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भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

AICRP on Palms Annual Report 2012-13

AICRP on Palms
वार्षिक प्रतिवेदन
Annual Report
2012-13

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

XXI Annual Group Meeting

Project Report Presentation by P.C. (Palms)

Visit of Shri. Narendra Modi, C.M. of Gujarat to NAU stall

Training Programme on "Capacity Building of Extension Functionaries on Potential of Oil Palm in NEH Region"

Visit to Pandirimamidi Centre

Visit to Ambajipeta Centre

AICRP on Palms

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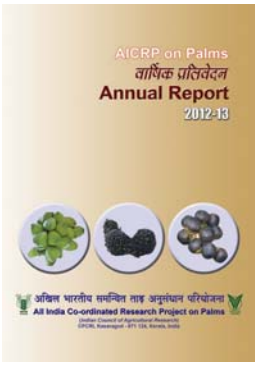

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Contents

I. Preface

Among the horticultural crops, Palms such as coconut, oil palm and palmyrah play a very significant role in contributing to Agrarian sector of our country. To evolve location specific technologies, the All India Coordinated Research Project on Palms is operating in multi-disciplinary team mode in twelve states representing different agro-climatic regions. During the period, nucleus seed gardens for the ten released varieties of coconut have been established. The evaluation of D x D, T x T hybrids of coconut and D x P (tenera) of oil palm are being continued in different locations for higher yield. In Karnataka and Andhra Pradesh, the yield performance of GBGD x PHOT and GBGD x LCOT is found to be superior and they will be recommended for release. In palmyrah, nine accessions from Nellore district of Andhra Pradesh were collected and conserved in the gene bank. Research output from drip-fertigation trials indicated saving of 25 to 50% of NPK fertilizers which could reduce the cost of production significantly. Coconut based integrated farming system with different component crops have been evaluated to improve soil health and increase the farm income. Timely monitoring and implementation of effective management practices have minimized the losses due to the occurrence of pests and diseases. Use of Pheromone lures to manage rhinoceros beetle and red palm weevil in coconut is an integral part of eco-friendly management practices. The results on use of bioagents for managing major diseases of coconut are encouraging. Attempts have been made to address the issues of post harvest value addition in palmyrah. For effective transfer of technologies, various training programmes and other extension activities have been carried out to reach the farmers and other stakeholders.

The Annual Report covers the research results emanated from the disciplines of genetic resources and crop improvement, crop production, crop protection and other related information of coconut, oil palm, palmyrah and sulphi palm pertaining to the period from April 2012 to March 2013. The report contains the results of experiments conducted at 13 centres on coconut, six centres on oil palm and two centres on palmyrah. The entire outcome reflects the multidisciplinary team efforts of the Scientists and the 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 the various objectives outlined in the project.

I record my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for his constant inspiration and guidance which helped to achieve the set targets. My sincere thanks to Dr. N.K. Krishna Kumar, Deputy Director General (Horticulture), ICAR for his valuable guidance and critical suggestions to improve the research output of the project. I acknowledge the continued help and guidance of Dr. George V. Thomas, Director and staff of CPCRI, Kasaragod, Dr. S. Arulraj, Director and staff of DOPR, Pedavegi (A.P.), Assistant Director General (Hort. I), and the staff at ICAR, New Delhi for smooth functioning of the Project. Further, I profusely acknowledge the technical and administrative support given by the Vice Chancellors, Directors of Research, Heads of the Divisions and Heads of Stations of various Agricultural/Horticultural Universities and Central Agriculture University for effective functioning of the Project.

I take this opportunity to express my sincere thanks to Dr. T.B. Basavaraju, Dr. S. Geethanjali, Dr. V. Devappa, Dr. N.B.V. Chalapathi Rao, Mr. M.S. Gawankar and Dr. Sanjeevraddi G. Reddi and other scientists for helping in compilation of the report. The assistance provided by Smt. K. Narayani, Shri P. Narayana Naik and Smt. K. Meenakshi in Project Coordinator's Cell is gratefully acknowledged. The assistance provided by Dr. B.A. Jerard and Dr. K. Subaharan for editing the report and Smt. K. Sreelatha and Dr. Alka Gupta for Hindi translation is also gratefully acknowledged.

June 2013

(Dr. Maheswarappa H.P.)

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 की 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 2012-13 की अवधि में मुख्य फसलों के शोध कार्य में हुई प्रगति इस रिपोर्ट में प्रस्तुत की गई है।

अनुसंधान उपलब्धियाँ 2012-13

नारियल :

फसल सुधार :

अम्बाजिपेट और अरसिकरे केंद्रों में मूल्यांकित छह संकरण संयुक्तों में से संकरण संयुक्त जैसे जी.बी.जी.डी. x एल.सी.टी. और जी. बी.जी.डी. x पी.एच.ओ.टी. में उच्च गुठली उपज और खोपड़ा मात्रा पायी गयी। जी.बी.जी.डी x एल.सी.टी. अर्ध लंबी आकार का संकर है जिससे 128.0 से 132.2 गुठली प्रति ताड़ प्रति वर्ष औसत गुठली उपज और 3.3 से 3.75 टन/हेक्टर/वर्ष खोपड़ा आय प्राप्त की गयी। जी.बी.जी.डी. x एल.सी.टी. उच्च उत्पादन क्षमता (128.0 से 130 गुठली प्रति ताड़ प्रति वर्ष) उत्तम खोपडा (3.75 टन/हेक्टर) और तेल उपज (2.78/हेक्टर) देने वाली संकर है। दोनों संकर राष्ट्रीय संकर के रूप में विमोचन के लिए प्रस्तावित किया गया है। विभिन्न सस्य जलवायु परिस्थिति में नूतन रूप में विमोचित नारियल प्रजातियों और संकर के बडे पैमाने पर बहुगुणन के लिए केंद्र बीज बाग की स्थापना की गई है। विभिन्न सस्य जलवायु क्षेत्रों में बौनी x बौनी और लंबी x लंबी संकरों का मूल्यांकन परीक्षण प्रगति पर है।

नारियल में उर्वरण

अलियार नगर, अम्बाजिपेट और अरसिकरे केंद्रों में ड्रिप सिंचाई से शुपार्शित नाईट्रोजन फोसफोरस पोटाश का 75% उर्वरण से सुपार्शित मात्रा के 25 प्रतिशत बचा जा सकता है। अम्बाजिपेट के आकड़े से यह स्पष्ट पाया गया कि उर्वरण के माध्यम से 100 प्रतिशत आर.डी.एफ. में अधिकतम गुठली उपज (111.5 गुठली/ताड) प्राप्त किया जाता है जो 75% आर.डी.एफ. के साथ समतुल्य पाया गया (98.5 गुठली/ताड़)। अरसिकरे में नियंत्रण के अधीन ड्रिप सिंचाई से 25% और 50% नाईट्रोजन फोसफोरस और पोटाश के प्रयोग से प्राप्त उपज की अपेक्षा ड्रिप सिंचाई के माध्यम से 100% नाईट्रोजन फोसफोरस पोटाश के प्रयोग से उच्च गुठली, खोपड़ा और तेल उपज प्रति ताड़ प्राप्त किया गया। ड्रिप सिंचाई से 100% नाईट्रोजन फोसफोरस पोटाश और मृदा प्रयोग से 100% नाईट्रोजन फोसफोरस और पोटाश के प्रयोग से प्राप्त गुठली, खोपडा और तेल उपज प्रति ताड ड्रिप सिंचाई से 75% नाईट्रोजन फोसफोरस और पोटाश के प्रयोग से रिकार्ड किया गया उपज क समतुल्य पाया गया।

नारियल आधारित फसलन पद्धित

अरसिकरे केंद्र में नींबू, सजनाफली और कोको की फसलन पद्धति मॉडल में नारियल की गुठली उपज 66.2 से 85.0 तक वृद्धि पायी गयी। 0.4 हेक्टर क्षेत्रफल से 115 कि ग्रा नींबू उपज और 677 कि. ग्रा सजनाफली प्राप्त किया गया। इस पद्धति से पुनःचक्रमण द्वारा जैव भार से 3400 कि. ग्रा वर्मीकम्पोस्ट प्राप्त किया गया जिसका पुनःचक्रमण इस पद्धति में किया जाता है। काहिकुची केंद्र में 0.40 हेक्टर में हल्दी, अनन्नास, असम नींबू, केला, काली मिर्च सम्मिलित फसलन पद्धति का विकास किया गया। अन्तर फसलों से उत्पादित जैवभार का पुनःचक्रमण कर वर्मीकंपोस्ट में परिवर्तन किया गया। फसलन पद्धित के कारण नारियल की गुठली उपज में 55 से 66 तक वृद्धि पायी गयी। फसलन पद्धति मॉडल का आर्थिक विश्लेषण किया गया और इस पद्धति से 1.75 लाभ मूल्य अनुपात के साथ प्रति हेक्टर 2,39,075/रुपए प्रति हेक्टर कुल आय प्राप्त किया गया। अलियार नगर में

वाणिज्यिक रुप में उगाए गए फूल फसलों में मरिगोल्ड 6,400 कि. ग्रा/हेक्टर उपज और कुल आय 73,000/रुपए/हेक्टर और लाभ मूल्य अनुपात 2.33 पाया गया। कॉफ्रिना से 6250 कि. ग्रा, 70000/ रुपए और 2.27 लाभ - मूल्य अनुपात) और क्रिसान्थमम से 5350 कि. ग्रा और 52000/- रुपए कुल आय और 1.95 लाभ - मूल्य अनुपात पाया गया।

रोग प्रबंधन

गैनोडेरमा व्याधिजन के विरुद्ध 5 एस सी हेक्साकोनज़ॉल का प्रभाव

बागवानी अनुसंधान स्टेशन, अरसिकरे और बागवानी अनुसंधान स्टेशन, अम्बाजिपेट में गैनोडेरमा व्याधिजन के विरुद्ध विभिन्न सांद्रण 0.1, 0.2, 0.3 और 0.4 प्रतिशत में 5 एस सी हेक्साकोनज़ॉल प्रतिपादन का परीक्षण किया गया। परिणाम से यह देखा गया कि दोनों केंद्रों में प्रयोगशाला परिस्थिति के अधीन सभी गाढापन में कवकनाशी प्रभावी रुप से व्याधिजन का अवरोधन किया जाता है।

तना स्त्रवण प्रबंधन

त्रैकोडेरमा लेप संविन्यास की तुलना में *त्रैकोडेरमा विरिडे* केक संविन्यास का प्रयोग नारियल में तना स्त्रवण रोग नियंत्रण में प्रभावी पाया गया।

कीट नियंत्रण

पत्ता चित्ति का जैविक प्रबंधन

पी. फ्लूरोसेन्स टॉल्क संविन्यास (50 ग्रा/ताड़/वर्ष) नीम केक (5 कि ग्रा/ताड /वर्ष) के मृदा प्रयोग के साथ तिमाही अंतराल में 25 मि. ली/ताड के दर में पी. फ्लूरोसेन्स संवर्द्धन पावित का मूल वेधन, पत्ता चित्ति के विरुद्ध उचित पाया गया।

कीट प्रबंधन

काला सिरवाली रोमिल इल्ली का प्रबंधन

आन्ध्रप्रदेश के पश्चिम गोदावरी जिले में प्रक्षेत्र परिस्थिति के अधीन बिना उन्दाल्पित परजीव्याभ की तुलना में गन्ध उन्दाल्पित गोनियस नेफान्टिडिस ने प्रारंभिक परजीव्याभीकरण 76.9 प्रतिशत दिखाया जो लक्ष्य कीट *ओपिसिना एरिनोसेल्ला* के विरुद्ध 62.90 परजीव्याभीकरण रिकार्ड किया गया। विमोचन के तीसरे महीने से उन्दाल्पन में 100% परजीव्याभीकरण और बिना उन्दाल्पन में 83.5% परजीव्याभीकण उपचार रिकार्ड किया गया। यह नारियल काला सिरवाली रोमिलइल्ली के प्रबंधन के लिए प्रक्षेत्र विमोचित उन्दाल्पित परजीव्याभ की प्रमुखता दिखाती है।

नाफ्थलीन बॉल्स, *मेटारैजियम अनिसोप्लिए*, *बाकुलोवाइरस* संवर्द्धन, फेरोमोन लुरेस संनिहित विभिन्न क्षेत्रों में ओरिक्टस राइनोसेरस के लिए समीकृत कीट प्रबंधन प्रौद्योगिकी के अनुसमर्थन से राईनोसेरस द्वारा पहुँचाई गई क्षति कम पायी गयी।

एरियोफिड कीट का प्रबंधन

अलियार नगर, अम्बाजिपेट और रत्नगिरी केंद्रों में उच्च औसत ग्रेड सूचकांक नियंत्रण रिकार्ड किया गया और मूल वेधन के साथ टी 1 - समीकृत कीट प्रबंधन कार्यान्वित बाग निम्नतम औसत ग्रेड सूचकांक नियंत्रण जैसे अलियार नगर, अम्बाजिपेट, रत्नगिरी में 2.38, 1.62 और 1.43 और मूल वेधन के बिना टी-2 समीकृत कीट प्रबंधन में उसके निकट सूचकांक पाया गया।

राईनोसेरस भृंग के विरुद्ध फेरोमोन ट्राप का प्रक्षेत्र मूल्यांकन

तीन भृंग (2 मादा 1 पुरुष) के नियंत्रण में परीक्षित तीन विभिन्न फेरोमोन ट्राप के बीच सी पी सी आर आई लूरे (एन पी एम) उच्चतम राइनोसेरस भृंग को 694 तक (433 मादा 261 पुरुष) पकडे पाया गया। और बाद में केम्टिका फेरोलुर ट्राप 337 (196 मादा 141 पुरुष), पी सी आई लुर ट्राप 261 (140 मादा 121 पुरुष)

लाल ताड़ घुन के विरुद्ध फेरोमोन ट्राप का प्रक्षेत्र मूल्यांकन

अम्बाजिपेट केंद्र में लाल ताड घुन फेरोमोन लुर पर किए गए अध्ययन से यह देखा गया कि अप्रैल 2012 में एन.पी.एम. कें रो फ अ सं लुर में कुल 639 भृंग पकडा गया जबकि पी सी आई लुर में 457 भृंग पकडा गया है। नियंत्रित ट्राप में कुछ नहीं पकड़ा गया। रत्नगिरी केंद्र में एन पी एम कें रो फ अ सं लुर से अप्रैल 2012 में 139 भृंग पकड़ा गया और पी सी आई लुर से 50 भृंग लेकिन नियंत्रित ट्राप में कुछ नहीं पकडा गया।

तेल ताड़

सूखा सक्षम के लिए विभिन्न तेल ताड समपित्रैक के मूल्यांकन

के अधीन, विभिन्न वासप्ररुप के बीच गंगावती केंद्र में 2011-12 अवधि में ताजा फल गुच्छ में महत्वपूर्ण भिन्नता पायी गयी। जेट एस-6, जेट एस-8 जेट एस-9, टी एस-5 एवं टी एस-7 की अपेक्षा वासप्ररुप जेट एस-3 उच्च औसत ताजा फल गुच्छ 6.99 टन/हेक्टर रिकार्ड किया गया। जेट एस-1 जेट एस-5 वासप्ररुप ताजा फल गुच्छ 5.08 और 4.90 टन/हेक्टर जेट एस3 के साथ क्रमशः समतुल्य पाया गया। विभिन्न शरीरक्रिया विज्ञान और जैव रासायनिक प्राचल से यह देखा गया कि अन्य समपित्रैक की अपेक्षा समपित्रैक जेट एस-1 एवं जेट एस-3 उच्च औसत सापेक्ष जल मात्रा, निम्न इलेक्ट्रोलाइट लीचिंग और सार्थक रुप से निम्न पेरोक्सिडेस क्रियाशीलता और अधिक तनाव सक्षम पाया गया। मुल्डे केंद्र में सिंचाई परिस्थिति के अधीन समपित्रैक जेट 8 उच्च उपज रिकार्ड किया गया अर्थात 11 टन/हेक्टर और असिंचित परिस्थिति के अधीन उपज वहीं था।

ताजा फलगुच्छ उपज मुख्य रुप से विभिन्न संकरों के बीच 2007 की अवधि में भिन्न थे गंगावती में, संकर एन.आर.सी.ओ.पी.-4 उच्च औसत ताजा फल गुच्छ उपज (8.5 टन/हेक्टर) रिकार्ड किया गया लेकिन एन.आर.सी.ओ.पी.- 1 और एन आर सी ओ पी-9 (7.2 और 7.1 टन/हेक्टर) समतुल्य पाया गया। विजयराय केंद्र में एन.आर.सी.ओ.पी.- 4 उच्च संख्या की फल गुच्छ (6.2) और एन.आर.सी.ओ.पी.- 6 (5.9)। एन.आर.सी.ओ.पी.- 5 अधिक गुच्छ भार और एन.आर.सी.ओ.पी.- 7 (10.3 कि ग्रा) एन.आर.सी.ओ.पी.- 6 (13.0 ठन/हेक्टर) रिकार्ड किया गया।

विजयराय में विभिन्न उर्वरण उपचार के बीच ताजा फल गुच्छ भिन्न पायी गयी। अन्य सभी उर्वरण और मृदा प्रयोग उपचार की अपेक्षा उपचार टी 4 अर्थात उर्वरण के माध्यम से 1200:600:1200 ग्रा नाईट्रोजन फोसफोरस पोटाश से उच्च ताजा फल गुच्छ 18.9 टन प्रति हेक्टर प्राप्त किया गया।

पॉमैरा

पॉमैरा का जर्मप्लाज़म सर्वेक्षण आन्ध्रप्रदेश के नेल्लूर जिला में अगस्त-सितंबर 2012 में अ भा स ताड अनुसंधान परियोजना, किल्लीकुलम और पान्डिरिममिडी केंद्रों द्वारा एन.बी.पी.जी.आर. के समन्वयन में आयोजित किया गया। आन्ध्रप्रदेश के नेल्लूर जिला के कार्यक्षम रुप से ताड वर्द्धित क्षेत्रों में भी सर्वेक्षण किया गया और 876 कि.मी. दूर यात्रा करने के बाद कुल 9 प्रजातियाँ विशेष गुण के साथ जुडाया गया। प्रत्येक प्रजाति से कुल 10 फल संग्रहित किया गया और बाग में 12 बीज प्रति पंक्ति बोया गया।

फूल रस (नीरा) के बहाव बढाने के लिए परीक्षण आयोजित किया गया। एक ही ताड के विभिन्न शूकीछद पर विभिन्न छेद कर जैसे नियंत्रण, क्रोस, वी चैनल और केंद्र छिद्र। परिणाम से यह देखा गया कि अन्य की तुलना में वी आकार के छेद से अधिक उपज प्राप्त किया गया और उपचार के बीच महत्वपूर्ण भिन्नता पायी गयी।

विभिन्न परिरक्षकों से जैसे सोडियम बेनजोएट, के एम एस और सिट्रिक अम्ल पूर्व तापन के साथ 15 मिनिट 90^0 सेटिग्रेड में 24 घंटे अंतराल में नमूनों को विश्लेषण गुण के लिए किया गया। परिणाम से यह देखा गया कि सुगंध और किण्वन शुरु करने के बाद नीरा केवल एक दिन के लिए परिरक्षित किया जा सकता है। यह भी निरीक्षण किया गया कि टेंपिंग विधि अर्थात संग्रहण उपकरणों की सफाई, चूर्ण मिलन और मौसम स्थिति के कारण अनियमित गुण ऑकडे प्राप्त किया जाता है।

इक्कीसवीं वार्षिक समूह बैठक

अखिल भारतीय समन्वित ताड अनुसंधान परियोजना की इक्कीसवीं वार्षिक समूह बैठक 11-13 जुलाई 2012 को कृषि कालेज और अनुसंधान संस्थान मदुरै में आयोजित की गई। समूह बैठक में अखिल भारतीय समन्वित ताड अनुसंधान परियोजना के 21 केंद्र, राज्य कृषि विश्वविद्यालय, कें रो फ अ सं, तेल ताड अनुसंधान निदेशालय, नारियल विकास बोर्ड और देश के 12 राज्य बागवानी विभाग के कुल 80 प्रतिनिधियों ने भाग लिया। समूह बैठक में नारियल, तेल ताड़, पॉमैरा ताड़ और फिशटेइल पॉल्म (सुल्फी ताड़) जारी अनुसंधान कार्यक्रमों की प्रगति पर चर्चा की गई।

अखिल भारतीय समन्वित ताड अनुसंधान परियोजना की वार्षिक समूह बैठक का उद्घाटन सत्र डॉ एन कुमार, संकाय अध्यक्ष (बागवानी), तमिलनाडु कृषि विश्वविद्यालय के स्वागत भाषण से शुरु की गई। डॉ. एच.पी. महेश्वरप्पा, परियोजना समन्वयक (ताड़) ने विभिन्न सस्य जलवायु अंचलों के अखिल

भारतीय समन्वित ताड़ अनुसंधान परियोजना के केंद्रों में ताड़ पर आयोजित अखिल भारतीय समन्वित अनुसंधान परियोजना की शोध उपलब्धियॉं और विशेष उपलब्धियॉं इस रिपोर्ट में प्रस्तुत की है।

विस्तार पद्धति हस्तांतरित करने की मुख्य सिफारिशें:

संकर जैसे जी.बी.जी.डी. x एल.सी.ओ.टी., जी.बी.जी.डी. x पी.एच.ओ.टी. और जी.बी.जी.डी x एफ.जे.टी. आदि का निष्पादन अम्बाजिपेट और अरसिकरें केंद्रों में अच्छा पाया गया। इन संकर राष्ट्रीय संकर के रुप में विमोचन के लिए प्रस्तावित किया जा सकता है।

निम्नलिखित नारियल आधारित औषधीय फसल संयुक्त क्रमानुगत क्षेत्रों में वाणिज्यिक स्वीकृति के लिए सिफारिश किया जा सकता है।

विभिन्न क्षेत्रों में नारियल बाग में अच्छी तरह निष्पादित औषधीय और सुगंधित फसलें आय बढाने के लिए पहचान लिया गया है और सिफारिश किया गया है।

अम्बाजिपेट - पाल्मारोसा, आम अदरक, पाचौली, सिट्रोनेल्ला

अलियार नगर - आल्पिनिया गालंगा, नींबू घास (*सिंपोपोगोन फ्लेक्सोसस*), पाचौली

अरसिकरे - नींबू घास (*सिंपोपोगोन फ्लेक्सोसस*), पाचौली, गार्डन रुप (*रुटा ग्रावेयोलेन्स*) तुलसी (*ओसिमम सान्क्टम*), कलमेघ, (*आन्द्रोग्राफिस पनिकुलेटा*), शिशुमूल (*मरान्टा अरुन्दिनेसिए*) और मकोई (*सोलानम निग्रम*)

काहिकुची-पिपली, पाचौली, सिट्रोनेल्ला, सर्पागन्धा

मन्डौरी - सर्पागन्धा, अश्वगन्धा, शिशुमूल

रत्नगिरी - शतावरी, अदुल्सा, शिशुमूल, नींबू घास, सिट्रोनेल्ला

वेप्पंकुलम - एलोवेरा, अल्पिनिया गलांगल, ओसिमम सान्क्टम

जगदलपुर - स्टेविया, आमहल्दी, सर्पागन्धा, टिकुर, पाचौली

पत्तों का निष्पत्रण पर किए गए अध्ययन से यह देखा गया कि जब पेड का निष्पत्रण 30 प्रतिशत स्तर तक होता है नियंत्रण की तुलना में मादा और पुरुष पेड़ों में नीरा और नुन्गु दोनों उपज में महत्वपूर्ण वृद्धि पायी गयी।

विभिन्न मुख्य फसलों के उचित जातियों के मूल्यांकन के क्षेत्र में शोध के मुख्य क्षेत्र जैसे :- विभिन्न सस्यजलवायु क्षेत्र, स्थानीय वासप्ररुप और उचित स्थानीय विशेष प्रजातियों का उपयोग कर संकर जाति का शोषण, पोषण और जल उपयोग दक्षता सुधारने के लिए उत्पादन पद्धित और जलवायु परिवर्तन घटाने के लिए फसलन पद्धित, जैव एजेंट का उपयोग पर केंद्रित होकर संरक्षण रणनीतियॉं, उत्पाद विविधीकरण और मूल्य वर्द्धन पर लक्षित कटाई उपरांत प्रौद्योगिकी आदि पहचान लिया गया।

डॉ. जॉर्ज वी. थॉमस, निदेशक, कें.रो.फ.अ.सं. ने अंतिम सत्र की अध्यक्षता की और डॉ. के. वाईरवन, संकाय कृषि कालेज एवं अनुसंधान संस्थान ने सह अध्यक्षता की। अध्यक्ष ने प्रतिभागियों एवं अतिथियों का स्वागत किया और बैठक की कार्यवाही पर विवरण दिया। परियोजना समन्वयक (ताड़) ने विशेष सिफारिश और विचार विमर्श के दौरान लिए गए निर्णयों की प्रस्तुति की। उसके बाद वर्ष 2012-13 के लिए तकनीकी कार्यक्रमें प्रस्तुत की और समूह बैठक में उसका अनुमोदन किया।

III. Executive Summary

The All India Coordinated Research Project (AICRP) on Palms was started in 1972 and presently, the mandate crops of the project are coconut, oil palm, palmyrah and sulphi palm. The AICRP Centres located in twelve States representing different agro-climatic regions have been successful in identifying location specific technologies to improve the productivity of mandate crops.

Achievements made in the technical programmes of the mandate crops under genetic resources and crop improvement, crop production, crop protection and post harvest technology during the year 2012-13 are presented in this report.

Research achievements during 2012-13

Coconut

Crop Improvement:

Out of six cross combinations evaluated at Ambajipeta and Arsikere centres, the cross combinations *viz.*, GBGD x LCOT, GBGD x PHOT were found to perform well in respect of higher nut yield and copra content. GBGD x LCOT is a semi-tall statured hybrid with mean yield of 128.0 to 132.2 nuts/palm/year and copra out turn of 3.3 to 3.75 t/ha/year. GBGD x PHOT is a hybrid with higher yield potential (128 to 130 nuts/palm/year), superior in copra (3.75 t/ha) and oil yield (2.78 t/ha). Both the hybrids have been proposed for release as national hybrids. For large scale multiplication of newly released coconut varieties and hybrids in different agroclimatic regions, nucleus seed gardens have been established. Trials on evaluation of DxD and TxT hybrids are in progress in different agro-climatic regions.

Fertigation in coconut:

A saving of 25% of recommended fertilizers is possible in coconut by adopting fertigation of 75% recommended NPK through drip irrigation at Aliyarnager, Ambajipeta and Arsikere centres. At Ambajipeta, application of 100% RDF through fertigation recorded maximum yield (115.5 nuts/palm) which was on par with 75% RDF through fertigation (98.5 nuts/palm). At Arsikere, The nut yield, copra yield and oil yield per palm were significantly higher with the application of 100% NPK through drip irrigation compared to control and application of 25% and 50% NPK through drip irrigation. Application of 75% NPK through drip irrigation recorded nut yield, copra yield and oil yield per palm which was on par with the application of 100% NPK through drip irrigation and 100% NPK through soil application.

Coconut based cropping system:

At Arsikere centre, the yield of coconut was improved to 85.0 from 66.2 nuts/palm/year in the cropping system model involving lime, drumstick and cocoa. The yield of lime was 115 kg and of drumstick was 677 kg in 0.4 ha area. Vermicompost produced from the recyclable biomass of the system was 3400 kg, which was recycled in the system. At Kahikuchi centre, the development of cropping system model comprising of turmeric, pineapple, Assam lemon, banana and black pepper was continued in an area of 0.40 ha. The biomass produced by intercrops is being recycled by converting into vermicompost. There was an increase in yield of coconut from 55 to 66 nuts / palm due to cropping system. Economic analysis of the cropping system model has been done and found that the net return of ₹ 2,39,075 per ha with a benefit- cost ratio of 1.75 was obtained with the system. At Aliyarnagar, among the five commercial flower crops raised, Marigold recorded a flower yield of 6,400 kg/ha with a net income of ₹ 73,000/ha and B:C ratio of 2.33 followed by Gomphrena (6,250 kg, ₹ 70,000 and 2.27) and Chrysanthemum (5,350 kg, ₹ 52,000 and 1.95, respectively).

Disease management:

Effect of hexaconazole 5% SC against the *Ganoderma* pathogen

Hexaconazole 5% SC formulation was tested at various concentrations *viz.*, 0.1, 0.2, 0.3 and 0.4 per cent

against the *Ganoderma* pathogen at HRS, Arsikere and HRS, Ambajipeta. The results revealed that the fungicide in all the concentrations effectively inhibited the pathogen under laboratory conditions.

Stem bleeding management:

Application of *Trichoderma viride* cake formulation was found effective in controlling the stem bleeding disease in coconut when compared to the application of *Trichoderma* paste formulation.

Biological management of leaf blight:

Root feeding of *P. fluorescens* culture filtrate @ 25 ml/palm at quarterly interval along with soil application of *P. fluorescens* talc formulation (50g/palm/yr) + Neem cake (5 kg/palm/yr) was found to be the best against leaf blight disease.

Pest management:

Management of black headed caterpillar:

Under field conditions in West Godavari District of Andhra Pradesh, olfactory conditioned *Goniozus nephantidis* showed initial parasitation of 76.9% as compared to unconditioned parasitodes which recorded 62.9% parasitation against target pest *Opisina arenosella.* After third month of release, 100 % parasitation in conditioned and only 83.5% parasitation in unconditioned parasitoids treatments was recorded stating the importance of field releasing conditioned parasitoids for managing coconut black headed caterpillar.

Validation of integrated pest management technology for *Oryctes rhinoceros* in different regions involving naphthalene balls, *Metarhizium anisopliae*, Baculovirus culture, Pheromone lures indicated reduction in the damage by rhinoceros.

Management of eriophyid mite:

At Aliyarnager, Ambajipeta and Ratnagiri centres, the control recorded the highest mean grade index and T1- IPM implemented garden with root feeding recorded lowest mean grade index *viz.*, 2.38,1.62 and 1.43, respectively and was closely followed by T_2 – IPM treatment without root feeding.

Field evaluation of pheromone traps against rhinoceros beetle:

Among the three different aggregation pheromone traps tried, CPCRI-Lure (NPM), was found to trap significantly the highest number of rhinoceros beetle up to 694 (433 female + 261 male) followed by Chemtica - Ferolure trap up to 337 (196 female + 141 male) and PCI lure trap up to 261(140 female + 121 male) as against only three beetles in Control, (2 female + 1 male).

Field evaluation of pheromone traps against red palm weevil:

At Ambajipeta centre, studies on red palm weevil pheromone lures revealed that a total of 639 beetles were caught in NPM CPCRI Lure from April 2012 as against 457 beetles trapped in PCI lure . No catches were observed in control trap. At Ratnagiri centre, a total of 139 beetles were observed in NPM CPCRI Lure from April 2012 as against 50 beetles trapped in PCI lure. No catches were observed in control trap.

Oil palm

Under evaluation of different oil palm genotypes for drought tolerance, the FFB yield during 2011-12 at Gangavati centre 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 5.1 and 4.9 t/ha, respectively were on par with ZS-3. The data on various physiological and biochemical parameters revealed that the genotype ZS-1 & ZS-3 recorded higher mean relative water content, lower electrolyte leaching and significantly lower peroxidase activity and appeared to be more stress tolerant than the other genotypes. At Mulde centre, Genotype ZS- 8 recorded the highest yield i.e. 11 t/ha under irrigated condition and the yield was same under rainfed condition also.

The FFB yield differed significantly among the various hybrids planted during 2007, and at Gangavathi, the hybrid NRCOP-4 recorded significantly higher mean FFB yield (8.5 t/ha) over other hybrids but it was on par with NRCOP -1 and NRCOP – 9 (7.2 and 7.1 t/ha,

respectively). At Vijayarai Centre, NRCOP-4 recorded higher number of bunches (6.2), followed by NRCOP-6 (5.9). NRCOP-5 recorded higher bunch weight (11.6 kg/ bunch) followed by NRCOP-7 (10.3 kg/bunch) while minimum bunch weight was recorded in NRCOP-1 (8.55 kg). The FFB yield recorded was the highest in NRCOP-10 (13.9 t/ha) followed by NRCOP-6 (13.0 t/ha).

At Vijayarai, the FFB yield differed significantly among different fertigation treatments. The treatment T_4 *i.e.,* 1200: 600: 1200g NPK through fertigation has recorded significantly higher FFB yield of 18.9 t/ ha over all other fertigation and soil application treatments.

Palmyrah

Germplasm survey of palmyrah was conducted at Nellore district of Andhra Pradesh during August-Sept. 2012 by AICRP Killikulam and Pandirimamidi centres in coordination with NBPGR. Potential palm growing areas of Nellore district of Andhra Pradesh were covered and after travelling a distance of 876 km, a total of 9 accessions with distinct characters were assembled. A total of 10 fruits were collected under each accession and sown in the orchard @ 12 seeds per line.

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 was significant difference among the treatments.

For improving the shelf life of the inflorescence sap (neera) 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 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.

XXI Annual Group Meeting

The XXI Annual Group Meeting of AICRP on Palms was held during 11-13 July 2012 at Agricultural College and Research Institute, Madurai. The group meeting was attended by 80 delegates from 21 centres of AICRP on Palms, State Agricultural Universities, Central Plantation Crops Research Institute (CPCRI), Directorate of Oil palm Research (DOPR), Coconut Development Board and State Department of Horticulture covering 12 states of the country. The group meeting discussed the progress of ongoing research programmes in coconut, oil palm, palmyrah and fish tail palm (sulphi palm).

The inaugural session of the XXI Annual group meeting commenced with the welcome address by Dr. N. Kumar, Dean (Horticulture), Tamil Nadu Agricultural University. Dr. H.P. Maheswarappa, Project Coordinator (Palms) presented the Coordinator's report narrating the salient findings and research achievements emanated from the All India Coordinated Research Project on Palms conducted in all the AICRP centres representing various agroclimatic zones.

Major recommendations to be passed on to extension system:

- The coconut hybrids like GBGD x LCOT, GBGD x PHOT and GBGD x Fiji tall are performing well in Ambajipeta and Arsikere Centres. These hybrids can be proposed for release as national hybrids.
- The following coconut based medicinal crop combinations could be recommended for commercial adoption at the respective regions.

Ambajipeta - Palmarosa, mango ginger, patchouli, citronella.

Aliyarnagar – *Alpinia galanga,* lemon grass (*Cymbopogon flexuosus*), patchouli.

Arsikere – Lemon grass (*Cymbopogon flexuosus*), garden rue (*Ruta graveolens*), tulsi (*Ocimum sanctum*), kalmegh (*Andrographis paniculata*), arrow root (*Maranta arundinaceae*) and makoi (*Solanum nigrum*).

Kahikuchi – Pipali, Patchouli, Citronella, Sarpagandha.

Mondouri – Sarpagandha, Aswagandha, Arrowroot.

Ratnagiri – Sathavari, Adulsa, Arrow root, Lemon grass, Citronella.

Veppankulam – *Aloe vera*, *Alpinia galangal*, *Ocimum sanctum.*

Jagadalpur – Stevia, Amahaldi, Sarpagandha, Tikhur, Patchouli.

- Study on defoliation of leaves in palmyrah on yields indicated that there has been significant increase in yield of both neera and nungu in male and female trees, as compared to the control, when the trees were defoliated to the level of 30 per cent.

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.

The Plenary Session was chaired by Dr. George V. Thomas, Director, CPCRI and Co-chaired by Dr. K. Vairavan, Dean, AC & RI, Madurai. Chairman welcomed the delegates and the guests and briefed about the proceedings of meeting. Project Coordinator (Palms) presented the salient recommendations and decisions taken during the deliberations followed by presentation of the technical programme for 2012-13 and it was approved by the group meeting.

IV. Profile of AICRP on Palms

Plantation crops constitute an important segment of horticulture in Indian agriculture. Palms such as coconut (*Cocos nucifera* L), oil palm (*Elaeis guineensis* Jacq.) and palmyrah (*Borassus flabellifer L.)* have contributed significantly for the Indian Agrarian Economy. To carry out the location specific research, the concept of AICRP was come into existence and to address the region specific research in these crops, the All India Coordinated Research Project on Palms was started in 1972. The broad mandates of the Project are:

- To identify, conserve and utilize elite genetic resources for useful traits in palms from different agro-climatic regions and to evaluate performance of varieties/hybrids under different locations and to facilitate release of varieties/hybrids;
- To improve input use efficiency and develop location-specific palm based integrated farming systems to enhance the productivity per unit area, and organic cultivation packages for palms and palm based farming system;
- Evolve bio-intensive pest and disease management strategies, modelling and forecasting of disease incidence and documentation of pest dynamics in changing scenario of palm ecosystem;
- Development of post-harvest technologies in palmyrah and to demonstrate and Transfer of technologies to the farmers.

