

Mango

The total mango germplasm collection stands at 450 with the addition of 34 indigenous types. 170 varieties were characterized as per 'Bioversity International Descriptor'. Evaluation of germplasm showed that Shahjahan had big sized fruits weighing more than 1 kg. The variety Kalakai had smaller fruits of 59g. The skin colour was attractive in the accessions Chettalli, Malgesh, Bandariya and Badami Modal and the pulp colour was orange in Gopal Bhog, Gidagana Mavu, Adamans Local, Dashehari Clone 51.

At CHES, Bhubaneswar, elite clones of mango were identified and collected from all over Eastern India, in particular, Narsinghpur area of Cuttack. The clones had wide variability with regard to fruit weight, TSS, pulp content and texture.

Banana

Twenty three culinary banana germplasms were evaluated for growth, yield and characters at CHES, Bhubaneswar. The highest plant height (3.7m) and highest pseudostem circumference (87.6cm) was recorded in Banthal (CHB-23). The highest bunch length (2.22m) was recorded in CHB-16 (Gaja Banthal) followed by 34cm in Paunsia Banthal (CHB-27). CHB-31 (Banthal) recorded the highest bunch weight of 21kg, whereas the minimum bunch weight (4.7kg) while highest no. of hands / bunch (23.3) was recorded in Batisa Banthal (CHB-5). Based on overall performance and quality yield, CHB-5 (Batisa Banthal) has shown promise as culinary banana genotype.

Guava

The total collection stands at 79 with two additional accessions viz., Ranipasand and SP No.7. Sixty varieties were evaluated for seed hardiness and six varieties were characterized using standard descriptor. The TSS was observed to be high (13.8 0B) in the variety Hisar Safeda.

Jackfruit

Twenty five genotypes of jackfruit (CHJ-1 to CHJ-25) have been collected from Jharkhand, West Bengal and Orissa and from Kandamal and Koraput districts of Orissa at CHES, Bhubaneswar. The seedling population of these genotypes has been raised in 'Field Gene Bank' and is being evaluated for vegetative growth

Pummelo

Pummelo varieties at CHES, Chettalli, showed significant differences in plant height, which ranged from 4.00 m in Watson to 6.22 m in Royal. Maximum canopy spread (5.30 m^2), canopy volume (41.7 m^3) , fruit height (15.4 cm) and lowest ascorbic acid content (33.3 mg / 100 g of fruit) was recorded in the genotype Devanahalli. Fruit weight ranged from 690.2 g in the cultivar Pink Flesh to 1600.3 g in cultivar Watson. The fruits of the cultivar, Kanapara, had highest ascorbic acid content of 38.3 mg / 100 g of fruit .

Rambutan

At CHES, Chettalli, higher fruit weight (42.5 g), maximum fruit length (4.9cm) and breadth (4.0cm) was recorded in CHES- 27. Fruits of this promising selection were red, ovoid to round in shape, bold with free stone from which pulp was easily separable. The average pulp content was 44.7%, T.S.S - 18.8°B, acidity- 0.85% and total sugars 16%.

CHES-27 Rambutan

Underutilized fruits

Currently underutilized fruit collection stands at 46, of which 27 have come to bearing. Carissa (sweet and sour), carambola, bilimbi, rose apple, watery rose apple, Manila tamarind, Jamaica plum, Canistel, Java plum, Macadamia nut, sweet tamarind, phalsa, edible mulberry were found to be promising. During the year fruits of three Carissa species, two tamarind varieties, Java plum, phalsa, two Psidium species were evaluated. Two new introductions from Sri Lanka, Ugrassa (*Flacourtia indica*) and lovi (*Flacourtia inermis*) produced fruits with exotic taste and flavor. Some of the less known fruits were evalauated for different fruit traits. In Carambola, fruit weight ranged from 9 -12g (mean = 10.4g), TSS ranged from 5 - 9°B (mean = 6.88°B) and mean acidity was 0.60%. In Lasoda fruit weight ranged from 2.15 -2.65 g (mean = 2.38 g), TSS ranged from 16 - 19.4°B (mean = 17.92°B) and mean acidity was 0.19%. Java plum recorded fruit weight ranging from 11

-19 g (mean = 14.4 g) and TSS varied from 10.4 -19.6°B (mean = 14.8°B) and mean acidity was 1.05%.

The open pollinated seedlings of different underutilized fruits were collected from diverse sources and maintained in the field gene bank at CHES, Chettalli. 188 collections of mandated under utilized fruits comprising of mangosteen(16), durian (11), Rambutan (50), avocado 12), passion fruit (12), kokum-*Garcinia indica* L. (10), Malabar tamarind – *Garcinia gummigutta* L. (3), Macadamia nut (3) and longan (2) are being maintained.

In order to domesticate several fruit species obtained from Western Ghats, these were transplanted to field at IIHR. Domesticates of 18 Governor's plum (*Flacourtia Montana*) plants adapted well exhibiting vigorous growth and bushy habit, producing good number of secondary laterals. Seedlings of Brazilian Jelly Guava (*Psidium guineense* Swartz), Cattley guava (*Psidium catleanum* var littorale) are being maintained under shade net for further growth and development to transplantation stage.

Bird of paradise

Forty-four genotypes of Bird of paradise were evaluated for growth, inflorescence yield and floral characters. During sixth year of planting, plants exhibited mean values of 132.09 cm plant height, 113.04 cm leaf length, 8.49 cm leaf breadth, 285.86 leaves/plant and 23.48 dichotomous branches/plant. Mean number of florets/spike was 8.13. Inflorescence length was 81.64 cm with 7.88 cm diameter of the stem. Among evaluated germplasm, 12 were found to produce more spike yield with desirable floral parameters. In gamma irradiated mutants, seedlings imposed with 5 kr and 10 kr of radiation, recorded significantly lower values for plant height, leaf length and leaf breadth. One variegated mutant observed in 10 Kr treatment is being monitored for the stability of the character observed.

Mushroom

Girnar forest ranges spreading over the districts of Kutch, Bhuj, Junagad, Rajkot, Sasan, Amreli and Jamnagar were explored for edible as well as wild mushroom documentation. Among the edible species, Kutch and Bhuj regions were dominated by the stalked puffball (*Lycoperdon sp*. Gasteromycete member), a locally popular variety, growing on sandy soil at high temperature and low humidity. The forest areas in Sasan, Amreli and Gir Sanctuary were dominated by the edible *Termitomyces sp*. A wild *Calocybe sp*. was collected from Junagadh area . Among the medicinal species *Ganoderma lucidum* was found abundantly but only two soft *Polyporus sp*. were documented. The *Calocybe sp*. and the puffball have been cultured and purified. Fructification could be induced by casing in the wild *Calocybe* species.

Stalked Puffball (*Lycoperdon sp*.)

Ashwagandha

Out of 190 accessions evaluated, the active ingredient (total Withanolides) estimated by HPLC ranged from 0.106 to 0.588 % in the germplasm and the checks recorded 0.308% (JA-20) and 0.106% (WSR). The germplasm was also assessed for 7 different withanolides to identify different chemo types. Five chemotypes with higher individual withanolide contents have been identified as promising. They are accession IIHR -WS-3 high in Withastromalonide (0.048%), Withanoside IV (0.227%) and Withanoside V (0.042%), IIHR -WS-111 for Withanone content (0.100%), IIHR -WS-71 for Withanolide B (0.068%), IIHR-WS-V-3 for Withaferine A (0.345%) and IIHR -WS-161 for Withanolide A (0.107%).

Aswagandha chemotypes with distinct morphology, Clockwise from top left - IIHR-WS—111, IIHR-WS-71, IIHR-WS-V-3 and IIHR-WS-3

3.1.2 Characterization

Mango

Among three polyembryonic varieties, germination was highest in Kensington pride (61%) followed by Nekkare (55.88%) and Vellaikulamban (31.94%). Number of seedlings/ stone was highest in Kensington Pride (2.38) followed by Nekkare (1.32) and Vellaikulamban (1.13). Observations recorded on plant height, number of leaves/plant and leaf area showed highly significant differences among varieties. Plant height and number of leaves was significantly higher in Nekkare whereas leaf area was significantly higher in Vellaikulamban compared to other varieties. DNA was isolated from mature leaves of Kensington Pride and Nekkare

seedlings (both nucellar and zygotic) using modified CTAB protocol. Quantification done using Spectrophotometer quality was ascertained using agarose gel electrophoresis. PCR work using SSR primers is in progress

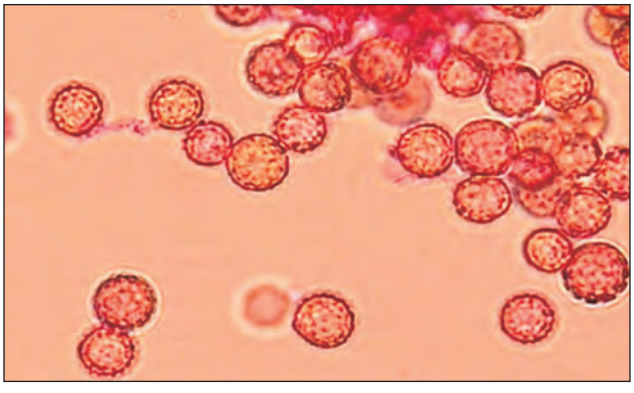
In order to identify the admixture among 269 mango cultivars, and to predict the number of populations present among these cultivars used for characterization, STRUCTURE analysis carried out, predicted that K=2, indicating two major population. Molecular barcodes have been generated for 269 Indian mango cultivars using crop DNA fingerprinting database software. Parentage analysis has been done for ten known offspring-parent combinations, which has assigned candidate parents to their respective offsprings with confidence level of 80% statistical significance. Phylogenetic study among *Mangifera spp* has been done using nuclear (ITS & ETS) markers and chloroplast (atpB-rbcL, rps16, trnL-F & petB-D) markers. Additionally a new type of marker *viz* flanking region of monomorphic microsatellite locus has been used for studying the phylogeny among six *Mangifera spp. M. indica, M. andamanica, M.griffiti, M. zeylania, M. odorata and M. camptosperma.* Attempt was also made to develop SNPs for mango characterization. Ten different EST sequences have been taken as source and primers designed, out of which two genes namely fructose biphosphate aldolase and cystathionine gamma synthase have been successfully amplified in ten mango cultivars. PCR products were sequenced and the sequences were aligned with Clustal W software and the SNP variations present among these cultivars were observed.

Crossandra

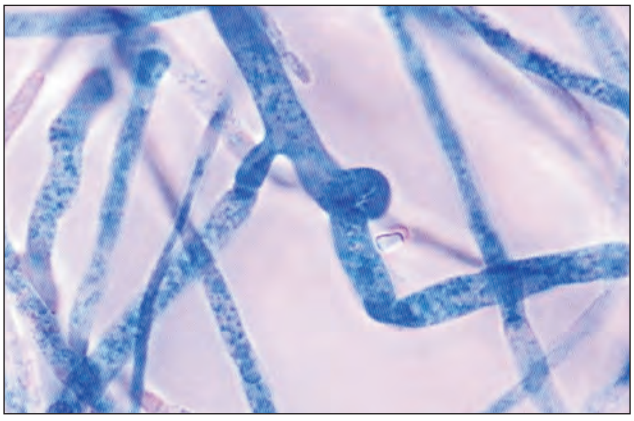
DNA was isolated from Arka Ambara, Arka Kanaka, 2005-1, 2005-2, Local Yellow, Mangalore Green and *C. nilotica*. ISSR PCR protocol was optimized and twenty primers produced good amplification of DNA fragments out of 90 UBC primers screened. Optimal annealing temperatures were identified by testing a range of different temperatures for each primer. Fingerprints of crossandra varieties were developed using UBC primers.

Mushroom

The basidiospores of *Lycoperdon* sp. were round and ornamented. The mycelium was dimitic with numerous calcium



Basidiospores of *Lycoperdon* sp



Mycelium of *Lycoperdon* sp

oxalate crystals and scant clamp connections. The basidiospores of *Calocybe* sp. were hyaline, pear shaped with distinct germpore.

Cultural characterization of the edible mushrooms *Podaxis pistillaris* , *Phellorina inquinans* and *Daedalia quercina* was carried out. *P. pistillaris* and *P. inquinans* showed an optimal mycelia growth at 35°C but could grow at 40°C too. The optimum medium for *Podaxis pistillaris* was malt extract agar and optimum pH range was 5.5 to 7.5. The optimum medium *for Phellorina inquinans* was oat meal agar and optimum pH range was 7.5 to 8.5. The optimal temperature for *D. quercina* mycelia growth was 35-40°C. It could grow at a temperature of 45°C too.

Ashwagandha

One ninety accessions were morphologically characterized using 48 quantitative and qualitative traits. Useful descriptors have been identified for developing the minimum descriptors for this crop. Fifteen true breeding distinct morphotypes have been morphologically characterized and they would be useful as reference set for DUS testing in this crop. In molecular characterization, the distinct types were initially screened for 144 RAPD Primers. Based on robustness and repeatability of bands 40 RAPD primers were selected and the whole set of accessions was screened for the selected primers. The number of bands recorded ranged from 1 to 10 and the banding pattern from 1 to 7. The extent of polymorphism in the primers ranged from 0 to 100 percent and 39 primers were found polymorphic. Three of the primers tested, classified the whole set of germplasm in to two distinct classes viz., early-medium maturing types/ annuals and late maturing types/perennials. Accession specific RAPD profile has been developed for 186 germplasm accessions and 15 morphotypes.

3.2 Crop improvement

3.2.1 Breeding for high yield and quality

Mango

Hybridization was carried out involving the varieties Alphonso, Vanraj, Amrapali and Arka Puneet. 28 progenies obtained are being evaluated. Fruit quality analysis

was carried out in thirteen hybrid progenies. The progeny, 20-10 from the combination Alphonso x Kerala Dwarf had good fruit quality and fruit size. The hybrids R_1P_4 and R_3P_5 from the combination Amrapali x Arka Anmol had higher pulp recovery, better pulp colour and TSS. About 200 half sibs of the early bearing variety 'Lazzat Baksh' were raised to select desirable progeny having higher yield, earliness and quality.

At CHES, Bhubaneswar, 19 varieties / hybrids were evaluated for yield and other characters. The highest fruit weight and pulp weight was recorded in Swarna Jehangir. The highest yield / plant was recorded in Amrapali (99kg). CHM-7, an early maturing mango clone has been identified for extremely early fruit maturity, attractive colour, good fruit yield, high TSS (25^0B) and freedom from fruit fly under coastal Orissa conditions.

Sapota

Hybridization was carried out involving the varieties, PKM-1, Cricket Ball and Kalipatti to develop dwarf stature variety with quality fruits. PKM-1 is the contributor of dwarfness, the varieties Cricket Ball and Kalipatti have quality fruits. A total of 160 hybrid seedlings have been planted in the field and preliminary observations on growth parameters showed variations among them. Another set of 280 hybrid seedlings are being raised in the nursery. Efforts were made to generate variability by raising a large number of open pollinated seedling populations. More than 2000 seedlings of varieties Cricket Ball and PKM-1 have been raised. Also seeds of Cricket Ball and PKM-1 were treated with varying doses of EMS and colchicine to induce mutation/ploidy.

At CHES, Bhubaneswar, six varieties of sapota were evaluated for yield attributing characters. The highest fruit weight (82.8g) , fruit length (7.46cm) and fruit circumference (16.25cm) was recorded in cricket ball. Highest TSS (31.13^0B) and lowest acidity (0.2%) was recorded with cv. Bhuripatti.

Guava

Eleven hybrid progenies from the combination Kamsari x Purple Local selected for good fruit quality and soft seeds were field planted along with Arka Mridula and Allahabad Safeda. One hybrid Arka Kiran from the combination Kamsari x Purple Local was identified for commercialization at the Institute level. It produces medium sized fruits (180-200 g), has soft seeds (9.0 kg cm^{-2}), deep pink coloured pulp, high TSS (12°Brix) and lycopene content (7.45 mg 100 g^{-1}). A total of 7800 hybrid progenies have been raised from the combination involving the varieties Arka Mridula, Allahabad Safeda, Purple Local, Sardar, Triploid, Apple Colour, Thailand and Kamsari and are being evaluated.

Strawberry

Genotypes were evaluated for phenological, reproductive stages like, days taken for flower bud appearance, flower opening, anther dehiscence, petal fall, fruit set and harvesting. Flowering was observed 45 to 60 days after planting and fruits came to harvest 25 to 36 days from fruit set depending on the varieties. Studies on pollen viability of selected genotypes at various floral developmental stages were also conducted during this period. A total of 128 flower buds were cross pollinated and the resulting hybrid seeds were collected and kept for stratification. The genotypes that came to bearing were evaluated for various physical and biochemical fruit characters. Fruit size was maximum with cv. Winter Dawn (ranging from 18 to 21 g) and TSS was highest in cv. Sweet Charlie, total acidity ranged from 0.8 to 1.2 per cent depending on the varieties.

Tomato

A total of thirty-seven F_1 hybrids including four commercial checks were evaluated for yield and fruit quality attributes. Three hybrids viz. Hybrid-162, Hybrid-240 and Hybrid-241 had consistent performance over three seasons. Hybrid-240 (89 t/ha) recorded the highest mean yield followed by Hybrid-241 (72t/ha) and Hybrid-162 (57 t/ha). Highest average fruit weight was recorded by Hybrid-162 (134 g) followed by Hybrid-240 (130 g) and Hybrid-241 (106 g). All the three hybrids had firm fruits (6kg/cm^2). H-162 and H-169 recorded higher fruit firmness of 7.140 kg/cm^2 and 6.050 kg/ cm^2 (at ripe stage), respectively, compared to Arka Ananya with firmness of 4.190 kg/ cm^2 and commercial hybrid Abhinava which had a firmness of 6.20 kg/cm^2. Hybrid-240 and Hybrid-241 surpassed the yield of commercial checks Shakthiman (59 t/ha) by 52.5 % and 22% respectively.

Hybrid 240

Brinjal

Ten individual plants with Manjarigota fruit type selected from cross, IIHR438 x IIHR-571 are evaluated for yield and quality. Four individual plants (cross involving non-spiny parent) viz;IIHR438 x IIHR-571-3-8-2-4-5 (2.80kg/plant), IIHR438 x IIHR-571-3-8-2-11-3 (2.50kg/plant), IIHR438 x IIHR-571-3-8-2-20-9 (2.40kg/plant) and IHR438 x IIHR-571-8-2-9-7-1 (2.20kg/plant) were found superior. In another set of 15 individual plants (IPS) derived from cross, IIHR228 x IIHR-571, three individual plants (cross involving spiny parent) viz. IIHR 228 x IIHR-571 -6-4-1-9-5 (2.60kg/plant), IIHR 228 x IIHR-571-6-4-1-5-12, (2.35kg/plant) and IIHR 228 x IIHR-571-3-12-1-10-3 (2.15kg/plant) were found superior.

At CHES, Bhubaneswar, 13 brinjal accessions were evaluated. Maximum number of fruits / plant was recorded in

F3 segregant of AB/ 60 x shyamali (407) followed by CHBL 64 (389) and CHBL 15 (300). Maximum yield/plot was recorded in CHBL 15 (28.36 kg) followed by CHBL 64 (26-30 kg) and CHBL 60 x shyamali (24.82 kg).

Okra

Nine F_1 hybrids including commercial check US-7109, Mahyco-10, Sarika and Shakti were evaluated during *Kharif*. Among them hybrid, OH-8 gave the highest fruit yield of 22.48 t/ha, while the check US 7109 recorded 18.81 tons/ha. OH-8 had medium fruit length (13.16 cm), fruit diameter (1.87 cm) and more fruits per plant (24.66). Among the advanced breeding lines evaluated, Selection-1 (ridgeless) round-fruited type was found to be the highest fruit yielder (23.09 t/ ha) followed by Arka Anamika (18.88 t/ha). Selection -1 had lush green, smooth, medium length fruits (10.90 cm) which are ridgeless, tender, and attractive with very good cooking and keeping qualities.

Selection –1

Chilli

Chilli F_1 hybrid Arka Harita has been released for Southern Karnataka zone. It is a CMS based high yielding F_1 hybrid for dual purpose, fresh and dry, suitable for *Kharif* and *Rabi* cultivation. The other salient characters of the hybrid are, fruit length- 8cm, diameter- 0.8 to1cm, smooth and highly pungent green fruits which turn red on maturity, tolerant to powdery mildew and chilli veinal mottle potyvirus, yields 35-38t/ ha (fresh) and 5-5.5t/ha (dry) in 180 days.

Arka Harita

MSH 206

Another CMS based high yielding, green chilli F_1 hybrid - MSH 206 suitable for *Kharif* and *Rabi* seasons has also been developed. It has a fruit length of 12cm, diameter- 1cm, smooth and medium pungent light green fruits which turn red on maturity, tolerant to chilli veinal mottle virus, yields 40-45t/ ha (fresh) & 5-5.5t/ha (dry) in 180 days.

At CHES, Bhubaneswar, among 17 elite accessions evaluated, highest green chilli yield / plant was recorded in CHCL263 (545g) followed by CHCL 219 (494.43g). Highest number of fruits/plant was recorded in CHCL 219 (340.5) followed by CHCL115 (219).

Onion

Two onion varieties namely Arka Ujjwal, a multiplier onion and Arka Swadista, a white onion for fermented preservation were identified for release at the Institute level. Arka Ujjwal has uniform bright dark red bulb color, compound bulb with flat shape, bulb size 4-5cm, number of bulblets/bulb 3-5, bulb weight 40-45g, TSS 16-18%, dry matter content 14-16% and bulb yield 20-25t/ha in 85 days. Arka Swadista variety has uniform white colour, bulbs are oval globe in shape, TSS 18-20%, dry matter content 15-18%, edible bulb 98%, weight 35-40g, small in size (3-3.5 cm) suitable for bottle preservation. It gives bulb yield 16-18t/ha in 105 days.

Arka Swadista

Arka Ujjwal

Two advanced Rose onion lines namely Rose-66 and Rose-67 and two yellow onion lines Yl-30 and YL-40 were selected with desired export qualities, bulb yield and related traits. Two advanced lines in each suitable for dehydration (WPL-56 and WPL-58) and paste (WPL-61 and WPL-64) were found superior for high bulb yield and related quality traits under field condition.

Cauliflower

Three advanced breeding lines viz., IIHR-316-1 (371g, 18.6 t/ha), IIHR-391-1(360g, 18.0 t/ha) and IIHR-371-1 (346g, 17.3 t/ha) were superior to the check variety, Pusa Meghana (294 g, 14.7 t/ha) and hybrid, NS-60 (321g, 16.1 t/ha) during *Kharif*. Out of 103 Individual plant progenies (IP's) evaluated, one IP of F_4 generation of IIHR-397, three IP's of F_5 generation of IIHR-264x IIHR-318 and IIHR-231 x IIHR-73, six IP's of F_6 generation of IIHR-341 have been advanced for further testing. In another set of the 586 IP's evaluated, 57 best IP's of the six breeding lines (IIHR-316-1, IIHR-73-56, IIHR-371-1, IIHR-379, IIHR-385 and IIHR-391-1) were advanced. Thirty nine superior IP's selected from the germplasm lines were advanced for inbred development. Sixty five male sterile F_1's (developed using three ogura ms back ground germplasm, namely IIHR- 405, IIHR-407 & IIHR-408) were back crossed with respective male parents to produce seeds of bc_1 generation. Twenty male sterile back cross populations belonging to bc_1, bc_2, bc_3, bc_4 generations (tournafortii ms back ground of IIHR-361) were back crossed with respective male parents for further evaluation. F_1 hybrid seeds of 16 different cross combinations using four male sterile lines (tournafortii ms back ground) namely, IIHR-73-24, IIHR-345, IIHR-375, IIHR-316-30 and 5 pollen parents namely, IIHR-260-1, IIHR-266-1-14, IIHR-345, IIHR-371, IIHR-391 were collected during *Rabi* season for further evaluation.

Carrot

High yielding carrot variety, Arka Suraj with high lycopene content has been recommended for release in Southern Karnataka. Two male sterile lines namely MSA-238 along with maintainer lines MSB-236 and male sterile lines MSA-284 and MSA-288 along with maintainer lines MSA-284 showed stable petalloid male sterility and maintainer lines were found fertile. Two male fertile C lines MF3 and MF 273 were found to give higher root yield with good qualities.

Watermelon

Watermelon variety, Arka Muthu (IIHR-81-1-3-4-6) has been identified for release at Institute level for high yield and good quality. It is an individual plant selection from Attur local collection. It has unique characters such as dwarf vine (vine length, 1.2m), shorter internodal length and early maturity (75-80 days) when compared to other commercial varieties (95-100 days). It produces round to oval fruits with dark green stripes and deep red flesh. Average fruit weight is 2.5 -3 kg with TSS ranging from 12 to 14 ^{0}B and fruit yield of 85 to 90 t/ha.

Arka Muthu- Watermelon

Among eight promising F_1 hybrids evaluated Hybrid MH-36 gave the highest fruit yield (41.00 t/ha) followed by MH-32 (32.50 t/ha), where as, the commercial check hybrid NS-910 gave 24.03t/ha. Hybrid-36 is early maturing (69 days), fruits are round partially netted, light green stripes on fruit, average fruit weight is 663.3g, TSS- 10.66 ^{0}B , salmon flesh with green border, crispy, good texture and taste. The incidence of downy mildew was 25 %.

French bean

Arka Sharath (IIHR-4) has been identified for release at the Institute level. It has high pod yield potential of 18.5 t/ha in 70 days and good pod quality. It has round, string less,

Arka Sharath

smooth pods suitable for steaming. Pods are crisp, fleshy with no parchment and perfectly round on cross section. Plants are bushy and photo insensitive and suitable for both *Kharif* and *Rabi* seasons. It gives maximum number of pods per plant (44.5) compared to checks.

Dolichos

Two pole type dolichos lines lines namely IIHR 167 (pod yield 19.0 t/ha) and IIHR 34 (18.0 t/ha.) were found to be phtoto-insensitive. Among the advance breeding lines (bush), maximum pod yield was obtained in Sel 1 x Sel 2 - 16-2 BK 3 (22.35 t/ha) as compared to Arka Jay (12.1 t/ha).

Pole dolichos IIHR 116

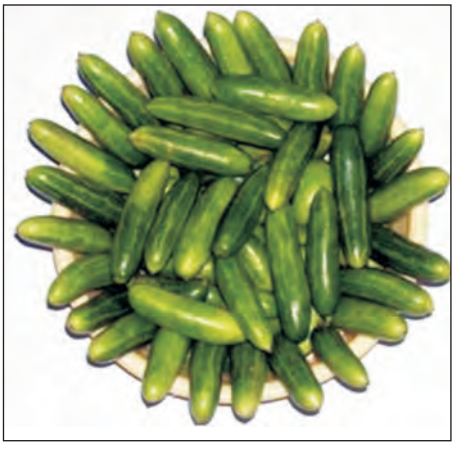
Bush dolichos (Sel 1 x Sel 2) 6-2-8-IPS-1

Amaranth

Twelve Amaranth selections along with 3 check varieties, Arka Suguna, Arka Arunima and Local check were evaluated at IIHR, Bangalore, CHES, Hirehalli and CHES, Bhubaneswar for yield and quality parameters like antioxidant capacity, nitrate and oxalate contents. At IIHR, during summer, maximum plant weight was recorded in IIHR-3-11 (160g) followed by IIHR-3-9 (156.7g) and IIHR-1-21 (156.7g) compared to the check Arka Suguna (81.7g). Maximum antioxidant capacity has been recorded by IIHR-1-24, IIHR-7-4 and IIHR-1-21 (559.5, 557.3 and 549.0 mg DPPH activity/ 100g fresh wt respectively) while minimum nitrate and oxalate contents have been recorded by IIHR-7-4 (41.8 and 1022mg /100 g fresh wt respectively). During *Kharif*, at IIHR Bangalore, IIHR-1-24 (180g) recorded maximum plant weight while maximum antioxidant capacity was recorded by IIHR-1-25 and IIHR-1-21 (425.4 and 419.6 mg DPPH activity/100g fresh wt respectively). Minimum nitrate content of 23.3 mg / 100 g fresh wt. has been recorded by IIHR-1-21, while IIHR-3-11 recorded lowest oxalate content of 1166 mg /100 g fresh wt. At CHES, Hirehalli, IIHR-3-15 (115g) and IIHR-1-21 (113.3g) have recorded maximum plant weight, maximum antioxidant capacity along with minimum nitrate content has been recorded by IIHR-3-9 (596.4 mg DPPH activity and 14.9 mg /100 g fresh wt. respectively). At CHES, Bhubaneswar, IIHR-70-2 (228.1g) has recorded maximum plant weight while IIHR-1-21 recorded maximum antioxidant capacity (315.2 mg DPPH activity/100g fresh wt) and IIHR-1-4 recorded minimum nitrate content of 13 mg /100 g fresh wt.

Ivygourd

At CHES, Bhubaneswar, 18 ivy gourd lines including Indira-5 and Indira-35 as check were evaluated. Highest yield / plant was recorded in CHIG-33 (31.18kg) followed by CHIG-19 (28.33kg) and CHIG-13 (26.43kg) with a grand mean value of 13.93kg. Maximum fruit weight was recorded in CHIG-33 (17.44g) followed by CHIG-9 (15.51g) and CHIG-25 (14.95g). CHIG-15 (Arka Neelachal Kunkhi), a promising genotype for salad purpose has been identified for release at Institute level. It has sequential fruiting habit and fruit develops by means of vegetative parthenocarpy. Hence, there is no need of male plants for pollination and more number of female plants can be accommodated per unit area. A single plant produces an yield of 20 kg fruits in one growing season. CHIG-33 (Arka Neelachal Sabuja), a high value culinary variety of ivy gourd has also been identified for release at Institute level. The variety has dark green fruit which stores well for 2-3 days and can withstand transport shock also. The plants are vigorous, producing high yield of fruits having more pulp and soft seeds.



Arka Neelachal Kunkhi

Arka Neelachal Sabuja

Pointed gourd

CHPG-15 (Arka Neelachal Kirti) a high yielding pointed gourd variety with solid core developed at CHES, Bhubaneswar, has been identified for release at Institute level. The average

fruit weight is 45-50 and one plant produces more than 28 kg fruits in one season of 10-11 months. With better management practices, 50-60 tonnes/ha fruit yield (2500 plants/ha) can be obtained from CHPG-15 under upland conditions.

Spine gourd

CHSG-28 (Arka Neelachal Shree), a very high yielding variety, identified for release at Institute level, has been developed from a large gene pool of spine gourd at CHES, Bhubaneswar. This variety has good appearance, high yield (4-5 kg/plant) and high market preference. The vine of this variety is thin and spreading which grows very well on three line wire trellis system.

Teasel gourd

CHTG-2 (Arka Neelachal Gaurav) is a soft seeded teasel gourd variety with dark green, oval fruits having small spines and has been identified for release at Institute level. The fruit is 6.0 cm long and 3.8cm thick (diameter at centre) with an average fruit weight of 50g. The plant produces 230-250 fruits in a cropping season with sufficient pollination. The variety needs hand pollination for assured yield which varies between 12-15kg per plant per year.

Rose

Seven advanced lines were evaluated in polyhouse for their potential to produce cut flowers. IIHRR 9-1, IIHRR 7-2, IIHRR 7-1, IIHRP 2-28-1, IIHRP 3-18-2 were found to be most promising with long stalk, and attractive flowers. IIHRR 7-1 has big blooms of red color with a bud length- 4.5 cm and very slow opening taking nearly 10 days from bud to fully open stage. IIHRP 204 has long flower stalk (85cm) with elongated pedicel (12cm). Advanced line IIHRR 9-1 was found to be promising with flowers of attractive shade of red color and dark green shining foliage and has commercial potential. It also has long flower stalk (65cm) with an attractive bud (4cm long), fewer thorns (6 thorns/10 cm stem), long vase life (8 days) and produced 105-110 flowers/m^2 /year.

Tuberose

Arka Niranthara (Tuberose Hybrid Selection-1), has been identified for release by the Institute Varietal Identification Committee. It has higher spike yield, earliness and prolonged flowering period. The bulbs of this hybrid have been multiplied for trials at various centres under AICRP (Floriculture).

Arka Niranthara

Gladiolus

Gladiolus hybrid selection Arka Naveen (IIHR G-5) is a pedigree selection of the cross 74-39-1 X Tropic Seas identified by the Institute for release. It is selected for its flower quality. Florets are wavy, purple violet (82.C) having red purple (72.B) margin with yellow green (154.D) blotch, and yield 1-2 marketable spikes/corm. Another gladiolus variety identified for release at institute level is Arka Gold (IIHR G-9). This line was developed by hybridization followed by selection of Greenbay x Gold Medal 412. It is selected for its flower quality. Florets are slightly ruffled are wavy, yellow (4.C) in colour, having yellow (6.C) lower lip with red (39.A) blotch, and yield 1-1.5 marketable spikes/corm.

The third gladiolus variety identified for release by the Institute is Arka Amar (IIHR-10), a pedigree selection of gladiolus hybrid Watermelon Pink X Aarti, selected for its flower quality and Fusarium wilt resistance. Florets are red (46.D) with red (45.B) margin & white (155.B) on tepals with yellow blotch (2.CV). Florets are wavy and arranged in double rows. It yields 1-2 marketable spikes per corm.

Arka Gold

Arka Naveen

Arka Amar

Carnation

Arka Flame (IIHRP-1) was approved by State Level Variety Evaluation Committee and recommended for release in Southern Karnataka under protected cultivation. It is a standard type carnation with single flower borne on straight stalks. It yields 300-360 flowers/m^2 /year with an average stalk length of 65 cm. Flower stalks of are thick and straight and transportation is easy.

Dianthus

Dianthus hybrid Arka Tejas, has been identified by for its commercial potential as an ornamental pot plant. It is an inter specific hybrid between carnation (*D. caryophyllus*) and *D. chinensis*. This hybrid has attractive red coloured single whorl flowers. It has been registered (INGR No. 08102) for its unique ornamental characters. The plants have dark red flowers with contrasting white anthers and lush green foliage back ground which make it an attractive pot plant for landscaping and interior arrangements.

Arka Flame

Arka Tejas

Gerbera

Six advanced lines were evaluated for quality parameters. Maximum stalk length (48.80 cm) and disc diameter (3.27 cm) was found in 99-1, maximum number of flowers/plant/month (4.77) was recorded in 99-5. For the second consecutive year, seven advanced lines were evaluated for quality characters. Line 2004-3 recorded maximum stalk diameter (4.36 mm) and disc diameter (3.50 cm). Maximum stalk length (42.05 cm) and vase life (7.52 days) was recorded in 2004-1, while, maximum flower diameter (9.20 cm) and number of flowers per plant (4.10) were recorded in 2000-1 and 2004-2, respectively. Another 14 advance lines were evaluated for quality characters. Maximum stalk length (41.06 cm) was recorded in 2006-5, stalk diameter (4.36 mm) in 2006-6, flower diameter (9.76 cm) in 2000-1, disc diameter (3.86 cm) in 2006-2, number of flowers per plant (4.32) in 2006-4 and vase life in 2006-7.

Chrysanthemum

Among the 8 hybrids evaluated for seven characters, hybrid-1 recorded greater plant height (86.25 cm). Maximum plant spread (66.22 cm), flower diameter (5.68 cm), flower yield/ plant (704.50 g) and early flowering (104.86 days) was recorded from hybrid-4. Altogether, 102 crosses were made using Arka Pink Star as pollen parent to incorporate early flowering.

Crossandra

Two promising hybrids were proposed for registration viz., IIHR 2005-1 which is a hybrid between Local X Arka Ambara. The plant and flower morphology of this hybrid resembles that of Arka Ambara, however with a change in flower colour. The flower size and yield is superior to Arka Ambara and it has an unique flower colour (Orange Red group 32.A). The hybrid selection IIHR 2005-2 is a hybrid between Crossandra nilotica X Mangalore Local. The size and the yield of the flower are bigger than both the parents.

Specialty flowers

Twenty four accessions of Heliconia were evaluated for various vegetative and floral characteristics. Since, many of them are known by local names, efforts were made to identify the species to which they belong. Wide variation was observed among the varieties with respect to plant habit as well as flowering behaviour. Golden Torch and Lady Di were found to be profusely flowering and had prolonged blooming period.

Coleus forskholii

Eleven promising hybrids along with the check were evaluated for root yield. Out of them 3 hybrids (HY 08-50, 06-8 and 05-10) recorded significantly high dry root yield /plant (80 to 84 g) over the check K-8 (68g). From the hybrid population raised from 8 crosses ten selections based on the root yield were made for further evaluation. Among the selections dry root yield ranged from 63 to 88g. From the OP population from 7 good tuberous selections eight selections are made for further evaluation. The dry root yield among the selections varied from 60 to 82g. Yield trial with 10 selections from OP population showed that the lines 08-OP 9, 08-OP 12 and 08-OP-7 recorded higher dry root yield ranging from 70-82 g compared to the check K8 (68g).

Mucuna sp.

Two elite lines of *Mucuna pruriens* var, utilis were identified for release at Institute level. Arka Dhanvantri has high seed yield and L-dopa content among non-itchy lines. The line produces purple flowers on long inflorescence on the top nodes. No fruiting/ flowering from basal nodes were observed. The plants come to flowering in 90-95 days and mature in 185-190 days. The immature fruits are smooth and

Arka Dhanwantari

Arka Aswini

green in colour, mature pods lack itchy trichomes. The seeds are medium size with shiny black seed coat with 100 seed weight ranging from 90-100 g. It gives a seed yield of 4-5 t/ha and mean L-Dopa content of 4.52%. Arka Aswini is an early flowering and early maturing line of Kewanch. It produces purple flowers on a short raceme, flowering and fruiting starting from the basal nodes. The line comes to flowering in 35-40 days and comes to maturity with in 120-130 days. The immature fruits are smooth and black in colour with dense black trichomes on the pods. Mature pods possess soft and non itchy trichomes. The seeds are bold with mottled black seed coat and 100 seed weight ranges from 155 to 160 g. It gives a seed yield of 1.8 to 2.8 t/ha with an average L-Dopa content of 3.47%.

Segregating populations from different crosses were evaluated for yield and yield attributes. High variability was observed for seed yield, flower color and bearing habit in three F3 populations evaluated. Fifteen individual plant selections from the F3 populations were advanced for further evaluation. Eight F5 progenies were evaluated for seed yield . Two families 2-18-10-2 and 2-18-9-8 recorded high mean seed yield of 423 and 398 g/plant. Selections from F 5 are advanced to next generation.

Ashwagandha

Eleven promising lines in early to medium maturity group and 2 accessions in late maturity group were selected based on superiority to checks JA-20 and WSR. They were evaluated for both dry root yield and active ingredient over three years. Based on three years of evaluation 11 accessions in early to medium maturity group IIHR-WS-3 (18.63g, 0.588%), IIHR-WS-17 (15.57g,0.354%), IIHR-WS-18 (14.33g,0.445%), IIHR-WS-25 (14.23g,0.392%), IIHR-WS-32(14.0g,0.475%, IIHR-WS-33 (30.37g,0.307%), IIHR-WS-48 (12.33g,0.418%), IIHR-WS-107(15.0g,0.341%), IIHR-WS-111(13.5g,0.343%), IIHR-WS-159 (11.9g,0.465%) and IIHR-WS-V-3 (10.0g,0.513%) were found superior to check JA-20 (8.4g,0.308%) for both dry root yield (g/plant) and total withanolide content (%) and 2 accessions IIHR-WS-131(31.3g,0.374%) and IIHR-WS-161(48.5g,0.312%) in late maturity group were found superior to check WSR for total withanolide content and were selected as promising lines

The lines IIHR-WS-33 recorded highest dry root yield (30.37 g) followed by IIHR-WS-3 (18.30g) in early to medium maturity group over JA-20 for both yield and total withanolide content. In late maturity group two selections recorded higher active ingredient over check WSR.

Total withanolide content of 9 F1 hybrids varied from 0.137 to 0.265 % and Hybrid 7 and 14 were found to be promising. F_2 populations from 10 different crosses were assessed for root yield and yield attributes. All the populations recorded ideal root length (30-35cm), 7 populations had desired root thickness, the number of roots varied from 3 to 14 and mean fresh root yield ranged from 22.10g to 60.20g/plant. HY-5 and HY-12 populations recorded higher yield with all desirable root traits. F_2 hybrid populations were screened for epilachna beetle (*Henosepilachna vigintioctopunctata*) hybrid populations (Hybrid- 5, 21 & 15) showed very low incidence.

Kokam

Flowering and fruiting was observed for the first time in grafted and seedling plants which are 5 years old. The seedlings were either erect or semi drooping while the grafts were drooping in habit. The fruit weight ranged from 27.6 to 34.4 g in grafted plants and 22.25 to 32.2 g in seedlings. The fruit colour measured in terms of anthocyanin content varied from 0.471 to 1.186 % in fruits of grafted plants. It varied from 0.350 to 1.740% in fruits of seedling plants. The acidity of fruits varied from 11.58 to 13.80% in fruits of grafted plants while it varied from 14.91 to 20.22% in fruits of seedling plants. Hydroxy Citric Acid (HCA) content determined in 2 samples of fruits varied from 13.58 to 15.10 in fruits of grafted plants and 13.76 to 16.56 in fruits of seedling plants.

Mappia foetida

The entire distribution of the species in Western Ghats was mapped with the help of DIVA GIS software. Germination studies of *M.foetida* seeds showed 90% germination in laboratory condition. Variation in distribution of alkaloids CPT (camptothecin) and 9-methoxy CPT was observed among plant parts. In vitro conservation both at standard culture condition and reduced culture conditions of this species was established. Induction of somatic embryos and multiple shoots have been attained. Genetic diversity analysis with ISSR molecular marker indicated a low level of genetic diversity within the Chikmagalur population. Genetic fidelity assessment of *in vitro* propagated plants showed a low level of soma-clonal variation among the cultures.

3.2.2 Breeding for biotic stress resistance

Mango

Twenty seven mango varieties/hybrids were evaluated against powdery mildew, anthracnose, bacterial canker and red rust. While powdery mildew incidence was lowest in Himsagar (5.15%) , Kesar recorded lowest incidence of anthracnose (4.89%) and Swarna Jehangir was found to have lowest incidence of bacterial canker (1.89%). Red rust incidence was lowest in Arka Neelachal Kesri (2.78%).

Pomegranate

In order to incorporate the bacterial blight resistance/ tolerance of Daru and Nana into Bhagwa hybridization was effected with double hybrids and a back cross hybrids. Occurrence of resistant / tolerant progenies at low frequencies in the crosses involving Daru and Nana with commercial varieties was noted, which could be the role of many recessive genes in controlling the disease resistance. Altogether 245 hybrids of Bhagwa X {(Ganesh) X Nana) X Daru}, 150 of {(Ganesh X Nana) X Daru} X (Ganesh X Nana)} X Bhagwa and 19 bacterial bight resistant hybrids were given to NRC on pomegranate Solapur. In addition, 250 hybrids of other parental combinations were also given to NRC, for further screening and use in breeding work. Field screening of pomegranate hybrids for bacterial blight resistance at Sangola, Maharashtra during March 2010, showed that 3 among 55 hybrids involving cultivated varieties, Daru and Nana had partial resistance to blight.

Guava

Ten guava varieties/hybrids were screened against diseases under field conditions. Lowest incidence of dry rot (3.28%) was in L-49. Styler end rot was lowest (2.54%) in Arka Mridula. Fruit canker incidence was lowest in Safed Jam (2.24%). Lowest incidence of anthracnose (2.02%) was recorded in Allahabad Safeda.

Sapota

Thirteen sapota varieties were screened against diseases under field conditions. While, leaf spot incidence was lowest (3.04%) on Pala, Sooty mold was lowest (1.78%) in Kalipatti. Fruit rot was not observed on any of the sapota varieties.

Passion fruit

Three different accessions (Kaveri, Yellow type and Andaman collection) were collected from different sources and multiplied for planting in the main filed. Over 1500 seeds were extracted from the selfed fruits of cv. Kaveri and were sown immediately. Seed germination started within a fortnight and continued till one month. Field observations on the 3 accessions showed that both Kaveri and Yellow type are susceptible but Andaman Collection was found to be tolerant.

Tomato

Seven advanced (BC1F8) breeding lines with combined resistance to Tomato Leaf Curl Virus (ToLCV) and Bacterial wilt (BW) and tolerance to early blight (EB) were evaluated during two seasons (summer and *Kharif*). All the 7 lines were resistant to ToLCV and BW in both the seasons. During *Kharif*, EB susceptible parent IIHR-2202 (82.8%) recorded the highest PDI, where as the EB resistant parent had 42% PDI under artificial inoculation at seedling stage. Of the 7 lines evaluated, 3 lines viz. TLBER 7-12-15-28, TLBER 7-12-15-29 and TLBER 7-4-11-34 had PDI less than 24%. TLBER 38-7-41-43 (49.3 t/ha) recorded the highest yield followed by TLBER 38-7-4-27 (44.3 t/ha) and TLBER 12-21-43-1 (40.3 t/ha). Nineteen BC1F3 families derived from the cross 15 SB SB x IIHR-2321 (ToLCV resistant parent) were evaluated for ToLCV resistance during summer. Sixty-one ToLCV immune plants were selected for further advancement. Ten advanced breeding lines were validated using Ty-2 and Ty-3 markers linked to ToLCV resistance. Eight plants carrying both Ty-2 and Ty-3 with high yield potential were further advanced. Among 3 hybrids evaluated for processing qualities, Hybrid-241 had high TSS (5.5^{0}Brix) and highest puree yield (49%).

Brinjal

In evaluation for bacterial wilt resistance, three individual plants viz. IIHR-3 x IIHR-108-1-2-46-53-14 (3.15kg /plant), IIHR-3 x IIHR-108-1-2-46-23-14 (2.90kg/palnt) and IIHR-3 x IIHR-108-1-63-4-8-1 (2.65g/plant) and three individual plants of cross between IIHR-7 x IIHR-108-4-4-37-4-6 (2.70kg/plant), IIHR-7x IIHR-108-4-2-37-34-11 (2.50kgs/plant) and IIHR-7 x IIHR-108-1-2-46-5-13 (2.35kg/plant) were found superior for yield with zero per cent bacterial wilt incidence in green long background. In Manjarigota fruit type, four individual plants viz. 2BMG-1 x IIHR438-1-2-46-1-10 (2.50kg/plant), 2BMG-1 x IIHR438-3-2-46-9-11 (2.35kg/plant), 2BMG-1 x IIHR438-1-2-25-4-15 (2.25kg/plant) and 2BMG-1 x IIHR438- 1-2-30-5-2 (2.20kg/plant) were found superior with no wilt incidence. New crosses between Arka Keshav, Arka Nidhi and IIHR-586 were attempted with an aim to incorporate bacterial wilt resistance into purple oblong background and F_1 seeds were obtained.

At CHES, Bhubaneswar, 13 advanced lines along with local check Utkal Madhuri were evaluated against bacterial wilt, little leaf and *Phomopsis* blight (fruit rot). Per cent disease incidence of bacterial wilt varied from 2.74 (CHBL-45) to 19.36 (CHBL-15). Per cent disease incidence of little leaf of brinjal ranged from 0 (CHBL-64, CHBL-47, CHBL-35 and CHBL-53) to 11.45 (CHBL-46). As regards to *Phomopsis* blight, the percent disease incidence was found in the range of 2.46 (CHBL-35) to 31.53 (CHBL-47). These lines were also evaluated against thrips, mite and brinjal fruit and shoot borer. CHB-P-47 (2.72/ leaf) and CHB-15 (3.08/leaf) were having significantly lower thrips population. Mite population was significantly lower on CHB-P-47 (4.83 mite/leaf) and CHB-30 (9.11 mite/leaf).

A total number of 147 genotypes are being screened for gall midge resistance. Fifteen flowers were randomly picked from each genotype at weekly interval. Flowers were dissected in the laboratory for presence of gall midge and per cent infestation was calculated. So far, out of 9 flower pickings only 5 genotypes recorded no infestation. Eight genotypes recorded low gall midge incidence. Main factor contributing to resistance appears to be the small size of the flowers in these genotypes though more than one mechanism is likely. *Solanum macrocarpon*, a wild species did not show any gall midge infestation on the flower or the fruit. In this genotype, the flower and the ovary is large and mechanism appears to

be antibiosis. There was also significant correlation between flower damage and fruit damage indicating retention of affected flowers that will lead to deformed fruits resulting in yield loss.

Okra

Among the advance generations screened against YVMV, interspecific crosses with *A. tetraphyllus*, *A. tuberculatus* and *A. callei* were found to be promising with least PDI . Preliminary data revealed that the resistance of *A. tetraphyllus* and *A. tuberculatus* is recessive in nature, as the F_1 hybrids were found to be susceptible and the resistant plants could be identified in later generations. Out of the progeny of the cross *A . callei* X Red Bhendi, 4 lines viz. 29, 91, 92 and 254 were free from YVMV under field conditions whereas the susceptible check AC-1685 recorded 86 % YVMV incidence. All these selected progeny were advanced for further evaluation.

Onion

Two F_1 hybrids namely PBR 357-145 x PBR128 (PDI 9.56) and PBR347-128 x PBR 140 (PDI 12.75) showed resistance to purple blotch disease. Three lines PBR-257 (PDI for purple blotch 12.45, basal rot 14.0 and white rot 16.54), PBR-272 (PDI for purple blotch 14.25, basal rot 16.80 and white rot 18.60) and PBR-355 (PDI for purple blotch 15.25, basal rot 16.85 and white rot 18.34) showed combined resistance to purple blotch, basal rot and white rot disease.

French Bean

Twenty five F4' s of the cross between IC-525260 and Arka Anoop, Arka Komal, Arka Suvidha and elite germplasm, IC525283 and IC 525284 were evaluated under field conditions for resistance against MYMV. One breeding line of the cross IC 525260 x IC 525283 gave 42 pods /plant and a pod yield of 18.0 t/ha. The pods were round, smooth and string less and the MYMV incidence was very less. Four breeding lines along with 4 popular varieties for tolerance to stem fly were evaluated and the breeding line (IC 525235 X Arka Anoop)-brown seeded, gave pod yield of 17.5 t/ha. with stabilized flower colour, pod shape and plant type but there was no incidence of stem fly during the season.

Cowpea

Two-advance breeding lines of the crosses involving Arka Suman, Arka Samrudhi, and VS 389 were evaluated for yield and rust resistance along with commercial checks. Maximum pod yield was recorded in the line IIHR-16 (b) of the cross (VS 389 X Arka Suman) (pod yield 20.5 t/ha) followed by IIHR-8 (VS-389 x Pusa Komal) with 19 t/ha. Both the breeding lines were resistant to rust.

Peas

Among the advanced breeding lines maximum pod yield was obtained in IIHR 18- IPS 3 (2.8 kg/row of 4 sqm) compared to check varieties Arka Ajit (1.8 kg). These lines were also resistant to powdery mildew and rust.

Water melon

Thirteen inter-specific cross derivatives of (AM x CC) x AM) BC_1 F_2 , 3 advance lines namely A.M X *C.Colocynthis* BC_1 F_2 , IIHR-85-5 X A. Manik BC_1 F_2 and (IIHR-175-2-1 X A.M) F_3 along with two checks Arka Manik (SC) and *C.Colocynthis* (RC) were evaluated for Watermelon Bud Necrosis Virus (WBNV) resistance during *Rabi* summer 2009. The individual plants showing resistance to WBNV were selfed and again backcrossed with recurrent parent Arka Manik to improve the fruit quality and advanced for further evaluation. Among the 48 watermelon germplasm lines screened against gummy stem blight during *Rabi* Summer, IIHR-85 (Citron group) was free from the disease while rest of the germplasm were moderately resistant or susceptible.

Ivy gourd

Seventeen lines of ivy gourd were evaluated for different insect pest incidence at CHES, Bhubaneswar. Leaf miner incidence was severe and the damage of this pest varied from 45.55 to 95.00 % leaf lowest in CHIG-15. Fruit fly infestation was recorded to be very low ranging from 0 to 1% in different accessions. Gall midge infestation varied from 22.61 to 47.34 % vine infestation, the lowest recorded in CHIG-33.

They were also evaluated against important diseases. Per cent disease incidence of anthracnose was lowest on CHIG-13 (2.00) and *Cercospora* leaf spot incidence was lowest in CHIG-13 (2.08%). Downy mildew recorded lowest incidence on CHIG-19 (3.62%) and *Fusarium* wilt incidence was lowest on CHIG-17 (6.25%).

Pointed gourd

Six pointed gourd accessions were evaluated at CHES, Bhubaneswar and maximum number of fruits/plant was recorded in CHPG-15 (249.76) followed by Narendra Parwal-702, Swarna Alaukik and Rajendra Parwal. CHPG-15 out yielded the other varieties. Thirty accessions of pointed gourd were evaluated against insect pests. Mite population varied from 3.72 to 22.23 per leaf. CHPG-8, CHPG-22, HARP-28 and CHPG-754 recorded significantly lower population of mites than others

Rose

Selection IIHR R 13-4-1 remained free from powdery mildew incidence both in polyhouse and in open field. IIHRP-13 and IIHRP-30 recorded minimum incidence of thrips (<20% damage).

3.2.3 Breeding for abiotic stress resistance

Chilli

Three advanced populations of EG 132 X VN2 and one of GCVMV2 X CM334 along with the check variety G4 were evaluated under rain free conditions for moisture stress tolerance in cement tanks. In these lines, the per cent injury varied from 10 to 12.3% compared to the parents (8 to 32.6%).

The promising lines were forwarded for large scale seed multiplication. Promising F_8 populations with combined resistance to CMV, CVMV and thrips in chilli were evaluated for yield, fruit quality, thrips and virus resistance and two promising populations were forwarded for large scale seed multiplication.

