वार्षिक प्रतिवेदन
ANNUAL REPORT
2011-12

भाकृअनुप
ICAR

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
All India Co-ordinated Research Project on Palms

(Indian Council of Agricultural Research)

CPCRI, Kasaragod-671 124, Kerala, India

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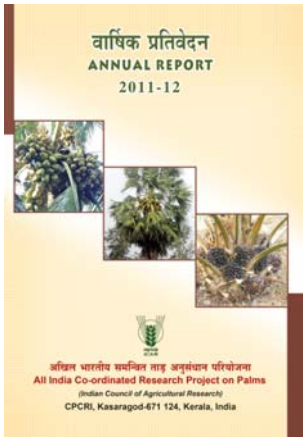

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I. PREFACE

The All India Co-ordinated Research Project (AICRP) on Palms, the research network under ICAR for palms comprises of 21 Co-ordinating Centres based in 12 State Agricultural Universities and one Central Agricultural University. The AICRPP Centres located in twelve States representing different agro-climatic regions could identify location specific technologies to address the problems of palms and palm based cropping systems. Several combinations of Tall x Tall and Dwarf x Dwarf coconut hybrids are under evaluation for their performance in yield and quality parameters under different agroclimatic conditions. Nucleus seed gardens are being established for released varieties of coconut in seven centres to meet the increasing demand for seedlings. During the period, 15 germplasm accessions of palmyrah with dwarf stature have been collected from Prakasam and Guntur districts of Andhra Pradesh. In the present era of globalised economy and free trade agreements, coconut growers are more exposed to economic risks and uncertainties due to the high degree of price fluctuations. In this context, region specific coconut based cropping systems with various combination of crops and medicinal and aromatic plants evolved through the AICRP on Palms Centres are important to improve the income from a unit area of coconut gardens. Similarly, integrated pest and disease management practices evolved at different Centres would enable to achieve effective control of major pests and diseases of coconut, thus ensuring higher profitability.

The Annual Report covers the research results emanated in coconut, oil palm, palmyrah and sulphi palm in respect of genetic resources and crop improvement, crop production, crop protection and other related information pertaining to the period from April 2011 to March 2012. The report contains results of experiments on coconut at 13 centres, six centres of oil palm and two centres of palmyrah. The entire outcome reflects the team efforts of the Scientists and staff of the AICRP Centres. I am thankful to all my Project Scientists and Staff in different Centres for their sincere work and sustained enthusiasm in achieving various objectives outlined in the project.

I take this opportunity to express my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for the encouragement and guidance given. My sincere thanks are due to Dr. H.P. Singh, Deputy Director General (Horticulture) (Retd.,) and Dr. N.K. Krishna Kumar, Deputy Director General (Horticulture), ICAR for their sustained guidance and encouragement in the progress of the Project. I acknowledge the continued support of Dr. S. Rajan, Assistant Director General (Hort. I) (Retd.,) and the staff at ICAR, New Delhi for their valuable help and guidance in the functioning of the Project. I express my sincere thanks to the Vice Chancellors, Directors of Research and Heads of Stations of various Agricultural Universities and different centres for their active involvement in ensuring the smooth conduct of the Project.

I take this opportunity to acknowledge the help rendered by Dr. Maheswarappa, H.P., Smt. K. Narayani, and Shri P. Narayana Naik in Project Coordinator's Cell in bringing out this report. The assistance provided by Dr. V. Krishnakumar in editing the report and that of Mrs. K. Sreelatha and Dr. Alka Gupta for Hindi translation is also gratefully acknowledged.

August 2012

(Dr. George V. Thomas)

II. कार्य सारांश

ताड़ आधारित फसलन पद्धित एवं ताड़ के लिए स्थानीय विशेष प्रौद्योगिकियों को विकसित करने के लिए अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना सन् 1972 में प्रारंभ की गई। वर्तमान में परियोजना का मुख्य फसल नारियल, तेल ताड़ और पॉमैरा है। विभिन्न सस्य जलवायु परिस्थितियों के बारह राज्यों में स्थित अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के केंद्रों द्वारा मुख्य फसलों की उत्पादन क्षमता बढ़ाने के लिए स्थानीय विशेष प्रौद्योगिकियों को विकसित करने में सफलता प्राप्त की गई है।

आनुवंशिक संसाधन और फसल सुधार, फसल प्रबंधन, फसल संरक्षण एवं कटाई उपरांत प्रौद्योगिकी के अधीन इस वर्ष 201112 की अवधि में मुख्य फसलों के शोध कार्य में हुई प्रगति इस रिपोर्ट में प्रस्तुत की गई है। इस वर्ष की अवधि में फसल प्रबंधन और फसल उत्पादन प्रौद्योगिकियॉ विकसित करने में अखिल भारतीय समन्वित ताड अनुसंधान परियोजना गणनीय प्रगति प्राप्त की गई है।

अनुसंधान उपलब्धियॉ 2011-12

नारियल

फसल सुधार

विभिन्न केंद्रों में विद्यमान जननद्रव्यों का उपयोग और प्रजातियों का विवरण विभिन्न केंद्रों में जारी किया जा रहा है। स्थानीय जननद्रव्यों के साथ विशेष गुणयुक्त बीज गुठली के संग्रहण, संरक्षण और मूल्यांकन के अधीन संग्रहण किया गया और रोपण किया गया और विभिन्न केंद्रों में उसका अनुरक्षण किया जा रहा है।

अम्बाजिपेट और अरसिकरे केंद्र में जी.बी.जी.डी x एल.सी.ओ.टी के संकरण संयुक्त में उच्च गुठली उपज (128 गुठली/ताड़/वर्ष) और 132 गुठली/ताड़/वर्ष (चार वर्ष के बाद) पायी गयी और जी.बी.जी.डी x पी.एच.ओ.टी में 119 गुठली/ताड़/वर्ष और 131 गुठली/ताड़/वार्ष क्रमशः पाया गया जबकि क्रमानुगत स्थानों में गोदावरी गंगा में 115 और कल्पतरु में 90 गुठली/ताड़/वर्ष प्राप्त किया गया। इसलिए आध्रप्रदेश और कर्नाटक के मैदान क्षेत्रों इन संयुक्त में कृषि केलिए विमोचित किया जा सकता है।

फसल उत्पादन

उर्वरण

अम्बाजिपेट के आकड़े से यह स्पष्ट पाया गया कि उर्वरण के माध्यम से 100 प्रतिशत आर.डी.एफ में अधिकतम गुठली उपज 88.5 गुठली/ताड प्राप्त किया जाता है जो अन्य उपचार से विशेष रूप से भिन्न है । नियंत्रण के अधीन निम्नतम उपज 52.5 गुठली/ताड़ रिकार्ड किया गया। अलियार नगर केंद्र में वर्ष 2010-11 की अवधि की औसत वार्षिक गुठली उपज से यह देखा गया कि आर डी एफ के 100 प्रतिशत में ड्रिप उर्वरण सॉख्यिकीय रूप में उत्तम पाया गया जो नियंत्रण की अपेक्षा 19.6 प्रतिशत अधिक उपज प्रदान किया जाता है । लेकिन आर डी एफ के 50(टी3) और 75 (टी4) का ड्रिप उर्वरण अलवाल प्रयोग (टी6) के माध्यम से 100 प्रतिशत आर डी एफ का समतुल्य पाया गया। रत्नगिरी केंद्र के परीक्षण परिणाम से यह देखा गया कि ड्रिप सिंचाई के माध्यम से 100 प्रतिशत अनुमोदित उर्वरक की मात्रा के अधीन दो वर्ष 2009-10 एवं 2010-11 का औसत उपज उच्च (116 गुठली) पाया गया जो ड्रिप सिंचाई से नाईट्रोजन फोसफोरस पोटाष का 50% और नाईट्रोजन फोसफोरस पोटाष का 75% के प्रयोग से प्राप्त उपज के समतुल्य पाया गया। काहिकुची केंद्र में ड्रिप सिंचाई (टी4) से नाईट्रोजन फोसफोरस पोटाश का 75% के प्रयोग से उच्चतम गुठली उपज 78.2 गुठली/ताड़/ वर्ष और ड्रिप से 100 नाईट्रोजन फोसफोरस पोटाश से निकटतम उपज प्राप्त किया गया। नियंत्रण के अधीन (टी1) निम्नतम उपज 51.9 गुठली/ताड़/वर्ष प्राप्त किया गया। तटीय बलुआर मृदा के अधीन (कासरगोड़) ड्रिप सिंचाई के माध्यम से 50% नाईट्रोजन फोसफोरस पोटाश के प्रयोग से उच्च नारियल उपज और ड्रिप सिंचाई के माध्यम से 75% और 100% नाईट्रोजन फोसफोरस

पोटाश के प्रयोग से प्राप्त उपज और मृदा के माध्यम से 100% नाईट्रोजन फोसफोरस पोटाश के प्रयोग से प्राप्त उपज समतुल्य पाया गया। अन्य उपचार की तुलना में ड्रिप उर्वरण के माध्यम से 25% नाईट्रोजन फोसफोरस पोटाश के प्रयोग से निम्नतम उपज रिकार्ड़ किया गया।

फसलन पद्धित

अलियार नगर में 2007-2011 फसलन अवधि में प्रौढ नारियल (18-21 वर्ष आयु) बाग में औषधीय पौध सिथारथई (*अल्पिनिया गालंगा*) और सुगंधी पौध नींबू घास *सिम्बोपोगोन फ्लक्सौसस* का निष्पादन उत्तम पाया गया। सिथारथई और नींबू घास का मूल्य लाभ अनुपात अच्छा पाया गया। मन्डौरी में नारियल + अश्वगंधा अधिकतम लाभ मूल्य अनुपात रिकार्ड किया गया और बाद में नारियल + एकंगी, नारियल + कलमेघ में निम्नतम लाभ मूल्य अनुपात रिकार्ड किया गया। रत्नगिरी में अन्तरफसल के रूप में विभिन्न औषधीय फसलों के निष्पादन को विचार करते हुए और विपणन मांग के अनुसार महाराष्ट्र के कोंकन क्षेत्रों के लिए नारियल रोपण में अन्तरफसल के रूप में शिशुमूल निम्बु घास, शतावरी, अडुल्सा, निम्बुक आदि सिफारिश किया गया है । लगातार उत्पादन क्षमता के लिए लवंग, केला, अनन्नास, जातिफल के साथ नारियल आधारित फसलन पद्धित का मूलयांकन किया जा रहा है।

कीट प्रबंधन

ओ. एरिनोसेल्ला के विरुद्ध प्रक्षेत्र में परजीव्याभ ब्रोकोनिड और परभक्षी का सुधारित परिश्रम का मूल्यांकन

अम्बाजिपेट और रत्नगिरी का परीक्षण परिणाम यह सूचित किया जाता है कि कीट लक्षण शून्य तक कम किया गया और दोनों केंद्रों में टी 1 उपचार में (परजीव्याभ का ओलफाक्टरी स्टिमुलेटड स्ट्रेइन्स) विमोचन के तीन महीने के बाद परजीव्याभीकरण 100 प्रतिशत पाया गया जबकि टी 2 उपचार में (परजीव्याभा का नॉन ओलफाक्टरी स्टिमुलेटड स्ट्रेइन्स) परजीवी के विमोचन के तीन महीने के बाद परजीव्याभीकरण प्रतिशत क्रमश 83.5 और 78.9 पाया गया।

विभिन्न क्षेत्रों में ओरिक्टस रिनोसेरस के लिए समीकृत कीट प्रबंधन प्रौद्योगिकी का विधिमान्यकरण

अम्बाजिपेट केंद्र में वूडिमुडि गॉव (पी गन्नवारम मण्डल) को परीक्षण कार्यान्वयन के लिए चुन लिया गया। निरीक्षण से यह देखा गया कि पत्ता क्षति 58.4 से 5.0 तक और तर्कु क्षति 25 से 3 प्रतिशत तक और लक्षण 60 से 5 प्रतिशत घटाव पाया गया। यह राईनोसेरस भृंग के प्रबंधन में समीकृत कीट प्रबंधन की प्रमुखता का विविधमान्यकरण को दिखाते है ।

ओ एरिनोसेला के विरुद्ध प्रक्षेत्र में परभक्षी (*कारडियोस्टेथस एक्सिगस*) और ब्राकोनिड के सुधारित परिश्रम का मूल्यांकन

अलियार नगर केंद्र में एज़डिराक्टिन टी एस 1% प्रतिशत अर्थात 5 मि ली + प्रति लिटर पानी में 1 मि. लीटर सान्डोविट की दर में 10,000 पी पी एम के छिड़काव के बाद 21 दिनों के अंतराल में छह बार 20:10:1 दर में दो लारवल परजीव्याभ *ब्राकोनिड्स, बेथिलिड्स* और प्यूपल परजीव्याभ कालसिड के विमोचन से *ओपिसिना एरिनोसेला* संख्या में महत्वपूर्ण कटौती 785.0 6.80 प्रति ताड पायी गयी फलस्वरूप लारवल परजीव्याभ जैसे *ब्राकोनिड्स*, *बेथिलिड्स* और कालजसिड्स और के बढती संतति के परजीव्याभीकरण के स्तर में क्रमश(कोलन) 2.75, 1.39 और 0.52 से 26.00 17.50 और 4.97 प्रतिशत बढोत्तरी पायी गयी।

एरियोफिड कीट प्रप्रंधन के लिए समीकृत कीट प्रबंधन और समीकृत सूत्रकृमि प्रबंधन

पोल्लाची क्षेत्र के पॉच स्थानों में एरियोफिड कीट के प्रबंधन के लिए समीकृत कीट प्रबंधन और समीकृत सूत्रकृमि प्रबंधन की प्रदर्शनी आयोजित की गई। अनुपचार की तुलना में समीकृत कीट प्रबंधन और समीकृत सूत्रकृमि प्रबंधन उपचारित ताडों में गुठली क्षति और एरियोफिड कीट संख्या में विशेष कमी पायी गयी।

समीकृत कीट प्रबंधन और समीकृत सूत्रकृमि प्रबंधन उपचारित ताडों में एरियोफिड कीट क्षति के साथ हरी गुठली संख्या में 2009 में 58%, 2010 में 40% और 2011 मे 37% कमी पायी गयी।

समीकृत कीट प्रबंधन और समीकृत सूत्रकृमि प्रबंधन उपचारित ताड़ों में कटाई के समय में औसत ग्रेड सूचकांक विशेष रूप

से कम रिकार्ड किया गया है। गुठली उपज में 1012 प्रतिशत विशेष बढोत्तरी पायी गयी।

साधारणतया अधिक उपयुक्त वनस्पतीय/कीटनाशियों के साथ प्राकृतिक शत्रुओं की संगतता

साधारणतया अधिक उपयुक्त वनस्पतीय/कीटनाशियों के साथ प्राकृतिक शत्रुओं की संगतता अध्ययन में यह देखा गया कि LD_{50} मूल्य के आधार पर परजीव्याभ *ब्राकोन ब्रेविकोर्निस* के लिए मोनोक्रोटोफोस अधिक विषालु और डैक्लोरोवोस, डैमेथोएट और कारबोफुरान उससे कम विषालु है।

रोग प्रबंधन

पत्ता चित्ती रोग तथा जलवायु ऑकडा

तापमान बढते ही पत्ता चित्ती रोग तीव्रता बढती जाती है। रोग तीक्ष्णता मार्च-अप्रैल में उच्च और अक्तूबर-दिसंबर में निम्न है।

थिलवियोप्सिस पारडोक्सा विरुद्ध देशी त्रैकोडेरमा जाति की कृत्रिम परिस्थिति विरोधी अध्ययन

थिलवियोप्सिस पारडोक्सा विरुद्ध त्रैकोडेरमा जाति के द्वय संवर्द्धन प्लेट परीक्षा से यह देखा गया कि परीक्षित त्रैकोडेरमा एकलन, तना स्त्रवण रोगहेतु टी. पारडोक्सा की वृद्धि निरोधन में प्रभावी है। विभिन्न त्रैकोडेरमा एकलन द्वारा टी.पारडोक्सा कारक का निरोधन प्रतिशत दर 43.33 से 78.89 है।

फाईटोफ्थोरा पॉल्मिवोरा के विरुद्ध देशी त्रैकोडेरमा जाति के कृत्रिम परिस्थिति विरोधी अध्ययन

फाईटाफ्थोरा पॉल्मिवोरा के विरुद्ध त्रैकोडेरमा जाति के द्वय संवर्द्धन प्लेट परीक्षा से यह देखा गया कि परीक्षित त्रैकोडेरमा एकलन कली सड़न रोगाणु , *पी .पॉल्मिवोरा* के विरुद्ध प्रभावी है। *पी. पॉल्मिवोरा* का निरोधन प्रतिशत दर 54.44 से 100 तक है।

आधार तना सड़न रोग फैलाव

जनवरी 2000 से मई 2011 तक की अवधि के लिए आधार तना सडन रोग फैलाव तथा जलवायु संघटक के बीच सहसंबंध अध्ययन से यह देखा गया कि बारिश दिनों की संख्या, बारिश और सापेक्ष आद्रता (2.00 बजे अपराह्न) के साथ नारियल में आधार तना सड़न रोग का उदग्र फैलाव के साथ विशेष रूप से प्रतिकूल संबंध पाया गया ।

आधार तना सड़न रोग का प्रबंधन

आधार तना सड़न रोग के प्रबंधन के लिए आरोपित विभिन्न उपचारों के बीच विभिन्न अंतराल में वही जैव एजेंट का मूल वेधन की तुलना में जैव एजेंट जैसे *त्रैकोडेरमा विरिडे* और *स्यूडोमोनस फ्लूरोसेंस* का आधार प्रयोग प्रभावी पाया गया। 5 कि. ग्रा नीम केक के साथ 50 ग्रा की दर में त्रैकोडेरमा विरिडे टाल्क संविन्यास का आधार प्रयोग प्रभावी पाया गया। इस विशेष उपचार के कोई भी ताड़ रोग लक्षण नहीं दिखाया। केवल नीम केक का प्रयोग भी प्रभावी पाया गया। जनवरी 2012 में टी 7 को छोड़कर सभी उपचार में कोई रोग लक्षण नहीं दिखाया। तिमाही, छमाही और वार्षिक अंतराल में त्रैकोडेरमा विरिडे का संवर्द्धन पावित के मूल वेधन के साथ 5 कि. ग्रा नीम केक के साथ 50 ग्रा की दर में त्रैकोडेरमा टाल्क संविन्यास संयुक्त का आधार प्रयोग प्रभावी पाया गया । नियंत्रणाधीन पौधो में उपचार के समय रोग लक्षण विकास तो नहीं है फिर भी जनवरी 2012 के अंत में चार पौधों में तीन रोग लक्षण दिखाया। इसी प्रकार मूल वेधन की तुलना में स्यूडोमोनस फ्लूरोसेंस सम्मिलित उपचार के बीच नीम केक के साथ जैव एजेंट का आधार प्रयोग प्रभावी पाया गया। उपचार आरोपण के बाद प्रक्षेत्र का उपज निष्पादन अच्छा पाया गया। उपचार आरोपण के पहले गुठली उपज 700 रिकार्ड किया गया था जबकि उपचार आरोपण के बाद गुठली उपज 1000 था। परीक्षण प्रगति पर है। अभी तक ऑकड़े से यह स्पष्ट है कि 5 कि. ग्रा नीम केक के साथ 50 ग्रा की दर में त्रैकोडेरमा टाल्क संविन्यास का संयुक्त का आधार प्रयोग आधार तना सड़न रोग के प्रबंधन के लिए नीरोगकारी विधियों के साथ प्रभावी रोगरोधी पैकेज पाया गया।

तेल ताड़

फसल सुधार

गंगावती केंद्र में 2011 की अवधि में सूखा सक्षमता के लिए तेल ताड़ जीनप्ररूप के मूल्यांकन के अधीन तेल ताड जीन

प्ररूप के लिए RWC में विशेष भिन्नताएँ पायी गयी। टी एस 5 (84.51) की तुलना में जीनप्ररूप zs-9 में जीन प्ररूप विशेष रूप से उच्च और उसके बाद zs-3 में पाया गया । विभिन्न जीनप्ररूप के बीच 2010-11 की अवधि में ताजा फल गुच्छ उपज में विशेष भिन्नता पायी गयी । zs-6, zs-8, zs-9,TS-5, TS-7 की अपेक्षा zs-3 उच्च औसत ताजा फल गुच्छ उपज 7.0 टन/हेक्टर अंकित किया गया जीनप्ररूप zs-1 और zs-5 से क्रमश ताजा फल गुच्छ 5.1 और 4.9 टन/हेक्टर प्राप्त किया गया जो zs-3 के समान पाया गया।

मुल्डे में अधिकतम उपज (9.2 टन/हेक्टर) ताजा फल गुच्छ जीनप्ररूप TS-5 से प्राप्त किया गया जो TS-6 के समान था। सिंचित परिस्थिति के अधीन TS-7 से अधिकतम उपज 11.3 टन/हेक्टर और असिंचित परिस्थिति में zs-6, से अधिकतम उपज 9.4 टन/हेक्टर प्राप्त किया गया ।

गंगावती में तेल ताड के नए संकर संयुक्त के मूल्यांकन में 2010-11 की अवधि में ताजा फल गुच्छ उपज विभिन्न संकरों के बीच विशेष भिन्नता पायी गयी। एन आर सी ओ पी 3,5,6,7 एवं 9 की अपेक्षा संकर एन आर सी ओ पी 4 से उच्च औसत ताजा फल गुच्छ उपज 4.86 टन/हेक्टर प्राप्त किया गया।

उर्वरण

मुल्डे केंद्र में 2010-11 की अवधि में उपज आंकडे से यह देखा गया कि उपज गुणों के लिए विभिन्न उपचारों के बीच कोई महत्वपूर्ण भिन्नता नहीं है। लेकिन उपचार टी 5 (उर्वरण के माध्यम से 1200:600:1800 ग्रा नाईट्रोजन फोसफोरस पोटाश) से अधिकतम गुच्छ भार 26.6 कि. ग्रा और उच्चतम उपज 22.7 टन/हेक्टर अंकित किया गया।

पॉमैरा

आनुवंशिक संसाधन

आंध्रप्रदेश के प्रकाशम और गुन्टूर में पॉमैरा के संग्रहण खोज के लिए एक संयुक्त सर्वेक्षण आयोजित किया गया। 683 कि मी दूर यात्रा के बाद 15 प्रजातियों का संग्रहण किया गया और अब किल्लिकुलम केंद्र का जननद्रव्य संग्रहण 238 हो गया है।

पॉमैरा का निष्पत्रण पर अध्ययन

गुच्छों की संख्या मादा पेडों पर उत्पादित कुल गुच्छों की संख्या और फलों की संख्या का निरीक्षण किया गया परिणाम से यह देखा गया कि 30 प्रतिशत के स्तर तक निष्पत्रित पेड स्थिर रूप से अधिकतम फूल संख्या (11) और प्रति पेड़ अधिक संख्या (100) के फल और उसके बाद 50 प्रतिशत निष्पत्रण होता है। पेड़ों की सूखा सक्षमता रचना निष्पत्रण से प्रभावित नहीं होता है इसलिए निष्पत्रित पेड़ सूखा के समय प्रभावित नहीं होते है ।

कटाई उपरांत प्रौद्योगिकी

एक ही पेड़ के विभिन्न शूकीछद पर विभिन्न प्रकार के काट जैसे नियंत्रण, वी चैनल और केंद्र द्वार बनाकर फूल रस (नीरा) बहाव बढ़ाने के लिए परीक्षण आयोजित किया गया। परिणाम से यह देखा गया कि अन्य की तुलना में वी आकर की काट से अधिक उपज और उपचारों के बीच महत्वपूर्ण भिन्नताएँ थी।

फूल रस के निधाय अवधि बढाने के लिए विभिन्न परिरक्षण अर्थात सोडियम बानसोएट, के एम एस और सिट्रिक अम्ल पहले गरम कर 15 मिनिट 90 डिग्री सेंटिग्रेड में और 24 घंटे के अंतराल में गुण के लिए नमूनों का विश्लेषण किया गया। परिणाम से यह देखा गया कि नीरा केवल एक ही दिन परिरक्षित किया जा सकता है। उसके बाद स्वाद नष्ट होता है और किण्वन शुरु होता है। यह निरीक्षित किया गया कि टेपिंग विधि के कारण अपोढ गुण ऑकडा देखा गया जैसे संग्रहण साधनों की सफाई, मिलाए गए नींबू का गुण मौसम स्थिति।

अखिल भारतीय समिन्वत ताड़ अनुसंधान परियोजना की बीसवीं द्विवार्षिक समूह बैठक

अखिल भारतीय समिन्वत ताड़ अनुसंधान परियोजना की बीसवीं द्विवार्षिक समूह बैठक अक्तूबर 15-17, 2011 तक केंद्रीय रोपण फसल अनुसंधान संस्थान में आयोजित की गई

मुख्य सिफारिशें

तमिलनाडु, आंध्रप्रदेश, कर्नाटक और केरल के विभिन्न क्षेत्रों के लिए उचित नारियल प्रजातियाँ (120-123 गुठली ताड़/वर्ष औसत उपज देने वाली) पहचान लिया गया ।

निम्न फसलन पद्धित उचित पाया गया और इसलिए क्रमानुगत क्षेत्रों में वाणिज्यिक रूप में स्वीकार करने के लिए सिफारिश किया गया।

- भुबनेश्वर - नारियल + केला + ट्यूब गुलाब (युवा नारियल बग में)
- जगदलपुर - नारियल + कालीमिर्च क्रिसान्थमम
- काहिकुची - नारियल + कालीमिर्च + हल्दी
- वेप्पंकुलम - नारियल + कालीमिर्च + केला + सूरन + धनिया
- रत्नगिरी - नारियल + हल्दी + केला + अनन्नास + कंदमूल

रुपांकित नया कार्यक्रम

- राइनोसेरस भृंग और लाल ताड घुन जैसे नारियल कीट के नियंत्रण के लिए फेरोमोन की क्षमता पर अध्ययन
- विभिन्न केंद्रों में नारियल/तेल ताड़ रोपण में मिश्रित फसल के रूप में कोको क्लॉन्स का मूल्यांकन
- विभिन्न केंद्रों में नारियल बाग में मिश्रित फसल के रूप में पुष्पित फसलों का मूल्यांकन

III. Executive Summary

All India Co-ordinated Research Project (AICRP) on Palms was started in 1972 to evolve the location specific technologies for palms and palm based cropping system. At present, the mandate crops of the project are coconut, oil palm and palmyrah. The AICRP Centres located in twelve States representing different agro-climatic regions have been successful in developing location specific technologies to improve the productivity of mandate crops.

Progress of research work in the mandate crops under genetic resources and crop improvement, crop production, crop protection and post harvest technology during the year 2011-12 is presented in this report. During the year, the AICRP could achieve remarkable progress in evolving crop management and crop protection technologies.

Research achievements during 2011-12

COCONUT

Genetic Resources & Crop Improvement:

Emphasis was given for collection of local ecotypes with special traits.

Utilization of existing germplasm and description of varieties are being continued in different centres. Under collection, conservation and evaluation of local germplasms with special traits, seed nuts have been collected and planted and are being maintained in different centres.

At Ambajipeta and Arsikere centres, the nut yield (average of 4 years) was higher in the cross combinations of GBGD x LCOT (128 nuts/palm/year and 132 nuts/palm/year, respectively) and GBGD x PHOT (119 nuts/palm/year and 131 nuts/palm/year, respectively) compared to Godavariganga (115 nuts/palm/year) and Kalpatharu (90 nuts/palm/year) in the respective places. Hence, these combinations can be released for cultivation in Andhra Pradesh and maidan tract of Karnataka.

Nucleus seed gardens are being established for released varieties of coconut in seven centres to meet the increasing demand of the planting material.

Location specification T x T and D x D hybrids are under evaluation for their yield potential.

Crop Production

Fertigation:

At Ambajipeta, it is evident from the data that the maximum nut yield (88.5 nuts/palm) was recorded in 100% RDF through fertigation which differed significantly from other treatments, and the lowest yield was recorded in control (52.5 nuts/palm). At Aliyarnagar centre, the mean yield during 2010-2011 revealed that drip fertigation at 100 % RDF (139 nuts/palm/year) was found to be statistically superior to other treatments which recorded 19.6 % increase in yield over the control. But, drip fertigation at 50% (T_3) and 75 % (T_4) RDF were found to be on par with 100% RDF through basin application (T_6). Experimental results of Ratnagiri centre indicated that, the mean yield of two years (2009-10 to 2010-11) was significantly higher under 100% RDF through drip irrigation (116 nuts/palm/year) which was on par with 50% NPK and 75% NPK through drip irrigation. At Kahikuchi centre, application of 75% NPK through drip irrigation (T_4) recorded significantly the highest yield of nuts (78.2 nuts/palm/year) closely followed by 100 % NPK through drip and the lowest nut yield of 51.9 nuts/palm/year was recorded under control (T_1). Under Littoral sandy soil (Kasaragod), the treatment 50 % NPK applied through drip irrigation recorded higher coconut yield which was on par with 75% and 100 % NPK applied through drip irrigation and 100 % NPK applied through soil. The treatment 25 % NPK applied through drip fertigation recorded significantly lower yield compared to other treatments.

Cropping System:

The medicinal plant Sitharathai (*Alpinia galanga*) and the aromatic plant Lemon grass (*Cymbopogon flexuosus*) were found to perform better in adult (18-21 year old) coconut garden in Aliyarnagar during the cropping period from 2007-2011. The cost benefit ratio was also found to be more with Sitharathai and Lemon grass. At Mondouri, coconut +Aswagandha recorded maximum B: C ratio followed by coconut + ekangi and the least B:C ratio was recorded in coconut + kalmegh. At Ratnagiri, considering the performance of different medicinal crops as intercrop and market demand, Arrowroot, Lemongrass, Shatavari, Adulsa and Citronella were recommended as intercrops in coconut plantation for Konkan region of Maharashtra. Coconut based cropping system with cinnamon, banana, pineapple, nutmeg is being evaluated for its sustainable productivity.

Pest Management:

Evaluation of improved strains of parasitoids (Braconid) and predators in the field against *O. arenosella*

The experimental results at Ambajipeta and Ratnagiri, indicated that, the pest incidence was reduced to nil and parasitization was 100 per cent at three months after release in the T_1 – treatment [Olfactory stimulated strains of *Parasitoids*], whereas in T_2– treatment [the non-

Olfactory stimulated strains of *Parasitoids*] there was 83.5 and 78.9 per cent parasitization, respectively after three months of release of parasite.

Validation of integrated pest management technology for *Oryctes rhinoceros* in different regions

At Ambajipeta centre, Voodimudi village (P. Gannavaram Mandal) was selected for the experiment implementation. The observations revealed that leaf damage came down from 58.4 to 5 per cent, spindle damage from 25 to 3 per cent and rhinoceros incidence from 60 to 5 per cent validating the importance of IPM in the management of this pest.

Evaluation of improved strains of parasitoids (Braconid) and predators (*Cardiostethus exiguss*) in the field against *O. arenosella*

At Aliyarnagar centre, spraying of Azadirachtin TS1% (i.e. 10,000 ppm) @5ml+ Sandovit 1ml/l of water followed by release of (olfactory stimulated) improved strains of two larval parasitoids Braconids, Bethylids and pupal parasitoid Chalcid @20:10:1 at 21 days interval for six times have shown significant reduction of *Opisina arenosella* population from 785.0 to 6.8 per palm. Consequently, there was an increase in the level of parasitisation of improved strains of larval parasitoids *viz.,* Braconids, Bethylids and Chalcids from 2.75%, 1.39% and 0.52% to 26.0%, 17.5% and 4.9%, respectively.

INM and IPM for Eriophyid mite

- INM and IPM demonstrations were carried out for the management of eriophyid mite in five locations of Pollachi area. Significant reduction in the mite population and nut damage in IPM & INM treated palms was noticed when compared to the untreated check.
- Per cent green nuts with eriophyid mite damage in IPM & INM treated palms were found to get reduced from 58 in 2009 to 40 in 2010 and 37 in 2011.
- Mean Grade Index recorded at the time of harvest was significantly low in IPM and INM treated palms. Significant increase in nut yield (10-12 per cent) was also observed.

Compatibility of natural enemies with the most commonly used botanicals/pesticides

In the study on compatibility of natural enemies with the most commonly used botanicals/pesticides, it was found that, based on LD_{50} value, monocrotophos was the most toxic followed by dichlorvos, dimethoate and carbofuran for the parasitoid *Bracon brevicornis*.

Disease management:

Leaf blight disease and weather data: Leaf blight disease intensity increased with increase in temperature. Disease intensity was high during March-April and low during October –December months.

In vitro antagonistic studies of native *Trichoderma* sp. against *Thielaviopsis paradoxa*

The dual culture plate assays of *Trichoderma* species against *Thielaviopsis paradoxa* revealed that the tested *Trichoderma* isolates were effective in inhibiting the growth of the stem bleeding pathogen. The per cent inhibition of *T. paradoxa* caused by different *Trichoderma* isolates ranged from 43.33 to 78.89.

In vitro antagonistic studies of native *Trichoderma* sp. against *Phytophthora palmivora*

The dual culture plate assays of *Trichoderma* sp. against *Phytophthora palmivora* proved that the tested *Trichoderma* isolates were effective against the bud rot pathogen. The per cent inhibition of *P. palmivora* ranged from 54.44 to 100.

Spread of basal stem rot (BSR) disease

Correlation studies between weather factors and spread of basal stem rot disease for the period from January 2000 to May 2011 indicated that number of rainy days, rainfall and relative humidity (at 2 pm) were having significantly negative relationship with vertical spread of basal stem rot disease in coconut.

Management of BSR

Among the various treatments imposed for management of basal stem rot disease, basal application of bio agents such as *Trichoderma viride* and *Pseudomonas fluorescens* were effective when compared to the root feeding of the same bio agents at different time intervals. Basal application of *Trichoderma viride* talc formulation @50 g combined with 5 kg of neem cake was found effective. None of the palms given with this particular treatment showed appearance of disease symptom. Application of neem cake alone was also effective. All the treatments showed no disease incidence except T_7 in January 2012. Basal application of *Trichoderma* talc formulation @ 50 g combined with 5 kg of neem cake along with root feeding of culture filtrates of *Trichoderma viride* at quarterly, six monthly and yearly intervals were also effective. In the control palms, even though the symptom development was not there at the time of imposition of the treatment, by the end of January 2012 three out of four palms showed the appearance of the disease. Similarly, among the treatments involving *Pseudomonas fluorescens*, basal application of the bio agent in combination with neem cake was effective when compared to the root feeding treatments. Overall yield performance of the field after treatment imposition was found to be good. Nut yield per acre before the treatment imposition was recorded as 700, whereas, that after treatment imposition was 1000. From the data till now it was evident that basal application of *Trichoderma* talc formulation @ 50 g combined with 5 kg of neem cake

was an effective curative package along with prophylactic measures for the management of basal stem rot disease.

Oil palm

Crop Improvement:

Under Evaluation of oil palm genotypes for drought tolerance at Gangavathi centre, during 2011, significant difference in the Relative Water Content (RWC) was observed for oil palm genotypes. RWC was significantly higher in the genotype ZS-9 (93.79) followed by ZS-3 (93.22) compared to TS-5 (84.51). The FFB yield during 2010-11 differed significantly among the various genotypes. The genotype ZS-3 recorded significantly higher mean FFB yield of 7.0 t/ha over ZS-6, ZS-8, ZS-9, TS-5 & TS-7. The genotypes ZS-1 and ZS-5 with FFB yields of 5.1 and 4.9 t/ha, respectively were on par with ZS-3.

At Mulde, the maximum yield of FFB (9.2 t/ha) was recorded with genotype TS- 5, which was at par with ZS-6. Under irrigated conditions, TS-7 gave the maximum yield of FFB (11.3 t/ha) while under rainfed conditions, ZS- 6 has given the maximum yield (9.4 t/ha).

In the evaluation of new cross combinations in oil palm at Gangavathi, the FFB yield during 2010-11 differed significantly among the various hybrids. The hybrid NRC OP-4 recorded significantly higher mean FFB yield of 4.86 t/ha over NRC OP-3, 5, 6, 7 & 9. The hybrid NRC OP -8, NRC OP -2, NRC OP -1 and NRC OP -10 were on par with NRC OP-4.

Fertigation:

Yield data during the year 2010-11 at Mulde centre, indicated that, there was no significant difference among the various treatments for yield characters. However, treatment T_5 (1200: 600: 1800 g NPK through fertigation) recorded maximum bunch weight (26.6 kg) and the highest yield of 22.7 t/ha.

Palmyrah

Genetic resources:

A joint survey was undertaken to explore the collection of palmyrah at Prakasam and Guntur districts of Andhra Pradesh. After traveling a distance of 683 km, a total of 15 accessions were assembled and the present germplasm collection at Killikulam centre stands as 238.

Study on defoliation of palmyrah:

Observation on number of bunches and total number of fruits produced in the female trees showed that the trees which were defoliated to the level of 30 % continued to consistently record the maximum number of inflorescences (11) and number of fruits (100) per tree followed by 50% defoliation. The drought tolerance mechanism of the trees is no way affected by defoliation and, hence, the defoliated trees may not suffer during periods of drought.

Post harvest technology:

Experiments were conducted for increasing the flow of inflorescence sap (neera) by different types of cut for spathe i.e control, cross, V channel and central hole in various spathe of the same palm. Results indicated that yields from V type cut were more as compared to others and there is significant difference among the treatments.

For improving the shelf life of the inflorescence sap by using various preservatives i.e sodium benzoate, KMS and citric acid with prior heating for 15 min at 90°C, samples were analysed for quality at 24 h interval. Results showed that neera can be preserved up to one day only, after that off flavour and fermentation starts. It was also observed that erratic quality data may be due to tapping procedure i.e., cleaning of collection device, quantity of lime added and weather condition.

XX Biennial Group Meeting of All India Co-ordinated Research Project on Palms

The XX Biennial Group Meeting of All India Co-ordinated Research Project on Palms was held during October 15-17, 2011 at Central Plantation Crops Research Institute, Kasaragod.

The major recommendations of the XX AICRP Group meeting:

- Coconut varieties suitable for different regions of Tamil Nadu, Andhra Pradesh, Karnataka and Kerala, yielding on an average 120 to 123 nuts/palm/year were identified.
- The following cropping system models were found to be ideal and hence, recommended for commercial adoption in the respective regions.