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) on which the centre is working

Sl. No.	Name of the Centre	Address
COCONUT		
1.	Aliyarnagar	Coconut Research Station, Aliyarnagar - 642 101, Coimbatore District, Tamil Nadu (TNAU, Tamil Nadu)
2.	Veppankulam	Coconut Research Station, Veppankulam -614 906, Thanjavur District, Tamil Nadu (TNAU, Tamil Nadu)
3.	Ambajipeta	Horticultural Research Station, Ambajipeta -533 214, East Godavari District, Andhra Pradesh(Dr. YSRHU, Andhra Pradesh)
4.	Arsikere	Horticultural Research Station, Arsikere - 573 103, Hassan District, Karnataka (UHS, Bagalkot, Karnataka)
5.	Bhubaneshwar	Department of Horticulture, Bhubaneswar – 751 003, Odisha (OUAT, Odisha)
6.	Jagadalpur	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagadalpur - 494 005, Chhattisgarh (IGKV,Chhattisgarh)
7.	Kahikuchi	Horticultural Research Station, Kahikuchi, Guwahati 781 017, Kamrup District (AAU, Assam)
8.	Mondouri	Directorate of Research, P.O. Kalyani – 741 235, Nadia District, West Bengal (BCKV, West Bengal)
9.	Ratnagiri	Regional Coconut Research Station, Bhatye - 421 612, Ratnagiri District, Maharashtra (Dr. BSKKV, Maharashtra)

10.	Navsari	ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari – 396 450, Gujarat (NAU, Gujarat)
11.	Sabour	Bihar Agricultural College, Sabour, Bhagalpur District – 813 210, Bihar (BAU, Bihar)
12.	Kasaragod	Central Plantation Crops Research Institute, Kasaragod 671 124. (CPCRI, ICAR)
13.	Pilicode	Regional Agricultural Research Station, Pilicode P.O., Kasaragod – 670 353, Kerala (KAU, Kerala)
OIL PALM		
14	Aduthurai (Shifted to Pattukkottai from Dec. 2012)	Agricultural Research Station - Pattukkotai- 614 602, Thanjavur District, Tamil Nadu (TNAU, Tamil Nadu)
15.	Gangavathi	Agricultural Research Station, Gangavathi-583 227, Koppal District, Karanataka (UHS,Bagalkot)
16.	Mulde	Agricultural Research Station, Mulde - 416 520, Kudal Taluk, Sindhudurg District, Maharashtra (Dr. BSKKV, Maharashtra)
17.	Madhopur	Regional Research Station, P.O. Madhopur – 845 454, Majhaulia Via., West Champaran Dist., Bihar (RAU, Bihar)
18.	Pasighat	College of Horticulture & Forestry, Pasighat – 791 102, Arunachal Pradesh (CAU, Imphal)
19.	Vijayarai	Horticultural Research Station, Vijayarai - 534 475, West Godavari District, Andhra Pradesh (Dr. YSRHU, Andhra Pradesh)
PALMYRAH		
20.	Killikulam	Agricultural College & Research Institute, Killikulam 628 252, Vallanad, Tuticorin Dist., Tamil Nadu (TNAU,Tamil Nadu)
21	Pandirimamidi	Horticultural Research Station, Pandirimamidi, Ramapachodavaram PO 533 288, East Godavari Dist., Andhra Pradesh. (Dr. YSRHU, Andhra Pradesh)

Budget

The budget for the year 2012-13 was Rs. 386.00 lakhs (ICAR share).

Head-wise budget (ICAR Share)

Sl. No.	Head	Expenditure actually booked as on 31th March 2012
1	Pay and Allowances	260.59
2	Travelling Allowances	11.43
3	Recurring Contingencies	108.85
4	HRD	5.13
	Total	386.00

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

Location of AICRP Centres

V. Experimental Results in Coconut

5.1 Genetic Resources and Crop Improvement

Gen. 1: Evaluation of existing germplasm in coconut

Centres: Bhubaneshwar, Navsari, Sabour

This is an observational trial being undertaken in three centres. The activity chart for Navsari and Sabour centre include acquiring planting materials from designated centres, and field planting, while observation of growth parameters at Bhubaneshwar centre.

Bhubaneshwar

A total of 16 accessions comprising of 5 dwarfs, 10 talls and a local check were planted during December 2004. The data on growth parameters revealed that the maximum plant height (8.2 m) was recorded in IND041 and the minimum plant height (3.8 m) was recorded in IND058. The stem girth was ranged from 52.2 cm (IND007) to 181.6cm (IND025) among different accessions. The number of functional leaves in the crown among the accessions ranged from 10.4 (IND007) to 21.8 (IND025). The leaf production rate per annum was higher (12.0) in Gautami Ganga and lesser (8.4) in IND007. Considering the other leaf characters, different genotypes behaved differently as the maximum petiole length (160.0 cm) was recorded in IND018, maximum leaf length (5.1 m) in Kera Keralam, maximum leaflet length (226.6 cm) in IND053 and maximum leaflet breadth (5.4 cm) in IND036. However, the minimum petiole length (82.0 cm), leaf length (2.86 m) and leaflet breadth (4.1 cm) were recorded in IND007.

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

Centres: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagdalpur, Kahikuchi, Mondouri, Pilicode, Ratnagiri, Veppankulam

Aliyarnagar

The replicated trial comprising 5 local ecotypes was planted in May 2008. Morphological parameters *viz.,* plant height (cm), stem girth (cm), annual leaf production, no. of functional leaves, petiole length (cm), no.of leaflets, leaflet length (cm) and leaflet breadth (cm) were recorded. Trunk formation was observed in most of the palms. Height of the palms ranged from 250 cm (CRP746) to 580 cm (CRP740). The girth at base ranged from 117.3 cm (CRP746) to 160.5 cm (CRP740). CRP738 showed higher leaf production rate (8.8) and recorded maximum number of functional leaves on the crown (16.5) (Table 1). CRP739, CRP740 and CRP742 recorded leaf lengths greater than 400 cm, while CRP738 recorded the highest petiole length (141.1 cm). The number of leaflets among the genotypes ranged from 65.3 to 83.5. The palms in this trial recorded an average leaflet length of 103.21 cm and leaflet breadth of 5.1 cm. While considering the phenotypic variability, coefficient of variation was observed to be less than 20% for all the traits recorded. Variability was the least for leaflet parameters. Early flowering was found in CRP738 with four palms in flowering phase. Flowering initiation was observed in one palm each in accessions CRP740 and CRP742.

Ambajipeta

The trial comprises of 13 local ecotypes *viz.,* CRP745 [Pillalakodi green], CRP746 [Pillalakodi brown], CRP747 [Jonnalarasi green], CRP748 [Jonnalarasi brown], CRP749 [Gangabondam], CRP750 [AMBECT-1], CRP751 [AMBECT-2], Itikulagunta ECT Big, Itikulagunta ECT Small, Saradapuram ECT, Srikakulam ECT, Vemulapalli ECT Big and Vemulapalli ECT Small. During February 2013, the accessions *viz.* Pillalakodi green, Pillalakodi brown, Jonnalarasi green, Jonnalarasi brown and Gangabondam were planted in RBD with four replications @ 4 palms per replication. Remaining accessions will be planted as an observational trial with 6 palms per genotype.

Table 1: Growth attributes of local ecotypes collected and conserved in different AICRP centres

Genotype	Girth (cm)	Height (cm)	LP*	Genotype	Girth (cm)	Height (cm)	LP*
Aliyarnagar				Mondouri			
CRP738	154.4	400.0	8.8	CRP779	115.0	65.0	14.0
CRP739	129.1	560.0	7.3	CRP780	110.0	80.0	15.0
CRP740	160.5	580.0	7.8	CRP781	109.0	82.0	14.0
CRP742	151.9	540.0	7.7	CRP782	118.0	69.0	13.0
CRP746	117.3	250.0	6.3	CRP783	108.0	62.0	14.0
Ratnagiri				Bhubaneshwar			
CRP757	127.6	536.9	6.3	CRP790	166.4	8.4	11.7
CRP758	118.7	564.4	6.2	CRP791	150.0	7.8	11.5
CRP759	128.0	595.6	6.4	CRP792	127.0	6.4	9.9
CRP760	115.2	537.9	6.2	CRP797	158.5	7.7	11.3
CRP761	117.2	551.9	6.4	CRP798	122.2	7.1	11.3
CRP762	123.9	581.2	5.8	CRP799	135.3	6.9	10.2

*LP- Number of leaves

Arsikere

Identification of palms in nine locations of coconut growing areas of maidan tract of Karnataka was made during 2010-11 and 2011-12. During 2012-13, ILG from Iraksandra, LMT-1 and LMT-2 from Maralur and SDT germplasm types have been identified at Doddasarangi villages of Tumkur Taluk. The growth parameters were recorded at nursery stage of the germplasm. CMJ-1 recorded more plant girth (12.8cm), number of leaves (5.4), leaf length (petiole 32.0 and leaflet bearing portion 26.4 cm) and leaflet numbers left (11.8) and right (12.8). For set II, collection of germplasm started in Alur village, Chamarajanagar taluk, Iraksandr, Malur and Doddasaraga villages, Tumkur taluk/ District. Morphological characters were documented in the identified palms.

Bhubaneshwar

Eleven local types of coconut germplasm were planted in December 2003 and tested in a RBD design with three replications (Table 1). There was no significant variation among different germplasms with respect to various growth characters except for the number of functional leaves on the crown. The maximum number of functional leaves on the crown (24.1) was recorded in CRP790 which was on par with CRP798 (23.7), CRP797 (22.7), CRP800 (21.9), CRP791 (20.5) and CRP799 (20.3). The minimum number of functional leaves on the crown (16.5) was recorded in CRP792. The accession CRP790 also showed its superiority over other genotypes with respect to plant height, plant girth, rate of leaf production /palm/year and leaflet breadth with the maximum corresponding values of 8.3 m, 166.3 cm, 11.6 and 5.1 cm, respectively. On the other hand, the minimum plant height (6.1 m), plant girth (122.2 cm), rate of leaf production (9.5 leaves/palm/year) and leaflet breadth (4.5 cm) were recorded in CRP800, CRP798, CRP793 and CRP800, respectively.

Jagdalpur

Survey for selection of cold tolerant germplasm was carried out from 2006-08 and 10 palms were selected from different parts of Bastar region and grouped into six ecotypes according to their location. The seedlings of six ecotypes were planted in July 2011. Mother palm marked last year for the yield parameters at village Sathosha, Block Backawand (Bastar) only was considered for further observations. Growth observation

of local germplasm showed the highest plant height, petiole length, leaf length and girth in CRP728, whereas, number of leaves on the crown was the highest (4.5) in CRP725.

Kahikuchi

The experiment was initiated with 10 local accessions of coconut in Assam along with two check varieties *viz.,* ASGT and WCT in RBD with three replications. These accessions were collected from four districts of Assam *viz.,* Kamrupa, Darrang, Nalbari, and Borpeta (CRP701 to CRP710) and planted in the main field during May 2005. The highest plant height (670 cm) and collar girth (151.7 cm) were recorded in Kamrupa. However, the highest number of functional leaves (18.7) and annual leaf production rate (11.8) were recorded in CRP703. The highest petiole length (161 cm) and leaf length (414 cm) were observed in CRP706 and CRP708, respectively. In case of leaflet number (right and left), the highest values (R: 117.5, L: 116.8) were recorded in CRP708. Leaflet length (112.0 cm) and maximum leaf breadth (6.97 cm) were observed in ASGT. Early flowering was recorded in accession CRP701, CRP703, CRP707 and ASGT which were 67 months from planting. No overlapping of male and female phases was observed in the flowered palms (Table 2).

View of local accessions (Kahikuchi)

Mondouri

Ten local types of germplasm from different districts of West Bengal were collected. Of these, five ecotypes have been planted as set I in the main field during 2007 in RBD. The highest trunk height (82 cm) was recorded in CRP781 followed by CRP780 (80 cm). Number of leaves (15) was maximum in CRP780.

Table 2: Floral parameters of local germplasm of coconut planted in 2005 (Kahikuchi)

Sl. No.	Accessions	No. of Inflorescences	No. of female flowers/ Inflorescence	No. of Spikelets	Male phase (days)	Female phase (days)
1	CRP 701	6.5	12.4	24.3	17.5	6.4
2	CRP 702	7.2	19.2	21.4	18.4	5.4
3	CRP 703	6.4	16.5	33.5	16.3	6.8
4	CRP 704	2.5	7.8	29.5	19.5	5.5
5	CRP 705	6.4	11.5	27.2	17.2	4.6
6	CRP 706	5.5	8.4	29.6	18.5	6.2
7	CRP 707	6.8	12.6	28.6	19.4	5.8
8	CRP708	-	-	-	-	-
9	CRO709	-	-	-	-	-
10	CRP710	2.5	11.4	30.8	20.4	6.5
11	ASGT	8.5	18.5	23.6	18.5	6.7
12	WCT	-	-	-	-	-
CD(P=0.05)		NS	NS	NS	NS	NS

NS: Not Significant

Maximum girth (118 cm) was recorded in CRP782 (Table 1). The highest length of leaf bearing portion (325 cm), leaflet count [left side (102) and right side (104)] were recorded in CRP781. However, leaflet length was maximum (112 cm) in CRP780 and leaf breadth was maximum (5.1 cm) in CRP782.

In set II, another five ecotypes have been planted in the main field during 2009. The highest plant height (441.7 cm) was recorded in CRP787 followed by CRP786 (438.7 cm). Number of leaves (16.2) was maximum in CRP787 and CRP785. Maximum girth (76.7 cm) was recorded in CRP785. Regarding the different leaf parameters, the highest length of leaf bearing portion (287 cm) was recorded in CRP786, leaflet number [left side (75)] was maximum in CRP788 and right side (72) were recorded in CRP784. However, leaflet length was maximum (78 cm) in CRP787 and leaf breadth was maximum (4.5 cm) in CRP787.

Pilicode

Dwarf types with quality nuts suitable for oil extraction, culinary and tender nut purposes is proposed to be located in northern districts of Kerala and evaluated for popularization in this region. A dwarf/ semi tall ecotype with high copra and rich oil content was identified from Annur area, Payyanur. The seed nuts of this ecotype was collected and sown in nursery during-June-July 2012.

Ratnagiri

The vegetative growth parameters were recorded during the fifth year of planting during 2007 (Table 1). All the growth parameters showed non-significant differences among the treatments. The average height ranged from 536.8 cm to 595.6 cm. The average girth ranged from 115.2 cm to 128.0 cm. The leaf production rate per annum ranged from 5.8 to 6.4. The number of functional leaves on the crown ranged from 11.2 to 13.2. The leaf length ranged from 228.4 cm to 243.1 cm. Petiole length ranged from 60.4 cm to 79.6 cm. CRP759 was vigorous, recording the maximum height (595.6 cm), girth (128.0 cm), more number of leaf production per year (6.4) and functional leaves on the crown (13.2). Flowering was observed in the experimental plot of CRP758, at the age of 61 months from planting and at 31st leaf stage.

Veppankulam

The results indicated that the number of functional leaves was the highest in Aliyarnagar tall (32) followed by Kera Keralam (31). CRP 716 recorded the highest petiole length of 1.85 m, followed by CRP 717 with 1.68 m. CRP 718 registered the highest length of leaf (4.5 m) followed by WCT (4.3 m). The leaflet length was the highest is CRP 718 (1.4 m), followed by CRP 716 (1.3 m). CRP 719 showed the highest leaf breadth of 6.00 cm, followed by WCT (5.9 cm). No. of leaflets was the highest in CRP 716 (212) followed by CRP 719 (209).

Gen. 2: Production and evaluation of new cross combinations in coconut

Centres: Ambajipeta, Arsikere, Bhubaneshwar

Ambajipeta

The trial was laid out during 1985 with six cross combinations in RBD replicated thrice. The data on yield and quality parameters of nuts was recorded during the year 2011-12. Among the hybrids, significant differences were recorded for plant height, age at first flowering, number of bunches per annum, nut yield per annum, dehusked fruit weight and oil content. Significantly higher yield of 132.7 nuts per palm was recorded in GBGD x LCOT hybrid followed by GBGD x PHOT with 122.2 nuts. GBGD x LCOT also recorded the highest oil yield of 19.4 kg/palm and it was on par with GBGD x PHOT hybrid with 16.4 kg oil/palm. The yield attributing and tender quality parameters are presented in Table 3.

Arsikere

The set I trial consisting of nine hybrids and one local check was initiated to assess the performance of indigenous and exotic crosses along with the local cultivar. The trial was laid during 1987 in RBD with three replications. The palm height, girth, cumulative leaf production and leaf production rate were not significant between different cross combinations. The palm girth was higher in WCT x GBGD cross. The nut, copra and oil yield performance during 2011-12 were significantly higher in GBGD x LCOT followed by GBGD x PHOT,

Table 3: Yield attributing and tender nut quality parameters of the coconut hybrids (Ambajipeta)

Genotypes	No. of bunches/ year	No. of nuts	Tendernut water content (ml)	Sweetness of water	Taste of tender kernel	TSS (^{0}brix)
ECTxCGD	11.2	105.2	218.0	Good	Good	5.9
GBGD x ECT	9.5	106.2	296.7	Good	Good	5.9
GBGD x FJT	9.0	109.2	267.7	Good	Good	6.0
GBGD x PHOT	14.2	122.2	353.0	Good	Good	6.2
GBGD x LCOT	12.8	132.7	330.0	Good	Good	5.8
ECT x GBGD	10.ECT8	116.3	286.0	Good	Good	5.3
CD(P=0.05)	2.6	9.7	NS	-	-	0.3

NS= Not significant

Table 4: Yield characters of different hybrids during 2011-12 (Arsikere)

Hybrids/Variety	Nut yield (nuts/palm)	Copra yield (kg/palm)	Oil yield (kg/palm)
CCNT x LCT	83.0	11.3	7.2
LCOT x PHOT	79.3	10.7	6.9
LCOT x CCNT	70.7	10.0	6.5
WCT x COD	96.6	15.8	10.4
WCT x GBGD	94.7	15.1	10.1
WCT x MYD	112.3	19.0	12.6
GBGD x FJT	138.8	22.7	14.6
GBGD x PHOT	129.5	21.7	14.4
GBGD x LCOT	140.0	23.0	15.0
TPT	95.5	15.5	10.3
CD (P=0.05)	16.9	3.5	2.2

GBGD x LCOT Crown

Bunch of GBGD x LCOT

GBGD x FJT (Table 4). Mean copra yield was significantly higher in combinations *viz.,* GBGD x LCOT (21.3 kg/palm), GBGD x PHOT (21.3 kg/palm) and GBGD x FJT (19.3 kg/palm). Oil content was also significantly higher

in GBGD x LCOT, GBGD x PHOT and GBGD x FJT. Since the nut, copra and oil yield were higher in the cross combinations of GBGD x LCOT, GBGD x FJT and GBGD x PHOT compared to check Tiptur Tall, these combinations are proposed to be recommended for cultivation in the maidan tract of Karnataka. The set II trial consists of four hybrids and 1 local check (TPT). The trial 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 MYD x TPT. Girth of palm and the rate of leaf production were not significant. The mean yield was significantly higher in hybrid MYD x TPT combination (97.9 nuts/palm/year) compared to other hybrids and local check. The same trend was observed with copra content and oil yield also.

Bhubaneshwar

The trial was planted in November 2005 with eight hybrids and a tall variety in RBD with four replications. The observations on growth characters recorded revealed that there was no significant variation among the hybrids and the check.

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

Centres: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Kahikuchi, Mondouri, Pilicode, Ratnagiri, Veppankulam.

Aliyarnagar

Five location specific cross combinations *viz.,* IND007 x Aliyarnagar Tall, Aliyarnagar Tall x MGD, MGD x Aliyarnagar Tall, IND007 x WCT and IND054 x Aliyarnagar Tall were planted in the main field during September 2012 in four replications. Phenotypic data was recorded during December 2012 and analysed for I and II order statistical measures. The crosses recorded a mean height of 107.5 cm and a mean girth of 13.90 cm. On an average, the genotypes possessed 5.7 leaves with a leaf length of 80.2 cm and leaf breadth of 2.4 cm. Among the five cross combinations, IND054 x Aliyarnagar Tall was found to be significantly superior to other combinations in terms of height (167.1 cm), girth (17.7 cm), leaf length (1341.0 cm) and petiole length (58.1 cm). IND007 x Aliyarnagar Tall, Aliyarnagar Tall x MGD and MGD x Aliyarnagar Tall were found to be on par for growth parameters *viz.*, girth, leaf number, petiole length and leaf length. Leaf splitting was not yet observed in IND007 x Aliyarnagar Tall and IND007 x WCT crosses. The coefficient of variation for these phenotypic traits was less than 20%.

Ambajipeta

The seedlings of six cross combinations *viz.,* CRP509 x CCNT, GBGD x Kalpa Pratibha, CRP 509 x PHOT, GBGD x PHOT, PHOT x GBGD and CRP 509 x GBGD were planted in June 2011 in RBD with three replications. ECT x PHOT recorded the highest plant height (307.3 cm), leaf length (156.6 cm) and petiole length (63.0 cm). However, the number of functional leaves showed non significant differences among the crosses. Further ECT x PHOT recorded the highest leaflet counts (right-33.1 and left-31.3) and it was on par with PHOT x GBGD (Right-24.6 and Left-23.4). Leaflet length (73.6 cm) and leaflet breadth (3.0 cm) were also high in ECT x PHOT.

Arsikere

The seed nuts of all the crosses were harvested and sown in nursery during February –September 2011. Seedlings were planted during the last week of September 2012 in B1 plot. The seedling growth parameters revealed that the hybrid TPT X MYD was superior in terms of plant girth (16.0 cm), leaf length (petiole 45.0 and leaflet bearing portion 41.4 cm), and no. of leaflets (left 16.6 and right 17.6). TPT X LCOT hybrid combination recorded more leaflet length (49.4 cm).

Bhubaneshwar

The seedlings of five location specific cross combinations were planted in February 2008 in RBD with four replications. The palms in the trial are in the pre-bearing phase. The morphological data revealed that there was no significant variation among the palms in different cross combinations with respect to plant height, plant girth, annual leaf production rate and other

leaf characters. The number of functional leaves/palm (13.2) was significantly higher in the hybrid GBGD x BGRT, which was on par with the hybrid IND041 x GBGD, recording 12.1 leaves/palm. However, the maximum plant height (3.3m), girth (43.5cm) and leaf production rate (8.8 leaves/palm/year) were recorded in IND041 x GBGD, MGD x IND041 and GBGD x BGRT respectively. Among the different cross combinations tried, the hybrid IND041 x CRP794 exhibited poor growth with respect to girth (30.4 cm), leaf production rate (7.4 leaves/palm/year), leaf length (172.1 cm), petiole length (56. 5 cm) and the length of the leaflets (121 cm).

Kahikuchi

The experiment was undertaken with five cross combinations i.e., ASGT x CCNT, ASGT x PHOT, ASGT x IND058, CRP502 x ASGT and CRP501 x PHOT. The seedlings were planted in the main field during April 2009 in RBD with six palms per replication. The palms are in the juvenile stage. Observations indicated that the highest plant height (395 cm), girth (78 cm), maximum leaf production per year (11.6), and number of functional leaves/palm (16.6) were recorded in CRP501 x PHOT. ASGT x CCNT recorded the highest leaf length (286 cm), petiole length (94.6 cm), no.of leaflets (R:83.0, L:81.0), leaflet length (108.0 cm) and breadth (5.36 cm).

Mondouri

Among the five crosses, the maximum plant height (358.0 cm) and number of leaves (14.4) were observed in CRP509 x CRP502 followed by LCOT x PHOT. Maximum girth (69.6 cm) was recorded in CRP509 x JVT. Among the leaf parameters, the highest length of leaf bearing portion (250 cm) was observed in LCOT X PHOT, number of leaflet s (L:75, R:72) were recorded in CRP509 x JVT. However, leaflet length and leaf breadth (4.5 cm) were maximum in CRP509 x Kalyani Coconut-1.

Pilicode

Sixteen crosses were made during 2011-12 and 286 seed nuts were collected for sowing in June 2013. The pollination work of the crosses is being continued during this season.

Ratnagiri

The experiment was initiated in December 2006 with six cross combinations. There were no significant differences among different cross combinations with respect to leaf production and functional leaves on the crown in the year 2012. However, number of leaves produced ranged from 6.7 (BGRT x IND007) to 7.3 (CRP513 x IND007), while functional leaves on the crown ranged from 11.4 (CRP514 x IND007) to 14.2 (CRP513 x IND007). Significantly maximum height (630.8 cm) was recorded in IND007 x CRP514 which was on par with CRP513 x IND007 (613.7 cm), CRP514 x IND007 (608.9 cm), BGRT x IND007 (592.1 cm) and IND007 x CRP513 (578.3 cm). Significantly minimum height (481.2 cm) was recorded in IND007 x BGRT cross combination. Significantly maximum girth (130.1 cm) was recorded in CRP514 x IND007 which was on par with CRP513 x IND007 (129.9 cm), BGRT x IND007 (128.54 cm), IND007 x CRP514 (126.6 cm) and IND007 x CRP513 (113.5 cm). Significantly maximum leaf length (500.38 cm), leaflet count (L: 95.2 , R: 98.2) were recorded in IND007 x CRP513 cross combination, while CRP514 x IND007 recorded significantly maximum left leaflet length (103.4 cm) and right leaflet length (102.1 cm).

Veppankulam

Among the five crosses, IND 048 x WCT registered the highest no. of functional leaves of 27.2 followed by WCT x MGD (26.2). Length of the petiole was the highest in ADOT x IND 007 of 1.56 m followed by WCT x IND 048 (1.5 m). WCT x IND 048 recorded the highest length of leaf of 3.48 m followed by WCT x IND 074 of 3.4 m. No. of leaflets was found to be highest in WCT x IND 074 (194.7) followed by WCT x MGD (193.5), WCT x IND 074 recorded the highest length of leaflet (1.2 m) followed by WCT x MGD (1.1 m). Breadth of the leaflet was the highest in both WCT x IND 074 and WCT x IND 048 (5.7 m).

Among six hybrids, the highest volume of tender nut water was observed in MOD x WCT (380 ml) followed by WCTx MGD (275 ml). The Hybrid WCTx MGD recorded the highest quantity of tender nut meat of 125 g followed by the hybrid ADOT x COD (115 g). The total soluble sugars was high in the hybrids WCT x Kenthali Dwarf

(5.8°brix) followed by WCTX MGD (5.5 °brix). Organoleptic scores for tender nut water (8.0) and meat (7.0) were highest for the hybrid WCT x Kenthali Dwarf.

Gen. 3 : Trial of promising hybrids and varieties in coconut

Centres: Ambajipeta, Bhubaneshwar

Ambajipeta

Among the different hybrids and varieties evaluated, significant differences were recorded for girth at base, height, fruit weight, dehusked fruit weight, husk weight, quantity of water, copra content, copra yield (kg/palm), oil content and estimated oil yield (Table 5). Though the nut yields were non-significant, the highest yield of 119.6 nuts was recorded in ECT x GBGD. Regarding nut characters, the highest fruit weight was recorded in Chandra Laksha (1216.7 g) and it was on par with COD x WCT (1166.7 g). Copra output was the highest in ECT x CGD (23.9 kg/palm) followed by WCT x GBGD (20.9 kg/palm). However, WCT x GBGD recorded the highest oil yield of 13.1 kg per palm and it was on par with ECT x CGD (10.6 kg) and COD x WCT (10.12 kg).

Bhubaneshwar

The experiment was laid out with three hybrids (in which WCT is one of the parent plant), two promising varieties and one local check (IND041) in August 2004 in RBD with four replications. The data pertaining to different growth characters revealed that there was no significant variation among the cultivars tested in the trial. However, Chandra Kalpa registered the maximum plant height (6.4 m) and girth (119.6 cm) as compared to others. The maximum functional leaves on the crown (20.7), rate of leaf production (10.7 leaves/palm/year), petiole length (129.2 cm) and breadth of leaflet (5.2 cm) were observed in the hybrid WCT x COD. On the other hand, the hybrid COD x WCT exhibited poor growth with respect to all the recorded growth parameters as compared to the others.

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

Centres: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Kahikuchi, Ratnagiri and Veppankulam

Aliyarnagar

Five tall x tall cross combinations received from CPCRI, Kasaragod were planted in the main field during

Table 5: Fruit component traits of the coconut hybrids planted in 2002 (Ambajipeta)

Hybrids/ Varieties	Fruit weight (g)	Dehus-ked fruit weight (g)	Husk weight (g)	Kernel thick-ness (cm)	Shell thick-ness (cm)	Kernel weight (g)	Shell weight (g)	Husk thick-ness (cm)	Copra content (g/nut)	Copra output (kg/palm /year)	Oil content (%)
COD x WCT	1166.7	504.2	662.5	1.6	2.7	216.7	120.0	1.3	126.7	15.6	65.0
LCOT x GBGD	1058.3	486.7	571.8	1.2	3.0	183.3	106.7	1.4	111.7	13.7	62.3
WCT x GBGD	861.7	426.7	425.0	1.4	2.7	198.3	103.3	1.4	108.3	21.0	64.3
LCOT x COD	1216.7	575.0	641.7	1.2	2.8	180.0	106.7	1.4	190.0	20.9	65.0
ECTxCGD	758.3	408.3	350.0	1.7	2.7	148.3	91.7	1.7	126.7	23.9	61.7
ECTxMYD	1013.3	541.7	471.7	1.7	3.0	220.0	93.3	1.4	170.0	17.3	70.3
LCOT	958.3	438.3	520.0	1.3	3.0	216.7	113.3	1.3	139.2	14.3	63.0
PHOT	1150.0	606.7	543.3	1.2	3.3	216.7	160.0	1.3	126.7	14.5	61.3
ECT x GBGD	1066.0	556.7	510.0	1.2	2.7	150.0	100.0	1.4	150.0	20.4	66.0
S Em ±	66.9	38.3	50.6	0.1	0.4	17.3	12.9	0.1	8.6	1.8	0.8
CD (P=0.05)	202.33	115.95	152.98	0.26	N.S.	52.19	N.S.	N.S.	26.10	5.60	2.44

NS= Not Significant

Table 6: Performance of tall x tall cross combinations at various AICRP- Palms centres

Genotypes	WCT x TPT			LCOT x ADOT			BGRT x ADOT			ADOT x ECT			ECT x LCOT		
Traits	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*
AICRP centres															
Aliyarnagar	23.8	153.9	4.9	30.8	177.2	5.4	22.8	154.1	5.2	20.1	137.9	4.6	30.4	171.6	5.5
Arsikere	16.9	209.4	5.6	15.0	200.4	5.3	12.5	128.9	4.9	12.8	139.7	5.1	10.7	101.9	4.2
Ratnagiri	30.8	198.7	5.1	22.2	172.5	5.4	27.2	176.7	5.6	25.0	178.2	5.0	33.7	224.2	5.2
Veppankulam	41.0	268.0	9.0	41.5	245.0	11.0	38.0	235.0	9.0	56.5	318.0	13.0	42.0	282.0	11.0

*LP- Number of leaves

August 2011. Morpholgical parameters were recorded and statistically analysed (Table 6). The data revealed that the T x T crosses had recorded a mean height of 158.9 cm, mean girth of 25.6 cm with 5.1 functional leaves. The mean leaf length of the crosses was 185.3 cm, while petiole length was 78.3 cm. The mean leaflet length and breadth recorded by these combinations were 70.9 cm and 3.9 cm, respectively. Among the T x T cross combinations, no significant differences were observed for girth, height, functional leaves and leaflet breadth. LCOT x ADOT and ECT x LCOT were on par and significantly superior to other combinations for leaf parameters *viz.,* petiole length, leaf length, leaflet length etc. Among the traits measured, girth at base showed the highest variability (24.2%).

Ambajipeta

Seed nuts of five cross combinations were received from CPCRI, Kasaragod and nursery was raised. The experimental palms were planted in June 2011 with four replications. The TxT hybrids exhibited significant differences for all growth traits except leaf length, leaflet length and leaflet breadth. WCT x TPT recorded the highest plant height of 242.8 cm and number of functional leaves (7.7) and it was on par with LCOT x ADOT with plant height of 187.1 cm and 7.5 number of functional leaves and BGRT x ADOT with plant height of 182.1 cm and 7.5 number of functional leaves. WCT x TPT recorded the highest left leaflet number (32.9) and right leaflet number (31.8) and it was on par with BGRT x ADOT and LCOT x ADOT.

Arsikere

The seedlings were planted during the second week of September 2012. The growth parameters recorded at nursery stage showed that the hybrid WCT x TPT recorded more plant girth (16.9 cm), number of leaves, leaflet length (70.6 cm), leaflet breadth (3.7 cm) and LCOT x ADOT combination recorded more leaf length (petiole 912.0 and leaflet bearing portion 135.4 cm) (Table 6).

Bhubaneshwar

The seed nuts of the crosses of WCT x TPT, LCOT x ADOT, BGRT x ADOT and ADOT x ECT, ECT x LCOT were received and seedlings were raised for planting in the main field.

Kahikuchi

Seedlings of the tall x tall crosses except IND 018 x CRP 509 and Local Check (ASGT) have been planted during October 2012 in the main field. Seedlings of the cross combination IND018 x CRP509 and ASGT are in the nursery stage and will be planted in the main field during June 2013. The highest plant height (175 cm), girth (18 cm) and number of leaves (7.0) were observed in WCT x TPT, whereas, the hybrid BGRT x ADOT recorded the highest petiole length (96 cm).

Ratnagiri

The experiment was planted in August 2011. Morphological observations revealed that significantly maximum height (224.2 cm) was recorded in the cross combination CRP509 x LCOT followed by BGRT (201.1 cm) and WCT x TPT (198.1 cm). Significantly minimum

height (172.5 cm) was recorded in LCOT x IND018 cross combination. Significantly maximum girth (33.7 cm) was recorded in CRP509 x LCOT which was followed by (WCT x TPT) (30.8 cm) (Table 6). There were non- significant differences for all other growth characters among the treatments.

Veppankulam

Five T x T cross combinations were planted along with check in A4 Block during the first week of 2011. Among the hybrids, IND018 x CRP509 registered the highest number of functional leaves (13) (Table 6). The highest leaf length was noticed in CRP509 x LCOT (3.3 m). No.of leaflets the highest in LCOT x IND018 (111). Higher girth was found in IND018 x CRP509 (56.5 cm).

Gen. 10A : Performance of new (experimental) cross combinations of Tall x Tall in coconut

Centres: Ambajipeta, Ratnagiri, Veppankulam

Ambajipeta

The seed nuts of cross combinations *viz.,* JVT x CRP 509, PHOT x CRP 509, FJT x CRP509, LCOT x CRP509, CRP509 x JVT, CCNT x CRP509 and CRP509 x FJT were received from CPCRI, Kasaragod and nursery was raised and the experiment was planted in August 2011. None of the T x T hybrids showed significant values for growth characters.

Ratnagiri

The experiment was planted in August 2009 with 7 cross combinations and a local check in three replications. Significantly maximum number of leaves (6.5) was recorded in PHOT x CRP513 which was on par with BGRT x PHOT (6.4), PHOT x BGRT (6.3), BGRT (6.1) and PHOT X CRP514 (5.6) cross combinations. Significantly minimum number of leaves/year was recorded in CRP514 x PHOT. Significantly maximum leaf length (29.2 cm) was recorded in BGRT x PHOT, which was on par with PHOT x CRP513 (28.8 cm), PHOT x BGRT (25.2 cm) and PHOT x CRP514 (24.1 cm). The cross combination PHOT x CRP513 showed vigorous growth, while PHOT x BGRT showed dwarf growth characters with respect to all vegetative traits.

Veppankulam

Eight new T x T cross combinations made at Veppankulam were planted during March 2010. Among the cross combinations, number of functional leaves was the highest in CRP509 x CRP511 (14). The highest plant girth was recorded in WCT x PHOT hybrid (45.0 cm) followed by CRP509 x CRP511 (36.5 cm). WCT x PHOT recorded plant height of 2.88 m followed by CRP509 x WCT (2.55 m). Number of leaflets was the highest in CRP509 x PHOT (81). The check VHC3 recorded the highest leaf length of 2.93 m.

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

Centres: Ambajipeta, Mondouri, Ratnagiri, Veppankulam, Pilicode

Ambajipeta

The experiment was planted in 2011 and plants are in vegetative phase. Among the different D x D hybrids, significant differences were recorded for plant height and petiole length and the remaining growth characters were non-significant. COD x MYD hybrid showed the highest plant height of 224.8 cm and petiole length of 95.2 cm and it is on par with COD x MGD hybrid with a plant height of 200.5 cm and petiole length of 94.6 cm.

Mondouri

The highest plant height (171.2 cm) was recorded in MYD x CGD followed by 159.2 cm in GBGD x MOD. Number of leaves (9) was maximum in COD x MGD. Maximum girth (15.5 cm) was recorded in COD x MYD (Table 7). The highest length of leaf bearing portion (105 cm) was in MYD x CGD.

Pilicode

The mother palms in nine accessions viz., CGD, CDO, MGD, MOD, CYD, MYD, GBGD, Thembli, Ayiramkachi were identified and marked for crossing programme.

Ratnagiri

The growth parameters were recorded during the first year after planting of D x D hybrids (Table 7). All the growth parameters showed non-significant differences among the hybrid combinations except for petiole length.

Table 7: Performance of Growth characters of dwarf x dwarf cross combinations at various centres

Genotypes	CODxMYD			COD x MGD			MYD x CGD			GBGD x MOD			CGD x MGD		
Traits	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*
AICRP centres															
Mondouri	15.5	118.5	8.0	12.5	147.7	9.0	12.2	171.2	9.0	13.3	159.2	8.0	11.2	157.7	9.0
Ratnagiri	23.1	134.4	2.4	17.6	142.9	2.5	21.4	117.1	2.1	21.2	133.1	2.1	16.4	114.5	2.2
Veppankulam	48.0	298.0	10.0	47.0	287.0	13.0	48.5	265.0	12.0	55.5	294.0	13.0	49.5	291.0	14.0

*LP- Number of leaves

Veppankulam

Five D x D cross combinations *viz.,* COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD and CGD x MGD were planted along with check during January 2011. Seedlings have established well and the morphological characters of these D x D cross combinations were studied (Table 7). Among the hybrids, CGDx MGD registered the highest number of functional leaves (14). The highest leaf length was noticed in the hybrid MYD x IND029 (3.39 m). Number of leaflets was the highest in the hybrid CGDx MGD (133).

Gen.12 : Demonstration of released varieties of coconut in different agro-climatic regions

Centres: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagdalpur, Kahikuchi, Navsari, Ratnagiri, Sabour and Veppankulam

Aliyarnagar

During this year, seedlings were nurtured for early establishment. *Inter se* crossing is in progress for Kalpa Pratibha for gap filling. Seed nuts of other genotypes have been obtained from CPCRI, Kasaragod and sown in the nursery. Seed nuts/seedlings of Kerakeralam, Gautami Ganga, Kahikuchi hybrid and Konkan Bhatye hybrid were obtained from Veppankulam, Ambajipeta and Ratnagiri centres and used for gap filling as and when mortality was observed.

Morphological observations were recorded for the seedlings planted in the main field. Among the ten genotypes, Kalpa Mitra recorded the maximum height of 198 cm, while Kera Bastar recorded the maximum girth of 30.2 cm, with 7.2 leaves on an average. The leaf length ranged from 98.8 (Kalyani coconut 1) to 198.0 (Kalpa Mitra). The mean number of leaflets on the left and right recorded by the genotypes were 34.3 and 33.9. Kalpa Prathiba, Kalpa Dhenu, Kera Bastar and Konkan Bhatye hybrid recorded leaflet lengths greater than 50 cm. Kalpa Dhenu and Kera Bastar also recorded leaflet breadths greater than 3.0 cm. Among the nine traits measured, variability was higher for girth (29.8%) followed by height of seedlings (22.2%). Variability for all leaf parameters except petiole length was lesser than 20%.

