AICRP on Palms

वार्षिक प्रतिवेदन

Annual Report

2013-14

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना

(भारतीय कृषि अनुसंधान परिषद)

कासरगोड़, केरल - 671 124, भारत

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

(*Indian Council of Agricultural Research*)

CPCRI, Kasaragod - 671 124, Kerala


MAP SHOWING AICRP ON PALMS CENTRES
JAMMU & KASHMIR
HIMACHAL PRADESH
PUNJAB
UTTARANCHAL
HARYANA
RAJASTHAN
UTTAR PRADESH
Madhopur
SIKKIM
ARUNACHAL PRADESH
Pasighat
Kahikuchi
ASSAM
NAGALAND
BIHAR
Sabour
MEGHALAYA
MANIPUR
GUJARATH
MADHYA PRADESH
JHARKHAND
WEST BENGAL
TRIPURA
MIZORAM
Modouri
Naysari
CHATTISGARH
Bhubaneswar
ODISHA
MAHARASHTRA
Jagadalpur
Ratnagiri
TELANGANA
Pandiripamidi
Vijayarai
Mulde
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GOA
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Kasaragod
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LAKSHADWEEP
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Veppankulam
TAMIL NADU
Pattukkottai
KERALA
Killikulam
ANDAMAN & NICOBAR ISLANDS

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ANNUAL REPORT

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अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना

All India Co-ordinated Research Project on Palms

(Indian Council of Agricultural Research)

C.P.C.R.I., KASARAGOD - 671 124, KERALA, INDIA

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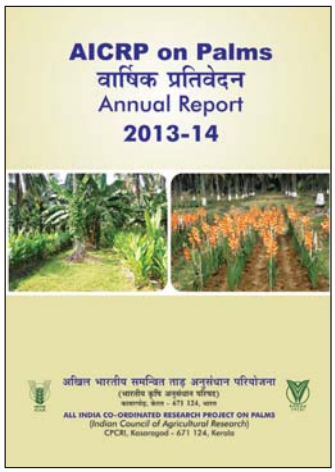

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Contents

I. प्रस्तावना

नारियल, तेल ताड़, पॉमैरा और मद्यद्रुम पर अनुसंधान 12 राज्यों के 21 केंद्रों में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना कार्यरत है। वर्ष 2013-14 में तीन उच्च उपज प्रदत्त संकरों जैसे जी.बी.जी.डी. x पी. एच.ओ.टी., जी.बी.जी.डी. x एल.सी.ओ.टी. और जी.बी.जी.डी. x एफ.जे.टी. के विमोचन द्वारा एक महत्वपूर्ण उपलब्धि प्राप्त की गई है और इन प्रजातियों के विमोचन एवं अधिसूचना हेतु फसल मानकों पर केंद्रीय उप समिति को प्रस्ताव प्रस्तुत किया गया है। विमोचित प्रजातियों के केंद्रित बीज बाग की स्थापना और गुणी रोपाई सामग्रियों की आवश्यकताओं की पूर्ति के लिए विमोचित प्रजातियों के पैतृक सामग्रियों के लिए प्रयास किया जा रा है। देशी और विदेशी जननद्रव्यों के संरक्षण के साथ विभिन्न स्थानों में नारियल की बौनी x बौनी और लंबी x लंबी संकरों का मूल्यांकन जारी किया जा रहा है। तेल ताड में डूरा x पिसिफेरा संकर (टेनरा) का मूल्यांकन विभिन्न स्थानों में किया जा रहा है। सूखा सक्षम डूरा प्रजाति का विकास प्रारंभ किया गया है। पॉमैरा में कर्नाटक के दक्षिण कन्नड से सात प्रजातियों का संग्रहण कर किल्लिकुलम और पान्डिरिममिडी के जननद्रव्य केंद्र में संरक्षण किया जा रहा है। मद्यद्रुम में ओडिषा के जेयपोर और कोरापुट क्षेत्रों से जननद्रव्य संग्रहण का प्रयास किया जा रहा है।नारियल पर उर्वरण अध्ययन से यह देखा गया कि उत्पादन क्षमता और गुण पर बिना प्रभाव से 25 से 50 प्रतिशत की मात्रा तक उर्वरक बचा जा सकते है। विभिन्न प्रबंधन पद्धितयों के अधीन स्थानीय विशेष फसलों के साथ नारियल आधारित सस्यन पद्धित का मूल्यांकन किया गया। फूल फसलों के साथ अन्तर फसलन से नारियल कृषकों को उच्च आय प्राप्त किया गया। नोनी पौधों की तुलना में ऊत संवर्द्धित पौधों के साथ अन्तर फसलन से उच्च फल उपज प्राप्त किया गया। नारियल में रोग प्रबंधन के अधीन गनोडरमा एकलन का रोगकारी प्रचण्डता और व्यूहाण्विय गुणावगुणन किया गया। अम्बाजिपेटा स्थानों में तना स्त्रवण रोग कम करने में ट्रैकोडेरमा पेस्ट संविन्यास की तुलना में *ट्रैकोडेरमा वैरेन्स* केक का प्रयोग अधिक प्रभावी पायी गयी। पूर्व उपाधीयित परजीव्याभ *गोनियोसस नेफान्डिडिस* के विमोचन के विरुद्ध *ओपिसिना एरिनोसेल्ला* के विमोचन से कीट संख्या में कमी पायी गयी। कें रो फ अ सं द्वारा विकसति एन पी एम ल्युर अन्य ल्युर की तुलना में अधिक लाल ताड घुन को पकडा गया है। पॉमैरा में मूल्य वर्द्धन में फूल रस और तरल भ्रूणपोष के परिरक्षण का प्रयास और कन्द चूर्ण उपयुक्त उपोत्पाद के विकास का प्रयास किया जा रहा है। प्रौद्योगिकी हस्तांतरण के विषय में विभिन्न प्रशिक्षण कार्यक्रम और विस्तार गतिविधियाँ सभी केंद्रों में आयोजित की जा रही है।

मैं अपना निष्ठापूर्वक आभार डॉ. एस. अय्यप्पन; सचिव, डेयर एवं महानिदेशक, भा.कृ.अनु.प. के प्रति व्यक्त करता हुँ जिन्होंने इस परियोजना पर निरंतर विवेचनात्मक मार्गदर्शन दिया है। डॉ. एन.के. कृष्णकुमार, उप महानिदेशक (बागवानी) भा.कृ.अनु.प., नई दिल्ली द्वारा दिए गए बहुमूल्य मार्गदर्शन एवं आलोचनात्मक सुझाव के लिए मैं अपनी कृतज्ञता ज्ञापित करता हुँ।

डॉ. जॉर्ज वी. थॉमस, निदेशक, कें रो फ अ सं और स्टाफ सदस्यों के प्रति आभार प्रकट करता हुँ जिन्होने सुचारु रूप से परियोजना जारी करने का तकनीकी मार्गदर्शन और मदद दिया है। डॉ. एस. अरुल राज, निदेशक और स्टाफ सदस्य, तेल ताड अनुसंधान निदेशालय, पेडवेगी, डॉ. एस.के. मल्होत्रा, सहायक महानिदेशक (बागवानी) और भा कृ अनु प के बागवानी विज्ञान अनुभाग के स्टाफ सदस्यों के मार्दर्शन के लिए विश्व आभार व्यक्त करता हुँ। विभिन्न कृषि/बागवानी विश्वविद्यालय के कुलपति/अनुसंधान निदेशक/प्रमुख, विभिन्न प्रभाग/स्टेशन प्रमुख के प्रति धन्यवाद प्रस्तुत करता हुँ जिन्होंने परियोजना के प्रभावी निष्पादन में मदद किया है। इस अवसर पर मैं डॉ. बी.बी. बसवराजु, डॉ. एस. गीतांजली, डॉ. आई. जॉनसन, डॉ. एन.बी.वी. चलप्पति रॉव, डॉ संजीव रेड्डी, जी रेडडी और इंजिनीयर पी सी वेंगय्या और अन्य वैज्ञानिकों को धन्यवाद अर्पित करता हुँ जिन्होंने इस रिपोर्ट के संकलन में मदद किया है।

डॉ. विनायग हेग्डे, प्रमुख (फसल संरक्षण), डॉ. के. सुबहरन, वरिष्ठ वैज्ञानिक, डॉ. बी.ए. जेरार्ड, प्रधान वैज्ञानिक, डॉ. पी. सुब्रमणियन, प्रधान वैज्ञानिक, और डॉ. राजकुमार, के प्रति धन्यवाद ज्ञापन करता हुँ जिन्होंने विभिन्न गतिविधियों के प्रभावी अनुवीक्षा एवं तकनीकी मार्गदर्शन दिया है। श्रीमती के. नारायणी, निजी सचिव और श्री पी नारायणा नायिक, प्रवर श्रेणी लिपिक को भी साधुवाद देता हुँ जिन्होंने इस रिपोर्ट के निष्पादन में मदद और समन्वयन कार्य किया है। हिंदी अनुवाद के लिए श्रीमती श्रीलता के., वरिष्ठ तकनीकी अधिकारी (राजभाषा) को भी धन्यवाद प्रस्तुत करता हुँ।

एच.पी. महेश्वरप्पा

जुलाई, 2014

डॉ. एच. पी. महेश्वरप्पा

I. Preface

The All India Co-ordinated Research Project (AICRP) on Palms is operating in 21 centres covering 12 States dealing with research on coconut, oil palm, palmyrah and fish tail palm. During the year 2013-14, significant achievements have been made by releasing three coconut hybrids *viz*; GBGD x PHOT, GBGD x LCOT and GBGD x FJT which are high yielders and proposal has been submitted to Central Sub-committee on crop standards for notification and release of varieties. Efforts have been made to establish nucleus seed gardens of released varieties and parental materials of released hybrids in order to meet the demand for quality planting material. The evaluation of D x D and T x T hybrids of coconut is continuing in different locations along with conservation of exotic and indigenous germplasms. In oil palm, D x P hybrids (*Tenera*) are being evaluated in different locations and development of *dura* type tolerant to drought has been initiated. In palmyrah, seven accessions from Dakshin Kannada district of Karnataka were collected and conserved in the gene bank of Killikulam and Pandirimamidi centres. In the fish tail palm, efforts were made to collect the germplasm from Jeypore and Koraput areas of Odisha. Studies on fertigation on coconut resulted in saving of fertilizer to the tune of 25 to 50% without affecting productivity and quality. Coconut based cropping system with location specific crops have been evaluated under different management practices. Inter-cropping with flower crops has resulted in higher net income to the coconut farmers. Intercropping with Noni tissue culture plants resulted in higher fruit yield compared to seedlings. Under disease management in coconut, pathogenic virulence of *Ganoderma* isolates and molecular characterization have been carried out. Application of cake formulation of *Trichoderma virens* was highly effective in reducing the stem bleeding compared to *Trichoderma viride* paste formulation at Ambajipeta location. Release of pre-conditioned parasitoids of *Goniozus nephantidis* against black headed caterpillar (*Opisina arenosella*) resulted in reduction of the pest population. NPM Lure developed by CPCRI has trapped higher number of red palm weevil compared to other lures. In value addition in palmyrah, attempts have been made to preserve the inflorescence sap and liquid endosperm as well as development of by-products utilizing tuber flour. In the transfer of technology aspect, various training programmes and extension activities have been carried out in all the centres.

I place my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for his critical and constant guidance for the project. The valuable guidance and critical suggestions provided by Dr. N.K. Krishna Kumar, DDG (Horticulture Science), ICAR, New Delhi are highly acknowledged.

I acknowledge the continued technical guidance provided by Dr. George V. Thomas, Director and staff of CPCRI, Kasaragod, Dr. S. Arulraj, Director and staff of DOPR, Pedavegi, Dr. S. K. Malhotra, ADG (Horticulture Science-II), Dr. T. Janakiram, ADG (Horticulture Science-I) and the staff of Horticulture Science Division of ICAR, New Delhi for smooth functioning of the project. Further the technical and administrative support given by the Vice Chancellors, Directors of Research, Head of Divisions, Head of Stations of various Agricultural/Horticultural Universities for effective functioning of the project is greatly acknowledged. I take this opportunity to express my sincere thanks to Dr. T. B. Basavaraju, Dr. S. Geethanjali, Dr. I. Johnson, Dr. NBV Chalapathi Rao, Dr. Sanjeevraddi G. Reddi and Er. P. C. Vengaiah and other scientists for helping in compilation of the report.

I record my sincere thanks to Dr. Vinayaka Hegde, HOD, Dr. K. Subaharan, Sr. Scientist, Dr. B. A. Jerard, Principal Scientist, Dr. P. Subramanian, Principal Scientist and Dr. Rajkumar, Scientist CPCRI, Kasaragod for their effective monitoring and technical guidance for various activities. The support and coordination of Smt. K. Narayani, Private Secretary and Shri P. Narayana Naik, UDC, in smooth functioning of the Project Co-ordinator cell and the help rendered by Mrs. K. Sreelatha for Hindi translation are greatly acknowledged.