Capsicum

Among the bell pepper advanced populations evaluated for heat tolerance, fruit yield/ plant ranged from 1-1.5 kg with an average fruit weight of 150-200g. During the evaluation period the maximum temperature of 36 ^{0}C and minimum temperature of 22 ^{0}C was recorded. Promising individual plant selections of CHT1, CHT3, CHT5, CHT 8, CHT 18, PBC 843, PBC 848 and PBC 1022 were forwarded for large scale seed multiplication.

Heat tolerant capsicum

Onion

Five advanced lines MST 48, MST 52, MST 42, MST 46 and MST 43 showed tolerance to soil moisture stress with the good bulb yield and qualities.

French bean

F_5 population of the crosses between IC 525224 (heat tolerant), IC 525239 and high yielding varieties Arka Komal and Arka Anoop were evaluated during summer 2009 for high temperature tolerance. Pod yield was maximum (13.5t/ ha) in IC 525224 X IC 525239- 05-1-6 with minimum per cent injury to cell membrane (12 %).

Dolichos

Among breeding lines (F6) evaluated during summer, (IIHR 6-1 x Oregon Sugar pod) 2 BK– IPS 23 (3.80 t/ha) and (18 x Oregon sugar pod) IPS 1-1, (2.6 t/ha) were found to be tolerant to high temperature as compared to IIHR 544 check (pod yield 1.6 t/ha).

3.2.4 Biotechnological Approaches in Crop improvement

3.2.4.1 Development of Molecular Markers

Pomegranate

In order to develop molecular markers linked to bacterial blight, genomic DNA was isolated from cultivars Bhagwa, Daru, Ganesh and segregating population (F2) derived from Ganesh x Daru. A total of 906 primers were used to examine parental polymorphism for Bhagwa, [(Ganesh x Nana) x Daru], Ganesh and Daru. Out of which 440 primers amplified for Daru, Ganesh, Bhagwa, and F_1 [(Ganesh x Nana) x Daru]. However, 40 RAPD primers and one ISSR primer showed polymorphism for Ganesh and Daru. DNA from 80 F_2 (Ganesh X Daru) were amplified for selected 40 RAPD and one ISSR marker, to generate a linkage map. Out of 41 markers, 35 were mapped and 6 remained unlinked. Eight linkage groups were formed which varied widely in length, from 3.3 to 39.8 cM. The map covered a total length of 146.3 cM. Maximum numbers of markers 8 were found in the linkage group LG6 and LG2. Bulk Segregant Analysis (BSA) was carried out to identify marker linked to bacterial blight. None of the primer showed polymorphism for the bulks. Further, DNA was isolated from a new set of population (200 F1s) derived from cross between Bhagwa and triple cross (Ganesh x Nana x Daru) parent. Since, microsatellites have not been isolated in pomegranate, cross amplification with Guava and Eucalyptus SSRs (they share common order- Myrtales) were examined, but no polymorphism was observed between the parents for these primers.

Guava

Efforts were made to identify molecular markers for soft seeds and flesh color. The parents (Kamsari and Local Purple) and 513 F1s were used for the study. Genomic DNA was extracted from them and 23 SSR and 500 RAPD primers were used for screening. SSR primers could detect polymorphism among parents but could not identify a marker linked to seed hardness/softness. Later 500 RAPD markers were screened out of which 25 primers belonging to OPQ, OPM, OPH, OPA etc series have been found to give consistent results in bulk of F1s and parents. Optimization of the conventional CTAB protocol was undertaken on account of the poor yield and low quality of DNA from guava leaves. Increasing the concentration of â mercaptoethanol in the extraction buffer by 10 folds (to 2 ml) substantially enhanced the yield and quality of DNA. RAPD and IISR based approaches were tried with a view to develop molecular markers linked to flesh colour in guava. Four guava genotypes, including 2 white-fleshed (Allahabad Safeda, Arka Mridula) and 2 red-fleshed (Purple Local, Kamsari) cultivars were chosen for initial screening. Fifty RAPD primers were used for the preliminary screening, out of which 8 showed amplification specific to either red or white type. Based on the results, 4 primers (OPB5, OPB9, OPC8 and OPH9) were further tested employing DNA from 3 individual plants from each of the 4 genotypes. These

primers gave consistent results as with the previous results. Forty ISSR primers were also employed in the preliminary screening out of which 8 (ISSR UBC- 810, 815, 818, 824, 825, 840, 846 & 853) showed polymorphic bands. The RAPD and ISSR screening will be extended to the hybrids from the cross between Arka Mridula and Purple Local once the seedlings come to bearing.

Papaya

In order to develop molecular marker linked to PRSV, genomic DNA was isolated from *C. papaya* var. Surya and V. cauliflora. Thirty SSR Primers screened for both parents, only 2 primers were polymorphic for V. cauliflora. The genetic diversity between the two genera was studied with help of markers and they were found to be highly diverse. Eleven ISSR primers 807, 810, 814, 815, 817, 834, 836, 841, 844, 856 and 889 were found to produce highly polymorphic and highly reproducible bands. RAPD primers also showed polymorphism, 16 primers of O, D, G, R and S series generated highly polymorphic and reproducible bands.

Betelvine

Three sex linked ISSR primers, IS 10, IS 8, IS 23 were identified from the screening of female and male bulks with selected ISSR primers. Primer IS 10 (14 mer) showed polymorphic bands between male and female bulk DNA showed very clear sex specific expression. The primer produces specific band in males and its expression is absent in females. Primer IS 8 (14 mer) produced band which is male specific. The band falls between 800-900 base pairs. Primer IS 23 (14 mer) produced a female specific band of 400-500 bp. Thee primers which showed sex specific expression were validated in 65 germplasm lines.

3.2.4.2 Gene cloning, regeneration systems and transgenic development

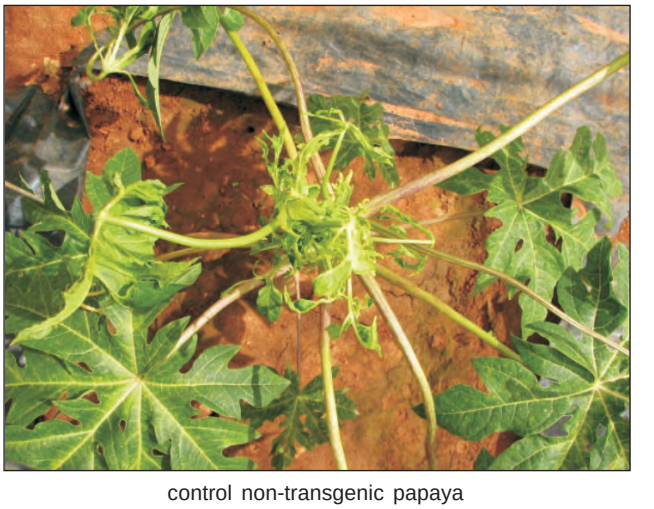
Pomegranate

Transgenic for bacterial wilt resistance was attempted through Agrobacterium mediated development using AMP gene. AMP protein cloned from onion seeds were expressed in prokaryotic expression system. The sequence coding for mature peptides were amplified using suitable primers and expressed in pMAL-c4X vector with maltose binding protein (MBP) fusion tag and transformed to TB1 *E.coli* cells. The protein expressed was extracted and MBP fused protein was purified by amylase resin and eluted with maltose. Molecular weight of the protein was approximately 11 KD. Purified proteins were eluted and tested for antimicrobial activity against *Xanthomonas auxinopodis* p.v purnicea. Inhibition of *Xanthomonas* by purified AMP was not seen in vitro diffusion tests. The reasons for this negative response of the purified protein are being looked into as the crude protein tested showed inhibition of the organism in broth culture. Standardisation of regeneration and transformation of pomegranate cv. Bhagwa was attempted using different explants (leaf, axillary buds, cotyledons and hypocotyledons). Shoot regeneration could be observed in 20% of leaf explants from 40 % of callusing observed. Up to 25% regeneration was obtained using axillary bud as explants. However rooting and shoot elongation was very slow. Hypocotyl and cotyledonary explants regenerated faster and gave rise to complete plants within 3 months. Transformation of cotyledons and hypocotyls with AMP gene through Agrobacterium mediated transformation was successful and 3 rooted putative transformants were obtained. Different hormonal combinations were tested for achieving elongation and proliferation of the transformants which was very slow.

Papaya

Transgenic resistant to PRSV was attempted with encouraging results. Forty seedlings from a T1 plant which had yellow flesh were raised in a seedling tray and at one month of age they were challenged with viruliferous aphids. Observation was taken one month after the challenge, 24 seedlings showed complete resistance while 40 control plants were all susceptible. The resistant plants were transplanted to net house along with 10 unchallenged controls. All plants were challenged 3 months after transplanting. One month after the challenge, all the plants which were resistant in seedling stage continued to be resistant. 6-8 months after transplanting flower initiation and the first symptoms of PRSV were observed. Both were

T2 plant of 6 month old papaya transgenic



control non-transgenic papaya

challenged after transplanting at 3 months of age while the transgenic plant was also challenged at seedling stage one month after germination.

Tomato

Two homozygous stabilized lines of transgenic tomato resistant to early blight, cv Arka Vikas with *Trichoderma harzianum* chitinase gene in T2 generation identified previously were confirmed once gain through PCR analysis in T3 generation as evidenced by absence of segregation of the chitinase gene by PCR. Two randomly chosen homozygous lines and one hemizygous line along with control revealed that the chitinase gene expression in plants of two homozygous lines was 2.5-4.0X higher than that of hemizygous lines. Screening of T3 seedlings of the two transgenic lines (N3-5 and N8-4) along with control Arka Vikas and Pusa Ruby against *Alternaria solani* revealed that one of the transgenic line N3-5 expressed 60% tolerance while the control and Pusa Ruby plants succumbed completely.

Enhanced tolerance to *Alternaria solani* by T3 transgenic tomato cv Arka Vikas in comparison to control tomato.

Four Arka Meghali lines and one each of Arka Vikas, Arka Saurabh and Pusa Ruby were raised along with non-transgenic controls. One line of Arka Meghali was highly resistant to PBNV upon challenge inoculation. It was also field-resistant to *Alternaria* during July-August under heavy rainfall conditions.

Combined resistance to PBNV & TLCV: T3 tomato Arka Saurabh event 130-13, T3 Arka Meghali events 227-14 & 231-12, T3 Arka Vikas event 225-7-5 and T3 Pusa Ruby event 138-4 were found promising. DNA was isolated from these plants and were molecularly characterized. T2-Generation tomato plants (transformed with a transcription factor dreb1A under the control of a desiccation inducible promoter rd29A, both from *Arabidopsis thaliana*) from four selected T1 lines were grown under uniform and randomised conditions for developing tomato transgenic for water stress resistance. Stress was imposed by withholding the watering for 7 days. Untransformed Arka Vikas and PKM-1 were used as controls for stress tolerance comparisons. Molecular analysis was performed for analysing the segregation of the transgene in the T2 progeny, four promoter and gene specific primer pairs were designed and tested for suitability for reliable PCR screening. Of these one primer pair amplifying a 525 bp fragment of promoter and gene was used for segregation analysis and a ratio of slightly less than 3:1 was obtained. A novel gene likely to confer drought tolerance was cloned from a drought tolerant land race of sorghum M-35-1 and sequenced, it had differed with the gene bank sorghum Dreb2 sequence by four amino acids. The full-length gene was sequenced and cloned in to a binary vector pBI121 and used for Agrobacterium mediated transformation of tomato plants for testing the efficacy of the gene in conferring drought tolerance. The sequence was deposited in the NCBI gene bank.

Brinjal

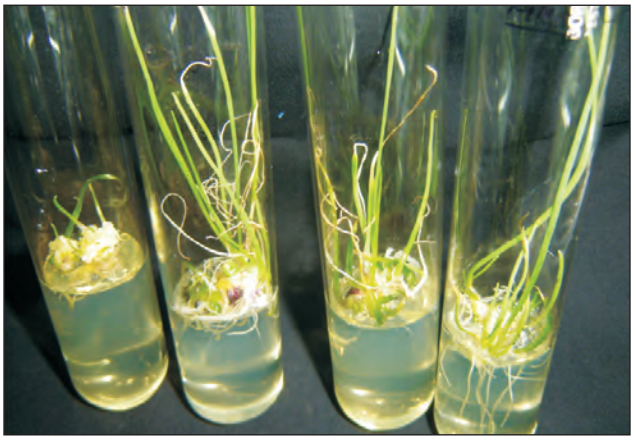
To develop Bt transgenic brinjal for resistance to the brinjal shoot and fruit borer, *Leucinodes orbonalis* in Arka Keshav variety, T_0 to T_2 stages of Cry2A Bt transgenic brinjal lines were generated and analyzed. Molecular analysis including PCR (using nptII and Bt gene specific primers), qualitative Bt protein expression analysis using lateral flow immunodiagnostic Bt strips (Xpresstrips, Desigen) and insect bioassays were carried out. T_1 and T_2 seeds were collected by selfing from the selected positive lines. Data on individual plant/line wise performance regarding Bt protein expression and resistance reaction towards challenge inoculation with first instar neonate larvae of the brinjal shoot and fruit borer, *L. orbonalis*, were generated for advancing the lines. In the continuing generation of additional T_0 lines by transformation, the Bt gene, Cry2A, obtained from NRCPB through a technical collaboration, earlier, which had been mobilized into Agrobacterium tumefaciens EHA105 host strain, was used for transformation. Basal MS media with various supplementations (hormonal, chemical and antibiotic combinations) were used, for preconditioning, cocultivation, shooting induction, shoot elongation and rooting induction.

In another approach, pBinBt-CRY2A gene construct in Agrobacterium was used for transformation. T_0 plants were tested for the presence and expression of the Bt gene using PCR and qualitative Dot ELISA using Bt Xpresstrips. Subsequently T_1 plants were also obtained by selfing the selected T_0 plants. Both T_1 and T_2 plants were also evaluated with PCR and qualitative dot ELISA. *Leucinodes orbonalis* cultures were field collected and subsequently maintained and multiplied both *ex vitro* and *in vitro*. Under *ex vitro* conditions, bored fruits were used for the collection of pupae and adult moth emergence in the transgenic greenhouse conditions through the multiplication of inoculum. The cultures were used to challenge the T_0 to T_2 lines for screening and identification of resistant plants. Presently, the lines are being tested using Southern.

Onion

To develop a transgenic, resistant to purple blotch, Agrobacterium mediated transformation of onion embryos was attempted using the *Trichoderma harzianum* chitinase (Th-chi) gene constructs under the expression of 35S promoter in a) binary plasmid pCAMBIA 1301 with hygromycin (HPT) and b) pBIN with kanamycin/ geneticin(NPT) selection (developed at IIHR). In addition

transformation with Th-chi gene constructs under the expression of ubiquitin promoter with hptII (pBSJ1) and pptII (phosphinothricin) pBSJ2 selection (received from Madurai Kamaraj University) has been initiated. Phosphinothricin sensitivity assay for embryos is being carried out to identify the right concentration to be used for transformation work. In addition, transgenic tobacco plants with Th-chi gene construct under the expression of 35 S promoter have been generated for validation of the transgene against the pathogen of interest i.e., *Alternaria porri*. The problem of rooting and hardening of onion transformants was addressed by standardizing the process in the untransformed regenerated plants. Extensive transformation of embryos with Th-chi gene construct under the expression of 35 S promoter with nptII and hptII selection was carried out. Based on information generated previously, geneticin was used as a selectable antibiotic for nptII marker instead of kanamycin. A total of 2370 embryo pieces were used for transformation and put for geneticin selection. An average of 15.6 to 22.4 % embryos from different batches gave rise to embryogenic callus clumps with an average proliferation score of 1.3 to 1.7. Some of these embryogenic callus clumps (3.4 to 27.1 %) have germinated on transfer to shoot induction medium. Many of these regenerating shoots have been shifted to aerated culture vessels and have given rise to 25 rooted plants



Regeneration of onion transformants in geneticin selection medium

3.3 Crop production

3.3.1 Canopy Architecture and Management

Mango

In a field trial involving planting densities of 1111 (3m x 3m), 400 (5m x 5m) and 178 (7.5m x 7.5m) 'Alphonso' trees / ha on 'Vellaikulamban' and 'Olour' rootstocks with or without the application of paclobutrazol, vegetative growth parameters such as tree height, tree spread, trunk girth, shoot length and internodal length were lower for paclobutrazol applied trees. Foliage area index was lower and diffuse radiation penetration to ground level was higher for wider spacing compared to closer spacing, on Vellaikulamban rootstock than on Olour rootstock and for paclobutrazol treatments compared to no paclobutrazol application. Leaves of shoots emerged during the current season had higher photosynthetic and instantaneous water use efficiency than the leaves from older shoots in the canopy, at all the photo synthetically active radiation (PAR) levels of 1400-1600 μ E m^{-2} s^{-1} in the fully exposed periphery, 500-600 μ E m^{-2} s^{-1} below the peripheral leaf layer and 90-100 μ E m^{-2} s^{-1} lower in the canopy receiving diffused PAR. The leaves in the interior of the canopy that are completely shaded, receiving PAR of 40 -50 and10-15 μ E m^{-2} s^{-1} did not contribute to net photosynthesis. Flowering was more on trees that received paclobutrazol treatments and for trees on Vellaikulamban rootstock than on Olour rootstock. The highest fruit yield of 6.74 t / ha during the tenth orchard year was obtained with 3m X 3m spacing using Olour rootstock and lower rate of paclobutrazol compared control at 10m X 10m spacing (100 trees / ha) on random Totapuri rootstock without paclobutrazol yielding only 1.4 t / ha. The treatment combinations did not affect fruit quality. Fruit samples from all the treatments were free of any paclobutrazol residues though soil samples collected at harvest showed residues in the range of 0.018 – 0.129 mg / kg for the lower rate and in the range of 0.238 – 0.650 mg / kg for the higher rate of paclobutrazol application.

Exploitation of stock-scion interactions is one of the means of canopy management. In one such study, plant height and trunk girth at stock, graft union and scion base were recorded on 3 year old Totapuri grafted on 8 different rootstocks. Maximum plant height was recorded with Totapuri and least with Vellaikulamban rootstocks. Maximum stock girth was with Nekkare and Olour rootstocks and least with Turpentine rootstock. Maximum scion girth was on Totapuri and minimum on Turpentine rootstocks. Fruit yield was negligible, however, no differences in fruit quality attributes such as fruit size, TSS and acidity were observed.

At CHES, Bhubaneswar, allowing four primary with 3 secondary branches in cv. Gulabkhas recorded the highest TCA above (79.93m^2) and below (126.74cm^2) the graft union. Plants without branch management (control) recorded the highest canopy area (7.00m^2) followed by the plants with four primary and three secondary. Cross sectional area of primary and secondary branches in different treatment revealed that the highest values were with four primary and three secondary (22.17cm^2 and 6.36cm^2 respectively) followed by three primary and three secondary (21.82cm^2 and 6.14cm^2), respectively. .

Grapes

Thinning of berries in seedless grapes is largely achieved by use of Gibberellic acid. However, to get a good shape for the bunch, trimming of main rachis is done in almost all the seedless cultivars. But exact portion of distal end of bunch to be removed varies from cultivar to cultivar with varying degree of response. In cultivar Flame Seedless if the bunch is not trimmed at varaison stage, the bunch will not only loose shape but also will have water berries with poor colour and quality berries in the lower portion of bunch. Hence, to know the exact level at which to pinch an exploratory trial

was initiated with 25% and 50% removal of distal end of the rachis post varaison. The results presented in Table 5.3.1 indicated that berry weight and other fruit quality parameters were significantly influenced by the treatments. Test berry weight was highest in bunches with 25% of its distal portion trimmed. Berry colour was the best in the treatment T2 i.e., 50% trimming (b- value: 2.31) followed by 25% trimming (b-value: 2.96). In control the colour development was poor.

Coloured grapes respond to varying sun light regimes and source regulation differently depending on variety as well as season of ripening. In order to achieve variable light regimes in the gable area, the growing shoot bearing bunches were halted with varying leaves from 5-13 beyond bunch. The results showed significant differences for fruit quality among the treatments. Highest test berry weight was recorded in the treatments which had longer shoot with more leaves (T4, T5 and T6) compared to shoots with less number of leaves suggesting that cultivar Flame Seedless required more leaf area compared to cultivars like Thompson Seedless for good bunch and berry development. Even though the above treatments could not influence individual berry development, bunch development in open gable area i.e., shoots with more light interception due to severe halting had higher TSS. Halting the shoots to 7 leaves (T2) proved better with deeper colour than those shoots with more leaves. All bunches on shoots which were not halted had poor coloured berries.

Effect of bunch trimming on quality of Flame Seedless grapes

Treatment	Bunch weight/vine (Kg)	Mean bunch wt. (g)	50 berries wt.(g)	Berry length (mm)	Berry diameter (mm)	Berry colour			TSS (^{o}B)	Acidity (%)
						(a)	(b)	(c)		
T1	25.6	573	280	19.8	17.8	5.13	2.96	26.88	19.4	0.42
T2	24.0	476	282	19.0	18.5	5.26	2.31	26.9	18.3	0.41
T3	32.0	602	226	16.8	15.8	3.76	5.42	29.39	16.4	0.46
C.D (%)	NS	NS	46.64*	2.33	2.39	NS	NS	NS	1.85**	NS
C.V (%)	33.11	39.74	15.35	5.78	5.78	20.00	20.04	3.49	2.73	5.49
S.E M ±	5.14	126.32	18.91	0.61	0.61	0.54	0.41	0.56	0.28	0.013

T1: 25% removal, T2: 50% removal, T3: Control (No trimming)

Effect of shoot halting and leaf regulation on quality of Flame Seedless grapes

Treatment	Bunch weight/vine (Kg)	Mean bunch wt. (g)	50 berries wt.(g)	Berry length (mm)	Berry diameter (mm)	Berry colour			TSS (^{o}B)	Acidity (%)
						(a)	(b)	(c)		
T1	11.2	375	179	18.5	18.0	8.0	3.5	34.2	20.6	0.44
T2	12.7	400	168	17.9	17.2	7.1	2.7	24.7	22.0	0.44
T3	12.7	600	174	17.4	16.6	7.4	4.0	27.3	19.0	0.40
T4	14.5	616	200	18.0	17.6	7.0	2.9	24.8	19.7	0.45
T5	16.0	600	200	17.6	17.2	5.5	6.1	35.8	19.6	0.47
T6	17.2	612	202	18.2	17.2	5.8	6.2	32.6	19.2	0.47
C.D (%)	4.40*	221.2*	21.8*	NS	NS	NS	1.95*	NS	1.98*	0.03**
C.V (%)	18.88	33.46	13.62	6.19	4.82	14.69	26.71	30.26	5.24	3.08
S.E M ±	1.35	94.72	14.33	0.64	0.48	0.59	0.59	5.14	0.60	0.007T1:

Halting to 5 leaves, T2: Halting to 7 leaves, T3: Halting to 9 leaves, T4: Halting to 11 leaves, T5: Halting to 13 leaves, T6: Control (No halting)

Guava

Trials conducted at CHES, Bhubaneswar indicated that the pruning time to guava trees planted at various spacing (S_1 : 5x5m, S_2 : 5 x 2.5, S_3 : 4 x 2m; S_4 : 3 x 1.5m, S_5 : 2.5 x 1.25m, S_6 : 2 x 1m) showed positive impact on vegetative growth of plants, biomass production, sprouting and flowering duration, fruiting and fruit yield. The maximum TCA, canopy Area, circumference of primary and secondary branches was recorded in control plot where no primary was done. Among the pruning treatments 15th May pruning (P_1) took minimum days for sprouting (13.25-16.75), for flowering from pruning (51.5-26.5) for fruit setting from flowering (16.75-22.0) and for fruit setting from pruning (72.25-76.50). However, fruits of only 15th May pruning were harvested till November. The highest yield (5.76 t/ha) was recorded with closer planting at 2.5 x 1.25m accommodating 3200 plants / ha.

3.3.2 Extending the harvest period

Mango

Paclobutrazol application affected days for maturity of fruit from flowering. Paclobutrazol @ 2.5 g a.i/ plant applied as soil drench during August last week advanced harvesting by 25.7 days compared to control in Totapuri. However, paclobutrazol application did not affect number of days taken for 50% flowering, fruit yield and quality parameters. Flowering percentage was influenced by paclobutrazol application and the most pronounced effect was with 5g a.i applied during last week of October, which recorded a flowering percentage of 93.3 where as control recorded only 35% flowering in Totapuri mango. Pruning previous season's fruited shoots 10 cm below panicle and foliar application of GA_3 100 ppm followed by paclobutrazol application during April affected the flowering percentage, average fruit weight and TSS. All the treatments increased the flowering percentage (70-96%) compared to control which recorded only 20% flowering. Fruit yield was not affected by different treatments, however, average fruit weight and TSS were affected by different treatments. Maximum fruit weight (371.2 g) and least TSS (14.60 ^{0}B) was recorded with the treatment pruning fruited shoots 10 cm below panicle and spraying GA_3 100 ppm three times and application of Cultar 10ml/ tree during April month. Least fruit weight (272.5g) was obtained with treatment pruning back fruited shoots 10cm below panicle and spraying GA_3 100 ppm twice in August and October months and application of Cultar 10ml/tree during April month. The different treatments did not induce any off season flowering in Totapuri mango.

Jasmine

In *Jasminum sambac* var. Single mogra, the effect of nutrient application in split doses on the off-season (winter) flowering was studied in an experiment consisting of five treatments. Application of 10 kg FYM + 120:240:240 g NPK per plant in 4 equal splits during critical periods during February, May, September and December recorded the minimum days required for bud initiation from pruning (16.50) and maximum number of flowers per plants (186.46), yield per plant (39.17g i.e., 174.07 kg/ha), and hundred bud weight (20.98 g) during November to February. T1 (control) recorded the lowest flower weight per plant (26.89 g per plant ~ 119.49 kg/ha). The flower quality in terms of bud length, pedicel length and flower size were recorded at monthly intervals during winter months. The mean bud length (1.11 cm) and pedicel length (1.26 cm) were maximum with application of 10 kg FYM + 120:240:240 g NPK per plant in 3 equal splits during January, May, and September. The maximum mean flower size (2.27 cm) was recorded in the treatment receiving 10 kg FYM + 120:240:240 g NPK per plant in 4 equal splits during critical periods in February, May, September and December.

3.3.3 Investigations on physiology of fruit disorders

Mango

Spongy tissue in Alphonso mango has been traced to the shift of seed in to germination mode and the consequent drain of moisture and other resources from the adjoining mesocarp based on a number of physiological and biochemical attributes. Further the following points emerged from these studies:

- Induction of dormancy in to seed *viv-a-vis* slowing the metabolic activity of seed has resulted in a significant reduction in spongy tissue incidence.
- Absence of spongy tissue was also found to be closely associated with loss of embryo viability.
- Absence of seed dormancy *vis-a-vis* enhanced seed metabolic activity is strongly associated with spongy tissue incidence.
- Possessing a non-dormant and viable seed is strongly associated with spongy tissue formation
- Radiotracer studies with tritium have confirmed significantly higher mobilization of water from mesocarp to seed vindicating the causative role of seed in spongy tissue formation.

Strategies to prevent spongy tissue formation have therefore been focused on inducing seed dormancy / reducing seed metabolic activity / death of embryonic axis through eco-friendly formulations.

3.3.4 Optimizing water productivity and nutrient management

Mango

The photosynthetic rate and transpiration rate were higher with 60% evaporation replenishment (ER) rate as compared to 50% of evaporation replenishment rate. Likewise, both the photosynthetic rate and transpiration rates increased with increase in evaporation rate and bio fertilizer dose and were highest with 60% evaporation replenishment and 300 g bio fertilizer. The fruit number and yields were higher with 60% ER (81 & 20 kg/plant) as compared to 50% ER (76 & 19.2 kg/plant) although the differences were not significant. The

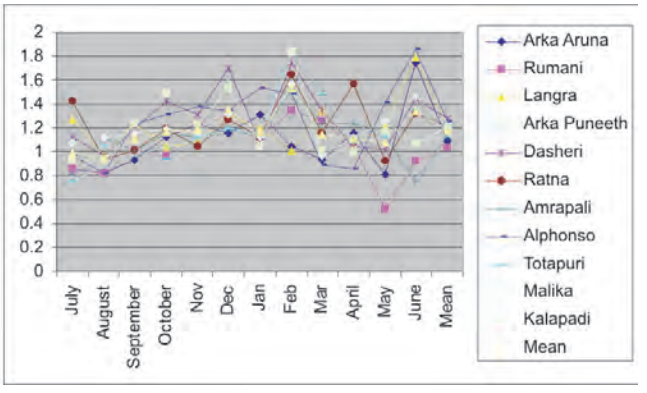
total soluble solids did not show any marked difference with ER. However, the water productivity was higher with 50% ER (18.6 kg/ha-mm). The yield increase in ER or with the application of bio fertilizer was not significant. The yields were highest with 60% of recommended dose of fertilizer and 300 g bio fertilizer application. The photosynthetic rate, stomatal conductance and transpiration rates were higher with Neeleshan followed by Goa mundkurd, Arka Neelkiran, Alphonso, Raspuri and were lowest with Amarpali. All these parameters increased with increase in fertigation levels and were lower with soil application. The fruit number as well as fruit yield per plant was significantly higher with Amarpali followed by Arka Neelkiran, Alphonso and Raspuri. Fertigation with 100% recommended dose of fertilizer recorded higher fruit number and yield as compared to soil application but on par with 75% of recommended dose of fertilizer.

Experiments conducted at CHES, Bhubaneswar revealed that the irrigation levels and mulching with organic waste (grass / paddy straw) and black polythene showed positive effect on Trunk Cross-sectional Area (TCA) below and above the graft union and total canopy area of plants as compared with untreated control in the 4th year of experimentation. Although there is no significant difference among the treatments with regard to TCA above and below the graft union but the irrigation at 25% ER with organic mulch recorded the maximum values (105.4 cm^2 and 157.5 cm^2 respectively) which was found at par with irrigation at 25% ER coupled with black polythene mulching. The canopy area (m^2) was also highest (10.4m^2) with 25% ER and paddy straw mulch. The first crop was harvested in which irrigation at 25%, 50% and 75% ER along with paddy straw mulching produced the maximum fruits in comparison with other mulches.

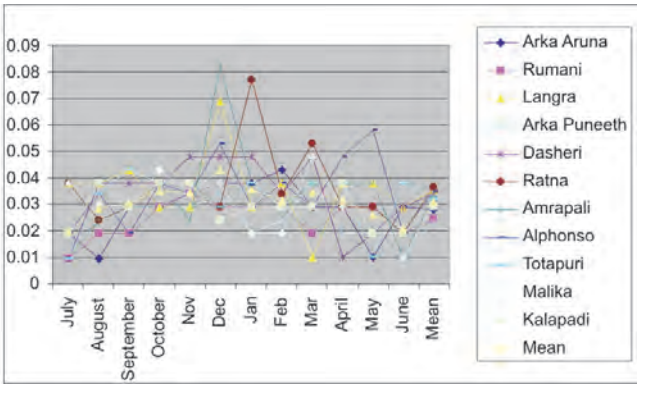
In another trial on rain fed production with 2 varieties, 4 level of *in situ* water harvesting and 3 level of mulching, initial results indicated that cup and saucer system of water harvesting coupled with paddy straw and / or plastic mulch produced the vigorous growth. Nursery raised plants showed the maximum height in trench system with organic mulch, TCA was maximum in half moon terracing with plastic mulch and Canopy area was maximum in cup and saucer system with organic mulch. For in situ raised plants, however the maximum height was recorded in full moon terracing with organic mulch, the maximum TCA was recorded in full moon terracing with plastic mulch and maximum canopy area was found in full moon terracing with organic mulch.

The mango cultivation in Palghat district, Kerala is becoming profitable due to early harvest (by 30 – 45 days than rest of S. India). In a survey to identify micronutrient disorders in this area, the analysis of leaves indicated boron (13 ppm) and zinc (14 ppm) deficiency and excess Mn and Fe. The soils were acidic (pH 5.2), but due to heavy rainfall (>1500 mm), boron is lost by leaching. Hence, widespread boron deficiency in Kerala needs to be addressed by combined soil application in June and foliar spray application in November – December for better crop growth and yield.

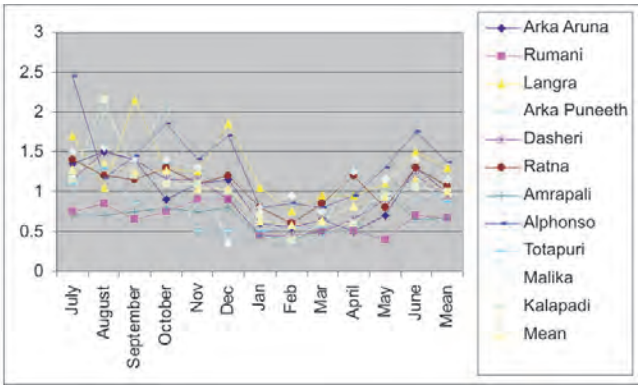
A study was undertaken to understand nutrient dynamics in mango orchard soils. It was found that the nutrient content of leaves and nutrient re-absorption during senescence decides the quantity of nutrients returned to the soil under such perennial crop systems. Dynamics of litter production and decomposition are the processes that replenish the soil nutrient pools, maintain soil life and thus endow sustainability to perennial crop orchards. Nutrient accretion to soil is primarily through litter fall and decomposition and leaf litter also serves as temporary sinks for nutrients. The rates at which litter falls and subsequently decay are thus important in understanding productivity and nutrient budgeting of orchards. Hence temporal nutrient content, nutrient re-absorption, litter fall dynamics in mango were studied. Three peak periods were recorded in nutrient content of mango varieties with one or two months time difference between dwarf and robust canopy varieties. First peak for nitrogen was observed during October to December which coincided with flower initiation. Second peak was observed during February- March coinciding with fruit maturation and the third during June coinciding with monsoon and initiation of fresh flush. In case of phosphorus the peak was observed during December-January and the second in May-June, whereas for potassium the peak was observed in July and gradually declined with time up to May indicating maximum absorption of K during monsoon period and gradual translocation to other plant parts.



Temporal variability in the N content in the leaves of eleven mango varieties

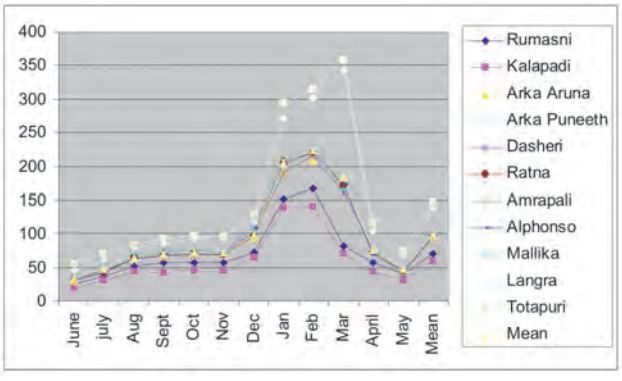


Temporal variability in the P content in the leaves of eleven mango varieties



Temporal variability in the K content in the leaves of eleven mango varieties

Further, litter fall was monitored over two years in 11 mango varieties, 2 dwarf canopy varieties (Rumani and Kalapadi), 7 medium canopy varieties (Arka Aruna, Arka Puneeth, Dasheri, Ratna, Amrapali and Alphonso) and 2 robust canopy varieties(Langra and Totapuri). Litter fall in the eleven varieties ranged from 713 g m^{-2} in Kalapadi to 1778 g m^{-2} in Totapuri over one year. The mean monthly litter fall varied from 59.4 g m^{-2} to 148 g m^{-2} in the same varieties, respectively. The variation in the quantity of litter production among different varieties ought to be due to inherent characteristics of these varieties and the quantity of litter fall varied with the type of canopy of the trees with dwarf varieties yielding least and the robust varieties yielding the highest litter. The months January, February and March generally recorded the peak in litter fall as it contained the flower and aborted young fruits and fruit drops. The peak for late varieties like Totapuri and Langra was in March, and it was February for the other 9 varieties.



Temporal variation in the litter fall in different mango varieties

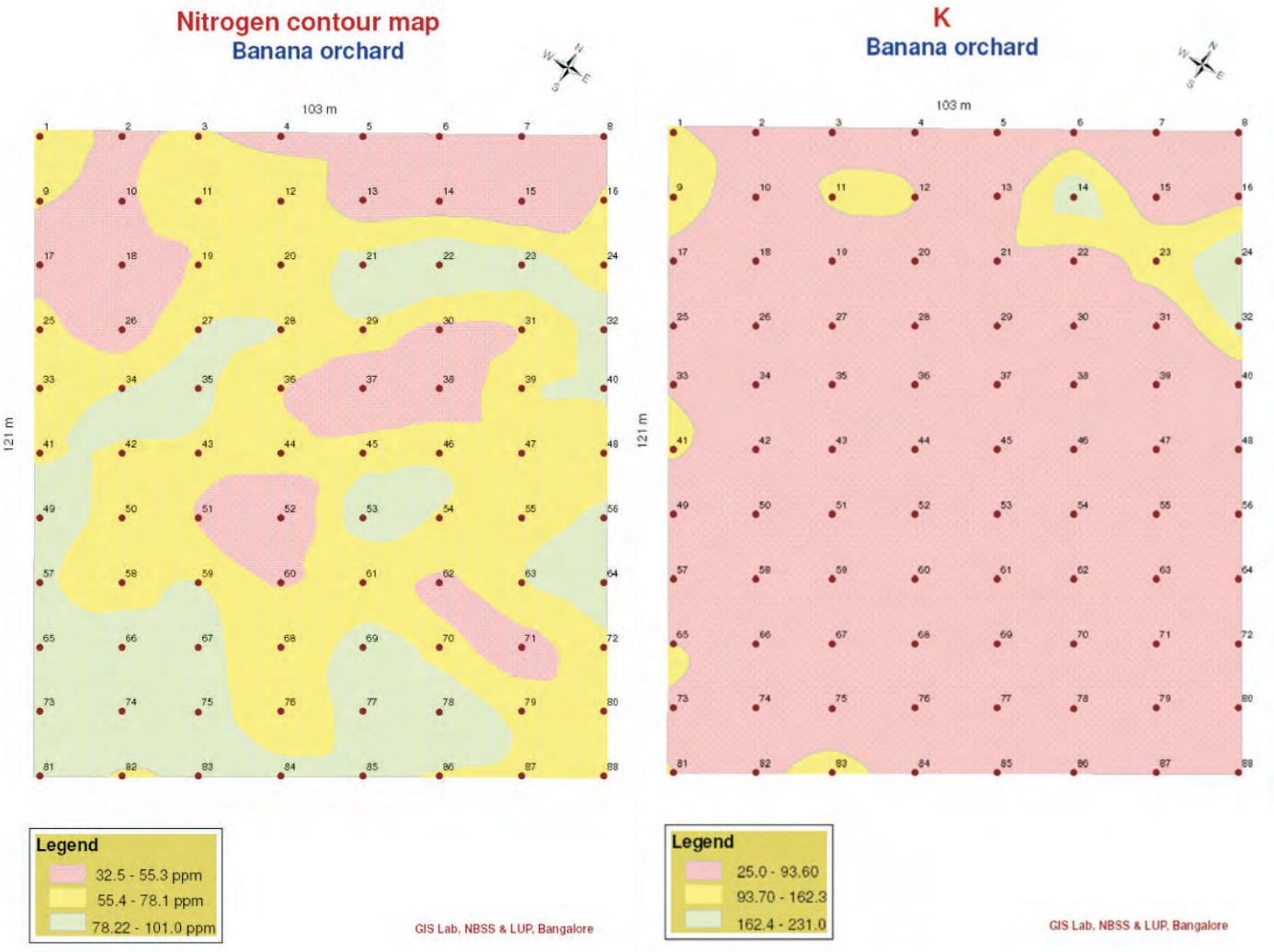
The litter samples of 11 mango varieties were analyzed for their nutrient content. Accretion of nutrients to the soil through litter fall was calculated. N addition through litter ranged from 8.6g m^{-2} in Totapuri to 21g m^{-2} in Mallika. The mean N addition irrespective of varieties was 14g m^{-2}. Similarly the mean K addition was 12g m^{-2}. Nutrient addition through litter did not match with the canopy volume or vigorousness of the tree. Ttotapuri is most robust but added least N and K, whereas Kalapadi a dwarf variety added fairly similar amounts of N and K. This is perhaps because, the trees were fertilized with same level of fertilizers irrespective of canopy volume or vigorousness of the tree.

Banana

The validation of leaf nutrient norms was carried out for cv Robusta in selected cropping enterprises. Initial sampling enabled identification of yield limiting nutrients and which were corrected in 10 treatment combinations to assess the relative build up of K, Zn and other nutrients in leaf and their influence on the magnitude of DRIS indices. Both K and Zn continued to be the yield-limiting nutrients until harvest under farmers practice as no additional K or Zn was applied. With the application of recommended dose of nutrients, the indices for K have improved although there was no substantial change in K concentration in leaf at harvest. In general, K concentration decreased with the advancing age of the plant. With advancing age Mg, Zn and Fe also became yield limiting nutrients whereas indices for K improved form negative to positive indicating adequacy of K application. With application of recommended dose of N and P with 400 g of K and 100 g $ZnSO_4$, the indices for K improved from negative to positive, however there was no substantial change in K concentration in leaf at harvest from initial stage. This indicated that the magnitude of the indices depends on the overall nutrient balance rather than the absolute nutrient concentration. The indices for Zn, which was negative became positive, while the concentration increased from initial 14.1 to 26.2 ppm. However there was an accompanying imbalance of Ca, Mg and Fe. The yield as expected increased with the application of recommended dose of fertilizer and further increase was noticed due to application of higher dose of K along with Zn. The NII was lowest with the correction of both K and Zn indicating that improving the yield limiting nutrient level in banana increased the yield and reduced the over all imbalance.

To work out the precision farming protocols for nutrient management in banana, a farmer's field measuring 120 m and 103 m was intensively sampled on a regular grid spacing. The soil properties indicated wide variation with in the field indicating that the plot is heterogeneous. The pH of the soil varied form 4.58 to 7.2. The EC of the soil were within the safe limit in all the locations. Among the available nutrients, nearly 38 % of samples had available N < 67 ppm and 48% of samples in the range of 67 to 100 ppm. The available P and K showed a wide variation with in the field, ranging from 25 to 231 ppm in K, and nearly 76 % of the samples tested low for K (< 62 ppm). Among the micronutrients, Fe concentration varied form 5.2 to 53, Mn from 4.4 to 27.5, Zn from 0.29 to 2.87 and that of Cu from 0.52 to 2.44 ppm respectively. Nearly 64 % of the samples were tested low for Zn with values less than 0.75 ppm. The visual observation of the maps indicated that there is a poor correlation among the soil properties. pH exhibited a significant correlation with Zn (0.532*), and a

poor correlation with P (0.184). The correlation with P and Zn was also weak. The nutrient contours enable dividing the entire field in to different management zones for rationalizing of nutrient application. The spatial variability studies investigate the potential benefits associated with grid sampling technique and delineation of nutrient management zones. The contour maps developed indicated nutrient hot spots if any existing in the field so that accurate sampling approaches can be developed for precise nutrient management.



Nutrient contour maps prepared for nitrogen and potassium in banana orchard.

Pomegranate

The survey of pomegranate orchards in Chitradurga and Koppal district indicated that Boron and Zinc deficiencies followed by Manganese are the predominant nutrient induced disorders in these districts resulting in fruit cracking, small fruits, poor colour, less marketable yield and higher diseases incidence.

Sapota

The photosynthetic rate, stomatal conductance and transpiration rates were higher with 60% ER as compared to 50% ER. Likewise, irrigation with 60% ER and application of 300g bio fertilizer recorded higher rates of photosynthesis, and transpiration rate. The fruit number and yields were higher with 60% ER (168 & 22.4 kg/pl) as compared to 50% evaporation rate although the differences were not significant. The water productivity was higher with 50% ER (21.6 kg/ha-mm) as compared to 50% evaporation rate (19.4 kg/ha-mm). The fruit number and yields were highest with 60% of recommended dose of fertilizer and 300 g bio fertilizer application as compared to other treatments.

Acid lime

The plant height, girth and tree volume were higher with 40% of evaporation replenishment rate under drip irrigation as compared to 50% of evaporation replenishment rate. The water productivity was higher with 40% ER as compared to 50% ER. The fruit yields increased with increase in ER and bio fertilizer application although the differences were not significant.

Tomato

Microbial consortium studies were initiated to promote growth and nutrient uptake for sustainable production in tomato. Out of 172 plant growth promoting rhizobacterial isolates *viz.*, *Azospirillum* (40), *Azotobacter* (36), phosphorous solubilizing bacteria (62) and fluorescent *pseudomonas* (34) isolated from different agro ecological tomato growing regions in Karnataka, the following isolates viz., *Azospirillum* (AzosH10), *Azotobacter (Azotbel2)*, Phosphobacteria (*Psbel6*) and *Pseudomonas* (*Mpf2*) were found to be superior in tomato rhizosphere competence, growth promotion and plant nutrient uptake as compared to other isolates. Similarly twenty four AM fungal isolates were isolated from different tomato growing regions. The predominant spores which exhibited higher infection percentage were tentatively identified as *Glomus macrocarpum*, *Glomus fasciculatum* and *Glomus mossae*. The selected dominant AM fungal isolates are being maintained for further evaluation studies. The selected isolates were used for microbial consortium preparation and it was observed that it can be stored for more than four months under room conditions. The prepared microbial consortium was evaluated for their growth promotion and nutrient uptake under glass house condition in tomato (Arka Ananya). The results indicated that the treatment which received microbial consortium @ 5 g per pot (*i.e.* 5 kg soil) along with sixty percent of nitrogen, phosphorous and full dose of potash recorded higher tomato yield (1187 g per plant) as compared to only inorganic fertilizer applied treatment (1142 g per plant).

Further, a study was taken up from the rhizosphere soil samples on a defined minimal medium and nutrient agar supplemented with different sources of insoluble zinc salts *viz.*, Zinc Oxide, Zinc Sulphate and Zinc Phosphate @ 0.1 % to isolate Zinc Solubilizing Bacteria (ZSB). The ability of the isolates to solubilize insoluble sources of zinc was detected by the formation of clear halos around the colonies. Based on the diameter of the halos the isolates were given a preliminary rating for their Zinc solubilizing ability.

Okra

An experiment was conducted with six treatments and four replications for the development of cost effective drip irrigation system for okra (Cv. Arka Anamika) production. The maximum yield (16.75 t/ha) was recorded from the recommended drip practice (inline drip) followed by the KB tape (250 micron,23 mm width) with 1.2 mm micro tube (16.16 t/ha).The lowest fruit yield of 12.40 t/ha was observed in furrow irrigation treatment. The use of lateral micro tubes for two and four rows did not show much difference with respect to fruit yield. The total evaporation during the crop growth period of 115 days (4th June-30th September) was 489.00 mm and the effective rainfall received was 224 mm.

Chilli

Chilli hybrid Arka Meghana was grown as rain fed crop during August-November (rainfall received during the growth period was 409.5 mm) with different nutrient management practices. The application of additional farm yard manure @12.5kg/ha other than the recommended dose of fertilizer recorded the maximum dry yield of 2.39 t/ha. The second highest dry yield (2.30t/ha) recorded by the treatment consisting of starter solution (10% N and 25 %) P_2O_5 at 4 and 14 days, Foliar spray (6% N,10% P_2O_5 and K_2O at 40,50,60 and 70 DAT) and application of bio-fertilizer (Azospirillium + PSB+ VAM @ 5kg each/ha). The control treatment recorded an yield of 1.78 t/ha.

Capsicum

Fertilizer prediction equations were developed for fertilizer N, P and K for the targeted yields of hybrid capsicum **Cv. Indra** following classical Ramamurthy's approach of soil test crop response correlations and the same is given below,

Fertilizer N = 11.9551 T – 0.7849 Soil test N
Fertilizer P = 6.9087 T - 1.6339 Soil test P
Fertilizer K = 8.4626 T - 0.7410 Soil test K,
where T is the yield target.

Using these equations one can calculate the fertilizer requirement of fields based on soil test values of N, P and K for the desired yield targets of hybrid capsicum

3.3.5. Optimizing production under abiotic streess

Grapes

The response of salinity (100 and 250 mM NaCl) imposed for 20 and 30 days on grape varieties (Cabernet Sauvignon, Sauvignon Blanc, Flame seedless and Sharad seedless) grafted on rootstocks, Dogridge and 110R revealed that the dry mass of leaves and shoot were negatively influenced by salinity, and the response was rootstock dependent. The leaf and shoot dry mass was, in general, high under salinity subjected plants of Flame seedless and Cabernet Sauvignon raised on Dogridge than those raised on 110R at both stages. The root to shoot dry mass ratio showed consistent increase with the increasing levels of salinity, and its values were higher at 30 than 20 days salinity under different treatments. The grape varieties raised on 110R recorded higher root to shoot dry mass ratio than those raised on Dogridge under salinity, with Sharad seedless followed by Sauvignon Blanc recording higher ratios. Photosynthesis rate and transpiration rate were high in the plants grown on Dogridge than on 110R under 100 and 250 mM NaCl treatments. The chlorophyll content was also high in the salinity imposed plants raised on Dogridge compared to those on 110R. Chlorophyll content was relatively higher in leaves of Cabernet Sauvignon followed by those of Flame seedless.

The leaf water potential values were relatively high in the salinity imposed plants raised on 110R than those raised on Dogridge. The grafted plants of Cabernet Sauvignon and Flame seedless showed high leaf water potential under both salinity levels and at both the stages. Salinity treatments also led to variable accumulation in glycine betaine and ABA in grape varieties, and the response was rootstock dependent. The varieties with 110R as rootstock under salinity

recorded higher glycine betaine and ABA contents than in varieties with Dogridge as rootstock at both the stages, and Cabernet Sauvignon recorded high glycine betaine accumulation, and Flame seedless high ABA accumulation. Sharad seedless experienced lesser increase in glycine betaine and ABA following salinity at both the stages. Thus varieties, Cabernet Sauvignon and Flame seedless on 110R as the rootstock appeared to have better salinity tolerance, and the tolerance is possibly attributed to low Na uptake from salinated soil, and induction in ABA and glycine betaine levels.

Salinity treatments (NaCl 100, 175 & 250 mM) imposed for 4 weeks led to greater accumulation in ABA and glycinebetaine in the roots of Dogridge and 110R, and lesser accumulation in St George, with higher NaCl levels influencing ABA to a greater extent. The cytokinins, ZR and DHZR contents increased upto 175 mM NaCl in the Dogridge and 110R but registered progressive decline in St George under salinity conditions. The concentrations of these cytokinins in the roots of salinity imposed rootstocks were high Dogridge and low in St George under all salinity levels. The ABA content with K/Na ratio (r=0.863 at 1%) and leaf water potential (r=0.735 at 1%), and glycine betaine (r=0.719 at 1%) with K/Na ratio in the salinated plants exhibited good positive relationship. The ZR contents were positively related with the root K^+ content (r = 0.823 at 1%).

Guava

Fifteen accessions (which survived upto 7.5 dSm^{-1}) were subjected to salt level upto 8.5 dSm^{-1} during the current year. Growth was found to be affected in accessions Red flesh, Karela, Chittidar, P.catellianum and Sardar. Chloride content in these accessions ranged from 1.82 to 2.52 %, but sodium accumulation in these accessions was not much (0.13 to 0.18%) and potassium content was in optimum range (1.3 to 2.1 %).

Sapota

Effect of irrigation waters with different SAR values (4, 8, and 12) was studied on six varieties of sapota. Fruit yield increased by 1.5 to 2.0 times with SAR_{12} waters. Varieties differed significantly in fruit yield. Varieties DHS-2 followed by DHS-1 and Calcutta Round recorded higher yields compared to other varieties. Nutrient composition of leaf showed that Zn, Cu and Mn contents reduced with increase in salinity levels. There was increase in Ca content in all the varieties with increase in salinity. K content remained more or less same at all salinity levels. Leaf Cl contents increased from 0.98 % with SAR_4 waters to 1.2 % with SAR_{12} waters.

Acid Lime

To identify the species / cultivar for sustaining productivity under adverse soil and water conditions viz high salinity, experiments were conducted in acid lime at slightly increased salt level upto 6.0dSm^{-1}. Performance of Tenali was best even at increased levels of salinity. The per cent reduction in yield was 38 in Tenali, 49 in Gudur and 55 in Local . The major nutrient which was affected most was potassium and its concentration decreased from 2.4 to 1.6 % when salinity level increased. P content decreased from 0.2 % to 0.15%. The chloride content was 1.19, 1.4 and 1.75 % in Tenali , Gudur and Local variety respectively. The increased Cl levels in all the varieties compared to that of last year was due to increased salt level in irrigation water. Na content of the leaves was mostly unaffected by increased salinity level.