Ambajipeta

With respect to growth attributes, Konkan Bhatye Coconut Hybrid-1 recorded the highest plant height (358.1 cm), leaf length (236.8 cm), petiole length (117.8 cm), left leaflet number (63.9) and right leaflet number (62.6), leaflet length (81.2 cm)and leaflet breadth (4.05 cm).

Arsikere

The seed nuts of coconut varieties *viz.,* Kera Keralam, Konkan Bhatye Coconut Hybrid -1, Kera Bastar, Kalpa Samrudhi, Gauthami Ganga, Kalpa Pratibha, Kalpa Mitra, Kalpa Dhenu, Kalparaksha and Kalyani Coconut -1 were sown in the nursery for production of seedlings. The seedlings have been planted during the first week of August 2011 except Kalyani Coconut -1, Kalpa Raksha and and Kalpatharu,which were planted during July 2012. The growth parameters recorded at the time of planting showed that Kalyani coconut-1 recorded maximum plant girth (41.0 cm), leaf length

(petiole 88.7 cm and leaf let bearing portion 144.8 cm), leaflet length (60.2 cm) and breadth (5.2 cm) and more leaf let numbers (L: 47.6, R:48.6). Kalpa Dhenu recorded the highest number of leaves (15.3) and the local check Kalpatharu recorded more leaflet length (66.7 cm).

Bhubaneshwar

The seednuts of Kalyani Coconut-I, Gautami Ganga, Konkan Bhatye coconut hybrid-1, Kera Keralam, Kera Bastar, Kalpa Samrudhi, Kalpa Pratibha, Kalparaksha and Kalpa Dhenu were collected and seedlings were raised for planting.

Jagdalpur

The available seedlings of Kalyani Coconut -1, Gauthami Ganga, Konkan Bhatye Coconut Hybrid-1, Kera Keralam and Kera Bastar have already been planted in June 2012. The growth observations showed that the highest plant height was observed in Kalyani Coconut -1, whereas the petiole length was the highest in Kera Bastar. Leaf length was the highest in Konkan Bhatye Coconut Hybrid -1 followed by Kera Keralam. Girth of plant was also the highest in Konkan Bhatye Coconut Hybrid -1.

Kahikuchi

Out of the ten coconut varieties/hybrids, seedlings of Konkan Bhatye Coconut Hybrid-1, Kera Keralam, Kera Bastar and Gauthami Ganga were planted in the main field during September 2011. Seedlings of Kalyani Coconut-1 were planted during October 2012. Morphological characters of five varieties/hybrids were recorded. The highest values in respect of plant height (168 cm), girth (34 cm), number of leaves (7), leaf length (145 cm), petiole length (85 cm), leaflet count (48), leaflet length (58 cm) and leaflet breadth (3.9 cm) were recorded in Konkan Bhatye Coconut Hybrid-1. The remaining coconut varieties are in the nursery stage. Seedlings of these cultivars will be planted by the middle of July 2013.

Ratnagiri

Morphological parameters recorded on the released varieties revealed that the average height of seedlings ranged from 118 cm to 256 cm, girth from 11.9 cm to 37.6 cm, leaf production per year from 4.6 to 6.0, leaf length from 50.3 cm to 141.2 cm, petiole length from 41.00 cm to 93.5 cm, left leaflets from 15.5 to 49.0, right leaflets from 17.0 to 51.0, and leaflet breadth from 1.8 cm to 3.2 cm.

Veppankulam

Morpological characters were recorded in five released hybrids/variety. Seed nuts of Kalyani Coconut-1, received from Aliyarnagar were sown in the nursery.

Gen. 13: Screening cocoa clones for their performance as intercrop in coconut gardens

Centres: Ambajipeta, Veppankulam

Ambajipeta

Six cocoa clones *viz.,* VTLCC1, VTLCH1, VTLCH2, VTLCH3, VTLCH4, VTLC 1 (Control) were planted in November 2008 in RBD with four replications. Maximum plant height (235.2 cm) was recorded by VTLCH4 followed by VTLCH2 (220.4 cm). Mean girth, height at first branching and East – West and North-South canopy spread showed non significant effect. Number of fruiting branches was the highest in VTLCI (5.0) and it was on par with VTLCH4 (4.6) and VTLCH3 (3.7).

Veppankulam

Cocoa grafts of five hybrids and one cultivar were received from CPCRI, Regional station, Vittal, Karnataka on 06.08.08 and the seedlings were planted on 14.08.2008. Observations on plant height and stem girth were recorded. VTLCH1 recorded the highest plant height of 321.0 cm followed by VTLCH3 (197.5 cm). Plant girth was the highest in CTLCC1 (28.0) cm followed by VTLCH1 (10.5 cm).

Gen 13 A: Multilocation testing trial of cocoa clones under palms

Centres : Arsikere, Pilicode, Ratnagiri

Arsikere

The cocoa clones/hybrids procured from CPCRI, Regional Station, Vittal were planted during September

with basin making and mulching operations surrounding the coconut palms and drip irrigation.

Pilicode

Out of 25 varieties of cocoa, six plants each of 24 varieties were received and planted as inter crop in coconut garden during September 2012. Crop is heavily infested by leaf eating caterpillar. Since Kasaragod district has been declared as an organic cultivation district, organic pesticides were only tried to control the pest.

Ratnagiri

The grafts collected from CPCRI, Regional Station, Vittal, Karnataka has been planted during November 2012.

Gen. 14 : Screening of black pepper varieties for their performance as intercrop in coconut gardens

Centres: Kahikuchi, Mondouri

Kahikuchi

Five black pepper varieties *viz.*, IISR Thevam, IISR Shakthi, IISR Malabar Excel, Sreekara and Panniyur-1 were selected for the trial. The rooted cuttings of these varieties were planted in the main field under coconut garden during September 2008 in RBD with four replications. The highest vine length of 4.25 m and vine girth of 4.1 cm were recorded in Panniyur-1, whereas, the lowest vine length (3.6 m) was observed in IISR Shakthi and vine girth (2.9 cm) in IISR Thevam. With regard to number of branches/vine among the varieties, the highest number of branches (14.6) was recorded in Sreekara and the lowest number (13.2) was found in IISR Thevam. Two varieties *viz.,* Panniyur-I and Sreekara have started flowering.

Mondouri

The cuttings of the five black pepper varieties were planted during 2010-11 in the main field under coconut garden. The growth characters with regard to vine length, number of branches/vine were recorded. The maximum vine length (412 cm) was recorded in Sreekara, whereas, minimum length was recorded in IISR Thevam (309 cm). Branch number was maximum in Sreekara (20) followed by Panniyur1 (18) and minimum was recorded in Malaber Excel (12). All the black pepper varieties started flowering during the third year of planting and have set fruits.

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

Centres: Aliyarnagar, Ambajipeta, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Ratnagiri and Veppankulam

Aliyarnagar

Seed nuts of Kera Keralam were periodically sown in the nursery and seedlings produced are being distributed to farmers. During 2012-13, 5000 seedlings were distributed to farmers from the mother palms maintained at CRS, Aliyarnagar. Kalpa Pratibha seed gardens are in early establishment phase, comprising of 30 seedlings. *Inter-se* crossing is also in progress to produce true to type seed nuts of Kalpa Pratibha.

COD Garden at Aliyarnagar

Ambajipeta

Multiplication of Gautami Ganga, Kera Bastar and Kalpa Pratibha was carried out. During 2012-13, 2682 seedlings of Gautami Ganga, 150 seedlings of Kalpa Pratibha and 58 seedlings of Kera Bastar have been produced.

Arsikere

The nursery of Kalpatharu variety has been established by sowing 17,800 seed nuts during February 2011 to February 2013. During 2012-13, 4702 seedlings were sold to the needy farmers.

Jagdalpur

Seed garden for coconut variety Kera Bastar was established in 2008. During this year, two seed gardens are being established one at the new site allotted with approximately 1.46 acres at SG College of Agriculture and Research Station Jagdalpur and another with approximately 1.5 acres at Shri Rajesh Naidu (Village – Kumhali, Jagdalpur Block).

Kahikuchi

As the female parent for the hybrid Kalpa Samrudhi (MYD x WCT) is limited at the centre, a mother block of MYD with 25 palms has been planted in the field. Simultaneous hybridization programme of the above cross is also being done to produce planting materials.

Mondouri

Seedlings of Kalyani Coconut-1, Kalpa Mitra and Kera Keralam have been planted and growth is satisfactory.

Ratnagiri

A total of 113 ECT palms have been established of which 20 palms are in bearing stage and 93 are in the pre bearing phase. Gautami Ganga seed garden has been established with 93 palms of which 10 are in bearing stage and 83 are in the pre bearing phase. Kera Bastar seed garden comprises of 167 palms, of which 8 are in bearing phase and 159 are in the pre-bearing stage.

Veppankulam

Seed garden of Kera Keralam variety has been established in an area of 2 ha and production of planting materials for Kalpa Pratibha variety is in progress with the available mother palms.

Gen. 20: Utilization of second generation selves and sib mated progenies of coconut

Pilicode

Twenty five experimental palms were identified and proper management practices were given. The pollination work has been started for selfing and *inter se* crossing with the identified six types. The selfing and *inter se* crosses were made for 12 combinations during 2011-12 and 239 seed nuts were collected during the season for sowing in June 2013. Selfing and *inter se* crossing programme are being continued during this season also.

5.2 Crop Production

Agr. 5: Studies on fertilizer application through micro-irrigation technique in coconut

Centres : Aliyarnagar, Ambajipeta, Arsikere, Kahikuchi, Kasaragod, Mondouri, Ratnagiri, Veppankulam

Objectives:

- To compare efficiency of soil application of fertilizers and fertigation in coconut nutrition
- To study the effect of fertigation on the productivities of coconut
- To work out the economic viability of fertigation over soil application

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 was initiated during 2007 in 18 year old coconut garden (VHC-2 hybrid) with 6 treatments. The fertilizers are being applied through drip fertigation in 10 splits from December to September in the form of Urea, Diammonium phosphate and Muriate of potash as sources of nitrogen, phosphorus and potassium, respectively. The nut yield of coconut during 2011-12 was significantly higher in drip fertigation of 100 per cent RDF (Table 8) compared to the other treatments but was on par with drip fertigation of 75 per cent RDF. Drip fertigation of 50 per cent RDF was on par with 100 per cent RDF through basin application.

Ambajipeta

The trial was initiated during November 2007 in 25 years old coconut garden of East Coast Tall variety. Application of 100% RDF through fertigation recorded maximum yield (115.5 nuts/palm) which was on par with 75% RDF through fertigation (98.5 nuts/palm) (Table 9). The number of leaves on crown (35.4) and the number of spadices per palm (13.9) were also higher in 100% RDF through fertigation and was on par with 75% RDF through drip fertigation. More number of female flowers per spadix (29.0) was observed in 100% RDF through fertigation and it was on par with 75% RDF through fertigation (27.0). Significant differences were observed among different treatments regarding nut quality characters except shell weight, husk weight and copra weight. The highest nut weight (1104.7 g) was recorded by 100% RDF of NPK through drip and it was on par with 75% of RDF through drip, 100% of RDF as soil application

Table 8: Nut yield of coconut as influenced by fertigation (Aliyarnagar)

Treatments	Coconut yield (nuts/palm/year)		
	Pre-treatment yield	2010-11	2011-12
T_1 - Control (No fertilizer)	105	90	89
T_2 - 25 % of RDF through drip irrigation	110	101	101
T_3 - 50 % of RDF through drip irrigation	119	119	122
T_4 - 75 % of RDF through drip irrigation	115	125	134
T_5 - 100 % of RDF through drip irrigation	116	139	144
T_6 - 100 % of the RDF through soil application	112	122	118
S. Ed ±	—	5.8	5.9
CD (P=0.05)	—	12.4	12.5

and 25% RDF through drip. Dehusked nut weight (474.5 g) was the highest in 100% RDF through drip and it was on par with 75% RDF through drip.

Kahikuchi

The experiment was laid out in adult coconut garden of 35 years old during October 2009. The

Table 9 : Yield attributes of coconut as influenced by fertigation (Ambajipeta)

Treatments	No. of leaves on crown	No. of spadices/ palm	No. of female flowers/ spadix	Yield (nuts/palm/yr)	
				Pre-treatment 2005-07	During 2011-12
T_1 - Control (No fertilizer)	26.9	9.8	15.6	58.2	67.3
T_2 - 25 % of RDF through drip irrigation	28.3	12.4	18.4	57.1	82.6
T_3 - 50 % of RDF through drip irrigation	31.8	13.0	26.5	62.2	91.8
T_4 - 75 % of RDF through drip irrigation	34.1	13.8	27.0	60.7	98.4
T_5 - 100 % of RDF through drip irrigation	35.3	13.9	29.0	61.1	115.4
T_6 - 100 % of the RDF through soil application	29.1	11.0	21.0	59.8	88.0
S Em ±	1.2	0.5	0.4	1.2	6.7
CD (P=0.05)	3.56	1.68	1.24	3.75	20.34

Arsikere

The experiment was initiated during July 2007 in RBD with four replications in 40 years old coconut garden of Tiptur Tall variety. The number of functional leaves and bunches per palm were not significantly influenced by the fertigation treatments. Application of 100% NPK through drip irrigation recorded significantly higher number of buttons per palm and nut setting per cent compared to control and application of 25% NPK through drip irrigation.

The nut yield, copra yield and oil yield per palm were significantly higher with the application of 100% NPK through drip irrigation compared to control and application of 25% and 50% NPK through drip irrigation. Application of 75% NPK through drip irrigation recorded nut yield, copra yield and oil yield per palm which was on par with the application of 100% NPK through drip irrigation and 100% NPK through soil application (Table 10). Hence, a saving of 25% of recommended fertilizers is possible in coconut by adopting fertigation of 75% recommended NPK through drip irrigation.

quantity of water used in drip irrigation was equal to 66% of pan evaporation with mulching. The number of functional leaves, annual leaf production, number of spadices per palm and number of female flowers per spadix were significantly higher with the application of 100% RDF through drip compared to other treatments. The nut yield during 2011-12 and also the mean over last three years was significantly higher with the application of 100% NPK through drip irrigation followed by 75% RDF through drip irrigation and 100% of RDF through soil application (Table 11). The soil nutrient status (NPK) as well as leaf nutrient content were also higher with the application of 100% NPK through drip system compared to other fertigation treatments. The economics of fertigation indicated that the treatment of 100% RDF through drip irrigation recorded the highest net returns and B:C ratio (₹ 96,185 per ha and 2.01) followed by 75% RDF through drip irrigation (₹ 89,060 per ha and 1.89) and 100% RDF as soil application (₹ 68,610 and 1.49) (Table 11).

Table 10: Nut and copra yield of coconut as influenced by fertigation treatments (Arsikere)

Treatments	Nut yield (nuts/palm)		Copra yield (kg/palm)	
	2010-11	2011-12	2010-11	2011-12
T_1 : Control (No fertilizer)	84.0	75.3	13.2	10.8
T_2 : 25% of Rec. NPK (Drip)	94.1	79.7	14.8	11.3
T_3 : 50% of Rec. NPK (Drip)	111.5	87.0	17.4	12.9
T_4 : 75% of Rec. NPK (Drip)	121.1	98.2	19.5	14.6
T_5 :100% of Rec. NPK (Drip)	129.6	106.3	20.9	16.0
T_6 :100% of Rec. NPK (Soil)	124.0	94.6	19.6	13.8
S. Em ±	6.7	4.0	1.3	0.5
CD (P=0.05)	20.32	11.95	3.96	1.48

Kasaragod

Among the fertigation levels, the coconut yield and copra was significantly higher in 100 % NPK fertigation which was on par with 75 and 50 per cent NPK applied through drip irrigation and significantly differed from 100% NPK through soil application, 25 % NPK through fertigation and control. The higher yield under drip fertigation treatments even under 50 percent reduction of fertilizer level is mainly due to increased availability of soil nitrogen, phosphorus and potassium, higher annual leaf production and higher photosynthetic activity and more number of female flowers production.

Mondouri

The number of functional leaves per palm (32.5), number of bunches per palm (10.2) and nut yield per palm (103.2) were maximum in 75% of RDF through drip system compared to other tretments. The soil analysis data revealed that significantly more soil nitrogen and potash content was recorded with the application of 75% of RDF through drip system (214 kg/ha and 120 kg/ha) as compared to control (167 kg/ha and 72 kg/ha). The higher phosphorus content in soil was recorded in 100% of RDF through drip system (23 kg/ha) as compared to control of no fertilizer application (Table 12).

Ratnagiri

The experiment was laid out in an adult coconut garden of WCT variety in sandy soil during 2006. It was

Table 11: Yield of coconut as influenced by fertigation treatments (Kahikuchi)

Treatments	Pre-experimental yield	Annual nut yield (nuts/palm) 2011-12	Copra yield (2011-12) (kg/palm/year)	Gross returns (₹)	Net returns (₹)
T_1 : Control (No fertilizer)	50.0	50.0	8.2	90300	49400
T_2 : 25 % of RDF through drip system	51.8	69.5	9.4	104300	59900
T_3 : 50% of RDF through drip system	52.0	76.4	10.4	113400	67635
T_4 : 75 % of RDF through drip system	53.2	90.3	12.4	136150	89060
T_5 : 100% of RDF through drip system	54.6	100.6	14.0	144025	96185
T_6 : 100% of RDF through soil application	50.6	74.3	10.3	114450	68610
CD (P=0.05)	NS	8.42	2.14		

NS : Not Significant

Table 12: Growth and yield of coconut as influenced by fertigation treatments (Mondouri)

Treatments	No. of functional leaves/ palm	No. of bunches/ palm	Nut yield/ palm
T_1 : Control (No fertilizer)	28.0	7.7	86.0
T_2 : 25% of Rec. NPK (Drip)	30.0	9.2	95.0
T_3 : 50% of Rec. NPK (Drip)	31.5	9.0	100.2
T_4 : 75% of Rec. NPK (Drip)	32.5	10.2	103.2
T_5 :100% of Rec. NPK (Drip)	30.5	9.2	102.5
T_6 :100% of Rec. NPK (Soil)	29.5	8.5	100.5
S. Em ±	0.3	0.2	1.1
CD (P=0.05)	0.65	0.42	2.32

observed that the treatment of 100% RDF through drip irrigation (T_5) recorded the highest yield of 108.2 nuts per palm and was significantly superior over T_1 and T_2 and at par with T_3, T_4 & T_6 (Table 13). The per cent increase in mean nut yield of three years (2009-10 to 2011-2012) over the pre-treatment yield was maximum in treatment T_5: 100% RD of NPK through drip irrigation (28.8) followed by T_4 : 75 % RD of NPK through drip irrigation (12.2) and T_3: 50% RD of NPK through drip irrigation (10.9). The copra yield was the highest in T_5 (16.2 kg/palm) followed by T_4 (14.4 kg/palm) and T_3 (14.3 kg/palm) and these treatments were significantly superior over T_1 (No fertilizer), T_2 (25% RD of NPK through drip irrigation) and T_6 (100% RD of NPK as soil application).

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

Table 13: Yield of coconut as influenced by fertigation treatments (Ratnagiri)

Treatments	Yield of coconut (Nuts//palm/yr)			Per cent increase over pre-treatment yield	Copra yield (kg/palm) (2009-12)
	Pre treatment (2002-06)	Transit Period (2006-09)	Post treatment (2009-12)		
T_1: Control (No fertilizer)	99	97	78.5	-20.4	10.1
T_2: 25 % of RD of NPK through drip	81	89	80.1	-1.0	10.8
T_3: 50% of RD of NPK through drip	85	91	94.3	11.0	14.3
T_4: 75% of RD of NPK through drip	88	96	98.8	12.2	14.4
T_5: 100 % of RD of NPK through drip	84	99	108.2	28.8	16.2
T_6: 100 % of RD of NPK as soil application	93	103	94.7	1.8	13.5
S.Em ±	7.5	5.3	5.0	-	0.6
CD (P=0.05)	NS	NS	15.06	-	1.92

NS: Not Significant

Sabour

The experiment was initiated during October 2012 in Sakhigopal Tall variety of coconut. The plant height varied from 1.9 cm (control- no fertilizer) to 3.2 cm (100% RDF through soil application) under different treatments. The collar girth varied from 43.5 cm (T_1) to 81.0 cm (T_6). Similarly, the number of functional leaves, leaf length, petiole length and leaflet length were higher in 100% RDF through soil application and application of 100% RDF through drip system compared to other treatments.

Veppankulam

The experiment was laid out in 27 years old ECT variety of coconut palms during 2007. Among the drip fertigation treatments, T_5 (100% of RDF of NPK) significantly recorded higher annual nut yield of 139.2 compared to other treatments (Table 14). Yield obtained under T4 treatment was also significantly higher (132.8 nuts/palm) when compared to T1, T2, T3 and T6. The soil analysis results on available N content revealed that T_6: 100% of RDF of NPK as soil application recorded significantly higher value of 248 kg/ha followed by T_4 (223 kg/ha), when compared to T_1: control (124 kg/ha). The available soil P was higher in T_6: 100% RDF as soil application (7. 92 kg/ha) compared to T_1: control (3.20 kg/ha) but was on par with T_5 and T_4. The available soil K was significantly higher in T_6: 100% of RDF of NPK as soil application (136 kg/ha) compared to T_1: control (75.33 kg/ha) and was on par with T_5: 100% of RDF of NPK through drip. The results of analysis revealed that the leaf N content was significantly higher in T_5: 100% RDF of NPK through drip (1.68 %) when compared to T_1: control (0.82%) but was on par with T_4 and T_6 (Table 15). The leaf P content was significantly higher in T_4: 100% of RDF of NPK through drip (0.13%) compared to T_1: control. The leaf K content was significantly higher in T_5: 100% of RDF of NPK through drip (1.3%) followed by T_4: 75% of RDF of NPK through drip and least in T_1: control (0.8%).

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

Centres: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour, Veppankulam

Objectives

- To develop location specific coconut based integrated cropping system models for different agro – climatic regions
- To assess the effect of the cropping system model on the productivity of coconut
- To elucidate the effect of soil moisture conservation practices on the growth of coconut and intercrops

Table 14: Effect of fertigation levels on nut yield of coconut (nuts/palm/year)- 2010-2012 (Veppankulam)

Treatments	Yield of coconut (nuts/palm/year)			Leaf nutrient content (%)		
	Pre expt. yield	2010-11	2011-12	N	P	K
T_1: Control (No fertilizer)	96.1	76.3	92.8	1.2	0.1	0.8
T_2: 25 % of RDF of NPK through drip	93.1	82.8	110.0	1.5	0.1	1.1
T_3: 50% of RDF of NPK through drip	85.9	87.4	122.0	1.6	0.1	1.2
T_4: 75% of RDF of NPK through drip	85.1	90.6	132.8	1.7	0.1	1.2
T_5: 100 % of RDF of NPK through drip	104.6	91.9	139.2	1.7	0.1	1.3
T_6: 100 % of RDF of NPK as soil application	86.8	85.3	115.1	1.6	0.1	1.2
S.Ed ±	2.2	7.7	1.2	0.006	-	0.005
CD (P=0.05)	4.82	NS	2.50	0.015	NS	0.012

NS: Not Significant

- To assess the impact of integrated nutrient management technology (with major emphasis on organic wastes recycling process) on soil fertility status and plant nutrient content in coconut
- To work out the economics of the cropping system model

The development of location specific cropping system models was started duing 2008-09 or in later years at different centres in an area of 0.40 ha. The crops were planted as per the combinations suggested for different agro–climatic regions. Soil and water conservation practices have been adopted by husk burial and mulching. Vermicomposting is being done using the wastes of coconut and intercrops. Integrated nutrient management was followed both for coconut and intercrops. Vemiwash was collected and applied to coconut and intercrops twice in a year.

Aliyarnagar

The crop combinations of Black Pepper + Cocoa + Elephant foot yam were planted in the coconut based cropping system model during 2008. However, the crop combinations have been modified into Coconut + Black Pepper + Cocoa + Banana + Moringa + Pineapple as per suggestions of the 21st Annual Group Meeting. The doses of N,P,K, organic manure like Vermicompost (VC), Composted Coir Pith (CCP), vermiwash, biofertilizer has been fixed and applied to each crop. Planting materials of banana (Grand Naine), pineapple (Kew), Moringa (PKM-1) and Black pepper (Panniyur-1) have been procured and planted in the cropping system as per the lay out plan.

The biometrical observations were recorded in three years old cocoa accessions: CCRP-1, CCRP-8, CCRP-9 and CCRP-10. The accession CCRP- 9 recorded the highest plant height of 2.7 m followed by CCRP-1 and CCRP-8 (2.6 m). The stem girth was higher in CCRP-9 (26.5 cm) followed by CCRP-1 and CCRP-10 (26.0 cm). The accession CCRP-1 registered the highest volume of crop canopy of 12.4 m^3 followed by 11.1 m^3 in CCRP-9. The coconut yield was higher in the cropping system (110 to 133 nuts/palm) compared to monocrop control (97 nuts/palm).

Ambajipeta

The crop combinations of Cocoa + Banana + Pineapple + Elephant foot yam + Heliconia were planted in the coconut based cropping system model during 2008. However, the crop combinations have been modified into Coconut + Cocoa + Banana + Pineapple + Tomato + Heliconia during 2012 by replacing Elephant foot yam with tomato. An yield of 138.5 nuts per palm in coconut, bean yield of 2.6 kg/plant in cocoa, fruit yield of 23.4 kg/plant in banana and fruit yield of 1.0 kg/plant in pineapple were recorded. The soil organic carbon, nitrogen, phosphorus and potassium contents were increased compared to initial years.

CBCS at Ambajipeta

Arsikere

The crops like black pepper, cocoa, lime and drumstick were planted in the coconut based cropping system model during October 2008 in an area of 0.40 ha. Banana was added to the cropping system during 2012-13. The establishment of intercrops except black pepper is satisfactory. Vermicomposting is being done using the biomass of coconut and vermiwash has been collected and applied to coconut and intercrops. The experiment has been maintained by green manuring, basin making and mulching. The number of functional leaves per palm, leaf production rate, number of inflorescence per palm and the number of female flowers per palm were increased with the intercropping of cocoa, lime and drumstick. Similarly, the yield of coconut was improved to 85.0 from 66.2 nuts/palm in

the cropping system model. The yield of lime was 115 kg and drumstick was 677 kg in 0.4 ha area. Vermicompost produced from the recyclable biomass of the system was 3,400 kg, which was recycled in the system.

Bhubaneshwar

The cropping system model comprising of guava (Arka Mridula- 24 Nos. & Arka Amulya- 24 Nos.), tissue culture banana (132 Nos.) and tuberose were planted with coconut palms (Sakhigopal Tall) in an area 0.40 ha during 2009. The average number of functional leaves per palm was 16.1 and that of leaf production rate was 10.5 leaves/palm/year. The average yield of guava was 2.5 kg/plant and that of banana was 13.0 kg/plant.

Jagadalpur

Crop combinations

Summer season - Coconut + Banana + Bottle gourd + Cowpea

Rainy season - Coconut + Guava+ Cinnamon + Banana + Colocasia + Amahaldi + Elephant Foot yam

Experiment was started during the year 2008 in a coconut garden of different germplasm accessions. The available recyclable biomass from the system was around 16, which is being converted into vermicompost and applied to the garden. The green manure crop Daincha was grown in the basin of coconut during rainy season and incorporated during Sept-Oct. months. The annual intercrop yield during 2011-12 Kharif was the highest in Elephant foot yam followed by Amahaldi but in case of Rabi season, highest yield was in the Bottle gourd. The coconut nut yield was 63 nuts/palm.

Kahikuchi

The development of cropping system model comprising of Turmeric, Pineapple, Assam lemon, Banana and Black pepper with coconut was started during September 2008 in an area of 0.40 ha. The biomass produced by intercrops is being recycled by converting into vermicompost. There was an increase in yield of coconut from 55 to 66 nuts per palm due to cropping system. Economic analysis of the cropping system model has been done and found that the net return of ₹ 2,39,075 per ha with a benefit- cost ratio of 1.75 was obtained with the system (Table 15). Studies on earthworm population revealed that maximum population (47/m^2) was observed in the month of July and the lowest population of 6/m^2 during December-January after 3 years of experimentation.

Table 15. Yield of crops in cropping system model during 2011-12 (Kahikuchi)

Sl.No.	Crops	Yield in 0.40 ha model
1	Black pepper	21 kg
2	Turmeric	3160 kg
3	Banana	2500 kg
4	Pineapple	680 kg
5	Assam lemon	378 kg
6	Coconut	4620 nuts

CBCS at Kahikuchi

Mandouri

The cropping system model comprising of coconut + Black pepper + Lime + Pineapple + Banana + Turmeric is being developed in an area of 0.40 ha. Pineapple yield was 120 kg and banana yield was 480 kg from the area. The coconut yield was increased to 72.3 nuts per palm from 63 nuts per palm after growing of intercrops in coconut garden.

Ratnagiri

The development of cropping system model comprising of Coconut + Nutmeg + Cinnamon + Banana + Pineapple was started during June 2008 in an area of

Table 16: Economics of coconut based cropping system (Ratnagiri)

Sl. No.	Particulars	2009-10	2010-11	2011-12
1	Cost of cultivation (₹/acre)	38350	36150	54000
2	Gross returns (₹/acre)	114000	86640	107270
3	Net returns (₹/acre)	75650	50490	53270
4	B:C Ratio	2.97	2.40	2.00

0.40 ha. The yield of coconut was increased from 76 to 110 nuts per palm after planting of intercrops with coconut. Soil NPK and leaf nutrient status of coconut were slightly increased after planting of different intercrops. Economics of coconut based integrated cropping system revealed that the net profit was ₹ 75,650/- during 2009-10 and ₹ 53,270/- during 2011-12 (Table 16).

Sabour

The development of coconut based cropping model comprising of Coconut + Pomegranate + Banana + Turmeric + Cowpea was started during 2009-10 with the planting of Sakhigopal Tall variety of coconut and other component crops. Biomass collected from pruning of pomegranate and guava was used as mulch for coconut and biomass of cowpea and turmeric was used for composting. Biomass from coconut was 178 kg, pomegranate was 456 kg, turmeric was 215 kg and cowpea was 148 kg.

Veppankulam

The cropping system model of Coconut + Black pepper + Banana + Elephant foot yam + Cocoa was initiated during July 2009. Five vermicomposting pits were formed and the vermiwash is being collected and applied to the crops in the system. The organic manures have been applied to crops as per treatments. The nutrient status of the soil was analyzed before experimentation and during experimentation. The initial soil nitrogen content was low, whereas, phosphorus and potassium contents were medium and these were increased during experiment. The leaf nutrient content in coconut during 2011-12 was 1.76% nitrogen, 0.08% phosphorus and 1.26% potassium. The biomass production was the highest in cocoa (10,029 kg/ha) followed by banana (8,425 kg/ha) and the lowest in pepper (41 kg/ha). The net income obtained from the coconut based cropping system during 2011-12 was ₹1,07,770 per ha with B:C ratio of 2.1 (Table 17).

CBCS at Veppankulam

Table 17: Yield and economics of coconut based cropping system during 2011-12 (Veppankulam)

Crops	Yield	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B:C ratio
1. Coconut	136 nuts/palm	1,19,000	56,480	62,520	2.1
2. Banana	6500 kg/ha	32,500	12,750	19,750	2.5
3. Black pepper	-	-	-	-	-
4. Elephant foot yam	9500 kg/ha	35,000	15,350	19,650	2.2
5. Cocoa (Dry beans)	230 kg/ha	16,100	10,250	5,850	1.6
Total		**2,02,600**	**94,830**	**1,07,770**	**2.1**

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

Centres: Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Ratnagiri, Veppankulam

Aliyarnagar

Morinda citrifolia (Noni) seedlings and tissue culture plants (25 each) were planted with spacing of 3.75 m in between two rows of coconut palms of 21 years age as a non replicated trial during 2008. The growth and yield of Noni was better in seedlings compared to tissue culture plants. The nut yield of coconut was improved with planting of Noni as mixed crop in coconut garden.

Ambajipeta

The observational trial on the performance of *Morinda citrifolia* (Noni) was laid out during August 2008 by planting 25 each of seedlings and tissue culture plants in the inter spaces of coconut. The growth parameters *viz*, plant height, girth and number of branches were recorded. Higher plant height (5.6 m) and number of branches per plant (63.8) were recorded in seedlings compared to tissue culture plants. Similarly, the fruit yield per plant was also higher in seedlings (8.2 kg/plant) compared to tissue culture plants (5.4 kg/plant). There was improvement in the yield of coconut. (Table 18).

Arsikere

The experiment was laid out during August 2008 by planting the seedlings/ tissue culture plants of Indian Noni (*Morinda citrifolia)* on 30.08.2008. The experiment is being maintained by cultivation, manuring, basin cleaning and regular watering. The plant height and number of primary branches per plant at the end of 4th year of planting was similar both in seedlings and tissue culture plants. However, the number of secondary branches per plant and plant spread were higher in tissue culture plants compared to seedlings. The number and weight of fruits per plant were also higher with the tissue culture plants compared to seedlings (Table 19). The juice content and the TSS were similar both in seedlings and tissue culture plants. The coconut yield was improved with the intercropping of Noni in coconut garden.

Jagadalpur

The observational trial on *Morinda citrifolia* (Noni) as intercrop in coconut garden was initiated during 2008. The plant height and stem girth were maximum in plants from seedlings, whereas, the number of branches was more in tissue culture plants. The fruit yield per plant was 925 g and 850 g, respectively in seedlings and tissue culture plants.

Kahikuchi

The seedlings and tissue culture plants of *Morinda citrifolia* were planted in the inter-row space of the coconut palms during August 2008. The growth of seedlings was better than tissue culture plants in respect of plant height (3.4 m), stem girth (20.4 cm) and number of branches per plant (17.8). The number of fruits per plant, individual fruit weight and fruit yield per plant were higher in seedlings compared to tissue culture plants. The TSS content was not varied between seedlings and tissue culture plants (Table 20).

Table 18: Growth and yield of *Morinda citrifolia* under coconut (Ambajipeta)

Planting material	Plant height (m)	Stem girth (cm)	No. of branches per plant	No. of fruits per plant	Fruit yield (kg/plant)	TSS (°Brix)	Coconut yield (nuts/palm)	
							Before planting of Noni	After 4 years of planting of Noni
Seedlings	5.6	34.7	63.8	121.4	8.2	12.4	98.0	108.0
Tissue culture plants	4.9	51.0	42.5	100.7	5.4	13.2	104.0	114.0

Table 19: Growth and yield of *Morinda citrifolia* under in coconut (Arsikere)

Sl.No.	Growth or yield parameter	Seedlings		Tissue culture plants	
		2010-11	2011-12	2010-11	2011-12
1	Plant height (m)	2.7	3.2	2.5	3.1
2	No. of primary branches/plant	40.5	43.0	37.9	42.7
3	No. of secondary branches/plant	26.6	31.7	28.0	49.9
4	Plant spread (m)	2.0	2.7	2.3	3.2
5	No. of fruits/plant	41.4	243.9	64.0	359.3
6	Weight of fruits (kg/plant)	0.8	11.5	1.7	16.1
7	Fruit yield (kg/ha) (356 plants/ha as mixed crop)	302.6	4108.0	623.0	5717.0
8	Juice content (%)	62.5	60.6	60.9	59.4
9	TSS (° Brix)	11.0	10.9	10.9	11.2

Mandouri

The Noni (*Morinda citrifolia*) seedlings and tissue culture plants were planted in coconut garden during 2008. The seedlings of Noni recorded higher plant height (3.29 m) as compared to tissue culture plants (3.05 m), while, the tissue culture plants recorded higher plant spread (3.20 m), stem girth (30 cm), number of branches (42) as compared to seedlings. Tissue culture plants also recorded more numbers of fruits per plant (70) as compared to seedlings (56).

Ratnagiri

The Noni (*Morinda citrifolia)* seedlings and tissue culture plants were planted as intercrop in coconut garden during 2008. The plant height of Noni ranged from 2.0 – 4.4 m with an average of 3.1 m in seedlings, whereas, it ranged from 1.9 – 3.8 m with an average of 2.7 m in the tissue culture plants after four years of planting. The yield of Noni was maximum in seedlings (273 fruits and 6.0 kg) compared to tissue culture plants (134 fruits and 3.4 kg). The juice content was 51% with a TSS of 7.4° Brix. The number of leaves on crown (28.4 to 28.7) and yield of nuts in coconut (76 to 83.8) were improved with mixedcropping of *Morinda citrifolia* with coconut (Table 21).

Veppankulam

The seedlings and tissue culture plants of *Morinda citrifolia* were planted in between coconut rows with a

Table 20: Growth and yield of *Morinda citrifolia* under coconut garden (Kahikuchi)

Planting material	Plant height (m)	No. of branches/ plant	Stem girth (cm)	No. of fruits/ plant	Individual fruit weight (g)	Fruit yield (kg/plant)	TSS (°Brix)
Seedlings	3.4	17.8	20.4	65.3	19.2	20.8	7.6
Tissue culture plants	3.0	15.2	17.5	44.8	17.6	16.6	7.6

Table 21: Growth observations of *Morinda citrifolia* under coconut (Ratnagiri)

Sl.No.	Planting material	Plant height (m)	No. of branches per plant	No. of fruits per plant	Fruit yield (kg/plant)
1.	Seedlings	3.1	20.5	273.0	6.0
2.	Tissue culture plants	2.7	18.3	134.0	3.4

plant spacing of 3 m. The tissue culture plants recorded higher plant height (3.0 m), stem girth (26.0 cm), number of branches per plant (30.1) and number of leaves per plant (537.0) as compared to seedlings. The fruit yield was also higher with tissue culture plants (35.0 kg/plant) compared to seedlings (22.6 kg/plant). The protein, fat, fiber, ash, TSS and juice content were higher in the fruits of tissue culture plants compared to seedlings. The nut yield of coconut was increased marginally with the planting of Noni in coconut garden.

Agr. 14. Performance of commercial flower crops under coconut garden

Centres: Aliyarnagar, Arsikere, Jagadalpur, Kahikuchi, Mondouri, Ratnagiri

Objective: To develop an appropriate cropping system with commercial flowers as intercrops compatible with coconut.