July, 2014

(Dr. H. P. Maheswarappa)

II. कार्य सारांश

अखिल भारतीय समिन्वित ताड़ अनुसंधान परियोजना केंद्र मुख्य फसलों की उत्पादनक्षमता बढ़ाने की स्थानीय विशेष प्रौद्योगिकियों के विकासन में सफलतापूर्वक विभिन्न सस्य जलवायु क्षेत्रों का प्रतिनिधित्व कर 12 राज्यों में स्थित है।

आनुवंशिक संसाधन, फसल सुधार, फसल उत्पादन, रोग प्रबंधन, कृमि कीट प्रबंधन और कटाई उपरांत प्रौद्योगियों के अधीन मुख्य फसलों में वर्ष 2013-14 की अवधि में हुई अनुसंधान कार्य की प्रगति इस रिपोर्ट में प्रस्तुत की गई है।

वर्ष 2013-14 अनुसंधान उपलब्धियाँ

नारियल

आनुवंशिक संसाधन और फसल सुधार

संकर जैसे जी.बी.जी.डी. x पी.एच.ओ.टी., जी.बी.जी.डी. x एल.सी.ओ.टी. की उच्च उत्पादनक्षमता के कारण आन्ध्रप्रदेश और कर्नाटक में कृषि के लिए सिफारिश किया गया है। संकर जी.बी.जी.डी. x एफ.जे.टी. का निष्पादन कर्नाटक में अच्छा पाया गया इसलिए उसकी उच्च उत्पादनक्षमता के कारण कर्नाटक में कृषि के लिए सिफारिश किया गया है। विमोचित नई प्रजातियों और संकरों के बड़े पैमाने की बहुगुणन के लिए विभिन्न सस्य जलवायु क्षेत्रों में केंद्र बीज बाग की स्थापना की गई।

फसल उत्पादन

उर्वरण: अम्बाजिपेट, अलियारनगर, काहिकुची और अरसिकरे केंद्रों में अनुमोदित नाईट्रोजन, फोसफोरस और पोटाश के 75% के प्रयोग से 25 प्रतिशत नाईट्रोजन, फोसफोरस, पोटाश के बचत के साथ उच्च उपज प्राप्त किया गया। जबकि मन्डौरी, कासरगोड, रत्नगिरी और वेप्पंकुलम केंद्रों में उच्च उत्पादनक्षमता के लिए अनुमोदित उर्वरक मात्रा के 50% अनुकूलतम है।

नारियल आधारित फसलन पद्धित

रत्नगिरी (महाराष्ट्रा) में विभिन्न पोषण प्रबंधन पद्धित के अधीन नारियल, कालीमिर्च, जातिफल, लवंग, केला, अनन्नास सम्मिलित फसलन पद्धित का मूल्यांकन किया जा रहा है। अनुमोदित नाईट्रोजन, फोसफोरस, पोटाश के 50% + वर्मिकपोस्ट के साथ जैविक पुनःचक्रमण + जैविक वर्मीवाश प्रयोग + जैव उर्वरक प्रयोग और हरा खाद प्रयोग ट 2 (131.6 गुठ्ली) जैसे महत्वपूर्ण उपचार में गुठ्ली प्रति ताड़ की संख्या उच्च रिकार्ड की गई जो अनुमोदित नाईट्रोजन, फोसफोरस, पोटाश का 75% + वर्मीकंपोस्ट के साथ जैविक पुनःचक्रमण (टी 1 (127.3 गुठ्ली) और पूर्ण जैविक (टी 3) (112.8 गुठ्ली) के बराबरी है। वेप्पम्कुलम में नारियल + कोको + काली मिर्च + केला + अरवी फसलन पद्धित का मूल्यांकन किया जा रहा है। और पूर्ण रूप से जैविक उपचार से उच्च कुल आय 175,380/- रुपए रिकार्ड किया गया है। जबकि इक फसलन से कुल आय 54,200/- रिकार्ड किया गया है।

अलियारनगर में नारियल के अन्तरफसल के रुप में पॉच वाणिज्य फूल फसल का वर्द्धन किया गया। गेंदा से 5948 कि.ग्रा/हेक्टर फूल उपज प्राप्त किया गया और 77,710 रुपए/हेक्टर कुल आय प्राप्त किया गया। और गोम्फ्रेना से 5074 कि. ग्रा/हेक्टर फूल उपज तथा कुल आय 60,230/ रुपए प्रति हेक्टर और गुलदाउदी से 4,912 कि.ग्रा/हेक्टर फूल उपज और कुल आय 56,990/ रुपए प्रति हेक्टर.

रोग प्रबंधन

प्रायोगशाला परिस्थिति के अधीन *गनोडेरमा लूसिडम* के विरुद्ध पॉच वानस्पतिक जैसे *एलियुम सदैवा, नेरियम ओलेन्टर, टिनोस्पोरा कोर्डिफोलिया, ओसिमम सान्क्टम* और *एजेल मरमेलॉस* के छानबीन से यह देखा गया कि *एलियुम सदैवा* का जलीय पत्ता निस्सार 5 प्रतिशत गाढापन में कवकजालीय वृद्धि का उच्च रूप में निरोधी है। और *ओसिमम सान्क्टम* 15 प्रतिशत गाढ़ापन में कवकजालीय वृद्धि का निरोधी है। काच परिस्थिति के अधीन *जी. अप्लनाटम* के विरुद्ध सात कवकानी का छानबीन किया गया। कवकानी जैसे पेन्सिकुरॉन (0.15) डैफेनोकोनज़ॉल (0.05 और 0.1) हेक्सकोनज़ोल (0.1) और कारबोक्सिन थिराम (0.2) के साथ प्लेट्स सुधारित करने से 100 प्रतिशत कवकजालीय वृदिध निरोधी पायी गयी।

गनोडेरमा संरोपित गमले में चना वर्द्धन से मुरझावट, पीलापन, पत्ते भौरे रंगीन हो जाना, आधार तना क्षेत्र पूर्ण रुप से सड़ जाने से बुआई के एक महीने के अन्दर ही मृत हो जाना आदि दिखाई पड़ते है। इसलिए आधार तना सड़न रोग प्रभावित पेड़ों को पहचानने के

लिए चना एक सूचकांक के रुप में उपयोग किया जा सकता है।

अम्बाजिपेट स्थानों में तना स्राव रोग कम करने में ट्रैकोडरमा विरन्स पेस्ट की तुलना में ट्रैकोडरमा विरन्स के संविन्यास का प्रयोग अधिक प्रभावी पायी गयी। लेकिन अरसिकरे स्थानों में ट्रैकोडरमा हरज़ियानम पेस्ट संविन्यास अधिक प्रभावी पायी गयी।

पत्ता चित्ती रोग लक्षण कम करने में तिमाही अंतराल में 5 कि. ग्रा / ताड़ खेत की खाद के साथ 300 ग्रा के दर में स्यूडोमोनस फ्लूरोसेंस, बेसिलस सब्टिलस और ट्रैकोडरमा विरिडे का प्रयोग प्रभावी पायी गयी।

कीट रोग प्रबंधन

सर्वेक्षण के भ्रमण में आन्ध्रप्रदेश के उत्तर तटीय जिला में, कायम्बत्तूर के अन्नामलाई ब्लॉक में और तमिलनाडु के धर्मपुरी जिला में हरुर ब्लॉक में और महाराष्ट्र के थाने के पालघड़ और टालसान्डे तहसिल में और कोल्हापुर जिला में नारियल काला सिरवाली कैटरपिल्लर *ओपिसिना एरिनोसेल्ला* का तीक्ष्ण लक्षण देखा गया। इस रोमिलइल्ली का परजीव्याभ का बहुगुणन अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्रों में क्रमानुगत राज्यों में कृषकों को वितरण किया गया (अलियार नगर 8,06,800 अम्बाजिपेट 32,30,000 और रत्नगिरी 92,000) रोमिल इल्ली का लक्षण और फैलाव पूर्ण रुप से जैविक नियन्त्रण से है।

अम्बाजिपेट और रत्नगिरी में नानोपोरस मट्रिक्स कें रो फ अ सं, ल्युर और भारत का कीट नियंत्रण, ल्युर की तुलना में काईरोमोन ब्लेन्ड के साथ नानोपोरस मट्रक्सि कें रो फ अ सं, ल्युर संस्थापित करने से अधिक संख्या में लाल ताड़ घुन को पकड़ा गया। जबकि अलियार नगर में नानोपोरस मट्रक्सि के रो फ अ सं, ल्युर अधिक घुन को पकडा गया और उसके कैरमोन ब्लेन्ड के साथ जोड़कर घुन को पकडा गया। इन तीनों केंद्रों में राईनोसेरस भृंग के विरुद्ध भारत का कीट नियंत्रण ल्युर वाणिज्यिक ल्युर की तुलना में नानोपोरस मट्रक्सि सीपीसीआरआई ल्युर अधिक भृंगों को पकडा गया।

तेल ताड़

गंगावती में सूखा सक्षम के लिए विभिन्न तेल ताड़ समपित्रैक के मूल्यांकन के अधीन समपित्रैक ZS 6, ZS 8, ZS 9, TS 5 एवं TS 7 की अपेक्षा ZS 3 उच्च औसत ताज़ा फल गुच्छ 7.7 टन/हेक्टर प्राप्त किया गया। मुल्डे में सिंचाई परिस्थिति में ZS 3 से उच्च ताजा फल गुच्छ उपज 12.7 टन/हेक्टर और ZS 5 से 10.7 टन/हेक्टर उच्च ताजा फल गुच्छ प्राप्त किया गया।

पाट्टुक्कोटाई में वर्ष 2006 में कृषकों के प्रक्षेत्र में संकर मूल्यांकन परीक्षण के अधीन रोपित संकर राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 17 से अन्य संकरों की तुलना में उच्चतम ताजा फल गुच्छ (135.5 कि /ताड) 19.4 टन/हेक्टर) प्राप्त किया गया।

वर्ष 2007 में रोपित विभिन्न संकरों के बीच ताजा फल गुच्छ उपज में महत्वपूर्ण भिन्नताएँ पायी गयी। गंगावती में संकर राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 4 से उच्च औसत ताजा फल गुच्छ उपज (10.6 टन/हेक्टर) राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 3 (5.9 टन/हेक्टर) राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 6 (7.3 टन/हेक्टर) जो शेष संकरों से प्राप्त उपज से भिन्न पाया गया। मुल्डे में राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 8 से अधिकतम ताजा फल गुच्छ (4.3टन/हेक्टर) विजयराय केंद्र में राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 4 से उच्चतम उपज 19.6 टन/हेक्टर प्राप्त किया गया और राष्ट्रीय तेल ताड़ अनुसंधान केंद्र 7 (8.2 टन/हेक्टर) प्राप्त किया गया।

पॉमैरा

कर्नाटक के दक्षिण कन्नड जिले मे सर्वेक्षण आयोजित किया गया था और सात जननद्रव्यों का संग्रहण किया गया और किल्लिकुलम और पान्डिरिममिडी केंद्रों में रोपण किया गया। कुल संग्रहण 254 प्रजातियों का संग्रहण किया गया। कर्नाटक के दक्षिण देश के अन्य स्थानों के पॉमैरा पेडों की तुलना में कन्नड़ जिला के पॉमैरा ताड़ हष्ठपुष्ट एवं मज़बूत है। बड़ा आकारित पत्ता, लंबी पत्ता वृन्त, अच्छा नीरा उपज प्राप्त किया जाता है। सी पीसीआरआई विधि से संग्रहित परोसने में तैयार विभिन्न रस के भण्डारण अध्ययन से किसी परिरक्षक के बिना भण्डारण काल 10 घंटे पाया गया। अध्ययन यह सुझाव दिया जाता है कि शीतीकरण परिस्थिति के अधीन अनुरक्षित परोसने में तैयार पेय के गुण में प्रारंभिक मूल्य से निम्नतम विचलन दिखाता है। ये पेय एक दिन के लिए स्वीकृत परिस्थिति में रखा जा सकता है।

कन्द चूर्ण आधारित उत्पादों की तैयारी पर किए गए अध्ययन से रोटी, बिस्कुट आदि विकसित मिश्रित आटा से बनाया जाता है। यह परिणाम देखा गया कि कंद चूर्ण की मात्रा अधिक होने से तीखापन अधिक हो जाता है।

मिश्रित चूर्ण के अनुमानित मिश्रण में व्यतियान देखा गया और उनके क्रमानुसार रोटी और बिस्कुट में व्यतियान देखा गया।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की बाईसवीं वार्षिक समूह बैठक

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की बाईसवीं वार्षिक समूह बैठक इन्दिरा गांधी कृषि विश्वविद्यालय, रायपुर, चत्तीसग़ढ में जुलाई 22-25, 2013 को आयोजित की गयी। इस समूह बैठक में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के 21 केंद्र, राज्य कृषि विश्वविद्यालय, कें रो फ असं, तेल ताड अनुसंधान निदेशालय, नारियल विकास बोर्ड और देश के 12 राज्यों के राज्य बागवानी विभाग, को सम्मिलित 100 प्रतिनिधियों ने भाग लिया।

समूह बैठक में नारियल, तेल ताड, पॉमैरा और मद्यद्रुम में जारी अनुधान कार्य की प्रगति पर चर्चा की गई। डॉ. एन.के. कृष्णकुमार, उप महानिदेशक (बागवानी), भा कृ अनु प, नई दिल्ली ने बैठक का उद्घाटन किया। डॉ. एस. के पाटील, कुलपति, इन्दिरा गांधी कृषि विश्वविद्यालय, रायपुर, चत्तीसग़ढ ने 22.07.2013 को आयोजित बैठक की अध्यक्षता की। डॉ. डी.ए. सरनाइक, निदेशक (अनुसंधान), इन्दिरा गांधी कृषि विश्वविद्यालय ने प्रतिनिधियों का स्वागत किया और डॉ. एच.पी. महेश्वरप्पा, परियोजना समन्वयक ने, अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना ने वार्षिक रिपोर्ट प्रस्तुत की। डॉ. टी.पी. राजेन्द्रन, सहायक महानिदेशक (पादप संरक्षण) और डॉ. जॉर्ज वी. थॉमस, निदेशक कें रो फ अ सं विशिष्ट अतिथि थे।

डॉ एन.के. कृष्णकुमार, उप महानिदेशक, भा कृ अनु प, नई दिल्ली ने अपने भाषण में पोषण सुरक्षा और फलस्वरुप देश की खाद्य सुरक्षा में बागवानी फसलों की प्रमुखता पर प्रकाश डाला। उन्होंने देश के मुख्य नारियल उत्पादित राज्यों में नारियल की अथाह निम्न उत्पादन क्षमता पर जोर दिया। उन्होंने सुझाव दिया कि नारियल का मूल्य वर्द्धन और विविधीरण पर ध्यान दिया जाना चाहिए। सुपारी कृषि लाभदायक है, लेकिन सर्वनाशी कीट एवं रोग अधिक धमकी उठाते है। उन्होंने आग्रह किया कि अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के सभी केंद्र अपने अनुसंधान के मूल समस्या जैसे जैव एजेंट के उपयोग के साथ कीटनाशी को निरकीटनाशी कृषि में परिवर्तन कर, श्रमिक दुर्लभता पर प्रौद्योगिकी दक्षता, नारियल में समीकृत कृषि पद्धित पर केंद्रित रहने के लिए आग्रह किया। पॉमैरा के अनुसरण में प्राथमिकताओं को नियत कर भविष्य योजनाओं का परिणाम निकालना है।

समूह बैठक की अवधि में सात तकनीकी सत्र में कार्रवाई रिपोर्ट, प्रजातियों का विमोचन प्रस्ताव, आनुवंशिक संसाधन और फसल सुधार, फसल उत्पादन, कीटरोग प्रबंधन रोग प्रबंधन और कटाई उपरांत प्रौद्योगिकी और प्रौद्योगिकी हस्तांतरण आदि आयोजित किया गया।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की बाईसवीं बैठक की मुख्य सिफारिशें जो विस्तार पद्धित को प्रस्तुत किया जाना है।

अम्बाजिपेट और अरसिकरे केंद्र में संकर जैसे जी.बी.जी.डी. x एल.सी.ओ.टी. और जी.बी.जी.डी. x पी.एच.ओ.टी. का निष्पादन अच्छा पाया गया। इस समूह बैठक में इन संकरों के विमोचन का प्रस्ताव किया गया। अरसिकरे केंद्र में जी.बी.जी.डी. x एफ.जे.टी. निष्पादन अच्छा पाया गया और कर्नाटक में विमोचन के लिए प्रस्ताव किया गया।