Chilli

In one of the physiological studies it was found that the application of glycinebetaine improves the plant growth of chilli under water stress. Hence, to analyze the endogenous glycinebetaine level in chilli cultivar for correlative studies and to find out the effect of application of exogenous glycinebetaine on physiological response under different levels of water stress i.e. 100% irrigation (control), 75% irrigation, 50% irrigation and no irrigation (100% stress) was considered. The endogenous level of glycinebetaine was higher in Arka Haritha (45.5 µmol/g f.w.) as compared to Arka Meghana (74.9 µmol/g f.w.) under controlled condition. The glycinebetaine level increased with increasing water stress in both the cultivars, but the increase was higher in Arka Haritha. In the plants treated with exogenous glycinebetaine the endogenous level of glycinebetaine increased in both the cultivars and the increase was more in Arka Haritha under 50% and 100% stress. The higher RWC in the treated plants further indicates the better turgidity in the treated plants. The root growth as measured by root length was not influenced by the glycinebetaine application in Arka Meghana, while in Arka Haritha the root length was greater in glycinebetaine applied plants under 50% and 100% stress, though the difference was not significant. Though, there was no significant difference in WUE in treated and untreated plants of both the cultivars up to 50% stress, the WUE was substantially higher in 100% stressed plants with glycinebetaine application. This may be associated with the higher P_N rate under stress. The effect of glycinebetaine on WUE was more prominent in 100% stressed plants and it was more effective in Arka Haritha compared to Arka Meghana.. There was considerable affect of exogenous application of glycinebetaine on photosynthetic response to water stress. The influence was more pronounced under 100% stress. Photosynthetic rate was 2 times more in Arka Meghana and 6 times more in Arka Haritha in treated plants under 100% stress. This may be due to maintenance of leaf turgidity and higher stomatal conductance in the treated plants.

Onion

Soil flooding is an environmental factor of seasonal occurrence that negatively affects plant performance. It induces progressive reduction in soil oxygen content and produces anoxic soil conditions. In one of the trials it was found that the root elongation was more sensitive to flooding. The root length reduced from 11.5 to 9.4 cm in Arka Kalyan and from 15.0 to 8.0 cm in ADR. The root and root dry weights

remained unaffected by flooding. Ethanol production in the roots increased by 54.0% in Arka Kalyan and 112.6% in ADR revealing the onset of anaerobic fermentation in roots by flooding. There was more than 60 to 80% reduction in photosynthetic rate in the onion cultivars and the reduction was more in ADR than Arka Kalyan. This was attributed to the reduction in stomatal conductance as it reduced from 0.9 mol m^{-2} s^{-1} to 0.2 mol m^{-2} s^{-1}. Flooding caused a gradual reduction in leaf chlorophyll content in both the cultivars which dhe onset of leaf abscission. There was 55 to 65% leaf abscission under flooding that caused 45 to 51% reduction in leaf area. The recovery in photosynthetic rate decreased with increasing flooding period. The negative effect of flooding on these morpho-physiological parameters resulted in a substantial reduction in bulb size and bulb yield. Cultivar Arka Kalyan performed better than ADR as indicated by lesser reduction in physiological parameters and bulb yield.

Response of onion to elevated CO_2 (550ppm) was studied in Open Top chambers. Two OTCs were maintained at 550 ppm and two were maintained at ambient level (365ppm) without any external CO_2 supply as chamber control (Ch-control). The study on the effect of elevated CO_2 on onion cv. Arka Kalyan showed that the elevated CO_2 (550 ppm) had influence on overall growth and development of onion. Under elevated CO_2, maximum leaf area of 11.27 dm^2 was observed compared to Ch-control (5.97dm^2). The shoot dry weight increase at 550 ppm was highest at 70 DAP (79%) over chamber control. Total biomass was maximum at 90 DAP (18.6 g/Plant) compared to control (13.40g/plant). The percent increment in total biomass at elevated CO_2 varied from 52 to 81 % at different growth stages. In onion increase in photosynthetic rate varied from 19.4 to 64.60 % during bulb development stage. A Yield increase of 24.0 % was observed over control at elevated CO_2. Yield increase was mainly due to increase in the bulb size.

The influence of CO_2 on the water-use of crops may well prove to be the most important benefit of increased CO_2 concentrations for agriculture. Response of onion to elevated CO_2 (550ppm) was studied in Open Top chambers. Under water stress imposed at 45 and 75 days after planting. Increased CO_2concentration resulted in decreased stomatal conductance and transpiration under both irrigated and water stress conditions. Decrease was higher under water stress conditions (26-46% at different growth stages). Decrease in transpiration rate varied from 14.9 to 25.53% under irrigated conditions at elevated CO_2. Under water stress conditions it varied from 16-29%.The reduction in stomatal conductance, had a consequent beneficial effect on leaf water potential (-1.9 M.Pa) .SLW increased under high CO@ and water stress (54.4g/m2) compared to plants grown under irrigated and elevated CO_2 (43.0g/m2).WUE was increased by 19% in CO_2 enrichment.

The studies conducted on the effect of temperature, a rise up to 3 ºC above ambient during *Rabi* season on two onion cultivars Arka Kalyan and Agrifound Dark Red (ADR) in the temperature gradient polycarbonate house showed increase in leaf area and dry matter production at bulb initiation stage. Photosynthesis rate among the genotypes and temperature levels did no show any differences and the rates ranged from 10.20 to 11.83 µ mol m^{-2} s^{-1}. During bulb maturation stage as the temperature increased from 1 to 3 ºC there was reduction in LAI, 16.44% in Arka Kalyan and 13.47% in ADR and total dry matter reduction of 13.67% in Arka Kalyan and 8.87% in ADR. Water stress caused reduction in LAI by 13.36 and 15.34% and TDM by 14.35 and 15.86% in Arka Kalyan and ADR, respectively. Water stress for 10 days reduced the photosynthesis rate by 47 to 57% at bulb maturation stage in both the cultivars. The combined effect of 3ºC increases in temperature and water stress for 10 days at bulb maturation stage caused 25.29% reduction in yield.

Carrot and Palak

Three cultivars of carrot and two cultivars of palak were screened for their Cd absorption capacity. Out of three carrot cultivars, Super new Kuroda accumulated highest Cd content in shoot as well as in root while cultivar Early Nantes accumulated lowest Cd content. Similarly palak cultivar All Green, accumulated higher Cd content compared tp cultivar Arka Anupama. To bring down heavy metal contamination of vegetables in peri urban areas alternate cropping system using flower crops like marigold instead of vegetables was proposed.

3.3.6 Propagation and mass production of genuine and disease free planting material

Passion fruit

A new project was initiated for developing micropropagation protocol for passion fruit hybrid Kaveri, propagules of which are in great demand. Decontamination procedure was optimized, aseptic cultures generated and shoot apex / nodal cultures were established from mature, field-grown vines; *de novo* thin cell layer cultures from young internodes were also established. Media combinations were worked out for shoot proliferation. Some cultures put forth single, elongated roots.

Micropropagation of passion fruit hybrid 'Kaveri' using shoot apex/nodal explants of mature origin

Carrot

A study was initiated on biochemical and molecular investigations in relation to seed quality assurance using Cv Nantes. It was found that the seeds aged naturally for 2 years under ambient conditions and seeds aged artificially for 3 days maintained 100 percent germination same as that of fresh seeds. However, seeds artificially aged for 6,9,12 and 15 days showed 37, 22, 4 and 0 % decline in germination. Seed proteins, extracted from both natural and artificial aged seeds, were subjected to SDS-PAGE and change in protein expression was compared. The differences in viability upon ageing were majorly due to difference membrane stability as evident from progressive increase in solute leakage and malonialdehyde content with every increment in ageing. Studies on seed profiles indicated aged seeds have less number of polypeptides compared to unaged.

Value addition to seeds through coating and pelleting as attempted. Gypsum in combination with cow dung or clay or neem or vermi compost powders (1:1 v/v) formed round and firm pellets in carrot and onion seeds. Germination of pelleted seeds was found to be at par with that ofnon pelleted seeds.

China Aster

In an effort to identify reasons for poor seed set and to improve seed set in China aster Cv. Poornima, based on pooled data of two years, it was found that the position of stigma below the level of anther cone at the time of maximum stigma receptivity (at one day after flower anthesis - 84.8 %) and pollen viability (on the day of flower anthesis -83.58%) prevented self pollination within the florets leading to poor seed yield. Studies on effect of chemicals/ nutrients to improve seed yield indicated that foliar sprays of Boric acid (0.1%) twice (I spray at one month after planting and II spray after 15 days) recorded the highest seed yield per plant of 4.99g (553kg/ha) which was significantly higher compared to untreated control (distilled water) of 1.86 g/plant. (206kg/ha).

French bean

With the objective of extending seed longevity, seeds of French bean cv. Arka Anoop dried to 8% moisture content, packed in cloth and polythene bags and stored at ambient as well as at controlled conditions (15 °C and 40% RH) showed no significant decline in seed germination and vigour even after 12 months of storage. Though there was a marked change in seed coat discoloration (visual), it was not reflected in reduction of seed viability. The germination and field emergence were above 95% after 12 months of storage.

3.3.7 Cropping system Studies

Mango

A study conducted at CHES, Bhubaneswar on long term management effects on soil quality revealed that soil physico-chemical properties, under intercropped mango production systems were better than only mango plantations. The soil is acidic was reaction, pH ranging in between 4.73 and 5.43. Soil organic carbon content significantly higher (0.34%) in intercropping than in control (0.27%), highest in mango-pineapple system (0.46%) , followed by mango-yam system (0.34%). Similarly, available nitrogen content increased up to 42% under intercropped systems than in sole mango crop, highest being in mango-pineapple (361.69 kg/ha).

Coorg mandarin

A cropping system trial was established in CHES, Chettalli during, 2004 and under this trial, Coorg mandarin budded plants (seedlings as check) were grown with coffee and black pepper trained on *Erythrina*. Seven treatments were imposed covering nutrient, disease and pest management. Various growth parameters viz. plant height, stock girth, bud joint girth, scion girth and plant spread (east-west & north-south) were recorded. Leaf samples were also collected following standard procedures to study the variations in leaf nutrient concentration as expected to be influenced by different treatments. Soil samples were collected from 0-15 and 15-30 cm depth and were analyzed for pH, organic carbon, microbial populations, available K and DTPA extractable Zn, Fe, Cu and Mn in soil. The over all effects of the treatments on growth parameters, soil properties and leaf nutrient concentrations were not significant. There was no significant difference in fruit yield of budded plants under different treatments. However, fruit yield of seedling plants were significantly lower than in budded plants.

Guava and Sapota

Representative soil samples were collected from drip circle and inter row spaces covering two soil depths viz. 0-15 and 15-30 cm of Guava and Sapota orchards of CHES, Chettalli as well as from adjacent undisturbed soil (reference soil) for analysis of soil quality indicators viz. pH, bulk density, organic carbon, maximum water holding capacity (MWH), nutrient status and activities of acid phosphatase and â-glucosidase enzymes. Long term orchard management resulted in increase in soil bulk density of guava and sapota orchards (12.7 to 13.5% in surface soil and 4.8 to 7.5% in sub surface soil) compared to the adjacent undisturbed soil. Increase in bulk density of the soils can be attributed to the decrease in organic carbon content of the soils since bulk density showed significant ($P<0.001$) positive correlation with organic carbon content of these soils. This caused compaction of the soil resulting poor soil aeration, more surface runoff and loss of nutrient from the soils.

Maximum water holding (MWH) capacity of surface (0-15 cm) and subsurface (15-30 cm) soils of guava and sapota orchards varied between 42.5 and 44.4% while in case of undisturbed soil, it was found to be 54.5 and 51.1 %. There was significant ($P< 0.01$ to $P<0.001$) fall in MWH capacity of the orchards soils compared with the undisturbed soil. Marked reduction (16.4-18.5%) in MWH capacity is due to reduction in porosity as indicated by high bulk density and reduction in organic matter status of the soils. The pH of orchard soils dropped to the tune of 15.5 to 18.5% in surface (0-15 cm) layer while the per cent reduction in case of sub-surface soils (15-30 cm) varied between 17.5 and 17.7%. Low

pH in orchard soils compared to the unaffected soil are the result of salt affect on soil pH arising out of long term fertilizer application as well as loss of basic cations viz. Ca and Mg from the soil due to high surface runoff resulting from soil compaction as indicated by the high bulk density of the orchard soils. The long-term orchard management resulted in significant reduction in status soil organic carbon (SOC) of orchard soils compared to the adjacent undisturbed soil. The extent of reduction of SOC in surface and sub-surface soils was found to be 36.5-40 and 37.5-39.5%, respectively. Significant reduction in SOC can be attributed to soil loss due to erosion (high bulk density, 1-3% slope), weeding, application of fertilizers and soil disturbance due to adoption of soil management practices. Soil disturbance enhances the oxidation of organic carbon of soil. The SOC is an important soil quality indicator and its maintenance is highly desirable. Though, the present status of SOC in the orchards is high (>0.75%) but the concentration of SOC in soil may decrease with time provided no organic matter management practices are adopted for long-term sustainability of these soils.

Long-term orchard management practices significantly reduced the activities of soil enzymes in comparision to that in undisturbed soil. The reduction in activities of acid phosphatase enzyme in surface (0-15 cm) and sub-surface (15-30 cm) soils of different orchards varied between 37.6 and 48.1 and 44.1 and 55.3%, respectively. The reduction in the activities of β-glucosidase enzyme in surface and sub-surface soils varied between 9.1 and 48.9 % and 28.8 and 53.1%, respectively. The reduction in activities of these enzymes in orchard soil can be attributed to the increase in bulk density, decrease in organic carbon and pH of the soils because the activities of these enzymes showed significant ($P<0.001$) negative correlation with bulk density and significant positive correlations with SOC and pH of the soils. Long term orchard management caused significant rise of DTPA extractable micronutrients viz. Zn , Fe, Cu & Mn and significant fall in concentration of exchangeable Ca and Mg in guava and sapota orchards. Significant rise in concentration Zn, Fe, Cu & Mn resulted from significant fall in pH of orchard soils. There was significant inverse correlation between pH and concentration of these nutrients (Zn $r= -0.44^{*}$, Cu $r = -0.63^{***}$, Mn $r= -0.81^{***}$, Fe $r= -0.49^{**}$). Significant fall in concentration of exchangeable Ca and Mg resulted from leaching and surface run-off. There was significant positive correlation between pH and concentration of these basic cations (Ca $r=0.92^{***}$, Mg $r = 0.79^{***}$. Available K in orchard soils reduced to the tune of 14-22% and significant fall in concentration of available K was observed in case of surface soils of guava and sub-surface soils of sapota orchards.

3.3.8 Protected cultivation

Tomato

Tomato hybrids namely Arka Ananya, NS 501 and Abhinava were grown in a naturally ventilated polyhouse during May to December with 3 plant populations. NS 501 recorded significantly higher yield (149 t/ha) compared to other two hybrids. Among the planting systems, 120cmx40cm spacing recorded significantly higher yield of 156 t/ha followed by 150cmx40cm (147.0 t/ha) and 75cm x 40cm (122t/ha). The plant height recorded was in the range of 260cm to 352cm in three different un-pruned hybrids, indicating the possibilities of growing determinate hybrids in polyhouse.

Okra

Slow crop growth of okra during winter is the major constraint for its optimum productivity in this season. Two cultivars of okra viz. Arka Anamika and US 7109 were grown in a naturally ventilated polyhouse during winter months with 3 dates of sowing in October and November to overcome the seasonal barrier in productivity. Okra fruit yield was significantly higher in mid-October planted crop (28.1 t/ha) compared to mid-November planted crop (21.5 t/ha). No significant difference in fruit yield was recorded between Arka Anamika and US7109 (25.5 t/ha and 26.6 t/ha, respectively).

Muskmelon

Two cultivars of musk melon viz. NS 10 and Sun were grown in a naturally ventilated polyhouse during winter months with 3 dates of sowing in October and November to increase productivity and quality of fruits. Muskmelon fruit yield was significantly higher in mid-October and early November planted crop (48.8 t/ha and 49.4 t/ha , respectively) compared to mid-November planted crop (35.7 t/ha). No significant difference in fruit yield was recorded between NS 10 and Sun (45.1 t/ha and 44.2 t/ha, respectively).

3.3.9 Organic farming

Mango

Development of an organic production technology for mango in Eastern India was attempted at CHES, Bhubaneswar using Cv. Mallika. It was found that there was no significant different in the growth pattern of the plants among the organic and non-organic treatments. Highest growth in terms of height was observed in plots receiving 5 kg FYM (290.42 cm) closely followed by those which received 10 kg FYM (282.20 cm). Least growth was observed in control (229.20 cm) with no fertilizer application. Highest disease (powdery mildew) incidence was observed in plots receiving recommended dose of fertilizers (87.0% incidence) closely followed by those which received 5 kg and 7.5 kg FYM with 76.8% and 76.3% disease incidence repectively, while least disease incidence was noticed in the control.

Papaya

A field trial on organic practices of Papaya cv. Surya was initiated with 12 nutrient combinations involving FYM , biofertilizers and vermicompost. Vegetative parameters were recorded at six twelve months after planting. At six months after planting vegetative parameters were found to be non significant among the different treatments. At 12 months after planting only plant girth was found to be significant and maximum girth (51.9 cm) was with the treatment 50% RDF

FYM +Azo+PSB+vermicompost and least girth (39.9cm) was with the treatment 100% RDF fertilizer treatment. Fruit yield fruit quality parameters were found to be non significant among the different treatments with 19 pickings of fruits.

At CHES, Chettalli, the trials on var. Coorg Honey Dew indicated that the yield/tree, fruit weight, and reducing sugar percentage were highest in the plants applied with inorganic fertilizers of 250:250:500 g NPK / plant /year while effect on fruit length, fruit girth, pulp thickness, TSS and total sugar were non significant. The plant treated with FYM was on par with T_1 (250:250:500 g NPK / plant /year).

Cabbage

An experiment was conducted to develop organic farming package for Cabbage cv. Unnathi with main emphasis on testing different levels of organic nutrient supply. The results indicated that the plant growth parameters were not affected by different organic treatments while the yield of organic treatments were in the range of 44.16 to 50.74 t/ha with highest yield of 50.74 t/ha in treatment receiving 100 percent RDN through FYM as compared to the conventional treatment yield of 61.53t/ha and an yield of 49.93 t/ha obtained with only chemical fertilizer application.

Medicinal crops

Field experiments were conducted on Ashwagandha, Coleus and Kalmegh with different doses of FYM and recommended NPK. The result indicated superiority of conventional practices (inorganic fertilizers + FYM) over organic practices in Coleus variety K-8 with maximum dry tuberous yield of 1610.5 kg/ha whereas the dry tuberous yield through organic practices (different doses of FYM) varied from 1216.7 to 1462.5 kg/ha. The lowest yield was in control with dry tuberous root yield of 1118.7 kg/ha. Application of recommended dose of FYM (10 t/ha) and NPK (75:75:50 kg/ha) produced maximum biomass yield of 2016.67 kg/ha followed by treatment with application of FYM at 20 t/ha (1826.67 kg/ha) in Kalmegh. In Ashwagandha, application of FYM (22.5 t/ha) produced maximum dry root seed yield of 273.33 kg/ha and 284.38 kg/ha whereas control yielded only 198.13 and 187.92 kg/ha respectively.

3.3.10 Pollination studies

Mango

Pollinator species diversity was recorded on seven varieties of mango viz., Alphonso, Banginapalli, Totapuri, Arka Anmol, Arka Nilkiran, Dasheri and Langra. Number of pollinators on 10 panicles in each variety was recorded at 2 hour interval starting from 7 am till 6 pm. Among different species found to be foraging on mango flowers, *Apis florea* was the dominant one (3.86/panicle/minute) followed by a calliphorid, *Chrysomya megacephala* (1.62) and a syrphid (0.70)(to be identified) and Indian bee, *A. cerana* (0.44). Peak foraging hours of *A. florea* were between 9 am and 11am with a second peak between 3 and 4 pm while that of dipterans were between 11 am and 3pm. Mean foraging time of *A. florae* per floret was 5-6 seconds, covering 4.5 florets in a single visit. Syrphids were quick fliers and spent only a mean time of 2-3 seconds per floret and covered 2.5 florets per visit. Nocturnal pollinating insect fauna recorded included some moths and beetles (yet to be identified). No honey bee activity was observed after 6pm. The nature of pollinators did not change significantly with change in variety of mango. Twenty panicles in each variety were bagged with a nylon mesh before flowering. There was 80 -90% reduction in fruit set of bagged flowers. It was also found that there was no correlation between fruit set in bagged panicles and the per cent bisexual flowers of respective variety. This experiment showed that insect pollinators played significant role in fruit setting of mango.

Apis florea foraging on mango flowers

A calliphorid pollinator on mango

3.4 Crop Protection

3.4.1 Pest surveillance and disease forecasting

Mango

Mango borer *Deonalis albizonalis* was absent in Tamil Nadu, Kerala, Karnataka and most of Andhra Pradesh, but was present in Krishna district of Andhra Pradesh in high proportion. Mango stone weevil, *Sternochetus mangiferae* is making its presence felt on Alphonso in Dharwar, Karnataka, where it was rare earlier. It was however, absent in Mehbubnagar, Rangareddy and Krishna districts of Andhra

Pradesh. Mango fruit fly, Bactrocera dorsalis infestation was found in Karnataka, Tamil Nadu, Kerala and Chitoor district of Andhra Pradesh. Fruit fly infestation was present in 28.8% of mango var. Alphonso in Dharwar, but absent in Banganapalli in Krishna, Mehbubnagar and Rangareddy districts of Andhra Pradesh.

In case of mango fruit fly, *B. dorsalis* regression with weather factors showed that B. dorsalis can be predicted by the equation:

y = – 4863 + 123 Min temp – 1.02 RHI + 79.23 RHII + 4298 Wind Sp - 2.57 Rainfall (R2 = 0.76)

Sapota

Monitoring of sapota seed borer, *Trymalitis margarias* infestation in off season (stray) mature sapota fruits across the varieties for the third consecutive season confirmed the findings that off season mature fruits of sapota serve as the major source of infestation by *T. margarias*. Continuous monitoring of green scale, *Coccus viridis*, over a period of 3 months under unsprayed conditions showed that the number of live scales per leaf ranged between 64.10 to 15.30 and number of crawlers per leaf reduced progressively to 28.7 to 0.8 crawlers per leaf. The natural mortality of scales also ranged between 3.60 to 35.00. A progression was observed in the natural parasitization slowly taking over the green scale population.

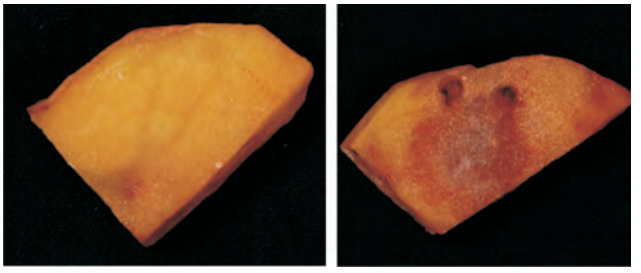
Guava

Tea mosquito bug infestation was scarce on plants till July. The population build up started from September with the emergence of new flushes and reached its peak during January- February. A reduviid bug, *Endochus inornatus* was observed preying on nymphs of the pest. Spiders belonging to salticidae and oxyopidae were also found to predate on nymphs and adults.

Tomato

Mealybug infestation was noticed on tomatoes grown in polyhouse, they were identified to two species, *Phenococcus solenopsis* and *Coccidohystrix insolitus*. *P solenopsis* was the predominant infesting on all parts of the plant.

To understand the factors responsible for serious out breaks of late blight on tomato since 2008, 20 isolates of *Phytophthora infestans* associated with late blight of tomato were isolated from infected leaves, stems and fruits using baiting technique on selective rye agar medium from different localities. Based on detailed morphological, ITS sequence data, sensitivity to metalaxyl and pathogenicity tests, two subgroups were identified within *P.infestans*. First group exhibited smooth combed colony and less sporulation on rye agar medium, less aggressive on tomato, no infection on potato and highly sensitive to metalaxyl. Second group had uniform colony pattern with cottony wool like aerial mycelium and high sporulation on rye agar medium, highly aggressive on both tomato and potato and tolerant to metalaxyl. This



Infection potential of *P.infestans* isolates of tomato on potato tubers.

gives an indication for sudden outbreaks of late blight on tomato in India. PCR based assay was developed for rapid detection of *P.infestans* in infected plant material using PINF and ITS 5 primers.

Onion

Fifteen isolates of Alternaria species infecting onion collected from different parts of the country were screened for virulence on variety N-53 . Isolates, OlA1(4.6cmX1.2cm), OlD1(2.8cmX0.9cm), OLMb(3.3cmX1.5cm), OLCh (2.3cmX1.0cm), OLlin (4.0cmX1.0cm), OLNau (3.5cmX0.8cm) and OLCd(4.0cmX0.9cm) were found aggressive in causing necrotic symptoms. *Alternaria* species adentified as *Alternaria porri*, *A.alternata*, *A.tenuissima*, *A. palandui* and *A.brassicola* infecting onion were screened for aggressiveness on variety N-53. Among the different species, *Alternaria porri* was found to be aggressive followed by *Alternaria palandui* by recording the lesion diameter of 4.6cmX1.2cm and 2.8cmX0.9cm after four days of inoculation.

3.4.2 Minimisation of yield losses due to insect pests and diseases

Mango

The mango fruit fly trap catch of B. dorsalis and B. correcta showed very positive and significant correlations with the length of the mango fruit. The population of B. dorsalis started peaking in Banganapalli and Totapuri when the fruit lengths were between 14 -16 cm in the first fortnight of May.

Azoxystrobin application was most effective in controlling anthracnose stem end rot, followed by thiophanate methyl and carbendazim. The per cent anthracnose infected fruits from the three treatments were 10%, 12% and 14% respectively while that with stem end rot were 8%, 10% and 10% respectively. Use of turmeric and neem leaf extracts resulted in 16% fruits with anthracnose, while application of extract of *V. negundo* leaves and garlic resulted in 18% and 20% diseased fruits respectively as compared to 36% diseased fruits in untreated control. Similarly, application extract of neem leaves, *V. negundo* leaves, garlic and turmeric controlled stem end rot in mango with 12, 14, 14 and 16 %, infected fruits, respectively, in each treatment compared to 26% in control. Aspergillus rot was not recorded in any of the treatments except in control where 6 % fruits had the disease.

Sapota

Deltamethrin treatment was found to be significantly superior over other treatments viz. dimethoate, Bt, neem soap and pongamia soap even after fourth harvest for control of sapota seed borer, *T. margarias*. Sequential spraying of deltamethrin-Bt-pongamia oil also reduced the borer damage as compared to the untreated control. Of 18 treatments screened for their efficacy in bringing down the scale population (*Coccus viridis*) along with soil drenching with chlorpyriphs 2.5 ml/l, buprofezin+ quinalphos found to be superior with no ant movement after two months, as compared to treatments with acephate, imidacloprid, thiamethoxam, buprofezin, pongamia oil quinolphos, dichlorvos, boric acid, acetic acid, emamectin benzoate, deltamethrin, lambda-cyhalothrin, boric acid + quinolphos, dichlorvos + pongamia oil.

Guava

The entomopathogen *Metarhzium anisopliae* was found to be efficient in controlling Ferrisia virgatta on guava while treatment with lamda – cyhalothrin, acetamiprid and B. bassiana showed that from the second week of spraying, guava fruit damage by tea mosquito bug was reduced considerably.

Tomato

Mealybug infestation in poly house could be controlled by release of Cryptolaemus grubs (5 to 10 per plant) and after 20 days this was on par with three chemical, one botanical and one IGR formulation tested for mealybug control.

Okra

Soil application of neem cake followed by sprays of Neem soap and NSP were effective for control of leaf hopper during *Kharif*, but moderately effective during summer when the pest incidence was very high when the hopper incidence was reduced from 153/palnt to 18-35/plant during summer. There was very little effect of fertilizers and micronutrients on incidence of leafhopper and hopper burn during *Kharif*. Mean leafhopper count and leafhopper burn rating ranged from 0.2 – 3.6 and 0 – 2.3 respectively. Regular precipitation did not facilitate build up of leafhoppers to a level where they could affect crop. Infestation levels were low.

Brinjal

Rynaxpyr (0.3 ml/l) application was consistently found superior over other insecticidal treatments to control brinjal shoot and fruit borer and resulted in average fruit damage of only 8.36 % (weight basis) as against 45.35 % in control

Chilli

Weekly spraying of *M. anisoplaie* @ 1x109 spores/ml with sunflower oil @0.01% followed by weekly release of *Blaptostethus pallescens* @1/plant recorded significant reduction in thrips population in chilli and capsicum. Sprinkler irrigation could also reduce the thrips number significantly without insecticide spray. Yield obtained in sprinkler plots were on par with insecticide treated plots (8 sprays at 15 days interval), indicating the utility of water sprinkler in managing thrips.

Onion

Threshold based sprays at a stage when thrips reached a population of 10/plant of botanicals and insecticides viz. neem soap, neem seed powder extract, dimethoate and acepate reduced the number of sprays to 3 from 5 scheduled sprays at 10 days interval and such threshold based sprays were recommended for managing onion thrips

More than150 cultures of potential micro organisms (bacteria and fungi) were isolated and evaluated for screening antagonistic effect against *Alternaria porri*., of which 10 bacteria and 5 fungi were short listed. All the bacterial cultures were opaque and creamy white to light yellow in colour. These cultures were broadly classified under Bacillus group. Effective bioagents were evaluated against purple blotch of onion under field condition among whichV-10b was found to be promising antagonist recording a percent disease incidence of 31.40 and a healthy bulb yield of 48.00 tons/ha as against a PDI of 37.06 and yield of 38.00 tons/ha in untreated control.

A 15 day's spray schedule of mancozeb was effective for the management of foliar disease of onion (cv.Bhima) during *Kharif*, recording a percent disease incidence of 35 and yield of 30.0 tons/ha as against a PDI of 45 and yield of 16.67 tons/ha in untreated control. For the management of foliar disease of onion (cv. N-2-4-1) during *Rabi*, a 60 days spray schedule of mancozeb resulted in reduced percent disease incidence of 62.86 as against a PDI of 70.46 in untreated control.

Bittergourd

IPM treatment consisting of bait spray (Deltamethrin 0.1 % + Jaggery 1 % + setting up of cuelure traps @ 10/acre) significantly decreased the melon fly damage (12.66%) in bittergourd as compared to rest of eleven chemical/ botanical treatments and control (19.15 % to 33.66 %). Setting up of cuelure traps significantly reduced the melon fly damage in bitter gourd in all harvests as against plots without cue lure. Chi square analysis of pooled harvests indicated significant reduction in melon fly damage in cue lure trap plots as against plots without cue lure ($\chi 2$ =512.8*, p= 0.05).

Pupation of final instar melonfly larvae was found to vary with soil moisture. Maximum pupation was noticed in 7.5 % moisture wherein 80 % larvae pupated, The extent of pupation declined as the moisture level increased from 15 % to 45 % with 45 % moisture recording lowest pupation (38 %). There was no pupation in 0 % moisture. In all soil moisture levels maximum pupation occurred between 0-2 cm depth. Cent per cent pupation occurred between 0-1 cm at 45 % soil moisture. 97.5 % pupation occurred between 0-2 cm depth at 7.5 % moisture, in other moisture levels it varied from 80-89 %. Temperature during the study ranged from 26- 31° C (Max) and 24-30° C (Min).

Rose

Various aromatic oils were evaluated at concentrations of 0.1% in combination with half the recommended dose of imidacloprid (0.25ml/l) against thrips on rose. Of the various oils tested, Lavender oil and Palma rosa oil showed highest synergistic action (100% mortality) against thrips followed by Patchouli oil (85.56 %).

3.4.3 Minimisation of yield losses due to nematodes

Banana

A method of management of nematodes in banana was standardised. Application of 2 kg of farm yard manure enriched with *Pseudomonas fluorescens* (109 cfu/g) and *Trichoderma harzianum* (106 cfu/g) per plant at the time of planting and at an interval of 6 months significantly reduced *Radopholus similis* and *M. incognita* on banana roots by 62 and 66% respectively.

Papaya

Application of 2 kg of farm yard manure enriched with *Pseudomonas fluorescens* (109 cfu/g) and *Paecilomyces lilacinus* (106 cfu/g) per plant at the time of planting at an interval of 6 months significantly reduced nematode infestation on papaya roots by 64 and 70% respectively and increased fruit yield by 24%.The cost benefit ratio (calculated for the marginal cost of the bio-pesticides and marginal returns accrued by the application of the bio-pesticide) was 1 : 3.6.

Okra

Treatment of okra seeds with *Pseudomonas fluorescens* (109 cfu/g) and *Paecilomyces lilacinus* (106 cfu/g) each at the rate of 10g /kg and subsequent application of 5 tons of farm yard manure enriched with the 5kg each of *P. fluorescens* (109 cfu/g) and P. lilacinus (106 cfu/g) per hectare, reduced *Rotylenculus reniformis* and *Meloidogyne incognita* in okra roots by 68% and 78% respectively and significantly reduced nematode induced disease complex. There was significant increase in the yield of crop by 25%. Cost benefit ratio (calculated for the additional cost of the bio-pesticides and additional returns accrued by the application of the bio-pesticide) was 1 : 3.3.

Carrot

Treatment of carrot seeds with *Pseudomonas fluorescens* (109 cfu/g) at the rate of 10g /kg and subsequent application of 5 tons of farm yard manure enriched with the 5kg each of *P. fluorescens* (109 cfu/g) and *T. harzianum* (106 cfu/g) per hectare, significantly reduced *Rotylenculus reniformis* and *Meloidogyne incognita* in carrot roots by 78% and 76% respectively. In untreated control 20.4% of carrots were infested with Erwinia soft rot while with *P. fluorescens* + *T. harzianum* treatment, only 3.4% of carrots had infestation and with *P. fluorescens* + *Paecilomyces lilacinus* 5.8% carrots had infestation.

Gladiolus

Experiment on management of disease complex using bio-pesticides on gladioli indicated that the treatment of gladioli corms with *Pseudomonas fluorescens* (10^9 cfu/g) and application of 5 tons of farm yard manure enriched with the 5kg each of of *T. harzianum* (106 cfu/g) and *P. fluorescens* (10^9 cfu/g) per hectare, significantly reduced *M. incognita* and *R. reniformis* by 74 and 82 % in roots of gladioli respectively. Combination of *Pochonia chlamydosporia* and *T. harzianum* did not prove effective in the management of nematodes in gladioli. In untreated control the fungal disease (caused by *Fusarium oxysporum* f. sp. gladioli) infestation was 32% and in *P. fluorescens* + *T. harzianum* treatment there was reduction of the disease. The infestation was 14.5%. Significant increase (22%) in the flower yield of gladioli was observed. Cost benefit ratio (calculated for the marginal cost of the bio-pesticides and marginal returns accrued by the application of the bio-pesticide) was 1 : 6.0

3.4.4 Minimisation of post harvest losses due to pests and diseases

Mango

Post harvest hot water treatment of mango cv Banganapalli showed that time exposures of 60, 75 and 90 minutes at 480 ^{o}C , resulted in no fruit fly infestation at full ripening of fruits and 100% mortality of the eggs as compared to, 90% infestation in control. There was also significant reduction in rot per cent in 75 min treatment, from 15.5% in control, to 4.9% in treated. 90 minutes treatment resulted in maximum fruit colour development.

Pre harvest application of azoxystrobin followed by post harvest application of azoxystrobin/thiophanate methyl was best for controlling anthracnose, stem end rot and Aspergillus rot in mango. Post harvest treatment with azoxystrobin preceded by the pre harvest application of turmeric extract/ Vitex negundo leaf extract was next in the order where only 3.33% fruits had both anthracnose and stem end rot as compared to 33.33 % fruits with anthracnose and 23.33 fruits with stem end rot in control. No incidence of Aspergillus rot was recorded in treated fruits whereas in untreated control 3.33 % fruits were infected. Similarly, hot water treatment for 10 min at 52°C preceded by pre harvest application of azoxystrobin was most effective for complete control of storage rots in mango fruits. Pre harvest treatment with thiophanate methyl/carbendazim followed by post harvest hot water treatment also resulted in very good control of these diseases. Combining such treatments was better as mango fruits which did not receive any pre harvest treatment but were subjected to post harvest hot water treatment alone resulted in 32%, 24% and 6% fruits infected with anthracnose, stem end and Aspergillus rot, respectively.

3.4.5 Evaluation of safety of pesticide treatments

Pomegranate

Foliar application of 2 g/l chlorpyrifos for control of fruit and shoot borer and 0.25 ml/l thiamethoxam for control of thrips,

aphids, mealybugs and whiteflies in pomegranate resulted in residue persistence for about 30 days on fruit peel with a half life of 6 and 8 days respectively. No residues of chlorpyriphos or thiamethoxam were detected in aril (edible part of fruit) but based on residue deposit on the fruit surface 35 days waiting period was recommended for both. Washing of fruit could dislodge 65 -75 % of residues of chlorpyrifos and 38 – 46% of thiamethoxam residues from fruit surface.

Combined soil drench application of chlorpyriphos and carbendazim in pomegranate resulted in slow uptake of carbendazim into plant and its gradual accumulation in the leaves in the order, water shoot leaves > 2nd flush > 1st flush. The residue build up of carbendazim in pomegranate fruit peel (greenish immature stage) was 0.44 & 0.64 ppm and 0.08 & 0.07 ppm in aril. However, there was no movement of chlorpyriphos residues from soil to leaves and fruit but these residues persisted in soil for more than 100 days.

Banana

Chlorpyriphos (used for control of pseudo stem weevil) drenching to banana variety "Kadali at 3 and 6 g/ l at 15 day interval, twice, resulted in its uptake into banana fruits and pseudostem. Uptake of chlorpyrifos residues was maximum in banana fruits sampled 2 hrs after the second application and mature banana fruits, peel and pulp after 20 days of treatment (at harvest) were free from chlorpyriphos residues. In pseudostem, trace amount of residues were detected in the lower part 15 days after the second application, while the upper part was free from any residues. No residues were detected in the pseudostem, at harvest.

Tomato

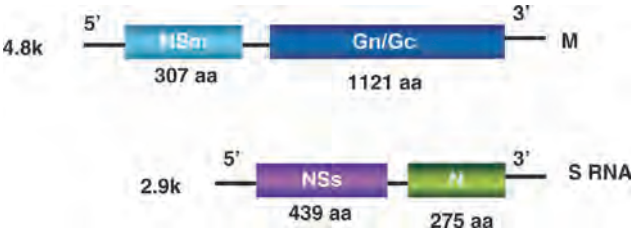
Tomato (var. Arka Ananya) was grown in field and polyhouse simultaneously. At fruit formation stage 4 applications of iprodione (4 g/l) and of chlorothalonil (2 g/l) made at weekly intervals to control early blight in tomato resulted in higher intial deposits of pesticides in polyhouse grown tomato. The rate of dissipation of iprodione (half life, t1/2= 5.7 days) and chlorothalonil ($t^{1/2}$= 7.2 days) was slower in polyhouse than in field grown tomato ($t^{1/2}$= 3.1 days and 6.6 days respectively) and required waiting period of 4 days in polyhouse and 1 day in open field for safe harvest of tomato.

3.4.6 Molecular characterization and detection of plant pathogens

Watermelon

The genome structure and organization of the small (S) RNA and medium (M) RNA for Watermelon bud necrosis virus (WBNV) Bangalore isolate has indicated that S RNA of WBNV is 3403 nt in long with two non-overlapping ORFs in ambisense orientation. The ORF (nt 67–1383) on the viral sense strand encodes the NSs protein with molecular mass of 49.6 kDa. The ORF (nt 3336–2509) on the viral complementary strand codes for the N protein with a mol. Wt. of 30.6 kDa and two ORFs are separated by an extremely longA/U-rich (77.7%) intergenic region (IGR) of 1133 nt (Fig).

Sequence analysis showed that the M-RNA was 4,805 nucleotides long and coded for movement protein (NSm) in the viral sense and the glycoprotein precursor (Gn and Gc) in the viral complementary sense. The two open reading frames are separated by a 413 nucleotide intergenic region. Phylogenetic analysis of the NSm and Gn/Gc genes from the BG isolate showed grouping with VI serogroup. Sequence analysis of the genome has indicated it belongs to group IV serogroup of Tospoviruses



Genome Organization of WBNV

Chilli

A cultivation independent PCR based assay for rapid detection of Colletotrichum capsici in infected chilli plant material was attempted by isolating DNA from 50 isolates of Colletotrichum capsici collected from different localities in India. When amplified the ITS region of r DNA with primer pair ITS1 and ITS4, all the isolates yielded single band size of 560bp. Phylogenetic analysis of the ITS – r DNA sequences, performed by the neighbour joining method, revealed that all C.capsici isolates were identical. The extraction protocol for DNA isolation from infected and healthy fruit stalk, calyx, pericarp of ripe fruit and seeds using a sbeadex® plant mini kit for PCR reactions was standarised. The amplified products were cloned, sequenced and primer pair OCCF and OCCR specific for C.capsici using soft ware primer blast and manual inspection was designed. The specificity of ITS primers for C.capsici was determined by cross checking with DNA isolated from *Colletotrichum gloeosporioides, C.acutatum, Cercospora capsici, Phytophthora capsici, Fusarium subglutinans, Alternaria alternata and Sclereotium rolfisi*, common pathogens found on chillies. The above primer pair selectively amplified only Colletotrichum capsici isolates but not other pathogens. The size of the amplified PCR product is 240bp. PCR amplification by 34 cycles of denaturation at 94°C for 60 s, annealing at 55°C for 60 s, and extension at 72°C for 1.5 min with an initial denaturation of 5 min at 94°C before cycling and a final extension step at 72°C for 5 min was optimized.

3.4.7 Chemical characterization of antifungal compounds from plants

Antifungal compounds present in *Catharanthus roseus* roots were confirmed to be oxindoles by HPLC purification and ultra violet spectral data analysis. Two antifungal compounds present in Aloe vera could be identified as aloin and aloe-emodin. One of the antifungal compounds present in the seeds of *Mucuna pruriens* could be identified as L-DOPA.

Synthetic studies on organophosphonates revealed that compounds with one heterocyclic moiety and one phenyl moiety are promising candidates to be developed as fungicides. Compounds with one polynuclear aromatic moiety also showed encouraging results.

3.4.8 Endophytic bacteria for disease control

Non-pathogenic endophytes were found in fresh isolations from wilted tomato plants by plating the bacterial ooze on Kelman-TTZ medium and then selecting the cultures showing fluidy red-white colony typical of *Ralstonia solanearum.* This emphasised the need for both molecular based identification coupled with pathogenicity testing to ensure the use of correct organism for screening purposes. Sixteen endophytic bacterial cultures that were isolated from non-host sources like grape, watermelon and papaya were used for the *in vitro* screening to identify organisms possessing any antagonistic effect against the pathogen. Four isolates (EB02, 06, 07 & 11) displayed clear inhibition zone development against *R. solanacearum* on Kelman–TTZ medium. Controlled glass house trials on the effectiveness of the above isolates in controlling the wilt pathogen are underway.

3.4.9 Miscellaneous studies

Compatibility of two synthetic insecticides (Indoxacarb and Spinosad), a microbial insecticide (NPV) and two fungicides (Chlorothalonil 75WP and Mancozeb 75WP) were tested in field. The tested insecticides and fungicides were compatible as their efficacy was not affected due to their mixing with each other. There were also no phytotoxic symptoms due to the use of insecticide and fungicide combinations and hence their mixing before spray can be recommended to control tomato early and late blight and fruit borer. Similarly , compatibility of two insecticides (acephate and fipronil) and two fungicides (chlorothalonil and zineb) in terms of their bioefficacy against thrips and purple blotch diseases in onion respectively was also established.

Effect of Tagetes essential oil sprays on diamondback moth larave was studied in laboratory. II instar caterpillars of DBM were sprayed with Tagetes essential oil and mortality recorded after 48 h. Spraying at 0.05%, 0.1%, 0.15%, 0.2% and 0.25% gave 22.5%, 47.5, 62.5, 85% and 97% mortality in DBM II instar caterpillars.

Biology of the parasitoid, Encarsia sp. of whiteflies, Bemisia tabaci and Trialeurodes vaporariorum was studied in the laboratory on B. tabaci on cotton plants. The total life span of the parasitoid was 21 days with total developmental period ranging from 12 to 17 days at 250 C. Axinoscymnus puttarudraiahi Kapur & Munshi, coccinellid predator was recorded from the field collected leaf samples infested with whitefly.

Under outreach programme on management of sucking pests of horticultural crops, aphids, thrips and whiteflies on mainly vegetable crops as host plants were collected from across the country for determination of biotypes. Six aphid , three thrips and two whitefly species were identified.

Degradation study of lindane, a persistent organochlorine pesticide. was carried out using two *Pleurotus spp*. (Basidiomycetes fungi), i.e *Pleurotus florida* and *Pleurotus sajour-caju* over a period 30 days. Complete degradation of lindane was observed by 30 days in medium inoculated with both the cultures. None of the eight degradation products of HCH, i.e. 1,3 Dichlorobenzene; 1,2 Dichloro benzene; 1,2,4 trichlorobenzene; 1,2,3 trichlorobenzene; 1,2,4,5 Tetrachlorobenzene; 1,2,3,5 Tetrachlorobenzene; 1,2,3,4 Tetrachlorobenzene, Pentachlorobenzene and 4 isomers, i.e. Alpha-HCH, Beta-HCH, Gamma-HCH, Delta-HCH were detected by GC-MS analyses, indicating complete degradation of lindane by both the species.

3.5 Crop utilization and farm mechanization

3. 5.1 Extending storage life of fruits

Mango

Alphonso and Banganapalli cultivars of mangoes (with or without wax coating) could be stored in unripe green condition without any chilling injury for 4 to 5 weeks at 8°C by Modified Atmosphere (MA) packing with semi permeable film (micro perforated D-955 film). Wax coating complimented with MAP though did not help in reducing the weight loss during low temperature storage but significantly reduced the weight loss after transferring the fruits to ambient temperature (24-31°C) for ripening.

Exposure of mature green Alphonso mangoes (500 kg mangoes per treatment) on to celfresh (½ tablet or 1 tablet per 1 m^3 concentration) that releases active 1-MCP gas did not significantly help in delaying the ripening and extending the shelf life of fruits at ambient temperature.

Sapota

The storage life of sapota (cv. Cricket ball) could be extended to 3 weeks at 10°C without any chilling injury when the fruits were MA packed with micro perforated LD film. The fruits ripened normally within 3 days when they were shifted to ambient conditions for ripening.

Papaya

The storage life of papaya (cv. Taiwan Red Lady) could be extended up to 1 month when the fungicide treated fruits were MA packed with micro-perforated D-955 film (0.0125 % ventilation) and stored at 18°C (75-80% RH) with less spoilage (5 %). Pre-storage hot water (HW) treatment did not control the spoilage compared to fungicide treatment. MA packed and stored papaya fruits were ripened to bright yellow surface colour (higher Hunter “a” and “b” values) without any shriveling and with high carotenoid and lycopene contents when compared to non-packed fruits.

Custard apple

The storage life of custard apple fruits (cv. Balanagar) could be extended to 2 weeks at 12°C without any chilling injury when the fruits were MA packed with 100 gauge PE or PD-

961 film. The fruits ripened normally within 4 days when they were shifted to ambient conditions for ripening. The storage life of custard apple (Hybrid 'Arka Sahan') fruits could be extended to 3 weeks at 15°C by exposing the fruits to 250 ppb 1-MCP for 6 hours with maintenance of higher firmness and quality when compared to 2 weeks in non-treated fruits. At ambient temperature (24-30°C) the shelf life could be extended by 3 to 4 days without affecting the quality.

Aonla

Aonla was found to be susceptible to chilling injury when stored below 15°C. The storage life could be extended to 2 weeks with maintenance of quality at 15°C by using PE lining (100 gauge) around the fruits. PE lining significantly reduced the weight loss (2% when compared to 8 % in control fruits) and maintained the firmness of aonla fruits during 3 weeks of storage at 15°C.

Optimum moisture content in osmotically dehydrated aonla segments for better quality and storage life was investigated using osmo-air dried aonla segments from different varieties viz. NA-7, NA-10, Krishna and Chakaiya. After 9 months of storage under ambient condition, the sample with maximum water activity had highest moisture content (15.3%) and NEB (0.091 OD 440nm). Osmo-air dried aonla segments with 12.2% moisture content and a_w 0.525 had good retention of greenish colour and lowest browning. It is recommended that final moisture content in osmotically dehydrated aonla should be maintained around 12-13% for better quality retention during storage.

3.5.2 Extending storage life of vegetables

Tomato & Bitter gourd

Scaled up trials confirmed that post harvest exposure of tomato and bitter gourd fruits to 1-MCP (an ethylene action inhibitor) at 250 ppb concentration or formulations containing 1-MCP for 18 hrs delayed the ripening, retained higher firmness and extended the storage life of these fruits. The above treatment extended the storage life of breaker harvested tomato fruits upto 6 weeks at 12 to 13°C and to 3 weeks at R.T. (25-28°C) as compared to two weeks without the treatment.

The above treatment delayed the ripening of bitter gourd fruits harvested at 12-14 days maturity and extended the storage life upto 14 days and packaging in PE (100 gauge) and storage at 12°C. The storage life of control fruits was 3 days without packaging and 5 days with packaging (PE 100g) at R.T. (25-32°C).

3.5.3 Product Development and Value Addition

Mango

Osmotically dehydrated mango slices of varieties Alphonso, Dushehari, Totapuri and Arka Anmol were prepared using standard process. Fresh Alphonso slices had total solids content of 21.1%, moisture 78.1% and water activity (a_w) 0.924. The water activity reduced to 0.883 after osmosis with moisture content of 43.8%. Osmo-air dried Alphonso slices stored under ambient condition after 10 months of storage indicated that, moisture content in samples varied from 12.3 to 20.5 % and water activity (a_w) ranged from 0.535 to 0.682. Samples having moisture content above 15% showed increase in non-enzymatic browning (NEB) and maximum NEB 0.386 (OD 440nm) was observed in sample with 20.5% moisture. Samples of Dushehari, Arka Anmol, and Totapuri containing moisture in range of 12.8-15.5% and water activity 0.549 to 0.629 had lower NEB (0.130 to 0.188 OD 440nm) and were highly acceptable due to better colour, and texture. However, osmotically dehydrated Alphonso slices with water activity of a_w 0.682 and 20.5% moisture developed mold growth even when packed in pet jar as well as punnets. Hence, it was concluded that osmo-air-dried mango slices should be dried to a moisture level of 12-15% and to be packed in punnets for better storage life of upto one year.

Banana

Process was standardized for the preparation of banana wine from *cv*. Robusta. The steps included the enzymatic juice extraction, fermentation of the optimally diluted juice using *S. cerevisiae* and the final clarification of the beverage. Sensory evaluation by hedonic scale rated the beverage as "Like much". The beverage possessed golden colour, pleasant banana aroma, 11 per cent alcohol and <0.5 per cent residual sugar.

Banana wine

Sapota wine

Pomegranate

Pomegranate (var.Kesar), RTS juice with varying composition of juice (10-25%), TSS (15-18° Brix), acidity (0.25%-0.3%), including one treatment with alternate sweetner (sucrolose) were prepared and studied. The product comprising of 25% juice, 18 °Brix and 0.30% acidity was judged best. The product with alternate sweetener had very low TSS, 4.2° Brix, and scored lower over all acceptability score due to poor consistency and flavour of the beverage.

Sapota

An alcoholic beverage was prepared from sapota using the yeast *Saccharomyces cerevisiae* UCD 522 as starter culture. The fermented beverage had 10-11.5 % alcohol, 0.44- 0.57, % acidity, 0.26-0.28 per cent residual sugar, 300-402 mg/l phenolics and <0.09 per cent volatile acidity. The strain was capable of completing the fermentation in 9 -11 days at 20^0C. The beverage was scored as 'Like moderately' by the panel of 11 tasters using a hedonic 9 point scale.

Custard apple

A beverage concentrate was prepared from which, carbonated RTS beverages were prepared by subjecting to either carbonation at 200 psi or no carbonation followed by addition of sodium benzoate at 100 ppm or mild heat treatment (55-60°C for 20 minutes). Spoilage organisms were not found in the treatment combinations involving heat treatment, while other contained few organisms though visible spoilage was not found. Carbonation at 200 psi CO_2 improved taste and overall acceptability of RTS beverage and addition of sodium benzoate (100 ppm) gave stability to the product up to 6 months.

Passion fruit

RTS beverages were prepared from passion fruit juice with the composition of 7 %juice, 15°-18°Brix and 0.25% acidity in case of control and 110-330 mg of sucrolose instead of sugar in others and heat processed. Sucrolose at 220mg or lower dose did not give sufficient sweetness in the beverage and required 330mg for good taste. In sensory evaluation, compared to control all the other recipes were best and among alternate sweeteners, the beverage with 330 mg of sucrolose was the best.

Fruit punches

Fruit punches were prepared by blending pulp/juice of different fruits such as amla, mango, passion fruit and custard apple in equal proportions and beverage concentrates were prepared. The TSS of the product varied between 58.5 to 61.0°B and acidity between 2.37 to 2.83. In over all acceptability the fruit punch comprising of amla, mango and passion fruit was judged the best due to better taste and flavour scores.

Fruit punches

Carrot

Juice of Ooty long variety of carrot, was extracted either with or without pectinase enzymes and RTS beverage prepared with 50% juice and with other additives such as cardamom (0.2%) and ginger (0.3%). Adjustment of sugar and acid content and additive combinations was tried. The yield of crude pulp was 59.4% and clarified juice was 93.0% of crude pulp. Carrot juice with cardamom and ginger extract incorporated had improved taste and the product had stability for six months under ambient storage conditions.

Dry flowers

Among three *Dendrobium* (orchid) varieties evaluated for dried flower qualities, var. Sonia yielded life like dried flower qualities viz. color, shape, size and texture containing 3% moisture and having more than 4 months of shelf life when dried in silica gel embedded hot air oven at 42° C for 48 hours. Flowers of var. Emma White turned from bright white to straw colour whereas var. Madam Pompadour showed charred effect after drying. Among three harvest stages of flowers of var. Sonia dried in silica gel embedded media at 42° C for 48 hours had higher flexibility 47° and retained its original greenish white color at basal portion of the outer sepals of half and ¾ open stage florets whereas the white color of basal portion of the outer sepals of fully open florets turned to straw color and exhibited poor flexibility (15°).