Aliyarnagar

Five commercial flower crops *viz.*, Chrysanthemum (*Dendranthema grandiflora*), Tuberose (*Polianthes tuberosa*), Marigold (*Tagetes erecta*), Zinnia (*Zinnia* sp.) and Gomphrena (*Gompherena globosa*) were planted during June-July 2012 in a coconut garden of 23 year old hybrid palms (VHC-2) planted at a spacing of 7.5 m x 7.5 m. The flower crops were grown in a plot size of 225 m^2 accommodating four palms. Coconut pure crop was maintained as control. The experiment was laid out in RBD with four replications. Seedlings of Marigold, Zinnia and Gomphrena and root cuttings of Chrysanthemum and corms of Tuberose were planted in the experiment. The recommended package of practices was followed for all the flower crops and coconut.

Gomphrena as intercrop in coconut (Aliyarnagar)

Initial soil analysis of the experimental plot indicated that the soil was low in available nitrogen (120 kg ha^{-1}), medium in P_2O_5 (19 kg ha^{-1}) and high in K_2O (522 kg ha^{-1}). The soil was sandy loam, non-calcareous, non-saline and neutral in pH. Among the five commercial flower crops raised, Marigold recorded a flower yield of 6,400 kg/ha with a net income of ₹ 73,000/ha and B:C ratio of 2.33 followed by Gomphrena (6,250 kg, ₹ 70,000 and 2.27) and Chrysanthemum (5,350 kg, ₹ 52000 and 1.95) (Table 22). Tuberose didn't flower which might be due to shade in coconut garden. Though Zinnia flowered well, it had less preference in the market.

Arsikere

The experiment was laid out in 40 year old coconut garden of Tiptur Tall variety planted with a spacing of 10m x 10m. Six commercial flower crops *viz.*, Heliconia, Chrysanthemum, Jasmine, Crossandra, China aster and Marigold were planted in the inter-row spaces of coconut during August-September 2012. A control plot of pure crop of coconut was also maintained. The experiment was laid out in RBD with 4 replications. The flowers in chrysanthemum, china aster and marigold were harvested and yield data recorded. Harvesting of

Table 22: Yield and economics of commercial flower crops intercropped in coconut garden (Aliyarnagar)

Flower crops	Yield(kg/ha)	Gross income (₹/ha)	Net income (₹/ha)	B:C ratio
Chrysanthemum	5,350	1,07,000	52,000	1.9
Tuberose	—	—	—	—
Marigold	6,400	1,28,000	73,000	2.3
Zinnia	—	—	—	—
Gomphrena	6,250	1,25,000	70,000	2.3

flowers has been started in crossandra from February 2013.

China aster as intercrop in coconut (Arsikere)

Chrysanthemum as intercrop in coconut (Arsikere)

Crossandra as intrecrop in coconut (Arsikere)

Jagdalpur

Experiment was initiated with commercial flower crops as intercrop in coconut garden : T1: Coconut + Tuberose, T-2: Coconut + Gerbera, T-3: Coconut + China Aster (Kharif) & Antirrhinum (Rabi), T-4: Coconut + Gaillardia (Kharif) & Gladiolus (Rabi), T-5: Coconut + Marigold (Kharif) & Zinnia (Rabi), and T-6: Coconut alone (Monocrop). The experiment was laid out in RBD with 4 replications.

The growth and yield characters of different Kharif season flower crops showed maximum plant height in Marigold and minimum in Gerbera, whereas, maximum number of leaves was found in China aster. Spike length is an important character for cut flower and it was highest in Tuberose followed by Gaillardia whereas No. of flowers were maximum in Marigold followed by Gaillardia.

The growth and yield characters of different Rabi season flower crops showed maximum plant height in Zinnia and minimum in Gerbera, whereas, maximum number of leaves in Antirrhinum. Number of branches was found maximum in Zinnia, whereas, the lowest in Gerbera and Tuberose. Spike length highest in Gladiolus followed by Tuberose, whereas, no. of flowers were maximum in Antirrhinum followed by Zinnia.

Kahikuchi

Five commercial flower crops *viz.*, Tuberose (*Polianthes tuberosa*), Gerbera (*Gerbera jamesonii*), Bird of Paradise (*Strelitzia reginae*), Heliconia (*Heliconia psittacorum* L.) and Marigold (*Tagetes erecta*) were planted during March-May in coconut garden. The experiment was laid out in RBD with 4 replications. The mature bulb of tuberose and suckers of gerbera were planted during March 2012, while the tissue culture plants of bird of paradise, suckers of heliconia and rooted cuttings of marigold were planted during May

Table 23. Yield of commercial flowers as intercrops in coconut garden (Kahikuchi)

Flower crops	Yield of flowers/ plot (Nos. per 18 m^2)	Yield of flowers/ ha (Nos. in lakh)
Tuberose	247.4 no.	1.2
Gerbera	396.9 no.	2.0
Bird of paradise	Vegetative stage	-
Heliconia	—do—	-
Marigold	—do—	-

2012. Of the five flower crops, flowers were harvested in tuberose and gerbera and data is presented in Table 23.

Tuberose as intercrop in coconut (Kahikuchi)

Mondouri

Marigold is found to be a promising commercial flower crop under coconut garden which recorded 24 flowers per plant with a vase life of three days. Tuberose recorded 52 cm of plant height with 29 leaves per plant, 49 cm of flower stalk and 23 florets per spike. Heliconia had a plant height of 125 cm, with 7 leaves per plant, 11 flowers per spike and flower stalk of 35 cm. Gladiolus recorded 125 cm plant height, 9 leaves per plant , 45 cm flower stalk with 12 florets per spike. Gerbera recorded 34 cm plant height with 45 leaves per plant, 25 cm flower stalk and 9 flowers per clump.

5.3 Disease Management

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

Collection of *Ganoderma* isolates from various locations

Centres: Ambajipeta, Arsikere, Veppankulam

Ambajipeta

Four type cultures of *Ganoderma lucidum* were obtained from Directorate of Mushroom Research, Solan Himachal Pradesh whereas the type cultures of *Ganoderma applanatum* were not available. DNA isolation and RAPD studies of the type cultures of *G.lucidum* are being carried out for comparison with the coconut *Ganoderma* isolates.

Arsikere

Among ten isolates tested for radial growth, ASK 1 and ASK 8 are fast growing as evidenced by recording 9.0 cm each in seven days after inoculation as against 3.2 cm to 8.1 cm radial growth in other isolates. Maximum biomass of 0.79g/100 ml of broth was recorded in ASK 4 followed by ASK 6 which accounted for 0.72g/100ml and both were found superior over the other treatments. All the isolates used for the study showed greater variability in colony morphological character-istics (Table 24 and Plate 1).

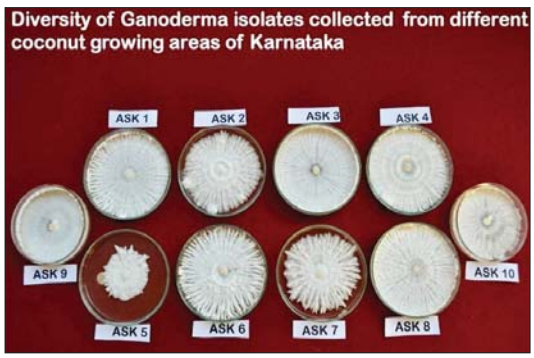

Plate 1: Morphological variability in *Ganoderma* isolates collected from Karnataka

Table 24. Cultural and morphological characteristics of *Ganoderma* isolates (Arsikere)

Sl. No.	Isolates	Growth (3 DAI) (cm)	Growth (7 DAI) (cm)	Colony characters
1	ASK 1	3.2	9.0	White and leathery
2	ASK 2	3.2	5.9	White and leathery with folding
3	ASK 3	3.0	5.9	White and leathery with folding
4	ASK 4	2.5	5.6	White and powdery
5	ASK 5	3.0	5.9	Initially white, later turned to brown colour and leathery
6	ASK 6	6.2	8.1	Pure white cottony growth
7	ASK 7	6.0	8.0	Pure white cottony growth
8	ASK 8	5.8	9.0	Pure white cottony growth
9	ASK 9	4.6	8.0	White and leathery
10	ASK 10	5.2	8.0	White, leathery and brown pigment on back side
S. Em ±		0.15	0.23	
CD (P=0.05)		0.44	0.47	

DAI: Days after inoculation

Veppankulam

Pathogenic virulence of *Ganoderma* isolates on coconut using sterilized soil

The cultures of 17 isolates of *Ganoderma lucidum viz..,* CRS 1, CRS 3, CRS 4, CRS 5, CRS 6, CRS 7, MSL 1, KKD 1, VK 1, TKT 1, PV 1, PV 2, VRM 1, VPM 1, VKD 1, PKK 1 and TTI 1 isolated from different places were mass multiplied separately on sorghum grains in poly bags. The pots were filled with sterilized sand + 300 g of sorghum grain based inoculum of each of the 17 isolates and were planted with ECT seedlings @ 1 / isolate on 28.05.2008. For control, two pots filled with sterilized sand alone were planted with ECT seedlings @ 1 / pot. The isolates namely MSL-1, VPM- I and TTI-1 were found to be more virulent and resulted in death of plants (Table

25). The trial was repeated with more number of replications and 12 isolates of *Ganoderma lucidum viz.,* CRS 1, CRS 3, CRS 4, CRS 5, CRS 6, CRS 7, TKT 1, PV 1, PV 2, VRM 1, VPM 1 and KKD1 available at CRS, Veppankulam by following same method of evaluation and the ECT seedlings were planted on 06.01.2011. Observations recorded on 01.03.2013 revealed that there were no significant differences between the isolates in reducing the number of leaves, height of plants and girth of seedlings.

Table 25. Pathogenic virulence of *Ganoderma* isolates on coconut using sterile soil (Veppankulam)

Sl. No.	Isolate	No. of leaves	Height (m)	Girth (cm)
1	CRS-1	16	1.17	16
2	CRS-3	18	1.24	17
3	CRS-4	17	1.02	17
4	CRS-5	14	0.95	21
5	CRS-6	10	1.37	18
6	CRS-7	11	1.45	18
7	MSL-1	Dead	Dead	Dead
8	KKD-1	13	1.20	16
9	VKI-1	12	1.33	17
10	TKT-1	11	1.24	17
11	PV-1	14	1.35	18
12	PV-2	14	1.18	19
13	VRM-1	16	1.02	18
14	VPM-1	Dead	Dead	Dead
15	VKD-1	14	1.21	17
16	PKK-1	12	1.43	18
17	TTI-1	Dead	Dead	Dead
18	Control	11	1.28	17

Epidemiology and disease forecasting

Impact of other palms and intercrops in coconut on occurrence and spread of disease

(Ambajipeta)

To study the impact of other palms and intercrops in coconut on occurrence and spread of disease, 50 palms in the field with sole coconut and field with coconut + banana were selected in Gannavaram village of East Godavari District. In sole coconut crop, out of 50 palms, five, seven, eight and nine coconut palms were found infected with the disease on June, July, August 2012 and February 2013, respectively. Whereas, in coconut intercropped with banana, eight palms out of fifty palms showed the symptoms till November 2012 and got increased to nine in December 2012, and 10 in February 2013.

Effect of weather parameters on vertical and horizontal spread of *Ganoderma* wilt disease

Arsikere

Plot having 50 palms were selected for the study of disease spread in relation to weather parameters during 2012-13. Vertical and horizontal spread of disease in coconut palms was recorded at monthly interval and the disease spread was correlated with rainfall, number of rainy days and temperature recorded at monthly intervals. The rate of vertical spread ranged from 0 to 575 cm. Temperature was found to have positive correlation with disease spread. Further, the spread of the Basal stem rot was more in sole crop when compared to the coconut intercroped with drumstick and banana.

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

Centres: Ambajipeta, Arsikere, Veppankulam

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

Arsikere

Among the four indigenous bio-agents collected from different coconut growing areas, the native isolate of *Trichoderma harzianum* collected from Coconut based cropping system (CBCS) plot at HRS, Arsikere recorded maximum biomass (0.76g) followed by *Trichodrema viride* (Shettigeri) which accounted for 0.70 g/100ml in potato dextrose broth. Further, the native isolate *T. harzianum* (CBCS) showed maximum inhibition of *Ganoderma applanatum* (ASK 1) by recording minimum radial growth of 2.65 cm followed by *Trichodrema viride* (Shettigeri) (2.70 cm) (Plate 2).

Plate 2: Effect of *Trichoderma harzianum* on *Ganoderma applanatum* (Arsikere)

Rhizosphere management-Integrated approach including bio-agents, botanicals, chemicals and INM

Ambajipeta, Arsikere, Veppankulam

The new BSR management trial with various treatments was initiated in all the three centres during 2012. The treatments are being imposed at the specified time intervals with the bio-agents, *Trichoderma viride* and *Pseudomonas fluorescens.* The data on soil microbial populations is being recorded at monthly intervals.

Treat No.	Treatment details
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 half yearly intervals.
T_3	Soil application of 500 g of talc based formulation 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 half yearly 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* (P.f.) + 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 half yearly 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

Effect of hexaconazole 5%SC against the *Ganoderma* pathogen

Hexaconazole 5% SC formulation was tested at various concentrations *viz.,* 0.1, 0.2, 0.3 and 0.4 per cent against the *Ganoderma* pathogen at HRS, Arsikere and HRS, Ambajipeta. The results revealed that the fungicide in all the concentrations effectively inhibited the pathogen under laboratory conditions in both the centres (Plate 3).

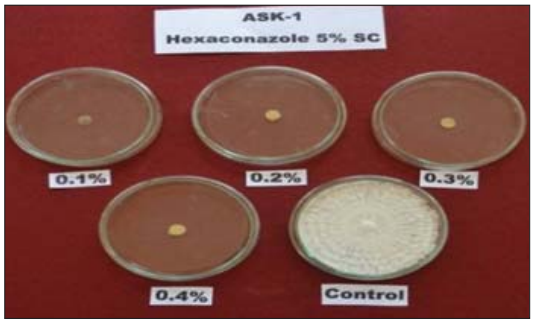

Plate 3: Effect of Hexaconazole 5% SC against *Ganoderma*

Effect of botanicals and bio-agents on basal stem rot disease (*in vitro*) and identification of active principle in effective botanicals

Efficacy of aqueous leaf extracts of five botanicals *viz., Vitex nigundo, Azadirachta indica, Eucalyptus* spp., *Calotropis procera,* and *Polyalthia longifolia* was screened against *Ganoderma lucidum* under *in vitro* condition at different concentrations *viz.*, 1, 5, 10, 15

and 20%. None of the botanicals tested were found effective against the *Ganoderma* (ASK1 and ASK 8) even at ten days after inoculation.

To assess the effect of bio-priming with *Pseudomonas fluorescens* and *Trichoderma viride* against BSR in coconut, a new experiment was initiated under glasshouse conditions. The pots were filled with sterilized sand and mixed with *Ganoderma lucidum* inoculum. ECT seedlings were dipped in 10 per cent suspension of *Pseudomonas fluorescens* and *Trichoderma viride* and planted in the pots. In the first post-treatment observations, the effect of biopriming with bioagents was statistically significant with respect to number of leaves, height of seedlings and girth of seedlings but in the second observation, only the height of seedlings was significant while the other parameters were on par with each other.

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

Aliyarnagar

Monitoring the spread of root (wilt) disease in Tamil Nadu

Survey was conducted on the occurrence of root (wilt) disease of coconut in Coimbatore, Theni, Dindigul and Kanyakumari districts in Tamil Nadu. The maximum incidence was noticed in Manakkadavu village followed by Ambarampalayam and Thappattaikizhavanpudur villages in Coimbatore district.

In Theni district, Melagudalur and Cumbum villages of Cumbum block showed 16.6 and 9.4 per cent root (wilt) incidence, respectively, whereas, in Theni block, the trees are free from the disease. In Tirupur district, Moongilthozhuvu village showed maximum root (wilt) incidence of 10.4% followed by Mogavanur village (6.6%), while the other villages were free from the disease.

Among the blocks surveyed in Kanyakumari district, the incidence recorded in Munchirai was 7.4% followed by Kurunthankodu (4.4%) and Thucklay (0.4%), while, Thovalai block was found free from root (wilt) incidence. Sasthankarai village of Kurunthangodu block has shown 13.6%, followed by the Nadaikkavu (11.7%) and Kattakkadai (11.3%) villages in Munchirai block.

Identification of indicator plants

Several annual plants *viz.*, green gram, black gram, sorghum, bajra, groundnut, banana and fodder grasses and the perennial crops like cocoa, nutmeg and arecanut grown in coconut gardens in the affected areas were periodically observed to identify an indicator plant for root (wilt) disease. None of the crops showed root (wilt) symptoms.

Validation of root (wilt) disease management strategies recommended by CPCRI

Location - Melagudalur village, Cumbum block, Theni district

Farmer - Th. D. Murugesan

Front line demonstration on root (wilt) management technologies in coconut was initiated in 0.4 ha to implement CPCRI recommended technologies for root (wilt) disease affected area in the Melagudalur village of Cumbum block in Theni district. The palms were 20 years old. The following package was implemented.

- Application of organic manure – FYM @ 25 kg/palm
- Soil application of bioagents – *Pseudomonas fluorescens* @ 100 g/palm along with neem cake @ 2 kg/palm
- Basin management with sunnhemp @ 50 g/palm
- Mulching the basin with coconut leaves
- Applying balanced dose of chemical fertilizers (Urea – 1.3 kg; superphosphate – 2.0 kg; Muriate of Potash – 2.0 kg/palm/year)
- Basin irrigation - 200 litres of water once in four days

Leaf rot management

a) Cut and remove the rotten portions of the spindle and the adjacent two leaves

b) Pouring 300 ml of fungicidal solution containing 2 ml of Contaf 5% EC around the spindle leaf

The plot was kept free from the damage caused by rhinoceros beetle, red palm weevil, basal stem rot, stem

bleeding and bud rot diseases. Observations on disease intensity and yield data were recorded. Disease assessment was done based on the disease grades assigned to flaccidity, yellowing and necrosis symptom in the second or third spiral as per the score chart. The average nut yield in the previous year was 98 while, the average yield during 2011-12 was 95 nuts/palm.

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

Centres: Ambajipeta, Arsikere

Ambajipeta

Stem bleeding

Field evaluation of antagonists against stem bleeding disease in coconut

Effect of *Trichoderma virens* cake formulation as well as *Trichoderma viride* paste application was tested against stem bleeding disease of coconut under field conditions. Fifty *T. virens* cakes received from CPCRI, Kasaragod were used for the study from March 2012 onwards along with paste application of *Trichoderma viride.* From the results, application of *T. virens* cake formulation was found to be effective when compared to the paste application of *T. viride* (Table 26).

Arsikere

Application of *T. virens* cake and *Trichoderma* paste application were imposed for the management of stem bleeding in coconut. The cake formulation of *T. virens* sporulated well and stem bleeding was reduced up to 15 days. Later, continuous bleeding was noticed even after placement of new cakes to the infected area. Further, the paste formulation of *Trichoderma* was not effective against stem bleeding of coconut under field condition in HRS, Arsikere situation.

Field evaluation of *T. viride* (Vanapalli isolate) against bud rot (Ambajipeta)

A total of 3000 nursery seedlings were selected and treatments were imposed on the plants. The percentage disease incidence observed in the *T. viride* treated plants was low when compared to the control plants. The percentage disease incidence in the treated plants was 1.16 and 1.13 PDI during January 2013 and February 2013 while the control was showing 1.6 and 1.46 PDI, respectively.

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

Centres: Ambajipeta, Aliyarnagar, Arsikere, Veppankulam

Ambajipeta

Survey was conducted in different mandals of East Godavari, West Godavari and Srikakulam districts of Andhra Pradesh during 2012-13. The major diseases observed in coconut gardens were basal stem rot, bud rot and stem bleeding along with minor incidence of grey leaf spot in Godavari and Srikakulam districts during last year (Table 27).

Aliyarnagar

The results showed that the leaf blight disease caused by *Lasiodiplodia theobromae* was the predominant disease in all the areas surveyed which ranged from 2.22 to 10.64 per cent. The maximum

Table 26: Effect of different formulations of *Trichoderma* for the stem bleeding of coconut (Ambajipeta)

Sl. No.	Treatments	No. of plants treated (in the month of April)	No. of plants showing dried symptom	No. of plants with partially dried symptom	No. of plants showing the symptom again	No. of plants with disease
1	*Trichoderma virens* cake application	30	17	12	—	1
2	*Trichoderma viride* paste application	30	17	—	8	5
3	Control	30	0	0	—	30

incidence of 10.64 per cent was recorded in Pethanaickanur village of Coimbatore district followed by 9.71 per cent in Periapatti village of Tirupur district (Table 28).

Maximum incidence of basal stem rot disease incidence was found in Periapatti village of Tirupur district (8.57%), while in other areas the incidence ranged from 0.06 to 1.83 per cent. There was no stem bleeding incidence in Theni and Tirupur districts while, Coimbatore, and Kanyakumari districts showed 0.01, and 0.44 per cent disease incidence, respectively.

There was no bud rot incidence recorded in Kanyakumari district. But low levels of bud rot incidences were recorded in Coimbatore (0.01%), Tirupur (0.05%) and Theni (0.03%) districts.

Arsikere

Basal stem rot, stem bleeding and leaf blight incidence was maximum in Tumkur district followed by Hassan. Bud rot incidence was noticed in Shimoga and South Canara districts, while in Tumkur and Hassan districts, only traces of the incidence was noticed (Table 29).

Veppankulam

Survey was conducted in different places in Thanjavur and Thiruvarur districts to assess the incidence of basal stem rot, stem bleeding and bud rot diseases in coconut. The results are presented in Table 30.

Altogether 4,185 palms were surveyed and among them, 159 palms were affected by BSR showing 3.79 % infection. Stem bleeding incidence was not noticed in any of the places surveyed and seven palms were found infected by bud rot disease.

Fixed plot survey: Vendakottai

In the fixed plot initiated at Vendakottai, the basal stem rot infection was 48 per cent during Jan. 2008,

Table 27: Incidence of major diseases of coconut in Andhra Pradesh (Ambajipeta)

Sl.No.	District	Mandal	Village	Disease incidence and severity (%)		
				BSR	SB	BR
1	Srikakulam	Kaviti	Kuttuma	8.0	-	1.0
			Manikyapuram	0.5	1.0	1.0
			Borivanka	30.5	-	1.0
			Biripuram	25.5	2.5	1.0
			Chandi-puttuga	10.5	1.0	1.0
			Jagati	18.0	0.5	1.0
		Kanchili	Kojjiria	10.0	5.5	1.5
			Sriram-puram	5.5	12.0	1.0
		Sompeta	Baruva	8.0	2.5	0.5
			Gollagondi	11.5	1.0	0.5
2	East Godavari		Gannavaram	25.3	1.0	1.5
			Kalavacharla	31.5	1.5	1.0
			Kesanapalli	23.0	1.5	1.0
			Antarvedi	26.5	2.0	2.0
3	West Godavari		Gopalapuram	15.2	3.4	1.0
			Kaja	11.2	2.5	2.5

BSR: Basal stem rot; SB: Stem bleeding; BR: Bud rot

Table 28: Survey on major diseases of coconut in Tamil Nadu (Aliyarnagar)

Name of the Village	No. of palms observed	No. of palms infected (%)			
		Stem bleeding	Basal stem rot	Leaf blight	Bud rot
I. District : Coimbatore					
1. Sethumadai	11640	0 (0.0)	0 (0.0)	280 (2.22)	3 (0.03)
2. Kambalapatti	3600	0 (0.0)	2 (0.06)	149 (4.13)	0 (0.0)
3. Pethanaickanur	2520	5 (0.2)	10 (0.39)	268 (10.64)	0 (0.0)
4. Thathur	5300	0 (0.0)	32 (0.60)	378 (7.13)	0 (0.0)
5. Vettaikaranpudur	4900	0 (0.0)	10 (0.20)	160 (3.27)	0 (0.0)
6. Ambarampalayam	7666	0 (0.0)	8 (0.10)	287 (3.74)	0 (0.0)
7. T.K. Pudur	4877	0 (0.0)	0 (0.0)	328 (6.72)	0 (0.0)
TOTAL	**40503**	**5 (0.01)**	**62 (0.15)**	**1850 (4.57)**	**3 (0.01)**
II. District : Tirupur ; block:Gudimangalam					
1. Pethappampatti	3400	0 (0.0)	16 (0.47)	124 (3.65)	0 (0.0)
2. Periapatti	700	0 (0.0)	60 (8.57)	68 (9.71)	0 (0.0)
2. Moongilthozhuvu	3290	0 (0.0)	18 (0.55)	166 (5.04)	4 (0.12)
TOTAL	**7390**	**0 (0.0)**	**94 (1.27)**	**358 (4.84)**	**4 (0.05)**
III. District : Theni					
2. Cumbum	4900	0 (0.0)	0 (0.0)	326 (6.65)	4 (0.08)
3. Melagudalur	7700	0 (0.0)	0 (0.0)	588 (7.64)	0 (0.0)
TOTAL	**12600**	**0 (0.0)**	**0 (0.0)**	**914 (7.25)**	**4 (0.03)**
IV. District : Kanyakumari					
1. Kaliakkavilai	230	0 (0.0)	0 (0.0)	12 (5.22)	0 (0.0)
2. Manavalakurichi	820	0 (0.0)	0 (0.0)	70 (8.54)	0 (0.0)
3. Thengaipattinam	1420	11 (0.77)	26(1.83)	92(6.48)	0 (0.0)
TOTAL	**2470**	**11 (0.44)**	**26 (1.05)**	**174 (7.04)**	**0 (0.0)**

(Values in bracket indicate the percentage disease incidence)

which increased up to 77 per cent during March 2011 over a period of 3 years and 2 months. The observation made during April 2012 showed further increase in the level of infection up to 84 per cent.

Mangadu

Another fixed plot survey is being initiated at Mangadu village in Alangudy taluk of Pudukottai district. The total number of palms in the field is 85. The first observation was taken on 12.12.2012 and the number of palms showing basal stem rot incidence was 28.The per cent infection was 32.94.

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

Centres: Aliyarnagar, Arsikere

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

Aliyarnagar

Pseudomonas fluorescens Pf1 100% culture suspension was evaluated at field condition in three different locations *viz.*, Kambalapatti, Karianchetti-palayam and Samathur villages of Pollachi taluk,

Table 29: Survey on diseases of coconut in major coconut growing areas of Karnataka (Arsikere)

Name of the District	Disease status			
Hassan	Basal stem rot (%)	Stem bleeding (%)	Leaf blight (PDI)	Bud rot (%)
Belur	5.00	1.60	3.80	0.00
Hassan	6.20	3.00	2.90	1.00
Channarayapattana	5.20	2.60	6.90	0.00
Arkalgodu	3.00	1.00	0.00	0.00
Arsikere	6.50	5.00	8.00	0.00
Total	**5.18**	**2.64**	**4.32**	**0.20**
Shimoga				
Badravathi	3.00	1.00	2.60	0.00
Hosanagara	0.00	0.00	0.00	3.00
Sagara	5.50	0.00	0.00	2.00
Shikaripura	0.00	2.00	1.20	2.00
Shimoga	4.00	0.00	2.38	0.00
Sorabha	5.00	0.00	0.00	0.00
Thirthahalli	0.00	0.00	0.00	6.00
Total	**2.50**	**0.43**	**0.88**	**1.86**
Tumkur				
Tiptur	08.00	3.00	15.60	0.00
C.N.Halli	07.50	5.20	9.00	0.00
Gubbi	02.00	1.30	7.30	0.00
Total	**5.83**	**2.83**	**10.63**	**0.00**
Dakshina Kannada				
Mangalore	0.00	0.00	0.00	0.00
Sullia	0.00	0.00	1.50	1.00
Belthangadi	0.00	0.00	0.00	2.60
Bantwal	0.00	0.00	0.00	0.00
Puttur	0.00	0.00	2.20	1.30
Total	**0.00**	**0.00**	**0.62**	**0.82**

* The data represents the average of five plots in the respective taluk. PDI – Per cent Disease Index

Coimbatore. Root feeding of *P. fluorescens* culture suspension was done @ 25 ml at an interval of quarterly, half yearly and once in a year. The root feeding was also combined with soil application of *P. fluorescens* talc formulation @ 50g/palm/yr + Neem cake 5 kg/palm/yr. 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.

The post-treatment observations revealed that the 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 (T_5)

was found to be the best in all the three locations and significantly reduced the incidence to 8.13, 8.14 and 6.53 per cent in Kambalapatti, Karianchettipalayam and Samathur trials, respectively. Moreover, the treatment T_5 was followed by T_1 (Root feeding of culture suspension at quarterly interval) and T_6 (Root feeding of culture suspension at half-yearly interval along with soil application of *P. fluorescens* Pf1 talc formulation (50g/palm/yr) + Neem cake (5 kg/palm/yr)) in Karianchettipalayam and Samathur trials, while at Kambalapatti, the treatments T_1 and T_6 were statistically onpar with T_5. (Table 30).

Arsikere

The experiment has been initiated in two locations *viz.*, Yalavare village and HRS, Arsikere with the following treatments. The pure culture of *P. fluorescens* was collected from NBAII, Bengaluru and all the treatments were imposed as per the schedule.

Treatments

T1 – Root Feeding -Culture suspension of *P. fluorescens* Pf1 (25 ml) at quarterly interval

T2 – Root Feeding -Culture suspension of *P. fluorescens* Pf1 (25 ml) at half yearly interval

T3 – Root Feeding -Culture suspension of *P. fluorescens* Pf1 (25 ml) once in a year

T4 – Soil Application-*P. fluorescens* Pf1 talc formulation (50g/palm/yr) + Neem cake (5kg/palm/yr)

T5 – T1 + T4

T6 – T2 + T4

T7 – T3 + T4

T8 – Soil application – Neem cake (5 kg/palm/yr)

T9 – Control

Table 30: Biological management of leaf blight disease of coconut

Treatments	Reduction in disease severity (%)		
	Kambalapatti	Karianchetti-palayam	Samathur
T1 – RF-Culture suspension of *P. fluorescens* Pf1 (25 ml) at quarterly interval	6.40^{a} (14.36)	6.27^{ab} (14.30)	4.8^{ab} (12.02)
T2 – RF-Culture suspension of *P. fluorescens* Pf1 (25 ml) at half yearly interval	4.00^{b} (11.49)	4.00^{bc} (11.20)	3.73^{ab} (11.02)
T3 – RF-Culture suspension of *P. fluorescens* Pf1 (25 ml) once in a year	1.53^{c} (6.89)	2.27^{cd} (8.60)	2.93^{bc} (9.32)
T4 – SA-*P. fluorescens* Pf1 talc formulation (50g/palm/yr) + Neem cake (5Kg/palm/yr)	1.20^{c} (6.20)	1.87^{d} (7.61)	2.73^{bc} (9.23)
T5 – T1 + T4	8.13^{a} (16.51)	8.14^{a} (16.23)	6.53^{a} (14.49)
T6 – T2 + T4	6.13^{a} (14.20)	6.00^{ab} (13.67)	4.53^{ab} (11.79)
T7 – T3 + T4	3.34^{b} (10.05)	2.80^{cd} (9.51)	2.40^{bc} (8.59)
T8 – SA – Neem cake (5 Kg/palm/yr)	1.07^{c} (5.84)	1.47^{d} (6.75)	0.93^{c} (5.49)
T9 - Control	3.06 (+)	3.86 (+)	4.00 (+)

RF – Root feeding ; SA – Soil application; Values in the parentheses are arcsine transformed values. The alphabet represents the treatment significance based on DMRT.

Development of microbial consortia for the management of leaf blight

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. The *in vitro* evaluation revealed that the rhizosphere bacteria *P. fluorescens* Pf1 and *Bacillus subtilis* (Kambalapatti) and the fungi *T. viride* (TNAU) were found highly effective against the leaf blight pathogen and recorded an inhibition zone of 12.7mm, 6.3mm and 6.7 mm, respectively. Hence, all the three antagonists were combined together to develop microbial consortia and the same was evaluated under field conditions during 2011-12 at Angalakurichi and Pethanaickanur villages of Pollachi taluk.

Application of microbial consortia @ 300g at quarterly interval along with FYM 5 kg as well as BS1 mixture -TNAU (@ 300g at quarterly interval) + FYM 5kg + Neem cake 5kg were found effective against leaf blight disease and were on par with the root feeding of carbendazim (2g in 100ml water) for three times at quarterly interval (Table 31).

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

Development of a diagnostic kit for early detection of basal stem rot disease

Centres: Ambajipeta , Arsikere, Veppankulam

Identification of indicator plants for basal stem rot disease

Ambajipeta:

Pots filled with sterilized soil were artificially inoculated with pure cultures of *Ganoderma* pathogen and were transplanted with Bengal gram seedlings. Infected plants showed withering, yellowing and browning of the lower leaves followed by upper leaves and further drying of entire plants (Plate 4). When the infected seedlings were uprooted, 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. Pure culture of *Ganoderma* was isolated from the basal stem regions of infected basal stem bits of bengal gram plant and the Koch's postulates were proved.

Plate 4. Bengal gram with wilting symptoms

Arsikere

Thirteen plant species were tested by artificial inoculation of *Ganoderma lucidum* (ASK1 and ASK8) multiplied on sorghum grains in pot culture studies. Among the plant species tested, only bengal gram showed wilting/partial wilting on 40 days after sowing. Further, wilted plants were subjected for re isolation, and *Ganoderma* was isolated from bengal gram and was found to be good indicator plant as evidenced by wilting of seedlings in pot culture.

Veppankulam

In order to find out the reaction of some crop plants to act as indicator hosts for the early detection of BSR, 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.

None of the plants both in pot culture and sick plot developed bark splitting and *Ganoderma* sporophore formation. Further, the roots from dead plants both from pot culture and sick plot were plated on PDA for re-isolation of *G. lucidum.* The basal stem rot pathogen could not be isolated from any of the plants tested.

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

Ambajipeta

Identification of indicator plants for bud rot disease

For identification of indicator plants, seedlings of brinjal, papaya, bengal gram, black gram, green gram,

Table 31: Effect of microbial consortia against leaf blight disease of coconut

Treat-ments	Details	Reduction in disease severity	
		Angala-kurichi	Pethanai-ckanur
T_1	MC @ 150g at quarterly interval + FYM 5 kg	11.99^{bc}	10.80^{cde}
T_2	MC @ 150g at half yearly interval + FYM 5 kg	9.80^{cd}	9.60^{def}
T_3	MC @ 150g once in a year + FYM 5 kg	6.85^{e}	5.73^{g}
T_4	MC @ 150g once in a year + FYM 5 kg + Neem Cake 5 kg	8.73^{de}	8.23^{fg}
T_5	MC @ 300g at quarterly interval + FYM 5 kg	14.53^{ab}	14.40^{ab}
T_6	MC @ 300g at half yearly interval + FYM 5 kg	11.80^{bc}	11.60^{bcd}
T_7	MC @ 300g once in a year + FYM 5 kg	9.63^{cd}	8.53^{efg}
T_8	MC @ 300g once in a year + FYM 5 kg + Neem Cake 5 kg	10.68^{cd}	9.87^{def}
T_9	BS1 mixture - TNAU consortia (300g @ quarterly interval) + FYM 5 kg	13.73^{b}	13.73^{abc}
T_{10}	BS1 mixture -TNAU (300g @ quarterly interval) + FYM 5kg + Neem cake 5kg	14.40^{ab}	14.13^{ab}
T_{11}	Neem cake alone – 5 kg/Palm/Year	2.27^{f}	3.03^{h}
T_{12}	Carbendazim (2g/100ml water) RF 3 times at 3 months interval	16.67^{a}	16.67^{a}
T_{13}	Control	4.67(+)	4.93(+)

MC: Microbial consortia; FYM: Farm Yard Manure; RF: Root Feeding; The alphabet represents the treatment significance based on DMRT.

horse gram, peas and beans were transplanted in pots containing artificially pathogen inoculated soil. None of them showed bud rot symptoms.

Path. 16 : Identification of coconut types resistance to *Ganoderma* wilt diseases

Screening of germplasms against Basal Stem Rot (BSR)

Centres: Ambajipeta, Arsikere, Veppankulam

Ambajipeta

Seed nuts of seven new varieties (Among the varieties tested, none found to be tolerant to BSR) were obtained and planted in sick soil at Gannavaram, East Godavari District at 3m x 3 m spacing as on farm trial in October 2010. (Java Giant, Chandra Kalpa, Spicata, Laccadive Micro, ECT, Ceylon Red, GBGD x ECT, Pillalakodi (Local variety) and Jonnalarasi (Local variety)

Arsikere

Locally available 10 varieties were planted for screening against *Ganoderma* wilt disease of coconut in the sick soils of HRS, Arsikere during 2012-13. The death of one seedling each was noticed in Ganga Bondam and WCT. The trial is in progress.

Veppankulam

The performance of different germplasms was tested against BSR disease in the *Ganoderma* sick plot at CRS, Veppankulam. Among 15 varieties/hybrids tested, all the three seedlings of ECT were dead due to BSR infection.

For screening against BSR, sixteen BSR tolerant seedlings were newly planted at Melasembalur village along with the 17 ECT seedlings which were planted during 2004. Only seven seedlings are surviving till date. In Pulichankadu village, 70 seedlings of different varieties were planted during the month of December 2009 and 36 were died due to BSR infection. The maximum per cent infection (70) was found in the variety AO, whereas, minimum level of infection was observed in Fiji.

In Thennankudy village, 14 different varieties were screened against *Ganoderma* wilt in the sick soils. Among them, the line RB was highly susceptible and showing maximum incidence (35%) while the ECTxCOD were free from infection.

5.4 Pest Management

Ent.3: Survey and monitoring of pest problems in coconut (eriophyid mite, rhinoceros beetle, red palm weevil, black headed caterpillar and other pests)

Centres: Aliyarnagar, Ambajipeta, Ratnagiri

Aliyarnagar

Roving survey

a. Black headed caterpillar

Survey on the infestation of coconut black headed caterpillar *Opisina arenosella* was undertaken during the period under report in selected coconut gardens at Coimbatore, Erode, Salem, Thirupur, Dindugal, Namakkal, Vellore, Karur, Theni, Dharmapuri and Krishnagiri districts. The mean per cent damage of coconut black headed caterpillar was found to be the highest in Dharmapuri (58.9) followed by Dindugal (27.2) and Erode (24.41) (Fig. 1).