2. अखिल भारतीय समन्वित ताड अनुसंधान परियोजना के विभिन्न केंद्रों में नारियल में उर्वरण पर किए गए अध्ययन 2007-08 से 2012-13 तक के आधार पर निम्नलिखित सिफारिशें देश के विभिन्न क्षेत्रों के लिए प्रस्तुत किए गए।

वेप्पम्कुलम मन्डौरी, रत्नगिरी और कासरगोड़ केंद्र

उर्वरक की अनुमोदित मात्रा के 50% और उर्वरक की अनुमोदित मात्रा के 75 प्रतिशत का प्रयोग और अनुमोदित मात्रा के 100% मृदा प्रयोग से प्राप्त गुठ्ली ओर खोपड़ा उपज प्रति ताड़ प्रति वर्ष समतुल्य पाया गया इसलिए अनुमोदित उर्वरक मात्रा का 50% शुपार्शित किया जा सकता है।

अलियार नगर, अम्बाजिपेट, अरसिकरे केंद्र

मृदा के माध्यम से अनुमोदित उर्वरक मात्रा के 100% प्रयोग से प्राप्त गुठ्ली उपज की तुलना में उर्वरण के माध्यम से अनुमोदित उर्वरक मात्रा के 75% प्रयोग से उच्च गुठ्ली और खोपड़ा उपज प्रति ताड़ प्रति वर्ष प्राप्त किया गया।और उर्वरण के माध्यम से अनुमोदित उर्वरक मात्रा के 100% प्रयोग से तुल्य उपज प्राप्त किया गया। इसलिए अनुमोदित उर्वरक मात्रा के 75% सिफारिश किया जा सकता है।

3. फसलन पद्धित स्वीकार करने से नारियल में उच्च उत्पादनक्षमता प्राप्त किया जा सकता है। क्षेत्र का सस्य जलवायु परिस्थिति के आधार पर फसल चुन लिया जा सकता है।

4. अरसिकरा, अम्बाजिपेट, मन्डौरी और वेप्पंगुलम केंद्र में नारियल में अन्तरफसल के रुप में नोनी पौध संवर्द्धन की तुलना में ऊत संवर्द्धित पौध उत्तम पाया गया। लेकिन अलियारनगर, भुबनेश्वर, जगदलपुर, काहिकुची और रत्नगिरी केंद्रों में नोनी पौधों का निष्पादन उत्तम पाया गया।

तनास्त्रावण प्रबंधन

5. ट्रैकोडेरमा पेस्ट संविन्यास की तुलना में नारियल में तना स्त्रवण रोग नियंत्रण में ट्रैकोडेरमा विरिडे केक संविन्यास प्रयोग प्रभावी पाया गया।

पत्ता चित्ती का जैविक प्रबंधन

6. *पी फ्लूरोसेंस* टाल्क संविन्यास (50ग्रा/ताड/वर्ष) नीम केक (5 कि. ग्रा/ताड/वर्ष) का मृदा प्रयोग के साथ तिमाही अंतराल में 25 मि ली /ताड़ दर में *पी फ्लूरोसेंस संवर्द्धन* निस्यंद का मूलवेधन पत्ता चित्ती रोग के विरुद्ध उत्तम पाया गया।

काला सिरवाली कैटरपिल्लर का प्रबंधन

7. नारियल काला सिरववाली कैटरपिल्लर, *ओ एरिनोसेल्ला* का परजीव्याभ की घ्राणशक्ति अनुकूलन पर सभी तीनों केंद्रों में अध्ययन आयोजित किया गया। डिम्भ कीट मल और डिम्भ क्षत पत्तों का गन्ध में खुला रखने से यह देखा गया कि अननुकूलन परजीव्याभ विमोचन उपचार की तुलना में अनुकूलन परजीव्याभ विमोचन उपचार में *ओ एरिनोसेल्ला* का परजीव्याभीकरण स्तर अधिक है। इसलिए *ओ एरिनोसेल्ला* के विरुद्ध परजीव्याभ विमोचन से 72 घंटे के लिए स्थिर रुप से अनुकुलन होना चोहिए।

8. फेरोमोन्स, *बाकुलोवाइरस*, नाफ्थलिन बॉल्स और *मेटारैजियम अनिसोप्लिए* के उपयोग सहित समीकृत कीट प्रबंधन का कार्यान्वयन पर सभी तीनों केंद्रों में अध्ययन आयोजित किया गया और एकीकृत कीट प्रबंधन पद्धित के कार्यान्वयन के एक वर्ष के बाद परीक्षणी बाग में पत्ता एवं तर्कु क्षति की कमी के साथ राईनोसेरस भृंग का लक्षण प्रति सेंट देखा गया।

सुल्फि मुर्झा का प्रबंधन

9. अलवाल प्रयोग के साथ *टी. हरज़ियानम* (1000 ग्र) जैविक खाद (10 कि. ग्रा) के साथ विभिन्न जैव एजेंट, जैव उर्वरक, फार्म खाद संयुक्त के प्रयोग के बाद *टी. हरज़ियानम* का 100 प्रतिशत संवर्द्धन निस्यंद, सुल्फि ताड़ में मुर्झा रोग नियंत्रण में सर्वोत्तम पाया गया।

II. Executive Summary

The AICRP centres located in twelve States representing different agro-climatic regions have been successful in developing location specific technologies to improve the productivity of mandate crops.

Progress of research work in the mandate crops under genetic resources and crop improvement, crop production, disease management, insect pest management and post harvest technology during the year 2013-14 is presented in this report.

Research achievements during 2013-14

Coconut:

Genetic resources and Crop improvement

The hybrids *viz*., GBGDx PHOT, GBGD x LCOT have been recommended for cultivation in Andhra Predesh and Karnataka for their higher productivity. The hybrid, GBGD x FJT has been found to perform well in Karnataka, and hence recommended for cultivation in Karnataka for its higher productivity. For large scale multiplication of newly released coconut varieties and hybrids in different agro-climatic regions, nucleus seed gardens have been established.

Crop production

Fertigation: At Ambajipeta, Aliyarnagar, Kahikuchi and Arsikere centres, application of 75 % of recommended NPK resulted in higher yield and net return with the saving of 25% of NPK. Whereas at Mondouri, Kasaragod, Ratnagiri and Veppankulam centres, application of 50% of recommended dose of fertilizer is optimum for higher productivity.

Coconut based cropping system

At Ratnagiri (Maharashtra), the cropping system comprising of coconut + black pepper + nutmeg + cinnamon + banana + pineapple is being evaluated under different nutrient management system. Significantly higher number of nuts per palm was recorded in treatment, 50% of recommended NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring (T_2) (131.6 nuts) which was at par with 75% of recommended NPK + organic recycling with vermicompost (T_1) (127.3 nuts) and fully organic (T_3) (112.8 nuts). At Veppankulam, coconut + cocoa + black pepper + banana + elephant foot yam cropping system is being evaluated and the treatment, fully organic has recorded higher net return of Rs.175,380/- followed by other treatment, whereas, mono cropping has recorded a net income of Rs.54,200/- only. At Aliyarnagar, among five commercial flower crops raised as intercrops in coconut, marigold recorded a flower yield of 5,948 kg/ha with a net income of Rs.77,710/ha followed by gomphrena with a flower yield of 5074 kg/ha and net income of Rs.60,230/ha. Chrysanthemum recorded a flower yield of 4,912 kg/ha with a net income of Rs.56,990/ha.

Disease management

Screening of five botanicals *viz*. *Allium sativum, Nerium oleander, Tinospora cordifolia, Ocimum sanctum* and *Aegle marmelos* against *Ganoderma lucidum* under laboratory conditions revealed that the aqueous leaf extract of *Allium sativum* was highly inhibitory to the mycelial growth at 5 per cent concentration followed by *Ocimum sanctum* at 15 percent concentration.

Among the seven fungicides screened against *G. applanatum* under *in vitro* condition, the plates amended with fungicides *viz*., Pencycuron (0.15%), Difenoconazole (0.05 and 0.1%), Hexaconazole (0.1%) and Carboxin + Thiram (0.2%) showed 100 per cent mycelial growth inhibition.

Growing bengal gram in the *Ganoderma* inoculated pots are showing withering, yellowing,

browning of leaves and complete rotting of the basal stem region leading to the death of the plants within a month after sowing. Hence, Bengal gram may be used as an indicator plant for the detection of basal stem rot affected trees.

Application of *Trichoderma virens* cake formulation was highly effective in reducing the stem bleeding compared to *Trichoderma viride* paste formulation at Ambajipeta location while, application of *Trichoderma harzianum* paste formulation was found to be effective at Arsikere location.

Soil application of microbial consortia consisting of *Pseudomonas fluorescens*, *Bacillus subtilis* and *Trichoderma viride* @ 300g along with FYM 5 kg/palm at quarterly interval was found to be effective in reducing the leaf blight disease incidence.

Insect pest management

During roving surveys, severe incidence of coconut black headed caterpillar (*Opisina arenosella*) was noticed in north coastal districts of Andhra Pradesh, in Anaimalai block of Coimbatore and Harur block of Dharmapuri districts of Tamil Nadu and in Palghar and Talsande Tahsil of Thane and Kolhapur districts of Maharashtra . The parsasitoids of this caterpillar multiplied at the AICRP centres in the respective states were supplied to farmers in large numbers (at Aliyarnagar 8,06,800, at Ambajipeta 32,30,000 and at Ratnagiri 92,000 numbers) and the incidence and spread of the caterpillar was contained successfully through biological control.

Nanoporous matrix CPCRI lure when installed along with Kairamone blend has trapped more number of red palm weevils as compared to Nanoporous matrix CPCRI lure and PCI lure at Amabjipeta and Ratnagiri. However, at Aliyarnagar, Nanoporous matrix CPCRI lure has trapped more weevils and followed by its combination with Kairamone blend. Against rhinoceros beetle at all the three centres, Nanoporous matrix CPCRI lure had significantly trapped higher number of beetles as compared to the commercial lure from PCI indicating the field efficacy of pheromone lures from CPCRI.

Oil Palm:

Under evaluation of different oil palm genotypes for drought tolerance at Gangavathi, the genotype ZS 3 recorded significantly higher mean FFB yield of 7.7t/ha over ZS 6, ZS 8, ZS 9, TS 5 & TS 7. At Mulde centre, genotype ZS 3 recorded the highest FFB yield of 12.7t/ha under irrigated condition and ZS 5 recorded the highest FFB yield 10.7t/ha.

At Pattukkotai, under hybrid evaluation trial planted during 2006 in farmers field, the hybrid NRCOP 17 recorded the highest FFB yield (135.5 kg/palm) (19.4 t/ha) compared to other hybrids.

The FFB yield differed significantly among the various hybrids planted during 2007, and at Gangavati, the hybrid NRCOP 4 recorded significantly higher mean FFB yield (10.6t/ha) over NRCOP 3 (5.9t/ha) and NRCOP 6 (7.3t/ha) and it was on par with remaining hybrids. At Mulde centre, NRCOP 8 gave the highest FFB yield of 4.3 t/ha. At Vijayarai centre, the FFB yield recorded was the highest in NRCOP 4 (19.6t/ha) followed by NRCOP 7 (8.2 t/ha).

Palmyrah:

The survey was conducted at Dakshina Kannada district of Karnataka and seven germplasms were assembled and planted in Killikulam and Pandirimamidi centres making the total collections to 254 accessions. The palmyrah trees of South Kannada district of Karnataka were robust, sturdy with big sized leaves with long petioles with good neera yield when compared to the palmyrah trees in other sites in the country. Storage study of different RTS sap collected through CPCRI method had a storage life of 10 h without any preservative. The study suggested that the RTS beverages maintained under refrigerated condition showed minimum deviation in quality from their initial value. These beverages remained in acceptable condition for one day.

Studies on preparation of tuber flour based products indicated that, bread and cookies were prepared with developed composite flours and the results showed that bitterness was increased with increase in quantity of tuber flour. Variations were observed in proximate composition of composite flour and their respective breads and cookies.

XXII Annual Group Meeting of AICRP on Palms

The XXII Annual Group Meeting of AICRP on Palms was held during 22-25 July, 2013 at Indira Gandhi Krishi Vishwavidhyalaya, Raipur (Chhattisgarh). The group meeting was attended by 100 delegates from 21 centres of AICRP on Palms, State Agricultural Universities, Central Plantation Crops Research Institute (CPCRI), Directorate of Oil Palm Research, 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 Group Meeting was inaugurated by Dr. N. K. Krishna Kumar, DDG (Horticulture Science), ICAR, New Delhi and presided over by Dr. S. K. Patil, Vice Chancellor, IGKV, Raipur (Chhattisgarh) on 22.07.2013 at IGKV Campus, Raipur. Dr. D. A. Sarnaik, Director of Research, IGKV welcomed the delegates and Dr. H. P. Maheswarappa, Project Co-ordinator (Palms) presented the annual report of AICRP on Palms. Dr. T. P. Rajendran, ADG (PP) and Dr. George V. Thomas, Director, CPCRI were guests of honour.

Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture Science), ICAR, New Delhi in his Chief Guest's address, highlighted the importance of horticultural crops in meeting the nutritional security and in turn the food security of the country. He accentuated the abysmally low productivity of coconut in the major coconut producing states of the country. He suggested that the research priorities should focus on diversification and value addition in coconut. Though arecanut cultivation is profitable, the devastating pests and diseases pose greater threat. He urged all the AICRP centres to focus their research on key issues *viz*., converting insecticide to non-insecticide farming with the use of bio-agents, technologies addressing labour scarcity and introducing integrated farming system in coconut. With respect to palmyrah, he emphasized that though palmyrah research is turning out a success, the future plan has to be worked out by setting priorities.

During the group meeting, seven technical sessions were held covering Action Taken Report, Variety release proposals, Genetic resources and Crop improvement, Crop production, Insect-pest management, Disease management and Post harvest technology and TOT.

The major recommendations of the XXII AICRP Group meeting to be passed on to Extension System:

1. The hybrids like GBGD x LCOT, and GBGD x PHOT are performing well in Ambajipeta and Arsikere Centres. These hybrids are proposed for release during this group meeting. GBGDx FJT is performing well in Arsikere centre and proposed for release for Karnataka.

2. Based on the studies taken up on fertigation in coconut at different centres of AICRP on Palms from 2007-08 to 2012-13, the following recommendations have been made for different regions of the country.

- Veppankulam, Mandouri, Ratnagiri and Kasaragod centres: The nut and copra yield per palm per year in fertigation of 50% RDF was on par with fertigation of 75% RDF and soil application of 100 per cent RDF. Hence, fertigation of 50% RDF can be recommended.