Dried dendrobium

Among five standard carnation varieties cut flowers evaluated var. Dona retained its original dark pink color and texture when dried in silica gel embedding. Flowers harvested at paint brush stage were found more suitable for flower color, texture shape and size. Shelf life and their suitability in varied dried flower products are being evaluated.

Celosia spicata and *C. plumose* inflorescence harvested at full colour stage yielded glossy and smooth texture dried flowers under shade air drying. These dried flowers had shelf life of seven months in open storage at RT. Among three methods tried, air drying under shade was found feasible to obtain superior quality dried inflorescence in cockscomb var. Magenta and discoloration in var. White.

Silica gel embedded hot air oven drying at 40° C for 24 h. yielded improved quality dried cosmos petals of bright orange and foliages of green colour with smooth texture. Maximum

shelf life of six months was obtained in 300 gauge poly ethylene package.

Showy bracts of seven varieties of bougainvillea harvested after the dew dry at their best size, shape and colour ,var. Partha (Dark purple) yielded smooth and bright color bracts when press dried. These bracts are suitable for greeting cards, wall frames, tea coasters and glass art.

3.5.4 Optimization of packaging and transport

Sapota

It was found that fully mature sapota (var.Cricket Ball) packed in CFB boxes of size 400x300x150mm, 5-ply rate with paper pieces as cushioning material was superior for road transportation as these transported to a distance of 400 km by road , ripened in 5 days after transportation had less spoilage and PLW and more firmness compared to those packed in CFB boxes of size 400X300X200mm and 400X300x250mm, in traditional bamboo basket and polythene bags.

Aonla

Fully mature aonla (Var.Krishna) packed in CFB boxes of non telescopic type of size 400X300X150mm with partition in between was found to be superior for road transportation and transported to a distance of 525 km by road and stored at room temperature for 10 days after transportation had less spoilage and more firmness compared to those packed in traditional bamboo basket and gunny bags.

Jasmine

Bulk packaging and transportation study was carried out with tight bud stage *Jasminum sambac* flowers. Quality of 6° C pre cooled flowers were better over 13° C pre cooled ones. Flowers remained white and opening was higher (75%) in bamboo basket. Temperature inside the thermocol box containing flowers was higher (33°C) as compared to CFB box (31°C) and bamboo basket (27° C). Flowers in the centre of the thermocol box exhibited discoloration.

3.5.5 Use of crop residue and processing waste

Mango

The process of extraction of total carotenoids from mango processing waste (peel and stones) was standardized using mixture containing 3 parts petroleum ether and 2 parts acetone. The extracted pigment was crystallized by separation of solvent mixture through evaporation in presence of a carrier (banana flour). The total carotenoids in the extract with 0.5 g banana flour as carrier was found to be 75.56 mg/100g while that with 1.0 g banana flour was found to be 199.48 mg/ 100g. About 228 ml of washings were obtained per kilogram of mango peel and stones waste which had 5.5^{o}Brix TSS. This washing when subjected to fermentation using yeast strain UCD 522, yielded 10.97 ml / kg spent sugar syrup as waste.

The process to produce ethanol from fruit processing waste was also standardized. The spent sugar syrup obtained as waste after osmotic dehydration of fruits had 44°B which was adjusted to 30°B and subjected to bio-ethanol fermentation using UCD 522 strain of yeast. The ethanol produced was distilled and purified. The volume of ethanol obtained was 125 ml / litre spent sugar syrup. This ethanol will be tested for blending with petrol for use in IC engines.

Cauliflower and Cabbage

Crop residue was determined in cauliflower(var. Tetrace) under farmer's field conditions which showed 57.30 tonnes of field residue /ha of which 40.70 tonnes/ha was cauliflower leaves. The total biomass was 121.100 tonnes/ha while economic yield was 63.80 tonnes/ha. Physico-chemical analysis of cauliflower leaf waste showed 87.37% moisture, 12.13% soluble solids, 0.49% acidity, 500 mg% vitamin C, 6.933% carbohydratres, 2.15% protein, 2.267% crude fibre and 3278µg/100 g total carotenoids on fresh weight basis.Similarly, physico-chemical analysis of cabbage leaf waste (cv.Unnathi) showed 6.0^{o}Brix soluble solids, 0.251 % acidity, 390 mg/100g vitamin C, 2.633% protein and 6537 µg / 100 g total carotenoids. Proximate composition analysis of cauliflower leaf residue showed 19.47%, 16.00% and 20.80% of carbohydrates, 11.32%, 10.38% and 10.76% proteins, 10.97%, 12.35% and 11.3% fibre content on dry weight basis in NS-60, PM and N-12 varieties respectively.

3.5.6 Mechanization of production and processing of horticultural crops

Fruit Crops

A tractor operated hydraulic harvesting platform for tree fruit crops has been designed and developed. It has an operator's platform, scissors lift mechanism and a trailer. The operator's platform is of the size 1.6 m x 1.2 m made up of mild steel and provided with the aluminium checkered plate floor to have standing grip while operation. The platform is provided with the side railing to a height of 1.2 m to protect the operator from fall and has a hinged door at the entrance side. The operator's platform is fitted above the scissors lift mechanism. The scissors lift has 1.2 m feet arms made up of mild steel hollow tube of 10cm x 4.5 cm and four stage scissors to lift the plat form to a height of 4 m at its maximum position. The scissors lift is operated by a two stage hydraulic cylinder of

Four operators harvesting mango fruits

0.1 m size dia of 1 m length. The cylinder is operated by the tractor hydraulic system. The hydraulic lift is fitted on the trailer of the size 3.4 m x 2.5 m at a height of 1 m from the ground level.

A long reach chain saw was also tested using the above mentioned tractor operated hydraulic platform for pruning mango trees at of 5th order branch. The observed capacity was one tree per hour upto a height of a 8 m.

Pomegranate

The hand operated pomegranate aril remover developed earlier has been modified as motorised aril remover. There are two hitting hubs fitted on reciprocating arms to hit the two halves of pomegranate fruit. The reciprocating arm is operated by a motor and gear box. The removed arils are collected through a sieve and collecting chute.

Chilli

Performance of a low cost chilli transplanter was evaluated. The field capacity of the transplanter for transplanting chilli was 0.16 ha/h The dry chilli yield for mechanically transplanted and manually transplanted chilli was 2.5 tonnes /ha and 2.3 tonnes /ha respectively. The operational cost for bed preparation and transplantating was Rs.2250 /ha in comparison to Rs.4800 /ha for manual ridge making and transplanting for chilli. The labour requirement for transplanting one ha by transplanter was 3 mandays whereas for manual ridge making and transplanting was 60 mandays for chillies.

Onion

Six-row tractor operated onion transplanter for flat bed has been designed and fabricated. Six labourers sit on the frame of the transplanter and place the root of the seedlings in the pits marked by the markers at the required spacing. The row spacing is 17 cm. and seedling spacing is planned to be 10 cm. Seedlings are to be singulated and placed in the required pit by the labour. Height in the seedling for transplanting is 15 cm. The field capacity was 0.9 ha/ h. when working at speed of 0.7 km/h.

Transplanting onion seedlings

3.6 Social Science Research and Computer Application

3.6.1 Economics of Production

Production feasibility and economics of input use efficiency

The net worth of the pomegranate cultivation was estimated by drawing cash inflows and out flows for 7 years of production during 2007-2008. The net present value (NPV) was Rs 5,48,505/ha and the benefit costs ratio (BCR) was 2.46 at 10 per cent discount rate. The internal rate of return (IRR) was more than 220 per cent per annum suggesting high return from pomegranate cultivation. The pay back period (PBP) was two years. The total annual employment generation was 269 labour days comprising of 175 days of men labour and 92 days of women labour. The average productivity was 11.61 t/ha with great degree of variability due to the problem of bacterial blight (57 % CV). The highest yield realized was 27.9 t/ha.

Cobb–Douglas production function failed to identify the variables which influence the production due to high variation in the returns which was caused by the adoption of different marketing practices like field, local market and pre harvest contract sales. Factor analysis was employed with SPSS XI software and 'twelve variable' instrument was subjected to principal component VARIMAX rotation. All the estimated communalities were high, indicating good representation of the variables. Further, the VARIMAX rotated factor matrix and factor loadings indicates that the factors of production of pomegranate clusters around four factors accounting for 72 per cent of total variation. The first component is most highly correlated with N (kg/ha), P (kg/ha), K (kg/ha), growth regulators (Rs/ha) and fungicide (Rs/ha), accounting for nearly 32 per cent of the variance suggesting that these factors are extremely important in production for getting higher returns. Labour, irrigation and miscellaneous costs involved in the production emerged as second most important set of variables to explain the production of pomegranate (18% variation). The third component is most highly correlated with FYM and insecticides, accounting for 11 per cent of the total variance. The final component which explains 10 per cent of variance includes establishment costs and plant density.

Economics of pest management practices under protected structure in capsicum

Data were augmented from cultivators in Bangalore and Tumkur districts of Karnataka. Net worth analysis was performed for 6 years. The discounted NPV at 10 per cent discount was Rs 2703337/ha. The BCR was 1.55 and the IRR was 70 per cent per annum signifying the economic importance of the crop. The pay back period was estimated to be less than two years or four production seasons. There was no IPM package in practice for management of pests and diseases in capsicum under protect net. All farmers in the sample used chemical means to manage pests and diseases. Phythoptera and bacterial wilt are emerging to be the major problems.

Economic feasibility and profitability in gerbera

On an average each farm in Anekal and Nelamangala regions of Karnataka allots up to 2.7 ha for gerbera cultivation. At least 6 different varieties were cultivated by the farmers and maximum plants were seen under variety Danna Ellan followed by Goliath. Cost of establishing a 500 sqmt polyhouse works out to Rs. 3,82,242 and nearly 54 per cent was spent on the construction of polyhouse alone. Planting material accounts for 26 per cent of the establishment costs i.e. Rs 99,150. On an average 2730 plants were accommodated with different colour combinations and cost of cultivation works out to Rs.1,58,000. Nearly 19 per cent was spent on material inputs like FYM, fertilizers and pesticides, 18.4 per cent on labour and 12 per cent on marketing. With a yield of 0.98 lakh flowers, gerbera cultivation assures a net return of Rs. 1.8 lakhs per polyhouse per annum. The project holds a net present worth of Rs. 2.45 lakhs and an IRR of 31 per cent.

3.6.2 Marketing, supply chain and price analysis

Market integration in pomegranate

Market correlations were used for market integration studies in eight important markets in India viz. Bangalore, Mumbai, Chennai, Kolkata, Ahmedabad, Delhi, Nagpur and Kanpur by using monthly and weekly prices and arrivals for 16 years from 1993 to 2008. The degree of association between the prices of different markets was significant among all the markets. It was strongest between Bangalore and Kanpur (r=0.880) followed by Kolkata (0.855), Chennai (0.770), Delhi (0.766), Mumbai (0.764), Nagpur (0.639) and weakest between Bangalore and Ahmedabad (0.451). Price forecasting models for pomegranate are being developed. Since the element of seasonality was observed in the time series data, seasonal ARIMA model was used to forecast prices in Bangalore and Kolkata markets. ARIMA (1, 1, 0) and ARIMA (1, 1, 1) were attempted to forecast the prices. The predicted prices for Bangalore, Kolkata and Delhi coincide with the actual prices in about 70 per cent of the cases. Further refinement is in progress.

Economics of post harvest loss in guava

Two main marketing channels viz., field sale and self marketing in Bangalore were practiced by the growers in Bangalore district, Karnataka. Post harvest losses (PHL) during different stages of handling in self marketing channel were assessed from thirty nine guava harvesting fields and thirty one retailers of guava in Bangalore. Total PHL was 13.29 per cent consisting of a loss of 9.17 per cent at field immediately after harvest and 4.12 per cent loss at retail level. The loss at the harvesting field consisted of over ripe fruits (2.93%), bird attack (0.24%), mealy bug (0.54%) and diseases like blossom end rot (1.32%) and canker (1.29%). Further, scratches on the fruit due to thrips, friction during transport, etc. accounted to the tune of 2.71 per cent. Loss at the retail level was mainly due to injury caused due to during heaping and crushed fruits during transit, unloading and loading.

Supply chains for horticultural crops

Corporate interventions such as Subhiksha, SAFAL, Reliance etc are making their way into retail marketing as an alternative to the exploitative marketing practices to promote direct marketing with least intermediaries between the producer and the final consumer. The SAFAL model of supply chain was evaluated to draw inferences for an optimized model that benefits all the stakeholders. This market expects the farmers to form groups called the Farmer Associations (FA) and undertakes all its procurement only though these societies. The FA supports the farmers in backward and forward linkages with the support of Safal Market. Based on the daily procurement and sale data collected from the market, two crops that figure maximum in their procurement list, viz., tomato and banana, have been selected for further analysis of marketing efficiency.

3.6.3 Exports

Export experienced significant growth of in 14.12 per cent in quantity (Q) and 21.63 per cent in value terms (V) with instability index ranges from 35 to 40 per cent. The major importers of Indian pomegranate which experienced positive, higher and significant growth are UAE (Q- 16 %; V- 22%), UK (Q-32 %, V- 44%) and Oman (Q- 39 %, V-42 %). Bangladesh showed lower growth while Saudi A*Rabi*a and Kuwait are experiencing declining growth. Of late, Netherlands, UK and Sri Lanka are emerging as major importers of Indian pomegranate. However, export to these destinations was found to be unstable as seen in the instability indices derived.

3.6.4 mpact of IIHR technology

Banana foliar nutrition

Foliar application of nutrients especially a combination of micronutrients helps quicker absorption and result in higher yield and better quality. 'Banana special' developed by the Institute in 2001-02 and has been tested on farmers' fields under NATP village level studies. The technology is now being adopted even for other fruit trees like pomegranate and guava with positive results. Economic impact of adoption of foliar nutrition in banana was assessed from a sample of 50 users and compared with 50 non users. Results revealed that though the use of the technology increases the cost of cultivation marginally, growers benefit from increased bunch weight and hence higher profits both in main and ratoon crops. The use of the formulation gave 10 per cent higher yield due to increased bunch weight and 24 per cent higher net return/ha. The popularity of the nutrition formulation has been growing steadily over the years. The Institute has been supplying the formulation through ATIC since 2003-04 and sold around 6 t. It is estimated that over 400 ha area of banana has benefited across three states with a net benefit of Rs 300 lakhs. The nutrient formulation has been commercialized through Institute's technology

management unit and has been licensed to NRDC for commercialization during 2009-10.

Tuberose var. Arka Prajwal

Arka Prajwal, a tuberose variety has been adopted by farmers of Karnataka and Tamil Nadu. Nearly 12 per cent of tuberose area is under this variety in Karnataka, mostly in Bangalore, Mysore and Gadag districts and about 4 per cent in Tamil Nadu, mostly in Tiruchirappalli, Erode, Salem, Palghat, Teni, Madurai, Tuticorn, Pudukkotai and Tiruvannanalai. A case study of 40 selected respondents revealed that farmers harvest tuberose flowers up to 15 t/ha and have benefited from the sale of bulbs as well.

3.6.5 Statistical models

Statistical models in mango

Response surface models for optimum dose of irrigation and fertigation in mango cv Arka Anmol, was developed and the results showed that 45.54 per cent of evaporation replenishment (ER), and 72.33 per cent of recommended dose of fertilizer (RDF) was found optimum which resulted in a yield of 15.20 kg/plant for the first year of experimentation in 2005. For the 2nd year, 41.3 per cent of ER and 87.9 per cent of RDF was found optimum which resulted in a yield of 26.09 kg/plant. For the 3rd year of experimentation, 40.48 per cent of ER and 72.13 per cent of RDF was found optimum doses which resulted in a yield of 24.00 kg/plant. Pooled analysis showed that, the optimum dose for optimum crop yield would be 46.41 per cent of ER and 78.57 per cent of RDF which would result in a yield of 29.65 kg/plant. Ideotype canopy architecture model for higher productivity constructed in cv Alphonso was estimated by regressing fruit yield/plant with 26 canopy characters indicated that about 91.6 per cent of the variability in fruit yield per plant (kg) could be explained by plant characters comprising of plant height, plant girth, plant spread NS & EW, TSA, canopy height, tree volume, light interception, no. of primary, secondary & tertiary branches, average length , girth & TSA of primary, secondary & tertiary branches.

Crop logging models in banana

In order to develop crop logging models for G-9 crop, information on different biometrical characters such as plant height (cm), plant girth (cm), leaf length (cm), leaf breadth (cm), no. of leaves and no. of suckers across four different growth stages of the crops were collected till seventh month of crop growth from 100 plants in farmers' field located at Anagalpura village of Dodballapur to work out the transition probability matrix. Four different homogenous clusters were made for constructing the transition probability matrix. Transition probabilities worked out showed for the presence of four homogenous clusters and that the plants moved from below average cluster to higher cluster with high probability of 0.72, which will form the base for developing crop logging models.

Optimizing the role of nutrition in brinjal

Models developed to understand the response of N, K and Ca & B on rating for leaf hopper damage in brinjal over different time-epoch showed that response to nitrogen resulted in a fourfold increase in rating (0.61 to 2.56) from 8th to 9th week of observation (105 DAP), whereas response to potassium remains constant after 5th week of observation (70 DAP) and the plots receiving Ca and B (1N 1P 1K + Ca+B) also resulted in three fold increase in rating (0.56 to 1.5) from 8th to 9th week of observation (105 DAP). Subsequent analysis further showed that there is a significant difference in the crop yield wherein only nitrogen was applied (14.07 kg) which was twice as much as that of plants receiving only potassium (7.32 kg) and the plants receiving Ca and B (1N 1P 1K + Ca+B) resulted in crop yield of 11.09 kg.

Thrips population dynamics in capsicum

Population dynamics models developed in cv Indira showed that in case of thrips rating less than 1.0, a model expressed as Y =2.92-0.43*max temp+0.079RH(1430hrs) could predict the incidence to the extent of 90.9 per cent. In case of thrips rating exceeding 3.0, a model expressed as Y = 6.39-0.31*max temp could predict the incidence to the extent of 80.1 per cent. Suitable prophylactic measures were adopted using the above results by the entomologist. The prediction powers of the models across different rating levels were in the range 80.5 to 94.0 per cent.

3.6.6 Transfer of Technology

Innovative extension, information and communication methodologies

Three approaches viz. group approach, voice messaging and techno-agents were implemented for transfer of technology in horticulture. Benchmark survey for 'group approach' was conducted in 2 horticultural villages viz. Agrahara and Antarahalli in Bangalore rural district, Karnataka. New interventions were made and group meetings were conducted with growers and experts from IIHR. The present cropping system was studied and based on group interaction, alternative cropping systems were suggested. For implementing 'voice messages for dissemination of horticultural technologies' a tie up has been made with IFFCO-AIRTEL for sending horticultural technologies from IIHR as voice messages. Fifty contact farmers in and around IIHR were given green SIM cards. IIHR is regularly giving technologies for periodic transmission to farmers as voice messages. SMS services have been started for vegetable crops like tomato, chilli, gourds, etc. Important and critical information on IPM and INM were disseminated.

Techno-agents in horticulture were developed within the village/community for creating effective linkage mechanism among horticultural research institutes, development agencies and farmers. Based on the problems reported, SMS were sent daily to techno-agents to take appropriate

measures. A total of 98 techno-agents were trained on IPM in tomato, cabbage and ridge gourd (29 techno-agents), foliar micro nutriment application in vegetables, banana and mango (13), cultivation of improved varieties of tomato, brinjal, ridge gourd and french beans (11), fruit fly management in mango and cucurbits (16), vegetable seedling production (2), enrichment of FYM with biofertilizer and biopesticides (18) and drip irrigation and fertigation (6). It was observed that the knowledge levels of techno-agents had increased significantly after participatory demonstrations and interaction meetings. Analysis of change in knowledge of 68 techno-agents indicated that the mean score of knowledge component of 'integrated nutrient management' of techno agents has increased from 13.1 (out of 30) before the participatory demonstrations and interaction meetings to a mean score of 22.4 after upgradation of knowledge level. Similarly the increase in mean score in the other knowledge components were, from 11.9 to 22.4 in IPM, from 9.4 to 22.6 in IDM and from 8.8 to 17.7 in pest and disease management in mango.

Identification of technological gaps

Participatory Rural Appraisal (PRA) was conducted in Karnataka, Tamil Nadu and Andhra Pradesh involving about 120 farmers, four marketing agencies and four research institutions /developmental departments to identify the technological gaps in adoption of IIHR technologies in protected cultivation of vegetable and ornamental crops, two varieties of french beans and one variety each in chilli, tomato and papaya. Technological gaps and constraints were categorized and prioritized based on their importance and the potential for technological intervention in different areas. Major technological gaps or constraints identified with respect to protected cultivation of vegetables were

1. Structural defects in the construction of poly/ nethouses and its poor maintenance, due to self construction or involvement of unprofessional people.
2. Lack of standard package for pests and diseases to control insect pests and diseases under poly house like *Phytopthera* and bacterial blight in bottle brinjal (36%), downy mildew, white flies and leaf miner in sweet cucumber (60%), and leaf miner in pole beans, (30 to 40%), rust; *Rhizoctonia* rot, white flies, thrips and mites in gerbera (25 to 30%), leading sometime to a crop loss up to 75 per cent.
3. Non availability of recommended crop rotation modules for different soil/climatic conditions under protected environment.
4. Indiscriminate use of pesticides as recommended by the unprofessional consultants, leading to increase in production cost and development of resistance.
5. Non-availability of quality bioagents and bio-pesticides, oils, foliar formulations, as recommended in the package.

Some of the suggestions received from the farmers for improvement of quality and safe production coupled with better marketing of vegetables were,

1. Development of vegetable varieties suitable for protected cultivation in coloured capsicum, sweet cucumber (Parthenocarpic) English tomato, cherry tomato, pole beans, seedless water melon. Varieties resistant to *Phytopthera* and gall midge in colored/ green capsicum, bacterial blight in bottle brinjal are highly desirable.
2. Grafting technology in gourds, melons, capsicum, bottle brinjal, tomato and other suitable solonaceous vegetables raising disease-free seedlings for protected cultivation.
3. Development of crop rotation models, crop specific IDM and IPM package with the inclusion of latest molecules/ products.
4. Field based demonstration of the IIHR varieties and technologies and assured supply of IIHR technologies and inputs through horticulture departments and KVK's. Intensive institute- farmers' interaction for better diffusion of technology.

Important crop based feed back/refinement suggested by technology users for further refinement and development were,

Papaya: Development of variety resistant/ tolerant to PRSV and fruits with more uniform size and shape and incorporating these characters in Surya and foliar nutrition package to overcome micro nutrient deficiency.

Tomato :Development of variety/hybrid with better shelf life, resistant to multiple diseases (particularly early and late blight/ *Phytopthera*) for open cultivation and hybrid for protected cultivation with uniform size/shape of fruits for at least 6 months duration.

Chilli: Development of hybrid resistant to multiple pest/ diseases (including powdery mildew, fruit rot, thrips) with all the good attributes of existing hybrid.

French bean: Development of variety with all the good characters of Arka Suvidha, resistant to rust, bacterial blight and mosaic

3.6.7 Gender Mainstreaming in Horticulture

List of various statements related to drudgery in horticultural operations were listed based on the review of literature, reports and consulting experts. Then, this preliminary set of items was subjected to rating by distributing to 100 judges. The responses of judges were obtained as most relevant (score of 3), relevant (2) and not relevant (1) in 3 point continuum scale. After collecting the judges' opinion, the average score was calculated and statements with more than 2 score of relevancy were included in the final schedule. A draft interview schedule against set objectives for measuring the variables of the study was prepared, pre-tested and necessary changes were incorporated. Data was collected by personal interview method in two villages each from two

taluks of Malur and Srinivaspura talukas of Kolar district, Karnataka.

3.6.8 Documentation of organic technologies

Data on 50 farmers who are growing horticultural crops in a farming system were collected from Kolar, Chikkaballapur, Dharwad, Udupi, Shimoga, Uttara Kannada, Dakshina Kannada, Chikkamagalore and Chamarajanagar districts in Karnataka. Farmers reduced the cost of cultivation significantly by practicing organic farming holistically and are satisfied with meagre profits. About 94 per cent of these farmers were non-certified and remaining farmers were certified mostly for arecanut crop. Documentation from 24 farmers from Tarikere Taluk, Chikkamagalore district on organic horticultural cultivation indicated that seeds of vegetable, fruit or field crops were soaked in fermented butter milk overnight and sown in nursery or directly in the main field. Germination was nearly 100 per cent compared to 80 per cent in non-soaked seeds. The seeds treated with beejamritha, another practice followed by the farmers also showed nearly 100% germination nearly 100 per cent and yielded higher but this data needs scientific validation. As regards technologies to control the incidence of pests and diseases which was practiced by farmers of Kollegal taluk, Chamarajanagar district, citronella leaves (25 kg), gliricidia fresh leaves (25 kg), chilli fruits (1 kg), tobacco fresh leaf (10 kg) and tinospora (5 kg) were chopped to small pieces into a drum containing water and allowed to soak for one month for fermentation. Stock solution was prepared and the diluted solution (in the ratio of 1:10-12 of stock solution and water) with soap as a surfactant was sprayed. Most of the pests of fruit and vegetable crops were controlled as reported by farmers.

Participatory rural appraisal has been carried out on organic production of horticultural crops in humid tropics with 30 growers in Coorg by consultative processes between farming community and multi disciplinary team of scientists. Several field level discussions were carried out using different participatory tools such as general transact, resource map, time line, time trends, technology map and indigenous technology map. Organic farming practices and methodology for preparation of organic inputs and problems faced by them were documented. Majority of organic farmers (53.33 %) had less than 5 years of experience in organic farming. Nearly 33.33 per cent of farmers had experience in the range of 5-10 years and about 13.4 per cent had 10-15 years experience. About 90 per cent of growers opted for seedlings where as remaining opted for disease free grafts. About 60 per cent of the growers have prepared organic inputs themselves and remaining growers purchased organic inputs from agro agencies. About 63.33 per cent of growers partially adopted organic nutrient management practices followed by full adoption (30%) and non-adoption (6.64%). About 46.67 per cent of growers partially adopted organic pest control practices followed by non adoption (36.66%) and full adoption (16.67%).

3.6.9 Computer application

Bioinformatics

Bioinformatics application on comparative genome analysis for characterization of Tomato ESTs has been conducted on stress responsive genes of known species and a gene AT5G67030 of A*Rabi*dopsis thaliana ABA1 responsible for tolerance to osmotic stress was found. The enzyme zeaxanthin epoxidase that encodes a single copy of gene, functions in first step of biosynthesis for abiotic stress hormone abscisic acid (ABA). Zeaxanthin epoxidase is an enzyme important in ABA biosynthesis. The known gene was then compared through comparative analysis using TIGR TC database and found TC191425 of tomato tentative consensus database sequences producing high-scoring segment pairs. It had shown maximum similarity of 72 per cent and error value of 9.0e-198 with a high scoring value of 4468. It also confirms the Zeaxanthin epoxidase in *Solanum lycopersicum* (Tomato). The sequence TC191425 was analysed with SGN cornel data sets and cent per cent match was found in Chromosome 2 of contig C02HBa0104A12. The TC sequence becomes subset of Chromosome 2 matching location in Chromosome 2 was and found at 49764-53783 bp of Chromosome 2 having strong match as the similarity was significant at 72 per cent with contig C02HBa0104A12. The gene coding region is possible around this region. The gene encodes for Zeaxanthin epoxidase enzyme a key molecule that regulates plant responses to abiotic stress, such as drought and salinity, and is required for stress tolerance have been located.

Digital dissemination system

New website for IIHR has been designed and developed using web 2.0 technologies with CMS features which were not available in the earlier version. The administrator and users can login to add /edit/ delete the contents of the web site. New database such as online market information service was integrated with the web site using component art software which provides online graphical charts of price and arrival trend of the commodity for 10 years. These are useful for the farmers and producers to visualize the trends in the various markets and decide the markets for disposal of produce and crop planning.

Information system for AICRP on Tropical Fruits

A Database has been designed and developed with different tables containing various data fields on varietal details and technologies developed for major tropical fruits grown under AICRP trials. Each table in the database is designed by identifying data fields, assigning proper data types, description with primary keys and foreign keys which uniquely identifies each record. Relationships and integrity established between the tables, enables to prevent redundant data and the uniqueness of the record is maintained. The tables can be redesigned with field names and appropriate data types and the values entered in the table can be edited and modified. Information can be retrieved from the database where the information in one table matches information in other. The table displays data of all the centres working under AICRP on Tropical Fruits, crops grown, varieties released and the technologies developed at that centre. ■

4. Transfer of Technology

Technology Assessed and Transferred

A large number of training and extension programmes were implemented for large scale dissemination of Institute technologies and other improved practices for overall development of horticulture by IIHR and its regional stations/ KVK as detailed below. The institute has a multi-pronged approach for transfer of technologies of the institute which includes:

- Front-line extension through training programmes
- Transfer of technology, assessment and refinement through demonstrations, trails and field days
- Dissemination of technologies through electronic media, print media, radio, TV programmes, exhibitions, interaction meetings/ group discussions etc.
- Popularization of the institute technologies through the Agricultural Technology Information Center of the institute.

4.1 Assessment and refinement of IIHR technologies

Improved varieties : During the year 23 varieties of fruits, vegetables, ornamental and medicinal plant varieties from IIHR were identified for release at Institute level, one chilli and one carnation variety were identified for release at State Level for Southern Karnataka.

Tomato IPM : Ten farmers' participatory demonstrations on IIHR technology of IPM in tomato were conducted in Bangalore rural, Chikkaballapur and Mysore districts of Karnataka. Data on pest and diseases were recorded by farmers themselves and results revealed that frequency of insecticide and fungicide sprays came down to 8 and 4 in IPM plots compared to 14 and 6 in farmer's practice plot, respectively. There was 17.6 per cent increase in the marketable yield in IPM plots (from 43.6 to 51.3 t/ha). Fruit borer incidence was 4.9 per cent in IPM plots compared to 15.2 per cent in farmers' practice plots.

IPM tomato farmer from Agrahara village

Improved varieties of french bean : Farmer participatory demonstrations on IIHR improved varieties viz. Arka Anoop and A. Suvidha was taken up in Antarahalli village of Doddaballapur Taluk in Bangalore rural district of Karnataka. Arka Anoop yielded 20.1 t/ha compared to 18.3t/ha in Arka Suvidha. Farmers rated the variety Arka Anoop higher on yield and rust resistance character compared to Arka Suvidha. But Arka Suvidha scored slightly higher in terms of marketability.

Farmers with Arka Anoop crop in Doddaballapur taluk

4.2 Training Programmes

Various training programmes were organized by the Institute on different aspects of horticulture during the period 2009-10, for officers of the developmental departments, KVK's, entrepreneurs and farmers for effective transfer of innovations. The list of trainings organised by the Division of Extension and Training at the main campus given is given below:

Training programmes organized at the Main station, Bangalore during 2009 - 2010

Sl. No.	Name of the programme	Date	Target Group/ Sponsors	No. of participants
1	Advances in production of Cucurbitaceous and other vegetable crops	7 -8 May 2009	Bayers Crop Science Ltd.	15
2	Post Harvest Technology of Mango from (Kerala)	22 -23 May 2009	Kerala Mango Growers	24
3	Grafting of Passion Fruit	3 -5 August 2009	Govt of Mizoram	4
4	Production of Quality Planting material through Scientific Nursery Techniques in Horticultural Crops	18 - 22 August 2009	Govt. of Andhra Pradesh	15
5	Hi-tech Floriculture for the Officers of Dept. of Horticulture, Govt. of Andhra Pradesh	15 -19 September 2009	Govt. of Andhra Pradesh	14
6	Advances in Production and Post Harvest Management of Mango	5- 9 October 2009	Dept. of Horticulture, Govt of Karnataka	20
7	Recent advances in integrated crop management and crop protection in vegetable crops	15 - 16 October 2009	United Phosphorous Limited	30
8	Recent advances in Integrated crop management and crop protection in vegetable crops	20- 21 October 2009	United Phosphorous Limited	20
9	Model Training Course on Protected Cultivation of High Value Vegetables Ornamental crops	22 – 29 October 2009	Directorate of Extn, DAC Ministry of Agriculture, India	18
10	Advances in Production and Post Harvest Management of Mango	17 - 21 November 2009	Deptt. of Horticulture Govt of Karnataka	20
11	Horticulture Technologies for the Progressive farmers from Moahali District of Punjab	21 - 25 December 2009	Govt of Punjab	9
12	SMS of Krishi Vigyan Kendra	4 - 8 January 2010	IIHR, Karnataka	8
13	Mushroom Production Technology	20 - 28 January 2010	Govt of Kerala	9
14	Post Harvest Management in Horticultural crop	2 - 11 February 2010	Govt of Kerala	10
15	Advances in Production and Post Harvest Management of Mango	16 - 20 February 2010	Govt of Karnataka	20
16.	Production Technology of Vegetables	11 – 12 March 2010	Dept. of Horticulture, Govt of Kerala	12

Training programmes organized at Krishi Vigyan Kendra, Hirehalli, Tumkur

Sl No	Enterprises	Duration days	No of courses	No of participants		
				Males	Females	Total
On Campus						
1.	Home Science– Value addition to Amla and Ragi	1	1	00	35	35
	Total	1	1	00	35	35
Off campus						
1.	Soil Sampling Technique	1	1	20	5	25
2.	Horticulture – IPM in Coconut	1	1	25	3	28
3.	Plant Protection – Pest Management in Coconut	1	1	29	1	30
4.	Plant Breeding – Quality seedling for high yield	1	1	28	2	30
5.	Agronomy – Production of Ragi	1	1	18	2	20
6.	Home Science – Role of SHGs - income generation	1	1	00	18	18
	Total	7	7	100	31	151

Training programmes organized at Krishi Vigyan Kendra Gonikopal

Sl No	Enterprises	Duration days	No of courses	No of participants		
				Males	Females	Total
On Campus						
1	Horticulture	1	17	56	233	289
2	Mushroom cultivation	1	3	-	64	64
3	Soil testing	1	8	320	3	323
4	Animal science	1	4	40	87	127
5	Home science	1	11	39	94	133
	Total		**43**	**455**	**487**	**936**
Off campus						
1	Horticulture	1	21	55	565	620
2	Mushroom cultivation	1	3	38	37	76
3	Vermicomposting	1	5	101	114	215
4	Agriculture	1	7	119	73	192
5	Animal science	1	9	107	180	287
6	Home science	1	10	3	241	244
	Total		**55**	**423**	**1210**	**1633**

Vocational trainings

Sl. No.	Enterprise	Duration in days	No of participants
1	Crochet	3	19
2	Tailoring	30	37
3	Needle work	10	3
4.	Nutritious dishes and preservation of fruit and vegetables	1	50

Sponsored training programmes

a) Three on campus training programmes were conducted for the benefit of farmers from three taluks viz. Madikeri, Virajpet and Somwarpet, under National Horticultural Mission of Government of Karnataka, "Organic cultivation of horticultural crops" and other agri. and allied enterprises. The details of the programme are as under.

Sl. No	Dates	No of participants	Beneficiaries from
1	7-10th September 2009	40	Somwarpet
2	14-16th November2009	40	Madikeri
3	25-27th November2009	40	Virajpet

b) A sponsored programme on "Personality and leadership development in youths" of 5days duration in collaboration with Kodagu Yuva Vakkuta, Nehru Yuvaka Sanga, Madikeri from 13-17th Feb. 2010. Forty youth participants consisting of 15male and 25 female participated.

4.3 Demonstrations and field days

4.3.1 Field Demonstrations

The efforts to demonstrate the institute developed technologies have been intensified in the past few years. Institute varieties, production technologies as well as products developed were assessed for their performance at the farmers' field during the period under report. A total of 47 field demonstrations as detailed below were conducted in different districts of Karnataka viz. Bangalore Rural (27), Chikkaballapura (1), Tumkur (3) Kolar (4), Ramanagar (5), Mandya (1) and Mysore(6) District.

Sl. No.	Demonstrations	No. of demonstrations	Variety/Village
1.	Foliar nutrition in Banana	2	Doddaballapur
2.	IPM in Cabbage	2	Seethakempanahalli (Bangalore rural district)
3.	IPM in Tomato	6	Agrahara (5), Silvepura, Bangalore north (1)
4.	IPM in Ridge gourd	2	Tammarasanahalli (1) and Silvepura (1), Bangalore Rural Dist.
5.	Peas (Arka Ajith)	2	Hirehalli, Tumkur
6.	Control of Shoot and fruit borer in Brinjal through tricho cards	1	Byrapura village of Hessaraghatta Hobli
7.	French bean (Arak Anoop and Arka Suvidha)	5	Doddaballapur(2), Chikkaballapura(1) Antarahalli, Doddaballapur, Bangalore rural dist (2)
8.	Management of fruit fly in Ridgegourd	1	Tamarsanahalli, Bangalore north, Bangalore rural
9.	Improved variety on French bean Arak Anoop	2	Doddaballapura, Hirehalli
10.	Foliar nutrition in mango	2	Sreenivasapura
11.	Demonstration on Crossandra var. Arka Ambara	2	Doddaballapur
12.	Management of collar rot in Peas	2	Pemmanahalli, Hirehalli
13.	Safe & quality production of coloured capsicum under shade net/polyhouse	8	Bangalore, Kolar, Ramanagar and Mysore Districts
14.	IIHR Chilli Hybrid	6	Mysore, Mandya Districts
15.	Cultivation of Arka Ambara	2	Bangalore, Mysore Districts
16.	Protected cultivation of coloured capsicum	1	Kanakapura Taluk, Ramanagara district, Malur taluk, Kolar district
17.	Protected cultivation of coloured Capsicum	1	Bangalore North, Anekal and Doddaballapura
18.	Net- house cultivation of coloured capsicum	1	Nanjagud, Mysore district
	Total	**113**	

4.3.2 Field Days and On Farm Training cum Interaction Meetings

Fields days were conducted to demonstrate the disseminated technologies to the farmers of adjoining areas and help them understand the importance and utility of the technologies. Seven field days were conducted on the successful technologies of the institute during 2008-09. The following farmer's on farm training cum interaction meetings were conducted,

Sl. No.	Topic	No. of Participants	Place and Date
1	IIHR varieties and Production Technology of French Beans	15 farmers and KVK staff of DB pura	Antarahalli village of Doddaballapura Taluk on 03.04.09
2	Organic cultivation of Horticultural crops	70 progressive farmers	Chikkaballapura Dist on 11.05.09
3	INM, IPM and IDM practices in Grapes	30 Grape growers from Bangalore North Taluk	IIHR, Bangalore on 01.09.2009
4	Management of fruit fly in mango	-	Srinivasapura and Devanahalli on 28.05.2009
5	Soil and water conservation techniques in Horticulture crops.	-	Hadonahalli, Doddaballapura taluk on 09.10.2009
6	French Beans variety - Arka Suvidha	20 farmers	Agrahara in Bangalore North taluk on 15.10.2009
7	Preparation of Vermi compost	15 farmers	Shivakote in Bangalore North taluk on 23.10.2009
8	Improved methods of Vegetable cultivation	120 farmers and 03 officers of DOA	Chikkaballapura on 30.10.09
9	Cultivation of Tomato variety Arka Ananya	20 farmers	Chintamani (Nayindanahalli) on 04.11.09
10	Balanced nutrition of horticultural crops	-	Thogarsi village, Shikaripura Taluk, Shimoga district on 16.12.2009
11	Mango fruit fly and mango stone weevil	-	Paiyur farm, Hosur Taluk on 6.01.10 , Kolar on 20.01.10, Srinivasapura taluk, Kolar distt. on 21.01.10 and on 16.2.10
12	Off-season mango production	-	Horticultural Research Station, Pechiparai, Kanyakumari, Tamil Nadu on 7-8 December, 2009.
13	Protected cultivation of vegetable crops	30 farmers and 5 officers of DOH and 6 scientists of IIHR, Bangalore	Malur taluk, Kolar district on 3.3.2010
14	Vegetable crop field day	200 farmers	IIHR, Bangalore on 24-2-2010
15	Management of blights in tomato	20 farmers and 5 scientists of IIHR	IIHR, Bangalore on 24-2-2010
16	Plant health management in Protected cultivation of vegetables	30 farmers and 5 scientist	JSS institute, Mysore on 31-08-2009.

4.4 Exhibition

IIHR participated in the following exhibitions organized at various places of the country.

Sl. No.	Name of the Exhibition	Venue	Date
1	Krishi Mela	JSS KVK, Suttur, Mysore	22nd to 27th January 2009
2.	Horti Fair "Sangam-2009" sponsored by National Horticulture Board	Pragathi Maidan, New Delhi	22nd to 24th May, 2009
3.	Apple Mela /Exhibition organized by NHB in collaboration with Karnatak Horticulture department	DOH, Lalbagh, Bangalore	9th to 12th Oct 2009
4.	Bharath Nirman Exhibition cum Interaction session organised by PIB, GOI, Bangalore	Gundlupet, Chamarajanagar Distt., Karnataka.	21st to 25th Nov 2009
5.	ICH 2009	Bangalore	9th to 12th November 2009
6.	Krishi Mela	UAS, Bangalore	19th to 22nd November 2009
7.	Orange show	DOH, Lalbagh Bangalore	2nd to 5th Jan 2010
8.	Exhibition during Vegetable group meeting was organized by IIHR, Bangalore and IIVR, Varanasi	IIHRBangalore	16th to 19th Jan 2010
9.	10th Rashtiya Kisan Mela on Citrus	NRCC Nagpur	21st and 22nd Feb 2010
10	International Extension Forum organized two days Seminar on "Women in Agriculture'	DRWA, Bhubaneswar, Orissa	4th and 5th December,2009
11	Regional Agriculture Fair at Ranchi,	IINRG, Ranchi, Jharkhand*	22nd to 24th February,2010
12	National Level Agmark Exhibition organized by Directorate of Marketing & Inspection, Govt. of India, Bhubaneswar	Exhibition Ground, Bhubaneswar, Orissa	23rd to 26th March, 2010
13	National Level Exhibition on "Production of quality seeds and planting material- Health Management in Horticultural crops"	New Delhi	11th to 14th March, 2010
14	Showcasing of ICAR technologies under the NAIP sub project 'Mobilizing mass media support for sharing Agro information'	IIHR, Bangalore	26th and 27th March 2010
15	XXVIII Workshop on All India Coordinated Research Project (AICRP) on vegetable Crops	IIHR, Bangalore	16th to 19th January, 2010
16	Krishi Mela 2009	GKVK, UAS, Bangalore	19th to 22nd November, 2009
17	National Conference on "Production of quality seeds and planting material-Health Management in Horticultural crops"	IARI, New Delhi	11th to 14th March, 2010.
	Diamond Jubilee celebration of CHES, Chettahalli	CHES, IIHR, Chettahalli	8th August, 2009
18	Inauguration of IIHR KVK at Hirehalli	KVK (IIHR) Hirehalli, Tumkur district	9th August, 09
19	Flower show at Madikeri organized "Production of quality seeds and planting material-Health Management in Horticultural crops"	Raja seat Madikeri	1st to 5th May 2009

* Obtained the 3rd position in the Eastern Zone.

4. 5 Technology transfer through Mass Media

The institute has been disseminating information through various programmes using different mass media tools as given below.

4.5.1 Television programmes

Live in Programme of Doordarshan : A Mango Seminar was conducted on 25.04.2009 at IIHR, Bangalore. About 200 growers from different districts of Karnataka participated in this seminar. This face-to-face interaction between the farmers and scientists on various problems faced by the mango growers and other issues related to mango crop was telecasted live on Doordarshan. The programme was attended by the Additional Director of Horticulture, Department of Horticulture, Govt. Of Karnataka, all the scientists working on Mango at IIHR as resource persons. Shri. Chandramouli, Deputy Director, DDK, Bangalore and Shri. Suresh Kumar, Programme Executive, DDK and various technical personnel from Doordarshan Kendra, Bangalore also participated in the seminar. The programme was recorded and telecast for 2 hours by Doordarshan Kendra, Bangalore on 02.05.2009.

Honourable Chief Minister of Karnataka Dr. B.S. Yedyurappa at the IIHR stall during Krishi Mela at GKVK, UAS, Bangalore

TV Programmes telecast on various technologies of the institute are listed below

Scientist	Programme	Network	Date of telecast
M. Prabhakar	Organic farming in cabbage	DD Chandana, Bangalore	08.02.10
M. Prabhakar	Organic production technology of tomato	DD Chandana, Bangalore	05.05.09
M. Prabhakar	Improved method of capsicum cultivation in kannada	DD Chandana, Bangalore	08.08.09
S.S. Hebbar	Improved method of capsicum cultivation in kannada	DD Chandana, Bangalore	22.12.09
R. Vere Gowda	Improved varieties of onion and their production technology	DD Chandana, Bangalore	-
B.Varalakshmi	Leafy Vegetable Varieties released from IIHR	DD Chandana, Bangalore	22.06.09
T.S. Aghora	Improved varieties of French bean, cowpea, peas and Dolichos bean of the institute".	DD Chandana, Bangalore	22.06.09
T.H. Singh	Brinjal Varieties of IIHR, Bangalore	DD Chandana, Bangalore	18.06.09
K. Madhavi Reddy	IIHR released chilli and *Capsicum* varieties / hybrids.	DD Chandana, Bangalore	18.06.09
M. R. Hegde	Activities of ATIC, IIHR	DD Chandana, Bangalore	18.08.09
Girija Ganeshan N.Ramachandran	Live programme on vegetable cultivation and disease management	DD Chandana, Bangalore	07.03.09
Girija Ganeshan	Disease management in Tomato using Biocontrol agents on	DD Chandana, Bangalore	29.04.09
B. Narayanaswamy	Scientific pepper cultivation	DD Chandana, Bangalore	01.09.09
B. Narayanaswamy	Management of areca gardens	DD Chandana, Bangalore	27.08.09
S .V. Joshi	Scientific pig farming	DD Chandana, Bangalore	20.09.09
B. Prabhakar	Sapota cultivation	DD Chandana, Bangalore	12.09.09
S. V. Joshi	Scientific goat farming	DD Chandana, Bangalore	20.12.09
Abraham Verghese M. R. Hegde	Management of fruit fly and stone weevil in mango	DD Chandana, Bangalore	09.04.09

Girija Ganeshan	Biological control of tomato diseases	Doordarshan Kendra, Bangalore	
C. Ashwath	Cultivation of crossandra	Doordarshan Kendra, Bangalore	04.08.09
N.K. Krishna Kumar	Management of viral transmitting pests in papaya	Doordarshan Kendra, Bangalore	-
P. Chowdappa	Integrated management of late blight in tomato	Doordarshan Kendra, Bangalore	
G.S. Prakash	Pruning and prophylactic management practices in grapes	Doordarshan Kendra, Bangalore	29.09.09
N.K. Krishna Kumar	Management of viral diseases in vegetables	Doordarshan Kendra, Bangalore	17.11.09

4.5.2 Radio Programmes

Radio programmes recorded and broadcast during 2009-10

Scientist	Programme	Network	Date
M.Prabhakar	Cultivation of cauliflower with organic method	AIR, Bangalore	09.09.09
S.S.Hebbar	Cultivation of chilli- dialogue in Kannada	AIR, Bangalore	13.05.09
T.S. Aghora	Recent Advances in cultivation of peas	AIR, Bangalore	16.09.09
T.N. Shivananda	Fertilizer Management of vegetable crops	AIR, Bangalore	04.09.09
Girija Ganeshan	Non chemical methods of disease control in fruits and vegetable crops	AIR, Bangalore	22.10.09

4.6 Agricultural Technology Information Center (ATIC)

The ATIC at IIHR, has been instrumental in providing technical know how as well as the literature/VCD's/ products, related to latest technologies developed by the institute and horticultural crop production technologies to farmers, entrepreneurs, students etc. The details of literature/ products sold through ATIC are as given under:

Sl. No.	Particulars	Quantity (Kg/number)	Amount (Rs)
1	Banana Special	9773	1,104,660
2	Mango Special	4026	571,930
3	Vegetable Special	3051	352,512
4	Citrus Special	165	24,750
5	Trichorich-N	2213	221,300
6	Pseudomonas fluorescens	758.7	189,675
7	Paecilomyces lilacinus	315	47,250
8	Pachonia Chlamydosporia	166	24,900
9	VAM	624	23,920
10	PSB	507	28,620
11	Azospirillum	346	19,920
12	Azotobacter	171	9,220
13	Pongamia Soap	1208	120,800
14	Neem Soap	371	46,380
15	ATIC F. No 1 to 12	1404	7,020
16	ATIC Publication	47	564
17	ATIC VCD	119	19,850
18	Mango Fruit Fly Traps	17675	452,675
19	Mango Fruit Fly Traps Plywood Traps	31939	319,390
20	Cue Lure Traps	11205	336,180
21	Cue Lure Wood	12409	186,135
22	Institute Folders	4596	22,980
23	Institute Publication	1861	120,880
24	Institute VCD	64	11,950
25	PHT Products	1827	67397
26	Vegetable Seeds & Sample Packet	3599	45,290
27	Soil Sampling testing	3	300
28	Harvester (Areca nut & Mango)	54	8,100
29	Miscellaneous	7768	38,855
	Total		**4,423,403**

Director, IIHR and the Scientists of the institute during a filed visit to the farmers demonstration plot.

Farmers visiting demonstration plot during scientists-farmers interaction meeting.

4.7 Other programmes organised

- A Brain Storming Session on Horticulture Development in Kodagu and farmers interaction was organized in commemoration of Diamond Jubilee Celebration of CHES, Chettalli on 8th August 2009 on the premises of Central Horticultural Experiment Station, Chettalli, Kodagu, Karnataka. Dr.H.P.Singh, Deputy Director General (Hort), ICAR, New Delhi inaugurated and presided over the function.

Dr. B.M.C.Reddy, former Director of CISH, Lucknow, Dr. H.P.Singh, Deputy Director General (Hort), ICAR, New Delhi, Dr. K.Shivaramu, Senior Scientist (Ento.) and Head In-charge, CHES, Chettalli, Dr. H.Ravishankar, Head of Plant Genetic Resources, IIHR, Bangalore and Dr. Amrik Singh Sidhu, Director, IIHR, Bangalore during the function.

- **Group Approach :** IIHR, Bangalore and Krishi Vigyan Kendra, Hirehalli identified a few groups of famers for transfer of IIHR technologies viz., resistant varieties (Peas) and China aster – Arka Kamini and micronutrients developed by IIHR.
- **Farmers Field School (FFS) :** FFS Programme was implemented in Gollarahatti village, Hirehalli Post, Tumkur Taluk and District after intensive survey. IPM in tomato was identified based on the thrust area. About 10 farmers were identified at Gollarahatti. Use of *trichorich* - N and *Pseudmonas fluorescens* for soil enrichment demonstration has been conducted, giving critical inputs. This programme was also implemented in Thuchamakeri village (Virajpet Tq). Integrated pest management of paddy was identified as a subject of FFS. Twenty five farmers have been covered under this programme . Five training's were conducted. A Field Day was conducted 16th Dec 2009 to popularise the technologies. In all 45 farmers attended the field day.
- **On-Farm Testing's (OFTS) :** Eighty OFT's were conducted on various technologies in different villages on various technologies like management of quick wilt in pepper, assessing ginger varieties, assessment on enhancement of bunch size in Banana, assessment on plant geometry in maize, management of inflorescence die back in arecanut, and nutrient management in ridge gourd.
- **Front Line Demonstrations (FLDs) :** Three hundred and thirty FLD's were conducted on various agricultural innovations in 14 different crops and other technologies in animal sciences. Total coverage under these FLD's was 72.25 ha. area and 110 units in animal sciences.
- **Soil testing campaigns/ Nutritional management :** KVK, Gonikoppal had conducted 7 soil testing campaigns in different villages in three taluks of the Kodagu district. A revenue of Rs.7650/- was added to the KVK income.
- **Animal Health Campaigns :** Two animal welfare campaigns were conducted at Parakatageri and Ramanagar villages in Vrajapet taluk. Awareness was created in the farmers about the incidence of Swine Fever and its effect on pig production. Sixty farmers and farm women participated.
- **Expert-Farmer Interface : A**n Expert- farmer Interface was organized at KVK, Gonikoppal on 21.7.09. The topic was " Soil and water conservation". Sri. Shreepadre, the Editor Adike Patrike was the resource person. This programme was attended by 50 farmers.