  Bhubaneshwar: Coconut + banana + tube rose (in young coconut garden)

  Jagadalpur: Coconut + black pepper + carnation + chrysanthemum

  Kahikuchi: Coconut + black pepper + turmeric

  Veppankulam: Coconut + black pepper + banana + elephant foot yam + coriander

  Ratnagiri: Coconut+turmeric+banana + pineapple + tapioca

  The following new programmes were formulated.

i. Studies on efficacy of aggregate pheromone for controlling coconut pests like rhinoceros beetle and red palm weevil.

ii. Evaluation of promising cocoa clones as mixed crop in coconut/oil palm plantations in different centers.

iii. Evaluation of flowering crops as mixed crops in coconut garden in different centers.

IV. Profile of AICRP on Palms

Among the palms, coconut, oil palm and palmyrah occupy a predominant place in Indian rural economy. More than 22 million people in rural areas are engaged in the production, processing and marketing of these crops and their products. To improve the productivity in these crops and thus the income level of the farmers, the All India Co-ordinated Research Project on Palms was started in 1972. The broad objectives of the Project are:

- to identify, conserve and utilize elite gene sources for useful traits in coconut, oil palm, palmyrah and underutilized palms from different agro-climatic regions,
- to evolve crop management technologies for location-specific coconut based farming systems,
- to evolve location-specific crop management technologies for oil palm cultivation, and
- to standardize location-specific bio-control based integrated pest and disease management schedules for coconut.

At present, the Project is implemented in 21 Centres including its headquarters at Kasaragod. Out of the 21 Centres, 13 Centres are conducting research on coconut, six on oil palm and two on palmyrah.

List of Centres with address and crop(s):

Sl. No.	Name of the Centre	SAU/CAU/Institute	Crop
1.	Aliyarnagar	Coconut Research Station, Aliyarnagar - 642 101, Coimbatore District, Tamil Nadu (TNAU, Tamil Nadu)	Coconut
2.	Veppankulam	Coconut Research Station, Veppankulam -614 906, Thanjavur District, Tamil Nadu (TNAU, Tamil Nadu)	Coconut
3.	Ambajipeta	Horticultural Research Station, Ambajipeta -533 214, East Godavari District, Andhra Pradesh(Dr. YSRHU, Andhra Pradesh)	Coconut
4.	Arsikere	Horticultural Research Station, Arsikere - 573 103, Hassan District, Karnataka (UHS, Bagalkot, Karnataka)	Coconut
5.	Bhubaneshwar	Department of Horticulture, Bhubaneswar – 751 003, Odisha (OUAT, Odisha)	Coconut
6.	Jagadalpur	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagadalpur - 494 005, Chhattisgarh (IGKV,Chhattisgarh)	Coconut
7.	Kahikuchi	Horticultural Research Station, Kahikuchi, Guwahati-781 017, Kamrup District (AAU, Assam)	Coconut
8.	Mondouri	Directorate of Research, P.O. Kalyani – 741 235, Nadia District, West Bengal (BCKV, West Bengal)	Coconut
9.	Navsari	ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari – 396 450, Gujarat (NAU, Gujarat)	Coconut
10.	Ratnagiri	Regional Coconut Research Station, Bhatye - 421 612, Ratnagiri District, Maharashtra (DBSKKV, Maharashtra)	Coconut
11.	Sabour	Bihar Agricultural College, Sabour, Bhagalpur District-813 210, Bihar (BAU, Bihar)	Coconut
12.	Kasaragod	Central Plantation Crops Research Institute, Kasaragod-671 124. (CPCRI, ICAR)	Coconut

Sl. No.	Name of the Centre	SAU/CAU/Institute	Crop
13.	Pilicode	Regional Agricultural Research Station, Pilicode P.O., Kasaragod – 670 353, Kerala (KAU, Kerala)	Coconut
14	Aduthurai	Tamil Nadu Rice Research Institute, Aduthurai - 612 101, Thanjavur District, Tamil Nadu (TNAU, Tamil Nadu)	Oil palm
15.	Gangavathi	Agricultural Research Station, Gangavathi-583 227, Koppal District, Karanataka (UHS,Bagalkot)	Oil Palm
16.	Mulde	Agricultural Research Station, Mulde - 416 520, Kudal Taluk, Sindhudurg District, Mharashtra (DBSKKV, Maharashtra)	Oil palm
17.	Madhopur	Regional Research Station, P.O. Madhopur – 845 454, Majhaulia Via., West Champaran Dist., Bihar (RAU, Bihar)	Oil Palm
18.	Pasighat	College of Horticulture & Forestry, Pasighat – 791 102, Arunachal Pradesh (CAU, Imphal)	Oil Palm
19.	Vijayarai	Horticultural Research Station, Vijayarai - 534 475, West Godavari District, Andhra Pradesh (Dr. YSRHU, Andhra Pradesh)	Oil Palm
20.	Killikulam	Agricultural College & Research Institute, Killikulam 628 252, Vallanad, Tuticorin Dist., Tamil Nadu (TNAU,Tamil Nadu)	Palmyrah
21	Pandirimamidi	Horticultural Research Station, Pandirimamidi, Ramapachodavaram PO-533 288, East Godavari Dist., Andhra Pradesh (Dr. YSRHU, Andhra Pradesh)	Palmyrah

Location of AICRP Centres

Budget

The budget for the year 2011-12 was Rs. 793.98 lakhs of which the ICAR's share was Rs. 596.95 lakhs.

Head-wise budget (ICAR Share) as on 31st March 2012

Sl. No.	Particulars	Expenditure (Rs. in Lakhs)
1	Pay and Allowances	517.25
2	Travelling Allowances	9.22
3	Recurring Contingencies	70.48
4	Non Recurring Contingencies	0.00
	Total	596.95

Mode of implementation

The scheme is implemented through the respective State Agricultural Universities on 75:25 basis of which 75% is ICAR share and the remaining 25% will be the share of the State Agricultural Universities. The scheme is implemented through 21 co-ordinating centres distributed in 12 states.

Staff Strength

Category	Present strength
Scientific	35
Technical	23
Administrative	3
Supporting	21
Total	**82**

V. Experimental results in Coconut

5.1 Genetic Resources & Crop Improvement

Gen. 1: Utilization of existing germplasm and description of varieties

(Aliyarnagar, Arsikere, Bhubaneswar, Navsari, Pilicode, Sabour, Veppakulam)

Aliyarnagar

A total of 15 accessions planted during 1994 under Set III trial are being maintained. Descriptor data pertaining to palm morphology, reproductive biology and fruit component traits were recorded. In this set, CRP 505 recorded maximum palm height (1.0 m) and girth (120.4 cm). The same genotype also recorded maximum leaflet length (142.2 cm) and leaflet breadth (6.2 cm). Number of functional leaves present in various accessions ranged from 26.5 (IND 007) to 45 (IND 032). Estimated nut yield/palm ranged from 62 (IND 011) to 133 (IND 042). IND 011 produced large sized nuts followed by IND 032 and VPM 3. Water content in the nuts of accessions ranged from 83.8 ml (IND 042) to 492.5 ml (IND 011). IND 042 also recorded the maximum copra out turn of 20.1 kg/palm/annum followed by IND 001 (19.4 kg/palm/annum) and Kerakeralam (18.7 kg/palm/annum).

Arsikere

Inter-se crossing in promising cultivars of coconut:

The Gen.1 and Gen. 3 trial plots on "Utilization of existing germplasm and description of varieties (Gen.1) and Trial on promising seed material in coconut (Gen.3)" are with the University of Agricultural Sciences, Bangalore after the establishment of University of Horticultural Sciences, Bagalkot during 2009-10. Interse crossing is being done in Nufella, Nuwehung, San Ramon, MYD and MOD of Gen-1 and PHOT, ADOT and LCOT of Gen-3. The nuts have been harvested and planted in nursery for production of seedlings.

Bhubaneswar

The experimental palms were planted in December 2004 with 16 varieties which include 5 dwarfs, 10 talls and a check variety. The data on growth parameters revealed that IND 041 and IND 053 recorded the maximum height and girth. IND 036 produced the maximum leaflet length (224.0 cm), while the minimum (135.0 cm) was recorded by the variety IND 058.

Navsari

Planting materials of different varieties such as COD, MYD, GBGD, CGD, Pratap, PHOT, LCOT, ADOT, BGL, BRR, BYL, FMS, Kappadam, Seychelles, Borneo, San Ramon and Gaum were received from Ratnagiri and planted in the nursery on 25th February 2011.

Pilicode

The mother palms of nine varieties *viz.*, CGD, COD, MGD, MOD, CYD, MYD, GBGD, Thembli, Ayiramkachi and male parents were identified and marked for crossing programme. The crossing schedules were prepared and pollination started. The experiment will be continued for 2012-13.

Sabour

Altogether 15 coconut accessions are to be tested under the project. Seed nuts of five accessions *viz.*, MYD, COD, MOD, KGD and GBGD have been planted in the main plot.

Veppankulam

Among the twelve genotypes planted during 1994, IND 057 recorded the highest palm height (9.5 m) followed by Aliyarnagar tall (9.3 m). The highest plant girth was recorded in IND 050 (0.98 m) followed by Kalpadhenu (0.93 m). IND 034 and Kalpadhenu recorded the highest no. of functional leaves (34.0). Length of the leaf was the highest in Kalparaksha (4.3 m). VPM 3 recorded the highest length of the petiole (1.4 m). Breadth of the leaflet was the highest in CRP 509 (MPM) with 6.4 cm. Length of leaflet was the highest in Aliyarnagar tall (129.0 cm) (Table 1).

Annual and cumulative nut yield

The annual nut yield during the year 2009-10 was the highest in CRP 509 (MPM) (144.8/palm) followed by IND 018 (142.3/palm). The annual nut yield during the year 2010-11 was the highest in VPM 3 (125.1 nuts/palm) followed by Aliyarnagar tall (105.6 nuts/palm). VPM 3 recorded the highest cumulative mean nut yield (113.3 nuts/palm) followed by CRP 509 (VPM) (104.7 nuts/palm) (Table 2).

The highest whole nut weight (1.3 kg), dehusked nut weight (850.5g), and wt. of kernel (400 g) was recorded in IND 034. Thickness of the kernel was the highest in CRP 509 (MPM)and Kalpatharu (1.4 cm). The highest copra weight was registered with IND 034 (203 g), while nut length was the highest with Kera chandra with 27.7cm.

Table 1. Morphological characteristics of germplasm accessions (Veppankulam)

Sl. No	Variety	Plant ht.(m)	Girth (m)	No.of leaves	Length of petiole (m)	Length of leaf (m)	Length of leaflet (cm)	Breadth of leaflet (cm)
1.	Kalparaksha	7.7	0.92	30.5	1.1	**4.3**	121.5	4.5
2.	AliyarnagarTall	9.2	0.80	30.5	1.2	4.3	**129.0**	5.0
3.	Kalpatharu	7.7	0.80	29.0	1.2	3.3	94.0	4.5
4.	IND 057	**9.5**	0.87	28.5	1.3	3.9	126.5	5.8
5.	IND 050	6.7	**0.98**	30.5	1.1	3.9	105.0	5.2
6.	IND 034	7.3	0.73	**34.0**	1.1	3.7	110.0	5.9
7.	VPM 3	7.4	0.84	31.5	**1.4**	4.2	128.0	5.2
8.	Chandra Kalpa	8.2	0.89	25.5	1.2	3.6	140.0	5.9
9.	IND 040	8.3	0.79	28.0	1.2	3.8	102.5	5.8
10.	Kalpa Dhenu	9.2	0.93	**34.0**	1.2	3.5	98.0	6.0
11.	CRP 509(MPM)	8.2	0.91	33.0	1.3	4.0	113.5	**6.4**
12.	CRP 509(VPM)	9.2	0.6	33.5	1.2	3.8	106.5	6.2
	SEd±	0.19	0.68	0.19	0.006	1.13	0.05	0.05
	CD (P=0.05)	0.40	0.142	0.40	0.013	2.34	0.11	0.11

Table 2. Annual nut yield & mean nut yield for germplasm set III (Veppankulam)

Sl. No.	Variety	Annual nut yield /palm		Cumulative mean nut yield/palm (9 years)
		2009-10	2010-11	
1.	Kalpa Raksha	89.2	86.4	75.5
2.	Aliyarnagar Tall	102.6	105.6	95.8
3.	Kalpatharu	87.9	80.0	89.9
4.	IND 057	76.4	88.2	93.1
5.	IND 050	66.8	90.8	75.2
6.	IND 034	85.4	84.3	79.4
7.	VPM 3	142.3	125.1	113.3
8.	Chandra Kalpa	79.0	79.3	72.2
9.	IND 040	118.7	71.7	83.4
10.	Kalpa Dhenu	130.7	86.7	94.9
11.	CRP 509 (MPM)	**144.8**	103.5	95.6
12.	CRP 509 (VPM)	104.9	101.1	104.7
	SEd±	2.27	1.26	-
	CD (P=0.05)	4.72	2.61	-

Gen. 1 A: Collection, conservation and evaluation of local germplasm

(Aliyarnagar, Ambajipeta, Arsikere, Bhubneswar, Jagadlpur, Kahikuchi, Mondouri, Pilicode, Ratnagiri, Veppankulam)

Aliyarnagar

A total of 11 ecotypes (CRP 735 to CRP 746) were collected from various districts of Tamil Nadu and under-planted in the completed Gen. 2 trial, both under replicated and observational trial. Flowering has commenced in genotypes raised under the observational trial. However, poor growth of young plants in replicated trial was observed due to the under- planting effect. To promote good growth of plants, older palms have been felled and cleared. In order to gap fill the dead palms due to the damage caused by felling, seed nuts from the identified mother palms have been collected and sown in the nursery.

Ambajipeta

The seedlings of accessions *viz.*, CRP 745 (Pillalakodi green), CRP 746 (Pillalakodi brown), CRP 747

(Jonnalarasi green), CRP 748 (Jonnalarasi brown), CRP 749 (Gangabondam), CRP 750 [AMB ECT-1], CRP 751 [AMB ECT-2] were planted in the main block. The data revealed that maximum plant height (4.6 m) and number of leaves per plant (13.1) was recorded by CRP 750 (AMB ECT -1) at 5 years after planting.

Arsikere

Identification of palms in nine locations of coconut growing areas of *maidan* tract of Karnataka was made during 2010-11 and 2011-12 as per the criteria given for collection, conservation and evaluation of local germplasm. During 2011-12, SAL-1, VNC-1, VNC-2, KVK-1, KMC-1, ALMP-1 and ALMP-2 germplasm types have been identified from Chamarajanagar district.

Bhubaneswar

The experimental palms were planted during December 2003 with 11 local types *viz*, CRP 790, CRP 791, CRP 792, CRP 793, CRP 794, CRP 795, CRP 796, CRP 797, CRP 798, CRP 799 and CRP 800. Local germplasm CRP 790 showed vigorous growth and recorded maximum height (7.9 m), girth (154.7 cm) and leaves produced per year (14.7). The highest leaf length was observed in CRP 797 (4.7 m). The maximum leaflet length was recorded in the variety CRP 796 (2.2 m) and the maximum leaflet breadth was recorded in the variety CRP 791 (5.3 cm).

Jagadalpur

The objective of the experiment is to identify and characterize the *in-situ* cold tolerant coconut palms that will perform better besides exposing to low temperature of less than 10° C for 2-3 months. In this regard, 10 palms were selected during 2006-08 from different parts of Bastar Zone. Observations in selected palms were continued during 2010-11. Seedlings of six ecotypes from selected germplasm were planted under Gen-2 plot during July 2011.

Mondouri

Ten local types of germplasm from different districts of West Bengal were collected. The five types of germplasm (set-I) have been planted in the main field during 2007 in RBD maintaining 7.5x7.5 m spacing. Another five types (set –II) have been planted in the main field during 2009. As the experiment is in the initial stage, observations on vegetative characters were recorded. The data showed that the highest plant height (2.2 m), number of leaves (8.2) and girth (25.5 cm) were recorded in the collection CRP 779 as compared to other germplasms collected under set- I. CRP 784 recorded maximum height as compared to other germplasms collected under set- II.

Pilicode

The mother palms and pollen palms of Anandhaganga, Lakshaganga, Keraganga and Kerasree were identified and marked. The crossing schedules were prepared and pollination has been initiated.

Kahikuchi

Set-I

The data on growth characters such as plant height, number of functional leaves and stem girth were recorded. The data showed that significantly the highest plant height (5.8 m) and number of functional leaves (17.6) were recorded for the collection CRP 703, while the maximum stem girth of 159.2 cm was recorded for the variety Kamrupa. On the other hand, the lowest plant height of 4.2 m and stem girth (115.3 cm) were recorded for the collection CRP710 while, minimum number of functional leaves (12.0) was recorded in CRP 706. The first flowering of palms was observed in collections CRP701, CRP702, CRP703, CRP705, CRP706, CRP707, CRP 710 and Kamrupa at the age of 67 to 73 months after planting.

Set-II

Altogether, five new local germplasm of coconut *viz*., CRP 711 to CRP 715 were collected from Nowgaon, Marigaon, Mangaldoi and Kamrup districts and seed nuts of these collections were sown in the nursery during February, 2008. One year old seedlings of these collections were planted in the main field in the last week of April 2009 following single row planting with six palms per collection. The experiment is in the initial stage and observations on plant height, number of leaves and stem girth at the base were recorded. The highest plant height of 3.3 m, number of leaves (9.5) and stem girth (75.2 cm) were observed in CRP 713 while the lowest values of these characters were recorded for the collection CRP 712.

Ratnagiri

Set-I

In respect of girth, height, number of leaves, and total no. of leaves, there was no significant difference among the accessions. However, CRP-762 (DBSKKV/CO-64) recorded maximum girth (97.1cm) and height (504.4cm).The maximum no. of leaves (6.13) and progressive total no. of leaves (31.50) was observed in CRP-757 (DBSKKV/CO-59). The flowering was started in the palms of CRP-758 (DBSKKV/CO-60).

Set-II

The growth observation on girth, height and number of leaves was recorded. Murud (DBSKKV- CO-68) recorded maximum girth (31.5cm) and height (180 cm). Palshet (DBSKKV- CO-66) recorded maximum no. of leaves (3.50) and progressive total no.of leaves (13.50).

Set-III

Survey of sweet coconut in Konkan region for production of seedlings by embryo culture technique

The growth observations on girth, height and number of leaves were recorded during December 2011. CRP-775 (DBSKKV- CO-83) recorded the maximum girth of 68.0 cm. CRP-771 (DBSKKV- CO-79) recorded the maximum height of 3.8m and CRP-774 (DBSKKV- CO-82) and CRP-775 (DBSKKV- CO-83) recorded the maximum no. of leaves (6.0). In respect of progressive total no. of leaves, CRP 775 (DBSKKV- CO-83) recorded the maximum (25.3) (Table 3).

Gen. 2 : Production and evaluation of new cross combinations

(Ambajipeta, Arsikere)

Ambajipeta

This trial consisting of five hybrids and one local cultivar was laid out during 1985 in RBD with four replications. Out of six cross combinations studied, Gauthami ganga x Double Century and Gautami ganga x Chandra kalpa proved the best with mean nut yield / palm / year of 118.4 and 128.7, copra content of 3.82 t/ha and 3.75 t/ha and oil yield of 2.64 t/ha and 2.73 t/ha, respectively (Table 4).

Table 3. Growth characteristics of local eco types of coconut (Ratnagiri)

Sr.No.	Type	Height (cm)	Girth(cm)	No. of leaves
1	CRP-763 (DBSKKV- CO-71)	310.0	43.7	5.3
2	CRP-764 (DBSKKV- CO-72)	306.7	58.7	5.0
3	CRP-765 (DBSKKV- CO-73)	261.7	48.7	5.0
4	CRP-766 (DBSKKV- CO-74)	266.7	46.3	5.0
5	CRP-767 (DBSKKV- CO-75)	263.3	43.7	5.0
6	CRP-768 (DBSKKV- CO-76)	240.0	38.0	5.5
7	CRP-769 (DBSKKV- CO-77)	250.0	40.0	4.8
8	CRP-770 (DBSKKV- CO-78)	330.0	56.7	4.7
9	CRP-771 (DBSKKV- CO-79)	376.7	55.7	5.3
10	CRP-772 (DBSKKV- CO-80)	267.3	51.0	5.7
11	CRP-773 (DBSKKV- CO-81)	261.7	45.0	5.7
12	CRP-774 (DBSKKV- CO-82)	258. 3	42.7	6.0
13	CRP-775 (DBSKKV- CO-83)	325.0	68.0	6.0
14	CRP-776 (DBSKKV- CO-84)	248.3	45.3	5.3
	Population Mean (42)	285.05	49.74	5.29
	Population Range	175-410	28-76	4-7
15	Embryo cultured plantlets(DBSKKV- CO-85 - DBSKKV- CO-90)	128.33 (80-205)	21.67 (13-36)	4.83 (4-6)

Veppankulam

Among the genotypes, number of leaves/palm was the highest in Aliyarnagar tall with 32.0 leaves followed by Kera Keralam (31.0) and CRP 718 (30.3). CRP 717 recorded the highest petiole length (1.75 m), leaf length (6.22m) and mean number of leaflets on both right (111.0) and left sides (111.3) of the leaf. Length of leaflet was the highest in CRP 718 (146.7 cm) and leaflet width was the highest in CRP 720 (6.4 cm).

Among the five entries, CRP 718 recorded the highest number of bunches per palm (13.5) followed by CRP 720 (13.0). Number of female flowers was the highest in CRP 716 (24.3) followed by CRP 720 (21.8). CRP 716 and CRP 718 recorded the highest number of nuts 8 weeks after pollination (6.0). Setting percentage was the highest in CRP 717 (35.8) followed by CRP 718 (35.7).

Based on the above data, the cross combination Gauthami Ganga x Double century and Gauthami ganga x Chandrakalpa can be recommended for release and commercial cultivation in Andhra Pradesh state.

Gauthami Ganga x Double Century

Table 4. Mean nut yield, copra yield and oil yield of different cross combinations (Ambajipeta)

Sl. No.	Cross combinations	Mean yield of nuts/ palm/year (2007-11)	Copra yield		Oil yield	
			kg/palm	t/ha	kg/palm	t/ha
1	VHC-1	111.3	14.95	2.62	10.66	1.86
2	Konkan Bhatye coconut hybrid -1	104.6	14.78	2.59	10.24	1.79
3	Gauthami Ganga x Kera bastar	108.5	16.80	2.94	13.02	2.28
4	Gauthami Ganga x Double century	118.4	21.86	3.82	15.11	2.64
5	Gauthami Ganga x Chandrakalpa	128.7	21.48	3.75	15.57	2.73
6	Godavari Ganga (check)	115.8	18.91	3.30	14.15	2.47
	SEM±	3.09	1.14	0.20	0.82	0.14
	CD (P=0.05)	9.31	3.43	0.59	2.47	0.43

Gauthami Ganga x Chandrakalpa

Arsikere

The evaluation trial was initiated to assess the performance of indigenous and exotic crosses along with local check- Kalpatharu. This trial consisting of nine hybrids and one local cultivar was laid out during 1987 in RBD with three replications. The observations on inflorescence and nut characteristics have been recorded.

The palm height was significantly higher in Keraganga (WCT x GBGD) while palm girth was higher in Chandra Kalpa x Kalpa Pratibha (LCOT x CCNT). The number of functional leaves and cumulative leaf production were significantly higher in Gouthami Ganga x Kerachandra (GBGD x PHOT) compared to other cross combinations while the leaf production rate was not differed significantly between different cross combinations.

The nut yield per palm during 2010-11 was significantly higher in Gouthami Ganga x Chandra Kalpa (GBGD x LCT) and Gouthami Ganga x Kerachandra (GBGD x PHOT) compared to other hybrids in the trial. The mean nut yield per palm over the last four years was significantly higher in Gouthami Ganga x Chandra kalpa (GBGD x LCOT) which was on par with Gouthami Ganga x Kerachandra (GBGD x PHOT) and Gouthami Ganga x Kera Bastar (GBGD x FJT) (Table 5).

The copra yield per palm during 2010-11 was significantly higher with Gouthami ganga x Kerachandra (GBGD x PHOT) followed by Gouthami Ganga x Chandra kalpa (GBGD x LCOT), Kerasree (WCT x MYD)

Table 5. Yield of different coconut hybrids (Arsikere)

Sl. No.	Hybrids/Variety	Coconut yield (nuts/palm/year)				
		2007-08	2008-09	2009-10	2010-11	Mean
1	Kalpa Pratibha x Chandrakalpa(CCNT x LCOT)	62.0	62.8	52.9	59.0	59.2
2	Chandra kalpa x Kerachandra(LCOT x PHOT)	78.1	73.8	80.8	84.0	79.2
3	Chandra kalpa x Kalpa Pratibha(LCOT x CCNT)	90.2	80.7	66.8	86.6	81.1
4	Kerasankara(WCT x COD)	85.3	90.2	98.7	87.7	90.5
5	Keraganga (WCT x GBGD)	89.2	85.7	91.9	89.0	88.9
6	Kerasree (WCT x MYD)	92.8	79.2	99.2	113.7	96.2
7	Gouthami ganga x Kera Bastar (GBGD x FJT)	121.2	118.8	111.2	111.2	115.6
8	Gouthami ganga x Kerachandra (GBGD x PHOT)	114.1	117.2	144.7	146.5	130.6
9	Gouthami ganga x Chandrakalpa (GBGD x LCOT)	123.4	112.7	147.6	145.7	132.4
10	Kalpatharu (TPT)	96.8	101.3	81.9	80.7	90.1
	S.Em ±	6.44	5.47	10.64	9.93	5.60
	CD (P=0.05)	19.15	16.26	31.60	29.51	16.65

and Gouthami ganga x Kera Bastar (GBGD x FJT). The mean copra yield per palm over the last four years was significantly higher in Gouthami ganga x Chandra kalpa (GBGD x LCOT) followed by Gouthami ganga x Kerachandra (GBD x PHOT) and Gouthami ganga x Kera Bastar (GBGD x FJT).

Set-II

The trial consisting of four hybrids and one local check-Kalpatharu was laid out during 1992 in RBD with four replications. The palm height, number of functional leaves and cumulative leaf production were significantly higher in the hybrid IND 058 x Kalpatharu (MYD x TPT) compared to other hybrids and local check- Kalpatharu (TPT). The nut yield per palm during 2009-10 to 2010-11 was significantly higher with IND 058 x Kalpatharu compared to other hybrids and Kalpatharu (Table 6).

Table 6. Yield of different hybrids of coconut (Arsikere)

Sl. No.	Hybrids/Variety	Coconut yield (nuts/palm/year)	
		2009-10	2010-11
1	Chandra sankara (COD x WCT)	54.2	78.9
2	Chandralaksha (LCOT x COD)	67.4	74.5
3	IND 058 x Kalpatharu (MYD x TPT)	87.5	106.4
4	Lakshaganga (LCOT x GBD)	66.7	89.8
5	Kalpatharu (TPT)	64.0	74.5
	S.Em ±	5.45	4.14
	CD (P=0.05)	16.79	12.75

MYD x TPT (Arsikere)

Gen 2 A: Evaluation of new coconut hybrids of location specific cross combinations

(Aliyarnagar, Ambajipeta, Arsikere, Kahikuchi, Ratnagiri, Veppankulam)

Aliyarnagar

The seedlings of the location specific cross combinations were under-planted in the completed Gen. 2 trial field. Crossing involving ALR (CN) 1 x MGD, MGD (Semi tall) x ALR (CN) 1, Kenthali Dwarf x ALR (CN) 1, COD x ALR (CN) 1 and COD x WCT is in progress to produce seedlings needed for the trial. Harvested seed nuts have been sown in the nursery. Field lay out was completed to accommodate four replications with six palms/genotype/replication.

Ambajipeta

The seedlings of cross combinations *viz*., CRP 509 x Kalpa Pratibha, Gauthami Ganga x Kalpa Pratibha, CRP 509 x Double Century, Gauthami Ganga x Double Century, Double Century x Gauthami Ganga, CRP 509 x Gauthami Ganga were in nursery and are ready for planting.

Arsikere

Cross combinations:

1. Kalpatharu x Kera Chandra (TPT x PHOT)
2. Kalpatharu x Chandrakalpa (TPT x LCOT)
3. Chandrakalpa x IND 058 (LCOT x MYD)
4. Chandrakalpa x IND 048 (LCOT x MOD)
5. Kalpatharu x IND 058 (TPT x MYD)
6. Kalpatharu x IND 048 (TPT x MOD)
7. Kalpatharu (Check) (TPT)

The seed nuts of all the crosses have been harvested and sown in nursery during February-September 2011.

Kahikuchi

The experiment is in the initial stage and observations revealed that the plant height and stem girth varied significantly among the different crosses and the highest plant height (3.8 m) and stem girth (54.3 cm) were recorded under CRP 501 x Kera Chandra and the lowest plant height (2.7 m) and stem girth (42.3 cm) were recorded in Kamrupa x Kalpa Pratibha and Kamrupa x IND 058, respectively. No significant differences were observed on number of leaves/palm; however, the maximum number of leaves (8.1) was recorded in CRP501 x Kera Chandra and the lowest value of 7.7 was noted in Kamrupa x Kalpa Pratibha.

Ratnagiri

In respect of girth, there was significant difference within the various cross combinations. The CRP-514 x IND 007 recorded maximum girth (101.9) which was significantly superior over IND 007 x Pratap (68.0) and at par with rest of the treatments. In respect of height, there was significant difference within the various cross combinations. The CRP-513 x IND 007 recorded maximum height (523.5cm) which was significantly superior over IND 007 x Pratap (380.6cm) and at par with rest of the treatments. In respect of no. of leaves and progressive total no. of leaves, there was no

significant difference within the various cross combinations.

Veppankulam

From the five cross combinations (planted during 2005 and 2006), number of leaves was the highest with Kera Keralam x IND 074 (33.7) followed by IND 048 x Kera Keralam (35.5). Kera Keralam x Kalparaksha, Kera Keralam x IND 048 and AOD x IND 007 recorded the highest petiole length of 1.4 m. Leaf length was the highest in the hybrid Kera Keralam x IND 048 (5.7 m). Kera Keralam x IND 074 recorded the highest number of leaflets on right (103.7) side of the frond, while Kera Keralam x IND 048 and Kera Keralam x IND 074 recorded the highest number of leaflets on left side (102.3) of the leaf. Length of leaflet was the highest in Kera Keralam x IND 048 (117.3 cm) and leaflet width was the highest in IND 048 x Kera Keralam with 5.6 cm.

Among the five new coconut hybrids, Kera Keralam x Kalparaksha recorded the highest whole nut weight (1.23 kg) followed by IND 048 x Kera Keralam (1.12 kg). IND 048 x Kera Keralam recorded the highest dehusked nut weight (735 g) followed by Kera Keralam x IND 048 (655g). Copra weight was the highest in Kera Keralam x IND 048 (365 g) followed by IND 048 x Kera Keralam (355 g) and nut breadth was the highest in IND 048 x Kera Keralam (18.0 cm) followed by Kera Keralam x IND 048 (17.5 cm). IND 048 x Kera Keralam and AOD x IND 007 recorded the highest nut length (22.0 cm) followed by Kera Keralam x Kalparaksha (21.5 cm). Kernel thickness was the highest in Kera Keralam x Kalparaksha (1.5 cm) followed by IND 048 x Kera Keralam (1.4 cm) and Kera Keralam x IND 048 recorded the highest kernel weight (435 g) followed by (415 g). Shell weight was the highest in Kera Keralam x Kalparaksha (195 g) followed by IND 048 x Kera Keralam and Kera Keralam x IND 074 (190 g). Among the hybrids, IND 048 x Kera Keralam recorded the annual nut yield of 44 nuts/palm/year followed by Kera Keralam x Kalparaksha (36 nuts/palm/year).

Gen. 3: Trial of promising seed material (Ambajipeta, Bhubaneswar)

Ambajipeta

The experiment was initiated during 2002 and the details of vegetative, reproductive characteristics and yield of hybrids/varieties are given in the Table 7.

Regarding total number of leaves on crown and mean number of spadices /palm/year, the varieties/hybrids showed non significant effect. The differences among the varieties/hybrids with respect to number of female flowers per palm and number of nuts per palm per year were found to be significant. Maximum number of female flowers/palm was registered in Godavari ganga (355.5) followed by VHC-II (327.9) and Chandralaksha (320.7). Regarding nut yield/palm (2010-11), the highest yield was recorded in Laksha ganga (66.4) followed by Kera Ganga (66.1) compared to the check Godavari ganga (63.1).

There were significant differences among the varieties/hybrids with respect to nut quality characters. The highest nut weight was recorded in Double Century (1498.7 g/nut) followed by Chandrasankara (1254.2 g/nut) compared to only 1045.8 g/nut in the check variety of Godavari Ganga. The highest dehusked nut weight was recorded in Double Century (715.5 g/nut) followed by Chandralaksha (710.2 g/nut) compared to 588.63 g/nut in Godavari ganga. The husk weight ranged from 399.6 g/nut- 769.9 g/nut and recorded maximum in Double Century (769.9 g/ nut). Entries *viz.*, Double Century (345.3 g/nut) and Chandrakalpa (315.4 g/nut) registered higher kernel weight compared to 288.5 g/nut in check variety of Godavari ganga.

Table 7. Vegetative growth characters and yield in coconut hybrids/varieties (Ambajipeta)

	Cross combinations	No. of leaves/ palm	No. of spadices/ palm/year	Female flowers/palm/ year	Nut yield/ palm/ year [2010-11]
1.	Chandra sankara (COD x WCT)	29.9	9.8	257.3	57.0
2.	Lakshaganga (LCOT x GBGD)	30.6	9.5	312.5	66.4
3.	Keraganga (WCT x GBGD)	29.7	9.8	298.2	66.1
4.	Chandralaksha (LCOT x COD)	31.7	9.9	320.7	58.8
5.	VHC-I(ECT x MGD)	36.5	12.2	194.9	44.5
6.	VHC-II (ECT x MYD)	31.7	10.4	327.9	47.3
7.	Chandrakalpa	30.2	10.6	223.0	41.8
8.	Double Century	30.3	10.2	263.6	47.1
9.	Godavari ganga (ECT x GBGD)	33.8	10.6	355.5	63.1
	S Em +	-	-	10.54	1.93
	CD(P=0.05)	NS	NS	31.59	5.78

NS: Non Significant

Bhubaneswar

The experiment was laid out with two promising varieties, three hybrids with IND 041 as check in August 2004. The variety Chandrakalpa produced the palms having maximum height, petiole length, petiole with leaf length, and leaflet breadth i.e. 6.11 m, 126.88 cm, 4.37 m and 5.35 cm, respectively. However, the variety Chandra sankara produced the palms having the minimum height, girth, leaves per palm, petiole length, petiole with leaf length, leaflet length and leaflet breadth i.e. 4.73 m, 68.12 cm, 10.31, 95.63 cm, 3.55 m, 1.82 m and 4.50 cm, respectively.

Gen.10: Performance of Tall x Tall hybrids of coconut in different agro climatic regions

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Kahikuchi, Navsari, Ratnagiri, Veppankulam)

Aliyarnagar

A total of five Tall x Tall hybrid combinations produced at CPCRI are being evaluated. Seednuts received from CPCRI were sown in the nursery and eight month old healthy seedlings were planted in the field in RBD with four replications/genotype. In each replication, each genotype was represented by 6 palms. Observations on plant height, girth and number of leaves were recorded. Among the T x T plant, LCOT x ADOT recorded the highest girth (19.0 cm). WCT x TPT combination recorded the maximum height of 154.8 cm, while BGR x ADOT recorded higher leaf production rate (6.1).

Ambajipeta

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of the cross combinations *viz*., WCT x TPT, LCOT x ADOT, BGR x ADOT, ADOT x ECT, ECT x LCOT and ECT x ECT were received from CPCRI, Kasaragod and nursery was raised.The experiment was planted in June 2011 and it is in the vegetative stage.

Arsikere

Cross combinations to be tested

i.	Kera Keralam x Kalpatharu	(WCT x TPT)
ii.	Chandrakalpa x IND 018	(LCOT x ADOT)
iii.	Pratap x IND 018	(BGR x ADOT)
iv.	IND 018 x CRP 509	(ADOT x ECT)
v.	CRP 509 x Chandrakalpa	(ECT x LCOT)
vi.	Kalpatharu (Check)	(TPT)

The seed nuts of all the above hybrids were received from CPCRI, Kasaragod and sown in the nursery for production of seedlings.

Bhubaneswar

Out of the five cross combinations, seed nuts of three cross combination *viz*., WCT x TPT, BGR x ADOT and ECT x LCOT have been planted in the nursery.

Kahikuchi

Cross combination to be tested

1. Kera Keralam x Kalpatharu
2. Chandrakalpa x VPM-3
3. Pratap x VPM-3
4. VPM-3 x CRP 509
5. CRP 509 x Chandrakalpa
6. Local check (Kamrupa)

The seed nuts of the above five cross combinations were received from the producing centre during June 2011 and sown in the nursery.

Navsari

Seednuts of the following crosses were received from CPCRI Kasaragod during mid May 2011 which were planted in the nursery.

1. BGR x ADOT
2. LCOT x ADOT
3. ECT x LCOT
4. WCT x TPT

Seednuts of five crosses such as WCT x TPT, LCOT x ADOT, BGR x ADOT, ECT x LCOT, ADOT x ECT were received from CPCRI Kasaragod during July 2011 and planted in the nursery.

Ratnagiri

5 hybrids +1 Local check

1) Kera KerlamxKalpatharu, 2) ChandrakalpaxIND 018, 3) Pratap x IND 018, 4) Ind 018 x CRP 509, 5) CRP 509 x Chandrakalpa, 6) Pratap (Local Check)

Seedlings of above material were planted during August 2011.

Veppankulam

Among the hybrids, Chandra kalpa x IND 018 registered the highest no. of functional leaves (10.5). The highest leaflength was noticed among the hybrid Kerakeralam x Kalapatharu (113.5 cm). Hybrid IND 018 x CRP 509 was found to register the highest length of leaflet of 98 cm. Hybrid Chandra kalpa x IND 018 recoreded the highest breadth of leaflet (4.6 cm). Number of leaflest was the highest in the hybrid IND 018 x CRP 509 (67.0).

Gen 10 A: Performance of new (experimental) cross combination of Tall x Tall hybrids in coconut in major agro-climatic regions

(Ambajipeta, Ratnagiri, Veppankulam)

Ambajipeta

The cross combinations *viz*., Kalpa Mitra x CRP 509, Double Century x CRP 509, Kera Bastar x CRP 509,

Chandrakalpa x CRP 509, CRP 509 x Kalpa mitra, Kalpa pratibha x CRP 509, CRP 509 x Kerabastar were done, nursery was raised and the experiment was planted in June 2011.