- Aliyarnagar, Ambajipeta, Arsikere centres: Application of 75% RDF through fertigation recorded significantly higher nut and copra yield per palm per year compared to soil application of 100% RDF and on par with 100% RDF through fertigation. Hence, fertigation of 75% RDF can be recommended.

3. Higher productivity in coconut can be achieved through the adoption of cropping system approach. The crops are to be selected based on agro-climatic situation of the region.

4. The performance of Noni as inter-crop in coconut is better in tissue culture plants compared to seedlings at Arsikere, Ambajipeta, Mandouri and Veppankulam Centres, while, seedlings are performing better at Aliyarnagar, Bhubaneshwar, Jagadalpur, Kahikuchi and Ratnagiri Centres.

Stem bleeding management

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

Biological management of leaf blight

6. Root feeding of *P. fluorescens* culture filtrate @ 25ml/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.

Management of black headed caterpillar

7. Studies conducted at all three centres on olfactory conditioning of parasitoids of coconut black headed caterpillar, *O. arenosella* by exposing them to the odor of larval frass and larval damaged leaves revealed that parasitisation levels of *O. arenosella* was found to be significantly more in conditioned parasitoid release treatment than in the unconditioned parasitoids release treatments. Hence, while releasing parasitoids against *O. arenosella,* they should be invariably olfactory conditioned for 72 h.

8. Studies conducted on the implementation of IPM package including use of pheromones, *Baculovirus*, naphthalene balls and *Metarhizium anisopliae* revealed that there was percent incidence of rhinoceros beetle along with reduction in leaf and spindle damage was noticed in the experimental gardens one year after implementation of IPM package.

Management of sulphi wilt

9. Among the combination of different bio-agents, bio-fertilizers, farmyard manure combination with basal application of *T. harzianum* (1000g)+ organic manure (10 kg) followed by crown application of 100% culture filtrate of *T. harzianum* were found superior to check the wilt disease in sulphi palm.

III. Profile of AICRP on Palms

Palms such as coconut (*Cocos nucifera* L.), oil palm (*Elaeis guineensis* Jacq.) and palmyrah (*Borassus flabellifer* L.) have played major role in the Indian agrarian economy. The concept of AICRP came into existence to carry out the location specific research, and to address the region specific problems. The All India Co-ordinated Research Project on Palms was started in 1972, with the following objectives:

- 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.
- Bio-intensive insect-pest and disease management strategies, modelling and forecasting of disease incidence and documenting insect pest dynamics in changing scenario of palm ecosystem.
- Develop 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.	Jagdalpur	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagdalpur - 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 (DBSKKV, 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	Pattukkottai	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, Mharashtra (DBSKKV, 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 2013-14 was Rs. 450.00 lakhs (ICAR share)

Sl. No.	Head	Expenditure as on 31-3-14
1	Pay & Allowances	269.00
2	T. A.	26.76
3	RC	132.08
4	HRD	22.16
	Total	450.00

Mode of implementation

The scheme is implemented through the respective State Agricultural/Horticultural 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

IV. Experimental Results in Coconut

4.1 Genetic Resources and Crop Improvement

Gen.1: Evaluation of existing germplasm in coconut

Centres: Bhubaneshwar, Navsari, Sabour

Bhubaneshwar

The observational trial, comprising 16 accessions including 4 dwarfs and 12 talls was initiated during December, 2004. The data on growth parameters (Table -1) revealed that, among 4 dwarfs, Gangabondam exhibited maximum stem girth (128.0cm), functional leaves (19.6), annual leaf production (12.0), length of leaf and leaflet (4.4 m & 1.1 m) & breadth of leaflet (4.8cm). MYD and COD recorded lower plant height (4.6 m) compared to Gangabondam and MGD (6.3 m).

Among the talls, performance of WCT and Guam was relatively better as maximum plant height (8.3m), higher annual leaf production (12.3), length of leaf (5.6m) and length and breadth of leaflet (1.2m & 5.4cm) were recorded in WCT.

Initiation of spadix was observed in all the dwarf accessions. The no. of inflorescences produced per palm ranged from 4.3 (MYD) to 11.3 (Gangabondam). The no. of female flowers per palm was maximum (133.3) in Gangabondam and minimum (52.2) in MGD. Among the talls, flowering was observed in all accessions except in Pratap & Sanramon. The maximum no. of inflorescences (11.5) and female flowers (195.0) were recorded in Guam and in AO, respectively.

Sabour

Altogether 15 coconut accessions are being evaluated and seed nuts of 5 accessions *viz*., MYD, COD (IND 007), MOD (IND 048), KGD and GBGD were planted in June, 2011 and remaining varieties were planted in July, 2013. The data depicted in table-1 revealed that plant height varied from 115.2 cm in KGD to 275.0 cm in MYD. Similarly collar girth was maximum (58.9 cm) in MYD followed by COD (49.5cm). Parameters like number of functional leaves and number of leaflets also showed similar trend. Young plants were protected against cold by polysheets covering during winter period.

Seedlings of var. LCOT (Chandra Kalpa), PHOT (Kera Chandra), ADOT(IND 018), Tiptur Tall (Kalpatharu), ECT (CPR 509), Arasampatti Tall (Aliyarnagar Tall), Zanzibar Tall(IND037), received from CRS, Veppankulam centre, and seed nuts of Assam Green Tall received from Kahikuchi centre, have been raised and planted in the main field during July, 2013.

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

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

Evaluation materials: 5-10 local ecotype collection (CRP series)

Experimental design: 5 ecotypes in RBD, other ecotypes will be maintained as an observational trial

Aliyarnagar

A total of 11 ecotypes were collected during 2007 from Coimbatore, Dindigul, Theni and Nagercoil districts of Tamil Nadu. Five ecotypes were maintained as a replicated trial and the rest were planted as an observational trial.

Replicated trial: The replicated trial comprises of 5 local ecotypes planted during May, 2008. Since the replicated trial was underplanted, felling of

adult palms during 2012 resulted in mortality of some plants, and the genotypes CRP735 and CRP736 did not establish well. Hence these genotypes have been replaced with CRP742 from Nagercoil district and CRP745 from Theni district. Seednuts were collected again from the identified mother palms, sown in the nursery and gap filling was done during 2013. Morphological observations for vegetative growth attributes revealed that the height of the genotypes ranged from 193.4cm (CRP742) to 256.4cm (CRP743). Maximum leaf production (13) was observed in CRP743. The same genotype was found to be superior to other genotypes for leaf length (458.5cm), petiole length (142.6cm) and total leaflets per leaf (173 leaflets).

Observational trial: Six genotypes are being maintained under this set. Trunk formation has been observed in all the palms. The palms have attained a mean trunk height of 97.5cm with a girth of 144.8cm at the base. Annual leaf production was maximum in CRP741 (11.8), while maximum functional leaves were recorded by CRP738 (27). CRP741 also recorded maximum number of leaflets per leaf (197), maximum leaf length (509.1cm) and petiole length (167.7cm). A few palms in each genotype have attained the flowering phase. The average age of first flowering ranged from 48 months (CRP738) to 57 months (CRP746). In genotypes *viz.,* CRP738, CRP740 and CRP742, the palm which attained flowering first was ear marked for floral observations. Floral parameters were recorded on five consecutive inflorescences. In CRP 738, the male phase lasted for 11.8 days, while female phase lasted for 6.8 days. In CRP740 and CRP742, the male and female phase lasted for 12.6 and 6.2 days, respectively. There was no overlapping between male and female phases in any of these genotypes.

Ambajipeta

So far 13 local elite germplasm accessions were collected from traditional coconut growing districts *viz.,*Srikakulam, East and West Godavari of AP and seedlings were raised. The experiment was laid out during February, 2013. Five accessions *viz.,* Pillalakodi green (CRP745),

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

Geno-type	Girth (cm)	Height (cm)	LP*	Geno-type	Girth (cm)	Height (cm)	LP*	Geno-type	Girth (cm)	Height (cm)	LP*
Aliyarnagar				Mondouri				Kahikuchi			
CRP737	46.5	214.9	7.1	CRP779	125.6	78.7	15.1	CRP 701	130.2	630	10.2
CRP739	82.5	193.4	8.6	CRP780	121.2	100.0	13.7	CRP 702	155.7	695	10.8
CRP740	96.2	256.4	12.7	CRP781	117.0	125.2	15.5	CRP 703	148.2	697	11.2
CRP742	56.5	216.6	7.2	CRP782	123.7	76.2	14.2	CRP 704	147.4	687	10.3
CRP746	91.4	222.8	9.8	CRP783	116.8	69.3	12.8	CRP 705	139.4	630	10.1
Jagdalpur				Navsari				CRP 706	124.4	645	11.1
CRP 723	20.5	134.7	5.3	CRP729	41.0	422.4	6.2	CRP 707	118.5	632	10.9
CRP 724	18.6	130.2	5.2	CRP730	36.8	386	5.2	CRP 708	129.2	628	11.3
CRP 725	20.4	133.6	5.8	CRP731	32.8	326	4.2	CRP 709	122.5	635	9.9
CRP 726	21.4	128.4	4.5	CRP734	14.6	104.6	3.8	CRP710	115.6	610	11.3
CRP 727	22.5	132.8	4.5								
CRP 728	25.6	147.6	5.0								

*LP- Leaf production

Table 2: Gen1A-Floral parameters of local germplasm of coconut planted in 2005, (Kahikuchi)

Sr. No.	Genotypes	Age at first flowering (Months)	No. of Inflore-scences	No. of female flowers/ Inflorecence	No. of Spikelets	First fl.leaf axil No.	Male phase (days)	Female phase (days)
1	CRP 701	67	7.1	14.5	24.2	53.4	17.5	6.4
2	CRP 702	68	7.6	23.7	21.7	54.5	18.4	5.4
3	CRP 703	67	7.1	17.2	34.2	52.2	16.3	6.8
4	CRP 704	78	4.5	9.5	29.7	58.4	19.5	5.5
5	CRP 705	70	7.6	13.8	27.2	56.5	17.2	4.6
6	CRP 706	70	7.9	9.7	29.0	56.2	18.5	6.2
7	CRP 707	67	7.5	15.5	30.2	52.5	19.4	5.8
8	CRP 708	70	5.1	10.0	20.6	57.0	18.0	4.5
9	CRP 709	72	4.6	8.6	22.3	58.2	19.2	5.1
10	CRP710	73	4.8	15.7	29.9	56.5	20.4	6.5
11	WCT	73	2.5	8.4	16.5	55.9	20.0	6.2
12	Assam GreenTall	67	9.0	24.5	18.74	53.4	18.5	6.7
	CD (P=0.05)	0.76	0.7	1.1	2.2	0.8	0.5	0.4

Pillalakodi brown (CRP46), Jonnalarasi brown (CRP748), ECT green (CRP750) and Ganga-bondam (CRP749) were planted in RBD with four replications @ 4palms/replication and the remaining accessions *viz.*, Jonnalarasi green (CRP747), ECT Brown (CRP751), Itikulagunta ECT Big (CRP754), Itikulagunta ECT Small, Sarada-puram ECT (CRP753), Srikakulam ECT (CRP752), Vemulapalli ECT Big, Vemulapalli ECT Small were planted as an observational trial with 6 palms per genotype and it is in establishment stage.

Arsikere

The seed nuts of identified palms were collected and planted in the nursery for seedling production. The seedlings selected among germplasm *viz.*, CRP811, CRP817, CRP818, CRP820, CRP821 and check variety TPT were planted during July, 2013 in C_1 plot with 4 replications in RBD. The observation recorded for growth parameters in the main field of replicated germplasm trial showed significance for all the traits except leaflet breadth and number of leaflets (left).

Observational trial: CRP823 and CRP816 were planted as observational entries with 10 palms each in E9plot. Later, CRP812, CRP815, CRP818, CRP822, KVK-1 and CRP 816 were planted on 08.08.13 in C_1 plot as observational entries. CRP813 was planted on 03.12.2013 in E_9 plot with five plants.

Bhubaneshwar

Eleven local accessions were planted during December, 2003 with 10 palms per accessions. The growth parameters recorded during the year revealed that the plant height was above 7.0m in almost all local accessions. The maximum plant height (8.5m) was recorded in CRP 790 and minimum plant height (6.9 m) in CRP 800. On the other hand, the minimum plant girth (128.9cm), no. of functional leaves and annual leaf production rate (21.1 & 10.7), breadth of leaflet (4.8 cm) and maximum petiole length (139.4 cm) were recorded in CRP 792, CRP 795, CRP 798 & CRP797, respectively. The length of leaf and leaflet among different local types ranged from 4.4m (CRP 799) to 5.2m (CRP 797) and

1.05m (CRP 790) to 1.3 m (CRP 796), respectively.

Jagdalpur

Replicated trial: The seedlings of six ecotypes from selected germplasm were planted during July 2011 in RBD with four replication and four palms per replication and growth observation were recorded. The highest plant height, petiole length, leaf length and girth of plant were recorded in CRP728, whereas functional leaves were maximum in CRP725. Further, four more palms were identified and marked in villages *viz.*, Satosha, Dharampura, Kondagaon and Sukma district and seed nuts were collected from the mother palm and sown in nursery.

Kahikuchi

Replicated trial: The experiment was initiated with 10 local accessions of coconut in Assam along with two check varieties *viz.,* Assam Green Tall and WCT in RBD with three replications. The accessions were collected from four districts of Assam *viz.,* Kamrup, Darrang, Nalbari, and Borpeta (CRP701 to CRP710) and planted in the main field during May, 2005. The data showed that the highest plant height (725cm), collar girth (157.1cm), number of functional leaves (20.15) and annual leaf production (11.45) were recorded in Assam Green Tall. The highest petiole length (162cm) and leaf length (417cm) were observed in CRP706 and CRP708, respectively. In case of leaflet number (right and left), the highest values (R: 117.3, L: 116.4) were recorded in CRP708 and the leaflet length (111.7cm) and maximum leaf breadth (6.95cm) was observed in Assam Green Tall. The reproductive parameters like age at first flowering, leaf axil for first flowering, average number of inflorescence, male phase, female phase etc. were recorded. Early flowering was recorded in accession *viz.,* CRP701, CRP703, CRP707 and Assam Green Tall which was 67 months from planting. No overlapping of male and female phases was observed in all the germplasm studied. With regard to nut characteristics and nut yield, the genotype CRP702 recoded the biggest nut size (length: 28.3 cm, girth: 49.2 cm) with nut weight (1450g/nut) and tender coconut water content of 375 ml/nut. Significantly the highest nut yield of 42.6 nuts/palm/year was observed in Assam Green Tall compared to other germplasm (Table 2).