■

5. Education and Training

5.1 Post-Graduate Education

The institute continued its post graduate education and training activities by offering guidance to students leading to M.Sc. and Ph.D degrees in collaboration with the following universities and research institutes :

i) University of Agricultural Sciences, Bangalore

ii) University of Agricultural Sciences, Dharwad

iii) Annamalai University, Chidambaram

iv) Birla Institute of Technology and Science (BITS) Pilani

v) Allahabad Agricultural Institute, Allahabad

vi) Sri Krishnadevaraya University, Ananthapur

vii) Jawaharlal Nehru Technological University (JNTU), Hyderabad

viii) Tamil Nadu Agricultural University, Coimbatore

ix) Kuvempu University, Shimoga

x) Bangalore University, Bangalore

Ten of our staff members routinely

5.1.1 M.Sc /Ph.D Degree awarded

The following students were awarded M.Sc /Ph.D degree under the guidance of IIHR scientists as detailed below:

S. No.	Student	University / Institution	Degree	Title of the project work	Name of guide
1	Ms. Mamatha, B.	UAS, GKVK, Bangalore	Ph.D. (SS & AC)	Soil and Nutrient Management studies in *Coleus vettieroides*, Jacob	Dr. T.N. Shivananda, IIHR, Bangalore
2	Mr Krishna Murthy S. L.	UAS, GKVK, Bangalore	Ph. D. (G& PB)	Relationship between parental phenotypic traits and AFLP marker based diversity with heterosis for yield and its contributing traits in Chilli (*Capsicum annuum* L.)	Dr K. Madhavi Reddy, IIHR, Bangalore as Co-Chairman
3	Mr. Santhosha, H. M.	UAS, GKVK, Bangalore	M.Sc. (Hort.)	Characterization and evaluation of early cauliflower germplasm under tropical conditions	Dr B. Varalakshmi, IIHR, Bangalore
4	Ms. Itishree Kar	TACT, Utkal University, Bhubaneswar	M Sc (Biotech)	Induction of defense response in tomato (*Solanum lycopersicum*) by elicitors	Dr Sudhamoy Mandal, CHES, Bhubaneswar
5	Ms. Priyambada Acharya	TACT, , Utkal University Bhubaneswar	M Sc (Biotech)	Reactive oxygen species signaling during interaction of eggplant and *Ralstonia solanacearum*	Dr Sudhamoy Mandal, CHES, Bhubaneswar
6	Mr Prashanth Kumar G M	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Molecular Fingerprinting of Okra accessions by DNA markers	Dr T V Ananthanarayanan, IIHR, Bangalore

7	Ms. Jaya Joshi	UAS, GKVK, Bangalore	M.Sc. (Ag.)	Biochemical studies on the development of corky tissue in sapota [Manilkara achras)	Dr S. Shivashankar, IIHR, Bangalore
8.	Mr.A.S. Harsha	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech	Induction of somatic embryogenesis a ctivity in pomegranate (*Punica granatum* L.) cultures of mature origin"	Dr. Leela Sahijram IIHR, Bangalore
9.	Mr A. Purushothama	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Evaluation of Bt transgenic brinjal cv. Arka Keshav and Bt trans genic tomato cv. Arka Vikas	Dr. H. S. Vageeshbabu IIHR, Bangalore
10.	Mr. K.N.Avinash	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Identification of DNA markers linked to bacterial blight disease in pomegranate (*Punica granatum* L.)	Dr K.V. Ravishankar IIHR, Bangalore
11.	Sheetal Nangau	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Development of molecular marker for pulp color in guava	Dr Pious Thomas IIHR, Bangalore
12.	Prabir Kumar Das	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Studies on somatic embryogenesis in papaya cv. Surya with referenc to endophytic bacterial association	Dr Pious Thomas IIHR, Bangalore
13.	Shailesh Yadav	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Integration and expression of chitinase gene in transgenic tomato	Dr J.B. Mythili IIHR, Bangalore
14.	NugshiLepden	UAS, GKVK, Bangalore	M Sc (Ag) (Biotech)	Development of transformants in pomegranate cv Bhagwa with AMP gene.	Dr Sukhada Mohandas IIHR, Bangalore

5.1.2 Recognition as Post-Graduate Faculty

The following scientists of the institute were recognized as Post Graduate Faculty during the year 2009-10.

- Dr. Rajiv Kumar, Senior Scientist (Hort) Division of Ornamental Crops recognized as a Post graduate teacher in the Department of Horticulture, UAS, GKVK, Bangalore
- Dr. G. Selvakunmar, Senior Scientist (Microbiology) recognized as a PG faculty by UAS, Bangalore in the Department of Agricultural Microbiology
- Dr K. Padmini, Senior Scientist (Hort.), section of Seed Science & Technology recognized as a Post Graduate teacher in the Division of Horticulture by UAS, GKVK, Bangalore
- Dr.R.Venugopalan, Senior Scientist (Agril. Statistics) was recognized as an external expert for conducting Pre - Ph.D. examination in Biostatistics at NIMHANS (Deemed University), Bangalore
- Mrs. V. Radhika, Scientist (SS) Division of Biotechnology was recognized as an external faculty at the Southern Regional Station ,National Dairy Research Institute to offer the course CS-521- Computer Software Packages for Statistical Analysis(2+1) for I year M. Tech (DT).

5.1.3 Short Term Project Training

The institute has been offering short term project work of 3 to 6 months to the students of other universities as partial fulfillment of their post graduate degree programme. During the year 27 students completed their project work in the disciplines of Biotechnology, PGR and Physiology & Biochemistry at IIHR, Hessaraghatta and at CHES, Bhubaneswar.

5.2 Faculty upgradation

5.2.1 Doctoral studies

The following staff members were granted permission to pursue higher studies leading to Doctoral degree as detailed below:

S. No.	Staff	Thesis title	University
1	S. Bhuvaneswari, Scientist (SS)	Studies on shelf life extension of minimally processed onion	Gandhigram Rural Institute (GRI), Deemed University, Gandhigram, Dindigul District, Tamil Nadu
2	B. L. Kashinath, T9	Studies on soil magnesium and its impact on tomato yield and quality in Alfisols of Kolar Dist. of Karnataka	
3	M. Senthilkumar, T6	Studies on enhancing input use efficiency through amalgamation f fertigation and Biofertilizer for sustainable production of Banana *cv.* Robusta (AAA)	

5.2.2 Post Doctoral Studies

- Dr E. R. Srinivasa Rao, Senior Scientist, Division of Vegetable Crops was awarded Post Doctoral Fellowship for one year (2009-10) and was deputed to AVRDC, Taiwan for pursuing PDF studies.
- Dr. Nita Khandekar Senior Scientist, Division of Extension and Training was awarded Commonwealth Academic Fellowship 2009 and was deputed to United Kingdom for six months from 28.9.2009.

5.3 Training of IIHR Staff

5.3.1 Abroad

- Dr. A. T. Sadashiva, Head, Division of Vegetable Crops and Dr. K. V. Ravishankar, Senior Scientist, Division of Biotechnology were deputed for Exposure visit to Research activities at AVRDC- the World Vegetable Centre, Taiwan, from May14-22,2009.
- Dr. K. V. Ravishankar, Senior Scientist, Division of Biotechnology was deputed to participate in ISHS/ Promusa Banana Symposium Global Perspective on Asian Challenges held during September 14-18, 2009 at Phoenix City Hotel, Guangzhou, Republic of China.
- Dr. Panneerselvam was deputed for foreign training in the area of Bio-remediation under Prof. Nanthi S. Bolan, Chair in Environmental Sciences (CFRA) & Dean of Post Graduate Studies, University of South Australia, from February 20 –May 19, 2010 under HRD program of NAIP under Component – I of Learning and Capacity Building (L&CB).
- Dr. Prakash Patil Principal Scientist, PC Cell (TF),was deputed to the Regional Training Workshop on "Methodology of genetic diversity assessment of cultivated and wild tropical fruit tree diversity" at Kuala Lumpur, Malaysia, from March 2-5, 2010.

5.3.2 In India

- Dr N. Mohan and Dr. T.S. Aghora, Principal Scientists, Division of Vegetable Crops, were deputed for a Learning Programme on "Advances in vegetables and vegetable breeding" from April 27-May 20 2009 at AVRDC-RCSA, ICRISAT, Hyderabad.
- Mrs. V. Radhika, Scientist (SS) Division of Biotechnology, was deputed for the Winter School on "Decision making in agriculture using data mining" at the National Centre for Agricultural Economics and Policy Research, New Delhi from October 27-November 16 , 2009.
- Dr N. Mohan, Principal Scientist, Division of Vegetable Crops, was deputed for the training programme on Principles and procedures of DUS testing of vegetable crops including cucurbits from November 3-7, 2009 at the Division of Seed Science and Technology, IARI, New Delhi.
- Dr. Prakash Patil, Principal Scientist, PC Cell (TF),was deputed to the Regional Training Programme on "Participatory approaches in promoting conservation, sustainable use and community based biodiversity management of tropical fruit tree diversity in Asia" at Bangalore from November 9 – 14, 2009.
- Dr.P.Srinivas, Sr. Scientist (Plant Pathology), CHES, Bhubaneshwar was deputed to the a training programme for 21 days (winter school) entitled "Bio-prospecting for micro organisms with agriculturally important traits using polyphasic approaches" held at IARI, New Delhi from November 17 –December 7, 2009.
- Mrs. Reena Rosy Thomas Scientist (SS) was deputed to the workshop on "Sensitization on net working and web hosting at NAARM, Rajendra Nagar, Hyderabad from February 2-4, 2010. ■

6. Awards and Recognitions

6.1 Awards

- The IIHR, Bangalore, received the Lt. Amit Singh Memorial Award for the Best Coordinating Centre of AICRP on vegetable crops. Dr. A.S.Sidhu, Director, IIHR received the award on behalf of the Institute from His Excellency the Governor of Karnataka, Dr. Hans Raj Bharadwaj on January 16, 2010 during the inaugural function of the 28th Group Meeting of AICRP on Vegetable crops held at IIHR, Hessaraghatta, Bangalore.
- Dr. Amrik Singh Sidhu, Director, IIHR received the prestigious Shri L.C. Sikka endowment award 2007-08 at the function held at NAAS, New Delhi on June 4, 2009.
- Narayana, C.K. received "J.S. Pruthi Award" for PHT of Fruits and Vegetables conferred by Association of Food Scientists and Technologists (India), CFTRI, Mysore during ICFOST-2009 on 22nd December 2009.
- Sudhakar Rao, D.V. received J.C. Anand Gold Medal, Instituted by Horticultural Society of India (HSI) for the year 2009 for significant contributions in Post Harvest Technology of Horticultural crops.
- Selvakumar, G. jointly received the World Intellectual Property Organization (WIPO, UN, Geneva) Gold Medal with S.N. Sushil, J.C. Bhatt and H.S.Gupta for best innovation of the year 2008 on 19.11.09.
- Sreenivasa Rao, E. was awarded the "Jawaharlal Nehru Young Scientist Award" for his Ph.D., thesis entitled "Studies on genetics of yield and resistance to early blight in Tomato" submitted to IARI, New Delhi.
- Doreyappa Gowda, I.N. , was awarded "Best Oral Presentation" (III place) for the paper entitled "Development of passion fruit blended RTS beverages" during the International Conference on Food Technology (INCOFTECH 2009), organized by Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu from 28th to 29th Aug 2009.
- Gopalakrishna Rao, K.P. was awarded first prize by the Karnataka State Agricultural Marketing Board, Bangalore for the popular article on "*Tharakarigala Koylothara Nirvahane Mattu Daasthanu*", published in October, 2008 issue of *Krishi pete* .
- Sudhakar Rao, D.V. , was awarded first prize for the popular article on "*Dalimbay Hannina koyilina nantharadha vyavastay*", published in November 2008 issue of *Krishi pete*
- Gajanana, T.M., Sreenivasa Murthy, D., Sudha, M. and. Hegde, M.R., 2008. jointly received best paper award for their article titled "Production and export of pomegranate – an economic appraisal (Kannada)", published in April 2009 issue of *Krishi Pete*.
- Kotur, S.C. was awarded the first Prize in Technical Articles Competition (TOLIC 2008-09) in Hindi, during the observance of Hindi fFortnight by Central Power Research Institute, Bangalore.

6.2 Recognitions

- Aghora, T.S. acted as Rapporteur for the Technical session –XI on "Resistant Varietals Trials" during the "XXVIII Group meeting of AICRP- Vegetable Crops" held at IIHR, Bangalore from 16-19th January, 2010.
- Akella Vani acted as convener at the Technical session on G.M. Seeds – Issues and Strategies at the National Conference on Production of Quality Seeds and Planting Material – Health Management in Horticultural Crops, held at New Delhi, 11-14th March, 2010.
- Ananthanarayanan,.T.V. was nominated as a member of Institute Management Committee of National Bureau of Plant Genetic Resources(NBPGR),New Delhi
- Aswath, C. was nominated as a Panel Member on Kerala Biotechnology Policy and Biodiversity Conservation Committee.
- Aswath, C. was nominated as a member of Research Advisory Group of Institute of Wood Science & Technology, Bangalore.
- Aswath, C acted as Rapporteur for the session on Crop Improvement during the International Conference on Horticulture (ICH-2009) held at Bangalore from November 9- 12, 2009.
- Aswath, C. has been inducted as "FELLOW" of Indian Society of Ornamental Horticulture, New Delhi.
- Debi Sharma, Chaired a session on "Interdisciplinary Areas of Environment" on 17th September 2009 at International Conference on Environment, Occupational and Lifestyle Concerns -Trans disciplinary approach, held at Bangalore.
- Debi Sharma was nominated as Member, Scientific Programme Committee, for International Conference on Environment, Occupational and Lifestyle Concerns - Tran's disciplinary approach, held at Bangalore from 16-19th Sept, 2009.

- Gajanana, T.M. acted as the Rapporteur for the session Screening technologies for horticultural development in socio-economic, agro-economic and agro-climatic perspectives, under Theme Area II: Institutional and policy support: socio-economic domains at ICH-2009, held at Bangalore from November 9-12, 2009.
- Kotur, S.C. was felicitated during the Diamond Jubilee Celebrations of CHES, Chethalli for Distinguished Contribution to Citrus Research.
- Leela Sahijram acted as Chairman, Technical Session IV: Current Developments in Genetic Engineering, National Symposium on Role of Biology & Biotechnology in Conservation of Biodiversity and Sustainable Development held at Gulbarga, from 22nd to 24th December, 2009.
- Leela Sahijram acted as Rapporteur for session on "Regeneration Systems", National Symposium on Horticultural Biotechnology (NSHB): Present status and future action plan, held at Bangalore from 28th to 30th October, 2009.
- Leela Sahijram was nominated as External Expert, Research Advisory Committee (RAC), Institute of Wood Science & Technology (IWST), Bangalore for 2009-2010.
- Madhavi Reddy K., acted as Rapporteur for the Technical session –IV on "Varietal Trials" during the "XXVIII Group meeting of AICRP- Vegetable Crops" held at IIHR, Bangalore from 16th to19, January, 2010.
- Madhavi Reddy, K. has been nominated as member of the Panel of Experts for formulating Integrated Crop Management for Chillies constituted by Spices Board, Cochin
- Meenakshi Srinivas was nominated as member of the 'National Standing Committee for women scientists' by the Department of Science and Technology Government of India.
- Mythili, J. B. has been nominated as an expert member of Project Monitoring Committee of Small Business Innovation Research Initiative (SBIRI) Project of DBT.
- Dr J.B. Mythili, acted as Rapporteuer in the plenary seesion for the theme area on 'Transgenics' in the National Seminar on Horticultural Biotechnology, held at IIHR, Bangalore, Oct 28-29,2009.
- Narayana, C.K. acted as a Rapporteur during brain storming technical session on Post Harvest Handling and Ripening of Banana held at NRC (Banana), Trichy on 21st August, 2009.
- Narayana, C.K. acted as Chairman of Technical Session on Banana Processing and Value Addition during the National Seminar on Banana Processing and Value Addition held at Vasavi Mahal, Trichy from 28th to 29th March, 2010.
- Narayana, C.K. has been nominated as RAC member of National Horticultural Research and Development Foundation, Nashik.
- Narayana, C.K.has been nominated by ICAR as Institute Management Committee Member of National Research Centre for Banana, Trichy for three years (2009-2012).
- Narayana, C.K.has been nominated as Member of Agricultural Systems and Management Sectional Committee, FAD-22 of Bureau of Indian Standards, Manak Bhavan, New Delhi.
- Prabhakar M. acted as Co-Chairman of Technical Session –III on "Vegetable Production (Agronomy)" during the "XXVIII Group meeting of AICRP- Vegetable Crops" held at IIHR, Bangalore from 16th to 19th, January, 2010.
- Raghupathi, H.B. acted as Rapporteur for session II in Indo-US work shop on Silicon in Agriculture 25th to 27th February 2010 at University of Agricultural Science, Bangalore.
- Rajiv Kumar acted as Rapporteur in the Technical Session 'Formulation of Technical Programme' during XIX Biennial Group Meeting of AICRP on Floriculture held at IARI, Pusa, New Delhi from 10th to12th December 2009.
- Rao, M.S. was nominated as a taskforce Committee member of DST (Department of Science and Technology), Ministry of Science and Technology, New Delhi, for the period 2010 – 2013.
- Ravishankar,K.V. acted as Rapporteur for the session on "Molecular breeding and genetic enhancement' during the international 6th Solanaceae Genome Workshop SOL2009, at New Delhi from 8th to 13th November, 2009.
- Sadashiva, A.T., acted as convener to on "Hybrid Seed Production" in the "National Conference on Production of quality seeds and Planting Material-Health management in Horticulture Crops" held from 11-14, March, 2010 at NASC, New Delhi.
- Soudamini Mohapatra, Chaired a session on "Chemicals in Food, Agriculture and Industry and Translocation Areas of Environment" at International Conference on Environment, Occupational and Lifestyle Concerns -Trans disciplinary approach, held at Bangalore from 16th to 19th Sept, 2009.
- Soudamini Mohapatra, elected as Vice President for South Zone in Society of Pesticide Science, IARI, India.
- Sreenivasa Murthy, D. acted as Rapporteur for the session National agricultural policy, programmes and economic growth under Theme Area II: Institutional and policy support: socio-economic domains at ICH-2009, held at Bangalore from November, 9-12, 2009.
- Sudhakar Rao, D.V. acted as a Rapporteur for the Technical session Post Harvest Technology of Fruit

Crops during the "Brainstorming session on Post Harvest Technology" held at IIVR, Varanasi from 24th to 25th November, 2009.

- Sujatha, K. acted as rapporteur for Technical Session - Crop Management - I on during International conference on Horticulture held at Bangalore from November, 9-12, 2009.
- Sukhada Mohandas, has been nominated as Member of the Institute Management Committee of NRC Banana, Tiruchirapalli
- Tiwari, R.B. acted as Rapporteur of the session on Technology for the Production of Specialized Foods for Health and Nutrition during the Indian Convention of Food Scientists and Technologists (ICFOST 2009) held at Bangalore 21st to 23rd December 2009.
- Tiwari, R.B. nominated as a Member of the Information Technology, Biotechnology & Food Technology Committee of Federation of Karnataka Chambers of Commerce and Industry (FKCCI), Bangalore for the year 2009-10.
- Vageeshbabu, H. S. acted as Convener in the National Seminar on "New Biology and Plant Engineering", organized by Jaipur National University, held on 1st and 2nd December 2009.
- Vageeshbabu, H. S. acted as Rapporteur of the Technical Session on "Food, Nutrition and Health Security" in the 2nd International Conference on Horticulture, held at Bangalore from 9th to 12th November, 2009.
- Varalakshmi, B. acted as Rapporteur for the Technical session on "Underutilized Crops" under the Theme Area I, during the International Conference on Horticulture, held at Bangalore from 9th to 12th November, 2009.
- Vasantha Kumar, T. acted as Convener for the technical session on Medical and Aromatic Plants on 13th March 2010 in the National Conference on Production of quality seeds and planting material-Health Management in Horticultural Crops, 11th to 14th March 2010 New Delhi.
- Veere Gowda, R. acted as Member and Rapporteur for the Technical session –VI on "Hybrid Trials" during the "XXVIII Group meeting of AICRP- Vegetable Crops" held at IIHR, Bangalore from 16th to 19th January, 2010.
- Venkata Rami Reddy, P. acted as a Rapporteur for the Session on Crop Protection during International Conference on Horticulture held at Bangalore from 9th to 12th November, 2009.
- Venkata Rami Reddy, P. was awarded a Certificate of Honour in recognition of the services rendered at CHES, Chettalli during the Diamond Jubilee Celebration of Central Horticultural Experiment Station, Chettalli on 8th August 2009.
- Vishal Nath has been nominated as "Member" of the Programme Advisory Committee, Ministry of Science and Technology, Government of India, New Delhi.
- Vishal Nath has been nominated as "Member" of Think Tank-cum-Steering Committee for Establishment of Centre of Excellence for Tribal Agriculture and Research (CETAR) at Mallijharan, Kasipur, Rayagada, Orissa.
- Vishal Nath has been nominated for the National Fellowship by Indian Society of Horticultural Research and Development, Uttarakhand for the year 2010.
- Yogeesha H.S. has acted as rapporteur for the Technical session on "Seed production" in the XXVIII Group meeting of AICRP on Vegetable crops held at Bangalore from16-19th January, 2010.
- Yogeesha H.S. acted as rapporteur for the Technical session on Crop diversification during International Conference on Horticulture (ICH-2009)- Horticulture for livelihood Security and Economic growth", at Bangalore from 9th to 12th November, 2009.

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7. Linkages and Collaborations

The institute has established linkages with many national and international organizations and institutes in the field of research, extension and human resource development under which collaborative research programmes and projects on topical issues and new and frontier areas of horticultural sciences are taken up. Gaps identified in the on going research programmes of the institute are bridged by externally funded collaborative research projects on a specified time scale. Some of the emerging issues and research in the frontier areas like biotechnology, information science and ICT are being taken up as Net work or Outreach projects.

7.1 International

The institute has established linkages with international organizations such as

- Asian Vegetable Research and Development Centre (AVRDC), Taiwan - institute is working on molecular markers in tomato and multiple disease resistance in chilli in collaboration with AVRDC
- Food and Agriculture Organisation (FAO), Rome.
- ICRISAT
- United Nations Environment Programme (UNEP-GEF) - Collaboration on conservation of wild fruit diversity.
- Sultanate of Oman – Collaboration on mango tree encyclopedia preparation.

World Bank Projects

The ICAR with funding from the World Bank has implemented various projects in the NARS as the National Agricultural Innovative Project (NAIP) in different modes of operations and the IIHR has been sanctioned with a total of eight projects working on mechanism of off season flowering and fruiting in mango, bioprospecting of genes and allele mining for abiotic stress tolerance, gender issues, mobilising mass media support for agro information sharing, AGROWEB, insect pest management (fruit borer), insect taxonomy and sustainable livelihood improvement. Skill up gradation and exposure visits and exchange of seeds and plant materials are also the part of these collaborations under which the scientists of the institute are deputed to other countries for up gradation of knowledge and skills in their respective fields.

7.2 National

Linkage with various national organizations listed below, have been established and the institute has taken up projects under financial assistance from these organizations. A total of nine projects on various aspects of biotechnology in horticultural crops under DBT, two projects under DST and CSIR, one project each under BARC, NCOF, NHB, APEDA and CWC are in operation at the institute. There are two projects operating under NMPB apart from two projects on Production of Breeder Seeds and Monitoring of Pesticide Residue under the Central Sector. Under another Centrally sponsored scheme, the institute has been offering diagnostics services and in this direction, has established a centre for certifying tissue culture plant materials of horticultural crops. This centre is also recognized by the Government as a Plant Quarantine Certification Agency of plant and seed materials for exports.

The institute has linkages with:

- Department of biotechnology (DBT), GOI, New Delhi,
- Department of Science and Technology (DST), GOI, New Delhi,
- Council of Scientific and Industrial Research (CSIR), GOI, New Delhi
- Bhaba Atomic Research Centre (BARC), Mumbai
- National Medicinal Plants Board (NMPB), New Delhi
- National Horticulture Mission
- National Horticulture Board (NHB)
- National Bank for Agriculture and Rural Development (NABARD)
- National Centre for Organisc Farming (NCOF), Bhubaneswar
- Ministry of Agriculture (MOA), GOI

ICAR Network/out reach projects

Emerging issues and new challenges in horticulture are tackled by target oriented programmes and projects under the schemes financed by ICAR under Net Work mode / Outreach projects. Presently there are eight net work projects in operation in which IIHR is the Lead centre in 4 projects and remaining are net working centers. Apart from these, 3 outreach projects are also in operation.

Linkages with State Departments

Ever since its establishment, the institute has had strong linkages with the State Department of Horticulture, Govt. of

Karnataka. The Department of Horticulture collaborates with the institute in all the extension programmes of horticulture including training and visits of farmers. The institute offers first line training programmes on advanced production technologies in horticultural crops to the extension officers /functionaries of the department and actively involves them in the PRA studies of the extension research. The department also collaborates in the e-extension and ITC studies. Apart from this the institute has also established linkages with Department of Agriculture in the field of seed production and certification and with Department of Water Resources and Department of Environment for various purposes.

Linkages with Private Sector

Strong linkages have been established with the private sector particularly with seed companies and pesticide producing companies. The seed companies have been collaborating with the institute for exchange of seed material for research and purchase of potential parental lines for further commercialization. The pesticide companies take up testing of their new molecules and products as paid-up trials. The institute also extends its modern laboratory facilities for analysis and testing of products on payment to various stakeholders.

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8. All India Co-ordinated Research Projects and Network Projects

8.1 All India Co-ordinated Research Projects

8.1.1 Tropical fruits

Crop Genetic Resources

Citrus: A total of 5 clones each in sweet orange and acid lime were collected at Rahuri while at Tinsukia, 16 accessions and at Tirupati, 17 accessions were added to the germplasm block. Among the rootstocks, Florida Rough and Rangpur lime 8744 strains were found promising against citrus nematode under Rahuri conditions.

Banana: Coimbatore centre collected 10 new germplasm while surveying Annamalai Hills and southern hilly and plain regions of Tamil Nadu. At Jorhat, 4 local indigenous germplasm were collected from Upper Brahmaputra Valley zones of Assam and 1 wild banana from the foot hills of Arunachal Pradesh. At Kannara, new accession Rajeli (AAB), which is plantain type and various accessions from NBPGR, New Delhi were field established for characterization and evaluation.

Papaya: At Coimbatore, a collection of 95 papaya accessions including 57 gynodioecious and 38 dioecious were raised and are being evaluated. The gynodioecious lines such as Higgins Solo, Sun Rise Solo, Sun Set Solo and CO-7 were found highly susceptible to PRSV.

Sapota: At Arabhavi**,** six accessions viz., Pilipatti, Zhumkia, Periya collections, Challa collections-1, 2 and 3 were collected and planted.

Jackfruit: Three superior types at Mohanpur and 5 collections (PDC selection, Vridhachalam selection, Palur selection, Yendal selection, Kerala sweet) at Periyakulam has been included in the germplasm block.

Crop Improvement

Citrus: In clonal selection, Valencia late variety of Sweet orange performed better at Akola. At Ludhiana, Grapefruit variety Star Ruby has been released for cultivation in Punjab. One lemon (Konkan region) at Rahuri and one mandarin at Tirupati (with high juice and easily removable peel) has been identified for further studies.

Banana: Two introductions viz., Yangambi Km5 (AAA), a resistant dessert banana and Big Ebanga (AAB), a false horn plantain were included in the package of recommendations of KAU owing to their superior performance. At Kovvur, a clone of Kovvur bontha was identified with 10 hands having 135 fingers and weighing 35 kg.

Papaya: Papaya hybrids involving Pusa Nanha as Male parent and Co1, Co 2, Co 4, Co 5 and Co 7 as female parents were raised and planted in field for evaluation. Intergeneric cross involving *C. papaya* and *V. cauliflora* were evaluated and planted in the field after artificial inoculation.

Jackfruit: In clonal selction, 1 accession of jackfruit having orange coloured flakes have been identified at Endapali Pudupatti area of Theni district by Periyakulam centre.

Crop Production

Citrus: At Akola, combination of AM + PSB + *Azospirillum* + *T. harzianum* at 500, 100, 100 and 100g per plant per year, respectively with 100 % recommended dose of fertilizer (RDF) was found better for vegetative growth in mandarin and acid lime while at Tirupati, application of 75 % RDF along with AM + PSB + *Azospirillum* + *T. harzianum* at 500, 100, 100 and 100g per plant per year, respectively has recorded better growth, yield and quality of sweet orange. At Akola, fertigation with 75% recommended dose of N and K_2O has been found better for acid lime.

Banana: At Kannara, planting 3 suckers per pit at a spacing of 2x3m with 100 % RDF has recorded highest yield per hectare and profit for Nendran banana. At Coimbatore, application of 100% RDF + AM (250 g/plant) + PSB (50 g/plant) + *Azospirillum* (50 g/plant) has recorded higher bunch weight (24.10 kg) and estimated yield (72.30 t/ha). At Jorhat, application of 60% of the recommended dose of N at 5months after planting, 20% at shooting and 20% at last hand opening stage and 40% recommended dose of K at shooting and 60% at last hand opening stage exhibited the highest yield (58.64 t/ha) in banana cv. Barjahaji (AAA). Application of 200:50:200g N:P_2O_5:K_2O per plant per crop, respectively with bunch spray of 2,4-D (10 ppm) at last hand opening was found to be effective in increasing yield (57.48 t/ha) in banana cv. Barjahaji (AAA) under Jorhat conditions. At Coimbatore, trial on determination of optimum LAI for banana revealed that the total fruit yield was high (79.9 t/ha) with plant spacing of 1.5 x 2.0m (2 suckers/hill) due to higher leaf area index (7.86/pit) coupled with better land and light use efficiency. At Pusa, tying a polybag containing mixture 7.5g each of urea and sulphate of potash in 500g of fresh cow-dung to the banana bunch resulted in 15 to 20% increase in average bunch weight.

Sapota: At Arabhavi**,** application of 10 kg vermicompost + 400:80:300g N:P_2O_5:K_2O per plant per year, respectively has resulted in better growth and yield (4020 fruits and 230.50 kg / tree) in 13 years old sapota cv. Kalipatii, while at Periyakulam, application of 5 kg vermicompost + 200:40:150g N:P_2O_5:K_2O per plant per year has registered the highest growth and

yield (88.50 kg/tree having 1150 fruits) in 13 years old PKM-1 sapota. Fertigation with 100% recommended dose of N and K_2O (400:450g/tree/year, respectively) has recorded higher yield in sapota cv. Kalipatti.

Crop protection

Coorg mandarin : At Chettalli, observations on IPM of vectors in Coorg mandarin revealed that planting curry leaf as a trap crop along the border coupled with insect growth regulator (IGR) spray (buprofezin @ 1.25 ml/l), followed by release of insect predator (*Mallada boninensis* @ 30 grubs/ plant) and one systemic insecticide spray (imidacloprid @ 0.3ml/l) at the interval of one month reduced the population of *psylla* and aphids to nil and 2.2 per plant, respectively. At Tirupati, among the synthetic chemicals, spraying of imidacloprid at 0.005% was found to be more effective against citrus leaf miner. While, among the natural products, spray of NSKE (5%) was found to be effective in reducing the leaf miner incidence. Spraying of *Bacillus thuringienisis* (BT at 0.5 to 1.0 g/l of water) was found to be more effective in reducing the larval population of citrus butterfly at Tirupati. Spraying streptomycin sulphate (100 ppm) with copper oxychloride (0.3%) was effective in reducing the canker incidence under Periyakulam conditions.

Banana: At Kovvur, incidence of rhizome weevil on banana (*Cosmopolites sordidus*) was observed at East Godavari district of Andhra Pradesh on Tellachakkerakeli cultivar. Incidence of scarring beetle, pseudostem borer, slug caterpillar and aphids were reported from Assam. Application of carbofuran 3G (40g/sucker) with carbendazim (0.2%), drenching during 4th, 6th and 8th month after planting significantly reduced the wilt incidence (0%) in banana at Coimbatore. Also, banana hybrid, H-531 (AAB) exhibited resistance against both nematode and *Fusarium* wilt under pot and field conditions. At Kannara, spray of propiconazole (0.05%) with petroleum based mineral oil (1%) was effective against Sigatoka leaf spot of banana.

Sapota: Flat limb disease has been recorded in sapota variety CO-2 and Kirthibarthi. At Gandevi, mid rib folder of sapota emerged as new threat. Spray of thiophanate methyl (0.1%) at Periyakulam and carbendazim (0.1%) at Arabhavi has effectively reduced the leaf spot disease.

8.1.2 Arid Zone Fruits

Custard Apple : Two hundred and fifty trispecies hybrids of atemoya (*Annona cherimola* Mill. X *A. squamosa* L) and *A. reticulata* L. were studied to investigate the inheritance of 4 foliage characteristics. Segregation for leaf colour (green or dark green), leaf angle (erect or drooping), leaf apex shape (rounded or pointed) and time of leaf fall (early/late/ intermediate) into discreet phenotypic classes revealed that their inheritance followed simple Mendelian genetics. Duplicate dominant gene interaction governed the leaf colour and leaf position. Further a single gene determined shape of leaf apex. Segregation of progenies for leaf fall suggested that codominant alleles were responsible for time of leaf fall. The hybrids were also studied for 12 tree and 16 fruit traits. Occurrence of diverse and novel segregants for tree shape and branching pattern suggested possibility of identifying efficient ideotypes. Variation in fruit shape, skin colour and skin surface, in addition to TSS (17 to 32°B), acidity (0.16 to 2.2%) and seeds (3 to 49/100g fruit), showed exciting opportunities for making selection for desirable traits.

8.1.3 Vegetable crops

Crop improvement

Tomato : Five entries were evaluated for bactrial wilt (BW) resistance under AVT-II. Susceptible check Pusa Ruby had 72% BW incidence; where as the remaining 4 entries were resistant to BW.

Okra : In IET, 10 F_1 hybrids and 2 commercial checks Pusa Sawani and Arka Anamika were evaluated. Hybrids 09/Ok-Hyb-10 (19.35 t/ha) and 09/Ok-Hyb-6 (18.42 t/ha) gave significantly higher fruit yield. In hybrid trail (AVT-I), out of 5 hybrids evaluated, hybrid 08/OK –Hyb-5 gave the significantly higher fruit yield (18.37 t/ha) and check Parbhani Kranti gave 15.98 t/ha. In AVT-II hybrid trail, out of 9 F_1 hybrids and 2 commercial checks hybrid JOH-05 gave the highest significant fruit yield (19.24 t/ha) followed by Prerana (17.55 t/ha).

Onion : Onion line NRCRO-1 (bulb yield 378 q/ha) in IET, Indam-44 (297 q/ha) in AVT 1, Sel-402 (297 q/ha) in AVT- 2, gave highest bulb yield. The bulb yield of check variety Arka Niketan was 381 q/ha.

Early cauliflower : Under IET trial, 4 entries along with two check varieties were evaluated. Maximum curd yield/ha has been recorded by CAUEVAR-1 (189.7 q/ha.) followed by CAUEVAR-3 (184.7 q/ha.) which were superior to both the checks, Pusa Meghana (153.1 q/ha.) and Early Kunwari (179.5 q/ha.)

French bean : All 27 germplasm lines of vegetable poded *Vigna unguiculata* sub sp *sesquipedali*s were evaluated . The pod yield ranged from 13.4 to 27.0 t/ha. Four lines namely, IC 471928, IC 471933, IC 471950 and IIHR-247 gave the pod yield more than 20 t/ha. Maximum green pod yield was recorded in IC 471933 (27 t/ha) followed by IIHR-247(22.6 t/ ha). IC 471937 was ready for harvest by 60 days.

In varietal trial AVT II, none of the entries out yielded, Arka Suvidha or Arka Komal, which gave maximum pod yield of 188.5 and 188.0 q/ha, respectively. Among the entries, DWD FB-53 gave maximum pod yield of 153 q/ha followed by DPPBBS-1 with 150 q/ha. In IET entry, 09/ FBVAR 5 gave maximum pod yield of 199 q/ha and out yielded the check varieties . However, 09/FBVAR1 gave pod yield of 183 q/ha which out yielded Arka Komal**.**

Cowpea : In varietal trial AVT I, none of the entries out yielded the local check Arka Samrudhi and Arka Garima. ACP-1 gave maximum pod yield of 146 q/ha. In IET entry, 09 COPBVAR5 gave maximum pod yield followed by 09 COPBVAR2 and none of the other entries out yielded the check Arka Garima.

Peas : In early AVT –I, maximum pod yield was recorded by VP 316 (5.2 t/ha). Among the midseason peas, 08 PMVAR-1

out yielded the check varieties with 12.4 t/ha. In powdery mildew resistant trial, AVT I and AVT II, Arka Ajit, the resistant check variety ranked first with pod yield of 9.8 t/ha.

Dolichos : In pole type IET, 08/Dol Po VAR/5 ranked first with 20 t/ha followed by 08/Dol Po VAR/3 (19.0 t/ha). In AVT I, TRC – Dolichos 1 ranked first with 23.3 t/ha followed by IIVR Sem 11 with 19.6 t/ha. In AVT II, IIVR Sem 8 ranked first with 17.7 t/ha.

Amaranth : Five new germplasm lines IIHR-259, IIHR-260 belonging to *Amaranhtus tricolor;* IIHR-261, IIHR-262 belonging to *A. spinosus* and IIHR-263 belonging to *A. viridis* were collected. All the lines had green leaves except IIHR-259 which had red leaves and stem. All these lines were characterized as per IBPGR Amaranth descriptor.

Crop production

Tomato : Significantly higher yield of 112.1 t/ha was recorded in hybrid Arka Ananya during *Rabi*-summer by adopting the precision farming practice of raised bed method of cultivation, drip irrigation, mulching, fertigation, foliar feeding of major nutrients, and foliar feeding of micronutrients. Furrow irrigated-non mulched non fertigated control recorded only 71.5 t/ha of yield.

Okra : Maximum yield of 31.0 t/ha was recorded in Arka Anamika during *Kharif* by adopting precision farming practice of raised bed method of cultivation, drip irrigation, mulching, fertigation, foliar feeding of major nutrients, and foliar feeding of micronutrients. Furrow irrigated-non mulched non fertigated control recorded only 12.5 t/ha of yield.

Capsicum: In hybrid Indra, closer spacing of 60 x 30 cm (in paired system of 90- 60 x 30 cm) with no pruning recorded highest yield (84.7 t/ha) in a naturally ventilated polyhouse. But the yield was on par with 60 x 30 cm spacing and 4-stem training (82.9 t/ha). In 3 pruning experiments, yield did not differ significantly between 4-stem pruning and no pruning (79-80 t/ha). However, fruit size significantly improved in 2-stem (159 g) and 4-stem (134 g) pruning systems compared to no pruning (110 g). Among high value colour types, green capsicum variety Indra recorded significantly higher yield (81.8 t/ha) than both the yellow type variety Arobelle (68.2 t/ha) and red type Bomby (71.4t/ha). The fruit size was significantly higher in 4-stem training system (139g) compared to no-pruning (117g). Between un-pruned and 4-stem pruning, significantly higher yield (80.4 t/ha) was observed in un-pruned compared to 4-stem pruning (67.2t/ha).

8.1.4 Ornamental Crops

Crop improvement

Rose : Two hundred seventy five accessions were maintained and 128 varieties were characterized as per AICRP descriptor guidelines. Out of 23 different cross combinations, Grandgala recorded maximum number of seed (12.4). It emerged as a better seed parent with 64.9 per cent of sinkers.

Gladiolus : A total of 61 varieties were maintained in the germplasm and four were added. Among 9 cultivars evaluated for vegetative and floral traits, Jyotsna and Shabnam were found promising. Crosses were made in 15 parental cross combinations involving 3 hybrid selections and 5 varieties. Varietal trial was carried out involving 7 hybrid selections/ cultivars. Based on 3 year's data and considering vegetative as well as floral traits, cultivars Arka Kesar {Floret Yellow-Orange (19.C) having Orange (25.D) margin. Blotch Orange-Red (32.C) with Yellow- Green (154.B) line.}, IIHR 87-22-1{ Red 46.D with Red 45.B margin and White (155.B) line on tepals}and Punjab Dawn{ Red 49.A with Red 43.A blotch having White Border} were recommended for commercial cultivation.

Carnation : Thirty two new genotypes were collected and in all 50 genotypes belong to 4 *Dianthus* species have been maintained. Twenty five genotypes have registered a length of the flower stem more than 55 cm (A Grade). Flower size ranged from 5.52 cm in 12-604 to 6.86 cm in Zucchero. The genotypes Larla recorded maximum vase life of 13.6 days. Thirteen genotypes have recorded vase life of more than 10 days in ordinary tap water under room condition. The number of flowers ranged from 2.6/plant in SU 1127 to 6.8/palnt in Hermes Orange. IIHR variety Arka Flame with 5 commercial varieties as check were evaluated. All 6 genotypes produced Grade A quality flowers (flower stem length > 55 cm). Arka Flame was superior and on par with four of the 5 genotypes used as checks for strength of flower stem, calyx splitting and susceptibility to diseases and pests,

Chrysanthemum : A total of 35 varieties were evaluated. The size of flower ranged from 1.93 cm in Swetha Sringar to 8.84 cm in Star Pink. The maximum number of flowers was recorded in cv. Pink Cloud (410.75/plant) and minimum in Poornima (63.35/plant). Average flower weight ranged from 0.78 g in Vasanthika to 5.79 g in Star Pink. The maximum flower yield was recorded in Nilima (903.2 g) and minimum was recorded in Lemons (104 g). Among 8 hybrids evaluated for quantitative characters, Hy-1, Hy-2, Hy-4, Hy-6 and Hy-8 were found suitable for cut flower purpose, while Hy-3, Hy-10 were found suitable for garden use. Among 6 cultivars evaluated, Yellow Gold has recorded the highest average flower weight and the yield (3.62 g and 739.91 g, respectively). Among 3 varieties Arka Ravi, Ravikiran and Jayanthi evaluated, the flower yield was highest in Ravi Kiran (757.24 g) followed by Jayanthi (606.43 g) and Arka Ravi (572.57 g).

Tuberose : Six single type cultivars and 5 double types were evaluated for various characteristics. Shringar, Suvasini, Prajwal and Vaibhav consistently performed better than other varieties. 'Vaibhav' recorded maximum spike yield than other varieties. Prajwal recorded maximum loose flower yield. Shringar recorded maximum multiplication of 23 bulbs per bulb planted.

Crop production

Chrysanthemum : Among 7 treatments comprising inorganic fertilizers in combination with organic manures in cv Chandni, the treatment combination of 75% RDF + FYM (1 kg /m2) +

vermicompost (300 g/m^2) + Azospirillum + PSB recorded significantly higher flower yield (190.4 g/plant and 4.57 kg/ 2.4 m^2) followed by treatment 75% RDF + FYM (1 kg /m^2)+ vermicompost (300 g/m^2) (182.3 g/plant and 4.38 kg/2.4 m^2). Control recorded 171.5 g/plant and 4.12 kg/2.4 m^2 flower yield.

Orchids : Application of 19:19:19 NPK @ 0.2% +1000 ppm $ZnSO_4$ on orchids cv. Dendrobium Sonia 17 as foliar sprays at fortnightly intervals resulted in maximum plant height maximum number of spikes per plant per year (7.17) and the number of florets/spike (11.05).

Tuberose : In cv. Prajwal, application of 75%RDF+1 Kg/sq. m FYM+300 g/sq. m Vermicompost+2g/plant Azospirillum+2g/plant PSB recorded the maximum number of florets per spike(40.23), yield of flowers per sq. m (53.86g) and hundred bud weight (133.77 g). Application of 75%RDF+1kg FYM/sq. m/yr +300 vermicomopost./sqm recorded the maximum number of spikes per sq. m. (25.33). In cv. Vaibhav, T7 (50%RDF+1 Kg/sq. m FYM+300 g/sq. m Vermicompost +2g/plant Azospirillum +2g/plant PSB) recorded the maximum yield of spikes per sq.m. (27.67) and number of florets per spike (34.60).

8.1.5 Medicinal, Aromatic Plants and Betel vine

Betel vine : Germplasm collection and evaluation - Three germplasm collections were added to the existing 98 germplasm. Promising high yielding clones are identified for growing under areca nut garden. The clone Godi Bangla (49.68 lakh leaves/ha) among female clones and Swarna Kapoori (35.14 lakh leaves/ha) among male clones recorded high leaf yield and showed very good plant vigour. Germplasm was screened for *Phytophthora* using West Bengal isolate by leaf inoculation. Out of 69 lines studied, *Piper colubrinum*, Kalipathi, Kali Bangla showed 0-5 per cent incidence. Among eight hybrids screened for disease reaction to *Phytophthora* (West Bengal isolate), hybrids 06-8 and 06-4 showed less than five per cent disease incidence. Disease incidence in other hybrids ranged from 11 to 80 per cent. IIHR BV 37 (SGM 1), IIHR BV 38 (Awamipan) and IIHR BV 67 (Andaman 1) are relatively free from anthracnose and powdery mildew. All Kapoori (male) clones are free from powdery mildew incidence. Out of 13 hybrids tested, 9 hybrids showed tolerance to powdery mildew. Hybrid 06-1 (SGM 1 x Swarna Kapoori) showed field tolerance to powdery mildew and marginal blight.

Inter specific hybridization: The female catkins of Simarali Babna, Bangla Nagaram fertilized with *P. colubrinum* pollen recorded 80 per cent fruit set. The fruits are nodular and ripened in 97 to 114 days with a germination ranged from 58 to 70 per cent. The putative hybrid seedlings are being established in seedling trays and maintained in polyhouse.

Evaluation of hybrids: Eight selected hybrids are field planted under areca nut garden and hybrid 06-10 recorded longer vines (294 cm) followed by Hy 06-1 (273.10cm). Hybrids 06-1, 06-4 and 06-11 are vigorous with desirable leaf traits.

Sex segregation in hybrids: Out of the hybrid plants established in the field under *Sesbania* support during 2007, lateral production was observed in 16 hybrids. Eight hybrids produced inflorescence. Hy 06-1 and 07-33 produced female catkins where as hybrids 06-4, 07-27 and 07-33 produced male inflorescence. Hys 06-13, 06-15 and 07-31 put forth laterals with inflorescences which failed to reach maturity making the identification of sex difficult.

8.2 ICAR Network projects

8.2.1 ICAR Network project on Transgenics in Crops- Banana (transgenics component)

In order to develop transgenic resistant to *Fusarium* wilt, 20 transgenic of cv Rasthali (syn Nanjangud Rasbale (AAB) plants, positive for the integration of the gene (AMP gene) as confirmed by PCR, RT-PCR and dot-blot analysis, were multiplied to 130 plants by micro propagation. Under pot conditions 10 transformants were screened for *Fusarium* resistance using non-destructive leaf bioassay and challenge inoculation. Non destructive leaf bioassay lesion area developed on transgenic banana leaf was 1.22-1.86 sq mm compared to 10.41-16.6 sqmm in susceptive non-transgenic susceptible leaf and the same was 1.1 sq mm in resistant check cultivar Pisang Lily. Transgenic plant roots challenged with *Fusarium* showed resistance to the pathogen to varying levels. Three plants showed *Fusarium* symptoms (20-40 % score) and plant survival compared to non transgenic susceptible (80-100 % score).Three fresh lines of embryogenic cell suspensions (ECS) with higher regenerative capacity were developed for Rasthali. Fresh transformation with Antimicrobial peptide gene (AMP) was carried out and transformants selected on G418 selection medium were established. AMP protein cloned from onion seeds and Defensin gene cloned from maize leaf were expressed in prokaryotic expression system. Purified protein exhibited antimicrobial activity against *Fusarium* infecting banana.

8.2.2 ICAR Network project on Functional genomics fusarium wilt resistance and drought tolerance in Banana

Seeds formed in intergeneric hybridization between *Musa balbisisana* (n=11) and *Ensete superbum* (n=9) were germinated *in vitro* in MS medium. Cytology and molecular marker analysis of 18 *in vitro* germinated seedlings showed that the putative hybrid seedlings resembled female parent, *Ensete superbu* and strongly supported the possibility of apomictic seed development in Ensete. Genetic analysis of GSS/EST- SSR developed for banana were utilized. Twenty six selected primers from previous study amplified a total of 88 alleles in the range of 2-6 alleles per locus with a mean of 3.38. The heterozygosity was in the range of 0.06 to 0.80 with a mean 0.40 and PIC range from 0.21- 0.77 with a mean 0.47. Thirty two SSR markers for 5 parental genotypes were employed to select genetically distant parents. The genetic distance value was 6.22 between Andaman wild(BB) and Beejeekela (BB), 6.17 between Calcutta-4 and Bee hee kela and 4.14 between Bee hee kela and Bhimothia. For gene expression studies, 36 genes likely to participate in defense

response were selected out of 94 non-redundant clones and the primers were designed to perform Real-Time PCR. Only 14 primers showed amplification and were standardized. Changes in expression level were studied for different stages. Down-regulated genes were examined during *Fusarium* wilt infection in resistance genotype Calcutta-4 in pot culture experiment. Reverse subtracted EST library was constructed from samples collected at 10DPI using PCR-based subtractive hybridization. Nearly, 100 clones were sequenced, where 67 non-redundant sequences were obtained.

8.2.3 ICAR Network project on evaluation of transgenic tomato lines for resistance to TLCV

Fifteen events namely 4 of Arka Meghali, 2 of A.Vikas, 4 of A. Saurabh and 5 of Pusa ruby were advanced to T2. Upon challenge inoculation and analysis by PCR, 8 events were advanced to T3 namely, Arka Meghali 171-2, 188-4, Arka Vikas 225-7, Arka Saurabh 130-12, 130-13, Pusa Ruby 138-4, 138-13 and 157-4. Thirty plants were raised in each generation and seedlings were challenge inoculated with viruliferous white flies. Nearly 15-20 flies were released per plant and repeated after one month of transplanting. All control plants were susceptible while transgenic plants segregated for resistance. The resistant plants in T3 are Arka Vikas 225-7-26, 225-7-27, 225-7-28 and Arka Saurabh T3 and T4 events, 130-13, 130-12, and 194-11. All T4 progeny of 194-11-7-202 were found resistant and PCR positive. Similarly T4 progeny of Arka Meghali event 190-14 were all resistant and PCR positive. All plants of Pusa Ruby 138-4-10-26 T4 were resistant and PCR positive

8.2.4 ICAR Network project on generation of Bt transgenic tomato for resistance to the fruit borer

Arka Vikas variety was selected because of its high general combining ability, tolerance to bacterial wilt, high yielding and good quality fruit characters. The Bt gene construct, *Cry1Aa3*, provided by NRCPB, was used for transformation. Transformed explants were shooted, rooted and hardened *in vitro* and *ex vitro* to get T_0 plants. The plants were analyzed by PCR and selfed to obtain T_1 seeds. Total genomic DNA was extracted using a modified CTAB protocol without the use of liquid nitrogen but using a modified CTAB buffer. Using *Cry1Aa3* Bt gene specific and *nptII*-gene specific primers, PCR was done to test the presence of transgene. Gene/ *nptII*-specific primers were used to identify Bt transgenic plants. Qualitative ELISA using lateral flow immuno- diagnostic strip (Bt Xpresstrips®, Desigen, Mahyco) was done on PCR positive plants for the detection of Bt protein expression *in planta*. Cry1Ac Bt XpresstripsÔ (Desigen, Jalna) were used for assessing the Bt protein expression, following manufacturer's instructions. The sample extraction was individually carried out for one single plant from each line. Resistance phenotyping was done on PCR and Qualitative ELISA positive plants. Transgenic plants from different lines were screened by a novel kanamycin feeding assay technique to differentiate kanamycin resistant homozygous and heterozygous plants from homozygous null segregant plants of selfed progeny. *Helicoverpa armigera* was artificially reared *in vitro* and freshly hatched first instar neonate larval cultures were used for challenging the Bt tomato plants. The inoculations were made either on young and developing whole fruits *in planta* or excised young leaves. On the resistant plants, either the first instar larvae failed to develop due to mortality or resulted in subsequent forced defective pupation without adult emergence.

8.2.5 ICAR Network Project on Transgenics in Crops-Functional Genomics in Tomato

Mapping populations (F3) were developed between early blight resistant and susceptible parents and F4 mapping populations were also developed between heat tolerant, drought tolerant and susceptible parents. Among the 525 SSR primers screened, 49 primers showed polymorphism between LA 1777 and 15SB SB, 10 primers showed the polymorphism between NCEBR-4 and CO-3, 12 primers showed the polymorphism between IIHR-2202 and 15 SB SB and 8 were polymorphic between RF4A and 15 SB SB.

8.2.6 All India Network Project on Pesticide Residues

Grapes : Residue study of fluopicolide was carried out using GC-MS on grape berries following treatment of fluopicolide 4.44 % + fosetyl aluminium 66.7% (Profiler 71.14 WG) at 2500 and 5000 g /ha. Analysis of fluopicolide residues in grapes and soil after 4 treatment sprays at 15 day intervals showed initial residue deposits of 0.582 and 1.324 ppm fluopicolide. Residues persisted for 30 days and dissipated with half-life($t_{1/2}$) of 10.23 and 12.3 days respectively.

Mango: Combination formulation of â-cyfluthrin (9%) + imidacloprid (21%) (Solomon 300 OD) was applied thrice to mango crop at 2 concentrations, 0.025 % and 0.05 % at fruit growth stage. Initial residues of b-cyfluthrin on mango fruits from the two treatments were 0.044 and 0.122 mg/kg, which persisted for 5 days ($t_{1/2}$ = 2.4 and 2.6 days). Initial residues of imidacloprid were 0.143 and 0.182 mg/kg ($t_{1/2}$ = 3.06 and 4.16 days).

Citrus: Residue study of carbaryl on citrus was carried out at CHES, Chettalli. Carbaryl(Sevin 50 WP) sprayed @ 0.2 and 0.4%. resulted in residues below quantifiable limit of 0.01 mg/kg in fruit pulp on all days.

Oxydemeton methyl (Metasystox 25 EC) was sprayed @ 0.025 and 0.05%. In fruit pulp residues were first detected on the 7th day from treatment at recommended dose and 5th day from treatment at double the recommended dose. Maximum residue deposit in the fruit pulp was 0.018 and 0.056 ppm at treatment with higher and lower doses, respectively. The residues in pulp reached below detectable level after 20 days. Quinalphos (Vazra 25 EC) was sprayed on citrus twice@ 0.07 % and 0.14 %. Residues of quinalphos in citrus fruit pulp were below the quantifiable limit of 0.01 mg/kg on all days.

Cucumber: Imidacloprid (70 WG) was sprayed @ 35 g /ha (24.5 g a.i./ha) and 70 g /ha (49.0 g a.i./ha).Initial residues of imidacloprid on cucumber from the two treatments were 0.195

and 0.808 mg/kg which reached below detectable level (BDL) at 5 days after spray from both the treatments ($t_{1/2}$ = 0.70 and 0.55 days). Considering the MRL value of 0.05 ppm (EU), 2 and 3 day pre harvest interval (PHI) was suggested.