Ratnagiri

Cross combinations

CRP-514 x Kerachandra
Kerachandra x CRP-514
CRP-513 x Kerachandra
Kerachandra x CRP-513
Pratap x Kerachandra
Kerachandra x Pratap
Chandrakalpa x Pratap
Pratap (Local Check)

The experiment was initiated during August 2009 with different cross combinations. The growth observations recorded in December 2011 revealed that there were no significant differences in respect of the height and no.of leaves within different cross combinations. In case of girth, Kerachandra x Pratap has recorded maximum girth (34.1cm) which was significantly superior over Chandrakalpa x Pratap (17.7 cm) and at par with rest of the treatments. In respect of total no. of leaves, there was significant difference among the various cross combinations. Kerachandra x CRP-513 recorded maximum (20.1) which was at par with CRP-514 x Kerachandra (17.58), CRP-513 x Kerachandra (17.6), Pratap x Kerachandra(18.6), Kerachandra x Pratap (16.4) and significantly superior over rest of the treatments.

Veppankulam

Hybrids

Kerakeralam x Kerachandra
CRP 509 x IND 037
CRP 509 x CRP 511
CRP 509 x Kerachandra
IND 034 x CRP 509
Kera chandra x Kera Keralam
Kera keralam x Kalpa Pratibha
VHC3 (ECT x MOD)

Among seven new TxT cross combinations, no.of functional leaves was the highest in hybrids Kera Keralam x Kerachandra and Kera Keralam x Kalpa Pratibha (9). The highest plant girth was recorded in hybrid Kera Keralam x Kalpa Pratibha (50.0 cm) followed by Kera Keralam x Kerachandra (48.5 cm). Kera Keralam x Kerachandra recorded plant height of 165 cm followed by Kerachandra x Kera Keralam (146.5 cm). No.of leaflets was the highest in hybrid IND 034 x CRP 509 (91). VHC 3 check recorded the highest leaflet length of 84 cm whereas, leaflet breadth was the highest in hybrid Kera Keralam x Kalpa Pratibha (5.4 cm).

Gen. 11: Performance of Dwarf x Dwarf hybrids in coconut in different agro-climatic regions

(Ambajipeta, Mondouri, Ratnagiri, Veppankulam)

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of the cross combinations *viz.*, IND 007 x IND 058, IND 007 x Kalparaksha, Kalparaksha x Kalpa Sree, Gauthami Ganga x IND 048, Kalpa Sree x Kalparaksha were supplied by CPCRI, Kasaragod for raising of nursery and evaluation in the above centres. Seednuts were sown in the nursery for seedling production.

Gen.12: Performance of newly released coconut varieties and hybrids in different agro climatic regions

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagadalpur, Kahikuchi, Mondouri, Pilicode, Navsari, Ratnagiri, Sabour, Veppankulam)

Sources of seed nuts of newly released varieties:

Sl. No.	Name of variety/ hybrid	Seednut source centre
1.	Kalyani coconut – 1	Aliyarnagar
2.	Gauthami ganga	Ambajipeta
3.	Konkan Bhatye Coconut Hybrid – 1	Ratnagiri
4.	Kalpa Dhenu	Kasaragod
5.	Kera Keralam	Veppankulam
6.	Kerabastar	Ratnagiri
7.	Kalpa Pratibha	Kasargod
8.	Kalpa Mitra	Kasargod
9.	Kalparaksha	Kasargod
10.	Kahikuchi hybrid – 1	Ratnagiri

Aliyarnagar

Ten genotypes representing eight varieties and two hybrids supplied by different AICRP centres are being evaluated for their performance at CRS, Aliyarnagar. Five genotypes *viz.*, Kera Keralam, Konkan Bhatye Coconut Hybrid -1, Kahikuchi Hybrid-1, Gautami ganga and Kera Bastar received during 2011 from Veppankulam, Ratnagiri and Ambajipeta centres were sown in the nursery. Healthy seedlings have been

transplanted in the main field. Observations on seedling height, girth and number of leaves were recorded. Girth of seedlings ranged from 16 cm (Kera Bastar) to 21.35cm (Kera Keralam). Maximum height (183.1 cm) and leaf production (7.4) were observed in the Konkan Bhatye hybrid. Seedlings of Kalpa Pratibha, Kalpa Mitra, Kalparaksha and Kalpa Dhenu were received from CPCRI, Kasaragod and planted directly in the main field during March 2012.

Ambajipeta

The selfing of Gauthami ganga was initiated during 2009 and about 450 nuts were despatched to all AICRP centres.

Arsikere

The seed nuts of coconut variety–CCS-9 (Kera Keralam) from Veppankulam centre, Konkan Bhatye Coconut Hybrid-1, CCS-8 (Kera Bastar) and Kahikuchi Coconut Hybrid-1 from Ratnagiri centre, Gauthami Ganga from Ambajipeta centre and CCS-4 (Kalpa Pratibha), CCS-5 (Kalpa Mitra), CCS-6 (Kalpa Dhenu) and CCS-7 (Kalparaksha) from CPCRI, Kasaragod and Kalyani coconut- 1 from Aliyarnagar centre have been received. The nuts have been sown in the nursery for production of seedlings. The seedlings have been planted during first week of August, 2011 except for Kalyani coconut-1 and Kalparaksha as the seed nuts of these varieties were received late. The seedlings of Kalyani coconut-1 and Kalparaksha will be planted during May/ June 2012.

Bhubaneswar

Seedlings of Kera Keralam, Kera Bastar, Konkan Bhatye Coconut Hybrid-1 and Gouthami Ganga have been planted in the field during March 2012.

Jagadalpur

Ten varieties (Listed above) are to be planted in western side of the Gen. III experiment at the centre.

Kahikuchi

Out of the ten coconut varieties/hybrids, seed nuts of six *viz*., Konkan Bhatye Coconut Hybrid-1, Kera Keralam, Kera Bastar, Gauthami Ganga, Kalyani Coconut-1 and Kahikuchi Coconut Hybrid-1 were received from the producing centres. Seedlings of Konkan Bhatye Coconut Hybrid-1, Kera Keralam and Kera Bastar had already been planted in the main field during September, 2011. Rest of seedlings of the coconut varieties/hybrid i.e., Gauthami Ganga, Kalyani Coconut-1 and Kahikuchi Coconut Hybrid-1 are in the nursery stage.

Mondouri

Out of ten released varieties, planting of five varieties have been completed and rest will be planted during 2012.

Navsari

Two varieties *viz*., Kokan Bhatye coconut Hybrid-1 and Kera Keralam were received and planted in nursery. Coconut variety Kera Bastar was received from Ratnagiri and planted in the nursery. The seedlings were planted in the field. Coconut variety Gauthami Ganga was received from Ambajipeta and planted in the nursery during first week of March 2011. Coconut variety Kalyani coconut (Jamaica Tall) was received from Aliyarnagar and planted in the nursery during August 2011.

Ratnagiri

This research station has supplied 30 seednuts of Konkan Bhatye Coconut Hybrid–1, Kera Bastar and Kahikuchi Hybrid-1 to all the AICRP Centers.

Sabour

Coconut var. Konkan Bhatye, Kera Bastar and Kahi kuchi Hybrid-1 were planted in the main plot. A bamboo based thatching has been done to protect the young plants from scorching sun. Twenty seven seed nuts of Gouthami ganga from Ambajipeta Centre and Kalyani Coconut from Aliyanagar centre were received. Percentage of seed germination in poly bag was 80-90 whereas, in open field, it was 50-60 only. Seedlings of Gauthami ganga and Kalyani coconut-1 have also been planted in the main field.

Veppankulam

Seedlings of Kera Keralam, Konkan Bhatye coconut hybrid -1, Kera Bastar, Kahikuchi hybrid and Gauthami Ganga were planted during September 2010. Morpological characters of five released hybrids / variety were studied. No. of functional leaves was the highest in Konkan Bhatye coconut hybrid -1 (11). Kera Keralam recorded the highest plant height of 50.0 cm. Plant girth was the highest in Konkan Bhatye coconut hybrid -1 (43.0 cm). No.of leaflets was the highest in Kahikuchi hybrid (69). Konkan Bhatye coconut hybrid-1 recorded the highest leaflet length of 79 cm and leaflet breadth of 3.9 cm.

Further, seed nuts of Kalyani Coconut-1 received from Aliyarnagar were sown in the nursery and the other released varieties (Kalpa Pratibha, Kalpa Mitra, Kalparaksha and Kalpa Dhenu) will be planted after receiving the seed nuts from the concerned centres.

Gen.13: Screening of cocoa clones for their performance as mixed crop in coconut gardens

(Ambajipeta, Navsari, Veppakulam)

Ambajipeta

Six cocoa clones *viz.*, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4, and VTLC-1 (Control) were planted during November 2008 in RBD with four replications and the clones have established in the field. Data on vegetative characters was recorded. Though non significant, maximum plant height (213.8 cm) was recorded by VTLCH- 3 followed by VTLCH-4 (206.7 cm). Mean girth was significantly the highest in VTLCH - 1 and it is on par with VTLCH-4(17.8 cm) and VTLC-1 (17.6 cm). Height at first branching and number of branches showed non significant effect.

Navsari

Five cocoa clones were planted in old coconut garden in RBD design with four replications. However, some gaps are there which needs to be filled. Pruning was done. The plant height was the highest (2.0 m) with VTLCC-1, whereas maximum girth was noted in VTLCH-2 (61.0 mm). The maximum spread was found in VTLCC-2.

Veppankulam

Cocoa grafts of five hybrids and one cultivar were received from CPCRI, RS, Vittal, Karnataka during August 2008 and planted in the field. The establishment of plants is good. VTLCH-1 recorded the highest plant height (321.0 cm) followed by VTLCH-3 (197.5 cm). Plant girth was the highest in CTLCC-1 (28.0 cm) followed by VTLCH-1 (10.5 cm).

Gen 14: Screening of Black Pepper varieties for their performance as mixed crop in coconut gardens

(Kahikuchi, Mondouri, Sabour)

Kahikuchi

Pre-experimental yield data of the base crop i.e. coconut for the last three years were recorded which ranged from 51 to 57 nuts/palm/year. In black pepper, the highest vine length of 3.7 m was recorded in IISR Malabar Excel, whereas, the lowest of 3.1 m was observed in Sreekara. No significant variations were observed in number of branches/vine among the varieties. However, the highest number of branches (12.6) was recorded in IISR Shakti and the lowest of 11.8 was found in IISR Thevam.

Mondouri

Collection of black pepper varieties has been taken up from IISR, Kozhikode for further multiplication by quick multiplication technique. The plants have been planted in the experimental plot during monsoon. All the varieties are performing well under West Bengal condition. Sreekara recorded maximum height (342 cm) and girth (2.6 cm) and average leaf number (78) followed by Panniyur- 1 variety of black pepper. The lowest height was recorded in IISR Thevam (265 cm) with average girth of 2.3cm. All the varieties have already started to flower during this year.

Gen. 15: Large scale multiplication of newly released coconut varieties and hybrids in different agro climatic regions

(Aliyarnagar, Jagadalpur, Kahikuchi, Mondouri, Ratnagiri)

Aliyarnagar

The genotypes *viz.*, Kera Keralam and Kalpa Pratibha are to be multiplied in large scale at CRS, Aliyarnagar. Mother palms of Kera Keralam have been selected and distribution of seedlings to farmers is in progress. Twenty five seedlings of Kalpa Pratibha have been planted to establish the nucleus seed garden.

Jagadalpur

Coconut variety- Kera Bastar is to be multiplied for production of planting material among farmers of Chhattisgarh. The seed gardens established in year 2008 are monitored and observation on morphological characters and survival percentage is being continued. The details of planting materials and seed gardens established are as below:

Kera Bastar seedling planted	-	300 Nos.
No. of seed gardens established	-	05

Kahikuchi

As the female parent for the hybrid MYD x WCT is limited at the centre, a block of MYD consisting of 25 palms is being developed first. Simultaneous hybridization programme of the above cross is also being done to produce planting materials.

Mondouri

Laying out of seed garden for large scale multiplication has been taken up. Planting of seedlings of Kalyani coconut-1, Kalpa Mitra (CCS-5), and Kera Keralam (CCS-9) have been completed as per technical programme.

Ratnagiri

For large scale multiplication of newly released coconut hybrid (Konkan Bhatye coconut Hybrid – 1), mother blocks with 70 seedlings of Gangabondam Green Dwarf and 120 East Coast Tall has been planted in the field.

5.2 Crop Production

Agr. 3B: Performance of medicinal and aromatic plants as intercrops in coconut gardens

(Aliyarnagar, Ratnagiri)

Aliyarnagar

Three medicinal plants viz., Karisalanganni (*Eclipta prostrata*), Siriyanangai (*Andrographis paniculata*) and Sitharathai (*Alpinia galanga*) and two aromatic plants viz., Lemongrass (*Cymbopogon flexuosus*) and Patchouli (*Pogostemon patchouli*) were grown in the coconut garden (22 year old) from April 2008.

During the year 2010-11, the aromatic plant, Lemongrass (*Cymbopogon flexuosus*) was found to record a leaf yield of 7,510 kg/ha with a net income of Rs. 21,135/ha and B:C ratio of 2.35. The medicinal plant, Sitharathai (*Alpinia galanga*) recorded 5,830 kg/ha of rhizomes with a net income of Rs.28,038/ha and B:C ratio of 2.55 during the 2010-2011 (Table 8).

Table 8. Crop yield and economics of medicinal and aromatic plants (2010-11) (Aliyarnagar)

Treatments	Economic part	Yield(kg/ha)	Net income(Rs/ha)	C:B ratio
Medicinal plants				
Siriyanangai (*Andrographis paniculata*)	Leaves	2,030	2,735	1.22
Sitharathai (*Alipinia galanga*)	Rhizomes	5,830	28,038	2.55
Karisalankanni(*Eclipta prostrata*)	Leaves	1,820	7,790	1.46
Aromatic plants				
Patchouli (*Pogostemon patchouli*)	Leaves	1,625	11,775	1.62
Lemongrass (*Cymbopogon flexuosus*)	Leaves	7,510	21,135	2.35

The data on nut yield revealed that, it was higher in the plots intercropped with Sitharathai (130) and Patchouli (122) followed by Lemon grass (116). But from the trend, it was observed that the per cent increase over the pre-treatment yield was more in Siriyanangai (7.4) and Karisalankanni (3.7). The medicinal and aromatic plants were analyzed for their essential oil content a week before harvest. Lemon grass and Sitharathai recorded the maximum oil content of 0.68% and 0.58%, respectively when compared to other three crops.

Ratnagiri

The experiment was laid out in June 2006 with five medicinal and aromatic intercrops with coconuts as main crop in RBD with four replications.

Yield: The average yield of coconut for four years (2002-06) was found non significant within the treatment and ranged from 72 to 89 nuts/palm/year. However, the yield of coconut was increased after growing different intercrops and it was significant and ranged from 84 to 99 nuts/palm/year. The highest yield was recorded in T_1 (Coconut + Shatavari) plot (99 nuts/palm) followed by T_3 (Coconut+Arrow root) (93 nuts/palm) and they were at par. The treatment T_1 was significantly superior over other treatments. Further, the per cent increase in nut yield in post treatment period over the pre treatment yield was maximum in Coconut + Adulasa (21.4) followed by Coconut + Arrowroot (20.2), Coconut + Lemon grass (15.0) and Coconut + Citronella (12.6) and Coconut + Shatavari (12.3).

The coconut equivalent yield data presented in Table 9 show that the intercrop yield in terms of coconut equivalent yield was also higher with Lemon grass followed by Arrowroot, Adulasa, Citronella and Shatavari.

Quality of medicinal plants: The Shatavarin in Shatavari, Vasaline in Adulasa, citranol in citronella and Sugar in Arrowroot were increased when grown in coconut garden as intercrops, whereas citral in Lemongrass was slightly reduced with intercrop.

Economics: The data regarding economics of coconut based intercropping system revealed that the highest net return was recorded under Coconut + lemon grass model (Rs. 96,200), followed by coconut + Arrowroot (Rs.93,200) and Coconut + Shatavari (Rs. 83,300). The C:B ratio was maximum from model Coconut + Lemon Grass (2.13), followed by Coconut + Arrowroot (2.10) and Coconut + Shatavari (2.09).

Table 9. Coconut equivalent yield of medicinal and aromatic plants in coconut based cropping system (Ratnagiri)

Treatment	Coconut equivalent yield in coconut based cropping system (no. of nuts/ha)		
	Coconut	Intercrop	Total
T_1 - C + Shatavari	17,325	3,500	20,825
T_2 - C + Adulasa	15,225	4,725	19,980
T_3 - C + Arrowroot	16,275	6,000	22,275
T_4 - C + Lemon grass	14,875	7,750	22,625
T_5- C + Citronella	14,700	4,125	18,825
T_6 - Coconut	14,350	-	14,350

Coconut + Arrowroot intercropping (Ratnagiri) (Inset arrowroot tubers)

Agr. 5A. Studies on fertiliser application through micro-irrigation techniques in coconut

(Aliyarnagar, Arsikere, Kahikuchi, Kasaragod, Mondouri, Ratnagiri, Veppankulam)

Treatments

T_1 : Control (No fertilizer)

T_2 : 25% of Rec. NPK through drip system

T_3 : 50% of Rec. NPK through drip system

T_4 : 75% of Rec. NPK through drip system

T_5 : 100% of Rec. NPK through drip system

T_6 : 100% of Rec. NPK as soil application (as per recommended schedule)

Design : RBD with 4 replications

Aliyarnagar

The experiment is being continued in a 23 year old coconut garden with 6 treatments. The fertilizers are being applied through drip fertigation in 10 splits from Dec. to Sept. with Urea, Diammonium phosphate and Muriate of potash as sources of nitrogen, phosphorus and potassium, respectively.

The mean annual nut yield during 2010-11 revealed that, drip fertigation at 100 per cent of RDF was found to be statistically superior to other treatments (139 nuts/palm/year) which recorded 19.6 per cent increased yield over the control. But, drip fertigation at 50 (T3) and 75 per cent (T4) of RDF were found to be on par with 100 per cent RDF through basin application (T6) (Table 10).

Ambajipeta

The trial was initiated during November 2007 in a 25 year old coconut garden of East Coast Tall variety. The maximum nut yield (101.2 nuts/palm) was recorded by 100% RDF through fertigation, and it was significantly different from other treatments, as against the lowest value observed in control (67.2 nuts/palm). The highest number of leaves on crown (37.3) was found in 75% RDF through fertigation. The maximum number of spadices per palm (13.7), and mean number of female flowers per spadix (29.5) were recorded by 100% RDF through fertigation (Table 11).

Regarding nut quality characters, the highest nut weight (1093.7g) and dehusked nut weight (472.5g) were recorded in the application of 100 % RDF through fertigation followed by 75% RDF through fertigation. Copra content and shell weight were found to be non significant among the different treatments.

Arsikere

The number of functional leaves and bunches per palm were not significantly influenced by the fertigation

Table 10. Nut yield and trend in nut yield of coconut (2007 to 2011) at various levels of drip fertigation (Aliyarnagar)

Treatments	Mean pre-treatment cumulative yield	Annual nut yield (Nos./palm/yr)			
		2007-08	2008-09	2009-10	2010-11
T1 - Control (No fertilizer)	105	104	89	95	90
T2 - 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip	110	108	104	114	101
T3 - 50 % of the RDF through drip	119	115	146	142	119
T4 - 75 % of the RDF through drip	115	118	144	153	125
T5 - 100 % of the RDF through drip	116	118	146	152	139
T6 - 100 % of the RDF through basin application	112	116	143	145	122
SEd±	—	—	18.4	13.4	5.8
CD (P=0.05)	—	NS	38.3	28.2	12.4

NS: Non Significant

Table 11. Yield attributes of coconut as influenced by fertigation (Ambajipeta)

Treatment	Total no. of leaves on crown	Mean no. of spadices/ palm	Mean no. of female flowers / spadix	Nut yield	
				Pre-treatment (2005-07)	During (2010-11)
T1 - Control (No fertilizer)	30.3	9.5	18.0	58.2	67.2
T2 - 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip	30.5	12.0	21.0	57.1	79.4
T3 - 50 % of the RDF through drip	33.7	12.8	27.0	62.2	85.6
T4 - 75 % of the RDF through drip	36.8	13.5	28.5	60.7	90.2
T5 - 100 % of the RDF through drip	37.3	13.7	29.5	61.1	101.2
T6 - 100 % of the RDF through basin application	32.9	10.8	22.0	59.8	83.0
S Em ±	0.27	0.72	1.12	1.25	4.46
CD (P=0.05)	0.83	2.30	3.59	3.75	13.56

treatments during all the four years of experimentation. The number of buttons per palm and nut setting percentage were significantly influenced from third year of fertigation. The mean data over four years showed that application of 100 % NPK through drip fertigation recorded significantly higher number of buttons per palm and nut setting percentage compared to control and application of 25 % NPK through drip fertigation. The soil nutrient status after four years of fertigation was significantly higher with the application of 100 % NPK through drip fertigation and soil application of 100 % NPK as per recommended schedule compared to other treatments. Similarly, the leaf nutrient status was also significantly higher with the application of 100 % NPK through drip fertigation followed by 75 % NPK through drip fertigation and soil application of 100 % NPK as per recommended schedule.

The mean nut yield per palm over four years from 2007-08 to 2010-11 was significantly higher with the application of 100 % NPK through drip irrigation compared to control and application of 25 % and 50 % NPK through drip fertigation (Table 12). Application of 75 % NPK through drip fertigation recorded nut yield per palm on par with the application of 100 % NPK through drip fertigation and 100 % NPK through soil application. The copra content recorded during 3rd and 4th year of experimentation was not significantly influenced by the fertigation treatments. The copra yield per palm during 3rd and 4th year of fertigation and also the mean copra yield per palm were significantly higher with the application of 100 % NPK through drip irrigation compared to control and application of 25 % NPK through drip irrigation.

Table 12. Yield of coconut as influenced by fertigation treatments (Arsikere)

Treatments	Pre-experimental yield (nuts/palm/year)	Experimental period (nuts/palm/year)				
	2005-07	2007-08	2008-09	2009-10	2010-11	Mean
T1 - Control (No fertilizer)	58.7	57.3	59.9	65.1	84.0	66.6
T2 - 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip	58.2	58.9	62.2	74.7	94.1	72.5
T3 - 50 % of the RDF through drip	58.2	64.8	66.4	80.1	111.5	80.7
T4 - 75 % of the RDF through drip	59.2	62.5	72.8	82.3	121.1	84.7
T5 - 100 % of the RDF through drip	60.2	70.5	82.2	87.8	129.6	92.5
T6 - 100 % of the RDF through basin application	61.3	64.2	70.6	84.4	124.0	85.8
S. Em ±	3.70	3.77	4.71	3.84	6.7	2.99
CD (P=0.05)	NS	NS	14.00	11.57	20.32	9.01

NS: Non Significant

Kahikuchi

Data on yield attributing characters and nut yield were recorded during the year. Soil and leaf samples were collected at the beginning of the experiment and after two years and analysed for NPK content. No significant difference was observed on the nut yield during pre-experimental period. The nut yield varied significantly due to the treatments during the experimentation. Application of 75 % NPK through drip fertigation (T_4) recorded significantly the highest yield of nuts (78.2 nuts/palm/year) (Table 13) closely followed by 100 % NPK through drip (77.2 nuts/palm) and the lowest nut yield of 51.9 nuts/palm/year was recorded under control (T_1). The highest number of leaves on the crown (35.4), number of spadices/palm/year (11.5), and female flowers/palm/year (218.6) were recorded in T_4 (75 % RDF of NPK through drip) followed by T_5 (100 % RDF of NPK) and the lowest values of these characters were obtained under control (T_1). However, no significant differences were observed between the treatments T_4 and T_5 on the characters studied. The soil nutrient status (NPK) as well as leaf nutrient content indicated higher nutrient status for both the cases with application of 75 % NPK through drip system compared to other fertigation treatments. The lowest soil and leaf nutrient status was recorded under control plots (No fertiliser).

Kasaragod

The experiment was started with the objective to study the effect of fertigation on coconut yield under coastal sandy soil. The treatments are 25, 50, 75 and 100 per cent NPK through drip irrigation and 100 per cent NPK through soil application. The fertilizer applied through drip irrigation was given in six equal splits avoiding the monsoon period. Irrigation was given @ 66 % of open pan evaporation and the quantity of water applied through drip was 32 l palm^{-1} day^{-1}. The conventional fertilizer application was followed as per the recommended practice. Physiological parameters like photosynthetic rate, transpiration rate and stomatal conductivity were recorded. It was observed that all the three factors were better in the treatment where 50 % of the recommended dose of fertilizer was applied through fertigation compared to other treatments (Fig. 1). Soil samples were collected and analysed for total N, available P, K, Ca, Mg and micronutrients and it was found that there was no significant difference among the treatments. The plant samples collected during different seasons (summer, monsoon and winter) were analyzed for major and micro nutrient contents and the results showed that the Cu and Zn content was low during all the seasons and Mn and Fe content were found to be more. The results of the experiment on fertigation to coconut monocrop showed that there was significant difference among different treatments. The treatment 50 per cent NPK applied through drip irrigation recorded higher coconut yield which was on par with 75 and 100 per cent NPK applied through drip irrigation and 100 per cent NPK applied through soil. The treatment 25 per cent NPK applied through drip fertigation recorded significantly lower yield compared to other treatments.

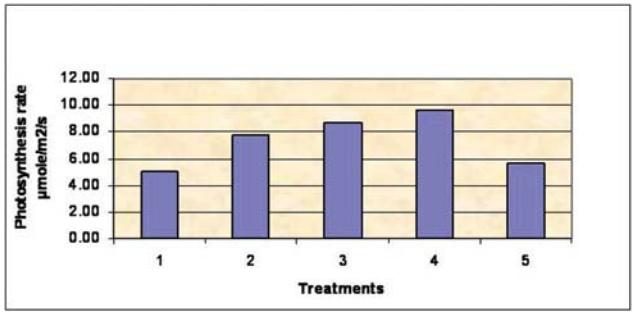


Fig.1. Effect of fertigation on photosysnthetic rate

Table 13. Growth and yield characteristics of coconut as influenced by treatments (Kahikuchi)

Treatments	No. of leaves on crown	No. of spadices/ palm	No. of female flowers/ palm/year	Nut yield/palm/year	
				Pre-experimental yield (average of 3 years)	During 2010 -11
T1 - Control (No fertilizer)	30.2	8.9	160.6	50.0	51.9
T2 - 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip	31.8	9.8	181.0	51.8	57.2
T3 - 50 % of the RDF through drip	33.2	10.7	194.6	52.0	62.0
T4 - 75 % of the RDF through drip	35.4	11.5	218.6	53.2	78.2
T5 - 100 % of the RDF through drip	35.0	11.2	211.4	54.6	77.2
T6 - 100 % of the RDF through basin application	32.0	10.8	190.3	50.6	67.2
CD (P=0.05)	1.12	0.81	10.25	NS	8.78

NS: Non Significant

Ratnagiri

The experiment was initiated in WCT coconut palm in sandy soil of Konkan region of Maharashtra during 2006. In the years 2002-06 and 2006-09 no significant variation in nut yield of coconut was recorded among the different treatments. However, increase in nut yield during transit period over pre-treatment yield was recorded during 2006-09. From the data of post-treatment yield, it was observed that the treatment T_5 recorded the highest yield of 116 nuts per palm and significantly superior over T_1 and T_2 and at par with T_3, T_4 and T_6 (Table 14).

Further, it was observed that the per cent increase in mean yield of two years (2009-10 to 2010-11) when compared with pre treatment yield was maximum in treatment T_5 i.e. 100 % RD of NPK through drip (38) followed by T_4 i.e 50 % RD of NPK through drip fertigation (18) and T_3 (16), respectively. The copra yield was the highest in T_5 (100 % RD of NPK through drip) (19.21 kg/palm) followed by T_3 (50% RD of NPK through drip) 15.06 kg/palm and significantly superior over T_1 (No fertilizer) and T_2 (25% RD through drip). The treatments T_3, T_4, T_5, and T_6 were at par.

Economics: The treatment T_5 (100% RDF through drip system) recorded the highest net return of Rs. 1,02,700 per ha, followed by T_4 (75 % RDF through drip system) Rs. 87,210 per ha and T_3 (50% RDF through drip system) Rs.81,525 per ha, whereas, it was Rs.78,405 per ha in T_6 (100 % RD of NPK as soil application). The C: B ratio was maximum from T_5 (2.72) followed by T_4 (2.49), T_3 (2.42) and T_6 (2.30).

Veppankulam

The field experiment was laid out in 27 years old ECT palms. The treatments were incorporated as per the programme scheduled from January, 2008. The fertigation was given up to March 2012. Among the drip fertigation treatments, T_5 (100 % of RD of NPK) significantly recorded the highest annual nut yield of 103 nuts next to T_6 -100 % of RD of NPK 96.26 nuts when compared to the T_1 – Control (No fertilizers) of 83.10 nuts. This yield expression may be due to the higher number of functional leaves/ palm, number of bunch / palm and increase in number of flowers/bunch when compared to the control (Table 15).

Table 14. Yield of coconut as influenced by fertigation treatments (Ratnagiri)

Treatment	Yield of coconut (nuts/palm)			Per cent increase over pre treatment yield	Copra yield (kg/palm)
	During 2002-06	During 2006-09	During 2009-2011		
Control(No fertilizer)	99	97	77	-22	9.84
25 % of RD of NPK through drip	81	89	83	2.5	11.14
50% of RD of NPK through drip	85	91	99	16	15.06
75% of RD of NPK through drip	88	96	104	18	14.53
100 % of RD of NPK through drip	84	99	116	38	19.21
100 % of RD of NPK as soil application	93	103	100	7	14.15
SEm ±	7.54	5.29	8.23	-	1.48
C.D. (P=0.05)	N.S.	N.S.	17.54	-	4.47

* R.D. – Recommended dose NS: Non Significant

Table 15. Biometric observations and mean annual nut yield (2010-11) (Veppankulam)

Treatments	No. of functional leaves/palm	No. of bunches / palm	No. of female flowers/ bunch	Mean annual nut yield
Control(No fertilizer)	27.3	6.7	13.7	83.1
25 % of RD of NPK through drip	31.6	8.2	17.2	86.7
50% of RD of NPK through drip	30.7	7.9	18.0	88.6
75% of RD of NPK through drip	31.8	8.2	19.9	90.6
100 % of RD of NPK through drip	32.1	8.7	19.8	102.9
100 % of RD of NPK as soil application	31.3	8.1	19.9	96.3
SEd ±	1.23	0.70	2.06	0.43
CD (P=0.05)	2.62	1.49	4.41	0.98

The treatment T_5 (100% of RD of NPK) recorded the higher cumulative nut yield (102.9) when compared to the control (85.3). The treatment T_5 (100% of RD of NPK) recorded the maximum percentage increase over pre experimental nut yield (17.7) but reduction in nut yield (-11.3) was observed under absolute control as well as 2.66 in T_2.

Agr. 10: Development of coconut based integrated cropping system models for different agro-climatic regions

(Aiyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour, Veppankulam)

Aliyarnagar

To conserve water, husk burial was carried out and during the year, planting of perennial/component crops such as black pepper and cocoa was done. As a component of integrated nutrient management, four sheds for vermicomposting were erected and started functioning. The green manure crop Dhaincha (*Sesbania aculeata*) was grown in coconut basins and incorporated *in situ* during the flowering stage. For irrigating the whole field, micro sprinkler system was laid out. The coconut palms represented 21 year old germplasm collection. All the observations on coconut and other component crops are being recorded.

Pruning of various clones of cocoa was done with the guidance of Assistants from Cadbury India Pvt. Ltd., and swabbing with Copper oxy chloride (COC) was carried out. Soil thermometers were installed at the centre of the coconut garden with proper protection and soil temperatures at 5 cm, 10 cm, 15 cm, 25 cm and 30 cm depth are being recorded. Elephant foot yam could not get established since the entire field was devastated by the wild boars at the early stage itself. Onion was also grown as intercrop.

The biometrical observations were recorded in the cocoa accessions. After two years of growth, the accession CCRP-9 recorded higher plant height (215.0 cm) followed by CCRP-10. The stem girth was higher in CCRP-9 (15.1 cm) followed by CCRP-1 (14.7 cm). The number of branches was also found more in CCRP-10 followed by CCRP-1.

The coconut garden comprises of palms with different germplasm. The number of female flowers, number of bunches and nut yield were recorded. The nut yield ranged between 83 nuts and 132 nuts/palm during 2010-11. The nut yield per palm per year was not consistent over the years and it varied from 70 in PHOT to 130 in SSG variety. The nut yield varied from 72 nuts to176 nuts/palm during pre-treatment period of 2007-08 and from 77 nuts to 144 nuts/palm during 2008-09.

Dhaincha as green manure crop (Aliyanagar)

Vermicomposting unit (Aliyanagar)

Ambajipeta

The trial was initiated during November 2008 in 20 years old Godavari Ganga plot as an observation trial. The intercrops viz., cocoa, banana, pineapple, elephant foot yam, heliconia were planted during November 2008 and the experimental plot is being maintained. The crops viz. coconut, banana, pineapple and elephant foot yam were harvested and data was recorded. The data on yield attributes *viz.*, the mean number of leaves on crown (33.0), mean number of bunches (12.4 per palm) and mean number of female flowers (buttons) per spadix (22.0) were recorded. Cocoa is in pre-bearing stage. Banana recorded a yield of 22.6 kg per plant. Elephant foot yam recorded a yield of 3.0 kg per plant (Table 16). The data on soil moisture content revealed

Table 16. Yield parameters of component crops in CBFS (Ambajipeta)

Crops	2010-11
Coconut	
No. of bunches per year	13.3
No. of buttons per bunch	22.2
Nut yield per palm	112.4
Copra content(g)	158.4
Oil content (%)	68.5
Other components	
Cocoa	Pre-bearing
Banana (kg per plant)	22.6
Pineapple (g per plant)	975.2
Elephant Foot Yam (kg)	3.0

that there was a slight increase in the percentage soil moisture as the depth of soil increases. The soil organic carbon, nitrogen, phosphorus and potassium contents have increased in June 2011 compared to initial values. This can be attributed to the fall of litter by various crops which were recycled into the soil. The population of earth worms was found to increase as compared to that of June 2010.

Coconut based integrated cropping system (Ambajipeta)

Arsikere

The experiment was initiated during October 2008 in an area of 0.40 ha to develop location specific coconut based integrated cropping system models for maidan tract of Karnataka. Black pepper, cocoa, lime and drumstick were planted. The establishment of intercrops except black pepper is satisfactory. Vermicomposting is being done using the wastes of coconut and glyricidia leaves grown along the border of the plot and application to coconut and intercrops is being done. The irrigation was provided through sprinkler system. Quantification of vermicompost and vermiwash production was done. Total vermicompost production was 2.75 t and vermiwash was 140 l (Table 17).

The number of functional leaves per palm, leaf production rate, number of inflorescences per palm and the number of female flowers per palm were increased with the intercropping of cocoa, lime and drumstick. Similarly, the nut and copra yield of coconut was improved in the cropping system model. The soil nutrient status in the basins of coconut and intercrops and also the leaf nutrient status of coconut were improved in the cropping system model.

Density of component crops in the CBCS model of 0.40 ha:

Coconut	50
Pepper	50
Drumstick	48
Lime	52
Cocoa	128

CBCS model at Arsikere

Jagadalpur

The crop combination for Jagdalpur centre for summer season was Coconut + Banana + Bottle gourd + Cowpea and Coconut + Banana + Colocasia + Elephant Foot yam + Amahaldi for rainy season. The initial soil nutrient, soil temperature, earthworm population and beneficial micro organism population

Table 17. Biomass production in 0.40 ha of CBCS model for vermicomposting (Arsikere)

Sl. No.	Particulars	Biomass and vermicompost production (2010-11)
1	Coconut spathe collected (no.)	659
2	Coconut leaves collected (no.)	658
3	Weight of spathe (sun dry) (kg)	527
4	Weight of leaves (sun dry) (kg)	1,480
5	Total waste collected (kg)	2,007
6	Cow dung added, fresh(kg)	200
7	Glyricidia leaves added (kg) (from 270 plants in the border of the plot)	1,180
8	Vermicompost produced (air dry) (kg)	2,750
9	Vermiwash collected (l)	140

were recorded. After three years of experimentation pH, EC, Organic carbon, N and K increased as compared to initial status while P content was slightly decreased. The soil moisture status in 10 cm, 20 cm and 30 cm depth of CBCS experiment plot was in increasing trend from February to May except in 30 cm depth in May and all the depths in June. The mean nut yield/palm for 2010-11 was 63 which was higher than initial yield. The biomass produced from CBCS experiment was 16.85 t/ha, and the same was utilized for vermicomposting and recycled back to system (Table 18). The N, P and K content of vermicompost was 1.76 %, 0.26 % and 0.45 %, respectively. The growth and yield parameter of coconut and component crops were recorded and the highest yield of 1125 kg/ha was from bottle gourd followed by Elephant foot yam (876.9 kg/ ha), whereas, coconut yield was 11,151 nuts/ha. The highest gross return was Rs.55,755/- from Coconut followed by Amahaldi Rs. 28,989/- and Elephant foot yam Rs. 19,292 per hectare.

Table 18. Biomass production from coconut and component crops (Jagadalpur)

Sl. No.	Crop	Biomass production (kg/ ha)
1.	Coconut	5,400
2.	Cow pea	875
3.	Bottle gourd	1,250
4.	Colocasia (White Gouraiya)	500
5.	Amahaldi	375
6.	Elephant foot yam (Gimikand)	1,400
7.	Munga	800
8.	Banana	-
9.	Weeds (4 weedings in kharif, 2 in summer)	6,250
	Grand total	16,850

Kahikuchi

Under CBCS model, flowering of pineapple and Assam lemon has been started. In case of banana, 60% harvesting was completed. There was an increase in coconut yield from 55 nuts/palm/year to 64.2 nuts/palm/year with a percentage increase of 16.27. Based on the harvestings so far done out of the main crop as well as intercrops, the gross return was found to be Rs. 97,777/ model/year.

As regard to soil nutrient status and soil microbial population, there was an increasing trend for soil nutrient (NPK) as well as soil microbial population (Bacteria, fungi and actinomycetes) after two years of experimentation over the initial status.

Navsari

Coconut based cropping systems

Crop combination: Coconut + Banana+ Turmeric + Cinnamon + Black Pepper

Integrated Nutrient Management

Vermicompost pit was made. Sunhemp green manure was grown and incorporated in the soil.