Observational trial: Five new coconut germplasm *viz.,* CRP711, CRP712, CRP713, CRP714, and CRP715 collected from two districts of Assam *viz.,* Nowgaon and Marigaon were planted in the main field during April, 2009. The plants are in juvenile stage and the observations on morphological para-meters were recorded during July, 2012 to June, 2013. The highest plant height (452cm) was observed in CRP713, whereas, the highest collar girth (111.6cm), leaf production (11.33) and functional leaves (9.10) were recorded in CRP715. The highest leaf length (309.3cm) and number of leaflets both right and left (85.8 & 84.5) and leaflet length (99.8cm) were observed in CRP714, while the longest petiole length (139.1cm) and leaf breadth (5.52cm) were found in CRP713.

Mondouri

Replicated trial: Ten local types of germplasm from different districts of West Bengal were collected. Of these, five ecotypes have been planted as a replicated trial in the main field during 2007 in RBD. Significant variations were observed for different vegetative characters. The data showed that the highest trunk height (125.25cm) was recorded in CRP781 followed by CRP780 (100cm). Number of leaves was maximum (15.5) in CRP781. Maximum girth (125.63cm) was recorded in CRP779. While observing the different leaf parameters, the highest length of leaf bearing portion (329.0cm) and leaflet number (102.2L; 104.2R) were recorded in CRP781. However, leaflet length was maximum in CRP779 (118.2cm) and leaf breadth was maximum in CRP782 (5.5cm).

Observational trial: Another 5 ecotypes have been planted as observational trial in the main field during 2009. From the data, it was observed that

the highest plant height was recorded in CRP787 (463.4cm) followed by CRP786 (459.3cm). Number of leaves was maximum in CRP785 (15.6). Maximum girth was recorded in CRP788 (90.2cm). Regarding different leaf parameters, the highest length of leaflet bearing portion was recorded in CRP786 (297.7cm). Leaflets were maximum in CRP788 (75L) and CRP784 (72R). However, leaflet length was maximum in CRP787 (88.5cm) and leaflet breadth was maximum in CRP787 (4.6cm).

Navsari

The four local germplasm were collected and planted in the field with randomization during the month of July, 2013. From the observations it was revealed that, the germplasm CRP 729 had significantly vigorous growth as compared to other germplasm of coconut.

Pilicode

Survey of local germplasm was continued and 6 types were located and described using the NBPGR descriptor. One dwarf type with high copra and oil from Annur in Payyannur and one each from Trivandrum, Mannuthy, Thrissur and Vorkady, Manjeshwar and two types from Azheethala, Nileswar were identified. The seed nuts of these types were collected for raising nursery and laying out the experiment.

Ratnagiri

Set I: The growth parameters *viz,*.height, girth, leaf production per annum, functional leaves, petiole length, number of leaflets, leaflet length and leaflet breadth showed non-significant differences among the genotypes.

Set II: During the initial growth period, wide variations were observed for all growth characters *viz,*. girth (21.8%), height (25.1%), number of leaves (12.2%), functional leaves (22.9%), leaf length (28.4%), petiole length (20.3%), leaflet number left (35.7%), leaflet number right (35.57%), leaflet length left (19.09%), leaflet length right (19.16%) and leaflet breadth (12.73%).

Set III: To evaluate sweet coconut (Mohacha Naral) type found in Guhagar Tahasil of Ratnagiri district (Maharashtra), fourteen seedlings and one set of embryo culture plantlets were planted in the field. The initial growth performance of the germplasm collection of these sweet coconut types showed wide variation for all growth parameters *viz.*, girth (28.6%), height (23.1%), number of leaves (21%), functional leaves (22.1%), leaf length (19.2%), petiole length (16.2%), leaflet (23.5%L; 22.8%), leaflet length (15.4%L; 14.0%R), and leaflet breadth (15.2%).

Sabour

Surveys have been made in coconut growing areas of Kahalgaon and Katihar, and Bhagalpur district. Thirteen collections were made and they were put for germination. But germination in most of the collected genotypes was very poor.

Veppankulam

Among sentence not complete them, five ecotypes have been planted and evaluated. The morphological attributes of the local ecotypes were evaluated. Among the genotypes, number of leaves was the highest in Aliyarnagar tall with 33.0 leaves/ palm followed by Kera Keralam (32.0) and CRP 718 (31.3). CRP 717 recorded the highest petiole length (1.8m), leaf length (6.3m) and number of leaflets on both right (112.9) and on left side (113.1m) of the leaf. Length of leaflet was highest in CRP 718 with 147.9cm and leaflet width was highest in CRP 720 of 6.4 cm. The palms started bearing since 2012, the first flowering was observed in 50th month in the ecotype CRP717 since the plants were planted as underplanting. The flower characters have been recorded. Among five entries CRP 718 recorded highest number of bunches per palm (30.5) followed by CRP 720 (13.0). No. of female flowers was highest in CRP 719 (24.3) followed by CRP 720 (21.8). CRP 716 and CRP 718 recorded highest no. of nuts 8 weeks after pollination (6.0).

Setting was highest in CRP 717 (35.8%) followed by CRP 718 (35.7%).

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

Centres: Arsikere, Bhubaneshwar, Veppankulam

Arsikere

The set II trial consists of 4 hybrids and 1 local check (TPT). The trial was laid out during 1992 on RBD with 4 replications. The observations and growth parameters and yield of nuts were recorded. The tree height and the cumulative leaves produced were significantly higher in MYD x TPT. Tree girth was significantly higher in TipturTall which was on par with LCO x GBGD and LCO x COD cross. The nut yield and copra yield during 2011-12 and 2012-13 was higher in MYD x TPT. The mean nut and copra yield were also higher in MYD x TPT, which was superior compared to other hybrids and local check (Table 3).

Bhubaneshwar

The trial, consisting of eight cross combinations and one tall cultivar as check was laid out during November, 2005 in RBD with four replications. The data on growth and floral attributes of the palms recorded during 2012-13 revealed that there was no significant variation among the cross combinations and the check except for the girth of the palm at the base and the length of the leaf. The maximum girth of the palm (159.1cm) was recorded in GBGD x PHOT hybrid which was on par with the other hybrids such as ECT x MYD (155.9cm), ECT x GBGD (149.9cm), GBGD x ECT (146.2cm) and the check, ECT (144.8cm). The minimum girth of the palm (123.5cm) was recorded in LOCT x COD hybrid. The longest leaf (4.8m) was recorded in GBGD x PHOT hybrid and the shortest leaf (4.4m) was recorded in LCOT x COD hybrid. The flowering was initiated in 52.6% palms.

Veppankulam

The experiment was started in the year 1986. Among the 14 hybrids, COD x WCT recorded maximum cumulative yield of 133 nut per palm over 15 years, whereas, ECT x COD recorded maximum annual nut yield of 193 nuts/palm for the year 2012-13 (Table 4).

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

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

Table 3: Gen2- Performance of coconut hybrids planted in 1992, (Arsikere)

Genotypes	Plant height (m)	Girth 1m from base (cm)	Functional leaves on the crown (No.)	Annual leaf production (No.)	*Mean nut yield (No.)	Mean copra (g)	Copra per annum* (kg/palm)	Oil content (%)	Estimated oil yield (kg/palm)
COD x WCT	4.9	74.6	21.9	12.1	79.5	149.6	12.0	63.9	7.6
LCO x COD	4.8	85.1	23.0	11.9	72.7	152.3	11.1	68.6	7.4
MYD x TPT	5.6	78.6	25.1	12.9	106.5	180.6	19.3	67.3	13.0
LCO x GBGD	5.2	83.4	22.5	12.2	86.3	162.6	14.1	68.7	9.5
Tiptur tall	4.6	88.1	22.5	12.2	77.4	163.5	12.7	68.6	8.5
SEm ±	0.3	2.4	1.0	0.2	3.7	3.4	0.6	3.2	0.4
CD (P=0.05)	0.8	7.3	3.2	0.7	11.4	10.5	2.0	9.9	1.4
CV %	10.8	5.8	9.0	3.6	8.7	4.2	9.4	9.5	9.7

*Mean data of 4 years (2009-2013)

Evalutation materials: 5-6 location specific cross combinations

Experimental design: RBD, 4 replications, 6 palms per genotype per replication

Aliyarnagar

Five location specific cross combinations *viz.*,Chowghat Orange Dwarf x Arasampatti Tall, Arasampatti Tall x Malayan Green Dwarf and Malayan Green Dwarf x Arasampatti Tall, Chowghat Orange Dwarf x West Coast Tall and Kenthali x Arasampatti Tall were planted in the main field during September, 2012 in four replications in RBD. Phenotypic data was recorded during June, 2013 and analysed for I and II order statistical measures. The crosses recorded a mean height of 154.6cm, girth of 25.1cm at the base with five functional leaves. On an average, there were 57 leaflets per leaf with a mean length of 57.0cm and breadth of 3.1cm. Variability was the highest for girth (18%) followed by height (17.5%). Leaf parameters recorded comparatively lower variability (<20%).

Table 4: Yield attributes of 14 hybrids planted during 1986 at CRS, Veppankulam

S. No.	Hybrids	Annual nut yield/palm/ year (2012-13)	Cumulative mean nut yield/palm (15 years)
1	COD x WCT	165.5	122.1
2	WCT x COD	188.5	133.9
3	WCT x MYD	102.5	113.9
4	GBGD x ECT	89.5	115.7
5	WCT x GBGD	159.9	117.1
6	LCT x PHOT	189.5	120.6
7	ECT x COD	192.5	98.6
8	GBGD x PHOT	122.5	87.0
9	LCT x CCNT	159.9	111.1
10	CCNT x PHOT	88.5	88.3
11	GBGD x LCT	145.9	111.0
12	GBGD x Fiji	132.5	73.2
13	CCNT x LCT	112.1	117.2
14	VHC 1	143.8	117.6
	Range	88.5 to 192.5	73.2 to 134.0
	CV (%)	27.5	29.9

ANOVA analysis showed that Kenthali x Arasampatti Tall, Arasampatti Tall x Malayan Green Dwarf and Malayan Green Dwarf x Arasampatti Tall were significantly superior to other combinations for height and girth. Malayan Green Dwarf x Arasampatti Tall and Kenthali x Arasampatti Tall had significantly more number of leaflets compared to other crosses. The cross combinations did not differ significantly for other leaf parameters such as leaf length, petiole length, functional leaves, leaflet length and leaflet breadth (Table 5).

Ambajipeta

The seedlings of cross combinations *viz.*, ECT x Cochin china, Ganga Bondam x Cochin China, ECT x Philippines Ordinary, Ganga Bondam x Philippines Ordinary, Philippines Ordinary x Gangabondam, ECT x Gangabondam were planted in June, 2011 in RBD with three replications. Due to Helen and Philin cyclones during October and November, 2013, some of the accessions were dead. Gap filling has been taken up during February, 2014 and the experiment is in vegetative stage and establishment stage. Observations recorded during 2012-13, revealed that, ECT x PHOT recorded the highest plant height (307.3cm), leaf length (156.8cm) and petiole length (63.0cm). Number of functional leaves showed no significant differences. ECT x PHOT recorded the highest right and left leaflet number of 33.1 and 31.2 and it is on par with PHOT x GBGD with 24.5 and 23.3 respectively. Leaflet length (73.6cm) and leaflet breadth (3.0cm) were also high in ECT x PHOT.

Arsikere

The trial was initiated with the crossing programme during 2009-10. The seed nuts of all the 6 hybrids *viz.*,TPT x PHOT, TPT x LCOT, LCOT x MYD, LCOT x MOD, TPT x MYD and TPTx

Table 5: Gen2A-Growth characters of location specific combinations planted in different AICRP centres

Genotype	Girth (cm)	Height (cm)	LP*	LL*	PL*	Genotype	Girth	Height (cm)	LP (cm)	LL	PL
Aliyarnagar						Kahikuchi					
COD x APT	18.8	139.5	4.7	131.3	47.1	AGT x Cochin China	98.0	437	10.4	352	101.0
APT x MGD	26.7	152.4	5.3	137.3	42.0	Kamrupa x Kerahandra	110.0	428	10.9	336	99.6
MGD x APT	30.8	171.5	5.5	137.5	45.1	Kamrupa x IND 058	102.0	390	10.6	311	94.3
COD x WCT	16.7	115.9	4.5	112.6	41.2	CRP502 x Kamrupa	112.0	401	11.2	340	96.0
KTD x APT	32.5	193.6	5.4	160.7	51.5	CRP501 x Kera Chandra	119.0	454	11.4	342	96.6
Arsikere						Mondouri					
TPT x PHOT	10.2	103.0	2.8	90.2	32.9	Chandra Kalpa x KeraChandra	80.0	487.3	14.0	296.2	65.7
TPT x LCT	12.2	117.0	3.1	117.8	52.0	CRP509 x CRP502	74.2	428.3	14.2	302.5	68.5
LCT x MYD	12.8	133.0	3.1	134.0	50.5	Kera Chandra x Chandra Kalpa	70.5	359.5	12.5	279.2	56.2
TPT x MOD	10.8	120.0	3.0	119.3	43.4	CRP509 x Jamaica	71.5	383.7	13.0	278.7	60.7
TPT x MYD	11.4	138.0	2.3	133.8	51.5	CRP509 x Java tall	89.5	425.7	14.2	297.5	63.9
TPT x MOD	10.6	114.0	3.2	114.3	41.9						

* LP - Leaf production, * LL - Leaf length, *PL - Petiole length

MOD were harvested and sown in nursery for production of seedlings. The best and uniform seedlings were selected and planted in the experiment plot in B1 plot on 25.09.2012 at HRS, Arsikere. The observations on growth parameters were recorded and statistically analysed. However, numerically plant height, girth, leaf production rate, and cumulative leaves were higher in local check TPT and functional leaves were more in TPT x MOD (Table 5).

Bhubaneshwar

The seedlings of five location specific cross combinations were planted in RBD with four replications during February, 2008. The morphological data recorded during the year revealed no significant difference among the palms in different cross combinations. The palms in the trial are in the pre-bearing phase, flowering was initiated only in the cross combinations of SKL x COD, SKL x GB and GB x Guam after 5 years of planting.

Kahikuchi

The experiment was undertaken with 5 cross combinations of coconut. The seedlings were planted in the main field during April, 2009 in RBD with six palms per replication. Data on morphological parameters indicated that the highest plant height (454cm), girth (119cm), maximum leaf production per year (11.4), and no. of functional leaves/palm (18.9) were recorded by CRP501 x Kera Chandra. On the other hand, Assam Green Tall x Cochin China recorded the highest leaf length

(352cm), petiole length (101cm), leaflet number (Right (R): 99.0, Left (L) :97.0), leaflet length (105.0cm) and breadth (5.37cm). First flowering was observed in Assam Green Tall x Cochin China and CRP502 x Assam Green Tall which is 54 months and 55 months, respectively (Table 5).