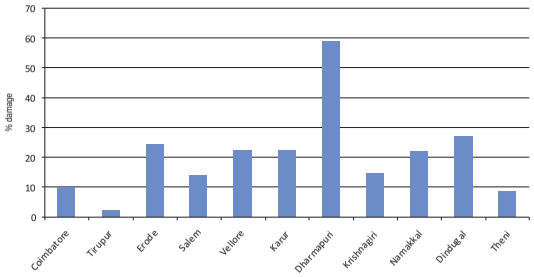

Fig. 1 : Per cent damage by black headed caterpillar

b. Rhinoceros beetle

In case of rhinoceros beetle, the mean per cent damage was found to be highest in Karur district (23.50), followed by Erode (20.04) and Namakkal (16.88) (Fig. 2).

Red palm weevil

There was no occurrence of red palm weevil incidence in all the above mentioned places.

Eriophyid mite

The per cent infestation of eriophyid mite in all the above mentioned places was found to be moderate to high ranging from 55.0 to 78.0.

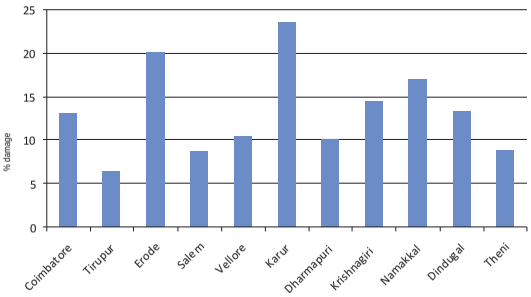

Fig. 2 : Per cent damage by rhinoceros beetle

Surveillance of emerging coconut pests

Survey conducted to record the occurrence of emerging pests of coconut is presented in Table 32. Severe incidence of red ants in Sethumadai, VK pudur, Mealy bugs in Mallapuram, Odukathur and rodents in all areas surveyed was observed.

Fixed plot Survey: Fixed plot survey was carried out in selected coconut gardens at five villages in five blocks (Table 33) of Coimbatore and Tirupur districts. Medium to severe intensity of rhinoceros beetle damage was noticed in gardens at TPK pudur, VK Pudur and Pethappampatty. Mild to severe intensity of eriophyid mite ranging from 70 to 92% was noticed in the surveyed areas. There was no incidence of coconut black headed caterpillar in the fixed plot villages. Red palm weevil incidence was to a tune of 8.0%. Trace level of sucking pest complex of scales and mealybugs were also noticed in the surveyed areas.

Ambajipeta

Roving survey carried out from April 2012 in 74 villages of major coconut growing districts of Andhra Pradesh revealed that coconut black headed caterpillar *O. arenosella* incidence initially observed on fish pond bund coconut palms from September 2012 and, was spread to pure coconut gardens especially after the rains received from Neelam cyclone in November 2012 in all the districts (except Krishna) surveyed. In the surveys carried out in the month of January 2013 in, Goganamatam village of East Godavari district of two new larval parasitoids of coconut slug caterpillar *M.*

Table 32: Surveillance on emerging coconut pests (2012-13) (Aliyarnagar)

Pests	Per cent infestation	Intensity	Places
Slug caterpillar (*Contheyla rotunda*)	10.00	Moderate	Aiyampalayam, Attur
Termites	10-15	Moderate	Nillakottai, Odaiyur
Leaf eating caterpillar (*Turnaca acuta*)	5.00	Low	Pudur
Coconut button borer (*Cyclodes omma*)	Traces	Very low	Kottur
Red ants (*Oecophylla smragdina*)	20-25	Severe	Sethumadai, VK pudur
Scales (*Aspidiotus destructor*)	12.00	Moderate	Mayanur, Anaimalai
Mealy bug (*Pseudococous longispinus, P. cocotis*)	20-25	Severe	Mallapuram, Odukathur
Rodents (Rats and Squirrels)	15-20	Severe	All places

Table 33: Fixed plot survey: Monitoring of coconut pests in Coimbatore and Tirupur Districts of Tamil Nadu (2012-13) (Aliyarnagar)

Name of the village	Rhinoceros beetle			Red palm weevil	Black headed caterpillar	Eriophyid mite				Sucking pests Scales & Mealy bug	Other pests
	Incidence (%)	Intensity				Incidence	Intensity				
		Leaf damage	Spindle damage				Young nuts	Harvested nuts	Mite population/4 mm^2		
VK Pudur	22.50	15.00	8.00	2.00	nil	73.00	2.32 (Mild)	3.00	12.56	Low	Termites
Sultanpettai	18.00	10.00	5.00	8.00	nil	90.00	3.00 (Severe)	3.85	20.50	Low	Slug caterpillar
Pethappampatty	20.00	13.00	3.00	5.50	nil	85.00	3.14 (Severe)	3.37	18.30	Low	Rodents
Devanurpudur	15.00	6.00	—	—	nil	70.00	2.25 (Mild)	3.15	11.60	Traces	Rodents
TPK Pudur	23.00	14.50	6.50	3.00	nil	92.00	2.88 (Medium)	3.78	23.20	Low	Rodents

nararia; *Euplectrus* sp. and *Euplectromorpha* sp. belonging to family Eulophidae (Hymenoptera) were identified and were found parasitising this caterpillar under field conditions effectively. A pupal parasitoid *Eurytoma monemae* was also recorded from the pupae of the slug caterpillar. Along with these parsitoids, a entomopathogenic fungi *Paecilomyces lilacinus* (Thom) Samson was also isolated from slug caterpillar in Chirutapudi village of East Godavari district.

Fixed plot survey

Fixed plot survey was undertaken in Palivela and Korlapativaripalem villages of East Godavari district. In case of mite incidence, the level of damage was medium

Larval parasitoid *Euplectrus* sp on slug caterpillar

at Palivela and more at Korlapativaripalem (Table 35). Low intensity of rhinoceros beetle damage was noticed in both the gardens. No incidence of red palm weevil and coconut black headed caterpillar was recorded in fixed plot surveyed villages.

of mite was mild to medium in both the districts surveyed (Fig. 4). The incidence of rhinoceros beetle and red palm weevil was 11.2,10.1 and 3.5, 5.0 per cent respectively, in Ratnagiri and Sindhudurg districts. The infestation of black headed caterpillar was noticed only in Ratnagiri district with an extent of 0.66 per cent only.

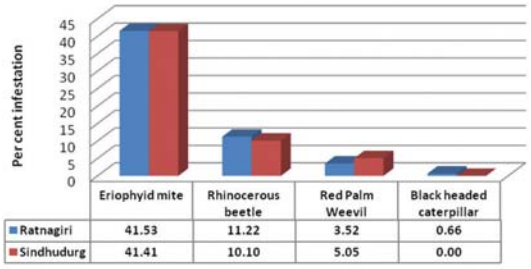

Fig. 4 : Incidence of major pests of coconut in Maharashtra (Roving survey)

Table 34: Incidence of major coconut pests in important coconut growing districts of Andhra Pradesh (Roving survey) (Ambajipeta)

Sr. No.	Name of District	Pest Incidence (%)			
		Black headed caterpillar	Rhinoceros beetle	Red palm weevil	Eriophyid mite*
1	Srikakulam	51.66	51.81	51.70	Mild to medium
2	Visakhapatnam	80.00	18.33	34.66	Mild to medium
3	East Godavari	85.57	34.85	16.66	Mild to medium
4	West Godavari	44.00	15.00	22.30	Mild to medium
5	Krishna	No incidence	12.50	33.50	Mild to medium

* Eriophyid mite incidence was found on all palms surveyed but with a mild to medium intensity only

Ratnagiri

Roving survey

Roving survey was carried out in Sindhudurg and Ratnagiri districts of Konkan region of Maharashtra from April 2012 to February 2013. In Ratnagiri district, Ratagiri, Guhagar, Rajapur and Lanja tahsils were selected and in Sindhudurg district Vijaydurg, Deogad, Vaibhavwadi, Kudal and Malvan tahsils were selected. The incidence of eriophyid mite was observed in all the gardens surveyed in the districts. The incidence of eriophyid mite was 41.5 per cent in Ratnagiri district and 41.4 per cent in Sindhudurg district. However, intensity

Fixed Plot Survey

Fixed plot survey was carried out to record the incidence and intensity of various pests of coconut at monthly interval from May to February 2013 at farmer's field in Ratnagiri taluka of Maharashtra (Fig. 5).

Eriophyid mite: The infestation of eriophyid mite was in the range of 33.3 to 46.7 per cent and maximum infestation of 46.7 per cent was observed in the month of February 2013.

Rhinoceros beetle: The infestation of rhinoceros beetle was in the range of 3.3 to 13.3 per cent and maximum infestation of 13.3 per cent was recorded in the month of June 2012.

Table 35 : Monitoring of coconut pests in East Godavari district of Andhra Pradesh (Fixed plot survey) (Ambajipeta)

Name of the Village	Incidence of different pests and intensity									
	Mite			Red palm weevil	Black headed caterpillar	Rhinoceros beetle			Slug caterpillar	Other pests
		Intensity					Intensity			
	Incidence (%)	Young nuts	Harvested nuts			Incidence(%)	Leaf damage (%)	Spindle damage (%)		
Palivela	100	1.52	1.20	—	—	5.0	11.0	—	Low	-
Korlapativari-palem	100	2.10	2.75	—	—	7.0	10.0	—	—	-

Red palm weevil: The infestation of red palm weevil was in the range of 3.3 to 6.7 per cent and maximum infestation of 6.7 per cent was observed in the months of June, July, August and September 2012.

Black headed caterpillar : The incidence of black headed caterpillar was noticed from the month of October 2012 and ranged from 6.7 to 16.8 per cent.

Ent 5: Management of eriophyid mite in coconut gardens

Centres: Aliyarnagar, Ambajipeta, Ratnagiri

The data on the intensity of eriophyid mite in 3rd bunch was collected to work out the mean grade index. Three treatments were imposed, T_1 - IPM implemented garden, T_2 – IPM treatment without root feeding and T_3 - control plot. In all the centres, the control recorded the highest mean grade index and T1- IPM implemented garden with root feeding recorded the lowest mean grade index *viz.*, 2.38,1.62 and 1.43 at Aliyarnagar, Ambajipeta, Ratnagiri and was closely followed by T_2 – IPM treatment without root feeding. However in all the centres except Aliyarnagar, T1 and T2 recorded medium grade index as compared to control which recorded severe grade index (Table 36).

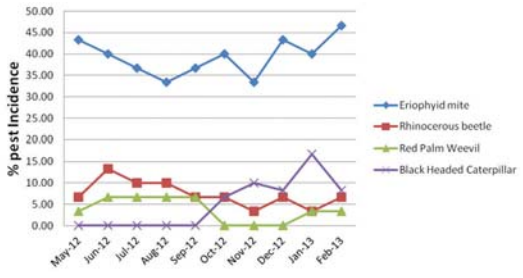

Fig. 5 : Intensity of major coconut pests in Maharashtra (Fixed plot)

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

Centres: Aliyarnagar, Ambajipeta, Ratnagiri

Aliyarnagar

Field evaluation trial on the efficacy of conditioned parasitoid (Olfactory stimulated) parasitoid (*Bracon brevicornis*) against coconut black headed caterpillar (*Opisina arenosella*) was conducted at Kulathupalayam during 2012-13. Thirty numbers of each conditioned and unconditioned braconid parasitoids were released on the black headed caterpillar infested sample palms for six times. Pre and post treatment observations on the no. of larvae/tree and population buildup of parasitoids (percent parasitism) were also recorded. Results indicated that release of conditioned parasitoids *B. breviconis* was found to be significantly more in reducing the black headed caterpillar population in coconut palms than the release of unconditioned parasitoids. Consequently, the level of per cent parasitisation is in the increasing trend (Table 37).

Ambajipeta

The field trial was conducted in coconut black headed caterpillar out break garden in Dwarapudi village of Kadiyam mandal in East Godavari district in the month of December 2012 as per CPCRI guidelines. There was a high initial larval population ranging around 81 per ten

Table 36: Influence of Management practices on eriophyid mite

		Grade index of mite infestation in 3rd bunch		
	Treatments	Aliyarnagar	Ambajipeta	Ratnagiri
April –June 2012	T1	2.45 (Severe)	2.10 (Severe)	1.90 (Severe)
	T2	2.90 (Severe)	1.94 (Medium)	1.94 (Severe)
	T3	3.44 (Severe)	2.10 (Severe)	2.91 (Severe)
September – October 12	T1	2.38 (Severe)	Root feeding treatment due in September, October and November 2012 could not be taken up due to heavy Cyclonic rains and water inundation in experimental gardens	1.47 (Medium)
	T2	2.75 (Severe)		1.52 (Medium)
	T3	3.53 (Severe)		2.78 (Severe)
December-12 to February - 13	T1	2.32 (Severe)	1.14 (Medium)	0.92 (Mild)
	T2	2.80 (Severe)	1.04 (Medium)	1.00 (Mild)
	T3	3.82 (Severe)	2.20 (Severe)	2.83 (Severe)
Mean	T1	2.38 (Severe)	1.62 (Medium)	1.43 (Medium)
	T2	2.82 (Severe)	1.49 (Medium)	1.48 (Medium)
	T3	3.60 (Severe)	2.15 (Severe)	2.84 (Severe)

leaflets in December 2012 and gradually decreased to 18.77 /ten leaflets with a high parasitisation of 77.05 per cent in conditioned and 33.55 /ten leaflets with aparasitisation of 58.81 per cent in unconditioned treatment in the month of March 2013. In untreated control, a larval population of 69.8 /ten leaflets was recorded and showed a very low parasitisation of 14.36 per cent (Table 38).

Ratnagiri

The larval parasitoid *Goniozus nephantidis* was mass multiplied in the laboratory for conducting experiment with pre-conditioning of parasitoids to improve the potency of parasitisation under laboratory conditions. Higher initial parasitization by *G. nephantidis* was observed in T_1 (Conditioned parasitoid) treatment i.e. 70.88 per cent after one month interval whereas, in T_2 (Unconditioned parasitoid) it was comparatively low i.e. 57.22 per cent. After 3rd month of release, 90.0 per cent parasitisation was observed in conditioned parasitoid treatment, whereas, in unconditioned parasitoid treatment, it was observed to be 78.3 per cent. An increase of pest population in untreated control was observed (Fig. 6).

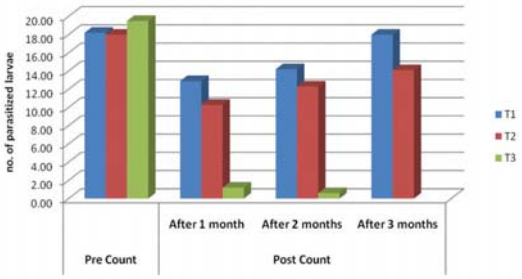

Fig. 6 : Avg. no. of parasitised larvae/leaflet (Ratnagiri)

Ent.12: Studies on field efficacy of commercially available pheromones against coconut pests *viz.*, rhinoceros beetle and red palm weevil

Centres: Aliyarnagar, Ambajipeta, Ratnagiri

Aliyarnagar

Field evaluation of pheromone traps against red palm weevil

Field evaluation of Pheromone lures *viz.*, CPCRI NPM lure, Chemtica Ferrolure, and PCI with control (Untreated check) against red palm weevil (*Rhynchophorus ferrugineus*) is further carried out both at Avalchinnampalayam and Odayakulam (June 2012 –

Table 37: Evaluation of conditioned parasitoid (OI factory stimulated) parasitoid (*Bracon brevicornis*) in the file against *Opisina arenosella* (2012-13) (Aliyarnagar)

Treatment		Pre release count (Mean no. of larvae /palm)	Post release count *(Mean no. of larvae /palm) after release of bio control agents					
			1 month	2 month	3 month	4 month	5 month	6 month
T1- Release of *B.brevicornis*@ 30/tree [with olfactory stimulation (OS)]		17.80 (4.22)	9.89 (3.14)	8.78 (2.96)	7.14 (2.67)	4.11 (2.02)	2.51 (1.58)	0.54 (0.73)
	pp **	6.85	47.24	56.06	69.20	73.60	78.40	86.73
T2-Release of *B.brevicornis*@ 30/tree [without OS]		15.88 (3.98)	12.76 (3.57)	10.03 (3.17)	8.69 (2.95)	6.28 (2.51)	3.54 (1.88)	2.06 (1.44)
	pp **	7.70	34.30	43.42	54.04	59.80	66.10	71.30
T3 [Control]		18.20 (4.27)	17.55 (4.19)	17.09 (4.13)	17.35 (4.17)	18.28 (4.28)	22.15 (4.71)	17.56 (4.19)
	pp **	6.10	2.65	1.34	1.41	1.72	1.03	0.79
SEd :		0.67	0.47	0.38	0.43	0.28	0.64	0.79
CD (P=0.05):		1.47	1.03	0.82	0.95	0.61	1.40	1.72
CV (%):		7.32	6.63	5.90	7.27	5.48	13.05	18.96

* mean of seven replications, pp ** - Per cent parasitisation, Figures in parentheses are in square root transformed values

Table 38: Field efficacy of *Goniozus nephantidis* against the coconut black headed caterpillar (Ambajipeta)

Treatment	(*O. arenosella* larval population/ten leaflets) Average of ten palms							
	Pre - release Dec 12		Post release					
			One month after release Jan 13		Two months after release Feb 13		Three months after release March 13	
	larval pop.	p.p.**	larval pop.	p.p.	larval pop.	p.p.	larval pop.	p.p.
T_1 - Conditioned	81.81 (9.09)*	0.0	54.6 (7.46)	33.26	33.64 (5.88)	58.88	18.77 (4.29)	77.05
T_2 – Un conditioned	81.47 (9.08)	0.0	64.8 (8.11)	20.46	49.77 (7.13)	38.91	33.55 (5.88)	58.81
T_3 - Control	81.51 (9.08)	0.0	76.8 (8.81)	5.78	63.80 (8.50)	21.72	69.8 (8.41)	14.36
SEM	0.04		0.05		0.04		0.08	
CD (P=0.05)	NS		0.16		0.13		0.25	

* Figures in parentheses are square root transformed values, pp ** - Per cent parasitisation; NS: Not Significant

March 2013). Among the four different aggregation pheromone traps tried, CPCRI NPM lure was found to trap significantly the highest number of red weevils up to 631 (351 females + 262 males), followed by Chemtica Ferrolure trap up to 325 (199 females + 126 males), PCI lure trap up to 285 (166 females + 119 males) as against only two in control. (1 female + 1 male) (Table 39).

Table 39: Evaluation of pheromone traps against red palm weevil (Aliyarnagar)

Pheromone lures	No. of red palm weevils trapped*			
	Total		Mean*	
	Females	Males	Females	Males
CPCRI NPM lure	351	262	70.2	52.4
Chemtica Ferrolure	199	126	39.8	25.2
PCI lure	166	119	33.2	23.8
Control (Untreated check)	1	1	0.2	0.2
Total	717	508	143.4	101.6
		SEd:	1.0199	0.8677
		CD (P=0.05):	2.2222	1.8906
		CV:	4.49	5.39

* Mean of five replications

Field evaluation of pheromone traps against Rhinoceros beetle

Location: Anaimalai and Kupichipudur

Field evaluation of Pheromone lures *viz.*, CPCRI NPM lure, Chemtica, Ferrolure and PCI with control (Untreated check) against rhinoceros beetle is futher carried out at Avalchinamalayam and Kupichipudur. (June 2012 – March 2013). Among the three different aggregation pheromone traps tried, CPCRI NPM lure was found to trap significantly the highest number of rhinoceros beetle up to 694 (433 females + 261 males) followed by Chemtica - Ferolure trap up to 337 (196 females + 141 males) and PCI lure trap up to 261 (140 females + 121 males) as against three beetles in Control, (2 females + 1 male) (Table 40).

Ambajipeta

At Ambajipeta, studies on red palm weevil pheromone lures were conducted from April 2012 to March 2013 with CPCRI NPM lure and PCI lure from April 2012 . CPCRI NPM trapped 166 weevils/ trap and was significantly higher than PCI lure that trapped 101 weevils / trap. No catches were observed in control trap (Fig. 7).

Ratnagiri

At Ratnagiri centre, studies on red palm weevil pheromone lures were conducted from April 2012 to March 2013. CPCRI NPM trapped significantly higher number of weevils (27.8 weevils / trap) as compared to the commercial lure from PCI that trapped 9.2 weevils/ trap. No catches were observed in control trap (Fig. 8).

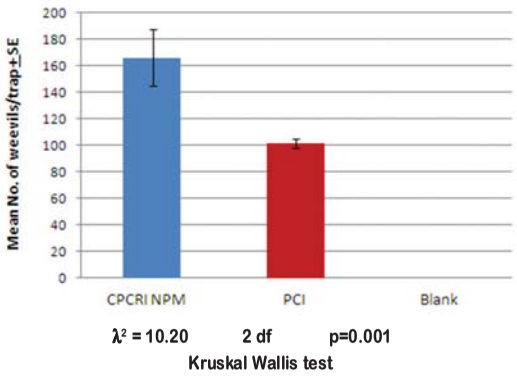

Fig. 7: Efficacy of red palm weevil pheromone lures (Ambajipeta)

Studies on rhinoceros beetle (Rhino lure)

Ambajipeta

The efficacy of CPCRI NPM lure and Pest Control India rhinoceros beetle lures was assessed. CPCRI NPM trapped significantly higher number of beetles (17.5 beetles / trap) as compared 6 beetles / trap in PCI lure. No catches were recorded in control trap (Fig. 9).

Ratnagiri

During the year 2012-13, CPCRI NPM lure trapped 24.2 beetles/ trap as compared PCI lure that trapped 5

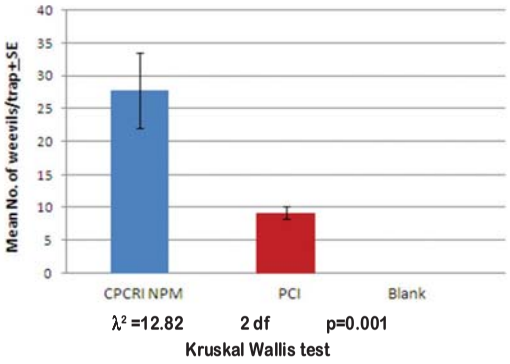

Fig. 8: Efficacy of red palm weevil pheromone lures (Ratnagiri)

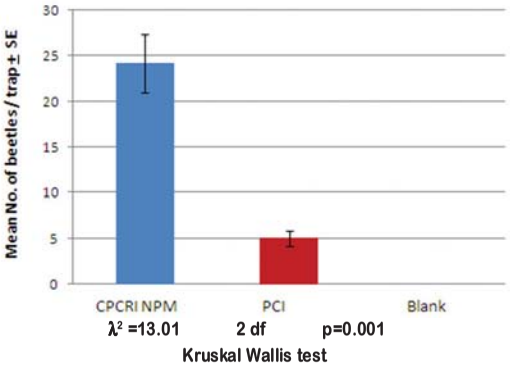

Fig. 10: Efficacy of pheromone lures against rhinoceros beetle (Ratnagiri)

Table 40: Field evaluation of pheromone traps against Rhinoceros beetle (Aliyarnagar)

Pheromone lures	No. of rhinoceros beetles trapped*			
	Total		Mean*	
	Female	Male	Female	Male
CPCRI NPM lure	433	261	86.6	52.2
Chemtica - Ferolure	196	141	39.2	28.2
PCI lure	140	121	28.0	24.2
Control (Untreated check)	2	1	0.4	0.2
Total	771	524	154.2	104.8
	SEd:	0.4023	0.6825	
	CD (P=0.05):	0.8766	1.4870	
	CV:	1.65	4.11*	

*Mean of five replications

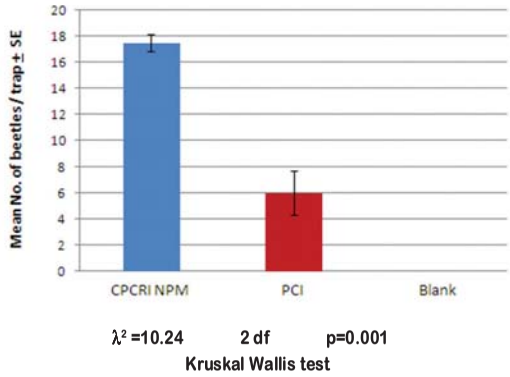

Fig. 9: Efficacy of pheromone lures against rhinoceros beetle (Ambajipeta)

beetles / trap. No beeltes were trapped in the control (Fig. 10).

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

Centres: Aliyarnagar, Ambajipeta, Ratnagiri

Aliyarnagar

Validation of integrated pest management technology demonstration plot for *Oryctes* rhinoceros was conducted at Semanampathy a new location. The recommended treatments were imposed after recording the pre treatment observations. The intensity of coconut rhinoceros beetle damage on leaf, spindle and spathe was recorded up to 37.5, 15.0 and 24.0 per cent respectively. Post treatment observations on the reduction of damage on leaf, spindle and spathe are also being recorded at six month intervals of time. The IPM

module for rhinoceros beetle results indicated that there was gradual decrease in the level of damage caused by rhinoceros beetle on leaf, spathe and spindle. On the other hand, there was marginal increase in the level of incidence of green muscardine fungus and baculo virus in the beetle population in the breeding sites of treated plots (Table 41).

leaf, spindle damage and multiple cut damage. In January 2013 the damage incidence decreased by fifty percent and a leaf damage of 8.5, spindle damage of 5.0 and multiple cut damage of 1.6 per cent were recorded in the experimental field (Table 42).

Table 41 : Validation of integrated pest management technology for *Oryctes rhinoceros* (Aliyarnagar)

Period of observations	Crop damage (%)			Per cent incidence of Baculovirus	Per cent incidence of Green Muscardine fungus
	Leaf	Spathe	Spindle		
Pre treatment (Jun. 2012)	37.50 (35.60)a	15.00 (22.50)a	24.00 (29.45)a	-	-
II. Post treatment					
Dec -2012	28.00 (32.70)b	10.50 (18.15)b	19.00 (25.35)b	9.50 (17.95)a	5.00 (11.25)a
Mar. 2013	24.50 (29.80)a	8.25 (15.96)a	16.75 (23.72)a	10.75 (18.96)b	7.00 (15.34)b

Figures in parentheses are in arcsine transformed values (Dunkans multiple range test: same alphabet denote statistically on par values)

Ambajipeta

Nagulanka village, P. Gannavaram Mandal, East Godavari district was selected for the experiment implementation from 2012. The metarhizium culture and Baculovirus culture were obtained from CPCRI, Kayangulam and are being maintained at Entomology lab, HRS, Ambajipeta. Pheromone lures were obtained from M/s. PCI Ltd. and installed in the gardens. The pre treatment infestation data showed 100 per cent incidence and a damage of 65.5, 30.0 and 36.4 per cent

Ratnagiri

The IPM package including use of pheromones, *baculovirus*, naphthalene balls and *Metarhizium anisopliae* was followed in an area of 10 ha. This trial was conducted in village Kalbadevi in Ratnagiri district. The observations were recorded on leaf damage and spindle damage at 10 months interval and it revealed that 93.7 per cent reduction in incidence of Rhinocerous beetle while 79.1 and 75.7 per cent reduction in leaf and spindle damage, respectively after implementation of IPM package (Table 43).

Table 42: Pre and Post treatment infestation levels of rhinoceros Beetle in the experimental garden (Ambajipeta)

Period of Observation	Name of the village	(%) Intensity			
		Leaf damage	Spindle damage	Multiple cut damage	Incidence (young palms)
May 2012 Pre treatment	Nagullanka	65.46	30.00	36.40	100.00
September 2012		9.74	7.00	2.65	70.00
January - 2013		8.50	5.00	1.58	50.00

Table 43 : Pre and post treatment infestation levels of rhinoceros beetles in the experimental gardens (Ratnagiri)

Total no. of palms	Pretreatments (%) April 2012		Post treatment (%) February 2013		Percent reduction				
	Incidence (%)	Leaf damage	Spindle damage	Incidence (%)	Leaf damage	Spindle damage	Incidence (%)	Leaf damage	Spindle damage
125	85.54	58.54	55.45	5.38	12.24	13.46	93.71	79.09	75.73

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

Centres: Aliyarnagar, Ambajipeta, Ratnagiri

Aliyarnagar

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

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

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

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

T4: Control

The spraying results revealed that the treatments T1 and T2 are on par in reducing the per cent infestation (intensity) of mite from 76.8, 77.2 (before spraying) to 40.6, 38.2, respectively and were better than T3 treatment (Table 44). Similarly the reduction of Grade index of T1 and T2 were also found to be on par and better than T3 as against control. Similar trend was also observed for the population of eriophyid mite /4 mm^2 (Table 45).

Ambajipeta

The experiment was initiated in the month of February 2012 with four treatments with 20 palms in each treatment (total 80 palms for the experiment). The mite pre treatment population which ranged from 2.38 to 3.92 / 1 mm^2 in February 2012 decreased to 0.69 to 1.36 / 1 mm^2 in March 2013. A general decline in mite population in control was also observed (Table 46). However, no predator population was observed in November 2012 and March 2013 sample nuts as compared to February 2012 and May 2012 months sample nuts. The lowest mite population of 0.24, 0.47 and 0.57/1mm^2 was continuously recorded in Treatment T3 (Spraying Palm oil – sulphur emulsion) during the

Table 44 : Evaluation of *Hirsutella thompsonii* against eriophyid mite (Population count) (Aliyarnagar)

Treatment	Pre-treatment		Post treatment (1st Spray)		Post treatment (2nd spray)		Post treatment (3rd Spray)	
	Mite/ 4mm^2	Predators	Mite/ 4mm^2	Predators	Mite/ 4mm^2	Predators	Mite/ 4mm^2	Predators
T1	71.20	1.79	57.97	1.60	48.60	1.37	32.80	1.19
T2	69.80	1.75	52.59	1.49	44.20	1.32	32.40	1.55
T3	68.60	1.69	61.80	1.51	57.80	1.43	58.40	1.29
T4	75.40	2.07	83.00	2.22	78.20	2.18	73.60	2.08
SE d	0.21	0.84	7.47	0.44	4.38	0.41	2.17	0.06
CD (P= 0.05)	0.46	0.18	8.50	18.74	5.56	19.31	4.73	0.14

Table 45 : Evaluation of *Hirsutella thompsonii* against eriophyid mite (Grade index) (Aliyarnagar)

Treatment	Pre-treatment		Post treatment (1st Spray)		Post treatment (2nd spray)		Post treatment (3rd Spray)	
	% mite incidence in nuts	Grade index	% mite incidence in nuts	Grade index	% mite incidence in nuts	Grade index	% mite incidence in nuts	Grade index
T1	76.82	3.62	63.47	3.34	55.12	2.94	43.59	2.73
T2	77.22	3.54	58.98	3.25	51.98	51.98	42.62	2.69
T3	77.00	3.67	72.20	3.60	65.30	3.30	61.98	3.13
T4	76.80	3.73	83.60	3.80	84.40	3.80	82.20	3.73
SE d	2.68	0.01	2.55	0.05	0.92	0.05	1.62	0.03
CD (P= 0.05)	5.84	0.02	5.57	0.11	2.00	0.11	3.53	0.03

entire observational period. Data on Grade index of harvested nuts revealed that in all the treatments except control, medium scale of mite intensity was recorded in February 2013 as compared to severe scale of mite intensity observed in February 2012. However, when compared to February 2012 the per cent mite incidence in nuts increased in February 2013 in all the treatments (Table 47).

Treatment T3 effect on mite infestation

Ratnagiri

The mite population which ranged from 2.65 to 3.62 / 1mm^2 in February 2012 decreased to 1.10 to 3.25 / 1mm^2 in March 2013. A low predator population was also recorded in all the treatments throughout the observational period. The lowest mite population of 1.40, 1.15 and 1.10 /1mm^2 was continuously recorded in Treatment T1 (Spraying talc formulation of *H.thompsonii* @20g/palm – 3 sprays) during the entire observational

Table 46: Population count of eriophyid mite and its predators / 1mm^2 during the study period (Ambajipeta)

Treatment	(Average of ten nuts of 3 months age expressed as population/1mm^2)							
	Pre-treatment (February 12)		May 2012		November 2012		March 2013	
	Mite	Predators	Mite	Predators	Mite	Predators	Mite	Predators
T1	2.38 (1.84)*	0.65	0.31 (1.13)	3.3	0.40 (1.20)	0	0.69 (1.26)	0
T2	3.49 (2.11)	0.9	1.30 (1.44)	0	0.10 (1.06)	0	0.94 (1.36)	0
T3	3.34 (1.54)	0.9	0.24 (1.09)	0	0.47 (1.19)	0	0.57 (1.23)	0
T4	3.92 (2.22)	1.2	1.64 (1.56)	1.5	1.44 (1.50)	0	1.36 (1.53)	0
SEM ±	0.17		0.10		0.06		-	
CD (P = 0.05)	0.50		0.30		0.18		NS	

*Fig. in parenthesis are n+1 values.; NS: Not Significant

Table 47: Grade index of harvested nuts and mite intensity during from February 2012 to February 2013 (Ambajipeta)

Treatment	Pre treatment harvested nuts scaleFeb 2012	Per cent mite incidence nuts Feb 2012	Grade index and mite intensity for Feb 2012 sprayed and Dec 2012 harvested nuts	Grade index for May 2012 sprayed and Feb 2013 harvested nuts	Per cent mite incidence nuts Feb 2013
T1	2.44 (Severe)	66.06	2.20 (Severe)	1.33 (Medium)	95.2
T2	2.49 (Severe)	70.03	2.13 (Severe)	2.00 (Medium)	97.4
T3	2.44 (Severe)	71.93	1.50 (Medium)	1.14 (Medium)	95.0
T4	2.43 (Severe)	68.33	2.50 (Severe)	2.40 (Severe)	98.6

period (Table 48).

Data on Grade index of harvested nuts revealed that in all the treatments except control medium scale of mite intensity was recorded in February 2013 as compared to severe scale of mite intensity observed in February 2012 and per cent mite incidence nuts decreased in treatment plots in February 2013 when compared to February 2012 (Table 49).

Table 48 : Population count of eriophyid mite and its predators / 1 mm^2 during the study period (Ratnagiri)

Treatment	Pre-treatment (February 2012)		Post treatment (May 2012)		Post treatment (November 2012)		Post treatment (March 2013)	
	Mite	Predators	Mite	Predators	Mite	Predators	Mite	Predators
T1	2.65	0.07	1.40	0.07	1.15	0.14	1.10	0.20
T2	3.20	0.05	1.57	0.04	1.42	0.09	1.38	1.20
T3	3.62	0.08	2.64	0.00	2.40	0.08	2.20	0.04
T4	3.19	0.05	3.02	0.05	3.07	0.00	3.25	0.02

Table 49: Grade index of harvested nuts and mite intensity from February 2012 to March 2013 (Ratnagiri)

Treatment	Pre treatment harvested nuts scale (Feb 2012)	Per cent mite incidence nuts (Feb 2012)	Grade index and mite intensity for Feb 2012 sprayed and Dec 2012 harvested nuts	Grade index for May 2012 sprayed and Feb 2013 harvested nuts	Per cent mite incidence nuts (Feb 2013)
T1	2.89 (Severe)	52.00 (46.36)	1.89 (Medium)	1.69 (Medium)	43.96 (41.53)
T2	3.15 (Severe)	54.65 (47.62)	2.15 (Severe)	1.92 (Medium)	39.72 (39.06)
T3	2.91 (Severe)	53.32 (48.02)	1.92 (Medium)	1.98 (Medium)	48.70 (44.26)
T4	2.89 (Severe)	61.91 (50.95)	3.10 (Severe)	3.55 (Severe)	61.12 (51.45)
	S.E.	N.S.			0.70
	CD (P=0.05)	5.80			2.00

NS: Not Significant

VI. Experimental Results in Oil Palm

6.1 Crop Improvement

Gen. 8: Studies on the comparative performance of different hybrid combinations of oil palm

Centres: Aduthurai

Aduthurai

Hybrids were planted during 2006 at Peraiyur Village, Thiruvarur District. The soil of the experimental field is red sandy loam, the design adopted was Randomized Block Design with three replications and six palms per treatment.

Ten hybrid combinations:

49 X 66 (NRCOP 11)	25 X 214 (NRCOP 12)	25 X 66 (NRCOP 13)
68 X 36 (NRCOP 14)	21 X 214 (NRCOP 15)	131 X 66 (NRCOP 16)
350 X 66 (NRCOP 17)	107 X 214 (NRCOP 18)	61 X 66 (NRCOP 19)
28 X 68 (NRCOP 20)		

Regular biometric observations were recorded and there was significant differences observed for plant height, number of leaves, number of female flowers and number of male flowers. Among the hybrids, the plant height ranged from 5.9 to 8.6 m and hybrid NRCOP14 alone recorded significantly higher plant height of 8.6 m. Number of leaves ranged from 34.8 to 39.6 and NRCOP 14, 13 and 11 recorded significantly higher number of leaves. The number of female and male flowers ranged from 4.8 to 9.2 and 3.2 to 5.1, respectively. Hybrids NRCOP 13, 19, 11, 17, 15 and 20 recorded significantly higher number of female flowers, whereas, hybrids NRCOP 11 and 18 recorded significantly higher number of male flowers.

Table 50 : Biometric observations for the hybrids (Aduthurai, 2012)

Hybrids	Plant height (m)	No. of leaves/plant	No. of female flowers/plant	No. of male flowers/ plant
NRCOP11	6.8	38.4	8.2	4.1
NRCOP12	7.4	35.9	6.6	3.8
NRCOP13	7.8	38.9	9.2	3.4
NRCOP14	8.6	39.6	6.8	3.3
NRCOP15	7.1	35.9	7.6	3.4
NRCOP16	5.9	34.8	4.8	3.2
NRCOP17	6.2	37.1	7.8	3.6
NRCOP18	6.4	37.3	5.6	5.1
NRCOP19	6.6	36.8	9.0	3.4
NRCOP20	6.9	36.2	7.2	3.6
S.E.=	0.4	0.8	0.7	0.3
C.D (P= 0.05)	1.3	2.4	2.0	0.8

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

Centres: Gangavati, Mulde

Gangavati

Oil palm genotypes consisted of six Zambian (ZS) and three Tanzanian (TS) selections planted during October 1998 adopting RBD with three replications:

T_1 : ZS - 1	T_6 : ZS - 9
T_2 : ZS - 3	T_7 : TS - 4
T_3 : ZS - 5	T_8 : TS - 5
T_4 : ZS - 8	T_9 : TS - 7
T_5 : ZS - 6	

Morphological and physiological parameters:

Number of leaves: The annual leaf production during 2011-12 differed significantly among the various genotypes. The genotype ZS-1 recorded significantly higher number of annual leaves (17.3) over ZS – 9 (14.3) but ZS -1 was on par with all the other genotypes (Table 51).