Ratnagiri

Crop combination: Coconut + Nutmeg + Cinnamon + Banana + Pineapple

Plant population in coconut based integrated farming system is as follows:

Sl. No.	Name of the crop	Variety / hybrids	No. of plants/grafts
1.	Coconut	D x T	70
2.	Nutmeg	Konkan Swad	54
3.	Cinnamon	Konkan Tej	246
4.	Banana	Konkan Safed Velchi	246
5.	Pineapple	Kew	4,320

The data regarding total number fronds on the crown and rate of frond production per year revealed that there was slight increase in total number of fronds and production of frond after planting the intercrops. The yield data revealed that the pre-treatment yield was 5,320 nuts/acre, whereas it was 7,140 nuts/ acre after planting the intercrops. Further, it was observed that the per cent increase in yield was 34 after planting the different intercrops.

Economics of coconut based integrated cropping system revealed that net return was negative in the first year after planting the intercrops. However, the net return was increased during second and third year after planting the intercrops i.e. Rs. 75,650/- and Rs. 50,490/- respectively (Table 19).

CBFS model at Ratnagiri

Table 19. Economics of Coconut based integrated cropping system (Ratnagiri)				
Sl. No.	Particulars	Year		
		2008-09	2009-10	2010-11
1	Cost of cultivation (Rs./acre)	93,800	38,350	36,150
2	Gross return (Rs/acre)	30,870	1,14,000	86,640
3	Net return (Rs/acre)	-62,930	+75,650	+50,490
4	C:B ratio	-0.33	2.97	2.40

Vermicompost Unit in integrated cropping system model (Ratnagiri)

CBFS model at Veppankulam

Veppankulam

The trial was implemented during July 2009 with the cropping system model of (Coconut + Black pepper + Banana + Elephant foot yam + Cocoa). Among the cropping system models, harvests of banana (Cavendish), and elephant foot yam (Sri Padma) were completed, whereas, cocoa (Hybrid F1) and black pepper are in fruiting stage.

Among the intercrops, banana recorded the net income of Rs.33,703/- with B: C ratio of 3.59, whereas, elephant foot yam recorded the net income of Rs.57,990/- with B: C ratio of 2.28. Coconut recorded the net income of Rs. 50,880 with B: C ratio of 2.27 (Table 20).

Agr. 11: Observational trial on the performance of *Morinda citrifolia* as mixed crop in coconut garden

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Ratnagri, Veppankulam)

Aliyarnagar

In a coconut garden with various germplasms of 21 years of age, *Morinda citrifolia* plants were planted in between two rows of coconut palms as non replicated trial (25 each of tissue culture plants and seedlings). Standard package of practices for Noni are being followed. Pruning is done so as to maintain uniform crop canopy and flowering. Plants were applied with

Table 20. Yield and economics of different crops in the model during 2010-11 (Veppankulam)					
Crops	Yield (kg/ha)	Gross return (Rs./ha)	Cost of cultivation (Rs./ha)	Net return (Rs./ha	B:C ratio
Banana	6,834	46,703	13,000	33,703	3.59
Black pepper	-	-	-	-	-
Elephant foot yam	12,324	1,03,240	45,250	57,990	2.28
Cocoa	-	-	-	-	-
Coconut (nuts/ palm)	122	91,000	40,120	50,880	2.27
Total	-	2,40,943	85,383	1,42,573	

10 kg of farmyard manure without any inorganic fertilizers. Though the crop has started bearing, debudding is being practiced to have proper vegetative growth. The seedlings were found to perform better than the tissue culture plants during 2008-2011. The plants were found to be frequently infested by red ants and sooty mould for which suitable plant protection measures were taken. The plants were also found to be infested with root knot nematode, and they were treated with Carobofuran @ 40 g/plant as a control measure.

As in the previous years, the biometric observations revealed that the performance of Noni at vegetative growth stage was found to be superior in the normally propagated seedlings than the tissue culture plants. An increasing trend in vegetative growth parameters was observed in the normal seedlings after three years of planting. The normal seedlings recorded a plant height of 216.1 cm as against 174.6 cm in tissue culture plants. The girth of plant in tissue culture plants was found to be lesser (13.1 cm) than the normal seedlings (14.5 cm). The number of branches was 23 in tissue culture plants, whereas, it was 31 in normally propagated seedlings.

The average coconut yield of various genotypes was recorded during 2010-11, and it was found to be more in coconut palms intercropped with tissue culture plants of Noni (104 nuts/palm) than in the area where normal seedlings of Noni were planted (97 nuts/palm). In comparison with the pre-treatment yield and yield in previous years, the nut yield revealed an inconsistent trend. Though there was a decrease in coconut yield during 2009-10 in both tissue culture and seedlings planted coconut trees, during 2010-11 it has increased especially in seedlings planted palms.

Quality attributes of Noni fruit

The noni fruits were harvested at an appropriate stage and analyzed for their quality parameters viz., Moisture (%), Pulp content (%) and TSS (° Brix) at Post Harvest Technology Centre, TNAU, Coimbatore and it was observed that there was no significant variation between tissue culture plants and seedling propagated plants.

Ambajipeta

The observation trial on the performance of *Morinda citrifolia* (Noni) was planted during August, 2008 with 25 plants each of seedlings and tissue culture plants in the inter spaces of coconut. The growth parameters viz, plant height, and number branches were recorded and the maximum plant height (4.5 m) and mean number of branches per plant (52.0) were recorded in seedlings when compared to tissue culture plants (3.6 m height and 36.2 branches per plant, respectively). The highest number of leaves on crown, mean number of spadices/ palm and mean number of female flowers in coconut were recorded in Noni seedlings plot (32.5, 11.2 and 19.4) when compared to Noni tissue culture plants (30.2, 10.4 and 17.2) (Table 21).

Arsikere

The experiment was laid out during August 2008 and seedlings and tissue culture materials of Noni (*Morinda citrifolia*) were planted. The data on growth and yield parameters of Noni have been recorded.

During 2010-11, the plant height of *Morinda citrifolia* at the end of 3 year of planting was higher in seedlings compared to tissue culture material (Table 22). The number of branches was similar in seedlings and tissue culture material. The number of leaves and plant spread were higher with tissue culture material compared to

Table 21. Growth and yield parameters of *Morinda citrifolia* under coconut (Ambajipeta)

Planting material	Plant height (m)	Stem girth (cm)	No. of branches per plant	Fruits per plant	Total fruit weight per plant (kg)	Coconut yield (No. per palm)	
						Before planting (2007-08)	After planting (2010-11)
Tissue culture plants	3.58	47.0	36.2	69.2	3.4	104	110
Seedlings	4.54	32.9	52.0	112.6	6.7	98	104

Table 22. Growth and yield of *Morinda citrifolia* as a mixed crop in coconut garden (Arsikere)

Sl. No.	Growth or yield parameter	Seedlings		Tissue culture plants	
		2009-10	2010-11	2009-10	2010-11
1.	Plant height (m)	1.8	2.8	1.8	2.5
2.	No. of primary branches/plant	15.2	40.5	27.0	37.9
3.	No. of secondary branches/plant	-	26.6	-	28.0
4.	No. of leaves/plant	174.1	739.6	426.1	1052.7
5.	Plant spread (m)	1.1	2.0	1.5	2.4
6.	No. of fruits/plant	26.6	41.4	62.5	64.0
7.	Weight of fruits (kg/plant)	0.2	0.9	0.4	1.8
8.	Fruit yield (kg/ha)(356 plants/ha as intercrop)	53.2	302.6	154.1	623.0
9.	Juice content (%)	-	62.5	-	60.9
10.	TSS (° Brix)	-	11.0	-	10.9

seedlings. The number and weight of fruits per plant were also higher with the tissue culture material compared to seedlings. The coconut yield was improved with the intercropping of noni in coconut garden.

Noni-Tissue culture plants (Arsikere)

Jagadalpur

The experiment was initiated during the year 2008 and the plant height, and stem girth were maximum in seedling plants but number of branches was more in tissue cultured plants. Flowering started in the month of December–January in both the types of plants and debudding was carried out at the time of flowering.

Kahikuchi

The growth as well as reproductive characters were recorded during 2011 and the normal seedling plants attained the maximum plant height (2.3 m), and number of branches/plant (16.6) as compared to the plants raised from tissue culture plants (Table 23). Seedlings also took less duration for first flowering (305 days) than the tissue cultured plants (310 days). With regard to flower diameter, flower stalk length, number of fruits/plant, individual fruit weight and fruit yield, the highest values of all these characters were obtained under seedling plants as compared to tissue culture plants.

Table 23. Growth characters of *Morinda citrifolia* (July 2010 to June 2011) (Kahikuchi)

Types of plant	Plant height (m)	No. of branches/ plant	Stem girth (cm)	Leaf area (sq. cm)
Normal seedlings	2.3	16.6	15.04	225.6
Tissue culture plants	1.9	14.7	13.80	158.2

Mondouri

Morinda citrifolia seedlings and tissue culture plants were planted during August 2008 in a coconut garden. Seedling plants of noni recorded more height (2.1 m) as compared to tissue culture plants (1.3 m).

Ratnagiri

The seedling height ranged from 113 cm to 155 cm with an average of 130 cm, whereas, it ranged from 23 cm to 83 cm with an average of 55 cm in the tissue culture plants at the time of planting. However, it ranged from 180 cm to 270 cm with an average of 206 cm in the seedlings, whereas, it ranged from 89 cm to 125 cm with an average of 137 cm in tissue culture plants after two years of planting. Further, number of branches ranged from 3 to 23 with an average of 10 in the seedlings plant. Whereas, it ranged from 2 to 11 with an average of 5 in the tissue culture plants after two years of planting. The yield data revealed that the coconut yield was increased by 26 percent after planting the noni as intercrop. The yield was maximum in seedling plants (2.7 kg/plant) when compared with tissue culture plants (0.5 kg/plant). Further, it was observed that the juice percentage of noni fruit was 51, whereas, TSS was 7.4 Brix only.

Veppankulam

Twenty five plants each of tissue culture and normal seedlings were planted in non replicated design with a spacing of 3 m x 3 m between two coconut rows. The tissue culture plants recorded higher plant height, no. of branches, no. of leaves, girth, fruit yield and fruit weight per plant compared to normal seedlings of noni (Table 24). The mean annual nut yield of coconut was recorded between tissue culture and normal Morinda plants. It was noticed that there was only numerical increase in nut yield as intercrops of Morinda in coconut garden. The protein, fat, fiber, ash, TSS and juice content of tissue culture fruits were higher when compared to normal seedlings.

Table 24. Biometric observations of Noni plants (2010-11) (Veppankulam)

Sl. No.	Particulars	Plant height (cm)	No. of branches	Girth (cm)	Average fruit yield (kg/plant)	Average fruit wt. (g)
1.	Tissue culture plants	289.4	27.5	25.0	29.8	627.2
2.	Seedlings	245.3	20.4	20.4	19.4	600.0

5.3 Disease Management

Path. 3: Etiology and epidemiology of basal stem rot disease of coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

Conservation and molecular characterization of *Ganoderma*

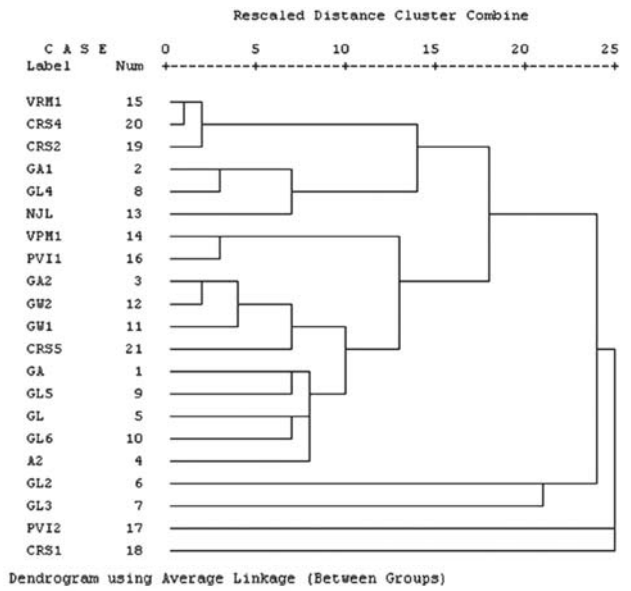
Analysis of isozyme profile of *Ganoderma* isolates by native PAGE:

Isozyme profiles of 23 isolates of *Ganoderma* of coconut and one isolate of Oil palm were carried out with four enzymes, Esterase, Catalase, Malate dehydrogenase and Peroxidase (Table 25) by native PAGE. All the four enzymes showed variation among the isolates. The *Ganoderma boninense* pathogen from oil palm showed more variation than from the *Ganoderma* isolates of coconut in all the four isozyme profiles indicating greater variation at the species level. The esterase profile of the isolates showed bands from 3 to 7, whereas, that of peroxidase profile from 1 to 3. Majority of the isolates showed 8 bands in the catalase profile except vanapalli (6 bands) and Ga (4 bands) (Fig. 2). The Vanapalli *Ganoderma* isolate also showed variation morphologically in the cultural studies. Growth of the Vanapalli isolate was slow and less profuse when compared to the other isolates. The malate dehydrogenase profile grouped majority of the isolates into two categories except four isolates (Narsapuram, Gopalapuram, Vanapalli and Ga). The isolates Ga1, Ga2, Gl2, Gl5, Gl6, GW1, GW2, NJL and A2 produced three bands, whereas, the isolates Gl, Gl3, Gl4, Kalavacharla, Antarvedi, Komaragiripatnam, Digamarru, VK Rayapuram, Mukhtheswaram and Appanapalli showed five bands indicating similarity among them (Fig. 3). The isolates Narsapuram, Gopalapuram and Vanapalli showed four bands and Ga showed two bands indicating variation.

RAPD-PCR studies with thirteen isolates of Ambajipeta (Ga, Ga1, Ga2, Gl, Gl2, Gl3, Gl4, Gl5, Gl6, Gw1, Gw2, NJL and A2) and eight isolates of Veppankulam (Vpm1, Vrm1, Pvi1, Pvi2, Crs1, Crs2, Crs4, Crs5) centre was carried out with RAPD primers Rfu1, Rfu2, Rfu3, Rfu4 and Rfu5. The dendrogram developed using average linkage between groups of the isolates Crs1 and Pvi2 of Veppankulam and Gl2 and Gl3 of Ambajipeta showed greater diversity from the other isolates of Ambajipeta and Veppankulam centres. The remaining isolates could be grouped in to two major clusters. Cluster 1 included the isolates Vrm1, Crs2, Crs4, Ga1, Gl4 and NJL. Cluster 2 included Vpm1, Pvi1, Ga2, Gw2, Gw1, Crs5, Ga, Gl, Gl5, Gl6 and A2.

Table 25. Isozyme profile of 24 *Ganoderma* isolates (No. of bands) (Ambajipeta)

Isolate	Esterase	Peroxi-dase	Cata-lase	Malate dehydro-genase
Ga	7	3	4	2
Ga1	7	3	8	3
Ga2	7	3	8	3
Gl	7	3	8	5
Gl2	7	3	8	3
Gl3	7	3	7	5
Gl4	7	3	8	5
Gl5	6	1	8	3
Gl6	5	1	8	3
Gwilt 1	6	1	8	3
G wilt 2	6	1	8	3
NJL	6	1	8	3
Oil palm	1	3	4	1
A2	6	3	8	3
Kalavacharla	6	2	8	5
Antarvedi	3	2	8	5
Komaragiripatnam	6	2	8	5
Vanapalli	3	2	6	4
Digamarru	3	3	8	5
VK Rayapuram	6	3	8	5
Mukhteswaram	6	2	8	5
Appanapalli	6	2	8	5
Narsapuram	7	2	8	4
Gopalapuram	7	2	8	4



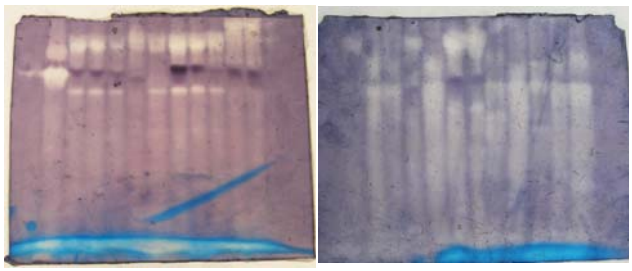


Fig.2. Isozyme profiles of Malate dehydrogenase enzyme of *Ganoderma* isolates

Fig. 3. Banding pattern of *Ganoderma* isolates with Rfu 1 and Rfu 2 primers

Epidemiology and disease forecasting

The rate of linear spread of the basal stem rot disease with respect to the weather parameters was recorded and tabulated for the period January 2011 to March 2012. Correlation studies between weather factors and spread of basal stem rot disease for the period from January 2011 to March 2012 indicated that number of rainy days and rainfall were found to have significantly negative relationship with vertical spread of basal stem rot disease in coconut.

Impact of intercrops in coconut on occurence and spread of disease

To study the impact of other palms and intercrops in coconut garden on the occurence and spread of disease, fifty palms in the field with sole coconut and another field with coconut + banana were selected in Gannavaram village of East Godavari District. Soil at the experimental site is sandy in nature near the Godavari river basin.

Linear and horizontal spread of the disease in those 50 palms was recorded during each month. In sole coconut crop, out of fifty palms, only one palm was infected with the disease up to August 2011. Three palms in October, four palms in November and five palms in March 2012 showed the symptoms. Whereas, in coconut intercropped with banana, out of fifty plants, four plants showed the symptoms till January 2011. No. of diseased palms increased to five in February 2011, six in March 2011, seven in October 2011, nine in December 2011 and ten in March 2012.

Arsikere

Collection of *Ganoderma* isolates from different coconut growing regions

Sl. No.	Location		Remarks
A	Taluk: Arsikere	Code	Isolated pure culture of *Ganoderma*
1	HRS, Arsikere	ASK1	-,,-
2	Jayapur	ASK 2	-,,-
3	Vanakamaranahalli	ASK3	-,,-
4	Hasahalli	ASK4	-,,-
5	Vrindavanahalli	ASK5	-,,-
B	Taluk: Tiptur		
1	Doddamarpnahalli	ASK6	-,,-

The cultures of six isolates of *Ganoderma lucidum viz.*, ASK1, ASK2, ASK3, ASK4, ASK5 and ASK6 were collected from different places and were mass multiplied on sterilized sorghum seeds in polyethylene bags. These isolates will be used to test the virulence.

Epidemiology and disease forecasting

Initially the status of the symptoms was recorded in the experimental plot to know the horizontal and vertical spread of the disease in due course of time. The experimental plot was selected to study the role of weather parameters like relative humidity, temperature (maximum and minimum), rainfall, sunshine hours and wind direction. This data will be used for the correlation of weather parameters with the horizontal and vertical spread of basal stem rot disease of coconut.

Veppankulam

Three isolates of *Ganoderma lucidum viz.*, MSL-1(Melasembalur), VPM- I (Veppankulam) and TTI-1(Thittakkudi) were found more virulent in terms of their pathogenic ability to cause death of coconut seedlings. *Ganoderma lucidum* isolates were collected from coconut, mango and palmyrah.

Path. 4: Management of basal stem rot disease in coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

Collection, conservation and characterization of bioagents from different locations

Isolation of *Trichoderma* spp.: Seventeen new *Trichoderma* isolates were collected from rhizosphere region of coconut palms from different villages of East Godavari and West Godavari districts *viz.*, Gudapalli, Kesavadasupalem, Antarvedi, Kesanapalli, Sakhinetipalli lanka, Vedangi, Allavaram, Godilanka, Vodalarevu, Rameswaram, Antarvedipalem, Gondi, G.Pedapudi, H. Kotturu, Kadali, Gudimellanka and Turupupalem using *Trichoderma* specific medium. The identified *Trichoderma* spp are *T.viride, T.harzianum, T.hamatum, T.longibrachiatum, T.virens* and *T.polysporum*.

The newly isolated species when tested for antagonistic activity against *Ganoderma applanatum* and *Ganoderma lucidum* in dual culture studies were found effective and are under the process of identification (Table 26 and 27). The dual culture plate assays of *Trichoderma* species against *Ganoderma applanatum*, and *Ganoderma lucidum* proved that the tested *Trichoderma* species were effective against the basal stem rot pathogens, *Ganoderma applanatum* and *Ganoderma lucidum*. Per cent inhibition of *Trichoderma* species against *Ganoderma applanatum* ranged from 72.22 to 100, and the per cent inhibition of *Trichoderma* species against *Ganoderma*

Table 26. Antagonistic activity of *Trichoderma* spp. on *Ganoderma applanatum* (Ambajipeta)

Sl. No.	Location of collection	District	Radial growth of test pathogen (mm)	Radial growth of *Trichoderma* spp. (mm)	Per cent inhibition of test pathogen over control
1	Y.Ramavaram	A	21	69	76.67
2	Sivakodu	A	19	71	78.89
3	Kaviti	C	29	61	67.78
4	Nandampudi	A	21	69	76.67
5	Peruru	A	25	65	72.22
6	Antervedi	A	0	90	100.00
7	Tallavalasa	C	17	73	81.11
8	Kesanapalli	A	0	90	100.00
9	Gopalapuram	B	0	90	100.00
10	Tallarevu	A	0	90	100.00
11	Zinnuru	C	31	59	65.56
12	Kaviti kothuru	C	30	60	66.67
13	Dagguluru	C	23	67	74.44
14	Gannavaram	A	0	90	100.00
15	Vanapalli	A	21	69	76.67
16	Allavaram	A	12	78	86.67
17	Control		90	0	0

A: East Godavari, B: West Godavari, C: Srikakulam

Table 27. Antagonistic activity of *Trichoderma* spp. on *Ganoderma lucidum*(Ambajipeta)

Sl. No.	Location of collection	District	Radial growth of test pathogen (mm)	Radial growth of *Trichoderma* spp. (mm)	Per cent inhibition of test pathogen over control
1	Y.Ramavaram	A	31	59	65.56
2	Sivakodu	A	25	65	72.22
3	Kaviti	C	39	51	56.67
4	Nandampudi	A	28	62	68.89
5	Peruru	A	37	53	58.89
6	Antervedi	A	0	90	100.00
7	Tallavalasa	C	0	90	100.00
8	Kesanapalli	A	30	60	66.67
9	Gopalapuram	B	0	90	100.00
10	Tallarevu	A	21	69	76.67
11	Zinnuru	C	12	78	86.67
12	Kaviti kothuru	C	29	61	67.78
13	Dagguluru	C	23	67	74.44
14	Gannavaram	A	0	90	100.00
15	Vanapalli	A	29	61	67.78
16	Allavaram	A	19	71	78.89
17	Control		90	0	0

A: East Godavari, B: West Godavari, C: Srikakulam

lucidum ranged from 56.67 to 100. Over all the *Trichoderma* species showed greater percent inhibition of *Ganoderma applanatum* than *Ganoderma lucidum*, the causal agents of basal stem rot disease of coconut. The *Trichoderma* species isolated from Antarvedi and Gannavaram villages of East Godavari District and Tallavalasa village of Visakhapatnam district showed 100 percent inhibition against *Ganoderma lucidum* pathogen. The *Trichoderma* species isolated from Antarvedi, Kesanapalli, Tallarevu and Gannavaram villages of East Godavari District and Gopalapuram village of West Godavari District showed 100 per cent inhibition against *Ganoderma applanatum* pathogen.

Rhizosphere management

The BSR management trial was initiated in August 2010 at Kesanapalli village of East Godavari District. The treatments are being imposed at the specified time intervals with the bioagents, *Trichoderma viride* and *Pseudomonas fluorescens*.

Basal application of bio agents such as *Trichoderma viride* and *Pseudomonas fluorescens* were effective when compared to the root feeding of the same bio agents at different time intervals. Basal application of talc formulation of *Trichoderma viride* @ 50 g combined with 5 kg of neem cake was found effective. None of the trees given with this particular treatment showed appearance of disease symptom. Application of neem cake alone was also effective. All the treatments except T_7 showed no disease incidence in January 2012. Basal application of talc formulation of *Trichoderma* @50 g combined with 5 kg of neem cake along with root feeding of culture filtrates of *Trichoderma viride* at quarterly, six month and yearly intervals were also effective. In the control plants, even though the symptom development was not there at the time of imposition of the treatment, by the end of January 2012, three out of four plants showed the appearance of the disease. Similarly, among the treatments involving *Pseudomonas fluorescens*, basal application of the bio agent in combination with neem cake was effective when compared to the root feeding treatments. Overall yield performance of the palms after treatment imposition was found to be good. Nut yield per acre before the treatment imposition was 700, whereas, it increased to 1,000 after treatment imposition. From the data till now it is evident that basal application of talc formulation of *Trichoderma* @50 g combined with 5 kg of neem cake is an effective curative package along with prophylactic measures for the management of basal stem rot disease.

The above BSR management trial was closed during the last biennial meeting of AICRP on palms. A new trial with the following treatments will be initiated in Ambajipeta, Arsikere and Veppankulam centres.

T_1 : Soil application of talc based formulation of 125g of *Trichoderma viride* + 1kg of neem cake / palm at quarterly intervals.

T_2 : Soil application of talc based formulation of 250 g of *Trichoderma viride* + 2 kg of neem cake / palm at six monthly intervals.

T_3 : Soil application of talc based formulation of 500 g of *Trichoderma viride* + 4 kg of neem cake / palm / year.

T_4 : Soil application of talc based formulation of 125 g of *Pseudomonas fluorescens* + 1 kg of neem cake / palm at quarterly intervals.

T_5 : Soil application of talc based formulation of 250 g of *Pseudomonas fluorescens* + 2 kg of neem cake / palm at six monthly intervals.

T_6 : Soil application of talc based formulation of 500 g of *Pseudomonas fluorescens* + 4 kg of neem cake / palm / year.

T_7 : Soil application of 125 g of talc based formulation of *Trichoderma viride* and *Pseudomonas fluorescens* + 1 kg of neem cake / palm at quarterly intervals.

T_8 : Soil application of 250 g of talc based formulation of *Trichoderma viride* and *Pseudomonas fluorescens* + 2 kg of neem cake / palm at six monthly intervals.

T_9 : Soil application of 500 g of talc based formulation of *Trichoderma viride* and *Pseudomonas fluorescens* + 4 kg of neem cake / palm / year.

T_{10} : Control

Rhizosphere engineering

Population dynamics of rhizosphere microflora of basal stem rot disease affected apparently healthy and healthy coconut palms were studied to find out their influence on the disease. Soil samples were collected from diseased and healthy palms of Gudapalli, Chintalamori, Gudimula, Kesanapalli, Sankaraguptam and Sakhinetipalli villages during the surveys. Serial dilution technique was adopted to study the microbial population in diseased and healthy palm rhizospheres. *Aspergillus niger, Aspergillus flavus, Rhizopus, Penicillium* spp. and bacterial colonies were the most common mycroflora present in all the samples. The colonies of *Trichoderma* were more in case of apparently healthy coconut palms when compared to the diseased palms.

Arsikere

Collection, conservation and characterization of bio-agents from different locations

Isolation and identification of microbial agents existing in rhizosphere region of coconut based cropping systems is being done to study the antagonistic properties. Soil samples were collected from the rhizosphere region of coconut based cropping system and *Trichoderma* spp. has been isolated by using *Trichoderma* specific medium (TSM). The plates were incubated in dark condition and identified as *T. harzianum* and *T. viride* based on the spore characteristics. These cultures are maintained for further use. In the disease management trial, the soil samples were collected before implementation of the treatment in the field to assess the colonization of bio-agents.

Veppankulam

Biopriming with PGPRs for disease resistance: To asses the effect of biopriming with *Pseudomonas fluorescens* and *Trichoderma viride* on BSR resistance in coconut, a new experiment was set up under glasshouse conditions. The pots were filled up with sterilized sand and mixed with *Ganoderma lucidum* inoculum. The ECT seedlings were dipped in 10 per cent suspension of *Pseudomonas fluorescens* and *Trichoderma viride* along with control and planted in the pots during July 2010.

Biopriming with the fungal biocontrol agent, *Trichoderma viride* increased the number of leaves, height of seedlings and girth of seedlings when compared to biopriming with the bacterial bioagent *Pseudomonas fluorescens*.

Studies on colonization of *Trichoderma viride* in the roots of coconut seedlings

An experiment was initiated to study the colonization of *Trichoderma viride* in the roots of coconut seedlings. One kg of talc based formulation of *Trichoderma viride* was mixed with autoclaved garden soil and was filled in cement pots of 55 cm diameter and 35 cm height (65 kg of autoclaved garden soil / pot). ECT seedlings were planted in the pots on 09.03.2012 and there are four replications for *T. viride* and one for control.

Path. 5: Assessing the incidence of root (wilt) disease in Tamil Nadu

Aliyarnagar

Survey was conducted on the occurrence of root (wilt) disease of coconut in Coimbatore, Theni, Dindigul and Kanyakumari districts in Tamil Nadu – Kerala border areas. Manakkadavu, Sethumadai and Gopalapuram (Nedumparai) villages of Anaimalai block in Coimbatore district recorded an average root (wilt) disease incidence of 3.3, 0.26 and 0.94%, respectively. Thimmankuthu village of Pollachi North block and Kettimalanpudur villages of Pollachi South block showed 0.21 and 1.41% disease incidence, respectively. Maximum incidence was noticed in Manakkadavu village followed by Gopalapuram (Nedumparai) villages in Coimbatore district.

In Theni district, K.K. Pati, Keelagudalur and Cumbum villages of Cumbum block showed 14.37%, 13.14% and 22.32%, respectively whereas, in Theni block the trees are free from the disease.

In Dindigul district, none of the trees was found with root (wilt) disease incidence among the villages surveyed. Among the blocks surveyed in Kanyakumari district, severe incidence was recorded in Thiruvattar (4.33%) block followed by Melpuram (0.66%) and Killiyur (0.58%), while, Rajakkamangalam and Agastheeswaram blocks were found free from root (wilt) incidence.

Identification of indicator plants

Several annual plants *viz*., green gram, black gram, millets (sorghum and bajra), groundnut, banana and fodder grasses grown in coconut gardens in the affected areas were periodically observed to identify a indicator plant for root (wilt) disease. None of the tested crops showed any positive response.

Path. 7 : Bio control of bud rot and stem bleeding diseases of coconut

(Ambajipeta, Arsikere)

Ambajipeta

Bud rot

Incidence of bud rot disease on coconut seedlings in nursery was high in rainy season and it ranged from 4.2% to 5.5%. Death of seedlings due to bud rot was found higher in Godavari Ganga (Hybrid coconut) when compared to the East Coast Tall. Incidence of bud rot disease in 2011 was less when compared to 2010 as there was less rainfall during that year.

Stem Bleeding

Field evaluation of antagonists against stem bleeding disease in coconut

Field experiment on evaluation of various formulations of *T.viride* against stem bleeding disease of coconut was carried out. Application of *Trichoderma viride* paste on the stem bleeding patches was continued on the diseased palms of HRS, Ambajipeta and by the time of June 2011, the diseased palms of the garden was reduced to 39 nos. Incidence of stem bleeding by June was reduced to 1.43%. But after that the number of diseased palms was again increased because of the rains as they washed out the *Trichoderma viride* paste that was applied. The incidence of stem bleeding was again increased to 4.81% by December 2011.

In vitro antagonistic studies of native *Trichoderma* species against *Thielaviopsis paradoxa*

The dual culture plate assays of *Trichoderma* species against *Thielaviopsis paradoxa* proved that the tested *Trichoderma* species were effective against the stem bleeding pathogen, *Thielaviopsis paradoxa*. Per cent inhibition of *Trichoderma* species against *Thielaviopsis paradoxa* ranged from 43.33 to 78.89 (Table 28).

In vitro antagonistic studies of native *Trichoderma* sp. against *Phytophthora palmivora*

The dual culture plate assays of *Trichoderma* sp against *Phytophthora palmivora* proved that the tested *Trichoderma* spp. were effective against the bud rot pathogen, *Phytophthora palmivora*. Per cent inhibition of *Trichoderma* sp against *Phytophthora palmivora* ranged from 54.44 to 100 (Table 29).

Arsikere

To develop bio-control based IDM approach against bud rot and stem bleeding diseases

The field experiments are planned to know the efficacy of different formulations of *Trichoderma* and *Pseudomonas fluorescence* against the bud rot and stem bleeding diseases of coconut. *Trichoderma viride* as well as *Psedomonas flurescence* were isolated from the native

Table 28. *In vitro* antagonistic activity of *Trichoderma* spp. on mycelial growth of *Thielaviopsis paradoxa* (Ambajipeta)

Sl. No.	Location of collection	District	Radial growth of test pathogen (mm)	Radial growth of *Trichoderma* spp. (mm)	Per cent inhibition of test pathogen over control
1	Y.Ramavaram	A	25	65	72.22
2	Sivakodu	A	46	44	48.89
3	Kaviti	C	43	47	52.22
4	Nandampudi	A	26	64	71.11
5	Peruru	A	51	39	43.33
6	Antervedi	A	39	51	56.67
7	Tallavalasa	C	47	43	47.78
8	Kesanapalli	A	42	48	53.33
9	Gopalapuram	B	49	41	45.56
10	Tallarevu	A	46	44	48.89
11	Zinnuru	C	19	71	78.89
12	Kaviti kothuru	C	31	59	65.56
13	Dagguluru	C	39	51	56.67
14	Gannavaram	A	40	50	55.56
15	Vanapalli	A	45	45	50.00
16	Allavaram	A	45	45	50.00
17	Control		90	0	0

A: East Godavari, B: West Godavari, C: Srikakulam

Table 29. *In vitro* antagonistic activity of *Trichoderma* spp on mycelial growth of *Phytophthora palmivora* (Ambajipeta)

Sl. No.	Location of collection	District	Radial growth of test pathogen (mm)	Radial growth of *Trichoderma* spp. (mm)	Per cent inhibition of test pathogen over control
1	Y.Ramavaram	A	39	51	56.67
2	Sivakodu	A	21	69	76.67
3	Kaviti	C	41	49	54.44
4	Nandampudi	A	25	65	72.22
5	Peruru	A	29	61	67.78
6	Antervedi	A	30	60	66.67
7	Tallavalasa	C	23	67	74.44
8	Kesanapalli	A	21	69	76.67
9	Gopalapuram	B	21	69	76.67
10	Tallarevu	A	19	71	78.89
11	Zinnuru	C	27	63	70.00
12	Kaviti kothuru	C	32	58	64.44
13	Dagguluru	C	25	65	72.22
14	Gannavaram	A	39	51	56.67
15	Vanapalli	A	0	90	100.00
16	Allavaram	A	36	54	60.00
17	Control		90	0	0

soil. In addition to indigenous isolates, Trichoderma cake developed from CPCRI will also be used for the experimentation purpose.

Path. 8: Survey and surveillance on diseases of coconut (bud rot, stem bleeding and *Ganoderma* wilt)

(Aliyarnagar, Ambajipeta, Arsikere, Veppankulam)

Aliyarnagar

A survey on the occurrence of coconut diseases *viz*., stem bleeding, basal stem rot, leaf blight and bud rot diseases was conducted in different villages of Coimbatore, Theni and Kanyakumari districts.

Leaf blight disease caused by *Lasiodiplodia theobromae* was the predominant disease in all the areas surveyed which ranged from 2.32 to 10.95 percent. The maximum incidence of 10.95 percent was recorded in Cumbum village of Theni district followed by 10.88 percent in Samathur village of Coimbatore district. Incidence of basal stem rot disease was found in Devanallur village of Coimbatore district (3.81%). There was no stem bleeding incidence in Theni district while,

Coimbatore, Tirupur and Kanyakumari districts showed 0.08, 0.16 and 1.79 per cent disease incidence.

Similarly, bud rot incidence was also at very low level in Tirupur (0.04%) district while, there was no bud rot incidence recorded in the remaining districts surveyed.

Ambajipeta

Surveys were conducted in different mandals of East Godavari, West Godavari, Srikakulam, Vijayanagaram and Visakhapatnam districts of Andhra Pradesh during 2011-12. The major diseases observed in coconut gardens were basal stem rot, bud rot and stem bleeding along with minor incidence of grey leaf spot. Mean per cent incidence of basal stem rot, bud rot and stem bleeding diseases on coconut recorded was 12.19, 4.97 and 1.10, respectively. Incidence of grey leaf spot disease was also observed to certain extent in East Godavari, Srikakulam and Vijayanagaram during last year.

Arsikere

Survey on the incidence and intensity of bud rot, stem bleeding and Ganoderma wilt

The survey was carried out in the Arsikere taluk of Hassan district (one taluk per year @ three villages/taluk) to know the important coconut disease scenario in this region. Among the villages surveyed, the basal stem rot (BSR) was recorded maximum (20%) in Vanakamaranahalli followed by Vrindavanahalli (15%) of Arsikere Taluk (Table 30). Whereas, stem bleeding and bud rot were recorded highest in Vanakamaranahalli (8) followed by Vrindavanahalli (5%) and the maximum leaf blight was noticed in (3.00 scale) in Jaipura village.

Path. 9 : Studies on management of leaf blight (*Lasiodiplodia theobromae*) disease of coconut

(Aliyarnagar, Arsikere)

Aliyarnagar

Field experiments were laid out at farmer's field in Kambalapatti, Karianchettipalayam and Samathur villages of Pollachi taluk, Coimbatore to find out the efficacy of *Pseudomonas fluorescens* against leaf blight pathogen. Root feeding of *P. fluorescens* culture filtrate was done @ 25 ml at quarterly, half yearly and once in a year. The root feeding was also combined with soil application of *P. fluorescens* talc formulation @ 50g/palm/year + Neem cake 5 kg/palm/year. About 25 leaflets were selected randomly from the lower 10 leaves in each palm and the disease was graded based on the 0-5 scale score chart (0: No infection; 1: < 10%; 2: 11 to 25%; 3: 26 to 50%; 4:51 to 75% ; 5: > 75% leaf area infected) and the percent disease index (PDI) was calculated.

Among the treatments, root feeding of *P. fluorescens* culture filtrate (25 ml) at quarterly interval combined with soil application of *P. fluorescens* talc formulation (50g) + Neem cake 5 kg was found to be the best in all the three locations and significantly reduced the incidence to 6.93%, 7.87% and 5.47% in Kambalapatti, Karianchettipalayam and Samathur trials, respectively. Thus, root feeding of *P. fluorescens* culture filtrate @ 25 ml/palm at quarterly interval along with soil application of *P. fluorescens* talc formulation (50 g/palm/year) + Neem cake (5 kg/palm/year) was found to be the best against leaf blight disease.