Mondouri

The data on vegetative growth parameters showed significant variation among the five different Tall x Tall crosses. Maximum plant height was recorded in Chandra Kalpa x Kera Chandra (487.2cm). Maximum number of leaves was observed in CRP509 x CRP502 (14.2) and CRP509 x Java. Maximum girth was recorded in CRP509 x Java Tall (89.5cm). In case of leaf parameters, the highest length of leaflet bearing portion was observed in CRP509 x CRP502 (302.5cm) while maximum number of leaflets per leaf (94.0L; 94.5R) were recorded in Chandra Kalpa x Kera Chandra. However leaflet length was maximum in CRP509 x Java tall (99.7cm) and leaf breadth was maximum in Chandra Kalpa X Kera Chandra (5.1cm) (Table 5).

Ratnagiri

The experiment was planted in December, 2006 with different cross combinations. Significantly maximum girth (125.4cm) was recorded in Pratap x COD which was on par with CRP514 x COD cross combination (122.0cm). Similarly, leaflet breadth varied significantly among different cross combinations. Maximum leaflet breadth (4.8cm) was recorded in COD x CRP513, which was closely followed by Pratap x COD (4.5cm). There were no significant differences among different cross combinations with respect to height, number of leaves/year, functional leaves on crown, leaf length and number of leaf lets per leaf. Flowering was observed in treatments four cross combinations. In all, 23 palms belonging to different cross combinations showed flowering when the palms had an average of 41 leaves and the average age at first flowering was 66 months.

Veppankulam

The experiment was started in 2006 with 5 hybrids and the morphological, floral and nut characters have been recorded. Among the five crosses, MOD x WCT registered the highest number of functional leaves (27.2) followed by WCT x MGD (26.2). Length of the petiole was the highest in VPM3 x COD (1.5m) followed by WCT x MOD (1.5m). WCT x MOD recorded the highest length of leaf of 3.4m followed by WCT x KEN (3.4m). Number of leaflets was found to be the highest in WCT x KEN (194.6) followed by WCT x MGD (193.5).WCT x KEN recorded the highest leaflet length of 1.1m followed by WCT x MGD of 1.1m. Breadth of the leaflet was the highest in both WCT x KEN and WCT x MOD (5.6m).

Among six hybrids, the total soluble sugar was the highest in WCT x KEN(5.80 ^{0}brix) followed by WCT x MGD (5.55 ^{0}brix). The highest volume of tender nut water was observed in MOD x WCT (380ml) followed by WCT x MGD (275ml). The hybrid WCT x MGD recorded the highest quantity of tender nut endosperm of 125g followed by hybrid VPM3 x COD (115g). Organoleptic scores for tender nut water and endosperm were the highest in the hybrid WCT x KEN (8.0 and 7.0).

Nut characters of new coconut hybrids were studied based on four nuts per genotype. Mean of the four nuts revealed that among the hybrids, MOD x WCT recorded the highest fruit weight (1193g), kernel weight (360g), fruit length (17.2cm) and fruit breadth (20.7cm) and kernel thickness of 1.1cm. Dehusked nut weight was the highest in WCT x KEN (580g). Among the 5 hybrids, MOD x WCT recorded maximum annual nut yield of 102.8 nuts in 2013-14 (three harvest made until March, 2014).

Gen. 3 :Trial of promising seed materials in coconut

Centres: Ambajipeta, Bhubaneshwar

Experiment details: RBD with 3 replications, 6 palms per genotype per replication

Experimental materials:

S. No.	Centres	Combinations evaluated
1	Ambajipeta	Chandra sankara, Chandra laksha, VHC1, VHC 2, Kera Ganga, Laksha Ganga, Double century, Godavari Ganga, Chandra Kalpa
2	Bhubaneshwar	Kera Sankara, Kera Ganga, Chandra sankara, Kera Chandra, Chandra Kalpa

Ambajipeta

Among the different hybrids and varieties, significant differences were observed for fruit weight, dehusked fruit weight, husk weight, water content, copra content, copra content/annum, oil content and estimated oil yield. The highest yield of 165 nuts was recorded in Godavari Ganga followed by Kera Ganga (140.4 nuts/palm). Regarding nut characters, the highest fruit weight was recorded by Chandra Laksha (1235 g) and it was on par with Chandra Sankara with 1172g fruit weight. Copra content per annum was the highest in Godavari Ganga (28.1kg) followed by Chandra Laksha with 27.7kg copra. Godavari Ganga also recorded highest oil yield of 18.3kg per palm and it was on par with Chandra Laksha (18.0kg) (Table 6).

Bhubaneshwar

The experiment was laid out with three hybrids, involving WCT as one of the parents, two promising varieties and one local check (IND 041) in August, 2004 in RBD with four replications. There was no significant variation among the tested in the trial except for the girth of the palm at the base. The girth of the palm was maximum (127.3cm) in WCT x COD hybrid and minimum (88.6cm) in COD x WCT hybrid.

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

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

Evaluation materials: Five tall x tall hybrids *viz.*, LCT x ADOT, ADOT x ECT, BGR x ADOT, ECT x LCT, WCT x TPT received from CPCRI, Kasaragod and a local check.

Experimental design: RBD with 4 replications, 6 palms per genotype per replication.

Aliyarnagar

Five tall x tall cross combinations received from CPCRI, Kasaragod were planted in the main field during August, 2011. The data revealed that the T x T crosses had attained a mean height of 307.1cm, with a girth of 63.6cm at the base. The plants produced about nine leaves per annum with a mean leaf length of 248.4cm and petiole length of 86.9cm. The plants produced 87.5 leaflets per leaf on an average. Considering the genotypic differences, LCOT x ADOT, ECT x LCOT and WCT x TPT had crossed a mean height of 300cm. LCOT x ADOT and ECT x LCOT produced longer leaves (82.9cm; 82.1cm) and more number of leaflets numerically (93 and 92 leaflets, respectively). However statistical analysis showed that there were no significant differences between the five hybrids for all the nine seedling parameters studied.Although these hybrid combinations are tall x tall crosses, one palm of WCT x TPT cross had flowered during December, 2013. The age of this palm during its first flowering was only 34 months (Table 7).

Ambajipeta

Seed nuts of the tall x tall cross combinations were received from CPCRI, Kasaragod and nursery was raised. Due to Helen and Philin cyclones in the year 2013, some of the accessions had died. Gap filling has been taken up during February, 2014 and the experiment is in vegetative stage. During the year 2012-13, observations revealed that, the tall x tall hybrids showed no significant differences for leaf length, leaflet length and leaflet breadth.

Table 6: Gen.3-Fruit component traits of the coconut hybrids planted in 2002, (Ambajipeta)

Genotypes	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Dehusked fruit weight (g)	Husk weight (g)	Kernel weight (g)	Copra content (g/nut)	Copra out turn (kg/palm/annum)	Oil content (%)	Estimated oil yield (kg/palm)
Chandra Sankara	21.6	14.5	1172.6	510.3	662.3	211.5	128.1	15.1	65.6	9.9
Laksha Ganga	19.4	13.3	1043.3	472.3	571	174.6	113.3	15.5	63.2	9.8
Kera Ganga	18.6	14.2	921.3	413.2	508.1	205.4	107.6	15.1	65.0	9.8
Chandra Laksha	19.8	13.0	1235.6	601.8	633.8	178.5	184.3	24.9	65.0	16.2
VHC I	19.4	14.5	755.3	398.2	357.1	152.3	125.6	12.5	62.1	7.7
VHC II	21.0	12.4	1042.3	555.7	486.7	224.7	172.2	17.0	70.3	12.0
Chandra Kalpa	19.6	12.8	1010.3	446.4	563.9	219.2	140.2	15.7	62.0	9.7
Double Century	18.5	15.9	1152 .0	611.3	540.7	221.5	147.6	16.0	62.3	10.0
Godavari Ganga	21.4	13.2	1082.0	572.5	509.5	216.4	151.2	25.0	65.0	16.3
SEm ±	1.9	2.1	71.02	29.4	-	18.5	10.1	-	0.8	-
CD (P=0.05)	N.S	N.S	213.1	88.2	-	N.S.	30.4	-	2.37	-

Arsikere

The seed nuts of all the 5 hybrids were received from CPCRI, Kasaragod and sown in nursery and seedlings were planted in experiment plots on 14.09.2012. The growth parameters were recorded and the data revealed that traits *viz.*, plant height, leaf length, leaflets among the hybrids was non significant.

Bhubaneshwar

The seedlings of five different tall x tall cross combinations (WCT x TPT, LCOT x ADOT, BGRT x ADOT, ECT x LOCT and ADOT x ECT) were raised and planted in the field along with the seedlings of local check (IND 041) in June, 2013.

Kahikuchi

Seedlings of the T x T crosses were planted during June, 2013. Morphological characters (leaf splitting not observed) of five hybrids including checks were recorded. The highest plant height (145cm), girth (21.6cm), number of leaves (6.6) were observed in LCT x ADOT whereas, the hybrid ADOT x ECT recorded the lowest plant height (117cm), stem girth (16.8cm) and least no. of leaves (5.0).

Navsari

This experiment was initiated by planting seedlings of crosses such as BGR x ADOT, LCOT x ADOT, ECT x LCOT, WCT x TPT, ADOT x ECT and Gandevi Selection as local check during July, 2013.

Ratnagiri

This experiment was initiated in August, 2011. The results obtained on growth performance of T x T hybrids revealed that significantly maximum height (284.5cm) was recorded in ECT x LCOT which was closely followed by WCT x TPT (271.6cm) and Pratap (248.3cm). There was no significant differences observed for girth and other leaf parameters.

Veppankulam

Among the hybrids, BGR x ADOT registered

Table 7: Gen10- Performance of tall x tall cross combinations at various AICRP (Palms) centres

Genotypes	WCT x TPT			LCOT x ADOT			BGR 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	59.8	309.6	9.1	75.4	356.0	9.2	62.2	264.6	9.3	49.1	264.4	9.1	71.5	341.0	9.6
Ambajipeta	-	242.8	7.7	-	187.1	7.5	-	182.1	7.5	-	117.3	5.6	-	177.1	6.5
Arsikere	18.5	170.0	6.4	19.9	184.0	6.5	15.2	129.0	6.0	15.9	124.0	6.4	13.9	95.0	5.3
Ratnagiri	66.7	271.6	6.9	58.0	236.0	6.7	63.9	233.9	6.6	62.1	245.7	6.1	71.7	284.5	6.9
Veppankulam	43.2	264.0	13.4	43.3	295.0	11.2	59.5	330.0	15.4	46.1	312.0	13.7	40.2	260.0	11.4

*LP- Number of leaves

the highest number of functional leaves (15.4). The highest leaf length was noticed in ADOT x ECT (3.45m). Number of leaflets was the highest in the WCT xTPT (124). Higher girth was found in BGR x ADOT (59.5cm) (Table 7).

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

Objective: To evaluate new T x T combinations at different locations

Centres: Ambajipeta, Ratnagiri, Veppankulam

Evaluation materials: Seven location specific tall x tall combinations

Experimental design: RBD with 3 replications, 6 palms per genotype per replication

Ambajipeta

The seednuts of cross combinations *viz.*, Java Tall x ECT, PHOT x ECT, Fiji Tall x ECT, LCO x ECT, ECT x Java Tall, Cochin China x ECT, ECT x Fiji Tall were received from CPCRI and nursery was raised and the seedlings were planted in August, 2011. During the year 2012-13, observations on growth attributing traits showed that the different T x T hybrids showed no significant effects. Due to Helen and Philin cyclones in the year 2013, some of the accessions had died. Gap filling has been taken up during February 2014 and the experiment is in vegetative stage.

Ratnagiri

The experimental seedlings were planted in August, 2009 with 7 cross combinations and a local check with three replications. It was observed that the height, girth and leaf parameters except the functional leaves did not differ significantly among the hybrids. Significantly maximum number of functional leaves on the crown was recorded in PHOT x CRP513 (11.4) which was closely followed by Pratap x PHOT (11.2), PHOT x Pratap (10.4), Pratap (10.1), CRP514 x PHOT (9.89) and PHOT x CRP514 (9.5). The cross combination PHOT x CRP513 showed vigorous growth, while LCOT x Pratap showed dwarf growth characters with respect to all vegetative characters.

Veppankulam

Eight new T x T cross combinations made at Veppankulam were planted in 14b block on 21.03.2010. Morphological characters of these cross combinations were recorded. Among the cross combinations, number of functional leaves was the highest in WCT x PHOT (11). The highest plant girth was recorded in WCT x Cochin China (50cm) followed by WCT x PHOT (48.5cm). WCT x PHO recorded plant height of 165cm followed by PHOT x WCT (146.5cm). Number of leaflets was the highest in SR x ECT (91). The local check VHC 3 recorded the highest leaf length of 84cm.

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

Centres: Ambajipeta, Mondouri, Ratnagiri, Veppankulam, Pilicode

Experimental materials: Five common D x D hybrids *viz.*, COD x MYD, COD x MGD,MYD x CGD, GBGD x MOD, CGD x MGD received from CPCRI, Kasaragod and a local check

Experimental design: RBD with 4 replications, 6 palms per genotype per replication

Ambajipeta

The experiment was planted during 2011. Among the different D x D hybrids, significant differences were observed for plant height and petiole length while for other characters, they showed no significant effect. During the year 2012-13, observations revealed that, COD x MYD hybrid showed the highest plant height of 224.7cm and petiole length of 95.1cm and it is on par with COD x MGD hybrid with plant height of 200.5cm and petiole length of 94.6cm. Due to Helen and Philin cyclones in the year 2013, some of the accessions had died. Planting material of Dwarf x Dwarf crosses were received from CPCRI, Kasaragod during March, 2014 and are being maintained in the nursery.

Mondouri

From the data recorded on growth traits, the highest plant height was recorded in MYD x CGD (172.7cm) followed by GBGD x MOD (163.5cm). Maximum number of leaves was recorded in MYD x CGD (8.0) and maximum girth was recorded in the COD x MYD (16.8cm) (Table 8).

Ratnagiri

The growth parameters recorded during second year after planting of Dwarf x Dwarf hybrids of coconut revealed no significant differences for height, functional leaves on the crown, leaf length, petiole length, leaflet count and leaflet breadth.Significantly maximum girth (52.3cm) was recorded in COD x MYD, which was on par with GBD x MOD (51.4cm), MYD x CGD (44.2cm), COD x MGD (42.0cm) and CGD x MGD (37.7cm) respectively. Significantly maximum number of leaves was recorded in GBD x MOD (7.4) which was closely followed by MYD x CGD (7.4), COD x MYD (7.1) and CGD x MGD (7.1), respectively.

Pilicode

The twenty seed nuts each of the five D x D hybrids were obtained from CPCRI, Kidu farm and sown in the nursery at this centre.