Cauliflower: Quinalphos (Vazra 25 EC) spray application was given to cauliflower at 2 concentrations, i.e 500 g /ha and 1000 g /ha. Initial residues of quinalphos on cauliflower from the two treatments were 1.19 and 1.84 mg/kg. Loss of quinalphos residues was very fast in the initial stages. Though the residues persisted beyond 10 days from both the treatments its level was very low. The residues of quinalphos dissipated with half-life of 4.8 and 5.3 days. Mancozeb 75 WP spray application was given to cauliflower crop thrice at day's interval @ 1500 g a.i. /ha (3 g/L) and 3000 g a.i. /ha (6 g/L). Residue analysis of mancozeb (as CS_2) on cauliflower heads was carried out and initial residues the two treatments were 5.9 and 11.18 mg/kg. The residues dissipated half-life of 3.68 and 4.34 days

Cabbage : Quinalphos (Vazra 25 EC) spray application was given to cabbage @ 500 g /ha (4 g/ L) and double dose 1000 g /ha (8 g/ L). Residue analysis of cabbage heads carried out after the third spray over a period of 10 days showed that initial residues of 0.992 and 1.23 mg/kg persisted beyond 10 days from both the treatments ($t_{1/2}$ = 4.54 and 5.4 days). Based on the persistence study and MRL value of 0.05 (EU), pre harvest interval (PHI) of 17.7 and 22.4 days was recommended.

Onion : Tebuconazole (Folicur 250 EC) spray application was given to onion crop at 2 concentrations, 187.5 g.a.i /ha and 375 g.a.i /ha. Residue analysis on onion leaf along with bulb was carried out over a period of 15 days. Initial residues from the two treatments were 0.628 and 1.228 mg/kg which dissipated with half-life of 5.08 and 7.68 days. Three spray applications of Mancozeb (Indofil Z-78) @ 1500 g a.i./ha and 3000 g a.i./ha were given to onion crop at weekly intervals esidues analysed in onion bulbs and leaves at different intervals. Initial residues from both the treatments were 1.0 and 2.3 mg/kg respectively which persisted for more than 5 days from treatment at lower dose with a half life of 1.6 days and for more than 10 days with a half life of 2.2 days from the higher treatment.

Quinalphos (Vazra 25 EC) applied to onion crop @ 300 g /ha 600 g /ha resulted in initial residues of 0.864 and 2.283 mg/kg respectively. Residues did not persist beyond 15 days from both the treatments($t_{1/2}$ = 1.67 and 2.57 days). Based on the persistence study and MRL of 0.05 ppm (EU), PHI recommended was 9 and 16.5 days respectively.

Chilli : Three spray applications of flubendiamide 24% + thiacloprid 24% (480 SC, w/v) @. 60 + 60 g a.i./ha and 120 + 120 g a.i./ha on chilli resulted in initial deposits of 0.49 and 0.99 mg/kg flubendiamide which persisted for 10 days. Thiacloprid residues on chilli were found to be 0.71 and 1.01 mg/kg which persisted for 10 days. No residues of toxic metabolite, des-iodo flubendiamide were detected in green or red chilli samples.

Oxydemeton methyl(Metasystox 25 EC) sprayed @ 500 and 1000 g a.i./ha resulted in initial residue deposits of 1.99 and 2.16 ppm following application at lower and higher concentrations respectively ($t_{1/2}$ = 2.9 and 3.0 days) which reached below quantifiable level of 0.01 ppm by 20th day in chilli sprayed with lower concentration and by 25th day in chilli sprayed with higher concentration. Based on the dissipation pattern and MRL of 0.02 ppm (EU), PHI 19 days was recommended

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9. Publications

9.1 Research papers

Published in refereed journals

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■

10. Research Projects

10.1 In house projects (ongoing and new)

PROJECT 1.1 Breeding for yield and quality in tropical fruits

Leader: M R Dinesh

Sub Projects

1.1.1 Genetic improvement of mango for yield and quality (**M.R. Dinesh,** C. Vasugi, Abraham Verghese, A.K. Saxena)

1.1.2 Development of multipurpose guava varieties by breeding (**M.R. Dinesh,** C. Vasugi, I.N. Doreyappa Gowda, Abraham Verghese)

1.1.3 Breeding sapota for dwarf tree stature with higher productivity (**A. Rekha,** M.R. Dinesh, A.K. Saxena, P.V.R. Reddy)

1.1.4 Evaluation of under-utilized fruits for yield, quality and adaptability (**S.H. Jalikop,** B.N.S. Murthy)

1.1.5 Improvement of jack fruit for quality and productivity (**Prakash Patil,** P.V.R. Reddy)

1.1.6 Improvement of pummelo for quality and productivity (**Prakash Patil,** P.V.R. Reddy, M. K. Reddy)

PROJECT 1.2 Breeding for biotic and abiotic resistance in tropical fruit crops

Leader : S.H Jalikop

Sub Projects

1.2.1 Breeding papaya for PRSV and leaf curl virus resistance (**C.Vasugi,** M.R. Dinesh, M. Krishna Reddy, Prakash Patil, N.K. Krishna Kumar)

1.2.2 Breeding day neutral strawberry with fruit rot resistance (**B.N.S Murthy,** A. Rekha, C. Gopalakrishanan , A. K. Saxena

1.2.3 Introgression of root rot resistance in purple passion fruit (**B.N.S Murthy,** S.H. Jalikop, A. K. Saxena)

1.2.4 Incorporation of bacterial blight resistance in pomegranate (S**.H. Jalikop,** B.N.S Murthy, C. Gopalakrishnan)

PROJECT 1.3 Canopy architecture engineering in tropical fruit crops

Leader : G.S. Prakash

Sub Projects

1.3.1 Canopy architecture for higher productivity in mango (**R.M. Kurian,** Y.T.N. Reddy, R.H. Laxman, Soudamani Mohapatra, R. Venugopalan)

1.3.2 Enhancing productivity of annona and fig through integrated nutrition and high density planting (**R. Chithiraichelvan,** V.V. Sulladmath, A.K. Saxena, P.D. Kamala Jayanthi, K.S. Shivashankara)

1.3.3 Architectural regulation for enhancing canopy photosynthetic efficiency in passion fruit (**V.V. Sulladmath,** R.Chithiraichelvan, R.H. Laxman, R. Venugopalan)

1.3.4 Enhancing productivity of guava and jamun through high density orcharding (**G.S. Prakash,** P. Sampathkumar, R.H. Laxman, P.D. Kamala Jayanthi, R. Venugopalan)

1.3.5 Enhancing productivity of jamun through high density orcharding (**V.V. Sulladmath,** P. Sampathkumar, R.H. Laxman, P.D. Kamala Jayanthi, R. Venugopalan)

PROJECT 1.4 Enhancing productivity of fruit crops

Leader : R. Chithiraichelvan

Sub Projects

1.4.1 Crop regulation studies in fruit crops (**P. Sampathkumar (Jamun),** Guava – G.S. Prakash, Mango – Y.T.N Reddy, Annona – R. Chithiraichelvan, K.S. Shivashankara, R. Venugopalan

1.4.2 Exploitation of stock-scion interactions for canopy vigour management and sustainable productivity (**R. Chithiraichelvan (Annona and Fig),** Guava – P. Sampathkumar, Mango –R.M Kurian, Jackfruit –V.V Sulladmath, K.K. Upreti, R. Venugopalan

PROJECT 1.5 Water productivity and nutrient dynamics in tropical fruit crops

Leader : K Srinivas

Sub Project

1.5.1 Optimizing water productivity and nutrient dynamics through integrated water and nutrient management of fruit crops (mango, acid lime and sapota) (**K. Srinivas,** P. Sampath Kumar, H.B. Raghupathi, P. Panneerselvam, N.K.S. Rao

PROJECT 1.6 Organic farming strategies in tropical fruit crops

Leader : Y.T.N Reddy

Sub Project

1.6.1 Organic production of fruit crops (mango, papaya and sapota)(**Y.T.N Reddy (Papaya),** Mango -Reju

M. Kurian, Sapota - V.V Sulladmath, Guava – R.Chithiraichelva, P. Panneerselvam, A.N. Ganesh Murthy, A.K. Saxena, P.D. Kamala Jayanthi

PROJECT 2.1 Breeding tropical vegetable crops for resistance to biotic and abiotic stresses with high yield and quality attributes through marker-assisted selection (MAS).

Leader : A.T.Sadashiva

Sub Projects

2.1.1 Breeding tomato for resistance to biotic and abiotic stresses and gene pyramiding for ToLCV resistance (**A.T. Sadashiva**, K. Madhavi Reddy, T.H. Singh, N.K. Krishna Kumar, N.K. Srinivas Rao, K.P. Gopalakrishna Rao, Girija Ganeshan, M. Prabhakar, M. Krishna Reddy, I.N. Doreyappa Gowda, K.S. Shivashankar, K.V. Ravishankar, S. S. Hebbar)

2.1.2 Breeding hot & sweet peppers (*Capsicum annuum* L.*)* for biotic and abiotic stress resistance integrating marker-assisted selection (MAS)(**K. Madhavi Reddy**, A.T. Sadashiva, T.H. Singh, N. Ramachandran, P. Chowdappa, M. Krishna Reddy, N. K. Krishna Kumar, H. R. Ranganath, N. K. S. Rao, R. M. Bhat, K. K. Upreti, V. Keshava Rao, M. Prabhakar, S. S. Hebbar, K. V. Ravishankar)

2.1.3 Breeding brinjal for resistance to bacterial wilt with high yield and quality attributes through marker-assisted selection (MAS) (**T.H. Singh**, A.T. Sadashiva, K. Madhavi Reddy, C. Gopalakrishnan, Anil Kumar Nair, K. V. Ravishankar)

2.1.4 Breeding Cucurbitaceous Crops (Watermelon and Muskmelon) for resistance to biotic stresses through marker assisted selection (MAS) (**E.Sreenivasa Rao**, B.Varalakshmi, M. Pitchaimuthu, Girija Ganeshan, H.R. Ranganath, M. Krishna Reddy, Mythili J.B, K.V. Ravishankar)

2.1.5 Breeding okra varieties/ hybrids for resistance to biotic stresses through MAS (**M. Pitchaimuthu**, E. Sreenivasa Rao, GirijaGaneshan, H.R. Ranganath, M. Krishna Reddy, Mythili J.B, S. S. Hebbar, K.V. Ravishankar)

2.1.6 Breeding French bean for resistance to biotic and abiotic stresses and Cowpea for resistance to rust & cowpea aphid borne mosaic virus through marker-assisted selection (MAS).(**T. S. Aghora**, N. Mohan, N. K. Srinivasa Rao, K.V. Ravishankar, Girija Ganeshan, P.N. Krishna Moorthy, M. Krishna Reddy, S.S. Hebbar)

2.1.7 Breeding peas For biotic and abiotic stresses and dolichos for yield and quality attributes through marker-assisted selection (MAS) (**N. Mohan**, T. S. Aghora, N. K. Srinivas Rao, K.V. Ravishankar, Girija Ganeshan, Anil Kumar Nair)

2.1.8 Breeding onion for resistance to biotic and abiotic stresses with high yield and quality attributes through marker-assisted selection (MAS). * Research on those aspects not addressed by NRC on Onion and Garlic, Rajgurunagar, Pune (**R. Veere Gowda**, B.Varalakshmi, E.Sreenivas Rao, P.N. Krishna Murthy,N.K. Srinivas Rao, Girija Ganeshan, P. Chowdappa, P.E. Rajashekaran, I.N.Doreyappa Gowda, R.B. Tiwari, K.V. Ravishankar, ,S.S.Hebbar)

2.1.9 Evolving F1 hybrids in tropical carrots with high yield and quality through marker-assisted selection (MAS) (**R. Veere Gowda**, B.Varalakshmi, E.Sreenivas Rao, Girija Ganeshan, V.K. Rao, Org., M. Srinivas Rao, M. Prabhakar, K.V. Ravishankar)

2.1.10 Breeding tropical cauliflower and amaranth for high yield and quality (**B. Varalakshmi**, R.Veere Gowda, C. Gopalakrishnan, P. Chowdappa, P.N. Krishna Murthy, M. Prabhakar, V. Keshava Rao, K.V. Ravishankar)

2.1.11 Breeding Ridge Gourd and Bottle Gourd for high yield and downy mildew resistance integrating maker assisted selection (MAS)(**B. Varalakshmi**, M. Pitchaimuthu, P. Chowdappa, H.R Ranganath, D.C. Lakshman Reddy, M. Prabhakar)

PROJECT 2.2: Developing production technology for tropical vegetables

Leader : M. Prabhakar

Sub Projects

2.2.1 Water management and rainfed production in vegetable crops (**Anil Kumar Nair**, M.Prabhakar, S.S. Hebbar, R.M. Bhat, H.B. Raghupathy)

2.2.2 Organic farming in vegetable crops (**M. Prabhakar**, S.S. Hebbar, Anil Kumar Nair, A.N. Ganesh Murthy, P.N. Kishnamurthy, Girija Ganeshan, D. Sreenivasa Murthy, K.S. Shivashankara, P. Panneer Selvam)

2.2.3 Protected cultivation in vegetable crops (**S. S. Hebbar**, M. Prabhakar, Anil Kumar Nai, R.M. Bhatt, H.B.Raghupathy)

PROJECT 3.1 Genetic improvement of Ornamental crops

Leader : Meenakshi Srinivas

Sub Projects

3.1.1 Genetic improvement of tuberose for high concrete yield and resistance to nematode (**Meenakshi Srinivas**, Rajiv Kumar, V. Keshava Rao, M.S. Rao)

3.1.2 Genetic improvement of gladiolus for quality and resistance to biotic stresses (**T.M. Rao,** M.V. Dhananjaya, N. Ramachandran, M. Krishna Reddy, K. Padmini)

3.1.3 Evolving Rose varieties(both open and polyhouse) for quality and resistance to powdery mildew, black spot and thrips (**Tejaswini,** M.V. Dhananjaya, N. Ramachandran, B. Jhansi Rani)

3.1.4 Breeding *Dianthus* species (Carnations, Pinks and Sweet Williams) for quality (**M.V. Dhananjaya**, Tejaswini, N.Ramachandran, B. Jhansi Rani)

3.1.5(a) Breeding Gerbera for quality

3.1.5(b) Breeding chrysanthemum var./ hybrid for off season flowering (**Rajiv Kumar**, Meenakshi Srinivas, N.Ramachandran, B. Jhansi Rani)

3.1.6 Breeding chrysanthemum and China aster for quality (**Rajiv Kumar**, Meenakshi Srinivas, N.Ramachandran)

3.1.7 Breeding crossandra for quality and novelty (**T.M.Rao**, M.V. Dhananjaya, N. Ramachandran)

3.1.8 Breeding of speciality flowers (Heliconia and Red ginger) for quality (**Meenakshi Srinivas,** Rajiv Kumar, N. Ramachandran)

PROJECT 3.2 Enhancing quality and production of ornamental crops through cultural practices

Leader : K. Sujatha

Sub Projects

3.2.1 Production technology for potential tropical cut flowers (**K. Sujatha,** Sujatha A. Nair Sangama, K.K. Upreti)

3.2.2 Induction of off-season flowering in *Jasminum sambac* through cultural practices (**Sujatha A. Nair**, H.P. Sumangala, R. Venugopalan)

3.2.3 Enhancing fillers production through cultural interventions (**K. Sujatha,** Sujatha A. Nair, Sangama)

3.2.4 Enhancing productivity of filler flowers (**H.P. Sumangala**, K.Sujatha)

3.2.5 Adaptability and Utilization of ornamentals for landscaping (**H.P. Sumangala**, T.M. Rao)

PROJECT 3.3 Genetic improvement of medicinal crops

Leader : T. Vasantha Kumar

Sub Projects

3.3.1 Identification of high yielding lines of *Aloe vera* for leaf and gel yield (**T. Vasantha Kumar**, K. Hima Bindu, J.N Eugene Sebastian, N. Ramachandran)

3.3.2 Evaluation of Coleus hybrids for tuber yield and forskolin content (**K. Hima Bindu**, T. Vasantha Kumar)

3.3.3 Identification of high yielding L-dopa lines in Mucuna species (**K. Hima Bindu,** T. Vasantha Kumar, J.N Eugene Sebastian)

3.3.4 Evaluation of Kokum (*Garcinia indica*) lines for yield and chemical content (**T. Vasantha Kumar,** K. Hima Bindu, J.N. Eugene Sebastian, C.Gopalakrishnan)

3.3.5 Evolving Ashwagandha varieties for high root yield and active ingredient (**D.H. Sukanya,** J.N Eugene Sebastian, C.Gopalakrishnan, B.Jhansi Rani, Soudamini Mohapatra)

3.3.6 Molecular characterization and standardization of regeneration protocols in Betelvine (*Piper betle* L.) (**K. Hima Bindu,** D.H. Sukanya, C. Aswath)

PROJECT 3.4 Production technology of medicinal crops

Leader : M.A. Suryanarayana

Sub Project

3.4.1 Standardizing of organic farming technology for export value medicinal crops (*Aswagandha, Kalmegh and Coleus forskohlii*) (**M.A. Suryanarayana,** J.N Eugene Sebastian, A.N. Ganeshamurthy)

PROJECT 3.5 Investigation on the chemistry of novel antifungal compounds

Leader : J.N. Eugene Sebastian

Sub Project

3.5.1. Chemical characterization of plant compounds active against Fungal pathogens of horticultural crops and oriented synthesis of some novel fungicides against fungal pathogens of horticultural crops (**J.N. Eugene Sebastian,** Girija Ganeshan)

PROJECT 4.1 : Post Harvest Management and Value addition to Horticultural Crops

Leader : Dr. C.K.Narayana

Sub Projects

4.1.1 Post harvest Management of Tropical fruits for extending storage life and quality maintenance – Mango, Custard apple, Papaya, Sapota & Guava(**D.V. Sudhakar Rao,** K.P. Gopalakrishna Rao , C.K.Narayana, K.S. Shivashankara, A.K. Saxena, Soudamini Mohapatra)

4.1.2 Post harvest Management of vegetables to extend storage life with maintenance of quality (Tomato, Capsicum, Okra and Bittergourd) **(K.P. Gopalakrishna Rao, D**.V. Sudhakar Rao, A.K. Saxena, Debi Sharma)

4.1.3 Microbiological studies in fruits, vegetables and their products (**K. Ranjitha,** C.K.Narayana, Dr. G.S. Prakash, Dr. Sampath Kumar, Dr. S. Shivashankar)

4.1.4 alue addition to fruits and vegetables by processing (Mango, Guava, Passion fruit, Sapota, Pineapple, Grapes, Carrot and Jackfruit) (**I.N. Doreyappa Gowda,** R.B. Tiwari, Dr. K.S. Shivashankara, Dr. K. Ranjitha, V.K. Rao)

4.1.5 Dehydration and freezing of fruits and vegetables for value addition and product diversification (mango, pineapple, banana, custard apple, guava, aonla, jackfruit, peas and other vegetables)(**R.B. Tiwari,** I.N. Doreyappa Gowda, Hima Bindu, K. Ranjitha, Debi Sharma, V.K. Rao)

4.1.6 Post harvest management and value addition of flowers and foliages of ornamental crops.(**Sangama,** S. Bhuvaneswari, V.K. Rao)

4.1.7 Standardization of packaging for transport of fruits and vegetables (**S. Bhuvaneswari,** C.K. Narayana, T.M. Gajanana, K. Ranjitha)

4.1.8 Use of vegetable crop residue and horticultural processing waste for value added products (**C.K. Narayana,** K. Ranjitha, G. Senthil Kumaran, D.V. Sudhakar Rao, I.N. Doreyappa Gowda, R.B. Tiwari, V. Keshava Rao, Meera Pandey)

4.1.8 Minimization of spoilage and safety risks in fresh cut vegetables (**K. Ranjitha,** K.P. Gopalakrishna Rao, Meera Pandey, K.S. Shivshanker)

PROJECT 4.2 Mechanization of production and processing of horticultural crops

Leader : S.C. Mandhar

Sub Projects

4.2.1. Development of sowing and transplanting machinery for horticultural crops (**S.C. Mandhar,** G. Senthil Kumaran, S. Shankar Hebbar)

4.2.2 Design and development of harvesters for horticultural crops (**G. Senthil Kumaran,** A. Carolin Rathinakumari, Y.T.N. Reddy, R. Veere Gowda)

4.2.3 Development of grading, packing and processing machinery for horticultural produce (**A. Carolin Rathinakumari,** G. Senthil Kumaran, A.K. Saxena., D.V. Sudhakar Rao, I.N. Doreyappa Gowda)

4.2.4 Use of advanced machinery for canopy architecture engineering for mango (**S.C. Mandhar)**

PROJECT 5.1 Investigations on tolerance to biotic and abiotic stresses for sustainable productivity in horticultural crops

Leader : N.K.S. Rao

Sub Projects

5.1.1 Studies on biochemical and molecular basis of salinity tolerance in horticultural crops and amelioration of stress responses by growth substances (**K.K. Upreti**, R.H. Laxman, R.M. Bhatt, M. Manmohan, L.R. Varalakshmi)

5.1.2 Molecular basis of systemic acquired resistance against diseases and allelopathic interactions in horticultural Crops (**S. Shivashankar,** V. Ravindra, V.K. Rao, P. Chowdappa, A.K. Saxena, A. Ganesha Murthy, P.N.Krishna Moorthy, P. Paneer Selvam)

5.1.3 Impact of elevated CO_2 on horticultural crops (**N.K. S. Rao,** R.M. Bhatt, K.K. Upreti, R.H. Laxman)

5.1.4 Studies on the impact of elevated temperature on growth, physiology and quality of horticultural crop (**R.H. Laxman,** N.K.S. Rao, K.K. Upreti, R.M. Bhatt, K.S. Shivashankara)

5.1.5 Physiological studies on impact of moisture stress on horticultural crops (**R.M. Bhatt,**N.K.S. Rao, K.K. Upreti, R.H. Laxman)

PROJECT 5.2 Investigations on physiological factors limiting productivity and quality of horticultural crops

Leader : V. Ravindra

Sub Projects

5.2.1 Investigations on the molecular physiology of fruit disorders – Mango and Pomegranate **(V. Ravindra,** S. Shivashankar, K. Srinivas, S.H. Jalikop)

5.2.2 Biochemical and molecular assessment of chilling injury in mango (K.S. Shivashankara, D.V. Sudhakara Rao, K.V. Ravishankar)

5.2.3 Isolation of natural antioxidants from mango processing waste (**V. K. Rao,** C.K. Narayana, I.N.D. Gowda, D.V. Sudhakar Rao)

PROJECT 6.1 Disease diagnostics and molecular characterization of plant pathogens in horticultural crops

Leader : M. Krishna Reddy

Sub Projects

6.1.1 Development of diagnostics and molecular characterization of bacteria, virus, viroid and phytoplasma infecting horticultural crops (**M. Krishna Reddy,** C. Gopalakrishnan, D. K. Samuel)

6.1.2 Development of recombinant protein and phage display based diagnostic kits for citrus greening bacterium, citrus Tristeza virus and cucumber mosaic virus (**D.K. Samuel,** M. Krishna Reddy)

6.1.3 Development of molecular diagnostics for rapid detection of quiescent infections of *Colletotrichum* and *Alterneria* in fruits and vegetables (**P. Chowdappa,** Girija Ganeshan)

PROJECT 6.2 Development of forecasting systems for effective management of diseases of fruits and vegetables

Leader : P. Chowdappa

Sub Projects

6.2.1 Development of disease prediction models for yellow rust in grapes(**A. K. Saxena,** N. Ramachandran, R. Venugopalan)

6.2.2 Development of disease forecasting models for the management of blights in tomato and anthracnose in Chillies (**P. Chowdappa,** Girija Ganeshan , R. Venugopalan)

6.2.2 Studies on the mechanism of the virus-host-vector interaction in vegetable crops (**M.Krishna Reddy,** N.K. Krishna Kumar, R. Ashokan, M. Manmohan, A.T. Sadashiva, K. Madhavi Reddy, M. Pitchaimuthu)

PROJECT 6.3 Development of integrated disease management strategies in horticultural crops

Leader : Girija Ganeshan

Sub Projects

6.3.1 Integrated management for pre and post-harvest diseases in fruits & vegetables (**A.K. Saxena,** N. Ramachandran, D.V. Sudhakar Rao, Soudamini Mohapatra)

6.3.4 Development of integrated disease management strategy for bacterial diseases of horticultural crops (pomegranate, tomato and brinjal) (**C. Gopalakrishnan,** M. Krishna Reddy, M.S. Rao, G. Selvakumar)

6.3.5 Identification and field evaluation of new bio agents for the integrated disease management of *Alternaria* blight disease in Tomato and Onion (**Girija Ganeshan,** P.Chowdappa, A N. Ganesha Murthy,S. Shivashankar)

PROJECT 6.4 Collection, improvement and utilization of mushrooms

Leader : Meera Pandey

Sub Project

6.4.1 Collection, documentation, characterization, conservation and evaluation of wild edible and medicinal mushrooms (**Meera Pandey)**

PROJECT 7.1: Pest Management in Fruit Crops

Leader : **Abraham Verghese**

Sub Projects

7.1.1 Surveillance and management of mango pests (Fruit fly, Stone weevil, hopper, fruit borer etc.) and guava **fruit fly.(Abraham Verghese,** P.D. Kamala Jayanthi)

7.1.2 Development of IPM for seed borer and soft green scale on sapota.(Kamala Jayanthi, Abraham Verghese, K. Gopalakrishna Pillai)

PROJECT 7.2 : Pest Management in Vegetable Crops

Leader : N.K. Krishna Kumar

Sub Projects

7.2.1 Studies on population dynamics and management of sucking pests on vegetable crops (N.K. Krishna **Kumar,** P. N. Krishna Murthy, **H.R.Ranganath)**

7.2.2 Use of botanicals/ essential oils for managing insect pests of vegetables (**P. N. Krishna Murthy,** N. K. Krishna Kumar, H.R. Ranganath)

7.2.3 **Development of IPM for the major pests of cucurbitaceous vegetables (H. R. Ranganath,** N. K. Krishna Kumar, P.N. Gangavisalakshy)

7.2.4 Monitoring and Management of insecticide resistance in major pests of horticultural crops (Thrips, mealy bugs, mites, brinjal shoot and fruit borer etc.) (**V. Sridhar,** P.D. Kamala Jayanthi, N. K. Krishna Kumar, B. Jhansi Rani, R. Asokan)

PROJECT 7.3 Pest management in ornamental, medicinal and aromatic crops

Leader : B. Jhansi Rani

Sub Project

7.3.1 Evaluation of insecticidal properties of selected botanicals and development of commercial formulations **for the management of major pests of** ornamental, medicinal and aromatic crops(J**hansi Rani,** V. Sridhar)

PROJECT 7.4 Biological control of major pests of horticultural crops

Leader : M. Mani

Sub Projects

7.4.1 Biointensive management of mealy bugs in horticultural crops (papaya, guava etc.)(**A. Krishnamoorthy,** M.Mani, P.N. Ganga Visalakshy, K. Gopalakrishna Pillai, D. SelvaKumar)

7.4.2 Biointensive management of thrips in horticultural crops (Chilli, capsicum, rose and onion) **P.N.Ganga Visalakshy,** A. Krishnamoorthy, K. Gopalakrishna Pillai) Biointensive management of whiteflies in horticultural crops **(brinjal, tomato, gerbera** etc.) (**K.Gopalkrishna Pillai,** M. Mani, B. Jhansi Rani, A.Krishnamoorthy, P.N.Ganga Visalakshy)

7.4.4 **Biointensive management of tea mosquito bug on guava (M. Mani,** Gopalakrishna Pillai,.P.N. Ganaga Vishalakshy, D.Sunderaraju)

7.4.5 **Biointensive management of** brinjal shoot and fruit borer (**P.N.Ganga Visalakshy,** A. Krishnamoorthy, P.N. Krishnamoorthy, H.R.Ranganath)

PROJECT 7.5 Management of Nematodes in Horticultural Crops

Leader : M.S. Rao

Sub Project

7.5.1 Studies on management of nematode induced disease complexes in horticultural crops (Banana, papaya, **capsicum, carrot, onion, gladioli etc.) using biopesticides(M. S. Rao,** C.Gopalakrishnan N.Ramachandran, Pious Thomas)

PROJECT 8.1. Integration of dynamics of Soil and - plant nutrient and its management in horticultural crops for yield and quality

Leader : M. Edward Raja

Sub Projects

8.1.1 Balanced nutrition in Mango and Pomegranate for yield, quality and disease resistance (**M. Edward Raja,** G. Selvakumar, A.K.Saxena)

8.1.2 Development of precision farming protocols for nutrient management in horticultural crops (**H.B. Raghupathi,** K.Srinivas, M.K.Chandraprakash)

8.1.3 Optimization of N, P and K fertilization in seed and vegetable purpose vegetables using isotopic techniques. **S.C. Kotur,** H.B.Raghupati

8.1.4 Nutrient dynamics in soil for Mango and development of fertilizer prediction equations for hybrid vegetables **A.N. Ganesh Murthy,** Y.T.N.Reddy)

8.1.5 Field validation of leaf nutrient diagnostic norms in fruit crops for higher profitability (**H.B. Raghupathi,** M.R.Hegde)

PROJECT 8.2. Soil health, food and environmental safety in horticultural cropping system

Leader : A.N. Ganesh Murthy

Sub Projects

8.2.1 Pesticide residue studies in fruits and related environment (**Soudamini Mohapatra,** A.K.Ahuja, Meera Pandey)

8.2.2 Behavior and fate of pesticide residues in fresh and processed vegetables (**Debi Sharma,** Soudamini Mohapatra, I.N.Doreyappa Gowda, S.Shankar Hebbar, R.B. Tiwari)

8.2.3 Plant uptake of soil applied pesticides and there persistence in soil (**A.K. Ahuja,** Soudamini Mohapatra, M.S.Rao, P.Chowdappa)

8.2.4 Development of microbial consortium for sustainable production of horticultural crops and improving soil Health (**Paneer Selvam,** A.N.Ganeshamurthy, G.Selvakumar)

8.2.5 Sustaining productivity of horticultural crops under adverse soil and water conditions in fruit and vegetables (high salinity and high metal toxicity)(**L.R. Varalakshmi,** M.Edward Raja)

8.2.5.1 Survey and monitoring of heavy metals in vegetable in peri-urban situations L.R.Varalakshmi, M.Edward Raja

8.2.5.2 Strategies to sustain and maintain productivity of horticultural crops under salt stress L.R.Varalakshmi, M.Edward Raja

8.2.6 Evaluation and improvement of soil quality of fruit orchards in Southern India (grapes, mango, pomegranate, citrus, guava and sapota)(**A.N. Ganesh Murthy,** Paneerselvam, L.R. Varalakshmi)

PROJECT 9.1 Development of molecular markers for application in horticultural crops

Leader : C.Aswath

Sub Projects

9.1.1 Identification of molecular markers linked to bacterial blight in pomegranate (**K.V. Ravishankar,** Kanupriya, S.H. Jalikop, C. Gopalakrishnan)

9.1.2 Identification of marker linked to pink pulp and soft seeds in guava (*Psidium guajava* L.) (**C. Aswath,** Kanupriya , M.R. Dinesh, P. Thomas, C. Vasugi)

9.1.3 Identification of markers linked rust resistance in snap bean (*Phaseolus vulgaris)* (**K.V. Ravishankar,** Kanupriya, T.S. Aghora, Girija Ganeshan)

9.1.4 Development of species specific markers for insect vectors (thrips, aphids and white fly) (**R. Asokan,** N.K. Krishna Kumar)

9.1.5 Identification of mt gene associated ORF and development of SCAR markers to differentiate male sterile, fertile and maintainer lines in carrot (**Lakshman Reddy, D.C.,** C.Aswath, R.Veeregowda)

9.1.6. Identification of markers linked to papaya ring spot virus resistance in intergeneric cross of papaya (*Carica papaya* x *Vasconcellea cauliflora*) (**Kanupriya,** C. Aswath, M.R Dinesh,, C. Vasugi, D.K. Samuel, Radhika)

9.1.6 In silico mining of expressed sequence tags (ESTs) for markers in melons and cucumber(**V. Radhika,** C. Aswath, Lakshman Reddy, D.C., M. Pitchaimuthu)

PROJECT 9.2 Gene cloning, regeneration systems and transgenic development for important horticultural traits

Leader : Sukhada Mohandas

Sub Projects

9.2.1 Development of somatic embryogenesis protocols in pomegranate cvs Bhagwa and Ganesh for application in obtaining non-chimeric transgenics (**Leela Sahijram,** H.S. Vagesh Babu)

9.2.2 Development of transgenic pomegranate cv. Bhagwa for bacterial wilt resistance

9.2.2.1 *Agrobacterium* and Biolistic mediated transgenic development using AMP gene (**Sukhada Mohandas,** M. Manamohan, S.H. Jalikop, C. Gopalakrishnan)

9.2.2.2 Electroporation mediated transgenic development using *Xa21* gene (**Akella Vani)**

9.2.3 Developing transgenic fruit crops resistant to PRSV in papaya (**Akela Vani,** C. Gopalakrishnan, D.K. Samuel)

9.2.4 Development of transgenic tomato resistant to early blight & chilli for Anthracnose (**J.B. Mythili,** M. Manamohan , Chowdappa, A.T. Sadashiva, K. Madhavi Reddy)

9.2.5 Developing transgenic vegetable crops resistant to viruses in tomato & watermelon (A**kella Vani,** M. Krishna Reddy, D.K. Samuel)

9.2.6 Development of Bt transgenic brinjal (**H.S. Vageeshbabu,** P.V.R. Reddy)

9.2.7 Development of transgenic tomato and chilli for abiotic stress resistance (**M. Manamohan,** Sukhada Mohandas, J.B. Mythili, A.T.Sadashiva, N.K.S.Rao, K. Madhavi Reddy, S.S.Hebbar)

9.2.8 Cloning of genes and development of constructs for resistance to important viruses diseases of horticultural crops to be used in NARS **(Akella Vani,** D.K. Samuel)

PROJECT 9.3 Endophytic and molecular microbiology

Leader : Pious Thomas

Sub Projects

9.3.1 Regeneration systems in horticultural crops with reference to management **and exploitation** of endophytes (**Pious Thomas,** C. Aswath)

9.3.2 Use of endophytic bacteria for the alleviation of bacterial wilt in tomato (**Pious Thomas,** C.Aswath, A.T. Sadashiva, M.S. Rao)

PROJECT 10.1: Impact Assessment and Transfer of Technology in Horticulture

Leader : S.D. Doijode

Sub Projects

10.1.1 Identification of technological gaps through PRA for the varieties and technologies developed by the Institute (**B. Balakrishna,** Saju George, S.D. Doijode, Nita Khandekar, Achala Paripurna)

10.1.2 Documentation of innovative horticultural technologies under real farm situations (**T.N. Shivananda,** S.D. Doijode, B. Balakrishna M.R.Hegde, Nita Khandekar, Achala Paripurna, Saju George)

10.1.3 Impact of capacity building of trainees on adoption of IIHR technologies including identification of future training needs (**Achala Paripurna,** S.D. Doijode, Nita Khandekar, T.N. Shivananda, B. Balakrishna, Saju George)

10.1.4 Assessment and refinement of IIHR technologies through farmers participatory demonstrations (**Saju George,** S.D. Doijode, M.R. Hegde, B. Balakrishna, Achala Paripurna)

10.1.5 (a) Application of Innovative Extension, Information and Communication Methodologies for transfer of Technology in Horticulture (**M.R. Hegde,** Nita Khandekar, Saju George, V.Radhika, M.K.Chandraprakash, Reena Rosy Thomas)

10.1.5 (b) Development of Decision Support Expert Systems and computer assisted instruction (CAI) modules for increasing production in fruit crops and their utility (**R. Chithiraichelvan,** B.N.S Murthy, Y.T.N. Reddy, M.R. Dinesh, Edward Raj, Abraham Verghese, A.K. Saxena, V. Radhika, R. Venugopalan)

10.1.5 (c) Development of an information system for AICRP on tropical fruits (**Reena Rosy Thomas,** Prakash Patil)

10.1.6 Gender Mainstreaming in horticulture (**Nita Khandekar,** S.D. Doijode, G.Senthil Kumaran, Sudhakar Rao, Meera Pandey, M.R. Hegde)

PROJECT 10.2: Economic Research, Statistical modeling and computer application in Horticulture

Leader : T.M. Gajanana

Sub Projects

10.2.1 Socio economic Impact of horticultural technologies on crop diversification, income, employment and trade (M. Sudha, T. M. Gajanana, D. Srinivasa Murthy, Nita Khandekar)

10.2.2 Marketing, supply chain and price analysis in horticultural crops (**T.M. Gajanana,** D. Sreenivasa Murthy Sudha Mysore, A.K. Saxena, D.V. Sudhakar Rao)

10.2.3 Economics of factor productivity and production efficiency in selected horticultural crops (**D. Sreenivasa Murthy ,** Sudha Mysore, T.M. Gajanana)

10.2.4 Development of statistical models for horticultural crops research (**R. Venugopalan,** M.K. Chandra Prakash, Y.T.N. Reddy, N.K. Krishna Kumar, K. Srinivas)

10.2.5 Application of Bio-informatics in characterization of tomato ESts by cross genome analysis with emphasis to stress related genes (**M.K.Chandra Prakash,** Akellavani, Reena Rosy Thomas, V.Radhika)

PROJECT 11.1 Exploration, collection and domestication of genetic resources in horticulture crops

Leader : S. Ganeshan

Sub Projects

11.1.1 Mapping hotspot areas of horticultural gene pool, distribution and database development (**S. Ganeshan,** P.E. Rajasekharan, Crop curators)

11.1.2 Optimization of germplasm domestication strategies for introducing new species of horticultural importance for crop diversification(**S. Ganeshan,** P.E. Rajasekharan, H.S. Yogeesha, K. Padmini, PVR Reddy)

PROJECT 11.2 Evaluation, characterization and valuation of germplasm

Leader : T.V.Ananthanarayanan

Sub Projects

11.2.1 Evaluation of Bird of paradise germplasm (**Anuradha Sane,** P.E. Rajasekharan)

11.2.3 DNA fingerprinting and genetic diversity analysis of horticultural crops germplasm (**T.V. Ananthanarayanan,** Anuradha Sane, M. R. Dinesh, T. Sakthivel, S.H.Jalikop)

11.2.4 (a) Pollinator diversity, ecology and economic importance in fruit crops germplasm

11.2.4 (b) Assessing the compatibility of new molecules of insecticides and fungicides used in horticultural crops. (**P. V. R. Reddy,**Abraham Verghese M. R. Dinesh,C. Vasugi)

PROJECT 11.3 Complementary conservation and germplasm enhancement

Leader : P.E. Rajasekharan

Sub Projects

11.3.1 Development of complementary conservation strategies for horticulture PGR's (recalcitrant seed, pollen and in vitro material) (**P.E. Rajasekharan,** S. Ganeshan, H.S. Yogeesha, Anuradha Sane, K. Bhanuprakash)

11.3.2 *In-vitro* conservation and maintenance of embryo rescued grape , triploid water melon and banana genotypes (**S. Ganeshan,** P.E. Rajasekharan, K. Padmini, Leela Sahijram, Pious Thomas)

11.3.3 Restoration of fertility in interspecific F_1 hybrid between *Solanum melongena* and *Solanum macrocarpon* (**K. Padmini,** T. H. Singh, P.E. Rajasekharan, Leela Sahijiram)

11.3.4 Identification of zygotic seedlings in polyembryonic mango using molecular approaches (**Anuradha Sane,** S.Ganeshan, M. R. Dinesh , K.V. Ravishankar, C. Vasugi)

11.3.6 Genetic stability of vitro raised germplasm of jackfruit and chrysanthemum (**Anuradha Sane,** P.E. Rajasekharan, Prakash Patil, A.Rekha)

11.3.7 Ultra drying as a cost effective technique to extend seed longevity of horticultural germplasm under ambient conditions (papaya, French bean, onion, china aster)(**H.S. Yogeesha,** K. Bhanuprakash , L. B. Naik, K.Padmini, R. Veere Gowda, T.S.Aghora, A. Rekha)

PROJECT 11.4 Multiplication and quality assurance of seed propagated horticultural crops

Leader : L.B. Naik

Sub Projects

11.4.1 Value addition to seeds through coating and pelleting in horticultural Crops (papaya, onion, carrot, china aster) (**H.S. Yogeesha,** L.B. Naik , K. Bhanuprakash, K.Padmini,P. Panneerselvam)

11.4.2 Studies on precision production practices for enhancement of seed yield and quality in Capsicum and China Aster (**L.B. Naik ,** H.S. Yogeesha)

11.4.3 Biochemical and molecular investigations in relation to seed quality assurance in vegetable crops (**K. Bhanuprakash,** H.S. Yogeesha, T.V. Ananthanarayanan)

11.4.4 Investigations on seed dormancy and viability in Custard apple, Karonda, *Macadamia tetraphylla*, *Cheronjee* (*Buchanania lanzan*) (**K. Bhanuprakash,** H.S. Yogeesha,, S.H. Jalikop)

PROJECT 11.5 Germplasm exchange, documentation and quarantine

Leader : T.V.Ananthanarayan

Sub Project

11.5.1 Monitoring and screening of introduced plant material for pest and disease incidence (**P.V.R. Reddy,** P.E. Rajasekharan, N. Ramachandran, M.Krishna Reddy, A.K. Saxena)

Central Horticultural Experiment Station, Bhubaneswar

PROJECT B1 : Plant genetic resource management and improvement in horticultural crops

Leader : Vishal Nath

Sub Projects

B.1.1 Collection, evaluation, characterization, conservation and documentation of germplasms of fruit crops of Eastern India (**V. Pandey*,** Vishal Nath, H. S. Singh, S. Mandal)

B.1.2 Improvement in pineapple for yield and quality (**V. Pandey*,** Vishal Nath)

B.1.3 Identification of varieties/hybrids and local elites of fruit crops suitable for Eastern India (**V. Pandey*Vishal Nath,** H. S. Singh, S. Mandal)

B.1.4 Collection, evaluation, characterization, conservation and documentation of germplasms of vegetable crops (**G. Naik,** B. Narsimha Rao, Vishal Nath, H. S. Singh, S. Mandal, L.K. Bharathi)

B.1.5 Evolving high yielding varieties/hybrids of Brinjal and chillies (**G. Naik B. Narsimha Rao,** Vishal Nath, H. S. Singh , S. Mandal, L.K. Bharathi)

B.1.6 Evolving high yielding varieties/hybrids in underutilized cucurbits (**Vishal Nath,** G. Naik, B. Narsimha Rao,H. S. Singh, S. Mandal, L.K. Bharathi

B.1.7 Evolving high yielding varieties/F1 hybrids in Okra (**B.Narsimha Rao, (P. Srinivas),** Vishal Nath, , G. Naik, H. S. Singh, S. Mandal)

B.1.8 Evolving high yielding varieties in pointed gourd(**B. Narsimha Rao, (P. Srinivas),** Vishal Nath, G. Naik, L. K. Bharathi)

PROJECT B2. Development of production technologies of horticultural crops for Eastern India

Leader : V. Pandey

Sub Projects

B.2.1 Determination of ideotype tree architecture for fruit crops (mango) (**Vishal Nath,** V. Pandey, H. S. Singh, S. Mandal)

B.2.2 Increasing water and nutrient use efficiency in fruit crops (**V. Pandey ,** Vishal Nath)

B.2.3 Canopy management in different densities for efficient photosynthesis and productivity in guava (**Vishal Nath,** V. Pandey)

B.2.4 Development of production technology of fruit crops under rainfed conditions of Eastern India (**Vishal Nath V. Pandey,** R. Saha , H. S. Singh, S. Mandal)

B.2.5 Development of organic production technology for mango in Eastern India (**R. Saha,** S. Mandal, HS. Singh)

B.2.6 Establishment of scion-root stock relationship with respect to plant vigour in mango (**V. Pandey,** Vishal Nath)

B.2.7 Development of production technology of vegetable crops for Eastern India (**B. Narsimha Rao, P. Srinivas),** G. Naik, R. Saha)

B.2.8 Characterization of hydro-physical and microbial properties of soil under different cultivation practices of horticultural crops in Eastern India (**R. Saha,** S. Mandal, Vishal Nath, V. Pandey, B. Narsimha Rao)

PROJECT B3. Management of biotic stress in horticultural crops for eastern India

Leader : H. S. Singh

Sub Projects

B.3.1 Monitoring and management of sucking pests in vegetables (**H. S. Singh, ,** S. Mandal, V. Pandey)

B.3.2 Induction of resistance in tomato and brinjal against wilt diseases through elicitors and bio control agents (**S. Mandal,** B. Narsimha Rao)

B.3.3 Monitoring and management of selected insect pests in fruit crops (**H. S. Singh,** V. Pandey)

B.3.4 Management of sucking pest in solanaceous vegetable crops (**H. S. Singh, S. Mandal,** R. Saha)

B.3.5 Reducing post-harvest losses of mango due to diseases using novel approaches (**S. Mandal,** H. S. Singh, V. Pandey)

B.3.6 Bio-prospecting of agriculturally important micro-organisms in under various horticultural cropping system for their potential exploitation for disease management, plant growth promotion and soil enrichment (**P. Srinivas,** Vishal Nath, S. Mandal, K. Laxminarayana)

PROJECT B4. Technology transfer of horticultural crops

Leader :B. Narsimha Rao

B.4.1 Development of Technology Park for selected horticultural technologies (**B. Narsimha Rao, (P. Srinivas),** Vishal Nath, H.S. Singh, S. Mandal, G. Naik, V. Pandey, R. Saha

Central horticultural experiment station, Chettalli

PROJECT C1.1: Evaluation of underutilized fruits and purification of papaya

Leader : T. Sakthivel

Sub Projects

C.1.1.1 Collection and evaluation of under utilized fruits for humid tropics (**T. Sakthivel,** K. Shivaramu)

C.1.1.2 Selection of stable hermaphrodite types of Coorg Honey Dew Papaya (**T. Sakthivel,** G. Karunakaran, M.R. Dinesh)

PROJECT C 2.1 Horticulture intervention to improve the productivity and soil health in fruit crops under humid tropics

Leader : S. Hazarika

Sub Projects

C.2.1.1 Refinement of technologies for improved productivity of Coorg mandarin (**T. Sakthivel,** S. Hazarika)

C.2.1.2 Studies on factors influencing soil quality of fruit orchards in southern India (Guava and Sapota) (**S. Hazarika,** A.N. Ganeshamurthy, T. Sakthivel)

C.2.1.3 Standardization of technology for organic production of papaya (**T. Sakthivel,** G. Karunakaran, D. Srinivasamurthy)

PROJECT C 3.1 Pollination and honey production under IPM of humid tropics

Leader : K. Shivaramu

C.3.1.1 Studies on management of insect vectors transmitting Citrus Greening Bacterium (CGB) and Citrus Tristeza Virus (CTV) (**K. Shivaramu,** T. Sakthivel)

C.3.1.2 Studies of factors influencing pollination and bee production (**K. Shivaramu,** T. Sakthivel)

PROJECT C 4.1 PRA on horticultural production in humid tropics

Leader : T.M. Reddy

C 4.1.1 PRA on organic production of horticultural crops in humid tropics (**T.M. Reddy,** K. Shivaramu)

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11. Consultancy Services

The Consultancy Processing Committee (CPC) finalized a number of advisory general consultancy, contract services and training programmes, to a wide range of clientele. All these activities enabled the proper utilization of the scientific expertise available at this institute. During the period under the report the total revenue generated from the consultancy services was Rs. 54,97,500

11.1 Contract services : Twelve paid up trails were undertaken and some of the important services provided were

- Evaluation of new formulations for insect / pest, disease control.
- Persistence of pesticide residues in horticultural crops.
- Testing of growth regulators and fertilizers.

11.2 Advisory / general consultancy : Important services provided included

- Testing of tissue culture plants for virus / fungus / bacteria / insect pests / mites / nematodes.
- Testing of seeds for the fungus and nematodes.
- Providing advisory services to the farmers and exporters.
- Seed germination tests.
- Recognition of certain private firms as R&D institution.
- Test for viral indexing of tissue culture plants.
- Issue of Phtyosanitary certificate.
- Estimation of proteins and antioxidants.
- Analysis of horticultural products for processing qualities.

Summary of revenue generation under consultancy services during 2009-10

Sl. No	Type of services	Revenue generated (Rs)
1	Contract service	42, 93, 500
2	Advisory / General consultancy	5, 48, 800
3	Other testing (virus, pathogens, pesticide residues, supply of functional drawings, etc)	6,55, 200
	TOTAL	**54,97,500**

IIHR, Bangalore conducts Training on various aspects of horticulture and encourages contract research. The persons or organizations interested in these services may contact Director, IIHR, Bangalore.

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12. RAC/IRC/QRT/IMC - Major Recommendations

Research Advisory Committee (RAC)

Chairman: Dr.K.L.Chadda

Members: Dr. G. Trivedi
Dr. Irullappan
Dr. A.N.Maurya
Dr. A.K.Singh
Dr. D.S.Khurdiya
Dr.A.Kariyanna
Dr. A.S.Sidhu, Director, IIHR, Bangalore

Member Secretary: Dr. M.R.Hegde

The 16th Research Advisory Committee Meeting of the Institute was held on February 24-25, 2010. The following recommendations were made.

The Chairman and the members of RAC in discussion

Main Station, IIHR, Bangalore

- Primary concern should be on exploring the required germplasm from different locations. Prioritization of crops and locations and prior planning is required to identify crops & areas for which exploration to be done. New tools like GIS can be employed for identifying the areas
- Need based research work on grapes for mild tropics may be continued. There is a need to standardize protocol for production of grapes for export in mild tropics.
- In mango root-stock study, address the problem of incompatibility and propagation.
- Package of practices are to be brought for Surya variety of papaya immediately highlighting on management of PRSV
- Dwarfing root stock work should be prioritized on mango followed by sapota and annona.
- In case of peas, lines suitable to summer or round the year production are required with focus on development of powdery mildew tolerant varieties.
- Emphasis has to be given for the development of vegetable varieties suitable for year round production/ protected cultivation.
- In seed production activities licensing, MOU-contract, popularization of the variety and seed village concept may be looked into.
- In crossandra, morphological differences should be clearly documented between the parents (eg, Delhi crossandra) and the hybrid.
- In landscape, efforts are required to collect more data, information & photographs so that it can be used to prepare suitable modules for different situations
- Extensive surveys to be conducted to identify wild flower species indigenous to our country that can be exploited commercially.
- Papaya mealy bug is reported to be severe in Tamil Nadu and may spread to other states. Contingency measures to tackle the problem may be worked out.
- Disease management protocol for mango under cold storage is required.
- Look for effective strategies for control of phytopthera as it is becoming wide spread disease in different horticultural crops
- Bring out bulletins on foliar formulations and its use in horticultural crops. Bulletin should comprise micronutrient deficiency symptoms and its management
- More work on precision farming protocol for nutrient management under protected cultivation is required.
- Formulation developed for control of spongy tissue should be tested in farmers fields to show it is usefulness and develop sufficient data to support and then only may be taken up for patenting.
- Development of molecular markers for polyembryonic/ monoembryonic varieties may be initiated. Work done in Israel may be referred.
- Collect wild genotypes of Daru in pomegranate and look for genetic variability. Daru is widely grown in Himachal Pradesh and more variation can be collected by visiting the place.
- Studies on molecular markers for identification of

zygotic / nucellar seedlings or polyembrony and mono embryonic seedlings in mango is required. Work done at Israel may be referred.

- The level of retention of neutracetical properties or nutrients of the beverage during the processing has to be studied.
- Several fruit punches are available in market. Study different best combinations before taking up experiment on them.
- Cost of packaging in aonla and benefit cost ratio of adopting this technology may be worked out.
- The data documented on post harvest losses may be used as a base for further work on minimization of post-harvest losses (pertaining to Division of Economics).
- Onion transplanter – the prototype methodology, feasibility is to be looked into. In crops like paddy transplanting have not become popular. For use of transplanting larger area is required. Hence, community approach is required for popularizing onion trans planter.
- Enlist the viable technologies fit for demonstration & transfer them from time to time.Technologies taken for demonstration may be prioritized in consultation with different divisions.
- Focus more on training KVK, NGO and official bodies who can in turn train farmers. In this regard stronger linkage is required with Zonal Project Directorate.
- Through market integration and price analysis studies, the reasons for sudden spurt or reduction in market rates of important food commodities must be explained.

Central Horticultural Experiment Station, Bhubaneswar

- Work on minor vegetables to be intensified. Publications on minor vegetables may be brought out.

Central Horticultural Experiment Station, Chettalli

- While selecting the technologies, discussion should be held with Departments of Horticulture, Agriculture, Animal Husbandry, Sericulture and Agricultural Universities, to chalk out technologies advocated for the farmers on the areas and also for conduct of demonstrations.

General Recommendations

- Strengthening Agricultural Technology Information Centre (ATIC) may be looked into.
- Deemed University will provide excellent opportunity for utilizing full potential of the scientific strength, on-going research programmes, providing quality education in frontier areas, capacity building and infrastructure development of IIHR.
- Good publications may be brought out comprising all the IIHR technologies including varieties which are in circulation.
- Scientists may concentrate on publishing research papers in journals having good impact factor and patronize it.
- Documentation of effect of climate change on productivity of horticultural crops, region-wise and crop-wise is to be carried out.
- While working on Genetically Modified (GM) crops, sufficient care should be taken to follow all the guidelines

Institute Research Committee (IRC)

Chairman: **Director**

Members: **All the Scientists of the Institute**

Member Secretary: **Dr. M. R. Hegde**

The 79th Institute Research Committee meeting was held during July 20 - 30, 2009 at I.I.H.R, Bangalore to review the progress of research work in the ongoing projects of the institute during the year 2008-09 and finalize the technical programme and plan of actions for the year 2009-10.