Leaf scorching: The number of leaves scorched per palm during 2011-12 differed significantly among the various genotypes. The genotype ZS-1 recorded significantly lower number of leaves scorched per palm (2.13) over other genotypes, but it was on par with genotype ZS-6, TS-5 and ZS-9 (3.0, 3.1 & 3.1, respectively).

Dried bunches: The number of dried FFB per palm differed significantly among the various genotypes. The genotype, ZS-5 recorded significantly lower number dried FFB per palm (1.44) over all the other genotypes except TS-4 (1.8).

Number of drooped leaves: The number of drooped leaves per palm during 2011-12 differed significantly among the various genotypes. The genotype ZS-1 recorded significantly lower number of drooped leaf per palm of 0.3 over all the other genotypes.

Inflorescence production

Number of male inflorescences: The number of male inflorescences differed significantly among different genotypes. It was lower with the genotype ZS-5 (4.1) over ZS-9, TS-4 and ZS-3 (4.4, 4.5 and 4.7, respectively).

Number of female inflorescences: Significant difference in number of female inflorescence among different genotypes was noticed. Mean number of female inflorescence was significantly higher with the genotype TS-4 (6.9) over TS-7, ZS-6, ZS-8 and ZS-5 (4.8, 5.1, 5.3 and 5.3, respectively).

Sex ratio: The sex ratio differed significantly among different genotypes. Mean per cent of sex ratio was significantly higher with the genotype TS-4 (59.62) over TS-7 and ZS-6 (46.7 and 48.0, respectively).

Biochemical parameters

Relative water content (RWC): RWC was significantly higher in the genotype TS-7 (93.90) over all the other genotypes.

Electrolyte leaching (% of final conductivity): Electrolyte leaching was significantly lower in the genotype ZS-5 (28.58) over all the other genotypes.

Lipid peroxidation (OD values): Lipid peroxidation was significantly lower in the genotype ZS-1 (0.008) over all the other genotypes.

Epicuticular wax (OD values): There was no significant difference in the OD values for epicuticular wax among the various genotypes.

Yield and yield attributing characters

Number of bunches: Number of bunches during 2011-12 differed significantly among the various genotypes. The genotypes ZS-3 recorded significantly higher number of bunches (4.20) over all the other genotypes (Table 52).

Bunch weight: The bunch weight did not differ significantly among the various genotypes. The genotype ZS-5 and ZS-3 recorded numerically higher weight of 15.8 and 15.7 kg/bunch, respectively.

Number of fruits per bunch: During 2011-12, significant difference in the number of fruits per bunch was observed. The number of fruits per bunch was significantly higher in the genotype ZS-8 (2866) over all the other genotypes.

Table 51: Morphological and physiological parameters of different drought tolerant oil palm genotypes (Gangavati, 2012)

Genotypes	Annual leaf production (no.)	No. of scorched leaves/palm	Dried bunches / palm	No. of drooped leaves /palm	No. male Infloresc-ence /palm	No. female Infloresc-ence/palm	Sex ratio (%)
ZS-1	17.3	2.1	3.5	0.3	5.8	5.8	49.9
ZS-3	16.0	2.6	2.7	1.7	4.7	6.4	55.4
ZS-5	15.4	2.7	1.4	0.8	4.1	5.3	55.9
ZS-8	16.1	3.3	2.2	1.4	5.0	5.3	50.9
ZS-6	16.4	3.0	2.5	1.9	5.5	5.1	48.0
ZS-9	14.3	3.1	3.0	1.5	4.4	5.5	55.5
TS-4	15.2	2.4	1.8	1.9	4.5	6.9	59.6
TS-5	16.2	3.1	3.7	1.6	5.2	5.4	51.6
TS-7	16.1	2.7	2.4	1.6	5.3	4.8	46.7
S. Em+/-	0.8	0.3	0.2	0.1	0.2	0.5	3.9
CD (P=0.05)	2.2	0.9	0.7	0.4	0.7	1.540	11.4

Mean fruit weight : There was significant difference in the mean single fruit weight. It was significantly higher in the genotype ZS-5 (10.17 g/fruit) over all the other genotypes, but it was on par with genotype ZS-6 (8.83 g/fruit).

FFB yield: The FFB yield during 2011-12 differed significantly among the various genotypes. The genotype ZS-3 recorded significantly higher FFB yield of 99.1 t/ha over all the other genotypes.

Mulde:

Objectives: To evaluate the Oil palm Dura accessions for drought tolerance.

Table 52: FFB yield of different drought tolerant oil palm genotypes (Gangavati, 2012)

Genotypes	Number of bunches	Mean bunch weight (kg)	No of fruits/ bunch	Mean fruit weight (g)	FFB Yield (t/ha)
ZS-1	2.6	15.1	1213	7.4	5.3
ZS-3	4.2	15.7	1619	8.1	9.1
ZS-5	2.8	15.8	1164	10.2	5.7
ZS-8	3.2	12.0	2866	5.0	5.6
ZS-6	2.94	13.4	1453	8.8	5.7
ZS-9	2.82	14.9	1514	8.4	5.9
TS-4	2.47	15.0	1207	8.4	6.0
TS-5	2.75	15.3	1517	7.1	6.0
TS-7	2.42	13.2	1728	6.7	4.5
SEm+/-	0.31	1.50	116.8	0.5	0.2
CD (P=0.05)	0.93	NS	343.5	1.3	0.6

N.S. : Not Significant

Genotypes:

i) G.B. 25/314	ii) G.B. 22/311	iii) G.B. 21/310
iv) ZS - 1	v) ZS - 2	vi) ZS - 3
vii) ZS – 5	viii) ZS - 6	ix) ZS - 9
x) TS – 2	xi) ZS - 8	xii) TS - 4
xiii) TS – 5	xiv) TS - 7	xv) TS - 8
xvi) TS – 9	xvii) TS - 10	xviii) TS -11
(G.B. - Guinea Bissau, TS - Tanzania, ZS- Zambia)		

Experiment was conducted by adopting Randomized Block Design with three replications and six palms per treatment. Oil palm seedlings were planted during June 1999. The trial was bifurcated into two sets: one set maintained under rainfed (3 palms) and another set (3 palms) under irrigated condition since Oct. 2008.

The data regarding yield of FFB revealed that genotypes have shown significant effect on number of bunches per palm. The highest number of FFB were recorded by the genotype TS-2 i.e. 8.4 bunches followed 8.0 bunches in Genotype ZS-2. Irrigation and interaction effect of irrigation and genotype did not show significant effect (Table 53). Genotypes have shown significant effect on average weight of bunch, while irrigation and interaction effects were non significant. Average weight of bunch was maximum in genotype ZS-8 (12.2 kg) followed by 11.9 kg in genotype TS-7. Data on yield of FFB revealed that there was no significant difference among the irrigation and rainfed palms as well as

Table 53: Yield performance of drought tolerant genotypes (Mulde, 2012)

Genotypes		Av. number of FFB		Mean	Av. wt. of FFB (kg/bunch)		Mean	FFB yield (t/ha)		Mean
		Rainfed	Irrigated		Rainfed	Irrigated		Rainfed	Irrigated	
V_1	G.B. 25/314	3.3	3.8	3.6	4.1	3.8	3.9	2.0	1.9	1.9
V_2	G.B. 22/311	3.8	4.6	4.2	5.3	5.5	5.4	3.0	3.6	3.3
V_3	G.B. 21/310	2.5	4.0	3.3	4.9	5.1	5.0	1.7	2.5	2.1
V_4	ZS –1	5.7	7.0	6.3	9.0	9.6	9.3	7.1	9.6	8.4
V_5	ZS-2	7.6	8.3	8.0	8.6	9.6	9.1	8.8	11.3	10.1
V_6	ZS- 3	7.9	5.6	6.8	8.5	9.9	9.2	9.6	8.0	8.8
V_7	ZS- 5	6.5	6.7	6.6	10.9	11.0	11.0	9.7	10.2	10.0
V_8	ZS- 6	8.0	7.2	7.6	10.0	9.2	9.6	11.2	9.4	10.3
V_9	ZS- 9	7.1	7.8	7.5	6.7	5.9	6.3	6.2	6.5	6.4
V_{10}	TS- 2	7.8	9.1	8.4	7.1	9.1	8.1	7.7	10.6	9.1
V_{11}	ZS-8	6.0	6.6	6.3	12.4	12.0	12.2	10.9	11.0	11.0
V_{12}	TS –4	4.9	4.0	4.5	9.5	8.5	9.1	6.5	5.0	5.7
V_{13}	TS- 5	4.3	4.9	4.6	12.1	9.4	10.7	6.2	6.6	6.4
V_{14}	TS-7 (Control)	3.8	4.0	3.9	12.8	10.9	11.9	6.7	6.1	6.4
V_{15}	TS-8	5.1	5.2	5.1	10.0	9.4	9.7	7.4	6.9	7.2
V_{16}	TS- 9	5.3	7.5	6.4	9.8	9.2	9.5	7.4	10.2	8.8
V_{17}	TS- 10	5.1	8.9	7.0	11.0	11.0	10.9	8.3	13.0	10.7
V_{18}	TS -11	4.6	5.0	4.8	9.4	10.7	10.0	5.8	8.2	7.0
	Mean	5.5	6.1	5.8	9.0	8.9		7.0	7.8	7.4
		S. E. ±	CD (P=0.05)	S. E. ±	CD (P=0.05)		S. E. ±	CD (P=0.05)		
Genotype (A)		0.9	2.4		0.9	2.5		1.1	3.1	
Irrigation (B)		0.3	N.S.		0.3	N.S.		0.4	N.S.	
Interaction (A X B)		1.2	N.S.		1.2	N.S.		1.5	N.S.	

N.S. : Not Significant

interaction of genotypes and irrigation treatment. Genotype ZS-8 has recorded highest yield of 11 t/ha both under irrigated and rainfed conditions (Table 53).

The relative water content (RWC), electrolyte leaching, lipid peroxides activity and epicuticular wax content in the leaf among the different genotypes were estimated. Genotypes and irrigation treatments as well as interaction of both factors have significant effect on RWC. The RWC values were more in the genotype TS-7 (85.2 %) as compared to the other genotypes. Among the genotypes, RWC was in a range of 75.4% (ZS-1) to 85.2% (TS-7) during severe stress period i.e. in the month of May. Rainfed condition showed significantly higher RWC (81.4%) as compared to irrigated conditions. Under rainfed condition, G.B. 21/310 genotype showed maximum RWC (86.2%) followed by ZS-6 (86.0%) under irrigated condition.

There was significant difference among the different genotypes for electrolyte leaching under irrigated and rainfed treatments. The interaction was also significant. The leaching was maximum (0.99 ms/ppt) in genotype G.B. 21/310. Under irrigated condition, electrolyte leaching was 0.95 ms/ppt and genotype TS–4 recorded the highest electrolyte leaching (1.25 ms/ppt) under irrigated conditions. Data on epicuticular wax content in the leaf revealed that there was significant difference among the different genotypes as well as under irrigated and rainfed treatments. Among the genotypes, ZS-6 recorded the lowest OD values (0.08) for wax content in the leaf tissues indicating less tolerant to stress. Genotype G.B. 25/314 recorded the highest OD (0.34) indicated that it is more tolerant to drought. Palms under rainfed condition recorded lower OD values (0.16) compared to irrigated palms. Genotype G.B. 25/314 recorded the highest OD values (0.50) under rainfed condition indicating more tolerance to drought.

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

Centres: Gangavati, Madhopur, Mulde, Pasighat, Aduthurai, Vijayarai

Gangavati

Ten new oil palm hybrids developed from DOPR, Regional Station, Palode were planted during 15th May 2007 by adopting RBD with three replications and 6 palms per treatment. Soil of the experimental field is black clay.

Hybrid cross combinations

1)	NRCOP1 (78D x 435P)	6)	NRCOP 6 (173D x 435P)
2)	NRCOP 2 (90D x 577P)	7)	NRCOP 7 (183D x 577P)
3)	NRCOP 3 (158D x 116P)	8)	NRCOP 8 (70D x 577P)
4)	NRCOP 4 (131D x 435P)	9)	NRCOP 9 (28D x 435P)
5)	NRCOP 5 (5D x 577P)	10)	NRCOP10 (345D x 577P)

Vegetative growth parameters: (Table 54)

Palm height: There was significant difference in the palm height for different oil palm hybrids. The palm height was significantly higher with the hybrid NRCOP-8 (5.3 m) over NRCOP-6 (4.3 m), but it was on par with other hybrid combinations.

Palm girth: Palm girth differed significantly among different hybrids. The palm girth was significantly higher with the hybrid NRCOP-5 (2.7 m) over NRCOP-6 (2.3 m). The other hybrids were on par with NRCOP -5.

Inflorescence production: (Table 54)

No. of male Inflorescence: The number of male inflorescence was significantly lower in the hybrid of NRCOP-8 (3.7) over NRCOP -4, NRCOP 2, NRCOP -1 & NRCOP-6 (8.5). The other hybrids NRCOP -5, NRCOP-7, NRCOP-9 & NRCOP-3 were on par with NRCOP-8.

No. of female Inflorescence: The number of female inflorescence was significantly higher in the hybrid of NRC OP-1 (8.3) over NRC OP -7 and NRCOP-8 (6.9 and 5.9 respectively). The other hybrids were on par with NRCOP-1.

Sex ratio: The sex ratio differed significantly for various hybrids. Higher sex ratio was observed with hybrid NRCOP – 5 (64.3%) over NRCOP -1, NRCOP -2, NRCOP -4, NRCOP -6 & NRCOP 10.

FFB Yield and Yield parameters: (Table 54)

Number of bunches per palm: The number of bunches per palm did not differ significantly among the hybrids.

Table 54: Growth and inflorescence production in different oil palm hybrids (Gangavati, 2012)

Hybrids	Height (m)	Palm girth (m)	Male inflore-scences/ palm	Female inflorescence-nces/ palm	Sex ratio (%)	Number of bunch-es/palm	Mean bun-ch weight (kg)	FFB yield (t/ha)
NRCOP-1	5.1	2.5	5.4	8.3	60.1	4.5	11.4	7.2
NRCOP-2	5.1	2.7	5.5	7.9	58.7	3.8	14.5	6.3
NRCOP-3	5.1	2.5	4.4	7.3	62.0	4.5	11.6	6.4
NRCOP-4	5.1	2.6	6.0	7.5	53.7	4.8	12.7	8.5
NRCOP-5	5.2	2.7	4.1	7.3	64.3	4.8	11.3	6.4
NRCOP-6	4.4	2.3	5.2	7.8	60.0	4.4	9.8	5.8
NRCOP-7	5.0	2.4	4.4	6.9	61.6	3.3	11.7	5.1
NRCOP-8	5.4	2.6	3.8	5.9	61.2	3.9	11.6	6.2
NRCOP-9	4.7	2.4	4.5	7.0	62.1	4.3	15.1	7.1
NRCOP-10	5.0	2.5	4.9	7.6	59.8	3.4	13.7	5.6
S. Em±	0.3	0.1	0.5	0. 5	1.2	0.5	0.8	0.7
CD (P=0.05)	1.0	0.4	1.4	1.3	3.7	1.6	2.3	1.9

Mean bunch weight: Mean bunch weight differed significantly among the various hybrids. The hybrid NRCOP–9 (15.07 kg) recorded significantly higher mean bunch weight over other hybrid combinations but it was on par with the hybrids NRCOP-2 and NRCOP-10 (14.5 & 13.7 kg, respectively).

FFB Yield per palm: The FFB yield per palm differed significantly among the various hybrids. The hybrid NRC OP-4 recorded significantly higher mean FFB yield per palm of 59.73 kg over other hybrids but it was on par with NRCOP-1 and NRCOP– 9 (50.30 & 49.58 kg per palm respectively).

FFB Yield: The FFB yield differed significantly among the various hybrids. The hybrid NRCOP-4 (8.5 t/ha) recorded significantly higher mean FFB yield over other hybrids but it was on par with the hybrids NRCOP -1 and NRCOP – 9 (7.2 and 7.1 t/ha, respectively).

Madhopur

Different hybrids were planted during May 2011 by adopting RBD, with six palms per treatment. 100% of the recommended dose was given of the fertilizer through drip irrigation. Palm height was significantly higher in NRCOP-8 (2.4m) and was on par with NRCOP-7, 3 and NRCOP-2. Palm girth and number of leaves per palm did not differ significantly during the year (Table 55).

General view of Gen. 8C trial (Gangavathi)

Bunch yield of NRCOP4 (Gangavathi)

Table 55: Growth performance of cross combination (Madhopur, 2012)

Hybrid	Palm height (m)	Palm girth (m)	No. of leaves/ plant
NRCOP1	1.6	0.6	12.4
NRCOP2	2.3	0.6	13.2
NRCOP3	2.3	0.6	13.3
NRCOP4	2.2	0.7	13.6
NRCOP5	2.0	0.7	13.3
NRCOP6	1.8	0.6	12.9
NRCOP7	2.3	0.6	12.7
NRCOP8	2.4	0.7	13.5
NRCOP9	1.5	0.7	13.0
NRCOP10	2.1	0.7	12.6
CD (P= 0.05)	0.35	NS	NS

NS: Not Significant

Mulde

Objective: Multilocation trial on the performance of the Oil palm hybrids

Treatments: 10 Hybrid Combinations

V_1)	78 D X 435 P	NRCOP 1	V_6)	173 D X 435 P	NRCOP 6
V_2)	90 D X 577 P	NRCOP 2	V_7)	183 D X 577 P	NRCOP 7
V_3)	158 D X 116 P	NRCOP 3	V_8)	70 D X 577 P	NRCOP 8
V_4)	131 D X 435 P	NRCOP 4	V_9)	28 D X 435 P	NRCOP 9
V_5)	5 D X 577 P	NRCOP 5	V_{10})	345 D X 577 P	NRCOP 10

Oil palm seedlings were planted during Sept. 2007, in RBD with three replications and nine plants per treatment.

Observations on growth characters did not show significant variation for average height, average girth and average number of leaves. Average height of the palm ranged between 1.2 to 1.7m. Average girth of the palm ranged between 1.8 m to 2.6 m and production of average number of leaves was in the range of 19.3 to 23.0.

Different genotypes did not show significant variation for production of average number of male, hermaphrodite and total inflorescences. However, percentage sex ratio was highest (45.0) in genotype NRCOP-7 whereas it was lowest (26.6) in NRCOP-6.

The data presented in Table 56 revealed that different genotypes showed significant variation for average weight of FFB only. Bunch weight was the highest in genotype NRCOP-1 (6.7 kg), whereas, it was the lowest in NRCOP (2.7 kg). Genotype NRCOP-8 recorded the highest yield (2.6 t/ha) whereas, it was lower (1.3 t/ha) in genotype NRCOP-4.

Table 56: Yield performances of different hybrid combinations (Mulde, 2012)

Hybrids	Av. No. of FFB	Av. wt. of FFB(kg)	Yield of FFB (kg/palm)	Yield of FFB (t/ha)
NRCOP 1	2.0	6.7	13.6	2.0
NRCOP 2	3.0	4.9	15.2	2.2
NRCOP 3	4.9	3.6	15.7	2.2
NRCOP 4	2.6	3.4	9.2	1.3
NRCOP 5	2.8	2.7	10.7	1.5
NRCOP 6	3.7	4.0	14.2	2.1
NRCOP 7	2.6	4.4	12.1	1.7
NRCOP 8	3.0	5.8	17.9	2.6
NRCOP 9	3.0	4.4	13.3	1.9
NRCOP10	3.0	4.0	11.4	1.6
SE ±	0.9	0.7	3.2	0.5
CD (P= 0.05)	N.S.	2.0	N.S.	N.S.

NS: Not Significant

Pasighat

Experimental details

No. of hybrid combinations was 10, planted in 3 replications with 6 palms/plot. The data on growth of the palms with respect to plant height in the entire cross combinations was at par over a period of one year. Difference in collar girth and number of leaves produced was observed. The collar girth (Table 57) was maximum (1.3 m) in NRCOP-29 which was on par with NRCOP-21, NRCOP-22, NRCOP-23 and NRCOP-27. The collar girth of NRCOP-29 was significantly higher than NRCOP-24, NRCOP-25, NRCOP-26, NRCOP-28 and NRCOP-30. Collar girth recorded was minimum (1.1 m) in NRCOP-

General view of Gen. 8C plot (Pasighat)

Table 57: Growth performances of Oil palm hybrids (Pasighat, 2012)

Cross Combination	Plant height (m)	Collar girth (m)	No. of leaves produced/ palm/year
NRCOP-21	3.7	1.2	14.2
NRCOP-22	3.6	1.2	12.1
NRCOP-23	3.7	1.2	14.5
NRCOP-24	3.5	1.1	11.3
NRCOP-25	3.4	1.1	12.1
NRCOP-26	3.6	1.1	11.6
NRCOP-27	3.5	1.2	12.3
NRCOP-28	3.6	1.2	12.6
NRCOP-29	3.6	1.3	14.6
NRCOP-30	3.5	1.1	10.5
CD (P= 0.05)	NS	0.14	2.05

NS: Not Significant

24. Maximum number of leaves (14.6) was produced by the cross combination NRCOP-29 which was statistically at par with NRCOP-23, NRCOP-21 and NRCOP-28. Leaf production in NRCOP-30 was the least (10.5) among the hybrids.

Aduthurai

Ten *Tenera* hybrids were planted during Sept. 2007, in the farmer plot at Peraiyur, Mannargudi taluk, Thiruvarur Dst. The design was RBD, with 3 replications and 6 palms per treatment. Soil of the experimental plot is Red sandy loam.

Ten hybrid combinations:

78 x 435 (NRCOP 1)	90 x 577 (NRCOP 2)	158 x 116 (NRCOP 3)
131 x 435 (NRCOP 4)	5 x 577 (NRCOP 5)	173 x 435 (NRCOP 6)
183 x 577 (NRCOP 7)	70 x 577 (NRCOP 8)	28 x 435 (NRCOP 9)
345 x 577 (NRCOP 10)		

The biometric observation on plant height, number of leaves per palm, number of female and male flowers produced were recorded and are presented in Table 58. Significant differences were observed for plant height, number of leaves, number of female flowers and number of male flowers among hybrids. Among the hybrid, the plant height ranged from 5.7 to 7.9 m and hybrid NRCOP 3 recorded higher plant height of 7.9 m. In case of number of leaves, it ranged from 30.7 to 39.1 and NRCOP8 and 10 recorded higher number of leaves. The number of female and male flowers ranged from 4.8 to 8.0 and 3.3 to 4.5, respectively. Hybrids NRCOP 10, 9 and 8 recorded significantly higher number of female flowers. In case of male flowers, hybrids NCROP 3, 9 and 6 recorded significantly higher number of male flowers.

Vijayarai

Seedlings were planted during 2007 in a Randomized block design with three replications and no. of palms /plot were six with a spacing of 9×9 m.

Growth parameters: The data revealed that there was no significant difference among the different cross combinations for any growth character under study (Table 59).

Yield parameters: No. of male inflorescences: NRCOP-3 has recorded maximum no. of male inflorescences per annum (8.1), whereas, it was minimum in NRCOP-4 (7.1).

No. of female inflorescences: NRCOP-8 has recorded maximum no. of female inflorescences (12.4) and NRCOP-10 has recorded minimum (10.7).

Sex ratio: Sex ratio varied from 56.5% to 61.9% (NRCOP-8).

No. of bunches: The maximum no. of bunches per palm was recorded in NRCOP-6 (8.19) and the lowest in NRCOP-2 (6.5).

Table 58: Biometric observations for the hybrids (Aduthurai, 2012)

Hybrid	Plant height (m)	No. of leaves	No. of female flowers	No. of male flowers
NRCOP1	5.7	33.1	4.8	3.3
NRCOP2	6.6	30.7	6.9	3.8
NRCOP3	7.9	35.6	6.9	4.5
NRCOP4	6.3	34.8	6.7	3.4
NRCOP5	6.7	35.8	6.4	3.4
NRCOP6	7.2	38.1	6.7	4.2
NRCOP7	7.3	34.0	5.6	3.8
NRCOP8	6.8	38.6	7.3	3.7
NRCOP9	7.3	34.9	7.6	4.4
NRCOP10	7.1	39.1	8.0	3.4
Mean	6.9	35.5	6.7	3.8
S.E.= ±	0.3	1.1	0.3	0.3
C.D. (P=0.05)	1.0	3.2	1.0	0.8

NS: Not Significant

Bunch weight per palm: The maximum bunch weight per palm was recorded in NRCOP-6 (101.8 kg) and the lowest in NRCOP-3 (73.5 kg).

FFB yield per ha: The maximum yield of fresh fruit bunches per palm as recorded in NRCOP-6 (14.6 t/ha) and the lowest in NRCOP-05 (9.8 t/ha).

Gen. 8 D : Progeny evaluation trials in oil palm

Centres: Gangavati, Madhopur, Mulde, Pasighat, Aduthurai, Vijayarai

Gangavati

Treatment details: No. of Cross combinations – 10

1	NRCOP 31	6	NRCOP 36
2	NRCOP 32	7	NRCOP 37
3	NRCOP 33	8	NRCOP 38
4	NRCOP 34	9	NRCOP 39
5	NRCOP 35	10	NRCOP 40

Ten cross combinations of Tenera hybrids

Code Number	Cross Combination	Code Number	Cross Combination
NRCOP 1	78 x 435	NRCOP 6	173 x 435
NRCOP 2	90 x 577	NRCOP 7	183 x 577
NRCOP 3	158 x 116	NRCOP 8	70 x 577
NRCOP 4	131 x 435	NRCOP 9	28 x 435
NRCOP 5	5 x 577	NRCOP10	345 x 577

Mean bunch weight: The maximum bunch weight was recorded in NRCOP-6 (13 kg) and the lowest in NRCOP-4 (9.5 kg).

Bunch yield of NRCOP 4 (Vijayarai)

Seedlings were planted during 2012, in RBD with 3 replications and 6 palms/plot. Spacing: 9m x 9m x 9m equilateral triangle method was adopted. The Soil type is Black clay.

Vegetative growth parameters:

Palm height: There was significant difference in the palm height among different hybrids. The palm height was significantly higher with the hybrid NRCOP-37 (22.2 cm) over NRCOP-34 and NRCOP-35 (20.9 and 20.8 cm, respectively).

Palm girth: Similarly, palm girth differed significantly among different hybrids. The palm girth was significantly

Table 59: Vegetative performance of different hybrids (Vijayarai 2012-13)

Hybrid	No. of male inflorescences/ palm	No. of female inflorescences/ palm	Sex ratio %	No. of bunches/ palm	Yield kg/palm	Average bunch weight (Kg)	FFB Yield (t/ha)
NRCOP1	8.0	11.5	59.0	7.1	89.6	12.6	12.8
NRCOP2	7.2	9.4	57.0	6.5	68.3	10.5	9.8
NRCOP3	8.1	10.8	57.2	7.6	73.5	9.6	10.5
NRCOP4	7.1	11.1	61.0	7.9	74.4	9.5	10.6
NRCOP5	7.4	9.8	57.0	8.2	91.8	11.2	13.1
NRCOP6	7.6	11.8	61.0	8.5	101.8	13.0	14.6
NRCOP7	7.3	10.6	59.2	7.8	89.8	11.5	12.8
NRCOP8	7.6	12.4	62.0	8.1	77.4	9.57	11.1
NRCOP9	7.3	11.7	62.0	6.8	69.1	10.2	9.9
NRCOP10	7.6	10.7	58.4	7.5	88.1	11.7	12.6
Mean	7.5	11.0	59.2	7.6	82.4	10.9	11.8
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

NS: Not Significant

higher with the hybrid NRC OP-37 (22.8 cm) over NRCOP-33 and NRCOP-40 (20.4 & 19.8 cm respectively) (Table 60).

Annual leaf production: The no. of leaves per palm differs significantly with different hybrids. The hybrid NRCOP-37 (12.9) recorded significantly higher no. of leaves per palm over NRCOP -32 and NRCOP -35 (11.1 and 10.8, respectively) but the other hybrids were on par with NRCOP – 37.

Table 60: Vegetative growth parameters of different oil palm hybrids (Gangavati, 2012)

Hybrids	Palm Height (cm)	No. of leaves	Palm Girth (cm)
NRC OP 31	20.6	12.6	21.7
NRC OP 32	20.5	11.1	22.0
NRC OP 33	20.6	11.4	20.4
NRC OP 34	20.9	11.6	22.5
NRC OP 35	20.8	10.8	21.2
NRC OP 36	19.3	12.9	21.8
NRC OP 37	22.2	12.9	22.8
NRC OP 38	20.6	12.3	21.7
NRC OP 39	19.7	12.4	21.1
NRC OP 40	19.6	12.1	19.8
S. Em ±	0.51	0.6	0.8
CD (p=0.05)	1.49	1.8	2.3

Madhopur

Ten cross combinations (NRCOP 31 to NRCOP 40) are under progeny evaluation trial. Palms are in secondary nursery stage and ready for planting in the main field.

Mulde

Total 500 sprouts of Ten Hybrid Combinations (50 of each combination) were collected from DOPR, Pedavegi and planted in the experimental field during October 2011, by adopting RDBD, with 8 palms/plot

Pasighat

No. of hybrid combinations : 10
Replications : 3
Plot size : 6 palms/plot
Design : RBD

The sprouts brought from DOPR, Pedavegi were raised in two stage nursery and the seedlings were

General view of Gen. 8D trial (Mulde)

transplanted in main field in July 2012. Growth parameters of the seedlings recorded in July 2012 prior to transplanting in main field is presented in Table 61.

The growth of the seedlings with respect to plant height and collar girth in secondary nursery was recorded to be statically at par in all the cross combinations (Table 61). Difference in number of leaves produced was observed. Maximum number of leaves (17.7) was produced in NRCOP-31 which was significantly higher than all other cross combinations. Minimum number of leaves (14.5) was recorded in NRCOP-37.

Table 61: Growth parameters of Oil Palm plants in secondary nursery (Pasighat, 2012).

Cross Combination	Plant height (m)	Collar girth (m)	No. of leaves
NRCOP-31	3.0	0.5	17.7
NRCOP-32	3.2	0.5	16.2
NRCOP-33	3.4	0.5	15.4
NRCOP-34	3.4	0.4	16.3
NRCOP-35	3.5	0.5	15.9
NRCOP-36	3.2	0.5	16.1
NRCOP-37	3.2	0.5	14.5
NRCOP-38	3.2	0.5	15.0
NRCOP-39	3.4	0.5	15.9
NRCOP-40	3.2	0.5	14.8
CD (P=0.05)	NS	NS	1.2
CV (%)	7.5	17.6	4.4

NS: Not Significant

Land was prepared and pits were dug prior to the onset of monsoon. Planting was done in July 2012 as per the experimental details.

Aduthurai (Pattukkottai)

Objectives : To evaluate ten *Tenera* hybrids for better growth and higher productivity and to select most suitable oil palm hybrid for Cauvery Delta Zone.

General view of Gen. 8D trial (Pattukkotai)

Treatments : 5 Hybrids (NRCOP 31, 32, 33, 38 and 39) Design: RBD, Spacing: 9 X 9 m, Replications: 4, Palms per plot: 6, Date of planting : 26.02.2013:

Among 9 hybrids received, only five hybrids have sufficient seedlings for the replicated trial. Other four hybrids *viz.*, NRCOP 34, 35, 36 and 37 were planted as

Table 62: Growth parameters of oil palm (Vijayarai, 2012)

Hybrid	Plant height (cm)	Plant girth (cm)	No. of leaves
NRCOP31	25.4	0.6	10.3
NRCOP32	29.7	0.6	11.3
NRCOP33	27.0	0.6	12.2
NRCOP34	27.0	0.6	11.8
NRCOP35	27.3	0.5	10.2
NRCOP36	24.4	0.5	10.1
NRCOP37	27.3	0.6	11.1
NRCOP38	27.2	0.5	12.6
NRCOP39	26.2	0.5	11.3
NRCOP40	26.8	0.5	11.0

non replicated trial for observation. The seedlings are being established.

Vijayarai

Set I with NRCOP 31 to 40 were planted during 2009.

Palm height: Maximum palm height was recorded in NRC0P-40 (29.7 cm) and minimum height in NRCOP-36 (24.4 cm).

Palm girth: Maximum palm girth was recorded in NRC0P-31 (0.56 m).

No. of leaves: Maximum no. of leaves was recorded in NRC0P-38 (12.6) and minimum no. of leaves in NRCOP-36 (10.10.1).

Gen. 13 A : Performance of cocoa varieties as mixed crop under oil palm plantations

Vijayarai

Experiment was initiated to evaluate the performance of cocoa varieties under oil palm plantation.

14 varieties such as (VTLC-1, VTLC9,VTLC-13,VTLC-17,VTLC-18,VTLC-20,VTLC-25,VTLC-36,VTLC-37,VTLC-57,VTLC-65,VTLC-128,VTLCH-3,VTLCH-4) were planted during December, 2012 in a RBD with two replications.

General view of Gen. 13A trial (Vijayarai)

6.2 Crop Production

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

Centres: Gangavati, Mulde, Vijayrai

Treatments

T1: 300:150:300 g NPK Palm through fertigation

T2: 600:300:600 g NPK Palm through fertigation

T3: 900:450:900 g NPK Palm through fertigation

T4: 1200:600:1200 g NPK Palm through fertigation

T5: 1200:600:1800 g NPK Palm through fertigation

T6: 1200:600:2700 g NPK Palm through fertigation

T7: 1200:600:2700 g NPK Palm 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 six splits.

Gangavati

Experiment was initiated in a garden planted during and 1989, treatments were imposed during 2008.

FFB Yield and Yield parameters :

Number of bunches per palm (Table 63):

Significant difference in number of bunches per palm was observed for different fertigation treatments. Application of 300:150:300 g NPK /palm/year through fertigation recorded higher no. of bunches per palm (3.1) over 1200:600:1800 g NPK/palm/year, 1200:600: 2700g NPK/palm/year through fertigation and 1200:600: 2700/ palm/year through soil application (2.3, 2.5 & 2.5, respectively).

The mean bunch weight was significantly higher in the treatment receiving fertigation of 1200:600:1200 g NPK/palm/year (19.7 kg/bunch) over all other fertigation and soil application treatments. The FFB yield differed significantly among various treatments. The fertigation treatment of 1200:600:1200 g NPK/palm/year recorded significantly higher FFB yield of 8.7 t/ha over all other fertigation and soil application treatments.

Mulde

Yield data during the year 2011-12 was recorded and presented in Table 63. Data revealed that there was no significant difference among the various treatments for yield characters.

Vijayarai

The FFB yield differed significantly among different

Table 63: Yield and yield attributes of oil palm as influenced by fertigation treatments during 2012 (Mulde)

	Treatments	Bunch weight (kg/palm)	No. of Palm FFB	Yield of FFB (kg/palm)	Yield of FFB (t/ ha)
T_1	300:150: 300g NPK through fertigation	24.2	4.0	98.0	14.0
T_2	600: 300:600g NPK through fertigation	21.3	4.3	91.8	13.1
T_3	900:450: 900 g NPK through fertigation	19.6	5.4	106.2	15.2
T_4	1200: 600:1200g NPK through fertigation	23.3	4.7	111.4	15.6
T_5	1200: 600: 1800g NPK through fertigation	23.8	6.2	147.6	21.1
T_6	1200: 600: 2700g NPK through fertigation	22.9	5.8	130.2	18.6
T_7	1200; 600; 2700g NPK through Soil application	24.5	5.3	130.5	18.7
	S. Em ±	1.2	0.5	12.9	2.4
	CD (P=0.05)	N.S.	N.S.	N.S	N.S.

NS: Not Significant

treatments. The treatment T_4 *i.e.,* 1200: 600: 1200g NPK through fertigation had recorded significantly higher FFB yield of 18.9 t/ha over all other fertigation and soil application treatments (Table 64). No. of bunches were found non-significant. Bunch weight per palm was also found non-significant and ranged from 100.1 kg to 124.7 kg per palm.

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, No. of palms per plot: 6

One hundred and fifty, 'Tenera' plants planted in August 2008 at the college farm are being used as experimental material.

General view of Agr. 12 trial (Pasighat)

The recommended dose of nutrients (1200:600: 1200 g/plant/year) was applied as per the treatment details in summer, pre-monsoon and post monsoon in the year 2012. Chemical fertilizers were applied in three split doses in T_2 and T_3 treatments in summer, pre-monsoon and post monsoon months. The organic manure treatment in T_2, T_4 and T_5 were applied in two split doses. Pollinating weevils brought during January 2013 from DOPR, Pedavegi were released in the plantation.

Morphological parameters such as plant height, girth and number of leaves were recorded in March 2013. Plant height, collar girth and number of leaves per

Table 64: Performance of yield and yield attributes as influenced by different fertigation treatments on oil palm during 2012 (Vijayarai)

Treatment	No. of bunches harvested	Bunch weight per palm (kg)	Average bunch weight (kg)	FFB Yield (t/ ha)
T_1: 300 : 150 : 300g (fertigation)	3.6	107.3	29.9	15.5
T_2: 600 : 300 : 600g (fertigation)	3.5	100.1	28.5	14.4
T_3: 900 : 450 : 900g (fertigation)	3.2	100.7	31.2	14.6
T_4: 1200 :600 :1200g (fertigation)	3.4	124.7	39.4	18.9
T_5: 1200 :600 :1800g (fertigation)	3.3	101.0	30.4	14.2
T_6: 1200 :600 :2700g (fertigation)	3.4	104.5	30.2	15.8
T_7: 1200 :600 :2700g (soil application)	3.0	100.4	33.8	14.6
Mean	3.4	107.3	31.9	15.4
S.Em±	0.067	3.55	0.96	0.43
CV(%)	9.69	14.80	10.44	9.20
CD (P=0.05)	NS	NS	NS	2.52

NS: Not Significant

plant were found to be non-significant among the treatments (Table 65).

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.