Table 30. Incidence of diseases in Arsikere taluk

Sl.No.	Name of the Village	% affected palms			Leaf blight (0-5 scale)
		Bud rot	Stem bleeding	Basal stem rot	
1	Jaipura	0	2	6	3.00
2	Vanakamaranahalli	2	8	20	1.65
3	Jakkanahalli	0	1	2	1.70
4	Vrindavanahalli	5	2	15	1.30

Veppankulam

Survey was conducted in various locations of Thanjavur and Thiruvarur districts to assess the incidence of basal stem rot, stem bleeding and bud rot in coconut. Stem bleeding and bud rot incidences were not noticed in any of the places were survey was undertaken. Altogether 11,659 palms were covered in the survey and among them, 145 palms were affected by BSR showing 1.24% infection.

Arsikere

The experiment has been initiated with two replications and three palms per replication.

Treatment details:

T_1 : Root feeding of 100% liquid culture of *Pseudomonas fluorescence* (25ml) at quarterly intervals

T_2 : Root feeding of 100% liquid culture of *Pseudomonas fluorescence* (25 ml) at six months interval

T_3 : Root feeding of 100% liquid culture of *Pseudomonas fluorescence* (25 ml) at once in a year

T_4 : SA of *Pseudomonas fluorescence* talc formulation 50g + 5 kg of neem cake/palm/year

T_5 : $T_1 + T_4$

T_6 : $T_2 + T_4$

T_7 : $T_3 + T_4$

T_8 : 5 kg neem cake/palm/year

T_9 : Control

In-vitro and *in-vivo* screening of bio-agents against the pathogen

Five leaf blight samples were collected from different locations and isolated by using Potato dextrose agar medium and all the samples were sent for identification. Further studies will be taken up after confirmation of the pathogen.

Path. 10: Early detection of basal stem rot disease in coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

Development of diagnostic kit for basal stem rot disease

The experiment was repeated by raising polyclonal antibodies in New Zealand White Rabbits against *Ganoderma applanatum* and *Ganoderma lucidum*. Pure cultures of *Ganoderma* strains were used to develop polyclonal antibodies. The developed antibodies were tested with the pure cultures as antigen in glass capillary tube assay, slide agglutination test and by indirect ELISA. Positive reaction of developed antiserum of *G. applanatum* and *G. lucidum* with their respective antigens was observed in glass capillary tube assay and slide agglutination tests by the formation of precipitations. The antiserum was then used to detect its sensitivity against the pathogens in indirect ELISA method. The method was standardized and found to be sensitive to detect the antigen up to 1:20,000 dilutions. Antiserum with its dilution of 1:10,000 was able to detect the antigen in 1:10, 1:100, 1:1000, 1:10000, 1:20000 dilutions. The experiments are being repeated and the detection of *Ganoderma* wilt or basal stem rot with the developed polyclonal antibodies from the diseased plants is in progress.

Sero detection of *Ganoderma applanatum*

Indirect form of ELISA (I-ELISA): The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (anti rabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added and absorbances were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the *Ganoderma applanatum* with antisera dilution of 1: 10000 and with antigen dilution up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.152 – 2.969 and 0.113 – 0.600, respectively in ELISA reader (Table 31).

Primary antibody at 1:10,000 dilution and secondary antibody at 1:10,000 dilution was used for all the samples. From the test it was found that the Primary antibody at 1:10,000 dilution and secondary antibody at 1:10,000 dilution can effectively detect the antigen concentrations up to $2x10^{-4}$.

Sero detection of *Ganoderma lucidum*

Indirect form of ELISA (I-ELISA): The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (antirabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added and absorbances were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the *Ganoderma lucidum* with antisera dilution of 1: 10,000 and with antigen dilution

Table 31. Sero detection of *G. applanatum* by indirect form of *ELISA* (OD values at 405 nm) (Ambajipeta)

Antigen dilutions	Replications				
	1	2	3	4	Buffer
10µg(10^{-1})	2.782	2.560	2.657	2.923	0.600
1 µg (10^{-2})	2.924	2.561	2.924	2.783	0.178
100ng (10^{-3})	2.439	2.314	2.217	2.881	0.149
10ng (10^{-4})	2.896	2.152	2.532	2.754	0.113
5ng ($2x10^{-4}$)	2.969	2.460	2.351	2.402	0.155

up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.133 to 2.916 and 0.132 – 1.805, respectively in ELISA reader (Table 32).

studies were initiated by inoculating pure culture of the pathogen to sterilized soil. The same soil was mixed thoroughly and different seeds were placed.

Table 32. Sero detection of *G. lucidum* by indirect form of *ELISA* (OD values at 405 nm)

Antigen dilutions	Replications				
	1	2	3	4	Buffer
10µg(10^{-1})	2.407	2.916	2.474	2.916	1.805
1 µg (10^{-2})	2.555	2.777	2.174	2.351	0.287
100ng (10^{-3})	2.735	2.133	2.098	2.876	0.328
10ng (10^{-4})	2.745	2.887	2.377	2.745	0.184
5ng ($2x10^{-4}$)	2.455	2.824	2.699	2.699	0.132

Primary antibody at 1:10,000 dilution and secondary antibody at 1:10,000 dilution was used for all the samples. From the test it was found that the Primary antibody at 1:10,000 dilution and secondary antibody at 1:10,000 dilution can effectively detect the antigen concentrations up to $2x10^{-4}$.

Identification of indicator plants for basal stem rot disease

Studies were repeated for validating Bengal gram plant as indicator plant for basal stem rot disease during 2011-12. Artificial inoculation of pure cultures of *Ganoderma* pathogen to the sterilized soil was done with each isolate before transferring of the germinated Bengal gram seedlings in pots. Infected plants showed withering, yellowing, browning of the lower set of leaves followed by upper leaves and drying of the plants. When the infected plants were uprooted and observed, whitish fungal growth was observed on the cotyledons. In later stages, complete rotting of the basal stem region and death of the plants were observed. Entire symptoms were visible within a month under artificial inoculation studies. Pure culture of *Ganoderma* was isolated from the basal stem regions of infected Bengal gram plant.

Indicator studies were also conducted with naturally sick soil of *Ganoderma* in pots along with artificial inoculation of the cultures. These plants also showed similar symptoms and culture of *Ganoderma* was isolated from the diseased plants. In another experiment, Bengal gram seedlings were sown in the basins of coconut palms in sick soil.

Arsikere

Identification of indicator plants for early detection of basal stem rot disease

Thirteen leguminous plants were selected to know the susceptibility to the *Ganoderma* spp. The pot culture

Sl.No.	Common name	Scientific name
1	Field bean	*Vicia faba*
2	Common bean	*Phaseolus vulgaris*
3	Cluster bean	*Cyamopsis tetragonoloba*
4	Hycianth bean	*Dolichos lablab*
5	Black gram	*Vigna mungo*
6	Peas	*Pisum sativum*
7	Peanut	*Arachis hypogaea*
8	Pigeon pea	*Cajanus cajan*
9	Chick pea	*Cicer arietinum*
10	Green gram	*Vigna radiata*
11	Cowpea	*Vigna unguculata*
12	Dhaincha	*Sesbania aculeata*
13	Sunhemp	*Crotalaria juncea*

Veppankulam

Seeds of Red gram, Bengal gram, Brinjal, Tomato, Bhendi, Cowpea, Green gram, Black gram, Chillies and Cluster beans were sown in pots filled with sterilized sand and inoculated with *Ganoderma lucidum* (multiplied on sorghum grains) on 06.12.2011 for testing the suitability of these crops as an indicator host for the early detection of BSR. The plants were observed for bark splitting and *Ganoderma* sporophore formation and none of the plant species exhibited these symptoms.

Path. 14: Etiology and epidemiology of leaf blight disease of coconut

(Aliyarnagar, Arsikere)

Aliyarnagar

Correlation studies revealed that the leaf blight disease intensity was increased with increase in temperature and the maximum disease intensity was observed during March-April. Disease intensity was reduced after the receipt of rainfall. Disease intensity was found to be the lowest during October-December (Fig. 4. and Table 33). The correlation of PDI with weather parameters revealed that, maximum temperature had a positive correlation with disease development ($r = + 0.79$; $R^2 = 0.624$), while

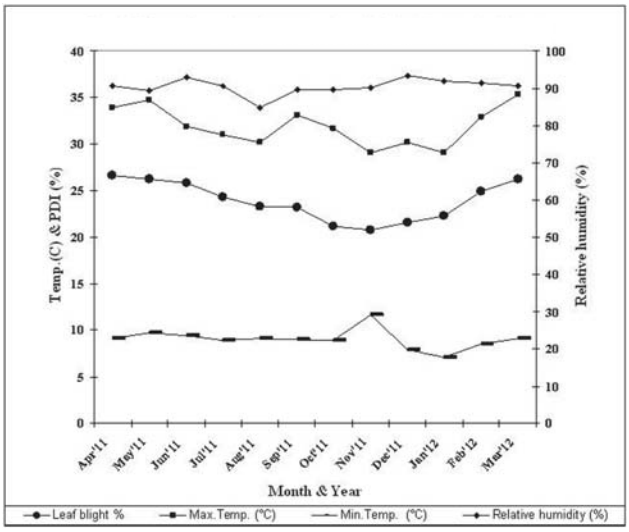


Fig. 4. Effect of weather factors on leaf blight disease incidence

Epidemiology and forecasting

The different meteorological observations were recorded on daily basis to know the impact of climatic change on the spread of the disease.

Path. 15:Early detection of bud rot disease of coconut

Ambajipeta

Development of diagnostic kit for bud rot disease

The experiment was carried out by raising polyclonal antibodies in New Zealand White Rabbits against *Phytophthora palmivora*. Pure cultures of *Phytophthora palmivora* strain was used to develop polyclonal antibodies. The developed antibodies were tested with the pure cultures as antigen in glass capillary tube assay, slide agglutination test and by indirect ELISA. Positive reaction of developed antiserum of *Phytophthora palmivora* with the pure culture of *Phytophthora* was observed in glass capillary tube assay and slide agglutination tests by the formation of precipitations. The antiserum was then used to detect its sensitivity against the pathogens in indirect ELISA method. The method was standardized and found to be sensitive to detect the antigen up to 1:20,000 dilution. Antiserum with its dilution of 1:10,000 was able to detect the antigen in 1:10, 1:100, 1:1000, 1:10,000, 1:20,000 dilutions.

Table 33. Correlation of weather parameters with leaf blight disease development (r values) (Aliyarnagar)

	Temp. (max.)	Temp. (min.)	Rainfall (mm)	RH (FN)	RH (AN)
PDI	0.79(0.624)	0.0068(0.0)	- 0.529(0.280)	0.057(0.003)	- 0.69(0.480)

evening relative humidity had a negative relationship (r= - 0.69; R^2=0.480). Other parameters such as minimum temperature, rainfall and evening relative humidity had no influence on the disease development.

Eleven different isolates of leaf blight pathogen from Subbaegoundanpudur, Samiyarpudur, Aliyarnagar, Angalakurichi, Kudimangalam, Karianchetipalayam, Samathur, Mannam, Kambalapatti, and Vakkampalayam villages of Pollachi Taluk of Coimbatore district and Veppankulam village of Thanjore district in Tamil Nadu were studied for genetic variability. DNA was isolated from all the isolates and subjected to PCR analysis with 20 random primers. Among them, random primers OPF 6, OPF 10, OPC 8, OPA 5 and AP12 showed variability among the isolates analysed. Analysis report revealed that a range of 42 to 66 percentage of similarity was observed among the *L. theobromae* isolates collected from different parts of Tamil Nadu. The experiment needs to be continued with more number of random primers.

Salient findings:

1. Leaf blight disease intensity increased with increase in temperature.
2. Disease intensity was high during March-April and found at the low during October -December.
3. A range of 42 to 66 percentage of similarity was observed among the *L. theobromae* isolates.

Arsikere

Collection of *Lasiodiplodia theobramae* isolates from various locations

Collected five samples of the pathogen and sent for the identification and pure culture is being maintained for further use in the laboratory.

Sero detection of *Phytophthora palmivora*

Indirect form of ELISA (I-ELISA): The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (antirabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added and the absorbances were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the *Phytophthora palmivora* with antisera dilution of 1 : 10,000 and with antigen dilution up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.306 – 2.969 and 0.114 – 0.156 respectively in ELISA reader. The experiments are being repeated and detection of *Phytophthora palmivora* pathogen or bud rot disease with the developed polyclonal antibodies is in progress.

Primary antibody at 1:10,000 dilution and secondary antibody at 1:10,000 dilution was used for all the

samples. From the test it was found that the Primary antibody at 1:10,000 dilution and secondary antibody at 1:10,000 dilution can effectively detect the antigen concentrations up to $2x10^{-4}$.

Collection of isolates and DNA studies of *Phytophthora palmivora*

Bud rot pathogen *Phytophthora palmivora* was collected from diseased coconut and cocoa plants of different places such as Ambajipeta, Malkipuram, Razole and Pulletikurru of East Godavari District. DNA isolation work was carried out and PCR studies is being carried out.

Identification of indicator plants for bud rot disease

Studies indicated that the occurrence of bud rot disease in coconut is related to the existence of palmyrah palm in coconut gardens. There is a positive correlation between the number of palmyrah palms to the per cent incidence of bud rot in coconut.

Path. 16: Identification of coconut types resistant to *Ganoderma* wilt disease

(Ambajipeta, Veppankulam)

Ambajipeta

Seed nuts of seven varieties were obtained and planted in sick soil at Gannavaram, East Godavari District at 3m x 3 m spacing during October 2010. In addition, two local varieties *viz.*, Pillalakodi and Jonnalarasi were also collected and planted along with the other varieties. The details of newly planted varieties along with number of seedlings are given in the Table 34.

Table 34. Varieties planted for screening germplasm resistant to basal stem rot disease of Coconut

Variety / Hybrid	Number of seedlings planted
Java Giant	5
Chandra Kalpa (LO)	4
Spicata	5
Laccadive Micro	8
ECT	14
Ceylon Red	3
GBGD x ECT	7
Pillalakodi (Local variety)	3
Jonnalarasi (Local variety)	3

Veppankulam

The seedlings of Selfed WCT were planted during April 2011 and ECT were planted during March 2012 in the BSR disease sick plot at CRS, Veppankulam for the evaluation of their resistance to basal stem rot disease in coconut. The performance of seedlings previously planted in the BSR sick plot at CRS, Veppankulam for evaluating their resistance to basal stem rot pathogen indicated that, among the 12 BSR tolerant plants and three seedlings each in ECT and WCT planted in the BSR sick plot during 2004, only four BSR tolerant plants and one WCT seedling are alive today, while all others have succumbed to death. In the on farm trial at Melasembalur village among the 16 BSR tolerant seedlings and 17 ECT seedlings planted during 2004, only seven and six are alive as on date while, others have died due to basal stem rot disease.

Path. 17: Studies on post harvest diseases of coconut

Aliyarnagar

Experiment on the effect of volatiles from antagonists *viz., Trichoderma viride, T. harzianum* against *Aspergillus flavus* was repeated this year using partitioned Petri plates. Studies again confirmed that none of the strains could inhibit the growth of *A. flavus*. The isolates might have not either produced volatiles or the produced volatiles were ineffective against *A. flavus*.

ICAR special grant scheme

Title: Devlopment of microbial consortia for the management of leaf blight of coconut incited by *Lasiodiploidia theobromae*

Place : Aliyarnagar

The effect of isolated rhizosphere fungal and bacterial antagonists in inhibiting the mycelial growth of the pathogen was assessed *in vitro* using dual plate technique. Five *Trichoderma viride* isolates, 10 isolates of *P. fluorescens* and 10 *Bacillus subtilis* isolated from the rhizosphere of coconut were screened against *Lasiodiplodia theobromae*. Three replications were maintained for each treatment and incubated at room temperature (27±1°C) for seven days. Suitable control plates were also maintained. The inhibition zone was measured. The *in vitro* evaluation revealed that the rhizosphere bacteria *P. fluorescens* Pf1 and *Bacillus subtilis* (Kambalapatti) and the fungi *T. viride* (TNAU) were highly effective against the leaf blight pathogen and recorded an inhibition zone of 12.7 mm, 6.3 mm and 6.7 mm, respectively. Hence, all the three antagonists are combined together to develop microbial consortia and the same was evaluated under field conditions at Angalakurichi and Pethanaickanur villages of Pollachi taluk. The developed microbial consortia containing the antagonists *viz., P. fluorescens* Pf1, *B. subtilis* (Kambalapatti) and *T. viride* (TV1) are evaluated under field condition.

5.4 Pest Management

Ent. 3: Survey and Monitoring of pest problems in Coconut:

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar:

Roving Survey:

a. Black headed caterpillar

A roving survey to assess the infestation of coconut black headed caterpillar *Opisina arenosella* was undertaken in eight districts *viz.*, Coimbatore, Erode, Salem, Thirupur, Dindugal, Sivagangai, Dharmapuri and Nammakkal of Tamil Nadu. The mean per cent damage of coconut black headed caterpillar was found to be the highest in Dharmapuri district (33.0), followed by Dindugal (31.8), Sivagangai (30.0), Erode (29.6) and other districts (Fig. 5).

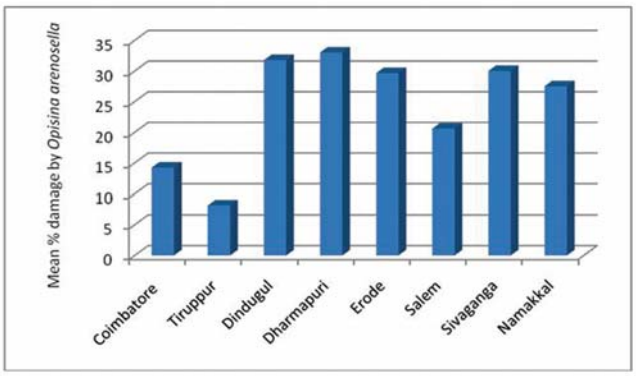


Fig. 5. Per cent damage by black headed caterpillar

b. Rhinoceros beetle

Survey on the infestation of coconut rhinoceros beetle was also undertaken in eight districts. The mean per cent damage of coconut rhinoceros beetle was found to be the highest in Sivagangai district (22.00), followed by Namakkal (16.60), Dindugal (13.39) and other districts (Fig. 6).

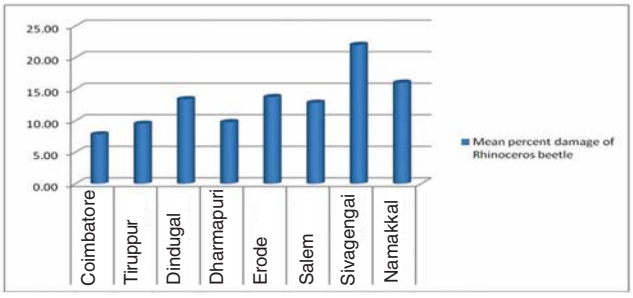


Fig. 6. Per cent damage by rhinoceros beetle

c. Red palm weevil

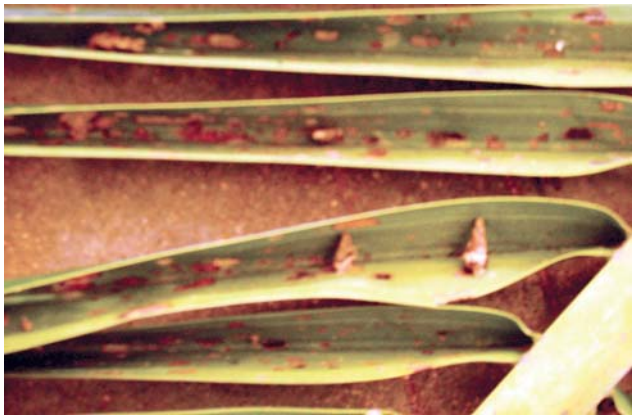
There was no occurrence of red palm weevil incidence in all the above mentioned places except traces level in Attur in Salem district, Oddanchattiram of Siddaiyankottai of Dindugal district.

d. Eriophyid mite

The per cent infestation of eriophyid mite in all the above mentioned places was found to be moderate to high ranging from 52.0 to 87.0

Surveillance of emerging coconut pest

Survey conducted to see the occurrence of emerging pest of coconut is presented in Table 35 and the incidence of bag worm, slug caterpillar, red ants, scales and mealy bugs incidence was found in severe intensity.



Bag worm

Different stages of slug caterpillar

Ambajipeta

Roving survey was conducted in 58 villages in East Godavari, seven villages in West Godavari, four villages in Visakhapatnam district, three villages in Vizianagram district and six villages in Srikakulam district of Andhra Pradesh and the intensity of various pests observed is presented in Table 36.

Fixed plot survey

Fixed plot survey was undertaken at Sakhinetipalli and Yedurlanka in East Godavari district. Mild to medium intensity of rhinoceros beetle damage was noticed in both the villages. Hundred per cent intensity of eriophyid mite was observed in both the fixed plot villages (Table 37).

Table 35. Surveillance of emerging coconut pests (2011-12) (Aliyarnagar)

Pests	Per cent infestation	Intensity	Places
Slug caterpillar (*Contheyla rotunda*)	15-30	Severe	Aiyampalayam Narasingapuram Pugalur
Termites	5-10	Moderate	Marandahalli Attur
Leaf eating caterpillar (*Turnaca acuta*)	10-13	Moderate	Pattiveeranpatty
Bag Worm (*Pteroma plgiophelps*)(New occurrence)	15.00	Severe	Anaimalai
Coconut button borer (*Cyclodes omma*)	Traces	Very low	Poosaripatty
Red ants (*Oecophylla smragdina*)	15 to 22	Severe	Saralaipathy
Scales (*Aspidiotus destructor*)	18.00	Severe	Dharapuram Manakadavu
Mealy bug (*Pseudococous longispinus, P. cocotis*)	10-20	Severe	Chempatty Siddaiyankottai
Rodents (Rats and palm civet)	5-10	Moderate	All places

Table 36. Intensity of coconut pests in different districts of Andhra Pradesh during 2011-12 (Roving survey) (Ambajipeta)

Sl. No.	District	No of villages surveyed	Red palm weevil	Rhinoceros beetle	Eriophyid mite	Other pests
I	Srikakulam	6	Medium	Medium to severe	Mild to medium incidence	High termite
2	Visakhapatnam	4	Nil to low scale	lower scale	Mild to medium	Tender nuts damage by monkeys
3	Vizianagram	3	Nil to low scale	lower scale	Mild to medium	-
4	East Godavari	58	Mild to medium	Low	Mild to medium	Slug caterpillar in isolated pockets, black headed caterpillar on coconut trees raised in fish pond bund
5	West Godavari	7	Mild to medium	Low	Mild to medium	Slug caterpillar in isolated pockets

Table 37. Monitoring of coconut pests in East Godavari of Andhra Pradesh during 2011 (up to December, 2011) [Fixed plot survey]

Name of the village	Mite				Red palm weevil	BHC	Rhinoceros beetle			Slug cater pillar	Other pests
		Intensity						Intensity			
	Inci-dence	Young nut	Harvested nut	Mite popu-lation / 4 mm^2			Inci-dence (%)	Leaf damage (%)	Spindle damage (%)		
Sakhinetipalli	100%	1.74 (Mild)	3.16 (Medium)	9.44	Nil	Nil	35.2	11.9	Nil	Low incidence	Bagworm
Yedurlanka	100%	2.33 (Mild)	2.92 (Medium)	18.03	Nil	Nil	22.5	9.41	Nil	Low incidence	Bagworm

BHC- Black Headed Caterpillars

In addition to Sakhinetipalli and Yedurlanka, two new locations *viz.*, Palivela of Kothapeta mandal and Korlapativaripalem of Ambajipeta mandal were selected for fixed plot survey in East Godavari district from January 2012. Low intensity of rhinoceros beetle damage was noticed in both the new gardens selected. In Palivela village, high incidence of coconut slug caterpillar was recorded in the months of January, February and March 2012 (Table 38).

Table 38. Monitoring of coconut pests in East Godavari of Andhra Pradesh during 2012 (from January 2012) [Fixed plot survey]

Name of the village	Incidence of different pests and intensity									
		Mite				Rhinoceros beetle				
		Intensity					Intensity			
	Incidence (%)	Young nut	Harvested nut	Red palm weevil	Black Headed caterpillar	Incidence (%)	Leaf damage (%)	Spindle damage (%)	Slug caterpillar	Other pests
Palivela	100	2.74	3.58	—	—	0.5	0.07	—	60	-
Korlapativari palem	100	2.46	3.41	—	—	2.5	0.11	—	0	-

Slug infestation at Vedireswaram village of East Godavari District (inset: Slug caterpillar)

Ratnagiri

A roving survey to monitor the incidence of pests was carried out at Ratnagiri and Sindhudurg districts of Maharashtra from April 2011 to March 2012. The rhinoceros beetle infestation in Ratnagiri and Sindhudurg were 12.98 to 14.20 per cent, respectively (Fig.7). In case of Red Palm Weevil, the damage level was higher in Sindhudurg district (3.9 per cent) followed by Ratnagiri district (2.9 per cent) (Fig. 8). The incidence of eriophyid mite was 53.6 per cent in Sindhudurg district followed by Ratnagiri (53.0 per cent) (Fig. 9). Black headed caterpillar was observed in Thane district of Konkan region of Maharashtra.

Fixed plot survey was carried out at three months interval from April 2011 in Ratnagiri district. The infestation of Rhinoceros beetle was in the range of 5 to 11 per cent. Maximum infestation (11.4 per cent) was in the month of July 2011. The infestation of Red palm weevil was in the range of 1.9 to 3.2 per cent. Maximum infestation (3.2 per cent) was in the month of Oct 2011. The infestation of eriophyid mite was in the range of 48.6 to 55.4 per cent. Maximum infestation (55.4 per cent) was in the month of January 2012. The incidence of Black headed caterpillar was not noticed during the fixed plot survey (Fig.10).

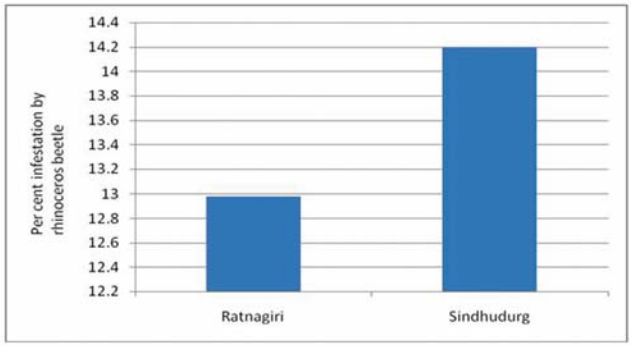


Fig. 7. Infestation by rhinoceros beetle

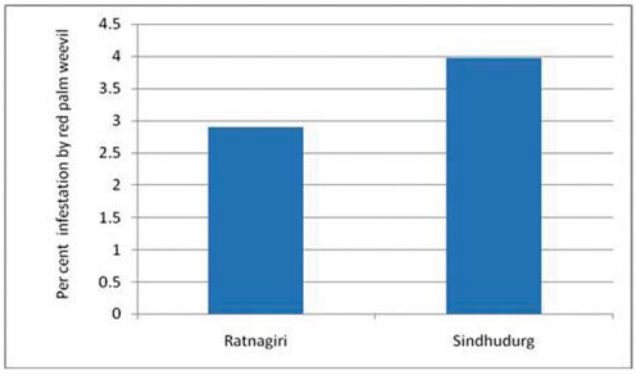


Fig. 8. Infestation by red palm weevil

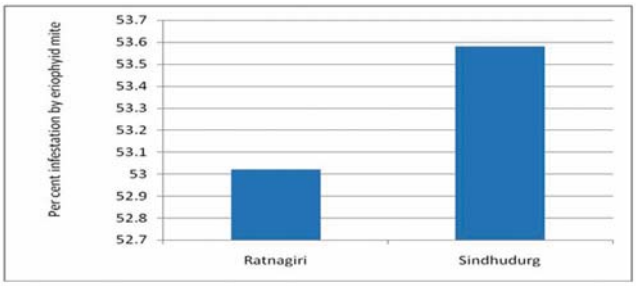


Fig. 9. Infestation by eriophyid mite

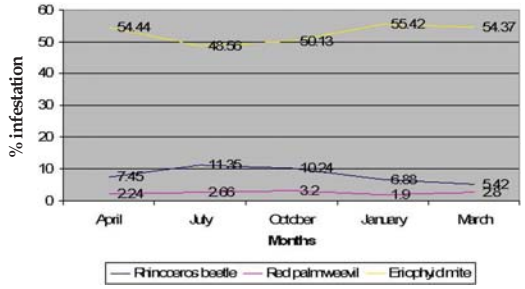


Fig. 10. Per cent infestation of major pests in fixed plot survey

Ent. 5: Management of eriophyid mite in coconut garden

(Aliyarnager, Ambajipeta, Ratnagiri)

The data on the intensity of eriophyid mite in 3rd bunch was collected to calculate the mean grade index. Three treatments were imposed, T_1 – IPM, T_2 – IPM without root feeding, and T_3 – Control. In all the centers, the control recorded the highest mean grade index.

In Aliyarnagar, the mean grade index was the lowest in T1 with IPM treated palms than the palms treated by IPM without root feeding and control (Fig. 11).

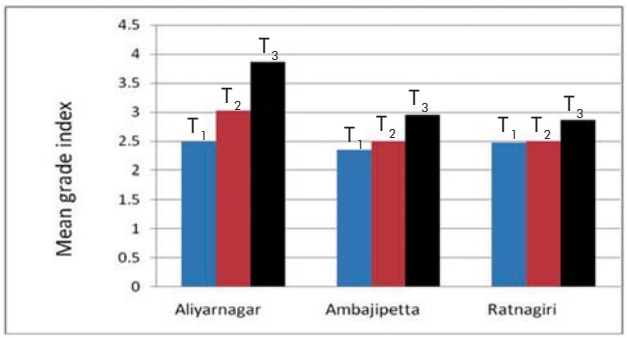


Fig.11. Mean grade index of eriophyid mite infestation

In case of Ambajipeta, mild intensity of mite i.e., 2.35 grade index was observed in the T_{1-} treatment (IPM implemented garden) and in the T_2–treatment (IPM treatment without root feeding) recorded 2.49 grade index (Mild) whereas 2.95 grade index (Medium) was recorded in control plot (T_3). In Ratnagiri, the control plot had the highest mean grade index of 2.86 while those palms under the IPM measures had a lower mean grade index of 2.47.

Ent. 10: Compatibility of natural enemies with the most commonly used botanicals / pesticides

(Aliyarnager, Ambajipeta)

Aliyarnagar

The relative toxicity of dichlorvos, carbofuran, dimethoate and monocrotophos on braconid parasitoids was worked out. The Median Lethal dose of insecticides to *Bracon brevicornis* was found to be lower for monocrotophos than dichlorvos followed by dimethoate and carbofuran (Table 39).

Table 39. Median Lethal dose of insectcides to *Bracon brevicornis* (Aliyarnagar)

Chemical	LD_{50} Value(ng/cm ^{2})
Dichlorvos	26.34
Carbofuran	44.26
Monocrotophos	18.91
Dimethoate	39.70

Ambajipeta

The parasitoids *Goniozus nephantidis* were exposed to various pesticides viz., phorate, monocrotophos, chlorpyriphos and carbaryl and the adult mortality was recorded up to seven days after treatment. At one day after treatment, the highest mortality (100 per cent) was recorded in phorate, chlorpyriphos and carbaryl at 2 ppm, 5 ppm and 10 ppm whereas, monocrotophos yielded only 35 per cent mortality at the highest concentration (10 ppm). The mortality per cent ranged from 0-15 in the lower concentrations (1.0 ppm, 0.5 ppm, 0.1 ppm, and 0.05 ppm). The observation on the seven days after treatment revealed that, even at lower concentration (1.00 ppm to 0.05 ppm), the mortality per cent ranged from 10-45 and nil mortality was observed in the control. Hence, the above mentioned pesticides are lethal to the parasite at higher concentrations (2 ppm, 5 ppm, 10 ppm) and relatively safer at lower concentrations(1 ppm, 0.5 ppm, 0.1 ppm and 0.05 ppm).

Ent. 11: Evaluation of improved strains of parasitoids (Braconid) and predators (*Cardiostethus exiguss*) in the field against *O. arenosella*

(Aliyarnager, Ambajipeta, Ratnagiri)

Aliyarnagar

A field trial on the effect of improved strains (conditioned) of bioagents against coconut black headed caterpillar (*Opisina arenosella*) was carried out at Oddanchathiram during this period. Thirty each conditioned and unconditioned *Bracon brevicornis* parasitoids were released on the black headed caterpillar infested sample palms for six times. Pre and post treatment observations on the number of larvae/palm and population build up of parasitoids (per cent parasitism) were also recorded. It is evident from the observation trial that release of conditioned parasitoids of *B. brevicornis* is found to decrease the black headed caterpillar population than the release of unconditioned parasitoids. Consequently, the level of per cent parasitisation is in the increasing trend.

Ambajipeta

The experiment was initiated in Undrajavaram, Tanuku mandal, West Godavari district. The pest incidence decreased completely at three months after release in the T_1–treatment (Olfactory stimulated strains of *Parasitoids*), whereas in T_2– treatment (the non- Olfactory stimulated strains of *Parasitoids*), the pest incidence decreased by 83.5 per cent after three months of release of parasitoid (Table 40).

Ratnagiri

As per CPCRI guidelines, the experiment was laid out in heavily infested gardens with *O. arenosella*. Plot size and sampling procedures were followed. Pre-release and post- release count was recorded at three weeks interval. The data given in Table 41 showed that the pest incidence

Table 40. Field efficacy of *Goniozus nephantidis* against the coconut black headed caterpillar (Ambajipeta)

Treatment	No of larvae/ leaflet (pre-release count)	No of larvae/ leaflet/tree (post release data)	Per cent parasitization	Post release observation
T1 [Conditioned]	18.00	4.16	76.9	1st month after release
T1 [Conditioned]	18.00	3.02	83.2	2nd month after release
T1 [Conditioned]	18.00	0.00	100.00	3rd month after release
T2 [Unconditioned]	18.10	6.71	62.90	1st month after release
T2 [Unconditioned]	18.10	5.10	71.8	2nd month after release
T2 [Unconditioned]	18.10	2.99	83.5	3rd month after release
T3 [Control]	19.12	18.92	1.05	1st month after release
T3 [Control]	19.12	18.73	2.0	2nd month after release
T3 [Control]	19.12	27.36	+43.09 increase in pest	3rd month after release

Table 41. Evaluation of pre-conditioned parasitoid (*Goniozus nephantidis*) in the field against *Opisina arenosella* (Ratnagiri)

Treatment	Pre-release count	Post-release count					
		No. of larvae/ leaflet/palm			Per cent Parasitization		
		1st week	2nd week	3rd week	1st week	2nd week	3rd week
T_1[Conditioned]	14.44	3.38	2.22	0.00	73.24	74.69	100.00
T_2[Unconditioned]	14.56	7.42	6.50	1.95	53.26	62.22	78.69
T_3 [Control]	14.66	11.52	11.46	12.56	2.29	4.80	-

reduced to 100 per cent at third week after release of conditioned parasite (T_1), whereas, the pest incidence reduced up to 78.69 per cent at third week after release of unconditioned parasite (T_2). In the Control, an increasing trend was observed in pest population and only 4.80 per cent parasitization was observed after second week. Hence, conditioned parasites worked well against the control of the pest.

Ent.12: Study on the field efficacy of pheromones against coconut rhinoceros beetle and red palm weevil

(Aliyarnager, Ambajipeta, Ratnagiri)

Field efficacy of the pheromone for rhinoceros beetle and red palm weevil were evaluated at Aliyarnagar, Ambajipeta and Ratnagiri. The nanopoprous matrix(NPM) loaded with ethyl 4 methyl octonate and 4 methyl 5 nonanol 4 methyl 5 nonanone (9:1) developed at CPCRI was compared with commercial lures from Chemtica and Pest Control India.

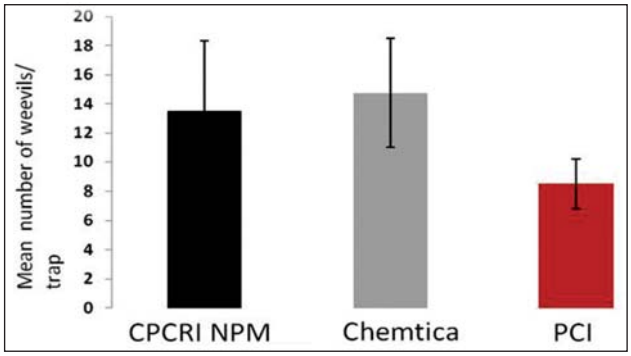
In Aliyarnagar and Ambajipeta, the CPCRI NPM was evaluated with Chemtica and PCI rhinoceros and red palm weevil lures. At Ratnagiri CPCRI NPM was compared with PCI lure for both the pests.

Aliyarnagar

The trial was initiated during June 2011. The efficacy of the red palm weevil lure was evaluated in farmer's garden at Avalchinampalayam and Odayakulam in Pollachi Taluk.

Red palm weevil

Based on the Kruskal Wallis test, there was no significant difference on the mean number of weevils trapped for various lures. The CPCRI NPM lure with lower load of lure (80 mg) could capture equal number of weevils as commercial lures (Fig. 12).

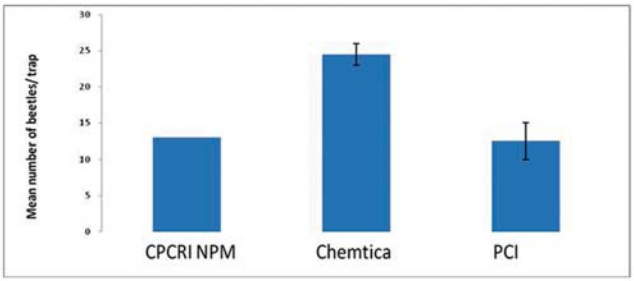


$\chi^2 = 1.77$ 2 df p=0.41 Kruskal Wallis test

Fig.12. Mean number of weevils as influenced by different lures

Rhinoceros beetle

In case of rhinoceros beetle, though higher number of beetles were trapped in Chemtica lure followed by CPCRINPM and PCI lures, the Kruskal Wallis test was not significant (Fig. 13). Here also, the CPCRI NPM had lower load of pheromone (200 mg) as compared to the commercial lures that had higher load of pheromone.