Following were the recommendations made;

- Shoot hole borer and yellow rust problem in grape especially in Bangalore Blue to be tackled.
- Work on breeding for resistance against late blight of tomato may be initiated.
- In bell pepper, work on phytophthora blight resistance may be initiated
- In all studies on stress management of vegetables, soil moisture content and cost benefit analysis be carried out.
- Work on triploid watermelon has to be intensified.
- Quality parameters, cost benefit ratio and pesticide residue analysis has to be carried out in all the studies related to organic cultivation of vegetables.
- Work on late blight on tomato grown in poly house may be taken up.
- All new varieties are to be registered with NBPGR on priority and DNA finger printing completed.
- Work may be initiated for development of varieties / hybrids of tomato, capsicum and bottle brinjal suitable under protected cultivation.
- A separate committee for multiplication of seeds and planting materials of all released varieties of IIHR need to be set up for production and supply of sufficient quantity of planting material. A scientist from Seed Science and Technology may be identified for co-ordinating production of seed and planting material.

- Protected cultivation of high value ornamental crops has to be given priority.
- Economics of commercial cultivation, seed production in open field and in poly house of various ornamental crops may be taken up by the scientists of economics section.
- The Division of Extension and Training has to conduct more demonstrations on the released varieties of ornamental crops for which required planting material has to be supplied by the Division of Ornamental Crops.
- A herbal garden with important medicinal plants may be developed and maintained at the Institute.
- Pre-harvest factors which also affect the post harvest quality of the fresh and processed fruits and vegetables should be included in studies on PHT.
- Cost effective grafting machine, chilli seed extractor, and multi-purpose tomato seed extraction cum pulp extraction machine may be developed..
- In climate change study, the beneficial effects of elevated CO_2 have to be quantified
- Disease diagnostics developed should be used for monitoring and forecasting of vegetable diseases.
- Development of viable IDM packages for economically important diseases of vegetables to be given priority.
- Bio agents may be tried for management of soil borne diseases of gladiolus and carnation.
- The mushroom flora of Western Ghats may be collected and documented on priority.
- Revised package of practices for mushroom may be published.
- Demonstration of scaling up production of mushroom and its economics has to be taken up.
- The disease management schedules standardized may be put on institute website on priority.
- Use of benozyol and carbendazim for PHM should be avoided due to residual problems.
- A botanical module for effective management of thrips, whiteflies and mealy bugs under poly house condition may be developed on priority.
- Pesticides recommended for different crop pests may be passed on to pesticide residue lab for assessing safe waiting periods.
- Basic work on vector and virus relation may be initiated.
- All the viable technologies developed by the divisions may be passed on to KVKs and University for demonstrations
- Insect and disease forecasting may be taken up and may be put on website and newspapers
- The maps prepared by NBSS and LUP on micronutrient status of different soils may be utilized and maps indicating potential area of nutrient deficiency in mango may be prepared.
- More awareness on heavy metals and vegetable cultivation in sewage water to be brought about
- Referral laboratory on pesticide residue analysis should be of international standard. The existing laboratory may be may be upgraded with funds from APEDA
- Public-private partnership may be encouraged in Bt transgenic brinjal as in the case of IARI.
- Close co-ordination required between bio-technologists, physiologists, breeders, entomologists, pathologists to have an integrated approach as all the research workers involved have equal responsibilities.
- The feedback collected through PRA on various aspects and its incorporation in research programme to be documented
- Training needs assessment to be studied systematically clientele wise including farmers. Feedback to be considered for refinement of training.
- Factors responsible for less proportion of exportable quality mangoes (Alphonso and Kesar) to be identified.
- Bio-informatics work related to crops and genes may be prioritized in consultation with the scientists of the Division of Biotechnology.
- Identify a village and multiply the seeds (seed village concept) so that our varieties can be popularized.
- Few success stories on adoption of IIHR technologies may be documented, compiled and submitted.
- Prioritization of crops pertaining to different hot spot regions for mapping needs to be provided by breeders.
- In late maturing variety of mango, anthracnose incidence may be recorded.
- Quality seed and planting material production needs focus at both Chettalli and Gonikoppal.
- Feedback information on package or rejuvenation of Coorg mandarin be obtained
- The quality of fruits and food safety components to be critically appraised

Institute Management Committee

Chairman:

Director, IIHR, Bangalore – 560 089

Members:

1. Dr.S.Rajan,
Asstt. Director General (Hort.-I),
ICAR, Krishi Anusandhan Bhavan,
New Delhi – 110 012.

2. Dr. A.K. Singh, Head,
Division of Fruits & Hort. Technology,
Indian Agriculture Research Institute
New Delhi.

3. Dr. N. Ramachandran, Head, Division of Plant Pathology, IIHR, Bangalore.

4 Dr. N.K.Srinivasa Rao, Principal Scientist,
Division of Plant Phys. & Biochemistry,
IIHR, Bangalore.

5. Dr. M. Prabhakar,
Principal Scientist,
Division of Vegetable Crops,
IIHR, Bangalore.

6. Additional Director of Horticulture (Fruits & Floriculture),
Government of Karnataka,
Lal Bagh, Bangalore-560 027

7. Director of Horticulture and Plantation Crops,
Government of Tamil Nadu,
Chepauk, Chennai – 600 005

8. Director of Research,
University of Agricultural Sciences,
Bangalore – 560 065

9. Senior Finance and Accounts Officer,
Central Marine Fisheries Research Institute,
Cochin – 682 014, Kerala.

10. Shri. Prabhakar Chandane,
President,
Maharashtra Pomegranate Growers Res. Association,
'Nisarg' Chhatrapathi Shivaji Market Yard,
Gultakadi, Pune – 411037

11. Shri. P. Sudhakar Rao,
National Pomegranate Growers Association of India,
R/O Plot No.13, HIG, Phase-II,
Vasanthalimpuram Colony,
Hyderabad – 500 070

Member-Secretary:

Shri. G. G. Harakangi,

Senior Administrative Officer,

IIHR, Bangalore

The research work of Division of Biotechnology in particular and the on going research programmes of other divisions were reviewed and following recommendations emerged during the deliberations.

- There is need to give emphasis on identification of varieties / hybrids tolerant / resistant to nodal blight in pomegranate and triesteza in citrus. There is also necessity to standardize the management practices by consolidating the available information with IIHR, Agricultural Universities and NRC for Pomegranate, Solapur in case of Pomegranate and IIHR, University of Agricultural Sciences, Bangalore; APAU, Hyderabad and NRC on Citrus in case of citrus. In this regard, Head, Division of Fruit Crops, Plant Pathology may take up steps to call a meeting to discuss strategies.
- It was pointed out that the pomegranate hybrid seedlings supplied to Maharashtra have contracted the disease. The concerned scientists may visit and monitor the same.
- Andhra Pradesh is also emerging as an important area for production of pomegranate and citrus. Although, in citrus Rangpur lime rootstock is advocated, the resultant grafted plants are also showing the symptoms of disease.
- Fursarium wilt is becoming serious, especially in Nanjangud Rasbale. All round efforts are needed to identify the resistant source and also management practices to overcome the problem.
- Quality vegetable seedling production is predominantly seen in and around Bangalore. However, there is need to popularize this method of seedling raising in other places also.
- For better control of insects under protected cultivation of horticultural crops, there is need to use 40 mesh net on the top of the polyhouse.
- There is need to standardize practices for taking up organic farming to address nutrient and plant protection aspects and take up protocol developments to answer the above.
- Stem cracking in rootstock portion of mango is widely seen. The reasons for the same have to be identified and management practices be worked out and popularized.
- In drumstick, pink discoloration of fruits is seen. The reasons for the same have to be identified and necessary control measures to be advocated.

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13. Presentation of Papers by Scientists in Conferences/Meetings/Seminars/Symposia, etc

Workshop on Expert System in Agriculture , 15th June, 2009, IASRI, New Delhi

- Chithiraichelvan, R. - Expert Systems in Horticulture

International Symposium on Pomegranate and Minor including Mediterranean Fruits, 23 – 27 June, 2009, UAS, Dharwad, Karnataka

- C. Gopalakrishna and A.K. Saxena -Management of bacterial blight disease of pomegranate in Southern Districts of Karnataka
- Jalikop, S. H. -Breeding pomegranate and Annonaceous fruits.
- Chithiraichelvan, R.- Contribution of canopy spread to yield in edible fig (*Ficus carica* L.) cv. Poona
- Jalikop, S. H., R. Venugopalan and R. Kumar. Association of fruit weight with seed number in artificially pollinated fruits of cv. Arka Sahan.
- Jalikop, S.H., K.S. Shivashankara and R. Kumar. Variability in Mulberry (*Morus spp*.) Accessions for plant and fruit traits and antioxidant Properties.
- Jalikop, S., R. Venugopalan and R. Kumar. Breeding pomegranate (*Punica granatum* L.) varieties free from aril browning.
- Jalikop, S.H. and R. Kumar. 'Double flower' pomegranate originated from a hard seeded acidic pomegranate by spontaneous dominant gene 'df' mutation.

CIMAP Golden Jubilee National Symposium on Medicinal and Aromatic Plants, 26th June, 2009, CIMAP, Bangalore

- Hima Bindu, K., Vasantha Kumar T. and Eugene Sebastian J Nidiry - Promising selections of velvet bean
- Sukanya , D. H., Kusuma V Pategar, Gayatri Datta , Hima Bindu K. and Eugene Sebastian J Nidiry -Yield potential of Aswagandha (*Withania somnifera* Dunal) gene pool.

Joint FAO-IAAE pre conference workshop on Innovative Policies and Institutions to Support Agro-Industries Development, 16 - 22 August, 2009, Beijing, China,

- Sudha Mysore -Linking farmers to market through processing - role of agro-industry clusters with special reference to mango crop in South India.

Workshop on Information Technology Applications in Horticultural Crops, 24 -25 August, 2009, Central Potato Research Institute, Shimla, Himachal Pradesh

- Chithiraichelvan, R. -An expert system prototype for selection of mango propagation method,
- Kotur,S.C., Sreenivasa Murthy, Gajanana, T.M. and Reena Rosy Thomas- Horticultural Resources Information Sytem: A Potential database for horticultural development

IX International Symposium on Thysanoptera and Tospoviruses, 31 August - 4 September, 2009, Brisbane Australia,

- Akella Vani -Human antibody genes confer resistance to tospovirus (PBNV) in tomato
- Akella Vani- Expression of nucleocapsid protein is lowered in challenged transgenic tomato plants carrying nucleocapsid gene of Peanut Bud Necrosis Virus

International Seminar on India Organic-Strategies to Surge Ahead, 10- 11 September, 2009, UAS, Bangalore

- Prabhakar, M, S.S.Hebbar, A.K. Nair, P. Pannerselvam, K. S. Shivashankara and R.S.Rajeshwari, - Studies on Organic Vegetable Production with Relevance to Productivity, Feasibility Quality and Soil Health.

ISHS / ProMusa Banana Symposium on Global Perspectives on Asian Challenges, 14-18 September, 2009, Guangzhou, China

- Rekha. A, K.V. Ravishankar and D.S. Ambika- Generation of mapping populations for segregation of 'B' genome
- Ravishankar, K.V., A. Rekha, V. Swarupa and G. Savitha- Gene expression analogies in roots of Calcutta-4 a resistant genotype for *Fusarium* wilt disease in banana
- Ravishankar, K.V., A. Rekha, G. Savitha, V. Swarupa and R.H. Laxman- Gene expression analogies in Bee Hee Kela (*M. balbisiana*), a tolerant genotype for drought in banana
- Ravishankar, K.V., A Rekha, V. Swarupa and G. Savitha - Gene expression analysis in roots of "Calcutta-4"- *Musa acuminata* ssp *burmanicoides* a resistant genotype for *Fusarium* wilt in Banana

International Conference on Environment, Occupational and Lifestyle Concerns – Transdisciplinary approach, 16-19 September, 2009, ROHC, Bangalore

- Debi Sharma, S.S. Hebbar and Soudamini Mohapatra- Behaviour of some pesticide residues in capsicum grown in polyhouse.
- Soudamini Mohapatra, P. Panneerselvam, M. Deepa, G.K. Jagadish, N. Rasmi, A.K. Ahuja, Debi Sharma and A. N. Ganeshmurthy - Degradation of bifenthrin by bacterial cultures isolated from enriched soils

International Cucurbitaceous Symposium, 21-26 September, 2009, Changsha, Hunan, China

- Pitchaimuthu, M, O.P.Dutta, V.S.R. Krishna Prasad and K.R.M. Swamy-Development and evaluation of triploid seedless watermelon [*Citrullus lanatus* (Thumb)]

National Conference on Production of Healthy Planting Material in Banana, 3-6 October, 2009, Jalgaon, Maharastra

- Kotur, S.C., Anjaneyulu, K. and Ramachandran, V. - Root activity distribution of 'Robusta' banana under high density planting as determined by tracer technique.
- Sakthivel, T. and H. Ravishankar- Performance appraisal of the *in vitro* propagated banana planting material of four commercial varieties with varying different plant densities under humid tropical conditions.
- Thomas, P. - Production of quality micropropagated banana plants: Dealing with microbial interferences,

Fourth National Symposium Noni for Empowerment and Prosperity, 24 - 25 October, 2009, Chennai.

- Vishal Nath, R.K. Verma, D.R. Singh and Ajay Mishra - Root distribution pattern of Noni (*Morinda citrifolia*) plants.
- Vishal Nath, V. Pandey, D.R. Singh, Rajesh Kumar Verma, and R.C. Srivastav - Exploratory observations on easy and economic means of transport of *Morinda citrifolia* (Indian noni) seedlings.
- Vishal Nath, V. Pandey, Rajesh Kumar Verma, Ajay Mishra and D.R. Singh - Effect of drip irrigation level and mulching on growth of young Noni plants under light soil conditions.

National Symposium on Microbial Wealth and Plant Health, 23 – 25 October, 2009, University of North Bengal, West Bengal, Siliguri,

- Girija Ganeshan and B.S. Chethana (2009) Bioefficacy of Curzate M8 72 WP against downy mildew of cucumber caused by *Pseudoperenosora cubensis.*
- Gopalakrishnan, C., A. K. Saxena and S.P. Kirthishree,- Effect of storage *in vitro* of *Xanthomonas axonopodis* pv. *punicae* on its virulence
- Saxena, A. K. and C. Gopalakrishna -Survival *in vivo* of conidia of *Colletotrichum gloeosporioides* causing anthracnose in pomegranate.

International Conference on Horticulture (ICH-2009) Horticulture for Livelihood Security and Economic Growth, 9-12 November, 2009, ITC Windsor Hotel, Bangalore

- Aswath. C and Vageeshbabu S. Hanur - Biotechnological interventions in horticulture and sustainable livelihood
- Aghora T. S -Inheritance of resistance to mungbean yellow mosaic virus (MYMV) in french bean (*Phaseolus vulgaris* L).
- Balakrishna, B, M.R. Hegde and S.D. Doijode - Holistic extension approach for cultivation of exotic vegetables under protected environment – A New approach for higher economic gains
- Doijode, S.D. -New Trends in retrieval of viable germplasm on conservation in different vegetable crops.
- Gajanana, T.M. -Post harvest handling, marketing and loss assessment of onion in Karnataka, India – an economic analysis
- Hazarika, S. Ganeshmurthy, A.N and Sakthivel, -Long term Orchard management effects on soil quality characteristics under subtropical climate of India.
- Jalikop, S.H. and Ravindra Kumar - Novel yellow miniature pomegranate-'Yellow nana' that can profit nurserymen.
- Krishnareddy, M.and Anupam Varma - Emerging viruses in Horticultural crops and their management.
- Madhavi Reddy, K., M.Krishna Reddy, K.V Ravishankar, G.Prakash Patil and S.Brinda -Search for the dominant Potyvirus resistant allele *(PVR4*) located on chromosome 10 in chilli veinal mottle potyvirus *(CHIVMV*) resistant cultivars of chilli (*Capsicum annuum L.).*
- Mandhar S.C and S.S. Hebbar -Design and development of raised bed former cum transplanter for chilli and other vegetable crops.
- Mani, - Biointensive insect management of fruit and vegetable
- Meenakshi Srinivas and Jankiram. T. - New Promising hybrid of tuberose for loose flowers.
- Mohan N., T.S. Aghora and Devaraju-. Morpho diversity of pole type dolichos *(Lablab purpureus* L) germplasm for pod yield and pod related traits.
- Mohapatra S and Debi Sharma. Persistence and Dissipation of tricyclazole residues on Banana
- Naik, L.B., Yogeesha, H.S., Bhanuprakash, K. and Padmini, K. and Madhusudan Rao, B. - Response of

capsicum (*Capsicum annuum* L.) seed crop to foliar sprays of micronutrients.

- P.Panneerselvam, A.N.Ganeshamurthy and P.Ramesh - Status of native plant growth promoting rhizobacteria (PGPR) in tomato thizosphere of different agro ecological regions in Karnataka.
- Padmani K, L.B.Naik and A.T.Sadashiva -Effect of female to male flower crossing ratioson hybrid seed yield in Tomato *(Lycopersicon esculentum Mill.)* cv.Arka Abhijit.
- Padmini.K , L.B.Naik and A.T.Sadashiva -Effect of female to male flower crossing ratios on hybrid seed yield in tomato (*Lycopersicon esculentum* .Mill) cv Arka Abhijit.
- Pitchaimuthu. M and K.R.M. Swamy -Development of F1 hybrids in watermelon [C*itrullus lanatus* (Thunb.) Matsum & Nakai] for high yield and quality
- Prabhkar, M., S.S.Hebbar and A.K.Nair -Indian vegetable farming technologies- present scenario and future thrusts.
- Prakash P. Devalakere and Vageeshbabu S. Hanur - A rapid *in vitro* regeneration system in brinjal (*Solanum melongena* L.).
- Prakash P. Devalakere and Vageeshbabu S. Hanur - High frequency *Agrobacterium*-mediated transformation in eggplant (*Solanum melongena* L.)
- Raghupathi, H. B. Anjaneyulu, K and Chandra Prakash, M. K. - Identification of Boron Imbalance in Papaya using Diagnosis and Recommended Integrated System (DRIS)
- Reddy, P. V. R. - Evaluation of *Annona* germplasm for resistance to mealybug, *Ferresia virigata* (Cokll.).
- Sadashiva, A.T, Girija Ganeshan, K.V..Ravishankar, T.H.Singh, T.K.Krithika, Deepa and R.Pushalatha - Breeding for early blight tolerance in Tomato (*Solanum licopersicon* L)
- Sadashiva, A.T., M. Krishna Reddy, K.V. Ravishankar, T. H. Singh, B. Manjunath, P.Swaranalatha, J.Deepa, K.Sudarshini and R.Pushalatha -Breeding for Begomovirus Resistance in Tomato (*Solanum licopersicon* L.)
- Sadashiva,A.T., Girija Ganeshan, K.V.Ravishankar, T.H,Singh, T.H.Krithika, Deepa and R.Pushpalatha - Breeding for early blight tolerance in tomato (*Solanum lycopersicon* L).
- Sidhu, A.S, M. Prabhkar and S. S. Hebbar- Vegetable research and development transforming rural economy in India.
- Singh, T.H, A.T.Sadashiva and K.Madhavi Reddy - Development of Hybrids Resistant to Bacterial wilt (*Ralstonia solanacearum*) in Eggplant (*Solanum melongena* L.)
- Sudha, M. - Regional pattern of economic growth and horticultural development and region specific major socio-economic constraints on horticultural development
- Sujatha A Nair and K. Sujatha - Influence of nutrition on yield, quality and profitability of orchid cv.Dendrobium Sonia 17".
- Sujatha, K., Sujatha, A. Nair, and Sangama - Performance of commercial gerbera cultivars under different shade levels in polyhouse and shade net structure.
- T.N. Shivananda, Saju George, MR Hegde - Micronutrient formulation in French bean var Arka Anoop nutrition
- Vageeshbabu S. H -Bt Transgenic Vegetables
- Vageeshbabu S. Hanur, Harendra Modak, P. M. Shamseer, A. Purushothama and R. Asokan - Development of *Cry2A* Bt transgenic eggplant for resistance to the shoot and fruit borer, *Leucinodes orbonalis* Guenee.
- Vageeshbabu S. Hanur, Harendra Modak, P. M. Shamseer, K. Boopal, K. N. Srividya, A. Purushothama and R. Asokan - Development of Bt transgenic eggplant (*Solanum melongena* L.) and tomato (*Solanum lycopersicon*) for resistance to the fruit borers.
- Vageeshbabu S. Hanur, K. Boopal, K. N. Srividya, A. Purushothama and R. Asokan - Development of *Cry1Aa3* Bt transgenic tomato for resistance to the fruit borer, *Helicoverpa armigera*.
- Varalakshmi, B. and V. Kesava Rao- Nutritional composition of some under utilized leafy vegetables.
- Venugopalan, R -Effect of outliers in statistical modeling for predicting the outbreak of antracnose in grapes
- Vijayakumar Rathod, N.C. Narse gouda and M. Pitchaimuthu -Genetic variability studies in bitter gourd (*Momordica charatntia* (L) genotypes
- Yogeesha,H.S, Shivananda, T.N., Bhanuprakash, K. and Naik, L.B.- Seed germination studies in Kalmegh (*Andrographis paniculata* L.) an important medicinal crop.

5th International Conference on Plant Pathology in the Globalized Era 10 – 13, November, 2009, IARI, New Delhi

- Chowdappa, P. - Leaf spot diseases of annual and perennial crops: assessing the challenges and finding solutions.
- Gopalakrishnan,C., A. K. Saxena and S.P. Keerthishree - Simple technique for screening pomegranate hybrids for resistance to bacterial blight disease.
- Krishna Reddy, M.- Outreach programmes for the management of viral diseases of horticultural crops in India.
- Saxena A. K. -Integrated management of anthracnose in banana.

- Saxena, A. K and Thilaka Rani - **Nursery diseases of fruit crops and their management.**
- Suryanarayana, V., Pradeep Kumar, V., and Krishnareddy, M. - Rosette of *Ficus amplecissima*, a new tree phytoplasma disease – biological and molecular confirmatory.

6th Solanaceae Genome Workshop, 8 - 13, November, 2009, New Delhi, India.

- Krishnareddy, M., Madhavi Reddy, K., and Ravishankar, K.V. (2009). Virus diagnosis and development of markers for resistance to viruses in chilli (*Capsicum annuum*).
- Prasad M, N.K Rai, M.K Reddy, K.V Ravishankar , S Chkraborty, P.P Sahu and A.T Sadashiva -Identification and molecular mapping of Tomato Leaf Curl New Delhi Virus (TOLCNDV) resistant gene(s) in Tomato *(Solanum lycopersicum L)*
- Sadashiva A.T, M.K Reddy, K.V Ravishankar, T.H Singh, B Manjunath, P. Swarnalatha, J Deepa, K Sudarshini and R. Pushpalatha - Breeding of Begomovirus resistance in Tomato *(Solanum lycopersicum L)*

7th Pacific Rim Conference on Biotechnology of *Bacillus thuringiensis* and its environmental impact, 25-28 November 2009, held at NAAS, New Delhi

- Vageeshbabu S. Hanur, H. Modak, P. M. Shamseer, K. Boopal and K. N. Srividya - Development of Bt transgenic eggplant and tomato resistant to fruit borers.

International Conference on Emerging Trends in Biotechnology, 4 - 6 December, 2009, Banaras Hindu University, Varanasi, India

- Venkataravanappa, V., Krishnareddy, M., C.N. Lakshiminarayana Reddy, Swaranalatha, P. and Salil Jalali, Transmission and variability of *Bhendi yellow vein mosaic virus* infecting okra India.

Interactive Meeting of Mealy Bugs, Leaf & Planthoppers and Pyllids in Horticultural and Agricultural crops, 5 - 6 December, 2009, IIHR, Bangalore, Karnataka

- Krishnareddy, M. - Leaf hopper and plant hopper transmitted diseases affecting fruits, vegetables and ornamentals- present status, future targets and management.

Recent Global Development in the Management of Plant Genetic Resources, 17-18 December, 2009, NBPGR, New Delhi

- Rajiv Kumar and Bidyut C. Deka - Collection and evaluation of gladiolus under sub-tropical mid hills of Meghalaya.

Recent Advances in Environmental Protection, International Conference and Exhibition, 17-19 December, 2009, St. John's College,Agra

- Soudamini Mohapatra and M.Deepa - Pesticide residue problem and ways to minimize it.

National Seminar on Production System Management In Adverse Conditions for Higher Productivity in A & N Islands, 22 – 24 December, 2009, CARI, Port Blair

- Vishal Nath, Bikash Das, D.R. Singh and H.P.Singh - Advances in Canopy Management in Perennials.

Plantinum Jubliee Symposium on Soil Science in Meeting the Challenges to Food Security and Environmental Quality, 22-25 December, 2009, IARI, New Delhi

- Hazarika, S., Ganeshmurthy, A.N and Sakthivel, T. - Spatial variability in quality characteristic of orchard soils under long term management practices in South Western Tropical India.
- Kotur, S.C.- Effect of depth of placement and level of ^{32}P-labelled superphosphate on yield and P use parameters of cauliflower.
- Raghupathi, H. B., Anjaneyulu K and Hegde, M. R. - Validation of DRIS ratio norms in banana.
- Soudamini Mohapatra, P. Panneerselvam, M. Deepa, G.K. Jagdish, N. Reshmi, A.K. Ahuja and Debi Sharma - Effect of bifenthrin treatment on soil microflora and its degradation by enrichment cultures. .

Plant and Animal Genome Conference -2010 (PAG- XVIII) 9 - 13 January, 2010, San Diego, California, USA

- Sadashiva, A.T., Krishnareddy, M., Ravishankar, K.V., Singh, T.H., Manjunath, B., Swarnalatha, P., Deepa, J., Sudarshini, K., and Puspalatha, R. - Breeding for begomovirus resistance in tomato (*Solanum lycopersicon* L.).

National Conference on Alien Insects, 21- 21 January, 2010, UAS, Dharwad, Karnataka

- Mani, M. - Origin, introduction and biointensive management of exotic spiralling whitefly,*Aleurodicus disperses* in India

National Consultative Meeting on Disease Diagnostics for Horticultural Crops, 22 - 24 January, 2010, Trichy, Tamil Nadu

- Chowdappa. P - Diagnostics developments, constraints and future prospects for foliar pathogens.
- Krishnareddy, M - Development and use of diagnostics in vegetable and ornamental crops.
- Krishnareddy, M - Accreditation facility for virus indexing in Horticultural crops.

National Symposium on Plant Cell Tissue and Organ Culture, Future prospects, 3 - 5 March, 2010, University of Calcutta, Kolkata

- Thomas, P. - Antibiotic resistant non-culturable endophytic bacteria in 'bacteria-cleansed' triploid watermelon stocks and their activation in senescing cultures,

International Conference on Medicinal Plants and Herbal drugs: Challenges and Opportunities in Cultivation Sustainable Utilization and Conservation (ICMHPD-2010), 4 - 6 March, 2010, Pachaiyappa's College, Chennai.

- Rao, V K., Kavitha, P., Abdul Kareem, V.K., Rajasekharan P.E. and Vasantha Kumar, T. - Accumulation of Camptothecin and 9-methoxy-camptothecin content in *Nothapodytes nimmoniana* leaves, an approach towards sustainable extraction.
- Vasantha Kumar T. - Medicinal Plants Challenges and opportunities

First Annual Conference on Recent trends in viral disease problems and Management" VIROCON 2010, 18 - 20 March, 2010, S.V.University, Tirupati, Andhra Pradesh.

- Venkataravanappa, V., Krishnareddy, M., Swaranalatha, P. and Salil Jalai - Whitefly detection, transmission and diversity of satellite DNAâ associated with *Bhendi yellow vein mosaic virus* infecting okra in India.

National Conference on Production of Quality Seeds and Planting Material– Health Management in Horticultural Crops, 11-14 March, 2010, NASC New Delhi.

- Bhanuprakash, K, Yogeesha, H.S. and Sowmya, K.J.- Studies on seed germination and morphology in important medicinal species.
- Chowdappa .P, Chethana C.S, Arvinda Narayana.V, Reddi Bhargavi. B, Sandya.H, Madura.S, Padma Priya.H.V, Nirmal Kumar.B.J, Mohan kumar.S.P, Thilagar.G, and Girija Ganeshan and Ramachandran, N -A simple PCR based assay for rapid identification of foliar fungal pathogens in infected plant material
- Chowdappa, P.- Detection of seed borne infections: Problems and Perspectives
- Dinesh M.R. -Production of quality Seeds of papaya
- Doijode, S.D. - Overview of storage of quality seeds in horticultural crops for present and future use
- Girija Ganeshan- Management of seedling diseases and production of healthy transplants in commercial vegetable nurseries.
- Gopalakrishna, C and A. K. Saxena - Production of disease free planting material for pomegranate cultivating
- Hima Bindu, K., Bhanu Prakash K. and Vasantha Kumar T. -Preliminary field and seed standards for velvet bean (*Mucuna pruriens* var *utilis*)
- Jalikop, S.H. and Ravindra Kumar - Differentiation of seedlings of sweet and sour karonda (*Carissa congesta*) in nursery and possibility of seed propagation.
- Krishnareddy, M., Samuel, D.K., Lakshmi Devi, V., and Arathi, K. - Recent advances in production of disease free planting material in vegetatively propagated horticultural crops.
- Madhavi Reddy, K. - Use of male sterile systems in hybrid seed production of chilli (*Capsicum annuum* L.)
- Manjunath S.Patil, C. Aswath and T.Janakiram - Production of disease-free planting material in anthurium (*Anthurium andreanum* Lind (Andre)) using Line X Tester
- Mohan, N. and T.S.Aghora, - Improved disease resistant garden pea varieties and strategies for the production of quality breeder seeds at IIHR.
- Murthy B.N.S. - Genotypic influence on runner and plug production in Strawberry (*Fragaria* × *ananassa* Duch.)
- Naik, L.B., H.S.Yogesha, K. Bhanupraksah, K. Padmini K - Value addition to seeds through pelleting in onion and carrot.
- Naik, L.B., Yogeesha, H.S., Bhanuprakash, K. and Padmini K - Nutrient and water management for quality seed production.
- Padmini, K, Yogeesha, H.S., Naik, L.B. and Sadashiva, A.T. - Effect of flower retention in crossing on hybrid seed yield in tomato (*Solanum lycopersicum* L)) cv. Arka Abhijit.
- Prabhakar , M. S. S.Hebbar and A.K.Nair - Advances in vegetable seedling production.
- Prakash G.S. - Current status of seeds and planting materials – National and International scenario
- R. Chithiraichelvan -Recent developments in rootstock-scion interaction in fruit crops.
- Rajiv Kumar and Bidyut C. Deka. - Effect of Benzyl Amino Purine (BAP) on growth, flowering and corm multiplication of gladiolus 'Candyman'.
- Reddy, Y.T.N. - Influence of pruning time and intensity on scion production and graft success of 'Alphonso' Mango
- Sakthivel.T,, Ravishankar.H., Krishna Reddy, M, Samuel, D.K., Pillai, G .K., Karunakaran,G and Raghupathi, H.B. - Identification of Superior clones for production of quality planting material of Coorg mandarin (*Citrus rerticulata* Blanco).

- Sumangala H.P. - Propagation of Native grass (*Lepturus radicans*) for Landscaping.
- Vasantha Kumar, K. Hima Bindu and D.H. Sukanya - Recent advances in development of improved varieties in medicinal and aromatic crops.
- Veere Gowda R and C.S. Pathak. - Studies on genetics of seed production in F_1 hybrid and parents of onion (*Allium cepa* Lin.).
- Veere Gowda. R, Saraswathi, K.M and Syamasunder Joshi - Studies on male sterility and its utilization in F_1 hybrid development in onion (*Allium cepa* Lin.).

National Symposium on Conservation Horticulture, 21 – 23 March, 2010, Dehradun, Uttarakhand

- Krishnareddy, M. - Technological interventions in plant virus disease management in subtropical fruits.
- Sidhu A.S. and M. Prabhakar - Technology Led Development for Commercial Vegetable Production.
- Sumangala H.P. - Interior and exterior landscaping for better environment.

■

14. Workshops/Seminars/Summer Institutes/ Farmers' Days etc Organized

IIHR Celebrates World Environment Day

The Institute celebrated World Environment Day on 5 June, 2009 by planting saplings of Rare, Endangered & Threatened (RET) Medicinal Plants, *viz*., *Oroxylum indicum*, *Saraca asoca* and *Salacia oblonga*. Dr. Meenakshi Srinivas, In-charge Director and Heads of Divisions/Scientists and other staff members planted 25 saplings in the Field Gene Bank of RET Medicinal Plants at IIHR, Hessaraghatta, Bangalore.

Dr. Meenakshi Srinivas, Director In-Charge, planting a sapling of *Oroxylum indicum* to commemorate World Environment Day on 5 June, 2009

International Day for Biodiversity (IDB)

Introduction and/or spread of Invasive Alien Species (IAS) outside their natural past or present distribution, and those that have invaded and affected native biota in almost every ecosystem on this planet, has become a matter of concern/ red threat today. These invasions on crops, pastures, forests, biosphere and the total environment, have caused an overwhelming loss (estimated to be over a trillion US dollars). Realizing the importance of this issue and its unforeseen effects on development of humankind, the Convention on Biological Diversity (CBD) under the aegis of United Nations Environment Programme (UNEP) announced observance of International Day for Biodiversity-2009 on 22 May, 2009 with "Biodiversity and Invasive Alien Species" as its theme. With a basic objective of drawing attention of one and all around the globe to a very critical issue faced by our planet today, the CBD appealed to all international and national governmental and non-governmental bodies, and people at large, to observe International Day for Biological Diversity by organizing various kinds of awareness programmes for the larger benefit of the society.

The Indian Institute of Horticultural Research, Bangalore, contributed its mite to this burning issue by observing 22 May, 2009 as International Day for Biological Diversity at its Hessaraghatta campus by organizing popular lectures on the theme for its staff members. Two invited lectures were organized on the occasion. Dr. R. Raghavendra Rao, Emeritus Scientist, CIMAP, delivered a talk on 'Invasive alien plant species and their impact on biodiversity of India' while, Dr. Abraham Verghese, Principal Scientist (Agril. Entom.), delivered a talk on 'Invasive alien animal species and their impact on biodiversity of India'. This programme was organized by the Division of Plant Genetic Resources of IIHR, Bangalore. All categories of the staff comprising of scientific, technical and administrative personnel participated in the programme.

Launch of Outreach Programme on Diagnosis and Management of Leaf Spot Diseases in Field and Horticultural Crops

Recognizing the economic importance and widespread impact of leaf spot diseases caused by *Alternaria*, *Colletotrichum* and *Cercospora* that have become major production constraints in several field and horticultural crops, the Indian Council of Agricultural Research, New Delhi, sanctioned a network project on "Diagnosis and management of leaf spot diseases of field and horticultural crops", with a total budget of Rs.795 lakh for three years. The network project is proposed to be implemented in 16 centres across the country, of which eight centres shall work on field crops (rapeseed mustard, mung bean, groundnut, sugarcane and sesame), seven shall work on horticultural crops (tomato, cauliflower, chilli, mango, grape and cardamom) while one centre is granted to IIHR, Bangalore. The IIHR, Bangalore, apart from coordinating all Network project activities, will also work on *Alternaria* and *Colletotrichum* diseases in tomato, onion and chilli, with Dr P. Chowdappa as the Principal Investigator and the Network Co-ordinator. The project was launched on 12 June, 2009 at

Dr. H.P.Singh, DDG(Hort.), ICAR, New Delhi launching the out reach programme on Diagnosis and management of leaf spot diseases for field and horticultural crops

the National Agricultural Research Centre, New Delhi, under the chairmanship of Dr. H.P. Singh, Deputy Director General (Horticulture) New Delhi. The project is expected to develop cutting-edge technologies across crops and geographical regions and would enhance understanding of these diseases and help generate eco-friendly, sustainable technologies. Critical gaps identified and to be addressed are: establishment of a National Culture Repository, spanning the spectrum of pathogen diversity / races, species-specific PCR based ready-to-use diagnostic tools, disease decision-supporting systems, molecular markers for sensitivity to fungicides and virulence, bio-fungicides, bio-intensive IDM, knowledge centres, training of manpower and development of user-friendly bioinformatics platform.

Launch of Outreach Programme on Management of Sucking Pests of Horticultural Crops

Sucking pests, *viz*., aphids, thrips, whiteflies, mealy bugs, leafhoppers, plant hoppers, mites, etc. have become a matter of serious concern in a number of agri-horticultural crops. Besides being pests directly, some of these are also important vectors of plant pathogens. Heavy crop loss due to these, at times upto 90-95%, is of major concern to productivity of many crops, ultimately affecting AGDP of the nation. Increased resistance to insecticides, resurgence of pests (due to either withdrawal of insecticides or over-emphasis), indiscriminate use of pesticides, global warning, decreased precipitation, are other factors adding a new dimension to the problem. Realizing the importance of this emerging problem, the Indian Council of Agricultural Research sanctioned a network project on "Management of sucking pests of horticultural crops" as an outreach programme. The IIHR, Bangalore is the lead centre, with Dr. N.K. Krishna Kumar as the PI. CISH, Lucknow, NRC for Cashew, Puttur, Karnataka, NRC for Citrus, Nagpur, NRC for Onion and Garlic, Pune, IISR, Calicut, and PDBC, Bangalore, are other participating centres. The programme aims at:

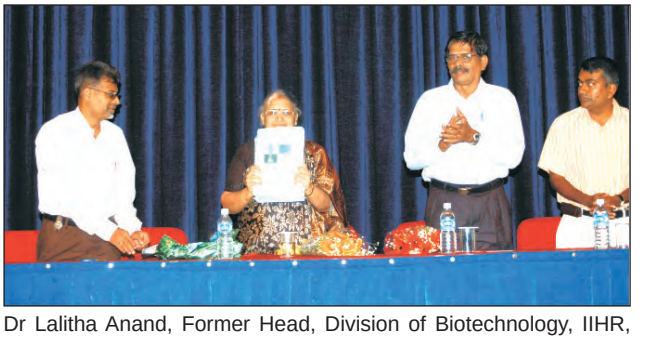
1. Molecular systematics (coupled with morphological keys) for identification of species of sucking pests
2. Determination and distribution of biotypes in *Aphis gossypii*, *Thrips palmi*, *T. tabaci*, etc.
3. Studies on internal anatomy and digestive physiology of important sucking pests
4. Ecology of tri-trophic interactions (crop, pest & natural enemy) of important sucking pests in horticultural ecosystems
5. Studies on insecticide resistance in *Aphis gossypii*, *Thrips palmi*, *T. tabaci* and *Amrasca splendens*
6. IPM of important sucking insect pests of horticultural crops under open-field and protected cultivation

It is expected that the network project will address and manage emerging problems in horticultural crops by identifying sucking pests and their biotypes; a key requirement for integrated pest management and vector transmission. It is also expected that the outcome of the project will help minimize use of insecticides and contribute to food safety.

The outreach programme was launched by Dr. H.P. Singh, DDG(H), ICAR, New Delhi, on 11 June , 2009 at the Central Institute of Subtropical Horticulture (CISH), Lucknow, during a meeting of entomologists of Horticulture Division of ICAR, to fine-tune plant protection research and identify priority areas of research in horticultural crops.

Summer School on Non-conventional Approaches for Improvement of Horticultural Crops

Realizing the importance of the role of biotechnology in improvement of horticultural crops and the need for human resource development in biotechnology, the Division of Biotechnology, IIHR, Bangalore organized a 21-days Summer School on "Non-conventional approaches for crop improvement in horticultural crops", from 16 June to 06 July, 2009 with financial support from the ICAR,New Delhi. Dr. C. Aswath, Head, and Dr. H.S. Vageeshbabu, Senior Scientist, Division of Biotechnology, acted as Course Director and Course Coordinator, respectively. Candidates from various states of the country with different backgrounds, mostly in the younger age-group, participated. The training was held in three major areas of biotechnology, *viz*; (i) Tissue culture and micropropagation, (ii) Transgenics and (iii) Molecular markers along with endophyte research. Both theory and practicals with hands-on training were provided, along with demonstrations, in over 35 exhaustive and comprehensive sessions. The participants visited important plant biotechnology industries in and around Bangalore, including Cameson Biotechnologies, Doddaballapur, Metahelix, Jigani, Sigma-Aldrich Corporation, Jigani, Monsanto Research Centre, and UAS, GKVK, Bangalore.



Dr Lalitha Anand, Former Head, Division of Biotechnology, IIHR, Bangalore releasing a training manual during the inaugural function of Summer School

Diamond Jubilee celebrations at CHES, Chettalli

The Central Horticultural Experiment Station (CHES), Chettalli – a Regional Station of IIHR – completed 75 years of existence and celebrations were organized on the occasion of its Diamond Jubilee. A Brainstorming Session on "Horticulture Development in Kodagu and Farmers' Interaction" was organized to commemorate the event on 08/08/2009 on the

Dr H.P. Singh, DDG(H), releasing the commemorative publication "Sixty years of CHES, Chettalli" at Diamond Jubilee celebrations of the Station

premises of the Station in Chettalli, Kodagu, Karnataka.

Dr H.P. Singh, Deputy Director General (Hort.), ICAR, New Delhi, inaugurated the function and presided over it. On this momentous occasion, he released a publication entitled "Sixty years of CHES, Chettalli" especially brought out by the Station. Also, Dr Singh felicitated twenty scientists, both in-service and retired, for their contribution to horticultural research and valuable services rendered by them to growers of citrus in the Kodagu region.

In his presidential address, Dr H.P. Singh outlined current developments and revolutionary advances in horticultural research in national development. He further said that Indian farmers notwithstanding natural calamities, scarcity of water resources and farm labour, must try and adopt new technologies. He cautioned against wastage of water saying that reduction in average size of land-holdings for cultivation and the increasing population may pose serious problems in future if conservation of water and population control are not addressed. Despite these shortcomings, adequate food production has been realized by arduous efforts of agricultural scientists, support from the government and by co-operation from farmers. New and inventive strategies were made possible in agricultural production. Dr H.P. Singh called upon farmers to embrace change in a fast changing world. Fortunately farmers of Kodagu district are open to new technologies, he added. Farmers in India can obviate depressing times by switching over to greenhouse cultivation wherever land-holdings are meager and thereby generate better yields and income with greater employment opportunities By adopting better water management in newly introduced fruit crops, profitable production is possible. Indian scientists are revolutionizing research in this regard. Dr H.P. Singh advised growers to face problems of any kind of scarcity as an opportunity to try new concepts with determination and success will certainly be within reach. He quoted references from *Bhagwad Gita* and Hindu *puranas* which showed that our saints and *rishis* in ancient times deduced scientifically. As a result of research efforts, today India has highest yield in potato and cauliflower. Fruits are easily accessible from villages to the Delhi market. He hoped that growers would always co-operate with scientists and work together. A horticultural revolution has triggered off in India and the Government has invested greatly in this sector.

Dr H.P. Singh further said that it was possible to improve bee-keeping in Kodagu. With alternate crops and improved cultivation methodologies, it was possible to earn more.

Dr H.P. Singh said that Kodagu district was ideally suited for growing horticultural crops and planters should come forward to borrow new scientific technologies and implement them. Horticulture Research Station at Chettalli has done yeoman research on citrus variety Coorg mandarin, Coorg Honey dew papaya, and he lauded the success achieved by the station in evolving a hybrid variety of passion fruit, *viz*., Kaveri. Dr H.P. Singh felicitated former scientists of CHES, Chettalli, *viz*., Dr P.P. Nanjappa, Shri D.P. Muthanna, Dr B. Prasanna Kumar, Shri K.S. Shamasundaran, Shri M.T. Subbaiah, Dr K. Anjaneyalu, Dr H. Ravishankar, Dr M.M. Mustaffa, Dr B.S. Bhumannavar, Dr S.C. Kotur, Dr V.V. Sulladmath, Dr R. Chithiraichelvan and, also, scientists currently working there, viz., Dr K. Shivaramu and Dr T. Sakthivel.

Director Dr. Amrik Singh Sidhu addressing the gathering

Dr Amrik Singh Sidhu, Director, IIHR, Bangalore, gave the welcome address. Dr H. Ravishankar (former Head, CHES, Chettalli and Head, Plant Genetic Resources, IIHR, Bangalore), at present Director, CISH, Lucknow, conducted the proceedings on the occasion. In his introductory address, Dr H. Ravishankar stated that health, happiness and economic empowerment could all be assured by engaging in horticultural production. He commended sincere efforts by the then Commissioner and Diwan Bahadur, Late Shri K. Chengappa (during 1950's), the then Chief Minister of Coorg Province, and Late Shri C.M. Poonacha, Dr K.M. Ayyappa, Shri P.P. Nanjappa and Shri K.M. Ganapathy in establishing and developing the Research Station, for working predominantly on Coorg mandarin and other viable horticultural crops for Kodagu region. The house paid rich tributes to these great souls by observing silence for two minutes.

Dr B.M.C. Reddy, former Director, CISH, Lucknow, and Dr K. Shivaramu, Senior Scientist (Entom.) and Head In-charge, CHES, Chettalli, also graced the dais. The inaugural session was followed by a technical session on horticultural development in Kodagu and interaction with farmers. During the session, Dr Vijay Shivankar, Director, NRC on Citrus, Nagpur, spoke on "Status of citrus cultivation and possibilities of revival of Coorg mandarin cultivation in

Kodagu". Dr M.M. Mustaffa, Director, NRC on Banana, Trichy, gave a talk on "Banana production in the tropical humid conditions of Kodagu". Dr Venugopal, Head, Cardamom Research Center, Appangala, spoke on "Spice crops' production: problems and prospects in Kodagu". Dr S.K. Naskar, Director, CTCRI, Thiruvananthapuram, spoke on "Potential tuber crop production under tropical humid conditions of Kodagu". Dr H. Ravishankar also delivered a note on "Potential horticultural crops for diversification - feasibilities and identification of sites for expansion". Dr T. Sakthivel, Scientist (SS) (Hort.), CHES, Chettalli, talked on "Production, quality planting material – role of CHES, Chettalli".

About 200 progressive growers actively participated in the Diamond Jubilee celebrations.

Awareness programme on mitigating bacterial blight in pomegranate

Pomegranate crop is severely affected by bacterial blight disease in Maharashtra, Karnataka and Andhra Pradesh. Farmers in these regions are faced with severe difficulty in managing this disease, with no measures available at hand. To create awareness among pomegranate growers on management practices to be followed, two training programmes were conducted in growers' fields under Network project on "Mitigating bacterial blight disease of pomegranate in Maharashtra, Karnataka and Andhra Pradesh", sponsored by the National Horticulture Mission. The first training programme was organized at Yemmerahalli, Sira Taluk, Tumkur District, on 26.07.2009 and the second programme was held at Bennehalli, Jagalur Taluk, Davanagere District, on 02.08.2009.

Training programme at Sira, Tumkur District

A total of 200 farmers participated in both these programmes. Dr. C. Gopalakrishnan, Principal Scientist, and Dr. A. K. Saxena, Senior Scientist, Division of Plant Pathology, addressed the farmers on various aspects relevant for effective management of bacterial blight and fungal diseases of pomegranate. Lectures and practical demonstrations were held and farmers were enlightened on disease diagnosis, spread and management of these diseases, right from pruning until harvest. Very good interactions ensued among farmers, and, between farmers and scientists. Mr. Vishwanath Gowda, Assistant Director (Horticulture), Department of Horticulture, Sira, and Mr. Pandurangappa, Assistant Director (Horticulture), Department of Horticulture, Jagalur Taluk, helped successfully organize the farmers' meet. They also participated actively and explained various initiatives undertaken by Department of Horticulture, Government of Karnataka, to promote the cultivation of pomegranate. Shri. Shivakumar, Taluk President, Krishi Sangha and Member representing All India Pomegranate Growers' Association, and, Shri Madhava Reddy, President, Fruit Growers' Association, Jagalur Taluk, also attended the programme. Shri Chickkananjappa (Yemmerahalli, Sira) and Shri J.S. Manjunath (Bennehalli, Jagalur), in whose orchards the demonstrations were held, for effective management of bacterial blight under the network project, also interacted with farmers and apprised them of the usefulness of the technology in managing bacterial blight and fugal diseases of pomegranate.

Training programme at Jagalur, Davanagere District

New Krishi Vigyan Kendra inaugurated at Tumkur, under IIHR

A new Krishi Vigyan Kendra (KVK) was sanctioned by ICAR, New Delhi, for Tumkur District, Karnataka with effect from 24th March, 2009 and was inaugurated at Central Horticultural Experiment Station (CHES), Hirehalli, Tumkur District under the aegis of Indian Institute of Horticultural Research, Bangalore, on 9th August, 2009. The inaugural function was graced by Dr. H.P. Singh, Deputy Director General (Horticulture) and Dr. K.D. Kokate, Deputy Director General (Extension), Indian Council of Agricultural Research, New Delhi. Dr. Amrik Singh Sidhu, Director, Indian Institute of Horticultural Research (IIHR), Bangalore, presided over

Inauguration of Krishi Vigyan Kendra at Hirehalli in the presence of Dr. H.P. Singh, DDG(Hort.), ICAR, Dr. K.D. Kokate, DDG(AE), ICAR, Dr. Amrik Singh Sidhu, Director & Dr. M.R. Hegde, Chairman, RMCC, IIHR, Bangalore, Dr. Prabhukumar, ZPD, Zone VIII, Bangalore, and Dr. R.S. Kulkarni, Director (Extn.), University of Agricultural Sciences, Bangalore

the function. The new KVK at Hirehalli will cater to (a)Tumkur (b)Pavagada (c)Sira (d)Koratagere and (e)Madhugiri taluks of Tumkur District and has become operational at the existing building of CHES, Hirehalli (which had earlier been an Experimental Station under CPCRI, Kasargod from1958 to 2002 and was handed over to IIHR, Bangalore, in 2002). It has played a significant role in releasing high-yielding varieties of areca nut and other plantation crops. Located bang on the Pune-Bangalore National highway (Golden Quadrilateral corridor) 58 kms north-west of Bangalore, the station is highly accessible by road and rail. The railhead is located right opposite CHES on the Miraj-Bangalore line. With this strategic location and an instructional farm, the KVK has given great impetus to horticultural development in the area. The inaugural programme was attended by over 200 farmers, various officials of the University of Agricultural Sciences, Bangalore; Departments of Agriculture and Horticulture, GoK and other KVKs besides the staff of IIHR, Bangalore. Dr. Kokate, in his remarks, highlighted the importance of this KVK and suggested steps to be taken make it effective and farmer-friendly. Dr. H.P. Singh, in his address, stressed the importance of horticulture in the present day and the role KVK in progress of the region. Hon'ble DDG(H) opined that with active technical back-up from IIHR and good work, the KVK at Hirehalli will no doubt turn out to be one of the best centres in the country.

IIHR hosts National Seminar on Horticultural Biotechnology

A national seminar on horticultural biotechnology was organized by IIHR on its premises in Bangalore on 28th – 29th October, 2009 and was inaugurated by Dr H.P. Singh, DDG (Hort.), ICAR. Directors of various ICAR Institutes working on horticultural biotechnology attended the seminar, among others, and presented their progress of work. DDG(H) reviewed the action taken report pertaining to the seminar held during 2007 in this context. He also suggested a few changes in the present programmes and exhorted the scientists to work as per current needs and give greater thrust to molecular marker work to support the breeders.

The seminar included the following sessions:

- Functional genomics & molecular markers
- Transgenics
- Regeneration & tissue culture
- Molecular diagnostics
- Bioinformatics

Interactive meeting on plant & leaf hoppers, psyllids and mealy bugs

An interactive meeting on plant & leaf hoppers, psyllids and mealy bugs in field/ horticultural crops was jointly organized by the Indian Institute of Horticultural Research, Bangalore (IIHR) and Association for Advancement of Pest Management in Horticultural Ecosystems (AAPMHE) at IIHR, Bangalore, on 5th and 6th December, 2009. The meeting was presided over by Dr. T.P. Rajendran, ADG (Plant Protection), ICAR, New Delhi. Fifty four delegates, comprising entomologists from various ICAR institutes, SAUs and the plant protection industry attended the meeting. Various issues like crop loss due to sucking pests, biotypes, vector role, their annual biology including non-crop hosts, their natural-enemy spectrum, adaptations and resistance development to existing management strategies were deliberated in the meeting. Two documents on the existing research information on these pests were brought out in the meeting. The meeting succeeded in serving as a platform for exchanging ideas and updating information on sucking pests.