General view of Agr. 13 trial (Pasighat)

Table 65: Growth parameters of Oil palm plants recorded in March 2013 (Pasighat)

Treatment	Plant height (cm)	Collar girth (m)	No. of leaves/ plant
T_1	27.8	1.3	28.2
T_2	29.8	1.1	28.2
T_3	33.6	1.6	29.9
T_4	29.2	1.3	28.9
T_5	31.4	1.4	29.4
CD (P=0.05)	NS	NS	NS
CV (%)	19.48	27.04	3.839

NS: Not Significant

The average plant height, collar girth and number of leaves per plant recorded in month of March 2013 were 43.9 cm, 2.0 m and 28.8 leaves per palm, respectively. Flowering in all the palms been observed. The average number of male and female flowers per palm was 1.68, empty bunches 7.46/ palm and fruiting bunches 0.54/ palm. More number of EFB was recorded due to lack of pollination in the initial phase of flowering.

VII. Experimental Results in Palmyrah

7.1 Genetic Resources

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

(Killikulam, Pandirimamidi)

A joint survey of palmyrah germplasm was carried out at Nellore district of Andhra Pradesh, during August-Sept. 2012, along with the scientist from NBPGR, Regional Station, Hyderabad. Potential palm growing areas of Nellore district were covered and a total of nine accessions with ten fruits were collected under each accession (Table 66). The total germplasm maintained at Kilikulam in 247 and at Pandirimamidi is 272 nos.

Germplasm AP 03 / 12

Table 66: Details of Palmyrah germplasm collected from Nellore district of Andhra Pradesh during Aug-Sept. 2012

S. No.	Accession No.	Date of collection	Village Name	Mandal
1	AP 01 / 12	31.8.2012	Kovur	Kovur
2	AP 02 / 12	31.8.2012	Gamallapalam	Kodavaluru
3	AP 03 / 12	1.9.2012	Malluru	Muthukuru
4	AP 04 / 12	1.9.2012	Ramadamchatram	Venkatachalam
5	AP 05 / 12	1.9.2012	Vengannapalam	Kodta
6	AP 06 / 12	2.9.2012	Chinnagotlagunta	Vengatagiri
7	AP 07 / 12	2.9.2012	Tummuru	Naidupeta
8	AP 08 / 12	3.9.2012	Veernakollu	Kaligiri
9	AP 09 / 12	3.9.2012	Chennuru	Dagadarthi

Germplasm AP 02 / 12

Germplasm evaluation

Killikulam

The germplasm collected are regularly being evaluated for various biometrical characters viz; plant height (cm), number of leaves, leaf length and stalk length. During January 2013, the germplasm so far assembled were scored for the above biometrical characters and the abstract of data recorded in various blocks are furnished in (Table 67).

The results showed that the germplasm lines planted during 1997 recorded the maximum values for

Germplasm

Germplasm AP 07 / 12

Germplasm AP 08 / 12

Germplasm AP 09 / 12

all the parameters studied. ACC 67 recorded higher values for plant height and number of leaves. ACC 41 continued to record the highest values for leaf length and stalk length during the current year also.

Performance of Palmyrah during 2012

The results of the data recorded from the germplasm planted in 1991 indicated that the accession 4/91 recorded maximum palm height (1.05 m) followed by accession 6/91 (1.01 m). The stem girth also recorded maximum in accession 4/91 followed by accession 6/91.The flowering data has shown that Acc. 9/91 recorded the maximum number of 9.6 bunches and the lowest number of bunches was recorded with Acc.7/91 i.e.,3.5 number of bunches. Among the collection of germplasm during 1993, accession 17/93 has recorded maximum values in terms of palm height (8.25 m), number of leaves (12.6) and number of bunches (8.5).The highest number of fruits per bunch (69) was recorded in the accession 19/93. The accession 16/93 has recorded maximum values for stem girth, lamina length and lamina breadth.

Under the accessions planted during 1994, maximum palm height was seen with accession 27/94. The maximum values in terms of stem girth, number of leaves and lamina breadth was recorded with accession 25/94. Much variation was observed among the 1995 planted germplasm. The accession 41/95, which is very slow in growth even after 17 years, has recorded the lowest mean values in all the parameters. However, the maximum mean values in terms of palm height, stem girth, number of leaves, lamina length and lamina breadth was recorded with accession 39/95.

Table 67: Abstract of biometrical observations recorded during January 2013 (Killikulam)

Year of planting	Plant height (cm)		No. of leaves	
1995	337.0 (Acc. 18)	163.0 (Acc. 38)	20.1 (Acc. 18)	9.0 (Acc. 40)
1997	450.0 (Acc. 67)	177.0 (Acc. 46)	28.6 (Acc. 67)	11.8 (Acc. 48)
1999	201.0 (Acc. 73)	71.2 (Acc. 83)	14.25 (Acc. 73)	3.4 (Acc. 79, 82)
2001	300.0 (Acc. 92)	85.0 (Acc. 96)	16.0 (Acc. 92)	6.0 (Acc. 94)
2001	229.0 (Acc. 102)	72.0 (Acc. 113)	15.6 (Acc. 102)	3.6 (Acc. 1072)
2002	198.0 (Acc. 115)	93.0 (Acc. 125)	12.6 (Acc. 116)	9.4 (Acc. 125)
2002	191.8 (Acc. 134)	84.0 (Acc. 132)	11.4 (Ac. 173)	6.2 (Acc. 132)
2003	78.0 (Acc. 155)	69.0 (Acc. 153)	8.0 (Acc. 153)	4.2 (Acc. 149)
2004	100.2 (Acc. 160)	58.2 (Acc. 170)	9.4 (Acc. 168,167)	5.7 (Acc. 171)
2005	145.0 (Acc. 174)	74.0 (Acc. 179)	9.8 (Acc. 174)	5.2 (Acc. 179)
2006	102.0 (Acc. 192)	58.8 (Acc. 183)	10.8 (Acc. 193)	4.4 (Acc. 190)
2007	96.0 (Acc. 203)	78.0 (Acc. 202)	8.0 (Acc. 203)	5.6 (Acc. 198)
2008	77.4 (Acc. 210)	55.0 (Acc. 212)	8.3 (Acc. 216)	3.6 (Acc. 215)
2009	66.6 (Acc. 218, 219)	49.0 (Acc. 223)	5.4 (Acc. 219)	2.25 (Acc. 224)
2009	70.0 (Acc. 237, 239)	52.2 (Acc. 248)	3.8 (Acc. 237)	1.7 (Acc. 246)
2010	82.2 (Acc. 256)	47.4 (Acc. 250)	4.4 (Acc. 256)	1.8 (Acc. 250, 251)
2011	72.8 (Acc. 273)	16.2 (Acc. 262)	3.0 (Acc. 273, 274)	1.0 (Acc. 262, 263)

Among the 1998 planted germplasm accessions, flowering was observed for the first time during this year in accession 51/98. The accession 55/98 has recorded the highest palm height, number of leaves, lamina length and lamina breadth. The results from the data collected from 1999 planted accessions showed that maximum palm height of 5.5 m was recorded with the accession 64/99 and the highest number of leaves was recorded with accession 62/99 and the maximum stem girth was recorded in accession 63/99.

The data collected from the 18 accessions planted during the year 2000 indicated that the highest values in terms of palm height, lamina length, and petiole length were recorded with the accession 68/00. However, the maximum number of leaves was recorded in the accession 83/00. The lowest values in terms of palm height, lamina length, and petiole length was recorded with the accession 79/00.

Among the germplasm accessions planted during the year 2001, the maximum palm height was recorded with the accession 121/01. The same accession has recorded maximum mean values in terms of lamina length, lamina breadth and petiole length. However, the highest number of leaves was recorded with accession 100/01.

The 2002 planted accessions collected from Nalgonda district of Andhra Pradesh showed the maximum palm height, lamina length, lamina breadth and petiole length with the accession 133/02 and the maximum number of leaves was recorded with the accession 136/02.

Among the germplasm collected from Tamil Nadu and planted during 2002, the accession 158/02 recorded maximum palm height, number of leaves and petiole length. The lowest values for all the observations was recorded with the accession 160/02. Among the 2003 planted accessions, palm height, number of leaves and petiole length recorded was the highest with the accession 164/03, however the lamina breadth and lamina length recorded was maximum with accession 173/03.

Among the germplasm accessions collected during 2004, accession 182/04 has recorded maximum palm height and the highest number of leaves. The leaf length and leaf breadth recorded were maximum with accession 177/04. Among the accessions collected during the year 2006, accession 200/06 has recorded maximum palm height and lamina breadth and accession 196/06 has produced the highest number of leaves.

The data collected from germplasm planted during 2007 showed maximum palm height, number of leaves and lamina length with the accession 209/07.The accession 206/07 has recorded maximum values in terms of lamina breadth and petiole length.

Table 68: Abstract on the performance of Palmyrah germplasm accessions at Pandirimamidi during the year

Block		Palm height (m)		Stem girth (m)		No. of leaves	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1991	Accession	11/91	4/91	11/91	4/91	6/91	12/91
	Value	7.84	10.58	1.56	1.98	11.2	14
1993	Acc	20/93	17/93	22/93	16/93	20/93	17/93
	Value	5.54	8.25	1.40	1.61	10.2	12.6
1994	Acc	24/94	27/94	24/94	26/94	24/94	25/94
	Value	6.25	8.17	1.42	1.78	11.8	13
1995	Acc	41/95	39/95	41/95	38/95	41/95	38/95
	Value	2.57	6.34	1.21	1.65	10.4	12
1998	Acc	57/98	55/98	54/98	56/98	53/98	55/98
	Value	4.25	7.18	1.27	1.77	10.4	12.4
1999	Acc	59/99	64/99	65/99	63/99	59/99	62/99
	Value	3.15	5.54	1.28	1.84	10.2	13
2000	Acc	79/00	68/00	-	-	79/00	83/00
	Value	0.82	4.31	-	-	4	17
2001	Acc	112/01	121/01	-	-	112/01	100/01
	Value	0.93	5.0	-	-	7.0	18.4
2002 AP	Acc	130/02	133/02	-	-	143/02	136/02
	Value	2.1	3.53	-	-	8.2	12.0
2002 TN	Acc	160/02	158/02	-	-	157/02	158/02
	Value	0.99	3.51	-	-	5.0	16
2003	Acc	168/03	164/03	-	-	168/03	164/03
	Value	1.42	4.0	-	-	6.2	15
2004	Acc	187/04	182/04	-	-	187/04	182/04
	Value	1.0	2.4	-	-	4.8	13.6
2006	Acc	191/06	200/06	-	-	191/06	196/06
	Value	0.62	1.48	-	-	3	9
2007	Acc	205/07	209/07	-	-	205/07	209/07
	Value	0.75	1.48	-	-	3.6	7.2
2008	Acc	222/08	220/08	-	-	222/08	218/08
	Value	0.35	0.98	-	-	2.5	6.25
2009	Acc	230/09	226/09	-	-	230/09	227/09
	Value	0.40	0.69	-	-	3.4	7.2

Gen. 16 : Growth and development studies in Palmyrah

Root studies in Palmyrah:

Pandirimamidi

Under growth and development studies in Palmyrah, root studies were initiated to know the growth pattern of roots in different root zones around the Palmyrah tree. Trees of various age groups i.e., 5,10,15,20 and 25 years were selected for the study and four trees were selected per age group. A trench was dug from the base of the palmyrah tree to a distance of 90 cm with a dimension of 30 cm width, 60 cm depth and 90 cm length. The trench was divided into three equal linear zones of 30 cm (Zone A), 60 cm (Zone B) and 90 cm (Zone C) away from trunk. Each of these three zones were again divided into three depths of 0-30 cm, 30-60 cm and 60-90 cm and as such 9 trench zones ie. A1, A2 and A3 under zone A; B1, B2 and B3 under zone B and C1, C2 and C3 under zone C were prepared. All the 9 zones were filled with coir pith and irrigation was provided to the above trees at regular intervals. The data will be recorded at three months intervals on the number of roots in each of the nine zones regardless of their origin after excavating the coir pith. After recording the data, the trench will be refilled with the coir pith.

Feasibility study on transplanting of Palmyrah trees of varying age groups

Pandirimamidi, Killikulam

Palmyrah trees of 1, 2, 3, 5, 7 and 10 years old were identified for transplanting studies. During October 2012, five trees each from the age group 1, 3, and 5 years were dug out from the soil without causing any damage to the roots. The same trees were planted in the experimental plot at 4m x 4 m spacing and the trees were irrigated regularly and observed for survival. Among the one year old transplanted trees, out of five trees, four have put forth new leaf at 30 to 40 days after transplanting and survived. Among the 3 year old transplanted trees, out of five trees, only one tree could survive and remaining four trees died within 10 days. Among the 5 year old transplanted trees, all the five trees died within one week.

7.2 Post Harvest Technology

PHT-1: Standardization and commercialization of inflorescence sap extraction and inflorescence sap based products (jaggery, palm sugar and candy)

Pandirimamidi

1. Standardization of tapping techniques of inflorescence sap (neera)

Studies were conducted for increasing the flow of 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 no significant difference among the treatments. V type cut yielded more as compared to others for particular time and total yield during season was more in cross type cut. It was also observed that yield increases with increase in surface area of the cut portion of the spathe.

Experiments results of study conducted for improving the yield of neera by applying anti oxidant (Ethephon, EDTA, BHT, CaOH, Citric Acid) to the sliced portion of the spathe showed that, yield increases with the application of Ethephon followed by citric acid.

2. Improving the shelf life of inflorescence sap

Chemical processing: Neera can be stored under refrigerated condition for 7 days by adopting the heating process for 5 min. under 90°C followed by 0.1% pottassium metabisulphate (KMS) or 0.1% sodium benzoate.

Membrane processing: Neera can be stored under refrigerated condition for 60 days by adopting the heating process for 5 min under 90°C followed by micro filtration under 1 kg/cm^2 pressure for 10 min. operation. Qualitative characters of neera are presented in Table 69. It is observed that, even after 60 days, the overall acceptability was good.

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

Pandirimamidi

Experimental results for identifying the maturity stage of tubers for higher nutritive values indicated that, 4th and 5th month tubers were having higher nutritive value than other samples. Tuber samples were collected from 13 accessions of 1991 planted germplasm block at the age of 3, 4 and 5 months after germination and analyzed.

Studies on preparation of flour and suji from palmyrah tuber by various methods i.e raw tuber (T1), autoclave cooked and dried (T2), open fired (T3), fired in iron tin and directly dried (T4) were made. The tubers were cut into pieces and dried at 60°C for 24 hrs, milled using pulveriser to pass through a 250 µm sieve, packaged in polyethelyne bag and kept in a refrigerator (4°C). The moisture content of the palmyrah tuber flour was 5.19%. The ash and fat contents (dry matter basis) were 2.60% and 0.57%, respectively. The protein content, fibre content and carbohydrate content were 3.20%, 10.17% and 69.38%, respectively. The caloric value obtained was 282.19 kcal/100g. The pH and titratable acidity values were 5.78 and 1.12%

Table 69: Quality characters of membrane processed (micro filtration) female infloresence sap (Neera)

Days after	pH	Acidity	TSS (° Brix)	Protein (mg)	Vit. C,(mg/ 100 ml)	Colour	Taste	OA
1	7.5	0.1	12.5	14.5	4.0	Clear	Sweet	Good
15	7.0	0.1	12.0	13.0	3.5	Clear	Sweet	Good
30	7.0	0.2	12.0	12.0	3.5	Clear	Sweet	Good
45	7.0	0.2	12.0	12.0	3.5	Clear	Sweet	Good
60	7.0	0.2	12.0	12.0	3.5	Not Clear	Sweet	Good

OA; Overall Acceptability

Table 70: Proximate composition of tender fruit endosperm of 70 days from initiation (Room temp/at 4°C)

Days after	Moisture Content (%)		Protein (%)		Fat (%)		Ash (%)		Vit. C (mg/100 ml)	
	(A)	(R)	(A)	(R)	(A)	(R)	(A)	(R)	(A)	(R)
1	93	93	0.6	0.6	0.1	0.1	0.2	0.2	64	64
2	77	93	0.5	0.6	0.1	0.1	0.2	0.2	60	64
3	65	93	0.5	0.6	0.1	0.1	0.1	0.2	30	60
4	47.0	92	0.5	0.6	0.1	0.1	0.1	0.2	30	60
5	37.0	92	0.5	0.6	0	0	0.1	0.2	23	60
6	35	92	0.5	0.6	0	0	0.1	0.2	22	60

A: Room temperature

R: Refrigerated condition

respectively. Water absorption capacity (18%), fat absorption capacity (14.0%) and bulk density (0.70 g/cm^3) were recorded for the palmyrah tuber flour. The values for swelling power, foam capacity and foam stability were 4.55, 21.32% and 29%, respectively. The values were moderately higher than of similar flours and the flour may be used directly or combined with other flours for preparation of foods.

Biscuits and bread were prepared with tuber flours of 5, 10 and 15% and results showed the increase in bitterness with increase of tuber flour. It was also observed that flour from autoclave cooked tuber has good taste as compared to other flours.

PHT-4: Sandardization of preservation technique for palmyrah tender fruit endosperm (nungu)

Pandirimamidi

Experiments were conducted for identifying the maturity stage for nungu. Tender fruit of 50, 60, 70 and 80 days from flower initiation were collected and evaluated by sensory. It was observed that the fruit had more water at the age up to 60 days and less quantity of endosperm. At the age of 70 days from the initiation of flower, it had more pulp as compared to others for tender nut and at the age of 80 days it had harder pulp, which is suitable for jam and jelly preparation only. Thus it was observed that the age of 70 days followed by 60 days nungu was better option as compared to others (Table 70).

The dehydrated samples treated with sugar syrup concentrations of 50 and 60 Brix were found to be acceptable in sensory qualities except slight colour change during storage. Nungu in deep freezer lost its originality.

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

Gen. 17: Collection, conservation and evaluation of Sulphi (*Caryota urens*) germplasm

Jagadalpur

Sulphi germplasm at Raipur

Survey for identification of germplasm in Raipur was conducted and one accession was marked for further obser-vations and simultaneously seeds of selected palms were collected. The plant height was 12.0 m, girth 180 cm, no. of leaves were 20, length of petiole was 1.50 m, total leaf length was 4.5 m and the fruit was with two seeds.

Fourteen germplasms have been identified so far, out of which eight germplasms were of tall type, three were semidwarf, two were dwarf type and one was of two seeded fruit.

Two seeded germplasm

Gen. 18: Growth and development studies in Sulphi palm (*Caryota urens*)

It was observed from the data that, for 15 months old seedling, the root length was 26 cm, shoot length was 16 cm and no. roots were 5 (Table). For 18 months old seedling, it was observed that the root length was 42 cm, shoot length was 24 cm and no. of roots were 6. There was not much difference in the no. of leaves and root girth.

15 days old seedling

Infloresence of Sulphi Palm

The observation on five year old seedling indicated that the growth rate of leaf was 4.5-4.9 cm /day and growth rate of stem was 0.10 cm /day.

From a palm of more than 18 years, inflorescence was cut and observations were made. It was found that the weight of inflorescence was 35 kg, no. of spikes was 350, no. of seeds/spike was 150 and length of the inflorescence was above 3.5 m.

Ripe seeds were collected and kept in gunny bag under shade and water was sprinkled over a gunny bag and after 45-55 days the seeds were sprouted and ultimately seeds were sown in nursery bed or in polybags. It was observed that within 45-50 days, seeds were germinated as compared to other seeds.

Table 71: Growth observation of seedling plants

S.No.	Age of plant	Root length (cm)	Shoot length (cm)	No. of leaves	No. of roots	Root girth (cm)
1	15 months	26.0	16.0	4.0	5.0	4.3
2	18 months	42.0	24.0	4.0	6.0	4.5

Special grant scheme:

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

On the basis of extensive survey of 24 villages, wilt disease incidence was recorded 15.08%, 31.71%, 41.58% and 56.5% in the year of 2010, 2011, 2012 and 2013, respectively. Disease incidence was increased up to 16.6%, 9.34% and 15.2% in 2011, 2012 and 2013, respectively over initial incidence of 15.08% recorded during the year 2010.

Under symptomatological study, different types of symptoms like wilting/root rot, leaf blight, leaf spot and stem cracking were observed. Most frequently, root rot, leaf blight and final wilting symptoms were observed in diseased plant. Initially, the symptom appears on leaves which turn as brown colour, further the drying progressed from the margin. Three types of wilting symptoms were observed during survey. The first symptom was observed on spindle leaf, 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. Second symptom, appears on the lower or older leaves which will become pale yellow color to brownish color, later on leading to incomplete drying of the leaves and finally resulting in death of the palms. In the third symptom, all leaves of plant became chlorotic and turned into pale yellow to brown color leading to complete wilting and death of the palm. The colour of the vascular bundles of lateral root turn to brownish to black colored due to fungal infection. As disease advances, the roots became rotten and lead to secondary infection by fungus like *Aspergillus, Bionacteria, Rhizoctonia* etc., bacteria and nematodes.

Inoculation of all fungal strain on the host revealed that the strain G-1 was found to be more virulent followed by B-1 in causing the wilt symptom. During the artificial inoculation, the symptoms developed by the G-1 fungal strain were found similar to that of the natural occurrence. Pathogenicity of the isolate G-1 was confirmed six times and the strain G-1 showed 99% sequence similarity with genus *Fusarium* sp. Link. Finally, the pathogen was confirmed as *Fusarium oxysporum*. This fungus has many different strains that cause wilt diseases in a range of plants, although this strain is restricted to a very limited host range.

In order to manage the disease the treatments including combination of different biocontrol agent, biofertilizers, farmyard manure etc were evaluated under *in vivo* condition. Among them, the treatments including basal application of *T. harzianum* + organic manure and crown application of 100% culture filtrate of *T. harzianum* were found effective against the wilt disease of sulphi palm.

IX. Centre-wise Budget during 2012-13 (ICAR share)

(Rupees in Lakhs)

Centre	Pay	TA	RC	HRD	Total
Aliyarnagar	23.00	0.50	2.35	0.00	25.85
Ambajipeta	29.45	1.00	3.75	0.00	34.20
Arsikere	19.50	0.60	2.40	0.00	22.50
Jagadalpur	9.40	0.50	27.10	2.00	39.00
Kahikuchi	23.62	2.60	13.65	0.13	40.00
Bhubaneshwar	8.00	0.40	7.60	0.00	16.00
Mondouri	10.00	0.30	1.70	0.00	12.00
Ratnagiri	41.72	0.60	2.00	0.00	44.32
Veppankulam	31.50	0.60	2.00	0.00	34.10
Navsari	3.85	0.25	18.90	2.00	25.00
Sabour	3.85	0.35	1.00	0.00	5.20
Killikulam	11.50	0.70	2.00	0.00	14.20
Pandirimamidi	15.80	0.50	2.80	0.00	19.10
Aduthurai	7.00	0.25	1.30	0.00	8.55
Gangavathy	7.50	0.20	1.40	0.00	9.10
Mulde	8.50	0.20	1.40	0.00	10.10
Vijayarai	6.40	0.20	1.00	0.00	7.60
Pasighat	0.00	1.25	12.75	1.00	15.00
Madhopur	0.00	0.35	2.75	0.00	3.10
Pilicode	0.00	0.08	1.00	0.00	1.08
Total	260.59	11.43	108.85	5.13	386.00

X. Monitoring centres and Meetings

Monitoring

During the reporting period, the Project Coordinator has monitored the functioning of different AICRP centres by visiting them and keeping constant touch with all the centres through phone and email. Time to time advise and direction was given for proper implementation of the technical programmes. Monthly progress report and budget utilization information were obtained from centres regularly and the same was reviewed critically. During the visit to centres, discussions were held with Vice chancellor, Director of Research and Head of the Division of the SAUS's of the concerned centre as well as with the scientist of AICRP on Palms for the smooth functioning of the research programmes. After each visit, suggestions were given for implementing the technical programmes.

Centres visited (April 2012 – March, 2013)

Centres visited	Period
Bhubaneswar, Odisha	10.04.2012 to 12.04.2012
Sabour, Bihar	14.04.2012
Madhopur, Bihar	15.04.2012
Gangavathi, Karnataka	28.04.2012
Jagadalpur, Chhattisgarh	09.05.2012 & 10.05.2012
Aliyarnagar, TN	17.06.2012
Ratnagiri, Maharastra	28.07.2012 & 29.7.2012
Arsikere, Karnataka	18.08.2012
Veppankulam & ARS Farm, Pattukkottai, TN	05.10.2012 to 07.10.2012
Navsari, Gujarat	28.11.2012
Pandirimamidi, AP	07.01.2013
Ambajipeta, AP	08.01.2013
Vijayarai, AP	11.01.2013
Pilicode, Kerala	22.02.103

Group Meeting:

XXI Annual Group Meeting

The XXI Annual Group Meeting of AICRP on Palms was held during 11-13 July, 2012 at Agricultural College and Research Institute, Madurai. The group meeting was attended by 80 delegates from 21 centres of AICRP on Palms, State Agricultural Universities, Central Plantation Crops Research Institute (CPCRI), Directorate of Oil palm Research (DOPR), Coconut Development Board and State Department of Horticulture covering 12 states of the country. The group meeting discussed the progress of ongoing research programmes in coconut, oil palm, palmyrah palm and fish tail palm (sulphi palm).

The inaugural session of the XXI biennial group meeting of AICRP on Palms commenced with the welcome address by Dr. N. Kumar, Dean (Horticulture), Tamil Nadu Agricultural University. Dr. H.P. Maheswarappa, Project Coordinator (Palms) presented the Coordinator's report narrating the salient findings and research achievements emanated from the All India Coordinated Research Project on Palms conducted in all the AICRP centres representing various agroclimatic zones. Dr. H.P. Singh, Deputy Director General (Hort.), ICAR, New Delhi inaugurated the session. In his address, he highlighted the importance of horticultural crops in improving the livelihood of people. However, challenge

Dr. H.P. Singh, Deputy Director General (Hort.), ICAR, New Delhi inaugurated the session

still lies to increase the production and productivity of crops like coconut and oil palm. Hybrid production could help to realize the yield potential of coconut and a public-private participatory approach would be the best strategy to achieve sustainability in production and distribution of quality planting materials. Also, productivity gain could be achieved through integrated cropping system. He emphasized that AICRP centres should focus their research activities on key aspects such as development of microbial consortium for disease management, recycling biomass in forms such as vermicompost, understanding the genotype and environment interactions in view of climate change and investigating the role of pollinators in improving productivity. Further, dynamics of pest and disease evolution with climate change should be addressed. With respect to oil palm, he enumerated that oil palm cultivation is turning out a success story in states like Andhra Pradesh. However regeneration and large scale multiplication of well performing parent materials *viz.,* Dura and Pisifera should be ensured for production of high yielding hybrids.

Dr. P. Subbian, acting Vice-Chancellor of Tamil Nadu Agricultural University presided over the function. In his presidential address, he emphasized that a new platform on natural fibres launched by ICAR in the XII five year plan would give more impetus to coconut cultivation. He also assured that TNAU would take efforts to promote area expansion in oil palm. He stressed that research should be focused on development of dwarf hybrids, improved tools and machineries for harvesting and standardizing the technology for value added products in palms. He also suggested that Killikulam centre could be recognized by ICAR as a national active germplasm site for palmyrah due to its potential contribution in palmyrah germplasm collection and conservation.

Dr.P. Rethinam, Former Executive Director of Asian Pacific Coconut Community offered felicitations. In his felicitation, he expressed that impact has to be made on the availability of quality planting materials of released cultivars to farmers. As ample opportunities exist for value addition in coconut, focus should be given to tap the export market potential for products such as coconut sweeteners, coconut milk, virgin coconut oil and coir based geotextiles. He also opined that oil palm which is a potential source of vegetable oil should receive more attention in the coming years.

During this session, English and Telugu versions of the technical bulletin on "Integrated Pest and Disease Management in Coconut" were released by Dr. H.P. Singh, Deputy Director General, ICAR, New Delhi and Dr. P. Rethinam, Former Executive Director (APCC). As a token of motivation and encouragement to the AICRP scientists, best AICRP award was given to HRS, Ambajipeta, for their excellent contributions in coconut research. The award was sponsored by Lt. Amith Singh Memorial Foundation, New Delhi. Dr. Vairavan, Dean, Agricultural college and Research Institute, TNAU, Madurai ended the inaugural session by proposing the vote of thanks.

Release of Publication

Best centre award to Ambajipeta

Stakeholders meet:

At the outset the DDG (Hort) briefed the idea of this stakeholders meet and requested to be very brief in highlighting the constraints in the industry and the expectations from the research group.

Dr. Maheswar, Additional Director of Horticulture (Oil palm Scheme), Govt of Karnataka explained the developmental activities by the department on the promotion of oilpalm in Karnataka and also explained on the constraints. He explained that a novel approach of GIS based land identification, formation of oil palm growers groups, incentives based on the production of FFB, publicity and SMS facilities. Publication of monthly calendar of operations and pert chart for oil palm developmental agencies are followed. On the constraints on development of new selections for drought tolerance Dr. P. Rathinam, Former ED, APCC told that the drought types identified from other sources can be obtained and evaluated by the DOPR. The DDG suggested to identify and allot a land for intensive breeding programmes and many constraints can be overcome by dovetailing the oilpalm promotion with already operating welfare schemes of the state government. DDG also suggested to go for immediate purchase of tools and equipments for harvesting through other state schemes.

Dr. Dundi, JDH (Plantation Crops), Govt. of Karnataka suggested to concentrate and work on pest and diseases of coconut and DDG advised to discuss with scientists and chart out new programmes if any needed.

The deliberations of the group were conducted in different technical sessions held from 11th to 13th and the salient decisions and recommendations were presented during the Plenary Session held on 13th July, 2012. The sessions dealt with aspects such as (1) Stakeholders meet, (2) Variety release proposal, (3) Deliberations and discussions on topical issues to address the challenges, (4) Crop improvement in coconut, oil palm & palmyrah, (5) Crop Production in coconut, oil palm & palmyrah, (6) Pest management in coconut, (7) Disease management in coconut and (8) Post harvest technology in palmyrah & project on sulphi palm. The technical sessions were chaired by eminent scientists in the respective fields.

The Plenary Session was chaired by Dr. George V. Thomas, Director CPCRI and Co-chaired by Dr. K. Vairavan, Dean, AC & RI, Madurai. Chairman welcomed the delegates and the guests and briefed about the proceedings of meeting. Project Coordinator (Palms) presented the salient recommendations and decisions taken during the deliberations followed by presentation of the technical programme for 2012-13, which was approved by the group meeting.

Major recommendations to be passed on to extension system:

- The hybrids like GBGD x LCOT, GBGD x PHOT and GBGD x FJT are performing well in Ambajipeta and Arsikere Centres. These hybrids can be proposed for release as a national hybrids.
- The following coconut based medicinal crop combinations could be recommended for commercial adoption at the respective regions.

  Ambajipeta - Palmarosa, mango ginger, patchouli, citronella.

  Aliyarnagar – *Alpinia galanga,* Lemon grass (*Cymbopogon flexuosus*), Patchouli.

  Arsikere – Lemon grass (*Cymbopogon flexuosus*), garden rue (*Ruta graveolens*), tulsi (*Ocimum sanctum*), kalmegh (*Andrographis paniculata*), arrow root (*Maranta arundinaceae*) and makoi (*Solanum nigrum*).

  Kahikuchi – Pipali, Patchouli, Citronella, Sarpagandha.

  Mondouri – Sarpagandha, Aswagandha, Arrowroot.

  Ratnagiri - Sathavari, Adulsa, Arrow root, Lemon grass, Citronella.

  Veppankulam – *Aloe vera*, *Alpinia galangal*, *Ocimum sanctum.*

  Jagadalpur: Stevia, Amahaldi, Sarpagandha, Tikhur, Patchouli.
- Study on defoliation of leaves of Palmyrah on yields, indicated that there has been significant increase in yield of both neera and nungu in male and female

trees, as compared to the control, when the trees were defoliated to the level of 30 percent.

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.

Interactive meeting of Scientists of AICRP on Palms-Oil palm centers and scientists of DOPR Pedavegi, Andhra Pradesh

The interactive meeting of scientists of AICRP on Palms - Oil palm centers & scientists of DOPR, was held on 10th January, 2013 at Directorate of Oil palm Research (DOPR), Pedavegi, Andhra Pradesh. The interactive meeting was attended by scientists from 6 centers of AICRP on Palms (Oil palm), Project Coordinator (Palms), CPCRI, Kasargod, Director DOPR and scientists of DOPR, Pedavegi. The meeting was convened mainly to discuss the progress of ongoing research programmes in Oil palm & methodologies to be adopted while taking observations and new experiments on Oil palm.

The Interactive Meeting was commenced with the brief about the meeting by Dr. B.N. Rao, Principal Scientist (Hort.). Dr. S. Arulraj, Director, DOPR welcomed all the scientists for the meeting and he stressed the need for increasing the productivity of oil palm along with area expansion at different parts of the country. Under XII Plan, the target yield to be increased to 200 to 250 kg/palm and there is need to establish some more seed gardens to meet the demand of sprouts. Scientists working in AICRP centers have to play a major role in transfer of technology programmes in coordination with State Govt. He pointed out that, Govt. of India could spend Rs. 40,000 crores during last year for importing vegetable oil. Hence, in order to reduce the import of vegetable oil, there is a vast scope for meeting the demand of the vegetable oil through intensive research and development activities in oil palm crop.

Interactive meeting at DOPR Pedavegi

- Later presentations were made by scientists from 6 centres of oil palm on brief work done under ongoing research projects. During the presentations, discussions were held on each project and suggestions were given by scientists of DOPR, Pedavegi.

After the presentations, Director, DOPR emphasized to prioritize oil palm improvement programmes at each centre as there is need to evolve new improved varieties of oil palm and improvement of *Dura*, *Tenera* and *Pisifera* for higher productivity was emphasised.

In his brief, Dr. Maheswarappa, H.P. highlighted the scope for evolving suitable cropping system during first 3 years of oil palm cultivation and hence experiments may be initiated as per the requirement in different centers. Then, he thanked Director & scientists of DOPR for making all arrangements for the meeting and sought the full cooperation in future also.

Post lunch session included the discussions on observations to be recorded in oil palm experimental plots on growth and yield parameters in order to have uniform recording of data. There was a discussion on Water Requirement of oil palm in different region, which needs to be worked out as per Pan Evaporation data. Hence, all the centers may calculate the water requirement accordingly and adopt in the region. The yield data of oil palm needs to be presented for a period of April to March (as per financial year) in all the centers. Later a visit was made to bunch analysis laboratory to know about the oil extraction and estimation.

XI. Extension and popularization of technologies

Ambajipeta

- Organized a three day cocoa training programme in collaboration with DCCD, Kochi from 11th to 13th September 2012 to selected cocoa farmers.
- Two on campus residential 6 days training programmes on Friends of Coconut Trees (FOCT) were conducted with the assistance of Coconut Development Board, Kochi for 40 rural unemployed youth from 28.12.2012 to 5.1.2013 and from 28.1.2013 to 2.02.2013, respectively.

Field day (Ambajipeta)

FOCT training at HRS (Ambajipeta)

Field day was organized by the Centre for the benefit of extension workers and farmers:

- Field day was organized on making organic compost using coirpith waste and vermicompost using coconut leaf on 22nd December, 2012.
- Field day was organized on 12th February, 2013 on coconut based integrated cropping system model.
- The scientists of AICRP on Palms Ambajipeta center imparted training on coconut production and protection technologies to thirty input dealers from Palakollu, West Godavari District on 14.09.2012.

Training programme on coconut at Sakhinetipalli

Arikere

Training programme on "Cultivation, post harvest technology and marketing of coconut/copra"

Training programme on "Cultivation, post harvest technology and marketing of coconut/copra" was organized at Horticulture Research Station, Arsikere on 19.01.2013 in collaboration with the Karnataka State Agricultural Marketing Board, Mysore Division, Mysore. Mr. Devaraju, President, Arsikere Taluk Coconut Growers Association inaugurated the programme. He stressed the need for better management of coconut gardens, value addition and good marketing facilities for coconut and copra to make coconut industry a profitable venture. Mr. Ashok Kumar, General Manager, KSAMB, Mysore presided over the function. Mr. Eshwarappa, Secretary, APMC, Arsikere spoke on the marketing and storage facilities available at Agriculture Produce Market Committees. Dr. T.B. Basavaraju, Agronomist & Head, delivered lecture on Cultivation practices and PHT of coconut, Dr. V. Devappa, Associate Professor of Plant Pathology on Pest & disease management in coconut

and Dr. M. Prashanth, Associate Professor (GPB) on Coconut based integrated farming systems. About 40 farmers participated in the training programme.

Training programme at Arisikere

Veppankulam

- A field day on Demonstration of technologies in coconut cultivation was organized in a farmer's field at Silambavelankadu village of Pattukkottai taluk in Thanjavur district. Dr. S. Thiruvarassan, Asst. Prof. (Agronomy) welcomed the gathering. Dr. C. Natarajan, Professor and Head, Coconut Research Station, Veppankulam inaugurated the programme. He stressed the need for adoption of high-tech cultivation methods in coconut growing. The performance of coconut hybrids in farmer's field was explained by Dr. M. Kavitha, Asst. Prof. (Horticulture). The importance of growing intercrops in coconut for profit maximization was briefed to the farmer's by Dr. S. Thiruvarassan, Asst. Prof. (Agronomy). Dr. K. Rajappan, Assoc. Prof. (Plant Pathology) elaborated the management of coconut diseases. Nutrient management in coconut was explained by Dr. S. Mohandas, Assoc. Prof. (SS&AC). Pest management techniques were demonstrated by Dr. K. Ganesan, Asst. Prof. (Entomology). Dr. S. Thiruvarassan, Asst. Prof. (Agronomy) demonstrated the pruning methodology for cocoa.

  Dr. M. Surulirajan, Asst. Prof. (Plant Pathology) demonstrated the root feeding methodology for basal stem rot disease in coconut. A few progressive farmers shared their experiences in coconut cultivation. The scientists clarified the queries raised by the participants farmer's in coconut cultivation. Around 50 coconut growers have participated in the field day.