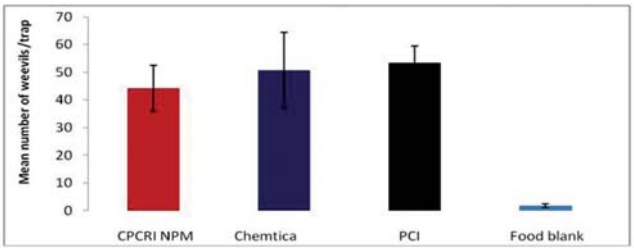
$\times^2 = 3.52$ 2 df p=0.17 Kruskal Wallis test

Fig. 13. Mean number of beetle as influenced by different lures

Ambajipeta

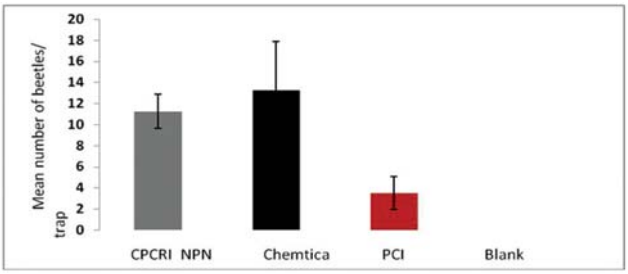
The field trial to assess the efficacy of red palm weevil lure was laid out at Moosalapalli and Ambajipetta. In case of rhinoceros beetle, the filed efficacy of the lure was assessed at Pedapudi and Vakkalanka.

The food blank recorded the lowest number of weevils. Maximum number of weevils was trapped in PCI followed by Chemtica and CPCRI NPM (Fig. 14). In case of rhinoceros beetle, no beetle was trapped in the blank. In case of lure, Chemtica trapped the highest number of beetles (13 beetle/ trap) followed by CPCRI NPM (11.5 beetles/ trap), whereas, PCI lure trapped the lowest number of beetles (3 beetle / trap) (Fig. 15).



$\times^2 = 8.90$ 3 df p=0.03 Kruskal Wallis test

Fig. 14. Mean number of weevils as influenced by different lures



$\times^2 = 12.16$ 3 df p=0.006 Kruskal Wallis test

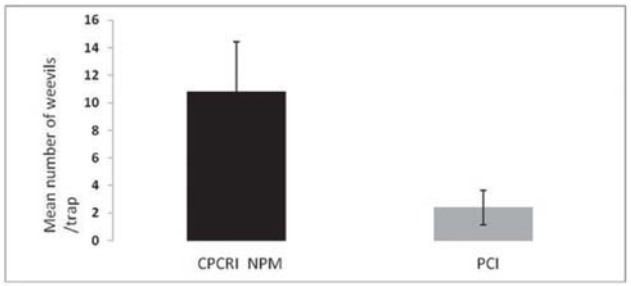
Fig. 15. Mean number of beetles as influenced by different lures

Ratnagiri

The field efficacy of CPCRI NPM loaded with pheromone lures for rhinoceros beetle and red palm weevils was compared with PCI lures.

CPCRI NPM trapped significantly higher number of weevils (11 weevils/ trap) as compared to PCI lure (2 weevils/trap) (Fig. 16). In case of rhinoceros beetles the CPCRI NPM trap had the highest catch (17 beetles/ trap). Both Chemtica and PCI lure trapped less than 5 beetles / trap (Fig. 17).

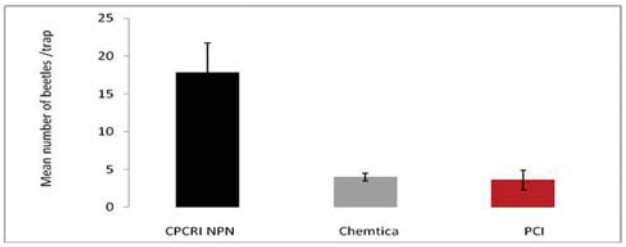
RPW



$\times^2 = 4.84$ 1 df p=0.02 Kruskal Wallis test

Fig. 16. Mean number of weevils as influenced by different lures

Rhinoceros beetle



$\times^2 = 9.67$ 2 dt p=0.007 Kruskal Wallis test

Fig. 17. Mean number of beetles as influenced by different lures

Ent.14: Validation of integrated pest management technology for *Oryctes rhinoceros* in different regions

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Validation of integrated pest management technology demonstration plot for *Oryctes rhinoceros* was continued at Odayakulam, Pollachi by imposing the recommended treatments. Pre- treatment observations on the per cent intensity of coconut rhinoceros beetle damage on leaf, spindle and spathe was recorded up to 42.50, 13.75 and 22.60, respectively (Table 42). Post treatment observations on the reduction of damage on leaf, spindle and spathe are also being recorded at six month intervals of time. Simultaneously the per cent intensity of baculovirus disease infection and GMF (*Metarhizium anisopliae*) are also being recorded at six month intervals

Table 42. Effect of Botanicals, microbial agent's and pheromones against rhinoceros beetle (Aliyarnagar)

Observations	Damage (%) on plant parts			Per cent incidence of *Baculovirus*	Per cent incidence of Green *Muscardine* fungus
	Leaf	Spathe	Spindle		
I.Pre treatment (Jan. 2010)	42.50 (40.69)a	13.75 (21.81)a	22.60 (28.39)a	-	-
II. Post treatment					
June -2010	31.25 (34.02)d	9.50 (18.05)d	18.30 (25.35)d	11.50 (19.82)a	7.00 (15.34)a
Dec. 2010	22.00 (27.97)c	6.80 (15.12)c	10.75 (19.19)c	13.50 (21.56)b	9.00 (17.46)b
June-2011	14.50 (22.38)b	3.25 (10.47)b	6.15 (14.42)b	15.60 (23.26)c	10.50 (18.91)c

(Values in parenthesis are Arcsine transformed values) (Dunkan's Multiple Range Test: Same alphabet denote statistically on par)

of time. The IPM module for rhinoceros beetle results indicated that there was a gradual decrease in the level of damage caused by rhinoceros beetle on leaf, spathe and spindle. On the other hand, there was increment in the level of incidence of Green muscardine fungus and baculo virus in the beetle population in the breeding sites of treated plots.

Ambajipeta

Voodimudi village (P. Gannavaram Mandal) was selected for the experiment implementation. The *Metarhizium* culture is being maintained at Entomology lab, HRS, Ambajipeta and *Baculovirus* culture was obtained from CPCRI, Kayangulam. Pheromone lures were also obtained from M/s. Chem Tica Pvt. Ltd., Trichur and installed in the gardens. The observations revealed that leaf damage came down from 58.4 % to 5.0%, spindle damage from 25.0% to 3.0% validating the importance of IPM in the management of rhinoceros beetle.

Ratnagiri

This trial was initiated in the village Kalbadevi of Ratnagiri district. Five newly planted coconut gardens were selected for this trial. Initial observations regarding incidence of rhinoceros beetle were taken. Application of phorate, naphthalene balls and installation of pheromone traps were completed. Rhinoceros beetle grubs were collected from breeding sites for isolation of natural strain of *Baculovirus* and *Metarhizium*. Further, *Metarhizium* and baculovirus cultures were obtained from CPCRI Kayangulam and maintained in laboratory. Further observations are in progress. Till now, 22.2% leaf damage and 15.3% spindle damage reduction was observed in respective gardens.

Ent. 16: Multi-location field evaluation of talc formulation of *Hirsutella thompsonii* (CPCRI isolate) against coconut eriophyid mite at AICRP palm centres

(Aliyarnagar, Ambajipeta, Ratnagiri)

The talc formulation of *H. thompsonii* and experimental protocol have been received from CPCRI, Kayankulam, Kerala. The following four treatments have been imposed in 200 coconut palms in the garden of farmers holding at Chinnakoppu, Aliyarnagar .

T1 : Spraying talc formulation of *H.thompsonii* @20g/palm – 3 sprays/year during November, February and May.

T2 : Spraying *H. thompsonii* @ 20g/palm during November and February, followed by botanical formulation (2% Neem oil -garlic - soap emulsion) during May

T3 : Spraying Palm oil-sulphur emulsion–3 sprays/year during November, February and May

T4 : Control

Pre-treatment observations on the population of eriophyid mite, per cent damage of nuts and intensity of mite damage etc., as per protocol have been recorded before imposing the treatments.

Post-treatment observations will be recorded before imposing the second round of treatment schedule.

VI. Experimental results in Oil Palm

6.1 Crop Improvement

Gen. 8: Studies on the comparative performance of different hybrid combinations of Oil Palm

Aduthurai

The hybrids evaluated showed prominence in plant height in the year of observation. The plant height varied from 5.10 m to 8.10 m with different hybrids. Consistently, NRCOP 14 has grown taller and established well. The hybrids NRCOP 19 and NRCOP 11 followed the NRCOP 14. The flowering was random and higher number of female flowers was observed in NRCOP 13 followed by NRCOP 19.

Gen. 8A. Evaluation of oil palm genotypes for drought tolerance

(Gangavathi, Mulde)

Gangavathi

Treatment details: The treatments consisted of six Zambian and three Tanzanian selections

Zambian selections (ZS)	Tanzanian selections (TS)
T_1 : ZS - 1	T_7 : TS - 4
T_2 : ZS - 3	T_8 : TS - 5
T_3 : ZS - 5	T_9 : TS - 7
T_4 : ZS - 8	Design: RBD, Replications: 3
T_5 : ZS - 6	Year of planting: October 1998
T_6 : ZS - 9	Spacing: 9 m x 9m x 9m equilateral triangle method/ Hexagonal.
	Soil type: Black clayey

Morphological and physiological parameters (Table 43)

Annual leaf production: The annual leaf production during 2010-11 did not differ significantly among the various genotypes. The genotype, ZS-1 and ZS-5 recorded numerically higher mean annual leaf production of 21.4 and 20.3, respectively.

Leaf scorching: The number of leaf scorched per palm during 2010-11 differed significantly among the various genotypes. The genotype ZS-1 recorded significantly lower number of leaf scorched per palm (2.2) over other genotypes, but it was on par with genotype ZS-3 (3.6).

Drying of FFBs: The number of dried FFB per palm during 2010-11 differed significantly among the various genotypes. The dried FFB were nil in genotype ZS-6 compared to TS-5 and TS-7 (2.5 and 3.0, respectively).

Drooping of leaves: The number of drooping leaf per palm during 2010-11 differed significantly among the various genotypes. The genotype ZS-1, ZS-3 and ZS-8 recorded significantly lower number of drooping leaf per palm (0.17 each) compared to ZS-5 (2.17).

Relative water content (RWC): During 2011, significant difference in the RWC was observed for oil palm genotypes. RWC was significantly higher in the genotype ZS-9 (93.79) over TS-5 (84.51). The next best genotype was ZS-3 (93.22).

Male flower production: There was no significant difference in number of male flowers among different genotypes. Mean number of male flowers was lower with the genotype ZS-5 and TS-5 (7.8 and 8.00, respectively).

Female flower production: There was no significant difference in number of female flowers among different genotypes. Mean number of female flowers was higher with the genotype ZS-3 and TS-5 (7.0 each).

Sex ratio: There was no significant difference in sex ratio among different genotypes. Mean per cent of sex ratio was higher with the genotype TS-5 and ZS-5 (46.22 and 44.82, respectively).

Bunch yield and yield parameters (Table 44)

Number of bunches: During 2010-11, significant difference in the number of bunches per palm was observed for oil palm genotypes. Mean number of bunches were significantly higher in the genotypes ZS-3 (4.37) followed by ZS-1 (4.09) and ZS-9 (4.02). Significantly lower number of bunches per palm was recorded in genotype ZS – 6 (2.85). Similarly there was significant difference in the mean bunch weight and it was significantly higher in the genotype ZS-3 (11.17 kg/bunch) followed by ZS-5 (10.76 kg/bunch) and ZS-6 (9.38 kg/bunch).

Number of fruits per bunch: During 2010-11, significant difference in the number of fruits per bunch was observed for oil palm genotypes and it was significantly higher in the genotype ZS-8 (3031) over all other genotypes. Similarly there was significant difference in the mean fruit weight and it was significantly higher in the genotype ZS-5 (9.6 g/fruit) followed by ZS-6 (8.5 g/fruit) and ZS-9 (8.3 g/fruit).

FFB yield: The FFB yield during 2010-11 differed significantly among the various genotypes. The genotype ZS-3 recorded significantly higher mean FFB yield of 6.99 t/ha over ZS-6, ZS-8, ZS-9, TS-5 & TS-7. The genotypes ZS-1 and ZS-5 with FFB yields of 5.08 and 4.90 t/ha respectively were on par with ZS-3.

General view of Gen 8A trial (Gangavathi)

Table 43. Morphological and physiological parameters of different drought tolerant oil palm genotypes during 2011 (Gangavathi)

Genotypes	Annual leaf production (no.)	Leaf scorching / palm (no.)	Drying of FFBs /palm	No. of leaf drooping /palm	RWC (%)
ZS-1	21.3	2.2	0.7	0.2	88.7
ZS-3	19.8	3.7	0.7	0.2	93.2
ZS-5	20.3	5.4	0.9	2.2	89.3
ZS-8	18.8	4.9	0.6	0.2	88.1
ZS-6	18.2	5.1	0.0	0.3	89.9
ZS-9	17.6	5.3	1.1	1.0	93.8
TS-4	19.6	5.1	1.1	0.7	89.8
TS-5	19.0	5.6	2.6	0.8	84.6
TS-7	18.7	5.4	3.0	1.8	89.3
SEm±	1.2	0.8	0.8	0.6	2.6
CD(P=0.05)	NS	2.2	2.1	1.8	7.6

Table 44. Bunch yield parameters and FFB yield of different drought tolerant oil palm genotypes during 2011(Gangavathi)

Genotypes	Number of bunches	Mean bunch weight (kg)	No.of fruits/bunch	Mean fruit weight (g)	FFB yield (t/ha)
ZS-1	4.1	8.7	1135.3	7.2	5.1
ZS-3	4.4	11.1	1534.7	7.5	7.0
ZS-5	3.1	10.8	1143.7	9.6	4.9
ZS-8	3.1	7.9	3031.0	4.4	3.5
ZS-6	2.9	9.4	1345.0	8.5	3.8
ZS-9	4.0	7.9	1437.7	8.3	4.6
TS-4	3.2	8.9	1147.3	7.9	4.1
TS-5	3.6	8.0	1464.0	6.9	4.4
TS-7	3.8	6.9	1655.7	6.7	3.7
SEm±	0.2	1.1	56.9	0.6	0.8
CD (P=0.05)	0.7	3.1	167.3	1.8	2.2

Performance of ZS-3 germplasm (Gangavathi)

Performance of ZS-1 germplasm (Gangavathi)

Mulde

The trial was bifurcated into two sets: one set under rainfed (3 palms) and another set (3 palms) under irrigated condition since October 2008.

The growth observations were recorded in various drought tolerant genotypes under irrigated and rainfed conditions. Drought tolerant genotypes of oil palm showed significant variation for average height and girth under irrigated and rainfed conditions (Table 45). Under irrigated condition, all Zambian genotypes recorded significantly lower plant height and ranged between 3.1 to 3.8 m. Among the Zambian genotypes, ZS-9 recorded the lowest height of 3.1 m, whereas, the Tanzanian genotype, TS-8 recorded maximum height (5.4 m). Under rainfed condition, G.B.25/314 recorded significantly maximum height of 4.9 m. All Zambian genotypes recorded significantly lower plant height. Average girth of the plant ranged between 2.5 m (ZS-2) to 3.0 m (TS-4 & TS-5) under irrigated condition. Under rainfed condition, it ranged between 2.6 m (ZS-2 & ZS-8) to 3.0 m (TS-4). Under any condition, ZS-2 recorded lower plant girth and TS-4 and TS-5 recorded maximum girth. As far as leaf production is concerned, genotypes did not show any significant variation under both the conditions. However, leaf production was lowered under rainfed condition.

Production of male, productive and total inflorescences (irrigated) were non significant. During 2011, production of male inflorescences ranged between 7.0 (ZS-1) to 3.1 (TS-8). Under rainfed condition, the genotype G.B. 22/311 recorded maximum number of male inflorescences (7.1).

The production of productive inflorescences was the lowest (2.3) in genotype ZS-3 while TS-8 produced maximum (6.5) productive inflorescences. Under rainfed condition, G.B. 21/310 recorded more (4.6) while ZS-3 recorded the lowest (1.3) productive inflorescences. The total inflorescences differed significantly in various genotypes under rainfed condition. The genotype G.B. 22/311 recorded the highest total inflorescences of 9.7, whereas, the genotype TS-11 recorded the lowest total inflorescences (5.1).

The data on yield performance of different drought tolerant genotypes were recorded under irrigated and rainfed conditions and are presented in Table 46. There was no significant difference among different genotypes.

Data on average weight of bunch (FFB) and yield of bunches revealed that under both the conditions, there was significant difference among the different genotypes. TS-7 recorded the highest bunch weight (12.4 kg) while G.B. 25/314 recorded lower bunch weight (2.7 kg) under irrigated condition. Under rainfed condition, the genotype ZS-8 recorded the highest bunch weight (2.9 kg) while G.B. 21/310 recorded lower bunch weight (3.8 kg). Under irrigated condition, TS-7 recorded the highest yield i.e. 78.7 kg per palm, whereas, G.B. 22/311 recorded 11.2 kg per palm only. Under rainfed condition, the genotype ZS-6 recorded significantly higher yield of 65.7 kg whereas, G.B. 22/311 recorded significantly lower yield of 9.8 kg per palm. Among all the genotypes, ZS-6 has shown less effect of irrigation on yield performance when compared with rainfed situation.

Drought Index: The response of plant to drought is evaluated by drought index (DI %) based on yield under both stress and non- stress conditions. Irrigation and genotypes have significant effect while their interaction is non- significant (Table 47). The maximum yield of FFB (9.2 t/ha.) was recorded by the genotype TS-5 which was at par with ZS- 6. Under irrigated conditions, TS-7 gave the maximum yield of FFB (11.3 t/ha.) while under rainfed conditions, ZS- 6 has given maximum yield (9.4 t/ha.). The yield levels under stress and non- stress conditions varied significantly and higher yield was under irrigated conditions. Drought index was the highest in ZS -1 (207.7%) showing better performance under rainfed condition. Out of eighteen genotypes, only seven genotypes showed drought index above 80 % of which four genotypes are of Zambian types *viz.*, ZS-1(207.7%),

Table 45. Number of inflorescences among the different genotypes under different conditions during 2010-11 (Mulde)

Genotypes	No. of male inflorescences		No. of productive inflorescences	
	Irrigated	Rainfed	Irrigated	Rainfed
G.B. 25/314	4.5	5.3	4.9	3.8
G.B. 22/311	6.9	7.1	3.0	2.7
G.B. 21/310	5.8	4.4	5.3	4.6
ZS –1	7.0	4.8	3.6	3.1
ZS-2	4.7	4.9	2.7	3.8
ZS- 3	5.0	4.7	2.3	1.3
ZS- 5	4.0	4.3	5.8	2.8
ZS- 6	3.7	3.9	4.8	3.7
ZS- 9	4.8	4.8	4.8	2.8
ZS-8	5.6	5.0	2.9	2.6
TS- 2	4.8	4.9	4.3	3.5
TS –4	4.4	4.8	3.1	2.8
TS- 5	3.8	4.1	2.6	3.1
TS-7 (Control)	3.8	4.1	3.6	3.2
TS-8	3.1	4.9	6.5	3.3
TS- 9	4.0	4.4	4.7	1.9
TS- 10	4.2	4.3	5.4	2.9
TS -11	4.0	3.7	2.6	1.4
S. Em ±	0.8	0.8	1.0	0.8
CD (P=0.05)	N.S.	N.S.	N.S.	N.S.

NS: Non Significant

Table 46. Yield performance of different genotypes under different conditions during 2010-11 (Mulde)

Genotypes	No. of FFB		Bunch weight (kg)		Yield of FFB (kg/palm)	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
G.B. 25/314	5.8	2.5	2.7	5.6	25.5	14.2
G.B. 22/311	2.2	2.5	5.0	4.4	11.2	9.8
G.B. 21/310	5.5	4.2	4.6	3.8	26.0	16.2
ZS –1	2.4	5.2	8.1	7.2	18.3	37.9
ZS-2	4.1	4.7	8.3	8.8	32.0	39.2
ZS- 3	4.2	2.8	9.5	6.0	41.5	15.9
ZS- 5	5.9	3.7	8.5	8.3	44.8	29.9
ZS- 6	6.5	7.9	9.8	8.5	61.4	65.7
ZS- 9	6.2	2.8	5.2	6.4	30.5	17.2
ZS-8	3.8	4.5	10.4	12.9	37.3	59.4
TS- 2	6.3	3.8	7.1	6.3	43.5	24.6
TS –4	2.7	4.2	9.7	8.7	25.3	34.8
TS- 5	6.4	7.4	10.2	9.7	65.0	64.0
TS-7 (Control)	6.6	3.0	12.4	9.5	78.7	30.0
TS-8	4.0	3.0	9.4	8.5	38.5	23.7
TS- 9	7.3	3.8	10.0	8.3	72.3	35.0
TS- 10	4.0	3.4	10.7	9.0	43.9	30.5
TS -11	3.9	2.9	12.0	9.6	47.2	28.9
S. Em ±	1.7	1.1	1.6	1.3	12.4	8.9
CD (P=0.05)	N.S.	N.S.	4.5	3.7	35.8	25.5

NS: Non Significant

ZS-2(121.7%), and ZS-8 (160.40%), two of Tanzanian *viz.*, TS-4 (138.9%) and TS-5 (97.8%) and one is of Guinea Bissau i.e. G.B. 22/311 (87.5%).

The data on lipid peroxidase activity among the different genotypes were recorded and it is seen that there was no effect on peroxides activity under any stress condition among different genotypes. However, OD values are more under irrigated condition in most of the genotypes.

Table 47. Yield performance and drought index of genotypes during 2010-11(Mulde)

Genotypes	Av. yield of FFB (t/ha)		Mean	Drought Index (%)
	Irrigated	Rainfed		
G.B. 25/314	3.6	2.0	2.8	55.6
G.B. 22/311	1.6	1.4	1.5	87.5
G.B. 21/310	3.7	2.3	3.0	62.2
ZS –1	2.6	5.4	4.0	207.7
ZS-2	4.6	5.6	5.1	121.7
ZS- 3	5.9	2.3	4.1	39.0
ZS- 5	6.4	4.3	5.3	67.2
ZS- 6	8.8	9.4	9.1	106.8
ZS- 9	4.4	2.5	3.4	56.8
ZS-8	5.3	8.5	6.9	160.4
TS- 2	6.2	3.5	4.9	56.5
TS–4	3.6	5.0	4.3	138.9
TS- 5	9.3	9.1	9.2	97.8
TS-7 (Control)	11.3	4.3	7.8	38.0
TS-8	5.5	3.4	4.4	61.8
TS- 9	10.3	5.0	7.7	48.5
TS- 10	6.3	4.4	5.3	69.8
TS -11	6.7	4.1	5.4	61.2
Mean	5.9	4.6	5.2	
	S. E. ±	CD (P=0.05)		
Genotype (A)	1.1	3.1		
Irrigation (B)	0.4	1.2		
Interaction (A X B)	1.5	N.S.		

NS: Non Significant

The relative water content (RWC) among the different genotypes was estimated and RWC per cent values were higher in most of the genotypes under irrigated condition as compared to rainfed condition for all the months. During severe stress period, RWC ranged from 70.8 per cent (ZS-8) to 81.7 per cent (TS-8) under rainfed condition, while under irrigated condition, it ranged from 76.2 per cent (G.B. 21/310) to 91.9 per cent (ZS-8) and the effect was more during stress period.

The data on electrolyte leaching among the different genotypes were recorded and data revealed that there was no significant difference among different genotypes, except during May 2011 under both conditions and under irrigated condition during April 2011. It is seen that as stress increases, percentage of electrolytes leaching increases. Similarly, under irrigated condition, percentage was more as compared to rainfed condition. During severe stress (May 2011), under irrigated condition, percentage of leachates varied from 42.0 (G.B. 25/314) to 53.7 (ZS-9). While under rainfed condition, it was varying from 41.7 per cent (TS-2) to 50.5 per cent (ZS-1).

General view of Gen 8A trial (Mulde)

Performance of ZS6 under rainfed condition (Mulde)

Gen. 8C: Evaluation of new cross combinations in oil palm

(Aduthurai, Gangavathi, Mulde, Vijayarai, Madhopur, Pasighat)

Aduthurai

The biometric observations on plant height, number of leaves per palm, number of female and male flowers produced were recorded during 2011 and presented below (Table 48).

Table 48. Biometric observations on hybrids (Aduthurai)

Hybrid	Plant height (m)	No. of leaves
NRCOP1	4.2	31.1
NRCOP2	4.8	28.6
NRCOP3	4.9	33.4
NRCOP4	4.8	33.2
NRCOP5	4.9	34.2
NRCOP6	4.9	36.4
NRCOP7	5.1	32.3
NRCOP8	4.8	39.4
NRCOP9	4.7	33.2
NRCOP10	5.3	38.3
SEd ±	1.1	5.02
CD (P=0.05)	2.8	12.9

The plant height of the hybrids varied from 4.2 m to 5.3 m during 2011. The hybrid NRCOP 10 produced taller plants followed by NRCOP 7. The number of leaves was maintained at 28 – 39 between different hybrids in 2011. The flowering has just started with NRCOP 2, NRCOP 6, NRCOP 3 and NRCOP 8 with more of female flowers. In general the male flower production was more with all hybrids.

Gangavathi

Ten new oil palm hybrids developed from Directorate of Oil Palm Research, Regional Station, Palode were planted during 2007 and the details are as follows.

Hybrid cross combinations:

1) NRCOP 1 (78D x 435P)
2) NRCOP 2 (90D x 577P)
3) NRCOP 3 (158D x 116P)
4) NRCOP 4 (131D x 435P)
5) NRCOP 5 (5D x 577P)
6) NRCOP 6 (173D x 435P)
7) NRCOP 7 (183D x 577P)
8) NRCOP 8 (70D x 577P)
9) NRCOP 9 (8D x 435P)
10) NRCOP10 (345D x 577P)

Design: RBD
Replications: 3
Palms/treatment : 6
Date of planting : 15-2-2007
Spacing : 9m x 9m x 9m equilateral triangle method
Soil type : Black clay

Vegetative growth parameters (Table 49)

Palm height: There was no significant difference in palm height among different hybrids. Mean palm height was higher with the hybrid NRCOP-4 and NRC OP-2 (4.5 m and 4.4 m, respectively).

Palm girth: Palm girth did not differ significantly. Mean palm girth was more in the case of NRC OP-2 and NRC OP-5 (2.6 m) followed by NRC OP-3 (2.3 m).

Annual leaf production rate: The annual rate of leaf production did not differ significantly. Annual leaf production rate was more with the hybrid NRC OP-4 (24.7) and NRC OP -1 (23.4).

Inflorescence production:

a) **No. of male flowers:** The number of male flowers was significantly less in the case of NRC OP-10 (3.83) over NRC OP -1 (8.5). The other hybrids were on par with NRC OP-10.

b). **No. of female flowers:** The number of female flowers did not differ significantly. The number of female flowers was more in the hybrids NRC OP-4 and NRCOP-8 (7.2 and 7.02, respectively) followed by NRCOP-10 (7).

Sex ratio: The sex ratio remained non significant for various hybrids. The mean sex ratio was more with NRC OP - 8 and NRC OP -4 (63.46 and 60.09, respectively).

FFB yield and yield parameters: (Table 50)

Number of bunches per palm: The number of bunches per palm did not differ significantly. The higher

Table 49. Vegetative growth parameters and inflorescence production of different oil palm hybrids during 2011 (Gangavathi)

Cross combination	Height (m)	Palm girth (m)	Annual leaf production	No.of male flowers	No.of female flowers	Sex ratio
NRCOP-1	4.3	2.3	23.4	8.5	6.8	44.2
NRCOP-2	4.4	2.6	21.4	5.7	6.9	53.4
NRCOP-3	4.2	2.3	22.2	4.9	5.2	52.8
NRCOP-4	4.5	2.4	24.7	4.7	7.2	60.1
NRCOP-5	4.4	2.6	23.2	4.6	5.9	57.3
NRCOP-6	3.9	2.2	20.4	4.1	5.2	54.2
NRCOP-7	4.1	2.4	23.0	4.4	5.6	55.7
NRCOP-8	4.2	2.4	22.2	4.1	7.0	63.5
NRCOP-9	4.0	2.2	22.7	4.5	5.3	54.1
NRCOP-10	3.9	2.2	20.7	3.8	7.0	61.3
S.Em±	0.3	0.2	1.7	0.7	1.2	4.8
CD (P=0.05)	NS	NS	NS	2.2	NS	NS

NS: Non Significant

Table 50. Yield attributes and FFB yield of different oil palm hybrids during 2011 (Gangavathi)

Cross combination	Number of bunches	Mean bunch weight (kg)	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP-1	3.9	6.0	27.7	3.9
NRCOP-2	4.7	5.4	27.8	3.9
NRCOP-3	2.6	4.7	12.8	1.8
NRCOP-4	4.7	6.2	34.0	4.9
NRCOP-5	4.0	4.2	17.4	2.6
NRCOP-6	3.7	4.7	18.7	2.7
NRCOP-7	3.2	4.4	15.0	2.2
NRCOP-8	4.7	6.1	29.2	4.2
NRCOP-9	3.3	5.6	19.2	2.7
NRCOP-10	4.9	4.3	23.9	3.4
S.Em±	0.9	0.1	2.5	0.5
CD (P=0.05)	NS	NS	7.5	1.5

NS: Non Significant

number of bunches per palm was observed with the hybrid NRCOP – 10, NRCOP– 8 and NRCOP 4 (4.94, 4.68 and 4.67, respectively).

Mean bunch weight: There was no significant difference in the mean bunch weight. Mean bunch weight was higher in the hybrid NRC OP- 4, NRC OP- 8, and NRC OP-1 (6.2, 6.1 and 6.0 kg, respectively).

FFB yield: The FFB yield during 2010-11 differed significantly among the various hybrids. The hybrid NRC OP-4 recorded significantly higher mean FFB yield of 4.86 t/ha over NRC OP-3, 5, 6, 7 and 9. The hybrid NRCOP -8, NRCOP -2, NRCOP-1 and NRCOP -10 were on par with NRC OP-4.

Performance of NRCOP-4 (Gangavathi)

Performance of NRCOP-8 (Gangavathi)

General view of Gen. 8C trial (Mulde)

Mulde

Various cross combinations of oil palm did not show significant variation for average height, average girth and average number of leaves. Average height of the palm ranged between 1.0m to 1.3 m. Average girth of the palm ranged between 1.7m to 2.3 m and production of average number of leaves was in the range of 19.5 to 22.3 (Table 51).

Vijayarai

Maximum plant height was recorded in NRCOP-4 with 4.6 m and the shortest plant height was recorded in NRC OP-10 with 3.7 m. The maximum number of leaves was recorded in NRC OP-1 (34.7) and the lowest number of leaves was recorded in NRCOP-2 (26). The plant girth recorded was maximum in NRC OP-4 (2.3 m) followed by NRCOP-7 (2.2 m). The lowest girth was recorded in NRCOP-2 with 1.75 m (Table 52).

Table 51. Growth performances of different hybrid combinations (Mulde)

Cross combination	Code number assigned	Height (m)	Girth (m)	No. of leaves/ palm
78 D X 435 P	NRCOP 1	1.1	1.9	20.7
90 D X 577 P	NRCOP 2	1.3	2.3	22.3
158 D X 116 P	NRCOP 3	1.2	2.2	21.2
131D X 435 P	NRCOP 4	1.1	1.8	19.5
5 D X 577 P	NRCOP 5	1.0	1.7	19.5
173 D X 435 P	NRCOP 6	1.2	2.2	20.5
183 D X 577 P	NRCOP 7	1.1	1.8	20.4
70 D X 557 P	NRCOP 8	1.2	2.1	20.5
28 D X 435 P	NRCOP 9	1.2	2.2	21.2
345 D X 577 P	NRCOP10	1.0	1.7	19.9
SEm ±	0.2	0.3	0.9	
CD (P=0.05)	N.S.	N.S.	N.S.	

Performance of NRCOP 2 (Mulde)

Performance of NRCOP 9 (Mulde)

Table 52. Growth parameters of different hybrid cross combinations of Oil Palm (Vijayarai)

Cross combination	Plant height (m)	Number of leaves/palm	Plant girth (m)
NRCOP-1	4.0	34.7	2.1
NRCOP-2	3.6	26.0	1.7
NRCOP-3	3.8	27.7	1.9
NRCOP-4	4.6	32.0	2.3
NRCOP-5	4.2	33.0	2.0
NRCOP-6	3.9	28.0	1.9
NRCOP-7	4.1	32.7	2.2
NRCOP-8	3.9	33.3	2.1
NRCOP-9	4.3	32.7	2.1
NRCOP-10	3.7	27.3	1.9
CD (P=0.05)	0.84	NS	7.97

NS: Non Significant

The plants started yielding from April 2011. The results were found non significant in respect of number of bunches/palm, FFB yield/palm and yield t/ha.

Pasighat

The secondary nursery seedlings were transplanted in the main field in August 2010 as per the above mentioned experimental details. The growth of the plants in main field recorded in March 2012 is presented in Table 53.

The growth of the plants with respect to plant height and stem girth in all the cross combinations was at par during the year. Difference in number of leaves produced was observed. Maximum number of leaves (18.9) was produced by the cross combination NRCOP-21 and the lowest leaf production in NRCOP-25(13.9).

Table 53. Growth parameters of Oil palm (Pasighat)

Cross Combination	Plant height (cm)	Collar girth (cm)	No. of leaves/ plant
NRCOP-21	248.9	80.6	18.9
NRCOP-22	256.1	78.7	16.7
NRCOP-23	242.7	71.1	16.5
NRCOP-24	221.8	70.8	14.4
NRCOP-25	257.6	71.2	13.9
NRCOP-26	246.9	74.2	15.5
NRCOP-27	244.4	74.1	16.1
NRCOP-28	257.4	77.5	17.5
NRCOP-29	255.3	82.2	16.9
NRCOP-30	251.4	69.5	16.9
SEm±	10.9	3.8	0.8
CD (P=0.05)	NS	NS	2.5
CV (%)	7.60	8.75	8.9

NS: Non Significant

General view of Gen 8C trial (Pasighat)

Gen. 8D: Progeny evaluation trials in oil palm

(Gangavahi, Mulde, Vijayarai, Pasighat)

Gangavathi

Ten sprouts of new oil palm hybrids (NRCOP -31 to 40) developed from DOPR, Pedavegi, Andhra Pradesh were received during December 2009. The growth characters of nursery seedlings indicated that, the palm height was higher with the hybrid NRCOP-35 (178.2 cm) followed by NRCOP 36 (154.3 cm). The lowest plant height was observed with the hybrid combination of NRCOP 40 (95.7 cm). The palm girth was more in the case of NRC OP-31 (21.2 cm) followed by NRC OP-33 (20.2 cm). The number of leaves per palm was more with the hybrid combination NRC OP-39 and NRCOP 31 (11.7 and 11.5, respectively). The lowest number was observed in hybrid combination of NRCOP 32.

Mulde

Total 500 sprouts of ten hybrids (NRCOP -31 to 40) (50 of each combination) were collected from DOPR, Pedavegi during December 2009. Planting in the experimental field has been completed in the month of October 2011. Plant growth is satisfactory.

General view of Gen 8D trial (Mulde)

Vijayarai

Sprouts of new cross combinations (NRCOP -31 to 40) obtained from the Directorate of Oil Palm Research have been planted in the primary nursery bags during December 2009. Seedlings were planted in the main field during September 2011.

Pasighat

The primary nursery seedlings were transferred to secondary nursery in October 2010. Growth parameters of the seedlings recorded in March 2012 is presented in Table 54. Among the hybrids, NRC OP-35 recorded the maximum height (2.1 m) and differed significantly over other hybrid, while NRCOP 31 has recorded the lowest plant height (1.6 m).

Table 54. Growth parameters of Oil Palm secondary nursery (Pasighat)

Cross Combination	Plant height (cm)	Collar girth (cm)	No. of leaves/ plant
NRCOP-31	1.6	36.3	12.5
NRCOP-32	1.9	36.2	11.9
NRCOP-33	1.8	37.5	12.0
NRCOP-34	1.9	38.6	12.3
NRCOP-35	2.1	38.4	12.3
NRCOP-36	1.9	38.5	12.0
NRCOP-37	2.0	38.2	11.3
NRCOP-38	1.9	38.2	11.0
NRCOP-39	1.9	38.2	11.8
NRCOP-40	1.8	37.9	11.7
SEm±	0.34	0.37	0.17
CD (P=0.05)	1.28	1.10	0.51
CV (%)	3.97	1.69	2.51

6.2 Crop Production

Agr. 6A : Studies on fertigation through micro - irrigation in oil palm

(Aduthurai, Gangavathi)

Treatments

T_1 : 300:150:300 g NPK /palm/year through fertigation

T_2 : 600:300: 600 g NPK /palm/year through fertigation

T_3 : 900:450: 900 g NPK /palm/year through fertigation

T_4 : 1200:600:1200g NPK/palm/year through fertigation

T_5 : 1200:600:1800 g NPK/palm/year through fertigation

T_6 : 1200:600:2700 g NPK/palm/year through fertigation

T_7 : 1200:600:2700 g NPK/palm/year through soil application

Fertilizer Source: Urea for nitrogen, Diammonium Phosphate for nitrogen and phosphorus and Muriate of potash for potassium. Fertigation is being given in 6 splits.

Aduthurai:

Date of planting : July 1989

Treatments imposed : From December 2008 onwards

The data on number of leaves alone attained statistical significance. Among the seven treatments, 1200:600:2700 g NPK/palm through soil application (T7) has recorded maximum number of leaves, while 1200:600:1800 g NPK/palm through Fertigation (T5) has registered maximum stem girth. The stem girth varied from 2.1 to 2.7 m with different treatments and number of leaves per palm ranged from 28.1 to 38.2 per palm. Fertilizer application method and doses of fertilizer had marked effect on number of bunches harvested and FFB yield. Significantly higher number of leaves and FFB harvest was obtained in T5 with 1200: 600: 1800 g NPK /palm/year through fertigation. 1200:600:1800 gm NPK/palm through Fertigation (T5) has attained more stem girth and produced more number of leaves / palm.

The leaf analysis for NPK of oil in fertigation trial showed marked significance in nitrogen and potassium. There was no significant difference observed in terms of P content of leaf. The N content was more with T_5 (1200: 600: 1800 g NPK /palm/year through fertigation) followed by T_7 and T_3. The P content of leaves varied from 0.36 to 0.47 % but did not show any significant difference between treatments. The K content of leaves ranged from 1.12 % to 2.21 %. Significantly higher K content was observed in T_5 (1200: 600: 1800 g NPK / palm/year through fertigation) compared to other treatments.