Veppankulam

Five D x D cross combinations were planted along with check on 4.1.2011. The plants have established well and the morphological characters of these D x D cross combinations were studied. Among the hybrids, COD x MYD registered the highest number of functional leaves (11.5). The highest leaf length was noticed among the hybrid VHC2 (106.5). Breadth of leaflet was maximum in the cross COD x MGD (4.1cm) (Table 8).

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

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

Table 8: Gen11- Performance of growth characters of dwarf x dwarf cross combinations at various AICRP- Palms centres

Genotypes	COD x MYD			COD x MGD			MYD x CGD			GBGDx 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	16.8	123.0	7.2	14.3	150.8	7.5	13.9	172.7	8.0	15.1	163.5	7.2	13.1	160.1	8.0
Ratnagiri	52.3	211.5	7.1	42.0	212.0	6.2	44.2	190.9	7.4	51.4	211.7	7.4	37.7	172.9	7.1
Veppankulam	48.0	298.0	11.5	47.0	287.0	9.0	48.5	265.0	10.0	55.5	294.0	9.0	49.5	291.0	10.0

*LP- Number of leaves

Demonstration materials: Ten nationally released coconut cultivars

Experimental design: Unreplicated observational trial with 10 palms per genotype

Aliyarnagar

Morphological observations were recorded for the plants of ten released varieties/ hybrids planted in the main field during 2012-2013. During this year, plants had recorded a mean height of 181.7cm and girth of 32.3cm. While the mean number of functional leaves recorded by the plants was 7, maximum functional leaves (9) were produced by Kera Bastar. Since Kalpa Mitra and Kera Keralam were planted at a later date, leaf splitting had not initiated in these genotypes. Kera Bastar and Kalpa Dhenu showed better establishment and performance compared to other genotypes in terms of height, girth and functional leaves. Variability was the highest for girth (28.2%) and least for petiole length (17%).

Ambajipeta

During 2012 -13, observations revealed that, Konkan Bhatye hybrid performed better with the highest plant height (358.1cm), leaf length (236.8cm), petiole length (117.8cm), leaflet number (63.9L; 62.6R), leaflet length (81.2cm) and leaflet breadth (4.0cm). However, due to Helen and Philin cyclones in the year 2013, some of the accessions had died. Gap filling has been taken up during February, 2014 and the experiment is in vegetative stage.

Arsikere

Seedlings of eight coconut varieties were planted on 01.08.2011, while Kalyani coconut-1, Kalpa Raksha along with the check Kalpataru were planted during July, 2012. Morphological parameters recorded during 2013 showed that Kalyani coconut-1 recorded maximum values for all the traits except petiole length. Kalpataru recorded lower values for most of the growth parameters.

Bhubaneshwar

The seedlings of Kalyani coconut-I, Gautami Ganga, Konkan Bhatye coconut hybrid-I, Kera Keralam, Kera Bastar, Kalpa Samrudhi, Kalpa Pratibha, Kalpa Raksha, Kalpa Dhenu and Sakhigopal local were planted in the main field during June 2013 as per the technical programme except the seedlings of Kalpa Mitra.

Jagdalpur

Out of ten cultivars to be tested under this trial, six genotypes *viz.,* Kalyani coconut -1, Gauthami Ganga, KBCH-1, Kera Keralam, Kahikuchi hybrid and Kera Bastar were planted in field in June 2012. The seedling/seednut of Kalpa Prathibha, Kalpa Mitra, Kalpa Raksha and Kalpa Dhenu of CPCRI were collected before monsoon and planted in field during August. The growth observation of released cultivars showed that highest plant height was attained by Kalyani coconut-1, whereas petiole length was the highest in Kera Bastar. Leaf length was the highest in Konkan Bhatye coconut hybrid -1 followed by Kera Keralam.

Kahikuchi

Planting of all the ten coconut varieties/hybrids was completed during July, 2013. However, out of the ten coconut varieties/hybrids, seedlings/seed nuts of Konkon Bhatye coconut hybrid-1, Kera Keralam, Kera Bastar and Gauthami Ganga and Kalyani coconut-1 were planted in the main field earlier during October, 2012. Morphological characters of these five varieties/hybrids were recorded. The highest values in terms of plant height (171cm), girth (37cm), number of leaves (7.0), leaf length (152cm), petiole length (88cm), leaflets per leaf (54), leaflet length (62cm) and leaflet breadth (4.2cm) were recorded in Konkan Bhatye coconut hybrid-1.

Mondouri

Out of 10 released varieties, 5 varieties have been planted in 2011. From the data recorded, it was observed that the highest plant height was recorded in Kalpa Mitra (316.0cm). Number of leaves was maximum in Kera Keralam(8.8).

Maximum girth was recorded in Kalpa Mitra (77.2cm).

Navsari

The experiment was started as a demonstration trial and planted during July, 2013.

Ratnagiri

Initial growth performance of the released varieties and hybrids revealed wide variations for all growth characters *viz.*,girth (27.2%), height (24.5%), number of leaves produced per year (7.7%), functional leaves on the crown (42.3%), leaf length (34.1%), petiole length (24.6%), leaflet number left (28.2%), leaf let number right (29.2%), leaflet length left (14.5%), leaflet length right (14.5%) and leaflet breadth (10.5%) respectively.

Veppankulam

Seedlings of Kera Keralam, GBGD x ECT coconut hybrid -1, Kera Bastar, MYD x WCT and Gauthami Ganga were planted on 02.09.2010 and 15.09.2010. Among these, number of functional leaves was the highest in GBGD x ECT (11). Kera Keralam recorded the highest plant height of 189.5cm. Plant girth was the highest in GBGD x ECT (56.4cm). Number of leaflets were highest in MYD x WCT (69). GBGD x ECT recorded the highest leaflet length of 79cm and leaflet breadth of 3.9cm.

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

Centres: Ambajipeta, Navsari, Veppankulam

Evaluation materials : Cocoa clones viz., VTLC 1, VTLCH 1, VTLCH 2, VTLCH 3, VTLCH 4, VTLCC 1

Experimental Design : RBD with 4 replications, 6 plants per clone per replication

Ambajipeta

Six cocoa clones were planted in November, 2008, in RBD with four replications and gap filling was done during December, 2012. The clones have established in the field. Though non-significant, maximum plant height was recorded by VTLCH 4 (240.5cm) followed by VTLCH 2 (223.8cm). The highest plant girth was recorded in VTLC 1 (28.3cm) followed by VTLCH 4 (25.8cm). Observations on yield data revealed that, VTLC 1 and VTLCH 4 recorded 1.5 kg dry beans per plant and were on par with each other (Table 10).

Navsari

Five cocoa clones such as VTLCC 1, VTLCH 1, VTLCH 2, VTLCH 3 and VTLCH 4 were

Table 9: Gen12- Performance of released varieties and hybrids at various AICRP- Palms centres

Centres	Aliyarnagar			Arsikere			Mondouri			Navsari		
Traits/ Genotypes	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*	Girth (cm)	Height (cm)	LP*
Kalyani Coconut-1	25.8	162.6	5.3	50.6	256.0	15.3	75.1	315.7	7.8	23.3	138.2	5.6
Gauthami Ganga	31.9	184.2	7.2	38.6	191.0	14.3	45.2	130.2	5.2	15.1	104.3	6.4
Konkan Bhatye Hybrid 1	31.8	178.3	7.4	43.0	216.5	13.1	69.1	296.8	8.6	18.4	90.5	6.3
Kalpa Dhenu	43.7	236.0	8.6	44.8	191.0	19.3	39.7	91.7	5.2	22.5	148.2	8.4
Kera Keralam	18.7	120.2	4.8	35.7	194.3	11.4	70.3	295.6	8.8	12.4	95.1	5.2
Kera Bastar	49.5	246.6	8.9	46.3	224.5	15.4	72.7	304.2	8.6	20.2	155.4	5.4
Kalpa Pratibha	35.7	180.7	7.1	31.9	175.8	12.1	38.3	82.5	6.4	21.2	138.5	7.2
Kalpa Mitra	23.4	151.0	5.1	33.8	215.0	10.6	77.2	316.0	7.6	19.3	106.5	6.1
Kalpa Raksha	33.0	196.0	6.3	25.2	153.5	7.5	39.1	92.1	5.2	18.7	111.3	7.1
Kalpa Samrudhi	30.2	161.4	6.0	21.3	129.2	7.3	18.3	30.1	3.4	16.3	92.3	7.1

*LP- Number of leaves

planted in old coconut garden in RBD design with four replications during 2009-10 Clones.

The observations on growth as well as pod characteristics were recorded. The growth attributes of different clones were found to be satisfactory. The data revealed that, significantly maximum plant height (3.5m), stem girth (39.5cm), height at first branching (12.0cm), number of branches/plant (5.4), number of pods/tree (48.0), weight of single dry bean (1.2g), dry bean yield/tree/year (1.8kg) was recorded in VTLCC 1 clone. Looking at the canopy spread, the VTLCH 3 clone showed significant effect at both E-W (3.6m) and N-S (3.3m), with maximum pod weight (45.2g). Regarding number of beans/pod, all the clones were found to be significant, however, VTLCH 4 clone recorded maximum number of beans/pod (20.1) as compared to rest of the cocoa clones.

Veppankulam

Cocoa grafts of 5 hybrids and one cultivar, received from CPCRI, RRS, Vittal, Karnataka were planted during August, 2008. The establishment of crop is good. Observation on plant height and stem girth was recorded. The data revealed that VTLCH 1 recorded the highest plant height of 356cm followed by VTLCH 4 (236cm). Plant girth was the highest in VTLCC 1 (34cm) followed by VTLCH 1 (26cm). The water shoots in the scion were removed periodically.

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

Centres :Aliyarnagar, Arsikere

Evaluation materials : 15 cocoa genotypes

Experimental Design: RBD with 2 replications, 6 plants per genotype per replication

Aliyarnagar

A total of 14 clones/hybrids including a control received from RS, Vittal, Karnataka were planted on 26.08.2013 with 14 treatments, 2 replications and 6 plants in each treatment. Observations on morphological characters revealed that the plant height ranged from 73.6 to 99.0cm, the highest being VTLCP 1 and lowest being VTLC 9 (Control). The number of branches was least in (4.1) in VTLC 9 (Control) and the highest in VTLCP 3 (8.7).

Arsikere

The cocoa clones/hybrids were procured from CPCRI Regional Station, Vittal and planted on 03.09.2012. The experiment was laid out in RBD with two replications. The establishment of cocoa

Table 10: Gen 13-Growth attributing characters of cocoa clones at Ambajipeta and Navsari.

Genotypes	Plant height (cm)	Girth (cm)	Height at 1st branch-ing(cm)	Dry bean yield (kg/ plant)	Geno types	Plant height (m)	Girth (cm)	Height at 1st branch-ing (cm)	Dry bean yield (kg/ plant)
Ambajipeta					Navsari				
VTLCC 1	219.6	22.3	79.3	1.0	VTLCC 1	3.5	39.5	12.1	1.9
VTLCH 1	222.1	24.5	110.0	1.2	VTLCH 1	3.4	39.0	29.4	1.0
VTLCH 2	223.8	24.0	70.8	1.3	VTLCH 2	2.5	26.0	31.1	1.4
VTLCH 3	219.2	25.4	79.1	1.0	VTLCH 3	2.6	29.0	25.5	1.4
VTLCH 4	240.5	25.8	78.0	1.5	VTLCH 4	3.2	39.0	22.7	1.5
VTLC 1	200.1	28.3	93.77	1.5					

grafts is satisfactory. The experiment has been maintained by basin making and mulching to coconut, basin making, mulching and shading to cocoa and drip irrigation to coconut and cocoa. The initial soil and coconut leaf samples were drawn and analysed for nutrient status. The observations on the number of functional leaves, inflorescence and female flowers, leaf production rate and the nut and copra yield were recorded in coconut. Similarly, the observations on growth parameters of cocoa at the end of first year have been recorded. The plant height, girth, number of branches, height at first branching, canopy height and canopy spread at first year of planting did not differ significantly between varieties/hybrids.

Cocoa clones under coconut at Arsikere Centre

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

Centres: Kahikuchi, Mondouri

Evaluation materials : Black pepper varieties

AICRP centre	Genotypes
Kahikuchi	IISR Thevam, IISR Sakthi, Sreekara, IISR Malabar Excel, Panniyur 1
Mondouri	IISR Thevam, IISR Sakthi, IISR Malabar Excel, IISR Sreekara, Panniyur 1

Kahikuchi

Five pepper varieties *viz.*, IISR Thevam, IISR Shakti, IISR Malabar Excel, Sreekara and Panniyur 1 were planted in the main field under coconut garden on 10th September, 2008 following RBD in 4 replications. Pre-experimental yield data of the base crop *i.e.* coconut for last three years was recorded which ranged from 51 to 57 nuts/palm/year. The initial soil nutrient status of the experimental plots were estimated. Observations on growth characters of Black pepper revealed that the highest vine length of 4.5m and vine girth of 5.8cm were recorded in Panniyur 1 whereas, the lowest vine length (3.6m) and vine girth (3.8cm) was observed in IISR Shakthi. The highest number of branches/vine (21.6) was recorded in Sreekara and the lowest was found in IISR Malabar Excel (16.0). All the five black pepper varieties have started flowering.

Table 11: Gen14- Growth and yield performance of black pepper varieties at Kahikuchi and Mondouri centre

Varieties	Vine length (m)	Girth (cm)	Orthotropic branches (No.)	Vine length (m)	Girth (cm)	Ortho tropic branches (No.)	No. of spikes
	Kahikuchi			Mondouri			
IISR Thevam	3.8	4.9	16.8	3.2	3.3	11.4	12.7
IISR Shakthi	3.7	3.8	18.0	3.5	2.9	9.1	13.5
ISR Malabar Excel	4.0	4.9	16.0	3.7	2.6	10.0	18.5
Sreekara	3.7	5.0	21.6	4.1	3.7	13.7	17.5
Panniyur 1	4.6	5.8	19.4	3.4	2.8	12.1	10.1

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, basal girth and berry production were recorded.Sreekara recorded the maximum vine length (4.1m) and girth (3.7 cm) whereas, IISR Thevam recorded the minimum vine length (3.2m). Branch number was maximum in Sreekara (13.7) followed by Panniyur 1 (12.1) and minimum was recorded in IISR Shakti (9.1). All the black pepper varieties started flowering during the third year of planting and have set fruits. The highest number of spikes was recorded in Malaber Excel (18.5) followed by Sreekara (17.5).

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

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

Aliyarnagar

Seed nuts from Kera Keralam mother palms are sown in the nursery periodically and seedlings produced are distributed to farmers on a small scale. Kalpa Pratibha seed gardens are in establishment phase, comprising of 30 plants. *Inter-se* crossing is also in progress to produce true to type seed nuts of Kalpa Pratibha. During 2013-14, 5000 seedlings of WCT, 1540 seedlings of Kalpataru and 1500 seedlings of COD x WCT were distributed to farmers from the mother palms and crossing blocks maintained at CRS, Aliyarnagar.