Release of publications at the Interactive meeting on plant & leaf hoppers, psyllids and mealy bugs

The 16th Group Discussion of AICRP and ICAR *ad-hoc* schemes on Tropical Fruits was held at KAU, Thrissur, Kerala from 16th to 19th November 2009 to review progress and identify research needs for formulating an effective technical programme for 2009- 2011. Participation of 103 delegates from across the country represented scientists from AICRP(TF) centres located at various ICAR Institutes and SAUs and, progressive farmers. Dr. D. Alexander, Director of Research, KAU, delivered the welcome address while Dr. A.S. Sidhu, Director, IIHR & Project Coordinator (TF) presented the report of research achievements made under the project over the past two years. Dr. S.B. Dandin, Special Officer, UHS, Bagalkot (Karnataka), in his presidential address, emphasised the need for developing technologies under AICRP (TF) project to benefit the farmer. Dr. H.P. Singh, DDG(Hort), ICAR, New Delhi, inaugurated the Group Discussion and complemented the progress made. He, however, emphasized the need for refining the technologies for acceptance by the farming community. He also felt that interaction of a technology with different agro-climatic regions of the country needs to be studied. Areas in need of

research attention are: post harvest management, packages for quality planting-material production and effective diagnostics. On this occasion, various publications, viz., Banana research at Kerala Agricultural University, Banana - Scientific cultivation practices and banana fibre utilization, and, brochures by Banana Research Station, Kannara, namely, (i) Pseudostem borer of banana, (ii) Fungal diseases of banana and (iii) Viral diseases of banana, were released. Action Taken Report (ATR) was presented by Dr. Prakash Patil, Sr. Scientist, and thereafter the discussions were held for three days on various aspects of production and protection of tropical fruits. Based on research needs, Rs. 5.00 lakh was sanctioned for clonal selection in banana and Rs. 2.00 lakh for strengthening banana breeding programme. Both the programmes will be coordinated by Director, NRC for banana, Trichy. In the Group Discussion, promising varieties released were: Phule Sharbati in acid lime, Phule mosambi in sweet orange, Arka Narang in pummelo and Arka Prabhat in papaya. In addition, promising clones identified were: Budu Bale (Pisang Awak) at Arabhavi, Mettupalyam (Pome) at Coimbatore, BRS-3 (Cavendish) at Jalgaon, KBS-8 (Dwarf Cavendish) and Kovvur Bontha (Monthan) at Kovvur in banana, and these were proposed for multilocational trials. The plenary session was chaired by Dr. S. Rajan, ADG(Hort-I), ICAR, New Delhi. Based on recommendations from different sessions, programmes were finalised which included strengthening of clonal selections in banana and intensifying the breeding programme; model for the managing *Phytophthora* in citrus; organic production technology for citrus and banana; impact of climate change, bud-borer management in sapota, and refinement of production technology for planting material in jackfruit. An ICAR *ad-hoc* scheme entitled "*Musa* genome mapping: Development of STMS markers for *Musa balbisiana*, Analysis of diversity and development of linkage map" was presented and results revealed that 64 micro-satellite markers were developed for the wild species. Also, a visit to BRS, Kannara, Thrissur, on 19th November, 2009 was arranged.

Impact of Climate Change on Horticultural Crops

A farmers' awareness programme on Impact of Climate Change on Horticultural Crops was organized on 9th December, 2009 under ICAR Network Project on Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change. About 150 farmers from Kolar, Chickkaballapur, Doddaballapur, Malur, Nanjanagud and Bangalore North taluk participated in the programme. The farmers' meet was inaugurated by Dr. K. Narayana Gowda, Dean (Agriculture), UAS, GKVK, Bangalore. The programme was presided over by Dr. M. Edward Raja, In-charge Director, IIHR, Bangalore. Dr. N.K. Srinivasa Rao, Principal Investigator of the Network Project, gave a brief introduction on climate change and horticultural crops. An extension folder entitled "Climate change and its impact on horticulture" and its Kannada version was also released during the occasion. Addressing the gathering, Dr. K. Narayana Gowda, emphasized the importance of this Farmers' Awareness Programme on Climate Change at a time when various countries were discussing issues of climate change at an International level in Copenhagen, Denmark. He emphasised the need to adopt technologies that help alleviate adverse impact of climate change. Drawing from his personal involvement in a community development programme, he stressed the role of fruit trees like Jackfruit, *Bael* and *Jamun*, which not only help reduce levels of carbon dioxide in the atmosphere, but are also remunerative to farmers. He called for involvement of farmers' groups in dissemination of technologies to be adopted, to overcome adverse effects of climate change on agriculture.

A technical session and an interaction programme was also held on the occasion. A questionnaire was developed and circulated among farmers to assess their extent of awareness about climate change. The framers, it turned out to be aware of climate change issues and climate variability. Majority of the farmers observed that increase in temperature and variability in rainfall pattern, which were important climatic parameters, and that they have noticed perceptible changes in these.

Chief Guest Dr. K. Narayana Gowda, Dean (Agriculture), UAS, GKVK, Bangalore releasing an extension folder entitled "Climate change and its impact on horticulture" and its Kannada version

Farmers participating in the interactive programme on climate change

Brain storming meeting on PHT

A Brain Storming Meeting on Post Harvest Technology of Horticultural Crops was held at Indian Institute of Vegetable Research, Varanasi in collaboration with IIHR, Bangalore on November 24 - 26, 2009 to take stock of developments made in the area of Post Harvest since the last interactive meeting held at IIHR, Bangalore during August 2008. The meeting was chaired by Dr. H. P. Singh, Deputy Director General

(Hort.), ICAR, New Delhi. Dr.R.T.Patil, Director, CIPHET, Ludhiana, Dr.Naskar, Director, CTCRI, Trivandrum, Dr.Pritam Chandra, Director, CIAE, Bhopal, Dr.K.K.Kumar, Director, NRC Litchi, Muzaffarpur, Dr.Mathura Rai, Director, IIVR, Varanasi were the other dignitaries who participated in the deliberations apart from 24 scientists from different ICAR institutes of Horticultural Division of ICAR attended the meeting. A proposal on Network Project on PHT of Horticultural Crops was presented by Dr.R.K.Gupta, Head, Division of Horticultural Processing which was accepted for implementation informally in the on-going research programme of different institutes under Post Harvest Technology projects which would be further strengthened after formally launching the project. Some of the significant recommendations made during the meeting were;

28th Group Meeting of All India Co-ordinated Research Project on Vegetable Crops

The 28th Group Meeting of All India Co-ordinated Research Project on Vegetable Crops from 16th -19th , January, 2010 was organized at IIHR, Bangalore jointly by the Indian Institute of Horticultural Research, Bangalore and Indian Institute of Vegetable Research, Varanasi. His Excellency, the Governor of Karnataka Dr. Hans Raj Bharadwaj was the Chief Guest who inaugurated the Group Meeting and addressed the gathering on January 16, 2010. Dr. H.P. Singh, DDG (H), ICAR, New Delhi delivered the key note address. In the beginning, Dr. A.S.Sidhu, Director, IIHR welcomed the guests and delegates followed by a brief presentation on " An over view on AICR on Vegetable Crops" by Dr. Dr. Mathura Rai, Director & Project Coordinator, IIVR, Varanasi, U.P.

His Excellency the Governor of Karnataka Dr. Hans Raj Bharadwaj inaugurating by lighting the lamp.

On this occasion the Lt. Amit Singh Memorial Award for the Best Coordinating Centre instituted by Lt. Amit Singh Memorial Foundation, New Delhi was conferred to the Indian Institute of Horticultural Research, Bangalore for the year 2009and was awarded by His Excellency The Governor of Karnataka. An exhibition showcasing the developed by research institutes and State Agricultural Universities /Krishi Vigyan Kendras ,private Seed Companies and input providing agencies was organized on the occasion which was inaugurated by His Excellency the Governor . More than 25 firms took part in the exhibition by putting up their stalls.

Dr. A.S. Sidhu, Director, IIHR receiving the best co-ordinating centre award from His Excellency the Governor of Karnataka Dr. Hans Raj Bharadwaj

His Excellency the Governor of Karnataka Dr. Hans Raj Bharadwaj inaugurating the Exhibition.

The work done during the last year by all the AICRP centers located in various State Agricultural Universities and other institutes was reviewed during the Group Meeting and Technical Programme of work for the next year were formulated and deliberations were held for three days on various topics like, germplasm collection& exploration, varietals trails, hybrid trials, physiology & biochemistry, disease & pest management, seed production etc., In the session on Public –Private Interface, germplasm exchange, sharing of segregating material between public institutes and private sector were also discussed. Apart from these a Brain Storming Session on Marker Assisted Breeding in Vegetables was also held on 16th January 2010 in the aftenoo.

More than 200 delegates representing various AICRP centers, seed production companies and input providers from across the country participated in the workshop.

Field day on Vegetabl Varieties

The Institute organized a field day on Vegetable Varieties Developed by IIHR on February 24, 2010 at the Field Demonstration Block at IIHR, Hessaraghatta Campus. Twenty eight varieties of 16 vegetable crops were demonstrated using improved production practices developed by the institute for the benefit of the farmers. Dr. K. L. Chadha, Former DDG

A view of demonstration with the guests and farmers.

(H), ICAR, New Delhi and Chairman, RAC, of IIHR was the Chief Guest and Dr. G Trivedi, Former Vice Chancellor, RAU, Bihar and Dr Kariyanna, Members of RAC of IIHR were the other guests present on the occasion.

More than 2050 farmers from in and around Hessaraghatta participated in the field day and witnessed the crop demonstration. On this occasion, Scientist-Farmers Meet was organized wherein scientists of the institute from different disciplines replied to the quarries on the problems being faced by the farmers in the production of vegetable crops.

Media Meet and Showcasing of Technology

The Indian Institute of Horticultural Research organized an Exhibition, Media Meet and Review Workshop at the campus of the Institute at Bangalore on March 26- 27, 2010, as a part of the NAIP Project on Mobilizing Mass Media Support for Sharing Agro Information

Dr. H. P. Singh, Deputy Director General (Hort.), Indian Council of Agricultural Research (ICAR) New Delhi was the Chief Guest and inaugurated the function on March 26, 2010. Dr T. P. Trivedi, Assistant Director General (ARIS) & Project Director (DIPA) ICAR, New Delhi delivered the inaugural address and Dr.A.S. Sidhu Director IIHR presided over the function.

An exhibition depicting the technologies developed in the field of agriculture/horticulture by research institutes and State Agricultural Universities was organized on the occasion. More than 20 institutes including Indian Institute of Horticultural Research, KVKs and extension centers showcased the technologies for the benefit of the farmers and general public on the occasion. Farmers in large numbers from in and around Hessaraghatta village took part in the event on the first day of the programme.

Dr. H. P. Singh DDG (Hort.), ICAR, New Delhi conducted a media interaction meeting organized to disseminate the technologies developed by IIHR Bangalore.

Media representatives from news dailies like The Hindu, Rajasthan Patrika, Udayavani (Kannada daily), The Observer and officials of Press Information Bureau (PIB), Press Trust of India (PTI), All India Radio (AIR), Doordarshan and Chandana (Kannada News Channel) participated in the discussion.

Dr. H.P. Singh, DDG (H) inaugurating the exhibition with Dr T. P. Trivedi, Assistant Director General (ARIS) & Project Director (DIPA) ICAR, New Delhi and Dr. A.S. Sidhu, Director, IIHR, Bangalore.

Dr T.P. Trivedi briefed about the NAIP project, its objectives and appealed to the media persons to give wider publicity to the technologies developed in the field of horticulture for the benefit of the farmers.

Farmers' interaction and review meeting of the project was conducted on March 27, 2010. Shri. Manoj Pandey, Additional Director General (PIB) was the Chief Guest on this occasion and delivered key note address and assured to extend all possible support to the project in achieving the objectives of the project and suggested to involve local leaders in the programme in order to get wider publicity in the media.

Dr. H.P. Singh, DDG (H) addressing the media persons.

Dr T P Trivedi, consortium leader briefly mentioned about the progress of the NAIP sub project 'Mobilizing Mass Media Support for Sharing Agro-Information' and further reviewed the on going programmes in the project. Dr.B.Meenakumari, Director, Central Institute of Fisheries Technology (CIFT), was the Guest of Honor and Dr. A. S. Sidhu, Director, IIHR presided over the function.

Shri. Manoj Pandey, Additional Director General (PIB) addressing the gathering.

15. Distinguished Visitors

IIHR, Bangalore

Dr H.P. Singh, Deputy Director General Horticulture) ICAR, New Delhi (17-18.04.2009; 18.04.2009; 17.12.2009; 07.01.2010; 08.01.2010; 16.01.2010; 26.03, 2010)

Dr Punia, Managing Director, Doctor Seeds Pvt.Ltd., Ludhiana (04.05.2009)

Dr Peter Handson, AVRDC, Taiwan (06.05.2009)

Dr R. Raghavendra Rao, Emeritus Scientist, CIMAP,(22.05.2009)

Dr K.L. Chadha, Former DDG (Hort), ICAR, New Delhi and Chairman RAC, IIHR, Bangalore (19.08.2009)

Dr S.B. Dandin, Special Officer, University of Horticultural Sciences, Bagalkot -(20.08.2009)

Dr T.P. Trivedi, T.P., Project Director and ADG (ARIS), ICAR, New Delhi (31.08.2009)

Dr S.K. Dutta, Deputy Director General(Crop Sciences) ICAR, New Delhi (31.08.2009)

Dr Nanajappa Dean (Post Graduate Education) UAS, G.K.V.K. Bangalore *(19.09.2009)*

Dr Anupam Verma Professor (Emi), IARI, New Delhi (23.09.2009)

Dr Peter Handson AVRDC, Taiwan (23.09.2009)

Dr D.P. Ray Vice Chancellor, OUACT Bhubaneswar (14.10.2009)

Dr R.P. Dua National Co-ordinator, NAIP New Delhi (22.10.2009)

Dr N.D. Tambhale ADG(Seeds), ICAR, New Delhi (23.10.2009)

Georgian Delegation- Dr Gelnn Ames, Dr Dan Mac Lean, Dr Braham Verma (07.11.2009)

Sri Veerappa Moily, Honorable Minister for Law, Justice and Company Affairs, Government of India, New Delhi (07.11.2009)

Sri K.C. Muniyappa Agricultural commissioner, Department of Agriculture, Government of Karnataka (30.11.2009)

Mr Serijus Minj Additional Chief Secretary, Government of Chattisgarh (03.12.2009)

Dr Mahadevappa Former Chairman ASRB, New Delhi (4.12.2009)

Dr P. Amarasinge and delegation Sri Lanka (14.12.2009)

Prof B.K. Chandrashekar Former Minister, Government of Karnataka (15.12.2009)

Dr K. Kasturirangan, Member,, Dr V.V. Sudamatte, Advisor (Agriculture), Dr Vandana Dwivedi, Joint Advisor (Agriculture) Planning Commission, Government of India, New Delhi (17.12.2009)

Shri Hans Raj Bhardwaj, His Excellency The Governor of Karnataka, Bangalore, Karnataka (16.01.2010)

The Honourable Governor of Karnataka , H.E. Dr. Hans Raj Bharadwaj at the IIHR exhibition

Dr S.L. Mehta, Dr N.T. Yedu Raj, Dr Mangala Sunder KrishnanICAR, New Delhi (23.01.2010)

Dr. Prem Nath Former ADG(FAO-UN) and Chairman, PNASF, Bangalore (17.02.2010)

Dr K.L. Chadha, Chairman, RAC; **Dr G. Trivedi,** Member, RAC; **Dr A.N. Mourya,** Member, RAC; **Dr A.K. Singh,** Member, RAC; **Dr D.S. Khurudia,** Member, RAC; **Dr I. Irulappan,** Member, RAC (24-25.02.2010)

Sri Manji Pandey Addition Director General (PIC), New Delhi (26.03.2010)

Dr. B. Meenakumari, Director, CIFT, Cochin (26.03.2010)

Shri V.V. Bhat Member Finance, Space Commission (30.03.2010)

Central Horticultural Experiment Station (CHES), Chettalli, Karnataka

Dr S. Gowda University of Florida, Citrus Research and ducation Centre, Lake Alfred, FL 33850, USA (02.05.2009)

Dr H.P. Singh, DDG (Hort), ICAR, New Delhi; **Dr B.M.C.**

Reddy, former Director, CISH, Lucknow ; **Dr V.A.Parathasarathy,** Director, IISR, Calicut; **Dr Vijay Shivankar**, Director, NRC Citrus, Nagpur ; **Dr M.M. Mustaffa,** Director, NRC Banana; **Dr.S.K.Naskar,** Director, CTCRI, Tiruvananthapuram (08.08.2009)

Dr Ranabir Singh Principal Scientist, NBPGR, Pusa Campus, New Delhi (08-02-2010)

Mr. Mumez Frangoing; **Mr.Boudet Daniel**, France (05-02-2010)

Central Horticultural Experiment Station (CHES), Bhubaneshwar, Orissa

Shri Surendra Naik Hon'ble Dy Chairman, Planning Board, Government of Orissa (17.09.2009)

Dr. H. P. Singh DDG (Hort.), ICAR, New Delhi (08.10.2009, 13.11.2009)

Dr. C. D. Mayee Chairman, ASRB, New Delhi (14.11.2009)

Prof. M.J. Modayil Member, ASRB, New Delhi (08.12.2009)
Dr. P.I. Peter; Dr. Sankarshan Sahoo (23.02.2010)

Dr. Kirti Singh; Dr. D. P. Ray; Dr. K. Pradhan (26.03.2010)

Krishi Vigyan Kendra (KVK), Gonikoppal, Karnataka

Sri Shreepadre Editor, Adike Patrike , Mangalore (21.7.2009)

Dr. H. P. Singh, DDG (Hort), ICAR New Delhi; **Dr. Parthasarathy**, Director, IISR Calicut; **Dr. M G Bhat,** Director, NRCC Puttur; **Dr. M M Mustaffa**, Director, NRC for Banana; **Dr. Anandraj**, Project Coordinator, IISR Calicut; **Dr. Karianna**, RAC member (07.08.2009)

Dr. Shivananda Murthy Director of Extension KVAFSU, Bidar (29.07.2009)

Dr. D L Maheswar Additional Director of Horticulture, GOK; **Dr. Shivaram Reddy**, Deputy Commissioner of Horticulture (NHM); **Dr. Shakeel Ahmad**, Deputy Director (Hort), Madikeri (20.09.2009)

Dr. V. G. Dhankumar Director, IIPM, Bangalore (11.11.2009)

Mrs. Deerghakesi Shivanna Former President, Kodagu, Jilla Panchayat Madikeri (05.12.2009)

Krishi Vigyan Kendra (KVK), Hirehalli, Karnataka

Dr H.P. Singh Deputy Director General (Horticulture) ICAR, New Delhi (19.04.2009)

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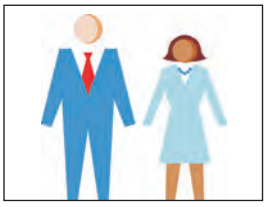

16. Personnel

Director

Amrik Singh Sidhu Ph.D.

Scientific Staff

Main Institute, Hessaraghatta, Bangalore, Karnataka

Division of Fruit Crops

Chittirai Chelvan, R. Ph.D.	Principal Scientist (Horticulture) & Head
Srinivas, K. Ph.D.	Principal Scientist (Agronomy)
Jalikop, S.H. Ph.D.	Principal Scientist (Plant Breeding)
Prakash, G.S. Ph.D.	Principal Scientist (Horticulture)
Sulladmath, V.V. Ph.D.	Principal Scientist (Horticulture)
Reddy, Y.T.N. Ph.D.	Principal Scientist (Horticulture)
Srinivas Murthy, B.N. Ph.D.	Principal Scientist (Horticulture)
Dinesh M.R. Ph.D.	Principal Scientist (Horticulture)
Reju M. Kurian Ph.D.	Principal Scientist (Horticulture)
Sampath Kumar Pamu Ph.D	Principal Scientist (Horticulture)
Rekha, A. Ph.D.	Senior Scientist (Genetics and Cytogenetics)
Vasugi, C. M.Sc. (Hort)	Scientist (SG) (Horticulture) w.e.f. 01.09.2009

Division of Vegetable Crops

Sadashiva, A.T. Ph.D.	Principal Scientist (Horticulture) & Head
Prabhakar, M. Ph.D.	Principal Scientist (Agronomy)
Veere Gowda, R. Ph.D.	Principal Scientist (Horticulture)
Madhavi Reddy, K. Ph.D.	Principal Scientist (Horticulture)
Aghora, T.S. Ph.D.	Principal Scientist (Horticulture)
Pitchaimuthu, M. Ph.D.	Senior Scientist (Horticulture)
Singh, T.H. Ph.D.	Senior Scientist (Horticulture)
Mohan, N. Ph.D.	Senior Scientist (Genetics and Cytogenetics)
Varalakshmi, B. Ph.D.	Senior Scientist (Horticulture)
Shankar Hebbar, S. Ph.D.	Senior Scientist (Agronomy)
Anil Kumar Nair, Ph.D.	Senior Scientist (Agronomy)
Srinivas Rao, E. Ph. D.	Senior Scientist (Horticulture) On deputation w.e.f 31.05.2009

Division of Ornamental Crops

Meenakshi Srinivas Ph.D.	Principal Scientist (Genetics & Cytogenetics) & Head up to 20.12.2009 Head (i/c) w.e.f. 21.12.2009
Rao, T.M. Ph.D	Principal Scientist (Horticulture)
Janakiram, T. Ph.D.	Principal Scientist (Horticulture) up to 13.8.09
Tejaswini Ph.D.	Principal Scientist (Plant Breeding)
Sujatha, K. Ph.D.	Principal Scientist (Horticulture)

Sujatha A Nair, PhD	Senior Scientist (Horticulture)
Dhananjaya, M.V. Ph.D.	Scientist (SS) (Plant Breeding)
Sumangala, H.P. M.Sc.(Hort)	Scientist (Horticulture)
Rajeev Kumar, Ph.D.	Senior Scientist (Horticulture) w.e.f. 01.09.2009

Division of Post Harvest Technology

Narayana, C.K. Ph.D	Principal Scientist (Horticulture) & Head
Gopal Krishna Rao, K.P. Ph.D.	Principal Scientist (Horticulture)
Doreyappa Gowda, I.N. Ph.D.	Principal Scientist (Horticulture)
Sudhakar Rao, D.V. Ph.D.	Principal Scientist (Horticulture)
Tewari, R.B. Ph.D.	Senior Scientist (Horticulture)
Sangama, Ph.D.	Senior Scientist (Horticulture)
Bhuvaneshwari, S., M.E	Scientist (SS) (Agricultural Structure and Processing Engineering)
Ranjitha. K, Ph.D.	Scientist (Microbiology)

Division of Plant Pathology

Ramachandran, N. Ph.D.	Principal Scientist (Plant Pathology) & Head
Girija Ganeshan Ph.D.	Principal Scientist (Plant Pathology)
Meera Pandey Ph.D.	Principal Scientist (Plant Pathology)
Chowdappa,P. Ph.D.	Principal Scientist (Plant Pathology)
Gopalakrishnan, C. Ph.D.	Principal Scientist (Plant Pathology)
Krishna Reddy, M. Ph.D.	Principal Scientist (Plant Pathology)
Saxena, A.K. Ph.D.	Senior Scientist (Plant Pathology)
Veena, S.S. Ph.D.	Senior Scientist (Plant Pathology) up to 18.07.2009
Samuel, D.K. M.Sc.	Scientist (SG) (Plant Pathology)

Division of Entomology and Nematology

Mannar Mani Ph.D.	Principal Scientist (Agricultural Entomology) & Head
Krishnamoorthy, A. Ph.D.	Principal Scientist (Agricultural Entomology)
Krishna Murthy, P.N. M.Sc.	Principal Scientist (Agricultural Entomology)
Abraham Verghese Ph.D.	Principal Scientist (Agricultural Entomology)
Krishna Kumar, N.K Ph.D.	Principal Scientist (Agricultural Entomology)
Srinivas Rao, M. Ph.D.	Principal Scientist (Nematology)
Jhansi Rani, B. Ph. D.	Principal Scientist (Agricultural Entomology)
Ranganath, H.R. Ph.D.	Principal Scientist (Agricultural Entomology)
Gopalakrishna Pillai, K. Ph.D.	Senior Scientist (Agricultural Entomology)
Ganga Vishalakshy, P.N. Ph.D.	Senior Scientist (Agricultural Entomology)
Sridhar, V. Ph.D	Senior Scientist (Agricultural Entomology)
Kamala Jayanthi, P.D. Ph. D.	Senior Scientist (Agricultural Entomology)

Division of Plant Physiology and Biochemistry

Shiva Shankar, S. Ph.D.	Principal Scientist (Biochemistry) & Head w.e.f. 01.05.2009
Srinivas Rao, N. K. Ph.D.	Principal Scientist (Plant Physiology) & Head (i/c) up to 30.04.2009
Bhatt, R. M. Ph.D.	Principal Scientist (Plant Physiology)
Ravindra, V. Ph.D.	Principal Scientist (Plant Physiology)
Upreti, K. K. Ph.D.	Principal Scientist (Organic Chemistry)
Shiva Shankar, K.S. Ph.D.	Senior Scientist (Plant Physiology)

Laxman, R. H. Ph.D.	Senior Scientist (Plant Physiology)
Keshava Rao, V Ph.D.	Senior Scientist (Organic Chemistry)

Division of Soil Science and Agricultural Chemistry

Edward Raja, M. Ph.D.	Principal Scientist (Soil Science) & Head
Ganeshamurthy, A.N. Ph.D.	Principal Scientist (Soil Science)
Anjaneyulu, K. Ph.D.	Principal Scientist (Soil Science) up to 31.05.2009
Kotur, S.C. Ph. D.	Principal Scientist (Soil Science)
Debi Sharma Ph.D.	Principal Scientist (Agricultural Chemistry)
Raghupathi, H.B. Ph.D.	Principal Scientist (Soil Science)
Soudamini Mahopatra Ph.D.	Senior Scientist (Organic Chemistry)
Ahuja, A.K. Ph.D.	Senior Scientist (Organic Chemistry)
Varalakshmi, L.R. Ph.D.	Senior Scientist (Soil Science)
Selvakumar, G. Ph.D.	Senior Scientist (Microbiology) w.e.f. 22.06.2009
Panneer Selvam, P., Ph.D.	Scientist (Microbiology)

Division of Extension and Training

Doijode, S.D. Ph.D.	Principal Scientist (Horticulture) & Head w.e.f. 20.04.2009
Hegde., M.R. Ph.D.	Principal Scientist (Agronomy) Head (i/c) up to 19.04.2009
Shivananda, T.N. Ph.D.	Principal Scientist (Soil Science)
Nita Khandekar, Ph.D.	Senior Scientist (Agricultural Extension)
Achala Paripurna, Ph.D.	Senior Scientist (Agricultural Entomology)
Balakrishna, B. Ph.D.	Senior Scientist (Agricultural Extension)
Saju George, M.Sc.	Scientist (SS) (Agricultural Extension)

Division of Plant Genetic Resources

Ravishankar, H. Ph.D.	Principal Scientist (Horticulture) & Head (i/c) up to 19.09.2009
Ananthanarayanan, T.V. Ph.D.	Principal Scientist (Biochemistry) Head (i/c) w.e.f . 20.09.2009
Ganeshan, S. Ph.D.	Principal Scientist (Genetics and Cytogenetics)
Rajashekharan., P.E. Ph.D.	Senior Scientist (Economic Botany)
Venkat Rami Reddy, P. Ph.D.	Senior Scientist (Agricultural Entomology)
Anuradha Sane, Ph.D	Senior Scientist (Horticulture)

Division of Biotechnology

Aswath, C. Ph.D.	Principal Scientist (Horticulture) & Head
Sukhada Mohandas Ph.D.	Principal Scientist (Plant Physiology)
Akella Vani Ph.D.	Principal Scientist (Genetics and Cytogenetics)
Leela Sahijram Ph.D.	Principal Scientist (Plant Physiology)
Mythili, J.B. Ph.D.	Principal Scientist (Biotechnology)
Pious Thomas Ph.D.	Principal Scientist (Horticulture)
Ravishankar, K.V. Ph.D.	Senior Scientist (Plant Physiology)
Ashokan, R. Ph.D.	Senior Scientist (Agricultural Entomology)
Manmohan, Ph.D.	Senior Scientist (Plant Physiology)
Vageesh Babu, H.S. Ph.D.	Senior Scientist (Biotechnology)
Kanupriya, Ph.D	Scientist (Horticulture)
Lakshmana Reddy, D.C. Ph. D	Scientist (Biotechnology) w.e.f. 06.07.2009
Radhika, V. M.Sc	Scientist (SS) (Computer Application) w.e.f. 04.12.2009

Section of Medicinal & Aromatic Crops (w.e.f. 11.03.2010)

Vasantha Kumar, T. Ph.D	Principal Scientist (Genetics and Cytogenetics) & Head (i/c)
Eugene Sebastian, J.N. Ph.D.	Principal Scientist (Organic Chemistry)
Sukanya, D.H. Ph.D	Principal Scientist (Plant Breeding)
Hima Bindu Ph.D.	Senior Scientist (Plant Breeding)
Suryanarayana, M.A. Ph.D	Senior Scientist (Horticulture)

Section of Agricultural Engineering (w.e.f. 11.03.2010)

Mandhar, S.C. M.Tech.	Principal Scientist (Farm Machinery & Power) & Head (i/c)
Senthil Kumaran, G. M.Tech. Ph.D.	Senior Scientist (Farm Machinery & Power)
Carolina Rathina Kumari, A., M.E.	Scientist (SS) (Farm Machinery & Power)

Section of Economics & Statistics (w.e.f. 11.03.2010)

Gajanana, T.M. Ph.D.	Principal Scientist (Agricultural Economics) & Head (i/c)
Sudha Mysore Ph.D.	Principal Scientist (Agricultural Economics)
Sreenivasa Murthy, D. Ph.D.	Senior Scientist (Agricultural Economics)
Venugopalan, R. Ph.D.	Senior Scientist (Agricultural Statistics)
Chandraprakash, M.K. M.C.A	Scientist (SS) (Computer Application)

Section of Seed Science & Technology (w.e.f. 11.03.2010)

Naik, L.B. Ph.D.	Principal Scientist (Agronomy) & Head (i/c)
Yogeesha, H.S. Ph.D.	Principal Scientist (Seed Technology)
Bhanu Prakash, K. Ph.D.	Senior Scientist (Plant Physiology)
Padmini, K. Ph.D.	Senior Scientist (Horticulture)

Research Management and Co-ordination cell (RMCC)

Radhika, V. M.Sc	Scientist (SS) (Computer Application) up to 03.12.2009

Project Co-ordinator's Cell (Tropical fruits)

Prakash Patil Ph.D.	Senior Scientist (Plant Physiology)
Vasugi, C. M.Sc.	Scientist (SG) (Horticulture) up to 31.08.2009
Reena Rosy Thomas M.C.A.	Scientist (SS) (Computer Application)

Central Horticultural Experiment Station (CHES), Chettalli, Karnataka

Doijode, S.D. Ph.D	Principal Scientist (Horticulture) & Head up to 19.04.2009
Shivaramu, K. Ph.D.	Senior Scientist (Agricultural Entomology) & Head (i/c) w.e.f. 20.04.2009
Samarendra Hazarika, Ph.D	Senior Scientist (Soil Microbiology)
Sakthivel, T. Ph.D.	Senior Scientist (Horticulture)
Karunakaran, G. M.Sc.	Scientist (SS) (Horticulture)
Reddy, T.M. M.Sc.	Scientist (SS) (Agricultural Extension)

Central Horticultural Experiment Station (CHES), Bhubaneshwar, Orissa

Vishal Nath, Ph.D.	Principal Scientist (Horticulture) & Head
Gourahari Naik Ph.D.	Principal Scientist (Genetics and Cytogenetics)
Hari Shankar Singh Ph.D.	Principal Scientist (Agricultural Entomology)
Vikramaditya Pandey Ph.D.	Senior Scientist (Horticulture) up to 08.05.2009
Rao, B.N. Ph.D.	Senior Scientist (Horticulture) up to 08.05.2009
Petikam Srinivas, Ph.D.	Senior Scientist (Plant Pathology) w.e.f. 30.06.2009
Sudhamoy Mondal M.Sc.	Scientist (SS) (Plant Pathology)

Bharathi, L.K. M.Sc.	Scientist (SS) (Horticulture)
Ritesh Saha, M.Sc.	Scientist (Soil Science) up to 22.08.2009

Krishi Vigyan Kendra (KVK), Gonikoppal, Karnataka

Narayanaswamy, B., Ph.D.	Programme Coordinator/Senior Scientist (Agricultural Extension)

Central Horticultural Experiment Station (CHES) and Krishi Vigyan Kendra (KVK), Hirehalli, Karnataka

Naik, L.B. Ph.D	Principal Scientist (Agronomy) & Programme Coordinator (i/c) *Stationed at Main station, Bangalore*
Rajeev Kumar, Ph.D	Senior Scientist (Horticulture) from 16.07.2009 to 31.08.2009

Technical Staff

Main Institute, Hessaraghatta, Bangalore, Karnataka

Division of Fruit Crops

Prakash, B. M.Sc.(Org Chem)	T -7-8 (T.O)(Lab)
Narayanappa, K.	T-5 (T.O.) (Field)
Vittala, T.S.	T-5 (T.O.) (Lab)
Ravindra Kumar, M.Sc. (Ag)	T-5 (T.O.) (Lab)
Govinda Gowda, R.	T-5 (T.O.) (Lab) up to 31.07.2009

Division of Vegetable Crops

Kashinath, B.L., M.Sc. (Ag)	T-9 (Farm Supdt.)
Umashankar, B.E., B.Sc. (Ag)	T-5 (T.O.) (Lab) w.e.f. 01.07.2009
Sunder Raj, K. R.	T-5 (T.O.) (Field)
Puttanna, M.A. (Econ)	T-5 (T.O.) (Lab)
Krishnappa, N.B.	T-5(T.O.) (Field)

Division of Ornamental Crops

Ramamurthy, R., B.Sc.	T-5 (T.O.) (L)
Revanna, H.C., B.Sc.	T-5 (T.O.) (F)

Division of Post Harvest Technology

Sarojini Jalali, M.Sc	T-9 (T.O.) (Lab)
Lokesh, C., B.Sc.	T-5 (T.O.) (Lab) w.e.f. 21.05.2009
Nagappa, M.Sc. (Eco. Env)	T-5 (T.O.) (Lab)
Reddappa, K., B.Sc., PGD (FT)	T-5 (T.O.) (Lab)
Nair, S.K.	T-5 (T.O.) (Field)
Chandrashekar, S.	T-5 (T.O.) (Field) up to 30.04.2009

Division of Plant Pathology

Salil Jalali, M.Sc.	T-7-8 (T.O.) (Lab)
Somaiah, B.N.	T-5 (T.O.) (Field) up to 30.06.2009
Earanna, K.R., B.Sc.	T-5 (T.O.) (Lab) up to 08.09.2009
John Saldana	T-5 (T.O.) (Field)
Sudarshan, B.	T-5 (T.O.) (Lab) w.e.f. 09.09.2009
Balasubramaniam, K., B.Sc., DIP(Med lab)	T-5 (TO.) (Lab)

Division of Entomology and Nematology

Sujatha, A., Ph.D	T- 7-8 (T.O.) (Lab)

Prakash, K.V., B.Sc., B.Ed.	T- 7-8 (T.O.) (Field)
Sreeramaiah, N.A.	T-5 (T.O.) (Field) w.e.f. 15.01.2010

Division of Plant Physiology and Biochemistry

Tapas Kumar Ray, M.Sc	T- 7-8 (T.O.) (Lab)
Jayaram, H.L., M.Sc. PGD	T- 7-8 (T.O.) (Lab)
Bujji Babu, C.S., M.Sc.(Bio. Chem)	T- 7-8 (T.O.) (Lab)
Chandrasekhar, S.C., M.Sc.	T-6 (T.O.) (Lab)
Nageswara Rao, A.D.D.V.S., B.Sc.	T-5 (T.O.) (Lab) w.e.f. 01.07.2009
Lakshmaiah, M.	T-5 (T.O.) (Lab)
Qazi, S.M., B.Sc.	T-5 (T.O.) (Lab)

Division of Soil Science and Agricultural Chemistry

Suresh, T.P., B.Sc. L.L.B.	T-7-8 (T.O.) (Lab)
Kacker, N.K., B.Sc.	T-7-8 (T.O.) (Lab)
Mazhar Jamil, B.Sc.	T-5 (T.O.) (Lab)
Shivanna, H.S., B.Sc.	T-5 (T.O.) (Field)
Jyothi V. Divakar, M.Sc.	T-5 (T.O.) Lab)

Division of Extension and Training

Gaddagimath, P.B. M.Sc. M.A.	T-7 (T.O.) (Inf. & Pub. Officer) w.e.f. 13.07.2009
Girija, B.U., B.A.	T-5 (T.O.) (Lab)
Bhojappa Gowda	T-5 (T.O.) (T.A.)
Sreeramaiah, N.A.	T-5 (TO) (Field) up to 14.01.2010
Earanna, K.R., B.Sc.	T-5 (T.O.) (Lab) w.e.f 09.09.2009

Division of Plant Genetic Resources

Shetti D.L., M.Sc (Agril Ento)	T-6 (T.O) (Lab)

Division of Biotechnology

Sreedhara, S.A., M.Sc. (Food Tech)	T-7-8 (T.O) (Lab)
Sudarshan, B.	T-5 (T.O.) (Lab) up to 08.09.2009

Section of Agricultural Engineering

Dayananda, P.	T-5 (T.O.) (Mechanic) w.e.f 15.05.2009

Section of Economics & Statistics

Dakshinamoorthy, V., MA., M.Phil(Econ)	T- 7-8 (T.O) (Lab.)
Thippeswamy, S. MCA	T- 6 (Sr. Computer Operator)
Kishore Kumar, N., B.Sc.	T- 5 (T.O.) (Computer)

Section of Seed Science & Technology

Arun, M.N. M.Sc (Ag)	T-6 (T.O) (Field)

Project Co-ordinator's Cell (Tropical Fruits)

Kushalappa, P.A., M.A.(Econ)	T-5 (T.O.) (Lab)

ARIS Cell

Jayasankar, N., Masters Dip in Comp.Appl.	T-5 (T.O.) Comp. Operator

Library

Mohan, K.C., Ph.D.	T- 9 (T.O.) (Lib)
Kalpana, K.,. M.Sc, B. Lib Sci	T- 7-8 (T.O.) (Lib)
Varadaraj, V., B.Sc, B. Lib Sci	T- 7-8 (T.O.) (Lib)
Shankara Prasad, K.V. M.Sc.(Lib Sci)	T- 5 (T.O.) (Lib)

Photography & Artist Cell

Goutam Basak, B.Sc.	T-6 (T.O) (Photographer)
Chandrashekaraiah, K., B.Com.	T-5 (T.O.) (D.R.A.)
Rajendra Astagi, M.F.A	T-5 (T.O.) (Artist)

Dispensary

Mandakranta Bhattacharya, MBBS, DLO	T-9 (Medical Officer)

Farm Management

Pandey, R.N., M.Sc (Ag)	T- 9 (T.O.) (Farm)
Biradar, M.B., M.Sc (Ag)	T- 7-8 (T.O.) (Farm)
Senthil Kumar, M., M.Sc. (Hort), M.B.A	T- 6 (T.O.) (Farm)
Shashtry, K.N., B.Sc.	T- 5 (T.O.) (Field) up to 31.07.2009
Dyavanna, C.	T- 5 (T.O.) (Field)

Workshop

Bhanu, A., B.E. (Civil)	T-7-8 (T.O.) (JME)
Robert Lewis	T-6 (T.O.) (Refri.)
Harish, K.M., B.E.(Civil)	T-5 (T.O.) (Civil Overseer)
Mahishi, V.K.	T-5 (T.O) (Elect.)
Lakshmana Kanthan, A.	T-5 (T.O.) (Turner)
Narendra, S.	T-5 (T.O.) (Elect.) w.e.f. 17.05.2009

Transport

Siddaram G. Kalashetty, B.E. (AE)	T-5 (T.O.) (Transport)
Nagaraj E. Kodekal	T-5 (T.O.) (Mech)
Sunderraj, G.	T-5 (T.O.) (Driver)

Security

Siddegowda, C.	T-5 (T.O.) (Field)

Central Horticultural Experiment Station (CHES), Chettalli, Karnataka

Patil, C.S. M.Sc, B. Lib Sci	T-6 (T.O) (Lib)
Kariyappa, K.B.	T-5 (T.O.) (Field)
Kaveriyappa, C.G.	T-5 (T.O.) (Field)
Shivarama, P.M.	T-5 (T.O.) (Field)
Ravi, M. B., B.Sc.	T-5 (T.O.) (Field)
Bollappa, M. M.	T-5 (T.O.) (Field)
Appanna, H. C.	T-5 (T.O.) (Field)
Chandrappa, C.B.	T-5 (T.O.) (Field)
Prabhakara, K.K., B.Sc. B.Ed.	T-5 (T.O.) (Field)
Jagadish Kumar, D.N.	T-5 (T.O.) (Elect)
Varadarajachary, K.V.	T-5 (T.O.) (Mechanic)

Central Horticultural Experiment Station (CHES), Bhubaneshwar, Orissa

Gaddagimath, P.B. M.Sc.(Org Chem)	T-7 (T.O.) (Inf. & Pub. Officer) up to 12.07.2009
Singray Majhi, B.Sc.(Ag), Dip(CA)	T-5 (T.O) (Lab)

Central Horticultural Experiment Station (CHES) and Krishi Vigyan Kendra (KVK), Hirehalli, Karnataka

Jagadish, K.N., M.Sc (Agri. Extn)	T-6 (T.O.) (Subject Matter Specialist) (Extension) w.e.f. 17.11.2009
Ramesh, P.R., M.Sc (Agri.)	T-6 (T.O.) (Subject Matter Specialist) (Soil Science) w.e.f. 17.11.2009
Prashanth, J.M. M.Sc (Horti)	T-6 (T.O.) (Subject Matter Specialist) (Horticulture) w.e.f. 24.11.2009
Hanumanthe Gowda, B., M.Sc (Pl Patho)	T-6 (T.O.) (Subject Matter Specialist) (Plant Protection) w.e.f. 02.12.2009
Radha R.Banakar, M.Sc (Home Science)	T-6 (T.O.) (Subject Matter Specialist) (Home Science) w.e.f. 05.12.2009
Somashekhar, Ph.D	T-6 (T.O.) (Subject Matter Specialist) (Plant Breeding) w.e.f. 07.12.2009

Krishi Vigyan Kendra (KVK), Gonikoppal, Karnataka

Prabhakara, B., M.Sc (Agri) Hort	T- 6 (T.O.) (Subject Matter Specialist)
Veerendrakumar, K.V., M.Sc.(Agri) Hort	T-6 (T.O.) (Subject Matter Specialist)
Devaiah, K. A., M. Sc. (Hort)	T-7 (T.O.) (Subject Matter Specialist)
Rina Basu, M.Sc (Home Science)	T-9 (STA) (Subject Matter Specialist)
Joshi, S.V., M.V. Sc	T-9 (STA) (Subject Matter Specialist)
Joyappa, P.K., B.Sc.	T-5 (T.O.) (Lab) - Programme Assistant
Padmavathy, M.K., M.Sc.	T-5 (T.O.) (Lab) - Programme Assistant
Vasantha Kumar C.K., M.Sc.	T-5 (T.O.) (Field) - Programme Assistant
Bopaiah, B. B, B.Sc.	T-5 (T.O.) (Field) - Programme Assistant

Administration and Accounts

Main Institute, Hessaraghatta, Bangalore, Karnataka

Administration

Harakangi, G. G., B.E. (Civil)	Senior Administrative Officer
Satyanaraya, P.	Administrative Officer up to 30.06.2009
Das, J. N. L., B.Sc., Phy (Hons), DPMIR	Assistant Administrative Officer (Admin)
Hanumanthaiah, K.	Assistant Administrative Officer (Cash &Bill)
Swarnamma, P.K., B.Sc.	Assistant Administrative Officer (Purchase)
Jagadeesan, A.K., MA(Hindi), PGD(Trasl)	Assistant Director (Official Language) w.e.f. 28.10.2009
Rajendran, S. B.Com.	P.A. to Director

Finance and Accounts

Sanchal Bilgrami, M.A.	Senior Finance & Accounts Officer
Ramachandrappa, B.N., B.Com.	Assistant Finance & Accounts Officer

Central Horticultural Experiment Station (CHES), Chettalli, Karnataka

Administration

Raghuraman, V., B.Com, L.L.B.	Assistant Administrative Officer (Admin)

The list indicates the staff position only.

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17. Women Empowerment

Role of women in agriculture in general and horticulture in particular has always been regarded as extremely important, as many of the horticultural activities such as post harvest management of horticultural produce, flower arrangement, dry flower products etc. can help women become small entrepreneurs, thereby empowering them. Indian Institute of horticultural Research makes conscious efforts to address issues related to women's empowerment and reduction of drudgery. Various activities taken up by this institute in this direction are presented below.

Krishi Vigyan Kendra (KVK), Gonikoppal

This centre imparted training to women self help groups in the field of horticulture, agriculture, animal husbandry and home science encouraging them to take up self employment along these lines.1700 women have been trained in different enterprises during the year under report. The centre also imparted 43 on campus and 55 off campus trainings in various fields. In all 1697 women participated in these trainings. The details of these trainings is given below:

On-campus training

Sl. No.	Name of the course	No. of courses	No. of female participants
1	Horticulture	17	233
2	Mushroom cultivation	3	64
3	Soil testing	8	3
4	Animal science	4	87
5	Home science	11	94
	Total	**43**	**487**

Off campus training

1	Horticulture	21	565
2	Mushroom cultivation	3	37
3	Vermicomposting	5	114
4	Agriculture	7	73
5	Animal science	9	180
6	Home science	10	241
	Total	**55**	**1210**

In addition to this, vocational training in crochet, tailoring and needle work was imparted to 59 participants. A 5 day long sponsored programme on "Personality and leadership development in youths" was also organized in Feb. 2010, in collaboration with Kodagu Yuva Vakkuta, Nehru Yuvaka Sanga, Madikeri. 25 young women participated in this programme.

Women in Agriculture Day

Women in Agriculture day was celebrated on 5.12.09 at KVK Gonikoppal. A training programme on preparation of nutritious dishes and preservation of fruit and vegetables was conducted on this occasion. Mrs. Deerghakesi Shivanna, former president of Kodagu Jilla Panchayat was the chief guest. Dr. B Narayanaswamy, Programme Coordinator and Head explained the role of women in agriculture and importance of celebrating this day. Fifty four farm women attended the function.

International Women's Day

IIHR, Bangalore

The Complaints Committee on Sexual Harassment of Women at Workplace including Womens' Cell, IIHR celebrated International Women's Day, 2010 by organizing two lectures viz., 'Women and Mental Health' and 'Parenting issues in children and adolescents' by Dr Prakashi Rajaram and Dr Indiramma both Associate professors, Dept. of psychiatric social work, Nimhans on 6th and 10th March respectively at IIHR A get-together of the IIHR Women Employees was organized in the auditorium in the forenoon which served as a platform for participants to air views on issues of their choice, during which Dr A. Vani, Principal Scientist, IIHR

Director IIHR addressing the gathering at International Women's day celebrations at IIHR

enthused the audience with a presentation on the special attributes of women. followed by a contributory lunch. The women's cell also hosted a free lunch to the women labourers of the Institute as a token of appreciation for their contribution to Agriculture

Krishi Vigyan Kendra, Hirehalli, Tumkur

A programme on International Women's Day was organized on 08.03.2010 at Krishi Vigyan Kendra, Hirehalli, Tumkur.

Farm women from Hirehalli and surrounding villages participating in the programme

Smt Shivarudramma, President, Grama Panchayat, Hirehalli inaugurated the Programme. The Programme was chaired by Dr.L.B.Naik, Programme Coordinator, KVK, Hirehalli, Tumkur. Smt. Sharadamma, Senior Assistant Director of Horticulture, Department of Horticulture was the chief guest. On this occasion, Kumari Radha R.Banakar, Subject Matter Specialist (Home Science) has imparted training on preparation of value added products of Aonla and Ragi to the participants. 40 farm women from Hirehalli and surrounding villages participated in the Programmed.

Krishi Vigyan Kendra, Gonikoppal, Kodagu

International Women's Day was celebrated on 9thMarch 2009. Dr, S V Joshi, Subject Matter Specialist (Livestock) explained about International women's day, on its inception and importance in bringing harmony in the society and providing strength to women fighting against social evils. A training programme was organized on nutritional aspects of cookery. This programme was attended by 40 farm women.

■

18. Miscellany

18.1 Rooftop Rainwater Harvesting system

Rainwater harvesting has been adopted in IIHR to provide supplemental water for the institute's requirements, to increase soil moisture levels for greenery and to increase the ground water table through artificial recharge. Rooftop rainwater harvesting system was provided in Biotech Lab, Auditorium, Administration Building and Library during the year 2009-10. About 1 lakh liters of rain water is estimated to be harvested in one spell of 25mm rainfall from these four buildings. The harvested water is used for irrigation in poly houses and also for recharging the ground water through a deep tubewell.

Rain Water Harvest System in Biotechnology building

Ground Water Recharge Deep Tubewell

18.2 Other infrastructure facilities

During the period April 2009 to March 2010 , works taken up under Plan, included, construction of extension to Division of Soil Science, construction of Farm Implements Shed, construction of Fertilizer Shed, water proofing of the roofs of all the buildings and renovation of all the polyhouses, nethouses and glasshouses.

Renovated Ornamental Crops Greenhouse

18.3 Sports

IIHR, Bangalore, bagged the Krishnamurthy Rolling Trophy for Runner up position in the ICAR South Zone Sports Meet held at CIFT, Cochin from 23rd to 27th Feb.2010. The IIHR Sports contingent comprising of 48 men and 2 women sportspersons led by Dr. Gopakrishna Pillai, Chief-de-mission, IIHR, participated in the above sports meet.

IIHR contingent lifting the trophy

18.4 Library facilities

The Library at this Institute is being gradually developed into an e-Library. Web Opac, an online catalogue of books & back volumes available in the Library, was set up for the readers to browse the contents of the available books. The CeRA – 'Consortium for e-Resources in Agriculture' has provided the online access to full text articles of journals from the following participating publishers**:** Springer, Elsevier (Science Direct), Taylor & Francis,CSIRO (Australia), Annual Reviews and Indian Journals.

18.5 Official Language

An official language magazine of IIHR, "Bagwani", was launched and the same was released by Dr. K.L. Chaddha, former DDG (Hort), ICAR. This magazine was awarded the second prize of prestigious "Ganesh Shankar Vidyarthi Krishi Patrika Puraskar" of Indian Council of Agricultural Research. The award was received by Dr. Amrik Singh Sidhu, Director, IIHR on 16th July, 2009.

Dr. Amrik Singh Sidhu, Director receiving the award from Union Minister Dr. Farooq Abdulla. Dr. Mangla Rai, Secretary, DARE & DG, ICAR and Shri A.K. Upadhyaya, Additional Secretary, DARE & Secretary, ICAR are also seen.

An article on "*Bagwani Faslon Mein Chidkav Dwara Poshak Tatwon Ka Saksham Prayog*" by Dr. S.C. Kotur, Principal Scientist, IIHR, was adjudged the best article in Hindi, during the technical writing competition organized by Town Official Language Implementation Committee, Bangalore.

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19. Meteorological Data

Meteorological Data April, 2009 – March, 2010 at

1) IIHR, Bangalore

Month	Temperature(°C)		Relative Humidity (%)		U.S.W.B Class'A' Pan Evaporation (mm)	Mean wind speed (km/h)	Rain fall (mm)
	Maximum	Minimum	07.30hrs.	14.00hrs.			
April '09	34.9	19.5	77.6	60.5	6.9	5.5	75.0
May '09	32.0	20.4	70.2	52.2	5.2	2.7	74.9
June '09	29.4	19.8	69.5	53.7	4.9	7.6	7.4
July '09	28.4	19.3	72.2	55.7	4.48	11.4	30.4
August '09	29.2	19.8	74.6	57.0	4.4	6.6	26.6
September '09	28.2	19.9	79.2	61.8	3.6	5.6	205.2
October '09	28.2	18.2	65.7	53.6	3.5	4.8	16.2
November '09	29.4	18.1	73.8	56.9	2.7	5.2	34.8
December '09	27.0	16.0	69.96	51.0	2.8	5.3	9.0
January '10	27.0	14.8	64.0	42.6	3.7	4.9	—
February '10	31.2	13.8	56.5	37.8	5.0	4.9	—
March '10	33.8	16.0	60.7	36.4	7.0	4.9	24.0

2) CHES, Chettalli

Month	Temperature(°C)		Relative Humidity (%)	Rain fall (mm)	No of Rainy Days
	Maximum	Minimum			
April '09	31.3	19.1	90.2	80.2	4
May '09	31.8	17.0	81.2	66.0	6
June '09	27.3	16.5	72.3	109.0	4
July '09	28.4	17.1	75.0	821.2	23
August '09	27.1	23.8	69.9	135.6	12
September '09	27.8	23.0	68.5	150.8	8
October '09	28.2	24.4	66.4	49.8	2
November '09	29.0	24.6	58.7	122.2	6
December '09	28.2	15.6	55.4	52.4	2
January '10	29.5	14.8	56.3	-	-
February '10	31.9	15.0	52.8	-	-
March '10	30.5	15.8	56.0	20.0	1

Varieties identified during 2009-10

Arka Kanaka (Crossandra)

Arka Ambara (Crossandra)

Arka Pinkstar (Chrysanthemum)

Arka Neelachal Kunkhi (Ivy gourd)

Arka Neelachal Sabuja (Ivy gourd)

Arka Neelachal Kirti (Pointed gourd)

Arka Neelachal Shree (Spine gourd)

Arka Neelachal Gaurav (Teasel gourd)

Arka Aishwarya (Watermelon) F_1

Arka Akash (Watermelon) F_1

Arka Naveen (Gladiolus)

Arka Gold (Gladiolus)

Arka Amar (Gladiolus)

Arka Dhanwantri (Mucuna)

Arka Ashwini (Mucuna)

Arka Nirantara (Tuberose)

Arka Muthu (Watermelon)

Arka Tejas (*Dianthus*)

Arka Swadista (Onion)

Arka Ujjwal (Onion)

Arka Prabhath (Papaya)

Arka Kiran (Guava)

Arka Sharath (French bean)

EVERY DROP COUNTS