Table 55. Biometric observations in fertigation trial (Aduthurai)

Treatment	Plant girth (m)	No. of leaves
T1	2.1	28.1
T2	2.7	32.6
T3	2.4	31.3
T4	2.5	31.6
T5	2.6	30.9
T6	2.4	31.5
T7	2.4	38.2
S.E.d±	0.37	2.56
CD(P=0.05)	NS	5.48

NS= Non significant

The yield has improved over the years with T_5 (1200: 600: 1800 g NPK /palm/year) through fertigation resulting in higher yield of 10.4 t/ha of FFB.

Gangavathi

FFB yield and yield parameters (Table 56)

Number of bunches per palm: The number of bunches per palm was significantly higher in the treatments T_7 (2.7) over T_2 treatment (1.5).

Mean bunch weight: The mean bunch weight was significantly higher in the treatment T_6 (21.4 kg) over T_3 treatment (12.2 kg). T_5 and T_4 were the next best treatments.

FFB Yield: The FFB yield was significantly higher in the treatment T_6 (7.4 t/ha.) over T_2 treatment (3.4 t/ha).

Mulde

Yield data during the year 2010-11 was recorded and presented in Table 57. There was no significant difference among the various treatments for yield characters. However, the treatment T_5 has given higher FFB yield (22.7 t/ha).

Agr. 12: Development of an integrated water and nutrient management model for oil palm cultivation in North –East Region

(Pasighat)

Treatments

T_1: Irrigation management through drip system

T_2: T_1+50% NPK as organic manure + 50% as chemical fertilizer

T_3: T_1+ 100% NPK as chemical fertilizers

T_4: T_1+ 100% NPK as organic manure

T_5: Rain fed + 100% NPK as organic manure

Replications: 4, Nos. of palms per plot: 6

Table 56. Effect of fertigation treatments on the FFB yield of oil palm during 2011 (Gangavathi)

	Treatments	Number of bunches/palm	Mean bunch weight (kg)	FFB yield (t/ha)
T1	300:150:300 g NPK through fertigation	2.0	15.4	4.34
T2	600:300:600 g NPK through fertigation	1.5	14.8	3.39
T3	900:450:900 g NPK through fertigation	2.6	12.2	4.61
T4	1200:600:1200 g NPK through fertigation	2.4	17.4	5.65
T5	1200:600:1800 g NPK through fertigation	2.3	18.2	5.64
T6	1200:600:2700 g NPK through fertigation	2.5	21.4	7.38
T7	1200:600:2700 g NPK through soil application	2.7	15.4	6.30
	SEm±	0.38	3.85	1.35
	CD(P=0.05)	1.12	8.34	3.96

Table 57. Yield parameters of oil palm as influenced by fertigation and soil application treatments during 2011 (Gangavathi)

	Treatments	Bunch weight (kg/palm)	No. of FFB/ palm	Yield of FFB (kg/palm)	Yield of FFB (t/ ha)
T_1	300: 150: 300g NPK through fertigation	21.9	4.9	105.7	15.1
T_2	600: 300: 600g NPK through fertigation	20.0	5.2	106.3	15.2
T_3	900: 450: 900 g NPK through fertigation	21.0	5.3	111.6	16.0.
T_4	1200: 600:1200g NPK through fertigation	22.8	5.9	135.6	19.4
T_5	1200: 600: 1800g NPK through fertigation	**26.6**	5.9	**158.4**	**22.7**
T_6	1200: 600: 2700g NPK through fertigation	19.2	5.8	111.9	16.0
T_7	1200: 600: 2700g NPK through Soil application	21.7	6.1	132.2	18.9
	SEm ±	**2.2**	**0.8**	**22.4**	**3.2**
	CD (P=0.05)	N.S.	N.S.	N.S	N.S.

NS : Non Significant

One hundred and fifty *tenera* plants were planted during August, 2008 at the College farm and are being used as experimental material for conducting this trial.

Morphological parameters such as plant height, girth and number of leaves were recorded during March 2012. Plant height (3.98 m), collar girth (1.77 m) and number of leaves per plant (21.87) recorded was maximum in T_3 .

Plants in T_5 showed maximum increase in growth with respect to plant height (33.07 %) and collar girth (34.36 %) over a period of one year. Increase in plant height (30.42 %) and collar girth (29.20%) was least in T_1 and T_2, respectively.

Agr. 13: Demonstration on oil palm production potential in North - East Region

(Pasighat)

The 29 oil palm seedlings planted in the year 2006 are being taken up as the material for this maximization plot and all the recommended crop management practices are being adopted to harvest maximum yield. The average plant height, collar girth and number of leaves per plant recorded during March 2012 were 4.82 m, 2.72 m and 29.76, respectively. Since April 2010 to March 2012, flowering in all the palms have been observed. The average number of male and female flowers per palm is 3.62 and 1.31, respectively. The sex ratio (Female:Male) per palm is 1:2.8. The average number of EFB per plant is 6.45 and this is due to lack of pollination.

General view of the Agr. 13 trial (Pasighat)

VII. Experimental results in Palmyrah

7. 1 Genetic resources

Gen. 9: Survey and collection of palmyrah germplasm and evaluation

(Killikulam, Pandirimamidi)

Killikulam

A joint survey was undertaken along with scientist of NBPGR, Regional Station, Hyderabad and Scientist of Pandirimamidi centre at Prakasam and Guntur districts of Andhra Pradesh during 31st July 2011 to 8th August 2011. A total of 15 accessions were collected and were sown in new area of the College orchard on 18.8.2011 @ 15 seeds per line and thus the present germplasm collection at Killikulam centre stands as 238 (Table 58).

Table 58. Abstract of germplasm so far assembled (Killikulam)

Block	Year of collection	Number of collections maintained
Block I (E)	1995	35
Block II (NA)	1997	26
Block III (NA)	1999	23
Block IV (EO)	2001	10
Block IVa (EO)	2001	8
Block V (EO)	2002	13
Block Va (EO)	2002	8
Block VI (EO)	2003	2
Block VII (EO)	2004	12
Block VIII (NA)	2005	9
Block VIII (NA)	2006	14
Block IX (NA)	2007	10
Block IX (NA)	2008	9
Accs. transferred from Pandirimamidi	2009	22
Block X (NA)	2009	9
Block X (NA)	2010	13
Block X (NA)	2011	15
Total		238

Germplasm evaluation

The germplasm collected are regularly being evaluated every year for various biometrical characters *viz;* plant height, number of leaves, leaf length and stalk length. During January, 2012, the germplasm so far assembled (223 nos.) were scored for the biometrical characters and the abstract of data recorded in various blocks are furnished in Table 59.

Germplasm AP. 04/11

Germplasm AP. 08/11

The results showed that the germplasm lines planted during 1997 recorded the maximum values for all the parameters studied. Acc. 041 continued to record the highest values for plant height, leaf length and stalk length during the current year also.

Pandirimamidi

Joint survey and collection undertaken during 2011

During the year 2011, a joint survey and collection of germplasm was taken up in the month of August in Prakasam and Guntur districts of Andhra Pradesh state. A total of 15 accessions have been collected mostly from dwarf palms. Passport data of the accessions have been prepared. Collected germplasm stones are sown in the centre in single rows adopting the spacing of 4 x 4 m after recording fruit parameters.

Table 59. Biometrical observations recorded during January, 2012 (Killikulam)

Year of planting	Plant height(cm)		No. of leaves		Leaf length(cm)		Stalk length(cm)	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1995	308.8 Acc. 18	144.2 Acc.38	16.3 Acc.18	5.7 Acc.40	88.00 Acc.03	59.0 Acc.38	116.0 Acc.18	65.4 Acc.38
1997	386.0 Acc.41	141.2 Acc.46	16.4 Acc.67	4.2 Acc.48	102.0 Acc.41	61.2 Acc.46	163.8 Acc.41	82.6 Acc.48
1999	168.4 Acc.73	68.0 Acc 83	12.8 Acc.73	2.4 Acc.79,82	66.2 Acc.73	35.6 Acc.82	76.5 Acc.69	18.0 Acc.82,83
2000	254.0 Acc.97	80.0 Acc.96	14.6 Acc.92	4.4 Acc.94	82.4 Acc.91	52.6 Acc.96	109.0 Acc.92	36.4 Acc.96
2001	197.2 Acc.102	70.0 Acc 113	11.0 Acc.102	2.2 Acc. 107,112	68.0 Acc.102	38.0 Acc.113	83.7 Acc. 103	23.6 Acc.107
2002	158.4 Acc.115	80.2 Acc.125	10.0 Acc.116	4.8 Acc.125	62.4 Acc.115	38.6 Acc.125	77.2 Acc.115	35.4 Acc125
2002	152.2 Acc.134	78.8 Acc.132	10.0 Acc.179	3.6 Acc.134	56.8 Acc.134	39.5 Acc.138	78.8 Acc.134	32.2 Acc.132
2003	76.2 Acc.153	66.2 Acc.149	6.50 Acc.153	4.20 Acc.149	48.50 Acc.153	40.50 Acc.149	28.30 Acc.153	18.8 Acc.149
2004	92.8 Acc.160	56.6 Acc.170	6.50 Acc.168	2.7 Acc.171	55.5 Acc.166	35.3 Acc.170	39.2 Acc.169	19.5 Acc.171
2005	110.6 Acc.174	72.4 Acc.177	7.2 Acc.176	4.0 Acc.179	58.4 Acc.180	49.4 Acc.182	58.4 Acc. 176,180	14.7 Acc.179
2006	93.2 Acc.192	52.6 Acc.186	7.2 Acc.193	4.0 Acc. 184,190	48.2 Acc.192	32.4 Acc.186	44.4 Acc. 185,194	15.6 Acc.183
2007	79.0 Acc.203	65.8 Acc.204	7.6 Acc.206	4.5 Acc. 197	55.6 Acc.204	44.7 Acc. 197,207	37.4 Acc.197	16.0 Acc.206
2008	68.4 Acc.210	53.6 Acc.211	4.2 Acc. 210,211	62.8 Acc. 215,217	57.0 Acc.209	41.0 Acc.212	27.0 Acc.211	10.0 Acc.212
2009	63.4 Acc.219	40.4 Acc.223	2.8 Acc.225	1.7 Acc. 224	-	-	-	-
2009	68.0 Acc. 237,239	35.6 Acc.244	-	-	-	-	-	-
2010	81.2	44.4	3.0	1.6				

Germplasm AP. 03/11

Germplasm AP. 01/11

Germplasm AP. 02/11

Places surveyed during 2011

Sl. No.	Place of collection	Mandal	No.of accessions collected
1	Kavuripalem	Chirala	2
2	Bullayapalem	Chirala	2
3	Bapatla drivers colony	Bapatla	1
4	Amudalapalli	Nizampatnam	1
5	Balavaripalem	Nagaram	1
6	Repalle	Repalle	1
7	Peturu	Bapatla	1
8	Kadavakudurugattu	Nizampatnam	1
9	Gudluru	Nagaram	1
10	Ponnaluru	Repalle	1
11	Mulukuduru	Ponnuru	1
12	Vegendla	Chebrolu	1
13	Kakumanu	Kakumanu	1

Performance of germplasm during 2012

1) Design: Observational

2) Plot size: 12 trees/accession

3) Spacing: 3 m x 3 m and 4 m x 4 m

4) Treatments: A total of 262 accessions were planted during the years 1991, 1993 to 1995, 1998 to 2004, and 2006 to 2011.

Existing germplasm blocks are evaluated for growth parameters. Data on palm height, stem girth, number of leaves produced, lamina length, lamina breadth and petiole lengths have been recorded for all the 12 germplasm blocks planted from the year 1991 to 2004 and data is given in Table 60.

Biometrical parameters recorded in different accessions is presented in Table 60.

Out of the 13 accessions planted during 1991, mean plant height was maximum in accession 4/91 (8.1 m) followed by Acc 6/91 (8.1). Maximum stem girth of 1.92 m was recorded in Accession- 4/91 followed by accession 13/91 (1.82 m). Among the 1993 planted accessions, maximum palm height (5.6 m) and stem girth (1.55 m) was recorded with accession 17/93 and 16/93. Accession 17/93 was superior with regard to leaf parameters also. Of the 14 accessions of 1994 collection, maximum plant height (7.5 m) was recorded in accession 37/94 and the highest number of leaves was recorded with accession 32/94 (17.3). Stem girth recorded was maximum in accession 25/94 (1.87 m).

Among the 13 accessions of 1995, accession 42/95 has recorded higher values in terms of palm height and leaf number. Stem girth was found the highest in 40/95 accession. The maximum palm height in 1998 accessions has been recorded with accession 56/98. The maximum stem girth has been observed in 58/98, while the maximum leaf number was recorded in 57/98.

Among the 8 accessions of 1999, palm height was the highest in accession 64/99. Number of leaves produced were the highest with accession 66/99 followed by 64/99 and62/99. Among the 18 accessions of 2000, height of the accession was the highest with accession 68/00. Number of leaves produced were higher in accession 75/00.

Of the 45 accessions of 2001 collection, plant height and number of leaves produced were higher in accession 121/01. Among the 18 accessions collected from Nalgonda district, plant height and number of leaves produced were the highest in 136/02 accession and higher leaf parameter values was observed in 135/02 over the other accessions.

Out of 13 accessions collected locally in 2003, accession 164/03 has shown higher palm height. The number of leaves was the highest in accession 164/03 and all the other leaf parameters recorded were higher in accession 173/03. Among the 2004 planted germplasms, accession 179/04 has recorded the highest palm height and the accession number 182/04 produced the highest number of leaves.

Gen. 16: Growth and development studies in Palmyrah

Pandirimamidi

The project was initiated during October 2007.

1. Early juvenile stage -5 years age (2006 Block)

Growth rates have been recorded at fortnightly intervals in 10 plants of 2006 block. In the early juvenile stage (5 year old plants), rate of petiole growth was slow and ranged from 1.94 mm to 2.75 mm among the different leaves in the same plant (Table 61). Growth rate was slower in the oldest leaf and comparatively faster

Table 60. Biometrical observations recorded during January 2012 (Pandirimamidi)

Block	Acc/ value	Palm height [m]		Stem girth [m]		No. of leaves		Lamina length [cm]		Lamina width [cm]		Petiole length [cm]	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1991	Acc	4	11	4	11	12	2	6	11	8	10	8	2
	value	8.14	5.80	1.92	1.51	13.0	11.2	1.21	0.83	1.57	1.22	1.64	1.04
1993	Acc	17	14	16	18	23	14	17	20	17	20	14	20
	value	5.64	3.68	1.55	1.37	14.2	11.2	1.12	0.79	1.39	1.13	1.41	1.18
1994	Acc	37	29	25	35	32	24	36	26	36	25	32	25
	value	7.50	2.36	1.87	1.29	17.3	12.0	1.22	0.89	1.68	1.17	1.53	1.26
1995	Acc	42	39	40	45	39	50	41	44	47	39	40	39
	value	3.40	1.24	1.71	1.21	20.7	11.0	0.94	0.80	1.34	1.09	1.39	0.95
1998	Acc	56	58	58	53	57	58	56	53	54	58	57	58
	value	5.00	2.36	2.10	1.43	14.4	11.5	1.11	0.76	1.50	1.07	1.45	1.13
1999	Acc	64	59	-	-	66	59	66	59	65	59	65	62
	value	3.44	1.20	-	-	18.8	12.4	0.90	0.76	1.32	1.12	1.31	1.07
2000	Acc	68	78	-	-	75	77	84	79	84	79	68	79
	value	2.10	0.31	-	-	20.0	9.2	1.05	0.50	1.59	0.46	1.55	0.36
2001	Acc	121	112	-	-	105	112	121	129	125	94	121	129
	value	2.75	0.15	-	-	20.8	8.0	1.03	0.47	1.24	0.26	1.25	0.55
2002AP	Acc	136	131	-	-	136	138	135	131	133	131	133	131
	value	1.25	0.46	-	-	16.0	11.8	1.15	0.73	1.69	1.07	1.63	0.67
2002TN	Acc	149	159	-	-	150	160	149	157	149	163	149	163
	value	1.34	0.58	-	-	16.8	5.0	1.02	1.71	1.41	0.38	1.37	0.47
2003	Acc	164	174	-	-	167	176	165	168	173	168	164	168
	value	1.85	0.26	-	-	19.0	8.4	0.90	0.48	1.35	0.62	1.44	0.53
2004	Acc	179	187	-	-	182	190	177	187	179	185	179	185
	value	0.68	0.21	-	-	16.0	6.2	0.81	0.42	1.21	0.65	1.02	0.60

Table 61. Growth and development of leaves in juvenile stage (Pandirimamidi)

Leaf number	Rate of petiole growth (mm)	Rate of lamina growth (cm)	Duration of leaf retention (days)
1	1.9	1.9	98-115
2	2.1	2.5	
3	2.7	2.8	
4	2.8	2.9	

in the youngest leaf. Lamina growth also exhibited the same pattern and it was slower (1.86 cm) in older leaves and faster (2.95 cm) in younger leaves. Duration of leaf retention ranged from 98 to 115 days among different leaves.

2. Juvenile phase: 8 years age (2003 Block)

In the juvenile plants of eight years old, petiole growth ranged from 6.43 cm to 12.10 cm (Table 62). The petiole growth rate was slower in older leaves and relatively faster in younger leaves, whereas, rate of lamina growth ranged from 2.10 cm to 11.92 cm. The

Table 62. Growth and development of leaves in juvenile stage (Pandirimamidi)

Leaf number	Rate of petiole growth (cm)	Rate of lamina growth (cm)
1	6.4	2.1
2	6.2	2.9
3	8.6	2.1
4	8.9	4.8
5	9.6	4.9
6	10.3	7.5
7	9.9	9.7
8	11.7	11.7
9	12.1	11.9
10	11.5	11.1

lamina growth rate also showed slower growth rate in older leaves and faster growth rate in younger leaves. The average rate of leaf emergence in 10 palms ranged between 28.40 days to 30.55 days.

3. Adult phase: 1991 Germplasm

In the adult phase, the rate of petiole growth varied from 2.2 cm to 11.7 cm among different aged leaves

(Table 63). The petiole growth rate was relatively faster in older leaves and slower in younger leaves. The petiole growth rate in female palms also has shown a similar trend and varied between 3.2 cm to 10.7 cm in different ages of leaves. The rate of leaf opening ranged from 26.5 days to 30.4 days in different age of leaves in male palms and it was in the range of 27.2 days to 30.5 days in female palms.

4. Inflorescence growth rate

Male palms started giving out the inflorescences in the second week of December (from 8.12.2011) compared to female palms which has started giving out the inflorescences in the third week of December (15.12.2011) and it continued up to 26.3.2012 in male palms and up to 15.3.2012 in female palms. Mean number of inflorescences recorded was 7.5 in male palms and 7.0 in female palms (Table 64). The mean length of inflorescences was 1.1 m in male palms and 1.2 m in female palms. The mean growth rate of inflorescence at 15 days interval recorded was 9.6 cm in male palms and 10.1 cm in female palms.

Killikulam

Experiment on rate and percentage of germination of seeds and production of tubers with reference to varied seed weight is being continued. Twenty seeds in each, from single, double and triple seeded fruits were selected and three range of seed weight *viz.*, 100-150 g, 150-200 g and 200-250g were selected and sown on 21.10.2011 in mound nursery. The speed / rate of germination and percentage of germination in each category of seeds were recorded and the results are furnished below (Table 65).

The results showed that the seeds of minimum seed weight ie.100-150 g recorded the maximum germination percentage irrespective of the number of seeds per fruit, the highest (96) being in the triple seeded fruits. As far as the rate of germination is concerned, the seeds with medium weight ie.150-200 g recorded the highest value in all the categories of fruits. The maximum value (44.7) was recorded in triple seeded fruits. Ten tubers were uprooted at 135 days after sowing for recording the tuber weight and other characters. The details are given in Table 66.

Table 63. Growth and development of leaves in adult palms (Pandirimamidi)

Leaf number	Rate of petiole growth (cm)		Rate of leaf opening (days)		Length of crown leaf at petiole formation (m)	
	Male	Female	Male	Female	Male	Female
1	11.28	10.65	30.2	29.7	0.99	1.02
2	11.66	9.92	29.5	27.2	1.01	0.88
3	9.71	9.32	30.4	30.5	0.92	0.97
4	7.80	10.23	26.5	29.5	1.00	1.03
5	7.74	8.52	29.0	27.7	1.02	0.92
6	8.07	7.46	30.5	30.0	1.00	1.04
7	5.65	4.33	29.5	29.5	0.93	0.97
8	2.23	3.15	30.2	30.2	0.85	0.86
9	2.99	3.95	28.5	29.2	1.03	0.93

Table 64. Inflorescence growth rate in male and female palms (Pandirimamidi)

Palm No.	Number of inflorescences	Period of production	Rate of growth/ 15 days (cm)	Mean length of inflorescence (m)
Male				
P1	8	8/12/11 to 14/3/12	8.53	1.22
P2	7	21/12/11 to 1/3/12	6.07	1.03
P3	7	14/12/11 to 26/3/12	11.46	1.15
P4	8	5/12/11 to 20/3/12	12.15	0.97
Mean	7.50		9.55	1.09
Female				
P1	5	15/12/12 to 25/2/12	9.61	1.33
P2	8	19/12/11 to 6/3/12	11.29	1.28
P3	7	19/01/12 to 15/3/12	10.12	0.91
P4	8	21/12/11 to 1/3/12	9.25	1.24
Mean	7.00		10.06	1.19

Table 65. Rate and germination percentage in varied seed weight (Killikulam)

Details	Single seeded fruits			Double seeded fruits			Triple seeded fruits		
	Weight of seeds (g)			Weight of seeds (g)			Weight of seeds (g)		
	100 - 150 g	150-200 g	200 - 250 g	100 - 150 g	150-200 g	200 - 250 g	100 - 150g	150-200 g	200 - 250 g
Rate of seed germination	20.9	29.1	18.6	37.3	42.2	25.9	31.1	44.7	23.8
Percentage of seed germination	84	80	64	92	92	88	96	92	80

Table 66. Characteristics of tuber collected from varied seed weight (Killikulam)

Details	Single seeded fruits			Double seeded fruits			Triple seeded fruits		
	Weight of seeds (g)			Weight of seeds (g)			Weight of seeds (g)		
	100 - 150 g	150-200 g	200 - 250 g	100 - 150 g	150-200 g	200 - 250 g	100 - 150g	150-200 g	200 - 250 g
Weight of whole tuber (g)	54.0	86.0	94.0	56.0	82.0	92.0	62.0	76.0	84.0
Length of tuber (cm)	34.6	24.6	25.0	28.4	26.2	25.0	21.8	25.6	24.4
Girth of tuber (cm)	7.2	7.6	9.0	6.8	8.0	8.8	6.6	7.0	9.0
Weight of tuber with out skin (g)	40.0	60.0	78.0	42.0	64.0	72.0	48.0	54.0	68.0

The results showed that weight of whole tuber, girth of tuber and weight of tuber without skin were maximum in single seeded fruits. More over, all the parameters studied were found to record maximum values in the category of seeds that had the maximum (200-250 g) seed weight, irrespective of seed number in fruits.

The seed tubers, five number in each of the above three categories, have been transplanted in poly bags for studying the feasibility of transplantation of the seedlings after definite period of sowing.

7.2 Crop Production

Agr. 9 : Studies on the influence of levels of defoliation on inflorescence sap yield and tender fruit yield in palmyrah

Killikulam

The following are the details of treatments imposed both in male and female trees to study the influence of defoliation on inflorescence sap and fruit yield.

T1 : 90% defoliation of leaves
T2 : 70% defoliation of leaves
T3 : 50% defoliation of leaves
T4 : 30% defoliation of leaves
T5 : Control

The trial is being continued for the fifth year and during the reporting period, recording the yield of fruits in female trees and inflorescence numbers in male trees were done right from flowering period. Based on the observation, it is evident that the trees which were defoliated to the level of 30% continued to record the maximum no. of inflorescences both in female and male trees. The result showed that the trees which were defoliated to the level of 30% recorded the maximum no. of bunches/tree and total no. of fruits/tree followed by 50% defoliation (Table 67).

Observations on total Chlorophyll content was made for male and female trees separately and the results showed that there was no definite influence of defoliation treatments on this parameter. However, maximum values were obtained in 50% defoliation followed by control.

Pandirimamidi

The trial was initiated during October 2007 with male and female palms available in the farm. Defoliation was carried out during October in all the blocks as per the treatments. Emergence of inflorescences began during January and tapping was resorted to and continued up to the end of April 2011.

In male palms, the highest inflorescence sap yields (104.8 l) have been recorded with 30% defoliation which is significantly superior over other treatments (Table 68). 70% defoliation treatment has recorded the lowest inflorescence sap yields (39.6 l). Mean number days taken for initiation of flowering ranged from 24.3 to 62.8 among the treatments. Early initiation of flowering (24.3 days) was recorded with control treatment. When yield of inflorescence was verified month wise, the highest inflorescence sap yields have been recorded in February followed by March month.

Table 67. Influence of defoliation on mean number of inflorescences in male and female trees and fruit yield in female trees (Killikulam)

Treatments	Mean no. of inflorescences		Fruit yield in female trees	
	Male	Female	No.of bunches/tree	Total no. of fruits /tree
90 % Defoliation	6.7	6.5	6.7	61.2
70 % Defoliation	5.7	9.5	10.0	75.7
50 % Defoliation	8.3	9.7	9.7	90.0
30 % Defoliation	9.7	10.5	11.0	100.0
Control	8.0	9.2	9.2	72.5
S.E(d)	0.29	0.48	0.47	2.71
C.D @ 1 %	0.891**	1.477 **	1.447**	18.303 **

Table 68. Effects of different levels of defoliation on the inflorescence sap yield (Pandirimamidi)

Treatment	Days for initiation of flowering after defoliation	No.of days tapped (duration)	Mean no. of inflorescences tapped	Total inflorescence sap yield (l)	Length of matured leaf stalk (m)
Male palms					
30% Defoliation	43.8	82.0	7.3	104.8	182.5
50% Defoliation	58.5	52.3	5.5	51.6	163.3
70% Defoliation	62.8	50.0	6.3	39.6	167.8
90% Defoliation	60.8	43.5	5.8	50.4	150.5
Control	24.3	74.3	6.8	71.9	171.8
SEm+	7.73	5.92	0.71	14.35	6.07
CD (P=0.05)	23.8	18.2	2.21	44.23	18.73

The highest tender fruit yield yield (2.2 kg/bunch) was recorded with the control (no defoliation) treatment followed by 30% defoliation(1.9 kg/bunch) (Table 69). 90% defoliation treatment has recorded the lowest tender fruit yield yield (1.0 kg/bunch). Mean no. of bunches per plant and mean no. of fruits per bunch were also the highest with no defoliation treatment i. e., 8.6 and 17.1, respectively followed by 30% defoliation. 90% defoliation treatment has recorded the lowest values in terms of mean no. of bunches per plant and mean no. of fruits per bunch (Table 70).

Mean number of days taken for initiation of flowering ranged from 20 to 40 among the treatments. In male palms, the highest inflorescence sap yield (136.8 l) was recorded with control followed by 50% defoliation (113.6 l) and 30% defoliation (108.3 l). When yields of inflorescence sap was verified month wise, the highest inflorescence sap yields have been recorded in February followed by March month. In female block, the highest inflorescence sap yield have been recorded in 30% defoliated palms (159.2 l) followed by control (58.8 l). In female palms inflorescence sap yield was the highest in March followed by April month.

Table 69. Tender fruit yield yields in female palms recorded during 2012 (Pandirimamidi)

Treatment	Mean no. of bunches per plant	Mean no. of fruits per bunch	Average wt. of bunch (kg)	Average wt. of fruits in bunch (kg)	Mean yield of tender fruit yield (kg/bunch)
30% defoliation	7.9	15.4	15.7	13.0	1.95
50% defoliation	6.6	16.1	14.6	12.5	1.53
70% defoliation	6.8	15.5	14.1	11.6	1.50
90% defoliation	6.3	10.7	7.0	5.7	0.98
Control	8.6	17.1	16.8	14.00	2.16
SEm±	0.22	0.57	0.66	0.62	0.18
CD (P=0.05)	0.68	1.72	1.99	1.90	0.55
CV (%)	6.88	8.50	10.82	12.36	25.87

Table 70. Effects of different levels of defoliation on the inflorescence sap yield (Pandirimamidi)

Treatment	Days for initiation of flowering after defoliation	No.of days tapped (duration)	Mean no. of inflorescences tapped	Total inflorescence sap yield (l)	Length of matured leaf stalk (m)
Male palms					
30% Defoliation	40	43.5	8.5	108.3	2.03
50% Defoliation	20	56.0	11.8	113.6	1.90
70% Defoliation	20	53.3	8.3	65.5	1.80
90% Defoliation	26	44.8	7.3	93.8	1.79
Control	25.6	47.8	10.3	136.8	1.90
SEm±	5.64	9.0		25.2	0.09
CD (P=0.05)	NS	NS		NS	NS
Female palms					
30% Defoliation	66.5	48.8	10.5	159.2	1.66
50% Defoliation	116.2	26.3	10.8	47.4	1.67
70% Defoliation	116.7	30.0	9.8	56.7	1.78
90% Defoliation	134.5	3.0	6.5	1.7	1.74
Control	46.5	54.5	10.8	58.8	1.83
SEm±	23.4	11.7	-	45.9	0.14
CD (P=0.05)	NS	NS	-	NS	NS

NS= Non Significant

Palm of 30% defoliation

7.3 Post harvest technology

PHT-1: Standardization and commercialization of inflorescence sap extraction and inflorescence sap based products (Jaggery, Palm Sugar and Candy)

Pandirimamidi

Experiments were conducted for increasing the flow of inflorescence sap (neera) by different types of cut for spathe *i.e* control, cross, V channel and central hole in various spathes of the same palm. Results showed among the treatments, V type cut yielded more sap as compared to other types of cut (Table 71).

Table 71. Effect cut surface shape on inflorescence sap yield (ml) (Pandirimamidi)

Type of cut	R1	R2	R3	R4	R5	Mean
Control	400	200	300	200	100	240
V Channel	600	300	400	200	150	330
Cross	0	0	200	100	0	60
Central hole	0	0	100	0	0	20

CD (P=0.05):137.87, CV :58.24%, SEm:42.32

Tapping was initiated with traditional practice and on the second day of flow of inflorescence sap and various chemicals were applied to the sliced portion of the spathe. The results showed that the ethrel (Ethephon) applied spathe gave more yield (almost double) followed by citric acid than control (Table 72).

Table 72. Effect chemical application on cut surface on inflorescence sap yield (ml) (Pandirimamidi)

	R1	R2	R3	R4	R5	Mean
Control	400	300	500	200	300	340
Ethephon	800	700	900	500	600	700
EDTA	300	400	500	300	300	360
CaOH	300	400	600	400	400	420
BHT	600	400	700	500	500	540
Citric acid	500	600	800	500	500	580

CD(P=0.05) : 90.75, CV=13.1%, SEm=30.5

For improving the shelf life of the inflorescence sap by using various preservatives i.e sodium benzoate, KMS and citric acid with prior heating for 15 min. at 90°C, samples were analysed for quality at 24 h intervals. Results showed that neera can be preserved up to one day only, after which off flavour and fermentation starts.

PHT. 2: Standardization of tuber flour based food products (like pizza, bakery items, confectionery, health mix etc.)

Pandirimamidi

Experiments were conducted for identifying the maturity stage of tubers for higher nutritive values. Total eight samples from eight weeks age to 15 weeks after planting were analyzed and results showed that samples of 12 weeks and 13 weeks are having higher nutritive values than other samples. Lot of variations among the samples occurred due to genetic variability.

Experiments were conducted for preparation of flour and suji from palmyrah tubers by various methods *i.e.*, autoclave cooked and dried, open fired, fired in iron tin and directly dried. Results showed that, autoclave cooked followed by drying in tray drier gave good quality of flour as compared to other methods.

PHT. 4: Standardization of preservation technique for Palmyrah tender fruit endosperm

Pandirimamidi

During the period, physical properties of tender fruit were measured. Average weight of tender fruit, 75 days after flower initiation, varied from 0.62 kg to 1.25 kg, diameter from 33 cm to 45 cm, height from 13 cm to 15 cm and average weight from 75 g to 80 g and about 25% tender fruits were mostly three seeded with equal distribution and rarely two seeded and single seeded.

Killikulam

Utilization of palmyrah plant parts for the extraction of fibre and fuel

Purchase of Palmyrah fibre extractor machine from Krishi Vigyan Kendra, CTRI, Rajanagaram Mandal, Andra Pradesh was completed. As a part of the study, a total of three fibre extraction (private) units were visited to assess the ongoing local practice of fibre extraction by the farmers.

It was noted that the efficiency of machines vary with the provision for hydraulic system for defibring of leaf bases. It also depends on the no. of spikes and length of spikes present in the frame of defibring unit. On enquiry from the farmers, it is assumed that about 36-50 leaf bases are required for getting one kg of fibre. One bundle is weighed as 56 kg and the sale price of such bundle is around Rs.1,600/ kg of bundle. The periodicity of cutting of leaf bases is once in a year only.

Standardization of preservation techniques for palmyrah tender fruit endosperm

Preparation of dehydrated nungu slices (candy) was attempted. Firm and semi ripe palmyrah tender fruits were selected for preliminary trial. The selected fruits were washed thoroughly in water and individual tender fruit endosperm kernel was separated and peeled and cut into slices of approximately 0.8 -1 cm thicknesses. The slices were blanched for 5 min. in boiling sugar syrup (40-60° brix) containing citric acid (0.3-0.5 %) and potassium meta bisulphite (0.1%) and kept overnight

in the same syrup. The fruit to syrup ratio was maintained at 1:1.5. Next day, the slices were drained and spread over trays and dried at 80°C for 1 h and 60°C for 6-7 h on a cabinet drier. Dried nungu slices were packed in plastic pouches and stored at room temperature for selection of the best treatment.

Recovery of edible portion and characteristic of the palmyrah tender fruit endosperm

Sl. No.	Particulars		Qty
1.	Weight of tender fruit endosperm (eight nos)	:	736 g
2.	Weight of the peel	:	148 g
3.	Weight of the edible portion	:	588 g
4.	Recovery of edible portion from tender fruit endosperm (%)	:	79.89
5.	Peeling loss (%)	:	20.10
6.	Average individual weight of the fruit endosperm	:	88.20 g
7.	Appearance of the tender fruit endosperm	:	White, soft gelatinous with little water inside the kernel

The dried tender fruit endosperm kernel (dried nungu) samples were evaluated organoleptically after one month of storage. All the samples were noticed with slight yellow colour development. Based on the sensory evaluation, the dehydrated samples treated with sugar syrup concentration of 50 and 60° brix was found to be acceptable in sensory qualities except slight colour change. The trial will be repeated with treatments 50 and 60° brix sugar syrup containing citric acid (0.5 %), potassium meta bisulphite (0.1%) and antioxidants like L- ascorbic acid with various temperatures of 40, 50, 60,70°C during osmosis to prevent color development during drying and storage.

VIII. Experimental results in Sulphi Palm (*Caryota urens*)

Gen. 17: Collection, conservation and evaluation of Sulphi germplasm

Jagadalpur

Survey was conducted for identification of germplasm in Kondagaon, Bakawand and Dantewada districts and five new palms were marked for further observations and simultaneously seeds of selected palms were collected for germination study. Among the thirteen germplasms identified, eight germplasm were tall type, three were semi dwarf and two were dwarf types. Among the selected palms, plant height was in the range of 8.6 m to 12.3 m in tall types. The maximum plant height (12.3 m) was observed in Dantewada district which have erect type as well as drooping types of plant (Table 73). The girth was in the range of 150 cm to 175 cm. Quantity of sap flow is maximum in drooping type of plant (26-28 l/day/tree) as compared to the erect type of palm. However, tall plant gave maximum sap as compared to semi dwarf and dwarf type of plant.

The observation of five year old sulphi palm indicated that, the leaf unfurling takes two months during March to September and three months during October to February months and 5-6 months was required for new emerging leaves. The growth rate of leaf was 4.0-4.5 cm/day during rainy season.

Effect of seed treatment on germination

Seeds from ripened fruits were extracted and treated with different treatments *viz.* T1-Cow dung slurry (dip for 7 days), T2- Hot water treatment (dip for 10 min), T3-Acid treatment (H_2SO_4, 98 % conc., dip for 10 min.) and T4- Control. After treating, the seeds were sown in nursery in complete randomized block design with five replications. The observation on days for germination and germination percentage was taken. The germination was early (90-120 days) for seeds treated with cow dung slurry as compared to hot water (120-150 days) and acid (150-180 days) treatments (Table 75), whereas, under control it took maximum days (300-360) for germination. The highest germination percentage (50-60) of sulphi seed was recorded in cow dung slurry followed by hot water (40-50) and acid treatment (30-40). The germination was the lowest (10-20%) in the control treatment.

Table 73. Survey for Sulphi germplasm

Sl. No.	Name of Farmer	Village	Plant type	Plant height (m)	Number of leaves	Girth (cm)	Length of petiole (m)	Total leaf length (m)	Quantity of sap/ day/tree (l)
1	Lakhan	Kondagaon	Tall	10.1	20	160	1.60	4.50	22-25
2	Chabilal	Dantewada	Tall (Drooping)	11.5	19	160	1.50	4.65	26-28
3	Sita Ram	Dantewada	Tall (Erect)	12.3	20	175	1.55	4.70	24-26
4	Shobharam	Ulnar	Tall	9.5	19	155	1.40	4.00	25-26
5	Sobha ram	Pikepal	Tall	8.6	18	150	1.30	3.90	24

Gen. 18: Growth and development studies in Sulphi palm

The growth observation of palms of different age group was undertaken. No. of leaves and root length were found to increase as age of seedlings increased from three months to one year, whereas number of roots remained constant in seedlings of different age groups (Table 74).

Table 74. Growth observation of seedling plants

Age of plant	Root length (cm)	Shoot length (cm)	No. of leaves	No. of roots	Root girth (cm)
Three months	8.0	05.0	1.0	4.0	2.0
Six months	12.0	08.0	2.0	4.0	2.0
One year	14.0	10.0	4.0	4.0	4.5

Inflorescence sap composition

The chemical composition of sulphi sap was estimated and TSS of sap was found to be 8.9-10.2%, reducing sugars 3-3.5%, total sugars 6-7.5%, pH 3.25-3.50 and acidity 0.21-0.30%. Sap production increased during winter months as compared to summer months up to 5-8 l/day. During rainy season, the sap flow was very little or sometimes stopped and the sap was insipid in taste.