Field day at Veppankulam

Visit of farmers to field (Veppankulam)

Aliyarnagar

Training on "Coconut based cropping system management and its benefits" was conducted at Coconut Research Station, Aliyarnagar on 01.02.2013

A one day training programme on "Coconut based cropping system management and its benefits" was conducted at Coconut Research Station, Aliyarnagar on 01.02.2013. This programme was organised so as to create awareness among the coconut growers about utilizing the coconut ecosystem in a better way to generate additional farm income apart from coconut. Information regarding the training, venue and time were communicated to the coconut farmers through local newspaper "Dinamalar" and through telephonic messages to farmer groups. A total of 50 farmers from

Pollachi participated in the training programme. The programme started with the welcome address by Dr. K. Rajamanickam, Professor (Entomology), the function was presided over by Dr. N. Shoba, Professor and Head. In her inaugural address, the need to integrate several components of crop management technologies was emphasised to make coconut cultivation, a highly remunerative enterprise. Following the inaugural address, a series of lectures were delivered on various coconut cultivation aspects.

During the morning session, lecture on the characteristic features of coconut tall and dwarf types and the need for selection of suitable coconut varieties and hybrids for improving coconut productivity was delivered by Dr. S. Geethanjali, Assistant Professor, (Plant Breeding and Genetics). Cocoa is going popular among farmers as a profitable intercrop due to the favourable climatic conditions existing in the coconut ecosystem. To insist upon this, an introduction to cocoa cultivation as an intercrop, covering its origin and distribution, cultivation aspects, market potential and benefits were elaborated by Dr. N. Shoba, Professor and Head. Pest and disease problems often pose serious threat to the successful cultivation of coconut and intercrops as well. Common pests and diseases encountered in the coconut fields along with the integrated management strategy to combat these biotic stresses were explained in detail by Dr. K. Rajamanickam, Professor (Entomology).

Dr. D. Rajakumar, Assistant Professor (Agronomy), in his lecture, demonstrated the vast potential for coconut based cropping system and management in improving not only the productivity but also the overall farm profitability. Effective utilisation of natural resources such as space, sunlight and water through suitable intercropping system comprising of annual, biennial and perennial crops over the different growth phases of coconut was highlighted. During field visits, the farmers were exposed to integrated management technologies in the intercropping, high density multi tier cropping and high density multi-species cropping systems maintained under AICRP-Palms trials.

Following field visits, an interactive discussion between farmers and scientists was held and feedback from farmers was obtained. The training programme ended with the vote of thanks proposed by Dr. D. Rajakumar, Assistant Professor (Agronomy).

Field visit by the farmers (Aliyarnagar)

Pandirimamidi

Field day conducted on neera processing on 06.12.12 for unemployed youth of tribal people

Training on neera tapping, and neera processing was given to Tribal youth of 35 members in collaboration with Integrated Tribal Development Agency (ITDA). They have shown very much interest on the neera processing as they knows only toddy from palmyrah and felt happy to drink sweet neera and asked for cost of the unit and processing details etc. some of them has shown interest to start industry in small scale in their villages if any financial assistance provided by ITDA.

Field day on neera tapping for youths (Pandirimamidi)

Jagadalpur

Field Day on Coconut

A Coconut field day was conducted in different districts of Bastar viz; Jagdalpur on dated 03 August and 12 December 2012, Bastar on dated 17-18 January 2013, Bijapur on dated 5-6 February 2013 and Narayanpur on dated 19-20 February 2013 and more than 100 farmers were actively participated in the training on different aspects of Coconut and intercropping in coconut as well as on sulphi palm. The coconut seedlings were also distributed to the farmers during the training programme.

Distribution of coconut seedlings to tribal farmers

Visits of Shri. Sharad Pawar, Union Agriculture Minister, Dr. Raman Singh, C.M. of Chhattisgarh & Dr. S. Ayyappan, DG, ICAR

XII. Publications

AICRP on Palms, 2012. Annual Report for 2011-12. All India Coordinated Research Project on Palms. (Eds, Maheswarappa, H. P., V. Krishnakumar and George V. Thomas). 96p.

AICRP on Palms, 2012. Proceedings and Recommendations of XXI Annual Group meeting. (Eds., Maheswarappa, H. P.). 96 p.

Aliyarnagar

Research articles in journals:

Ramjegathesh, R., Karthikeyan, G., Rajendran, L., **Johnson, I.**, Raguchender, T. and Samiyappan, R. 2012. Root (wilt) disease of coconut palms in South Asia – An overview. *Archives of Phytopathology and plant protection* **50** (20): 2485 – 2493.

Papers presented in conferences/seminars:

Johnson, I., Meena, B., Rajamanickam, K. and Sheela, J. 2012. Biological management of leaf blight disease of coconut using rhizosphere microbes. In: Abstracts of papers PLACROSYM XX Dec. 12-15, 2012. pp. 157.

Rajamanickam, K., Johnson, I. and Subaharan, K. 2012. Evaluation of egg larval predator anthocorid bug, *Cardiostethus exigus* Poppius against *Opisina arenosella* in Tamil Nadu. In Abstracts of papers PLACROSYM XX Dec. 12-15, 2012. pp. 177.

Rajakumar, D., Sathiyamoorthy, K., Arulraj, S. and Maheswarappa, H.P. 2012. Increasing the coconut productivity through drip fertigation technology. In: Abstracts of papers – PLACROSYM XX, December 12-15, 2012, pp.100.

Subaharan, K., Eswarmoorthy, M., Pavan Kumar, B.V.V.S., Vibina Venugopal, Chalapathi Rao, N.B.V., Gurav, S.S., Rajamanickam, K., Ganesan. S., and Raveendran, P. 2012. Nanomatrix for delivery of ethyl 4-methyl octonate, the pheromone of coconut rhinoceros beetle, *Oryctes rhinoceros*. In Abstracts of papers PLACROSYM XX, December 12-15, 2012. pp.113.

Booklets/Folders/Extension pamphlets:

Geethanjali, S., Rajakumar D., Shoba, N., and Rajamanickam, K. 2013. TNAU Coconut ALR 3 – A promising genotype for tender coconut.

Rajamanickam, K., Srinivasan, T., Johnson, I., Sheela J., and Shoba, N. 2013. Coconut black headed caterpillar management.

Ambajipeta:

Research Articles in Journals:

Chalapathi Rao, N.B.V, Snehalatharani, A. and Emmanuel, N. 2012. New report of *Paecilomyces lilacinus,* an entomopathogenic fungi on slug caterpillar of coconut. *Insect Environment* 17(4) 151-152.

Papers presented in conferences / seminars:

Chalapathi Rao, N.B.V, Snehalatharani, A. and Emmanuel, N. 2012. New record of promising entomopathogenic fungi on leaf eating caterpillars of coconut in Andhra Pradesh In: Abstracts of National Symposium on Ecofriendly Approaches to Pest Management for Sustainable Agriculture. OUAT, Bhubaneswar, Odisha 24th – 25th November, 2012. P.51-53.

Chalapathi Rao, N.B.V, Emmanuel, N. and Ramanandam, G. 2012. Status of coconut eriophyid mite and other emerging pest problems in coconut in Andhra Pradesh. In: Abstracts of National Symposium on Ecofriendly Approaches to Pest Management for Sustainable Agriculture. OUAT, Bhubaneswar, Odisha 24th – 25th November, 2012. P.1-3.

Chalapathi Rao, N.B.V, Emmanuel, N. and Maheswarappa, H.P. 2012. Impact of olfactory conditioned parasitoid *Goniozus Nephantidis* (Musebeck) in suppression of Coconut Black headed caterpillar *opisina arenosella* walker under field conditions in East Coast of Andhra Pradesh In: Abstracts of Papers PLACROSYM XX, Coimbatore, Tamil Nadu, 12-15th December, 2012.P.119-120.

Kalpana, M, Reddy, R.V.S.K, Gautham, B, Srinivasulu, B. Dorajee Rao, A.V.D, Rama Krishna, M. Padma, E. and Maheswarappa, H.P. 2012. Performance of Pre released F1 Cross combinations of Coconut in Andhra Pradesh. In: Abstracts of Papers PLACROSYM XX, Coimbatore, Tamil Nadu, 12-15th December, 2012. P.30.

Chalapathi Rao, N.B.V., Emmanuel, N. and Maheswarappa, H.P. 2012. Performance of medicinal and aromatic crops as intercrops in coconut gardens in East Godavari area of Andhra Pradesh. Impact of olfactory conditioned parasitoid *Goniozus Nephantidis* (Musebeck) in suppression of Coconut Black headed caterpillar *opisina arenosella* walker under field conditions in East coast of Andhra Pradesh In: Abstracts of Papers PLACROSYM XX, Coimbatore, Tamil Nadu, 12-15th December, 2012. P. 119-120.

Snehalatha Rani, A. Pushpa Rajyam, B. and Maheswarappa, H.P. 2012. Isozyme based diversity analysis studies of *Ganoderma* isolates of coconut from Andhra Pradesh. In: Abstracts of Papers PLACROSYM XX, Coimbatore, Tamil Nadu, 12-15th December, 2012. P.98.

Folders/Extension Pamphlets

Ramanandam, G., Chalapathi Rao, N.B.V., Padma, E. and Snehalatha Rani A. Scientific management practices for Coconut (pamphlet in telugu).

Ramanandam, G.,Chalapathi Rao, N.B.V. Padma, E. and Snehalatha Rani A. Scientific management in Cocoa (pamphlet in telugu).

Chalapathi Rao, N.B.V. and Ramanandam, G.2012. Integrated management practices for the control of coconut Slug caterpillar (pamphlet in telugu).

Chalapathi Rao, N.B.V, Ramanandam, G. and. Padma. E, Coconut black headed caterpillar management on fish pond bunds. (pamphlet in telugu).

Chalapathi Rao, N.B.V. and Ramanandam, G. Management of Slug caterpillar with light traps in coconut. (pamphlet in telugu).

Popular Articles in Newspapers / Magazines, etc.:

Padma, E., Ramanandam, G.,Kalpana, M., Chalapathi Rao, N.B.V., Emmanuel, N. and Snehalatha Rani, A. 2012. Kobbarilo naanyamaina mokkala utpathi. (Quality planting material production in coconut) In: Bharatiya Kobbari Patrika (Indian Coconut Journal) 8: P.4-9. (Telugu).

Ramanandam, G.,Padma, E.,Kalpana, M., Chalapathi Rao, N.B.V., Emmanuel N. and Snehalatha Rani, A.2012. Kobbari – Rakalu (Coconut – Varieties). In: Bharatiya Kobbari Patrika (Indian Coconut Journal) 8: 10-18. (Telugu).

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Chalapathi Rao, N.B.V., Emmanuel, N. and Padma, E. 2012. Kobbarini nashtaparache kshiradalu (yelukalu, gabbilalu) – nivarana padhathulu (Damage in coconut by Mammals (rats and bats) and their control) In: Bharatiya Kobbari Patrika. (Indian Coconut Journal) 8: 26-27. (Telugu).

Chalapathi Rao, N.B.V. and Emmanuel, N. 2012. Kobbarini kothaga aasisthunna Phalacra jaathi gomgali purugu – nivarana charyalu (New incidence of *Phalacra* caterpillar in coconut and its control) In: Bharatiya Kobbari Patrika. (Indian Coconut Journal) 8: 28-29. (Telugu).

Kalpana, M. Ramakrishna, Y. Dorajee Rao, A.V.D. 2012. A study on consumption of tender coconuts in Andhra Pradesh In: Swarna Sedyam- July- (Monthly journal Telugu): 51-52.

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Gautam, B. Ramakrishna, Y. Kalpana, M. 2012. Kobbari Thotallo misrama pantalu (Mixed cropping in coconut), In : Annadatha (Monthly journal Telugu - October,) P: 28-30.

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gical control of Rhinoceros beetle in coconut) In : Annadata (Monthly journal Telugu -March,) P.58-60.

Arsikere

A. Research papers

Basavaraju, T.B., Nanjappa, H.V. and Indiresh, K.M., 2012, Integrated nutrient management in Kalmegh (*Andrographis paniculata* Nees.) as intercrop in coconut garden. *Mysore J. Agric, Sci.,* 46 (2): 251-258.

Basavaraju, T.B., Nanjappa, H.V. and Umesha, K., 2012, Influence of integrated nutrient management practices on growth and yield of holy basil (*Ocimum sanctum* L.) intercropped with coconut. *Mysore J. Agric, Sci.,* 46 (3): 567-572.

Basavaraju, T.B., Nanjappa, H.V. and Indiresh, K.M., 2012, Dry matter accumulation and nutrient uptake in Kalmegh (*Andrographis paniculata* Nees.) intercropped in coconut garden as influenced by integrated nutrient management practices. *Mysore J. Agric, Sci.,* 46 (3): 658-660.

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Basavaraju, T.B., Nanjappa, H.V. and Indiresh, K.M., 2012, Influence of integrated nutrient management on dry matter accumulation and nutrient uptake in holy basil (*Ocimum sanctum* L.) as intercrop in coconut garden. *Mysore J. Agric, Sci.,* 46 (4): 920-923.

Palanna, K.B., Boraiah, B., Nagaraj, M.S., Basavaraju, T.B., and Thyagaraj, N.E., 2012, Etiology and epidemiology of Ganoderma wilt of coconut in dry tract of southern Karnataka. *Journal of Plantation Crops*, 40 (3): 153-157.

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Basavaraju, T.B., Bhagya, H.P., Prashanth, M., Arulraj, S. and Maheswarappa, H.P., 2012, Response of coconut to fertigation in *maidan* tract of Karnataka. In: Abstract of papers *PLACROSYM XX* held at UPASI Tea Research Foundation, Coimbatore during 12-15, December 2012, pp 71-72.

Indiresh, K.M., Basavaraju, T.B., Umeesha, K., Santhosha, H.M. and Jyothi, H.K., 2012, Coconut biodiversity in Dakshina Kannada District of Karnataka. In: Abstract of papers *PLACROSYM XX* held at UPASI Tea Research Foundation, Coimbatore during 12-15, December 2012, pp 20.

Prashanth, M., Basavaraju, T.B., Arulraj, S., Maheswarappa, H.P., Devappa, V. and Bhagya, H.P., 2012, Performance of different hybrids of coconut in *maidan* tract of Karnataka. In: Abstract of papers *PLACROSYM XX* held at UPASI Tea Research Foundation, Coimbatore during 12-15, December 2012, pp 27.

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Basavaraju, T.B., Palanna, K.B., Prashanth, M. and Bhagya, H.P., 2012, Major diseases of coconut and their integrated management (In Kannada). *Krishi Vignana*: Quarterly Kannada magazine, 36 (1): 1-3.

Basavaraju, T.B., Prashanth, M. and Bhagya, H.P., 2012, Nutrient management in coconut crop (In Kannada). *Krishi Vignana*: Quarterly Kannada magazine, 36 (2): 15-17.

Basavaraju, T.B., Prashanth, M. and Bhagya, H.P., 2012, Mixed crops in coconut garden (In Kannada). *Udyana Loka*: Quarterly Kannada magazine, 2 (1): 6-8.

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Bhubaneshwar:

Book chapters

Sahoo, S.C. and S.C. Swain. 2012. Coconut Farming: A Safe and Sustainable Horticulture. In: *Sustainable Horticulture–Development and Opportunities*. (Eds. Swain, S.C. and Patra, L.). Manglam Publishers & Distributors. New Delhi.

Gangavathi

Papers presented in conferences/seminars:

Sanjeevraddi G. Reddi., Patil D.R. and Mastana Reddy B.G. 2012. Comparative performance of different hybrid combinations of oil palm under Tungabhadra Command area of Karnataka, *Global conference on Horticultural crops for food, nutrition and lively hood options* held at May-28-31. Orissa University of Agriculture and Technology. Bhubanesrwar, odisha, India. *pp:77.*

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Sanjeevraddi G. Reddi,. Patil D.R,,.Maheshwarappa H.P. and.Mastana Reddy B.G.2012. Evaluation of African Oil Palm germplasm for drought tolerance. In Abstract of Papers *PLACROSYM-XX* Coimbatore, TN. *pp:20.*

Leaf lets/Folders

Sanjeevraddi.G.Reddi., D.R.Patil, B.G.Mastana Reddy and Chandravathi.B.2012. **"Tale Bele Krishi"** Folder was Published in Krishimela 2012-13 of ARS, Gangavathi,UAS,Raichur on 24 th -25 th November-2012.

Popular articles in news papers, magazines etc.

Sanjeevraddi G.Reddi and D.R.Patil. 2012. "Vishwasarha Adayakke Yenne Tale" Published in Annadata Monthly Magazine (Kannada), November -2012. pp:48, 52-53.

Sanjeevraddi G.Reddi and D.R.Patil. 2012. "Oil palm – harvesting and post harvest issues" Published in Annadata Monthly Magazine (Kannada), December -2012. pp:13-15.

Sanjeevraddi G. Reddi and D.R. Patil. 2013. "Importence of oil palm" Published in Monthly Magazine Krishi Munnade (Kannada), Februvary-2013 UAS, Dharwad. pp:8-11.

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Kahikuchi

Research papers:

Nath, J.C., Arulraj, S and Maheswarappa, H.P. 2012. Integrated nutrient management in COD x WCT hybrid coconut in alluvial clay-loam soil of Assam. *J. Plantn. Crops* 40(2):105-110.

Booklet/Bulletin:

Nath, J.C. 2011-12. Improved production technology of Coconut.

Nath, J.C. 2011-12. Nursery raising in Coconut.

Ratnagiri

Papers presented in conference / Seminars :

Borate, H.V. Malshe, K.V. Desai, B.G. Nagwekar, D.D. and Gurav, S.S. 2012. Studies On Consumption Pattern Of Coconut In Thane District Of Maharashtra. Abstract pubished in National Seminar on *"Technologies for Sustainable Horticulture in Rainfed Areas"* January 20-21, 2012 : 37.

Samdudeen, K., Rajesh, M.K., Nagwekar, D.D., Rashmi Ranghavn, Ajith Kumar, P, Devadas, K. and Anitha Karun. 2012. Genetic diversity in *Mohachao narel*, a sweet endosperm coconut population from Maharashtra. Abstract published in PLACROSYM XX Mechanisation for sustainable productivity December 12-15, 2012. pp: 16.

Gurav, S.S., Desai, V.S., Nagwekar, D.D. and Narangalkar, A.L. 2012. Field efficacy of commercially available pheromones for the management of red palm weevil *Rhynchophorus ferrugineus* Oliv. Of coconut. Abstract published in PLACROSYM XX Mechanisation for sustainable productivity December 12-15, 2012. pp. 109.

Pandirimamidi

Papers presented in conferences/seminars

Vengaiah, P C, Murthy, G. N., Prasad, K .R. 2013. Dehydration characteristics of Palmyrah tuber flour. 47th annual convention of ISAE (Indian Society of Agricultural Engineers), during 28-30 January, 2013, ANGRAU, Hyderabad, India.

Vengaiah, P C, Murthy, G. N., Prasad, K .R,, Kumari, K. U. 2013. Effect of processing on nutritional values of palmyrah (*Borassus flabellifer* L) tuber flour. "3rd Incoftech 2013'" International conference on food technology, 4-5, January, 2013 at IICPT. Thanjvur, India.

Murthy, G. N., Vengaiah, P. C,, Prasad, K .R., Kumari, K U, and Arulraj, S. 2012 Effect of defoliation on neera and nungu yield. In: Abstract of papers PLACROSYM XX, 12-15 December, 2012 at Coimbatore, India.

Vengaiah, P. C., Murthy, G .N., Prasad, K .R. Kumari, K U, and Arulraj, S. 2012. Value addition in Palmyrah-(*Borassus flabellifer* L) -Present Practices and Scope. In: Abstract of papers PLACROSYM XX, 12-15 December, 2012 at Coimbatore, India.

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Vengaiah, P.C., Murthy, G.N., Prasad, K.R., Kumari, K.U. 2012. Post harvest technology of Palmyrah (*Borassus flabellifer* L). Present Practises and Scope. International conference on food processing by omics group 22-24, November, 2012 at Hyderabad, India.

Popular articles in newspapers, Magazines

Vengaiah, P.C., Ravindra, D., Murthy, G.N., Prasad, K.R. and Usha, K.U., 2012, Tatibellam tayarilo melukubalau (Precautions to be taken while preparing jaggery from Palmyrah), Rytunestam, April 2012.

Vengaiah, P.C., 2013. Pandirimamidi lo tati meda utpattulapi parisodhanalu (Research on value added products from palmyrah at pandirimamidi). Sakshi daily. 26.03.13.

Veppankulam

Research articles:

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 symposia:

Thiruvarassan, S., Ganesan, K., Kavitha, M. Natarajan, C., Arulraj, S. and Maheswarappa, H.P. 2012. Performance of medicinal and aromatic plants as intercrops in coconut. In Abstract of papers PLACROSYM XX, 12-15 December, 2012 at Coimbatore, India. Pp.22.

Kavitha, M., Natarajan, C., Ganeshamurthy, K., Yuvraja, A. and Arulraj, S. 2012. D^2 diversity analysis in coconut germplasm. In: Abstract of papers PLACROSYM XX, 12-15 December, 2012 at Coimbatore, India. Pp. 72.

Popular articles in news papers, magazines

Surulirajan,M. and Rajappan.K. 2012. Bordeaux mixture to control coconut infestations. The Hindu 06.09.2012. P. 17.

XIII. Staff Position

HEAD QUARTERS

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Senior Scientist (Pathology)	:	Vacant
Scientist (Pathology)	:	Dr. A. Snehalatha Rani
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Jr. Entomologist	:	Sri. S.S. Gurav
Senior Clerk	:	Smt. S.S. Pednekar
Junior Agricultural Assistants	:	Mr. P.A. Shinde and Mr. H.B. Yadhav

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Scientist (Agronomy)	:	Sri. M.S. Gawankar
Senior Technical Assistant	:	Sri. Kharjiwkar (from 10.09.2012)
Field Assistant	:	Sou. R.S. Gunjal

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/Dr. S.C. Sahoo (wef: 05.07.2012)
Technical Assistant	:	Sri. 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	:	Sri. Panchalingam

Tamil Nadu Rice Research Institute, Aduthurai -612 101, Thanjavur Dist.

(Shifted to Agricultural Research Station, Pattukkottai – 614 602 Thanjavur Dist. from November, 2012) (Phone: 04373-235832)

Scientist (Agronomy) Professor	:	Dr. P. Devasenapathy/Dr. C. Natarajan (At Pattukkottai- w.e.f.: 01.11.2012)
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. M. Kavitha / Dr. P. Balasubramani (wef 05-12-2012)
Senior Scientist (Agronomy)	:	Dr. S. Thiruvarassan
Senior Scientist (Plant Pathology)	:	Dr. K. Rajappan
AAO		Th. B.Sundai
Junior Assistant		Sri. R. Saravanan
Office Assistant		Sri. 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/Dr. P. Aruna (wef 14-12-2012)
Scientist (Agrl. Food Processing Engineering)	:	Dr. I. Seegan Paul/Er. I. P. Sudagar (wef: 12-11-2012)
Technical Assistant	:	Sri. 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)	:	Sri. D.K. Ghosh
Technical Assistant	:	Sri. A.K. De

XIV. Weather data of Co-ordinating centres (January to December 2012)

COCONUT CENTRES

Aliyarnagar

Month	Temperature (°C)		RH (%)		Rainfall	Evaporation
	Max.	Min.	FN	AN	(mm)	(mm)
January	29.1	17.6	91.8	84.5	-	4.0
February	32.9	21.2	91.3	74.0	-	5.2
March	35.3	22.9	90.7	64.6	-	6.6
April	34.9	24.9	93.3	65.4	79.4	6.1
May	34.2	25.9	91.0	67.6	5.4	5.4
June	31.1	24.8	87.0	76.0	30.7	6.3
July	31.1	25.2	92.0	85.0	24.1	4.9
August	32.2	25.6	91.0	83.0	95.8	4. 6
September	30.4	26.9	89.0	84.0	11.3	3.5
October	31.3	25.0	89.0	88.0	283.3	2. 7
November	31.9	23.4	90.5	84.1	97.0	3.2
December	30.8	24.5	86.6	84.8	11.0	3.8
				Total	638.0	

Ambajipeta

Month	Temperature °C		R H (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	29.4	20.6	80.4	53.1	-
February	26.3	20.6	83.6	38.6	-
March	33.3	24.2	85.8	48.3	-
April	36.2	26.9	78.9	47.4	-
May	39.4	28.2	78.8	50.1	14.0
June	36.2	26.6	74.6	51.9	40.2
July	30.9	25.9	87.5	72.2	163.6
August	32.0	24.9	80.0	66.3	184.6
September	31.8	25.0	88.5	66.1	217.8
October	32.7	23.6	81.9	59.4	173.4
November	30.8	22.5	81.9	55.6	265.0
December	30.0	19.9	79.9	43.9	-
				Total	1058.6

Arsikere

Month	Temperature (°C)		Rainfall (mm)	R H (%)
	Max.	Min.		
January	29.2	11.2	-	50.4
February	31.0	12.3	-	49.9
March	34.3	15.7	-	47.6
April	34.3	15.4	141.8	57.7
May	33.7	16.8	9.8	61.1
June	31.8	16.0	4.0	64.3
July	31.0	15.9	37.4	66.8
August	30.5	14.3	48.8	72.0
September	31.3	13.0	44.6	67.8
October	30.8	11.2	15.6	65.0
November	29.4	12.3	64.0	60.5
December	30.0	11.9	-	57.2
		Total	366.0	

Bhubaneshwar

Month	Temperature (°C)		R H (%)		Rainfall (mm)	No. of rainy days	Bright sun shine hours	Evapo-ration (mm/day)
	Max.	Min.	FN	AN				
January	28.7	16.3	90.7	51.4	44.4	3	6.1	3.3
February	33.1	16.9	89.2	34.5	-	-	7.8	4.0
March	37.4	22.8	94.4	34.5	-	-	6.6	5.6
April	38.2	25.1	88.4	52.4	85.9	5	7.0	7.3
May	39.3	27.2	88.2	49.3	12.2	2	7.8	9.0
June	37.6	26.8	88.1	59.6	117.2	11	2.9	6.3
July	32.2	25.1	94.4	81.6	405.5	22	2.3	3.1
August	32.0	25.2	93.7	81.4	255.3	20	4.0	3.2
September	32.4	25.3	93.7	78.7	110.6	17	4.0	3.3
October	32.1	22.6	91.4	68.4	61.6	7	6.7	3.5
November	29.7	19.1	93.2	62.2	134.9	6	5.8	3.4
December	29.9	15.3	93.0	44.0	-	-	7.6	3.8
				Total	1227.6	93		

Jagadalpur

Month	Temperature (°C)		Rainfall	R H (%)		Wind Velocity	Evapo-ration	Bright sunshine hours
	Max.	Min.	(mm)	FN	AN	(Kmph)	(mm)	
January	26.7	10.5	39.4	90	50	3.5	2.5	6.7
February	31.5	11.7	0.0	88	42	0.0	5.4	8.5
March	35.2	14.3	1.8	86.9	32.6	4.2	6.5	8.8
April	35.8	20.3	87.7	86.1	45.3	6.7	7.1	8.1
May	39.1	38.5	25.8	69.6	25.8	5.9	7.2	6.7
June	33.6	23.7	157.2	69.4	46.5	7.3	5.4	4.8
July	26.8	21.4	399.8	91.9	74.8	6.5	2.0	1.4
August	31.0	21.2	486.7	91.7	74.6	5.3	1.1	2.0
September	28.4	21.2	424.8	90.6	64.7	3.5	1.5	3.5
October	30.4	18.5	54.4	90.3	48.3	2.9	2.7	7.2
November	28.6	14.9	20.9	89.9	47.0	2.3	2.8	6.4
December	29.4	10.8	0.0	88.6	35.0	2.2	3.4	8.9
		Total	1698.5					

Kahikuchi

Month	Temperature (° C)		R H (%)		Rain fall (mm)
	Max.	Min.	FN	AN	
January	24.6	9.9	91	74.0	7.2
February	26.6	12.9	78.0	54.0	0.0
March	29.3	16.6	70.0	53.0	12.5
April	31.5	20.2	72.0	60.0	53.5
May	32.8	22.9	79.0	68.0	132.7
June	32.3	25.6	87.6	84.8	231.0
July	33.6	26.2	90.5	86.4	190.9
August	33.8	25.9	88.5	85.6	388.1
September	31.3	24.9	85.5	81.0	227.2
October	28.9	22.3	83.0	80.0	53.2
November	27.1	15.2	81.5	80.1	0.0
December	24.2	11.9	87.8	85.0	0.0
				Total	1296.3

Mondouri

Month	Temperature (° C)		R H (%)		Rain fall (mm)
	Max.	Min.	FN	AN	
January	23.5	13.2	95.6	60.8	57.0
February	28.9	14.0	90.4	42.9	11.8
March	34.4	20.6	87.9	36.8	0.0
April	36.1	24.2	89.4	49.0	36.0
May	36.7	26.6	90.4	55.3	93.5
June	35.4	27.6	91.0	68.3	183.6
July	32.3	26.5	95.3	81.1	264.0
August	32.3	26.4	96.4	79.5	203.3
September	32.6	26.0	96.6	76.3	278.8
October	33.5	22.5	92.7	59.5	29.0
November	29.5	17.3	93.0	55.4	50.2
December	25.3	11.7	95.3	59.1	7.3
				Total	1214.5

Navsari

Month	Temperature (°C)		R H (%)		Rainfall	Rainy days
	Max.	Min.	FN	AN	(mm)	
January	28.8	12.3	81	55	-	-
February	31.8	13.5	71	26	-	-
March	34.9	16.5	79	23	-	-
April	35.8	23.0	85	43	-	-
May	33.9	26.2	81	57	6	1
June	31.1	27.0	84	68	155	9
July	30.7	26.3	92	83	271	19
August	30.0	25.6	93	83	200	15
September	30.2	24.5	93	76	618	16
October	34.9	22.1	80	47	12	2
November	33.1	14.8	73	31	-	-
December	31.7	16.4	72	34	-	-
				Total	1262	62

Pilicode

Months	Temperature (°C)		R H (%)	Number of	Rainfall
	Max.	Min.		rainy days	(mm)
January	32.0	19.5	69.0	0	0.0
February	32.9	20.9	70.0	0	2.2
March	33.0	23.0	70.0	1	2.6
April	33.9	22.6	72.0	6	52.6
May	33.1	24.6	73.0	3	86.6
June	30.0	23.0	70.0	27	904.9
July	30.0	22.0	88.5	28	516.6
August	29.0	23.0	89.0	27	879.5
September	30.0	23.0	81.0	20	352.5
October	32.0	23.0	79.0	10	134.1
November	32.0	22.0	75.0	7	77.5
December	33.0	21.0	72.0	0	0.0
			Total	129	3009.1

Ratnagiri

Months	Temperature (°C)		R H (%)		Rainfall	Rainy days
	Max.	Min.	FN	AN	(mm)	
January	30.6	16.2	69.6	53.5	0	0
February	32.8	17.3	61.4	53.3	0	0
March	31.4	19.1	74.7	62.9	0	0
April	33.0	23.5	75.7	68.3	0	0
May	30.0	24.1	73.6	68.4	1.4	1
June	30.9	23.2	87.2	80.1	759.8	25
July	29.2	23.0	90.3	87.9	1286.9	31
August	29.1	23.0	88.4	85.2	552.7	29
September	29.8	22.2	88.9	83.4	6.1	4
October	33.2	21.5	73.2	71.6	192.0	11
November	33.3	19.3	70.3	60.6	0	0
December	33.3	17.6	64.5	58.1	0	0
				Total	2798.9	101

Sabour

Month	Temperature (°C)		R H (%)		Rainfall	Wind	No. of
	Max.	Min.	FN	AN	(mm)	velocity (Kmph)	rainy days
January	20.6	9.2	90.5	65.0	18.0	3.4	4.0
February	25.8	9.9	79.5	41.5	0.0	4.3	0.0
March	31.1	14.3	67.7	35.9	3.5	4.0	2.0
April	35.3	20.9	63.1	42.9	6.5	7.2	3.0
May	37.6	24.1	64.1	43.0	35.5	7.0	2.0
June	37.5	26.5	77.6	53.0	27.4	8.1	4.0
July	32.3	25.2	87.0	76.4	277.4	6.8	24.0
August	31.8	25.5	87.3	74.7	140.8	6.6	17.0
September	31.0	24.5	90.5	79.2	102.1	5.5	12.0
October	30.8	19.6	87.5	65.0	41.0	2.3	4.0
November	27.0	12.4	88.0	51.0	14.8	2.1	2.0
December	21.0	8.6	95.8	64.9	0.0	3.1	0.0
				Total	667		74

Veppankulam

Month	Temperature (° C)		R H (%)	Rain fall	Evaporation
	Max.	Min.		(mm)	(mm)
January	30.5	20.6	89	-	2.5
February	31.6	21.5	80	6.2	3.6
March	33.0	26.4	78	-	3.9
April	34.6	26.8	74	24.0	4.2
May	35.7	27.8	74	-	4.2
June	36.8	30.1	80	8.4	4.0
July	33.8	30.4	77	13.0	3.0
August	36.5	30.3	80	38.8	3.2
September	37.0	32.2	85	73.8	2.6
October	34.4	26.7	89	188.6	2.7
November	30.5	25.2	92	89.5	2.0
December	37.6	28.5	94	7.8	3.0
			Total	419.9	

OILPALM CENTRES

Aduthurai

Month	Temperature (° C)		R H (%)	Rainfall	Evaporation
	Max.	Min.		(mm)	(mm)
January	29.7	19.2	96	3.6	3.4
February	32.2	19.7	95	0.0	4.6
March	35.0	22.0	94	5.6	5.6
April	36.8	24.7	87	0.0	6.1
May	37.9	26.0	77	29.4	6.9
June	37.2	25.7	71	27.6	8.3
July	34.7	24.9	79	32.2	6.9
August	34.5	24.6	79	21.4	6.2
September	35.7	24.7	84	124.4	5.4
October	31.4	23.9	92	415.0	3.4
November	30.8	22.6	89	87.6	3.7
December	29.4	21.8	94	30.4	5.5
			Total	777.2	

Gangavathi

Months	Temperature (° C)		Rainfall	R H (%)	
	Max.	Min.	(mm)	FN	AN
January	28.6	13.6	0	78	61
February	31.9	14.9	0	75	58
March	35.2	16.4	0	72	55
April	37.3	20.2	17.8	74	42
May	36.9	23.2	0	83	72
June	36.5	26.6	8.3	73	73
July	32.9	23.7	29.5	81	72
August	31.8	22.7	78.0	87	82
September	30.8	22.0	78.8	84	84
October	30.0	20.7	63	74	64
November	28.8	17.8	97	71	59
December	30.5	15.3	0	68	54
		Total	372. 3		

Madhopur

Months	Temperature (° C)		Rain fall	R H (%)
	Max.	Min.	(mm)	
January	20.7	9.6	-	87.9
February	29.2	13.9	1.3	85.8
March	34.5	19.4	3.8	75.8
April	38.5	24.9	12.7	70.8
May	42.9	27.9	25.4	65.3
June	40.7	29.5	105.7	77.1
July	36.8	28.0	471.9	81.9
August	39.1	28.5	236.3	79.6
September	37.9	27.1	516.6	80.6
October	38.2	23.6	-	81.2
November	33.2	16.3	-	80.9
December	22.7	12.2	-	87.9
		Total	1373.7	

Mulde

Month	Temperature (°C)		R H (%)		Wind speed	Sunshine (hrs)	Evapo-ration	Rainfall (mm)	Rainy days
	Max.	Min.	FN	AN	(kmph)		(mm)		
January	33.6	15.4	86	45	1.1	8.5	2.8	0	0
February	35.6	15.4	89	39	1.2	9	3.5	0	0
March	35.5	20.0	89	47	2.3	9.2	5.2	0	0
April	36.3	23.6	83	52	1.8	7.7	4.7	0	0
May	36.1	24.9	81	52	2.3	8.7	5.2	0	0
June	31.6	23.5	91	79	1.9	4.2	3.6	897.0	22
July	29.2	23.9	94	88	1.9	1.9	2.8	1018.8	31
August	29.3	23.7	93	87	1.9	2.6	3	837.9	26
September	30.1	23	93	79	1.6	2.9	2.9	461.9	21
October	33.5	22	90	62	0.6	6	3.1	184.5	11
November	34	19.9	91	51	0.4	7.1	2.8	4.0	1
December	35	19.8	88	52	0.7	8.3	3	0	0
							Total	3404.1	112

Vijayarai

Months	Temperature (° C)		R H (%)	Rainfall (mm)
	Max.	Min.		
January	32.8	24.9	70.4	44
February	34.1	24.3	64.3	0
March	37.5	21.3	66.7	0
April	39.3	19.2	63.4	0
May	41.0	21.3	64.4	48.9
June	40.9	22.3	58.4	198.4
July	37.2	21.0	71.6	360.8
August	36.6	21.8	74.5	402.5
September	36.5	18.2	75.3	193.6
October	35.9	22.9	71.6	191.0
November	34.6	24.0	71.5	173.4
December	33.8	24.6	68.4	0
			Total	1612.6

PALMYRAH Centres

Killikulam

Month	Temperature (° C)		R H (%)	Rainfall	Rainy
	Max.	Min.		(mm)	days
January	31.2	19.8	93.3	19.2	3
February	33.5	21.5	91.3	-	-
March	35.5	22.8	91.8	14.2	4
April	36.2	24.3	90.2	55.2	4
May	39.0	25.8	82.5	-	3
June	37.7	25.9	82.1	1.0	-
July	37.2	26.6	89.3	13.4	11
August	37.2	25.8	90.4	1.4	1
September	37.6	25.9	94.0	152.2	10
October	33.6	24.0	94.0	152.2	10
November	31.7	22.9	96.4	154.8	6
December	30.6	21.1	96.2	70.2	7
			Total	545.2	45

Pandirimamidi

Month	Temperature (°C)		R H (%)		Rainfall	No. of
	Max.	Min.	FN	AN	(mm)	Rainy Days
January	28.9	18.5	93	45	51.4	3
February	33.9	19.9	92	33	0.6	0
March	34.8	24.1	90	36	0	0
April	35.8	27.4	81	39	7.4	1
May	36.2	31.5	65	41	68.4	4
June	33.0	27.1	75	52	70.6	6
July	31.2	25.4	96	70	306.0	18
August	27.1	23.1	97	77	270.2	11
September	30.7	24.8	98	73	227.4	16
October	32.0	23.4	95	56	96.4	7
November	31.7	22.8	98	73	0	0
December	29.8	20.2	95	49	0	0
				Total	1098.4	66