Table 75. Effect of different treatments on germination of sulphi seed

Sl. No.	Treatments	Days for germination	Germination (%)
1.	T-1= Cow dung slurry (dip for 7 days)	90-120	50-60
2.	T-2= Hot water (dip for 10 min)	120-150	40-50
3.	T-3= Acid treatment (H_2SO_4,98% conc, dip for 10 min.)	150-180	30-40
4.	T-4= Control	300-360	10-20
	SEm±	4.91	1.64
	LSD at 5%	15.14	5.07

Gen. 19: Documentation of ethno-botanical information on Sulphi palm in Bastar region of Chhattisgarh

The mature wood is strong, heavy and durable and used over dug well for making platform, to pull irrigation bucket for irrigating fields through channel system. People of Bastar region makes a circular fencing by locally available trash and do not allow outsiders to enter near the tree and consider the tree as "kalp vriksha".

The inflorescence should be cut for first time for sulphi sap, known as "*chepti-meta*". The palm having more girth is known as "*Bhainsa sulphi*" which provides inflorescence sap of sour in taste, whereas, the palm having less girth is known as "*Sanp sulphi*" which provides inflorescence sap of little bit sweet in taste. Wood is also used for making huts or bed for relaxing in the field, and leaves are used for protection of vegetables.

Special grant scheme:

Title of the project: Identification and management of factors responsible for wilt of sulphi palm (*Caryota urens*, L.) in Bastar plateau.

Jagadalpur

Principal Investigator : Shri Raja Ram Bhanwar, Scientist (Plant Pathology)

Co- Investigators

1. Shri Ashwani Thakur, Scientist (Agronomy)
2. Dr. L.S.Verma, Scientist (Horticulture)
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Senior Research Fellow

Shri Prahlad Singh, (Plant Pathology)

Objectives

i. To survey and monitoring of wilt incidence in Bastar.

ii. To study of symptomatology of wilt in Sulphi palm

iii. To develop the procedure for diagnosis of causal organism and etiology study.

iv. To find out management practices for wilt of Sulphi palm

Symptomatology of wilt in Sulphi palm

Symptomatological studies were made on the basis of visual observation of wilt in almost all parts of Bastar district taking into account different age group of plants.

1. Wilt: Three types of wilt affected symptoms were observed during the survey of farmers' field.

The first symptom was observed as visible symptoms appearing on top of the newly emerged leaf (Bud rot) which is characterized by discoloration of top young leaf from the natural green to brownish color, later on resulting in complete drying or wilting of leaves.

The second symptom, wherein lower or older leaves becoming pale yellow color to brownish color, later on resulting in drying and death of plant.

The third symptom, wherein all leaves of plant showing chlorotic symptom and converting into pale yellow to brown color, later on the whole plant wilting and ultimately resulting in death of palm.

Wilt of sulphi palm

2. Leaf blight: Initial symptoms were observed in any one leaf blade of plant drying characteristically as brown colored, drying of leaves starting from the margin. This type of symptoms developed in all wilted palm initially.

Several spots on leaves were straw colored with dark brown, irregular shaped and pale brown halo around the spots and several rod shaped spores formed on the spot. These symptoms were observed in nursery plant or in less than six year old plants.

3. Stem cracking: This type of symptom was observed generally in stem of older plants (more than 10 year

old). The stems cracked vertically at the bottom portion of stem. However, wilted palms did not show such type of symptoms.

4. Root rot: Infection was observed below the ground level and roots of wilted palm were water soaked and soft. As disease advances, the roots became rotten and contaminated with some secondary fungus (e.g. *Aspergillus, Bionacteria, Rhizoctonia* etc.), bacteria and nematode. Such type of symptoms was observed in all partially and completely wilted palms.

Mode of infection:

After the symptomatological study, it could be concluded that various symptoms developed on aerial portion of tree which was due to infection on roots. In case of apical leaves drying, deep roots were infected, while in case of middle and lower leaves drying, side and upper roots were infected.

Procedure for diagnosis of causal organism and etiology study

Different fungal strains were isolated from various parts of infected *Caryota* palms e.g. roots, leaf and stem. Further, the isolated fungal strains were purified and multiplied in growing media (Potato Dextrose Agar medium). Thereafter, all the isolated fungal strains were evaluated for pathogenecity in *Caryota* test plant. Among all the different fungal strains, G-1(*Fusarium* spp) followed by B-1(*Aspergillus* spp) were found responsible for developing the wilt symptom in test plant.

Pathogenecity study in wilt of sulphi palm

Management practices for wilt of Sulphi palm

Among different treatment combinations of bio agent, antibiotics and organic manure, *Trichoderma harzianum* incorporated treatment (Basal application of *T. harzianum* + Organic manure) followed by crown application of 100% culture filtrate of *T. harzianum* were found to be superior to check the wilt in sulphi palm.

IX. Centre wise budget during 2011-12 (ICAR Share)

(Rupees in lakhs)

Sl. No.	Centre	Pay	Arrears	Pay Total	Travelling Allowance	Recurring Contingency	Total
1	Aliyarnagar	28.82	14.94	43.76	0.96	8.18	52.90
2	Ambajipeta	43.68	29.50	73.08	1.20	6.75	81.03
3	Arsikere	22.14	13.12	35.26	0.48	2.40	38.14
4	Jagadalpur	11.72	6.18	17.90	0.48	3.46	21.84
5	Kahikuchi	14.54	15.66	30.20	0.48	6.66	37.34
6	Bhubaneshwar	14.46	23.28	37.74	0.48	2.40	40.62
7	Mondouri	15.36	12.46	27.82	0.48	2.40	30.70
8	Ratnagiri	46.11	17.12	63.23	0.73	3.60	67.56
9	Veppankulam	33.14	17.98	51.12	0.72	4.74	56.58
10	Navsari	4.47	1.50	5.97	0.24	2.33	8.54
11	Sabour	4.47	3.40	7.87	0.24	2.33	10.44
12	Killikulam	15.03	12.14	27.17	0.48	2.40	30.05
13	Pandirimamidi	13.56	9.36	22.92	0.48	2.40	25.80
14	Aduthurai	10.18	5.82	16.00	0.24	1.20	17.44
15	Gangavathi	11.51	9.34	20.85	0.24	1.70	22.79
16	Mulde	10.20	6.06	16.26	0.22	1.20	17.68
17	Vijayarai	12.80	7.30	20.10	0.22	1.43	21.75
18	Pasighat	-	-	-	0.35	5.50	5.85
19	Madhopur	-	-	-	0.35	6.00	6.35
20	Pilicode	-	-	-	0.15	3.40	3.55
	Total	**312.19**	**205.16**	**517.25**	**9.22**	**70.48**	596.95

X. Group Meeting/Field Day organised

Group Meeting:

XX Biennial Group Meeting of All India Coordinated Research Project on Palms

The XX Biennial Group Meeting of All India Coordinated Research Project on Palms was held during October 15-17, 2011 at Central Plantation Crops Research Institute, Kasaragod.

The Group Meeting was inaugurated by Dr. H.P. Singh, DDG (Hort.), ICAR, New Delhi on 15th October, 2011. In his inaugural speech he stressed the need to classify coconut cultivation to cultural and commercial farming and to adopt separate strategies for developments for each one of them. Dr. S.B. Dandin, Vice Chancellor, UHS, Bagalkot, Karnataka presided and Dr. P. Rethinam, Former Executive Director, APCC and Mr. Thomas Mathew, Chief Coconut Development Officer, CDB, Cochin were the Guests of honour. The best AICRP on Palms center award was given to Regional Coconut Research Station, Bhatye, Ratnagiri for the year 2010-11 which was sponsored by Lt. Amit Singh Memorial Foundation, New Delhi.

The deliberations of the Group Meeting were conducted in six Technical Sessions dealing with (1) Crop improvement in coconut, oil palm & palmyrah, (2) Variety release proposal, (3) Crop Management in coconut, oil palm & palmyrah, (4) Pest management in coconut, (5) Disease management in coconut, and (6) Post harvest technology in palmyrah & project on sulphi palm.

The Plenary Session was chaired by Dr. S. Rajan, Asst. Director General (Hort.I), ICAR, New Delhi on 17th October 2011. Dr. George V. Thomas, Director CPCRI and PC (Palms) welcomed the delegates and the guests and briefed about the proceedings of meeting. Chairman of the above technical sessions presented the salient recommendations and decisions taken during technical sessions. Dr. H.P. Maheswarappa presented the technical programme for 2012-13 and 2013-14. Based on detailed discussions, the technical programmes were approved.

The major recommendations of the XX AICRP Group meeting:

- Coconut varieties suitable for different regions of Tamil Nadu, Andhra Pradesh, Karnataka and Kerala, yielding on an average 120 to 123 nuts/palm/year were identified.
- The following cropping system models are found to be ideal and hence, recommended for commercial adoption in the respective regions.

XX Biennial group meeting of AICRP on plams

Inauguration of group meeting of AICRP on plams

Best AICRP centre award to Ratnagiri centre

Bhubaneshwar: Coconut + banana + tube rose (in young coconut garden)

Jagadalpur: Coconut + black pepper + carnation + chrysanthemum

Kahikuchi: Coconut + black pepper + turmeric

Veppankulam: Coconut + black pepper + banana + elephant foot yam + coriander

Konkan region of Maharashtra: Coconut+Turmeric+ banana + pineapple + tapioca.

Suitable medicinal and aromatic crops for intercropping in coconut garden to increase the income of the farmers have been identified for different locations.

It was reported that root (wilt) disease of coconut is spreading to newer areas in Tamil Nadu and Karnataka. It was suggested to organize an interface meeting of Scientists and Developmental agencies of Tamil Nadu in such areas to sensitize the need of arresting the spread of the disease and to formulate integrated management programmes.

The new programmes formulated were:

i. Studies on efficacy of aggregate pheromone for controlling coconut pests like rhinoceros beetle and red palm weevil.

ii. Evaluation of promising cocoa clones as mixed crop in coconut/oil palm plantations in different centers.

iii. Evaluation of flowering crops as mixed crops in coconut garden in different centers.

Focus areas of research have been identified in the fields of evaluation of promising lines of various mandate crops for different agroclimatic regions; exploitation of hybrid vigour using local ecotypes and promising location specific accessions; production systems to improve nutrient and water use efficiency and cropping system for mitigating climate change; protection strategies with a focus on use of bioagents; and post harvest technology aimed at product diversification and value addition.

Field Day

Coconut Field Day was organized at AICRP Centre (Horticulture Research Station), Arsikere on 14th February 2012 in collaboration with All India Co-ordinated Research Project on Palms and Agriculture Research Station, Arsikere, KVK, Hassan and State Departments of Horticulture, Agriculture, Sericulture, Animal husbandry and Forestry. Sri. K.M. Shivalingegowda, MLA, Arsikere inaugurated the programme. He stressed the need for soil and moisture conservation and recycling of wastes in coconut gardens. Dr. M.B.Madalageri, Director of Research, University of Horticultural Sciences, Bagalkot presided over the function. Dr. Y.K.Kotikal, Director of Extension, UHS, Bagalkot, Dr. K.G. Parameshwarappa, Dean, College of Horticulture, Mudigere, Dr. H.P. Maheswarappa, Project Coordinator, AICRP on Palms, Kasargod, Sri. Vijaykumar Hallikeri, Deputy Director, Coconut Development Board, Bangalore, Sri. N. Krishnappa, Deputy Director of Horticulture, Hassan and Dr. T.R. Chandrashekar, President, Coconut Growers Association, Arsikere participated as Chief Guests.

Field Day at Arsikere centre

World coconut day celebration at HRS Ambajipet on 02.09.2011

In connection with the World coconut day, the scientists of AICRP on Palms, HRS Ambajipeta organized farmers – scientist interaction meet on 2nd September 2011. Sri Somayajulu, AGM, NABARD, East Godavari District attended as Chief Guest. Dr. S. M. Jaheeruddin, Retd. Associate Director of Research, Godavari zone, Sri. K. Chittibabu, AD Horticulture, East Godavari District, S. Subramanyam, President, Abhyudaya Karshaka Parishad, Mukkamala also participated in the interaction session. Around fifty coconut growers from different mandals of East Godavari District attended the meeting. Sri. Somayajulu, during his key note address, highlighted the importance of coconut palm in our daily life and stressed the importance of mechanization in coconut cultivation and product diversification in order to reduce the cultivation cost and to fetch higher income. The scientists of HRS Ambajipeta briefed the latest production and protection technologies for enhancing the production and productivity of coconut. They also clarified the queries raised by the participant farmers in coconut cultivation. A few progressive farmers were also felicitated on this occasion.

Felicitation to coconut farmers at Ambajipeta centre

XI. Staff Position

HEAD QUARTERS

Project Coordinator's Cell, CPCRI, Kasaragod-671 124, Kerala

Project Coordinator	:	Dr. George V. Thomas (Additional Charge Up to 29th Jan. 2012) Dr. Maheswarappa, H.P. (From 30th Jan. 2012)
Personal Assistant	:	Mrs. K. Narayani
UDC	:	Mr. P. Narayana Naik
Skilled supporting staff	:	Mrs. Meenakshi

ANDHRA PRADESH

Horticultural Research Station, Ambajipeta -533 214, East Godavari Dist.

(Phone: 08856-243847)

Senior Scientist (Horticulture)	:	Dr. G. Ramanandam (From 17-3-2012)
Senior Scientist (Entomology)	:	Dr.N.B.V.Chalapathi Rao
Scientist (Horticulture)	:	Mrs. E. Padma
Senior Scientist (Pathology)	:	Vacant
Scientist (Pathology)	:	Dr. A. Snehalatha Rani
Technical Assistant	:	Sri. Ch. Mallikharjuna Rao
AEO		1. Sri. S. Rambabu 2. Smt. N. Maheswari

Horticultural Research Station, Vijayarai - 534 475, West Godavari Dist.

(Phone: 08812-225826)

Scientist (Agronomy)	:	Sri. B. Prathap
Senior Technical Assistant	:	Vacant
Agricultural Extension Officer	:	Sri. M. Chandra Mohan

Horticultural Research Station, Pandirimamidi, Ramapachodavaram P.O. 533 288, East Godavari Dist.

(Phone: 08864-243577)

Senior Scientist (Horticulture)	:	Sri. G.N. Murthy (From 02-07-2011)
Scientist (Food Sci. &Tech.)	:	P.C. Vengaiah
Technical Assistant	:	A.S.R.Anjaneyulu

ARUNACHAL PRADESH

College of Horticulture and Forestry, Central Agricultural University, Pasighat-791 102, East Siang District.

(Phone: 0368-2224887/0368-2225066 (Fax)

Assistant Professor (Horticulture)	:	Dr. Barun Singh

ASSAM

Horticultural Research Station, Kahikuchi, Guwahati -781 017, Kamrup Dist.

(Phone: 0361-2842513)

Scientist (Horticulture)	:	Dr. J. C. Nath
Scientist (Agronomy)	:	Dr. K.K. Deka
Technical Assistant	:	Mr. P. Bora

BIHAR

Regional Agricultural Research Station, Madhopur, West Champaran
(Phone: 06252-280542)

Scientist (Hort.)	:	Mr. Parma Nand Mandal
	:	Mr. S.C. Narayan (From 18-11-2011)

Bihar Agricultural College, Sabour, Bhagalpur- 813210
(Pone: 0641-2451001)

Scientist (Horticulture)	:	Dr. Ruby Rani

GUJARAT

Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari AgriculturalUniversity, Navsari - 396450
(Phone : 02637-282144)

Scientist (Horticulture)	:	Dr. M.M.Patel

KARNATAKA

Horticltural Research Station, Arsikere -573 103, Hassan Dist.
(Phone: 08174-291565)

Senior Scientist (Hort.)	:	Dr. T.B. Basavaraju
Scientist (Plant Pathology)	:	Dr. V. Devappa
Senior Technical Assistant	:	Mrs. T.N.Lavanya (Contractual basis)
Field Assistant	:	Mr. K.E.Dayananda (Contractual basis)

Agricultural Research Station, Gangavathi -584 227, Koppal Dist.
(Phone: 08533 271443/08533 271034/08533 271030

Scientist (Agronomy)	:	Dr. Sanjeevraddi. G. Reddi
Research Assistant (Technical)	:	Vacant
Field Assistant	:	Ms. Nasareen Banu (from 10.1.2012)

MAHARASHTRA

Regional Coconut Research Station, Bhatye -425 612, Ratnagiri Dist.
(Phone: 02352 – 235077/02352 – 235331 (Fax))

Senior Scientist (Agronomy)	:	Dr. D. D. Nagwekar
Scientist (Plant Breeding)	:	Mr. V. S. Sawant
Jr. Entomologist	:	Shri. S. S. Gurav
Sr. Clerk	:	Smt. S.S. Pednekar
Junior Agricultural Assistants	:	Mr. P. A. ShindeMr. H. B. Yadhav

Agricultural Research Station, Mulde, Kudal Taluk, Sindhudurg Dist. - 416520
(Phone: 02362 244231- 244232/02362- 244231 (Fax))

Scientist (Agronomy)	:	Dr. M. S. Gawankar
Senior Technical Assistant	:	Shri. P. J. Chikhalikar (from June 2011 but posted at ATIC, Dapoli)
Field Assistant	:	Shri. D. B. Patil/ Sou. R. S. Gunjal (from June 2011)

CHHATTISGARH

Saheed Gundadhoor College of Agriculture & Research Institute, Kumharawand Farm, Jagadalpur- 494 005, Bastar Dist.
(Phone: 07782-229150/07782-229360(Fax))

Scientist (Horticulture)	:	Dr. L.S. Verma
Scientist (Horticulture)	:	Dr. S. Agrawal
Senior Technical Assistant	:	Vacant

ODISHA

Department of Horticulture, OUAT, Bhubaneshwar- 751 003
(Phone: 0674-2390463

Senior Scientist (Horticulture)	:	Dr. T. K. Das
Senior Scientist (Agronomy)	:	Dr. K. K. Pattnaik.
Tech. Assistant	:	Mr. P. K. Jena

TAMIL NADU

Coconut Research Station, Aliyarnagar- 642 101, Coimbatore Dist.
(Phone: 04253-288722)

Scientist (Entomology)	:	Dr. K. Rajamanickam
Scientist (Agronomy)	:	Dr. D. Rajakumar
Senior Scientist (Plant Breeding)	:	Dr. S. Geethanjali
Scientist (Plant Pathology)	:	Dr. I. Johnson
Technical Assistant	:	Mr. Panchalingam

Tamil Nadu Rice Research Institute, Aduthurai -612 101, Thanjavur Dist.
(Phone: 0435-2472881)

Scientist (Agronomy)	:	Dr. P. Devasenapathy
Senior Technical Assistant	:	Th.M.Ananad
Agricultural Assistant	:	Mrs. P.Kalaiselvi

Coconut Research Station, Veppankulam- 614 906, Thanjavur Dist.
(Phone: 04373-260205

Senior Scientist (PG&B)	:	Dr. Parthasarathy (Up to 31.1.2012)
Senior Scientist (Agronomy)	:	Dr. S. Thiruvarassan
Senior Scientist (Plant Pathology)	:	Dr. K. Rajappan
AAO	:	Th. B.Sundai
Junior Assistant	:	Mr. R. Saravanan
Office Assistant	:	Mr. P. Chelladurai
Junior Assistant cum Typist	:	Mrs. R. Kokila

Agricultural College & Research Institute, Killikulam -628 252, Vallanad, Tuticorin Dist.
(Phone: 04630-261226/04630 - 261268 (Fax))

Senior Scientist (Horticulture)	:	Dr. P. Nainar
Scientist (Agrl.Food Processing Engineering)	:	Dr.I.Seegan Paul,
Technical Assistant	:	Mr. M. Ananth

WEST BENGAL

Department of Plantation Crops, Faculty of Horticulture, BCKVV, Mondouri (Kalyani) -741 235, Nadia Dist.
(Phone: 033-25827574)

Scientist (Horticulture)	:	Dr. A. Bandyopadhyay
Scientist (Plant Breeding)	:	Mr. D. K. Ghosh
Technical Assistant	:	Mr. A. K. De

KERALA

Central Plantation Crops Research Institute, Kasaragod- 671 124
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Principal Scientist (Agronomy)	:	Dr. R. Dhanapal

Regional Agricultural Research Station, Pilicode, Kasaragod District- 670 533
(Ph.: 0467-2260632/2282737: Mob.: 09447692563.)

Associate Director of Research	:	Dr. Jayaprakash Naik

XI. Publications

AICRP on Palms, 2011. Annual Report for 2010-11. All India Co-ordinated Research Project on Palms. (Eds, Maheswarappa, H. P., Arulraj, S. and George V. Thomas). 105p.

Basavaraju, T.B., Palanna, K.B., Lavanya, T.N., Prashanth, M. and Arulraj, S. 2011. Growth and yield performance of coconut hybrids in *maidan* tract of Karnataka. *Journal of Plantation Crops*, **39** (1): 171-173.

Basavaraju, T.B., Nanjappa, H.V., Umesha, K., Vasundhara, M. and Arulraj, S. 2011. Intercropping of medicinal and aromatic plants in coconut gardens. *Journal of Plantation Crops,* **39** (2): 299-304.

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Emmanuel, N., Chalapathi Rao, N.B.V. and Snehalatha Rani, A. 2011. *Fusarium solani* (Mart.) as a naturally occurring pathogen of bagworm *Pteroma plagiophelps* in coconut. *Insect Environment*, **17** (1): 11-12.

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Gawhankar, M. S., Gajbhiye R.C. and Arulraj, S. 2010. Nutritional requirement of oil palm in Konkan region. *Journal of Plantation Crops,* **38**:183-187.

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Ghosh, D. K., Hore, J.K., Bandopadhyay, A. 2011. Effect of spacing and size of planting material on growth and yield of turmeric grown in coconut plantation . *J. Plantation Crops,* **39** (2):337-39.

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Nath, J. C. and Medhi, G., Saud, B.K., Deka, K.K., Chowdhury, D. and Arulraj, S. 2010. "Kahikuchi Coconut Hybrid-1" – A newly developed coconut hybrid for North East Region. *Indian Coconut Journal,* **53** (4): 21-22.

Thiruvarassan, S., Ganesan, K. , Mohandas, S. Kavitha. M. and Parthasarathy, P. 2012. Performance of aromatic plants as intercrops in coconut garden. *South Indian Horticulture.* **60**:102-104.

Papers presented in Seminar/Conferences

Emmanuel, N, Rao, N.B.V.C. and Snehalatha Rani, A. 2011. Influence of climate change on the outbreak of pests in the coconut farming systems in the Godavari districts of Andhra Pradesh. *In the Proceedings* of the National Seminar on "Climate change– Repositioning Coastal agriculture". pp 130-135. JNTU, Kakinada.

Nath, J. C. and Deka, K. K. 2010. Second generation coconut based high density multispecies cropping system in Assam. In: Abstracts *International Conference on Coconut Biodiversity for Prosperity*. CPCRI, Kasaragod, 25th -28th October 2010; p. 86.

Rao, N.B.V.C, Emmanuel, N. and Snehalatha Rani, A. 2011. Bio control based pest and disease management in coconut – An ecofriendly approach. In: *Proceedings of National Seminar on Environment and Sustainable Development,* October 28th-29th 2011, pp: 74.

Snehalatha Rani, A, Rao, N.B.V.C, Emmanuel, N. 2011. Climate change and its impact on coconut pathology. *In the proceedings* of the National Seminar on "Climate change–Repositioning Coastal agriculture". pp 136-142. JNTU, Kakinada.

XII. Weather data of Co-ordinated Centres (January to December 2011)

COCONUT CENTERS

Aliyarnagar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Evaporation (mm/day)
	Max.	Min.	FN	AN		
January	30.5	18.6	90.5	88.5	—	3.6
February	31.8	18.5	90.5	85.4	84.0	4.5
March	35.1	20.2	90.4	72.8	58.0	5.0
April	33.9	22.8	90.7	72.9	67.3	4.0
May	34.7	24.2	89.4	67.8	7.9	5.5
June	31.9	23.6	93.0	88.3	104.6	5.8
July	31.0	22.4	90.6	84.3	65.6	4.3
August	30.2	-	84.9	83.6	71.1	4.3
September	33.1	-	89.6	84.6	45.0	4.9
October	31.7	-	89.6	84.6	239.3	3.2
November	29.1	-	90.2	85.2	269.0	3.4
December	30.2	-	93.3	87.2	10.6	3.7
				Total	1022.4	

Ambajipeta

Month	Temperature (° C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	26.4	21.5	82.6	72.5	0
February	28.8	23.9	87.7	64.9	24.8
March	32.2	26.2	87.6	71.0	0
April	34.0	29.0	81.1	69.0	26.8
May	36.4	31.5	80.6	68.9	51.0
June	35.3	30.2	78.4	66.4	83.4
July	35.4	28.0	66.9	55.4	219.1
August	33.2	28.3	68.2	61.7	243.4
September	34.0	29.5	64.5	59.0	31.4
October	34.0	29.0	62.3	54.0	121.6
November	31.0	27.0	58.9	53.4	0
December	29.4	24.4	67.0	49.7	0
				Total	801.5

Arsikere

Month	Rainfall (mm)	Temperature (C)		Relative Humidity (%)
		Max.	Min.	
January	-	28.9	10.4	56.3
February	12.8	29.9	10.9	52.9
March	3.2	33.4	13.0	49.1
April	88.6	33.8	19.3	58.8
May	54.6	33.2	20.6	63.6
June	30.4	29.2	19.8	67.8
July	53.0	29.3	18.6	76.9
August	58.4	28.3	18.5	71.5
September	15.0	29.3	16.2	65.4
October	98.0	30.8	16.0	67.4
November	41.2	27.9	12.4	66.9
December	6.0	27.8	10.2	69.1
Total	461.2			

Bhubaneswar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Rainy days (above 25 mm)	Evaporation (mm/day)	Bright sunshine hours
	Max.	Min.	FN	AN				
January	25.0	14.0	85	35	5.0	1	3.4	8.0
February	24.3	17.4	90	34	4.0	1	3.8	8.5
March	31.1	20.3	92	45	5.4	2	5.4	8.5
April	32.5	25.9	90	45	5.4	1	7.5	8.6
May	35.1	27.1	85	55	190.3	8	7.0	7.5
June	35.5	27.2	90	65	196.1	10	5.1	5.1
July	33.0	25.2	90	70	201.2	15	3.5	5.4
August	33.3	26.4	92	70	253.5	15	3.5	5.0
September	31.8	25.7	94	69	280.2	18	3.3	5.4
October	31.8	24.5	90	71	185.3	10	3.3	4.8
November	28.0	20.5	87	55	55.6	1	3.3	5.9
December	23.0	13.9	80	50	45.5	1	3.3	5.2
				Total	1427.5			

Jagadalpur

Month	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)		Wind Velocity (kmph)	Evaporation (mm/day)	Bright sunshine hours
	Max.	Min.		FN	AN			
January	26.9	7.5	0.0	90.0	57.0	2.2	2.5	10.3
February	29.3	10.8	14.6	91.0	48.0	0.0	3.8	8.0
March	32.9	15.5	6.4	87.4	38.7	3.9	5.8	7.7
April	34.6	19.0	41.9	86.5	37.7	5.3	6.4	7.0
May	37.3	22.1	92.1	73.2	31.7	7.4	6.2	7.3
June	31.7	21.5	185.1	86.8	59.3	8.2	4.6	4.5
July	28.6	21.2	317.8	87.3	70.2	6.5	2.6	2.5
August	28.1	21.5	378.6	89.0	70.3	5.7	2.1	2.6
September	27.5	21.0	233.3	90.6	68.5	4.4	2.0	2.9
October	30.0	16.8	0.0	83.8	54.7	2.6	4.1	8.5
November	28.6	10.9	0.0	87.2	57.0	2.4	2.8	8.5
December	28.5	8.6	0.0	90.0	28.0	2.1	2.6	8.5
		Total	1269.8					

Kahikuchi

Month	Temperature (°C)		Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	23.9	10.1	85.6	0.0
February	27.8	13.0	74.1	0.0
March	30.9	16.4	70.6	12.5
April	31.2	22.2	76.3	102.3
May	33.0	24.1	79.0	125.4
June	33.4	26.4	82.0	225.8
July	34.6	26.7	86.6	360.1
August	33.8	25.9	87.4	307.9
September	32.7	25.4	82.5	71.0
October	31.8	24.0	81.4	28.6
November	27.8	16.9	84.5	0.0
December	24.2	11.8	86.2	0.0
			Total	1233.6

Mondouri

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	9.7	24.6	94.8	47.6	0.0
February	14.2	29.4	93.3	40.1	1.0
March	20.6	33.6	90.0	45.3	62.5
April	23.3	34.4	90.5	52.4	69.4
May	25.2	34.5	90.9	64.6	148.1
June	26.5	33.2	93.5	74.5	308.6
July	26.3	32.2	94.3	76.8	407.7
August	26.2	32.3	96.4	79.9	387.3
September	26.3	32.9	95.3	76.4	211.1
October	22.0	32.4	94.9	63.9	91.1
November	18.4	30.3	93.3	54.8	3.8
December	11.8	26.8	93.9	49.4	0.0
				Total	1690.6

Navsari

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	No. of rainy days
	Max.	Min.	FN	AN		
January	30.1	12.0	73	33	0.0	0
February	32.2	14.4	76	33	0.0	0
March	35.5	17.5	75	30	0.0	0
April	35.6	22.6	83	51	0.0	0
May	34.3	26.5	80	57	5.2	1
June	33.8	27.2	89	72	67.1	6
July	30.3	25.5	93	84	482.0	19
August	29.1	25.3	94	88	718.0	23
September	30.3	24.4	94	78	323.7	16
October	35.6	22.3	84	45	1.0	0
November	35.2	19.0	70	34	0.0	0
December	32.4	14.9	80	32	0.0	0
				Total	1597.0	65

Pilicode

Month	Temperature (°C)		Relative Humidity (%)	Number of rainy days	Rainfall (mm)
	Max.	Min.			
January	31.8	18.6	72.0	0	0.0
February	32.4	18.9	66.4	0	0.0
March	33.1	22.1	71.7	0	0.0
April	33.3	23.7	76.2	4	65.8
May	32.7	24.8	73.9	6	50.4
June	29.7	23.4	87.8	28	1038.5
July	29.3	22.9	90.8	30	1048.4
August	29.8	23.2	90.5	29	776.3
September	29.9	22.8	84.7	22	571.1
October	31.6	23.0	78.6	16	286.2
November	32.6	21.5	75.4	9	128.1
December	33.1	19.4	71.1	1	7.2
				Total	3972.0

Ratnagiri

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative Humidity (%)	
			Max.	Min.	FN	AN
January	0.0	-	33.2	17.9	56.2	53.0
February	0.0	-	32.7	18.5	64.9	55.1
March	0.0	-	33.7	21.8	66.7	62.2
April	0.0	-	32.6	24.3	74.7	65.6
May	15.0	1.0	33.3	26.4	75.9	67.9
June	1032.5	24.0	29.7	24.8	91.7	86.2
July	1076.6	26.0	28.0	23.6	94.4	91.4
August	705.2	29.0	28.8	24.1	92.6	88.0
September	318.2	14.0	29.8	23.5	89.6	79.0
October	58.5	4.0	32.7	23.4	77.8	72.4
November	49.2	2.0	34.3	21.6	63.5	58.9
December	0.0	-	33.9	19.0	63.0	57.0
Total	3255.2					

Sabour

Month	Temperature (° C)		Relative Humidity (%)		Rainfall	Wind velocity
	Max.	Min.	FN	AN	(mm)	(kmph)
January	19.3	6.0	91	53	3.0	4.1
February	25.8	3.0	85	43	0.8	3.4
March	31.9	14.7	74	38	36.8	5.7
April	33.9	22.5	77	45	94.5	5.1
May	34.2	22.8	83	59	85.5	7.6
June	32.2	23.2	85	72	337.6	6.9
July	32.1	25.1	90.	77	161.7	6.7
August	30.8	25.5	92	82	458.1	7.3
September	31.0	25.2	89	80	153.3	7.0
October	31.7	22.2	89	68	41.2	2.3
November	27.6	15.4	92	61	0.0	2.1
December	21.2	10.1	94	73	0.0	3.0
				Total	1372.5	

Veppankulam

Month	Temperature (°C)		Relative Humidity (%)		Rainfall
	Max.	Min.	FN	AN	(mm)
January	32.5	21.0	89	62	6.0
February	33.1	21.1	87	59	41.0
March	32.9	27.9	82	58	22.5
April	35.4	26.7	79	58	82.6
May	36.5	30.3	74	54	8.4
June	37.1	30.9	72	53	19.0
July	37.7	30.4	74	52	12.8
August	36.7	30.8	80	61	34.6
September	35.5	26.1	88	58	46.8
October	35.5	27.0	89	58	146.6
November	33.6	25.2	96	73	339.6
December	30.6	26.6	97	71	106.4
				Total	866.3

OIL PALM Centres

Aduthurai

Month	Temperature (°C)		Relative Humidity (%)	Wind Velocity (kmph)	Evaporation (mm/day)	Rainfall (mm)	No. of rainy days
	Max.	Min.					
January	29.7	20.3				26.4	1
February	31.3	20.3	95	5.3	7.3	2.6	1
March	34.5	21.4	95	4.8	9.2	0.0	0
April	35.6	24.2	92	3.9	7.8	125.0	4
May	37.3	25.7	84	6.1	8.6	11.2	1
June	35.9	25.6	79	9.1	6.8	25.6	1
July	34.6	24.8	80	7.6	5.5	104.8	5
August	33.8	24.6	86	6.8	6.1	156.0	4
September	33.9	23.9	85	6.4	7.5	140.4	4
October	32.0	23.4	95	2.7	5.3	215.4	13
November	29.5	22.3	94	4.4	4.6	289.8	12
December	29.0	20.7	93	4.9	4.7	77.8	5
					Total	1175.0	

Gangavathi

Month	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)	
	Max.	Min.		FN	AN
January	29.0	20.0	0.0	77.5	76.7
February	30.5	17.0	0.0	75.2	67.8
March	34.1	17.9	0.0	69.3	75.7
April	35.0	19.1	74.0	79.0	79.0
May	36.7	21.9	61.2	78.9	71.5
June	32.9	20.8	102.5	83.3	64.9
July	32.1	20.4	108.0	88.2	74.5
August	30.6	20.5	33.0	88.4	78.3
September	31.2	20.1	6.2	86.6	74.4
October	32.1	19.3	26.2	81.1	79.7
November	30.4	16.2	0.0	82.4	69.2
December	29.8	12.8	0.0	77.4	71.8
		Total	411.3		

Mulde

Month	Temperature (°C)		Relative Humidity (%)		Sunshine (hours)	Evaporation (mm/day)	Rainfall (mm)	No. of rainy days
	Max.	Min.	FN	AN				
January	34.5	14.5	92	48	8.7	2.8	0.0	0
February	35.2	15.9	92	55	8.6	3.5	0.0	0
March	36.8	19.8	91	51	8.1	4.2	0.0	0
April	36.3	23.3	84	52	8.4	5.0	0.0	0
May	36.4	25.0	84	58	8.2	4.8	1.0	0
June	30.5	24.3	94	88	1.6	3.1	1088.6	25
July	28.8	23.3	95	90	0.4	2.9	1430.6	30
August	28.9	23.6	93	89	1.0	3.2	990.7	30
September	30.3	23.1	94	81	4.5	3.1	546.1	18
October	33.8	23.1	92	64	6.7	3.1	193.6	7
November	35.0	20.1	88	51	8.2	3.3	63.6	2
December	34.9	19.1	90	56	7.5	2.5	0.0	0
						Total	4314.2	112

Madhopur

Month	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)
		Max.	Min.	
January	0.0	20.7	9.5	88.1
February	15.2	28.5	14.1	83.9
March	3.0	34.7	18.8	78.0
April	51.6	37.0	22.0	77.0
May	85.3	39.5	26.5	75.0
June	282.7	38.5	27.4	80.3
July	341.4	36.6	27.9	81.9
August	287.8	36.8	27.7	84.1
September	167.4	36.0	27.5	81.8
October	13.7	36.6	23.6	83.0
November	0.0	31.7	18.9	85.1
December	0.0	22.9	13.1	87.1
Total	1250.4			

Pasighat

Month	Temperature (°C)		Relative Humidity (%)	Rainfall (mm)	Evaporation (mm/day)
	Max.	Min.			
January	22.1	12.0	72.1	51.9	3.0
February	24.8	14.7	71.9	43.7	3.8
March	26.6	16.5	73.0	309.1	3.7
April	28.5	19.0	70.6	138.3	5.1
May	31.3	22.0	72.8	318.2	4.3
June	32.3	24.3	NA	472.0	4.3
July	30.1	24.1	84.8	817.7	3.2
August	32.5	24.1	74.3	399.3	4.6
September	32.6	23.9	75.8	364.7	4.4
October	32.6	29.2	65.7	15.0	4.9
November	28.2	16.4	63.6	2.1	4.5
December	25.8	14.4	64.8	57.7	4.2
			Total	2989.7	

Vijayarai

Month	Temperature °C		Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	38.2	22.6	65	0.0
February	40.7	24.5	64	0.0
March	40.0	23.4	64	67.5
April	38.4	21.1	67	246.6
May	37.5	20.9	72	244.6
June	37.4	20.8	69	77.5
July	36.6	20.6	67	39.0
August	35.6	23.2	65	0.0
September	33.6	24.3	65	0.0
October	32.8	24.9	70	44.0
November	34.1	24.3	64	0.0
December	37.5	21.3	67	0.0
			Total	719.2

Palmyrah Centres:

Killikulam

Month	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)	No. of rainy days
	Max.	Min.			
January	31.4	22.0	24.0	90	2
February	33.4	21.6	0.0	87	-
March	36.0	23.2	0.0	85	-
April	36.1	24.4	71.0	87	4
May	38.5	24.8	0.0	81	-
June	37.4	26.3	14.0	77	1
July	36.4	26.7	4.6	74	1
August	36.6	26.5	0.0	83	-
September	36.1	26.3	26.4	85	1
October	34.6	25.0	217.7	90	10
November	30.5	23.1	148.3	91	12
December	30.6	22.0	16.8	92	4
		Total	522.8		

Pandirimamidi

Month	Temperature (° C)		Relative Humidity (%)		Rainfall (mm)	No. of rainy days
	Max.	Min.	FN	AN		
January	29.4	15.8	97	42	0.0	0
February	31.6	19.0	95	35	0.0	0
March	35.9	22.3	76	42	0.0	0
April	33.8	24.5	96	52	87.0	6
May	36.3	26.5	90	49	31.6	3
June	34.0	27.2	85	52	81.4	4
July	31.2	25.3	96	70	185.2	9
August	27.1	23.1	97	77	405.2	18
September	30.7	24.8	98	73	136.2	10
October	32.0	23.4	95	56	51.6	5
November	31.2	21.4	87	44	0.0	0
December	20.6	13.6	68	29	0.0	0
				Total	978.2	

भाकृअनुप
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