Ambajipeta

During 2013-14, 2150 seedlings of Gautami Ganga, 180 seedlings of Kalpa Prathiba and 25 seedlings of Kera Bastar have been produced.

Arsikere

The nursery of Kalpataru has been established by sowing 8400 seed nuts from January, 2013 to September, 2013. In order to establish Kalpataru mother block, trees are selected and sibbing work has been attended to produce seed nuts and to raise the seedling at HRS, Arsikere.In addition, three hybrids namely GBGD x PHOT, GBGD x LCOT and GBGD x FJT have been proposed for release. GBGD is female parent in all the three hybrids and no female parent or mother block is available at our centre. Hence, selfed seedlings of GBGD were obtained from Ambajipeta, Hyderabad and planted at HRS, Arsikere.

Jagdalpur

The seed gardens of Kera Bastar established in 2008 is monitored and observation on morphological characters and survival percentage is continued. Gap filling and package of practices as per recommendation of CPCRI is adopted in the entire seed garden. During this year, two seed gardens have been established in one acre each at Bakawand Block and KVK, Narayanpur. Overall 390 seedlings of Kera Bastar have been planted in seven different gardens in the Bastar zone.

Kahikuchi

As the female parent for the hybrid 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.

Ratnagiri

About 175 seedlings each of ECT and Gangabondam and 290 seedlings of Fiji tall have been planted for establishment of mother palm gardens.

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.

4.2 Crop Production

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

(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 productivity 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

- The drip irrigation was given at 66% of Pan Evaporation (Eo) and the quantity of water given was calculated based on the 10 years average of mean monthly evaporation.
- Mulching was done to all the palms using coconut leaves.
- Urea, Diammonium phosphate and Muriate of potash were used as sources of nitrogen, phosphorus and potassium, respectively.
- Recommended farm yard manure @ 50 kg per palm per year was applied to all the palms.

Aliyarnagar

The experiment was initiated during 2007 in 18 year old coconut garden (VHC 2 hybrid) with six treatments. The fertilizers were 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

Table 12: Nut yield of coconut as influenced by fertigation during 2007-08 to 2012-13 (Aliyarnagar)

Treatments	Pre-treatment yield (Nuts/palm)	Coconut yield (Nuts/palm/year)						
		2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Mean
T_1 - Control (No fertilizer)	105	104	89	95	90	89	87	92.3
T_2 - 25% of Rec. NPK through drip system	110	108	104	114	101	101	102	105.0
T_3 - 50% of Rec. NPK through drip system	119	115	146	142	119	122	130	129.0
T_4 - 75% of Rec. NPK through drip system	115	118	144	153	125	134	135	134.8
T_5 - 100% of Rec. NPK through drip system	116	118	146	152	139	144	145	140.6
T_6 - 100% of Rec. NPK as soil application	112	116	143	145	122	118	129	128.8
SEm±	-	NS	13.0	9.5	4.1	4.2	2.8	2.7
CD (P=0.05)	-	-	38.3	28.2	12.4	12.5	8.4	8.4

nitrogen, phosphorus and potassium, respectively. The nut yield of coconut during 2012-13 was significantly higher in drip fertigation of 100 per cent RDF compared to 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 soil application. The mean nut yield over six years from 2007-08 to 2012-13 indicated that drip fertigation of 50 and 75 per cent of RDF were found to be on par with 100 per cent RDF through soil application. Hence, fertigation of 75 per cent RDF in 10 splits is recommended for coconut in coastal Tamil Nadu (Table 12).

Ambajipeta

The trial was initiated during November, 2007 in a 25 years old coconut garden of East Coast Tall variety. The number of leaves on the crown, the number of spadices per palm and the number of female flowers per spadix were higher in 100% RDF through fertigation which was on par with 75% RDF through fertigation. Similarly, application of 100% RDF through fertigation recorded higher nut yield which was on par with 75% RDF through fertigation. Hence, fertigation of 75% recommended NPK through drip irrigation in 10 splits is recommended for coconut in coastal Andhra Pradesh (Table 13).

Arsikere

The experiment was initiated during July, 2007 in RBD with four replications in a 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 percentage compared to control and application of 25% NPK through drip irrigation.

The nut, copra 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, copra and oil yield per palm on par with the application of 100% NPK through drip irrigation and 100% NPK through soil application (Table 14). The available nutrient status of soil and also the leaf nutrient

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

Treatments	Pre-treatment (2005-07)	Nut yield/palm/year					Mean
		2007-08	2008-09	2009-10	2010-11	2011-12	
T_1 - Control (No fertilizer)	58.2	56.8	75.8	57.7	67.2	67.3	64.9
T_2 - 25% of Rec. NPK through drip system	57.1	64.8	70.3	65.9	79.4	82.6	72.5
T_3 - 50% of Rec. NPK through drip system	62.3	72.0	70.5	73.1	85.6	91.8	78.5
T_4 - 75% of Rec. NPK through drip system	60.8	76.3	81.1	79.2	90.2	98.4	89.8
T_5 - 100% of Rec. NPK through drip system	61.1	80.1	80.4	81.3	101.2	115.4	91.6
T_6 - 100% of Rec. NPK as soil application	59.9	70.5	68.1	71.1	83.0	88.0	76.6
SEm ±	1.3	3.3	2.5	0.8	4.5	6.7	1.0
CD (P=0.05)	3.785	9.8	7.4	2.5	13.6	20.3	3.0

Table 14: Yield of coconut as influenced by fertigation treatments (Arsikere)

Treatments	Pre-expt. yield	Yield of coconut (Nuts/palm/year) (Experimental period)						
	(2005-07)	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Mean
T_1 - Control (No fertilizer)	58.7	57.3	59.9	65.1	84.0	75.3	90.5	72.0
T_2 - 25% of Rec. NPK through drip system	58.2	58.9	62.2	74.8	94.2	79.7	100.5	78.4
T_3 - 50% of Rec. NPK through drip system	58.2	64.8	66.44	80.2	111.5	87.1	113.3	87.2
T_4 - 75% of Rec. NPK through drip system	59.3	62.6	72.8	82.4	121.2	98.2	135.9	95.5
T_5 - 100% of Rec. NPK through drip system	60.2	70.5	82.2	87.8	129.6	106.3	143.0	103.2
T_6 - 100% of Rec. NPK as soil application	61.3	64.2	70.6	84.4	124.0	94.6	127.8	94.3
SEm ±	3.7	3.8	4.7	3.8	6.7	4.0	5.3	2.7
CD (P=0.05)	NS	NS	14.00	11.6	20.3	12.0	15.9	8.0

NS = Not significant

status were significantly higher in 100% NPK through drip irrigation and were on par with 75% NPK through drip irrigation and 100% NPK through soil application.

Table 15: Economics of fertigation in coconut- (Mean of 6 years) from 2007-08 to 2012-13 (Arsikere)

Treatments	Mean coconut yield (Nuts/ha)	Gross returns (Rs./ha)	Cost of production (Rs./ha)	Net returns (Rs./ha)
T_1 - Control (No fertilizer)	12817	76904	37800	39104
T_2 - 25% of Rec. NPK through drip system	13951	83707	40225	43482
T_3 - 50% of Rec. NPK through drip system	15523	93140	42600	50540
T_4 - 75% of Rec. NPK through drip system	16999	101991	44975	57016
T_5 - 100% of Rec. NPK through drip system	18374	110244	47350	62894
T_6 - 100% of Rec. NPK as soil application	16779	100672	49600	51072
SEm ±	472	2832	-	2832
CD (P=0.05)	1423	8536	-	8536

Note: The cost and returns were calculated based on 2012-13 prices; Coconut- Rs. 6.00/nut.

Table 16: Yield of coconut as influenced by fertigation treatments (Kahikuchi)

Treatments	Pre-experimental yield	Nut yield (Nuts/palm/year)				
		2009-10	2010-11	2011-12	2012-13	Mean
T_1 - Control (No fertilizer)	50.0	51.6	51.9	50.0	52.0	51.4
T_2 - 25% of Rec. NPK through drip system	51.8	52.3	57.2	69.5	71.0	62.5
T_3 - 50% of Rec. NPK through drip system	52.0	56.0	62.0	76.4	78.6	68.3
T_4 - 75% of Rec. NPK through drip system	53.2	63.8	78.2	90.3	104.0	87.2
T_5 - 100% of Rec. NPK through drip system	54.6	69.5	77.2	100.6	95.4	83.1
T_6 - 100% of Rec. NPK as soil application	50.6	54.6	67.2	74.3	77.8	68.5
CD (P=0.05)	NS	7.5	8.8	8.4	8.2	—

The net returns and B:C ratio were also higher with the application of 100% NPK through drip irrigation compared to other treatments. Application of 75% NPK through drip irrigation recorded higher net returns and B:C ratio compared to 100% NPK through soil application (Table 15). Hence, fertigation of 75% recommended NPK through drip irrigation in 10 splits is recommended for coconut in interior Karnataka.

Kahikuchi

The experiment was laid out in adult coconut garden of 35 years old during October, 2009. 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 75% RDF through drip irrigation compared to other treatments. The nut yield during 2012-13 and also the mean over last four years was significantly higher with the application of 75% NPK through drip irrigation followed by 100% RDF through drip irrigation (Table 16). The soil nutrient status (NPK) as well as leaf nutrient content of coconut were also higher with the application of 75% NPK through drip irrigation compared to other fertigation treatments. The economics of fertigation indicated that the applicationof 75% RDF through drip irrigation recorded the highest net returns and B:C ratio (Rs. 105470 per ha and 3.2) followed by 100% RDF through drip irrigation (Rs. 96625 per ha and 2.9).

Kasaragod

The experiment was started with the objective to study the effect of fertigation on coconut under coastal sandy soil. The treatment, 100 % recommended dose of NPK through soil application recorded lower yield and on par with 25% NPK through drip fertigation. Further application through soil (twice in a year 1/3rd during June and 2/3rd during Sept.-Octo.) in the conventional method of application could not withhold the applied fertilizer and make it available to the crop as it is sandy soil and exposed to heavy rainfall. The soil NPK was also found to be more in drip fertigation compared to conventional method of fertilizer application though there were no significant differences observed.

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 treatments. 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 (167kg/ha and 72 kg/ha). 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 17).

Ratnagiri

The experiment was laid out in an adult coconut garden of WCT variety in sandy soils during 2006. During transit period (2006-09), no significant variation in nut yield of coconut was observed among different treatments. During effective treatment period (2009-13), the nut and copra yield was significantly higher with the application of 100% RDF through drip irrigation followed by 75% and 50% RDF through drip irrigation and 100% RDF through soil application. Application of 50% RDF through drip irrigation recorded nut and copra yield on par with the soil application of 100% RDF (Table 18).

The economic analysis of fertilizer application through drip irrigation revealed that the application of 100% RDF through drip irrigation recorded the highest net returns (Rs. 102700/ha) followed by 75% RDF through drip irrigation (Rs. 87210/ha) and 50% RDF through drip irrigation (Rs. 81525/ha). The net returns in the treatments of application of 50, 75 and 100% RDF through drip irrigation were higher than the soil application of 100% RDF. Hence, fertigation of 50% recommended NPK through drip irrigation in 10 splits is recommended for coconut in Maharashtra.

Sabour

The experiment was initiated during October, 2012 in Sakhigopal Tall variety of coconut aged 4 years. The fertigation levels significantly

Table 17: Growth and yield of coconut and soil NPK status as influenced by fertigation treatments (Mondouri)

Treatments	No. of functional leaves/ palm	No. of bunches/ palm/ year	Nut yield/ palm/ year	Availables soil NPK (kg/ha)		
				N	P	K
T_1 - Control (No fertilizer)	28.0	7.7	86.0	167	18	72
T_2 - 25% of Rec. NPK through drip system	30.0	9.2	95.0	194	19	102
T_3 - 50% of Rec. NPK through drip system	31.5	9.0	100.2	207	22	112
T_4 - 75% of Rec. NPK through drip system	32.5	10.2	103.2	214	22	120
T_5 - 100% of Rec. NPK through drip system	30.5	9.2	102.5	212	23	119
T_6 - 100% of Rec. NPK as soil application	29.5	8.5	100.5	213	21	115
SEm ±	0.3	0.2	1.1	4.9	0.3	1.8
CD (P=0.05)	0.6	0.4	2.3	10.9	0.6	4.2

influenced the growth parameters of palms. Significantly higher plant height of 3.5 m was recorded in 100% RDF through fertigation followed by 100% RDF as soil application (3.3 m) and was on par with 75% RDF through fertigation (3.2 m). Collar girth varied from 46.7 cm in control to 81.4 cm in 100% RDF as soil application. The number of functional leaves, leaf length, petiole length and leaflet length were higher in 100% RDF through fertigation and 100 % RDF through soil application followed by 75% RDF through fertigation.

Veppankulam

The experiment was laid out in a 27 years old ECT variety of coconut palms during 2007. Among the fertigation treatments, application of 100% recommended NPK through drip irrigation recorded significantly higher nut yield followed by 75% and 50% recommended NPK through drip irrigation. The data on soil nutrient status indicated that the available NPK was significantly higher with the application of 100% recommended NPK as soil application followed by 100% and 75% recommended NPK through drip irrigation. The leaf nutrient status was higher with the application of 75 and 100% recommended NPK through drip irrigation and 100% recommended NPK as soil application compared to other treatments (Table 19). Application of 50% recommended NPK through drip irrigation recorded higher net returns (Rs. 99890 per ha) and benefit-cost ratio (1.72) compared to 100% recommended NPK as soil application (Rs. 91000 per ha and 1.51). Hence, fertigation of 50% recommended NPK through drip irrigation is recommended for coastal Tamil Nadu.

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

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

Objectives

- To develop location specific coconut based integrated cropping system models for different agro – climatic regions.

Table 18. Yield of coconut as influenced by fertigation treatments (Ratnagiri)

Treatments	Mean yield of coconut (Nuts//palm/year)			Mean copra yield (kg/palm) (2009-13)
	Pre treatment 2002-06	Transit period 2006-09	2009-13	
T_1 - Control (No fertilizer)	99	97	78.8	10.2
T_2 - 25% of Rec. NPK through drip system	81	89	82.6	11.1
T_3 - 50% of Rec. NPK through drip system	85	91	96.3	14.2
T_4 - 75% of Rec. NPK through drip system	88	96	100.6	14.2
T_5 - 100% of Rec. NPK through drip system	84	99	113.8	18.6
T_6 - 100% of Rec. NPK as soil application	93	103	96.3	14.7
SEm ±	7.54	5.29	2.8	0.6
CD (P=0.05)	NS	NS	8.0	1.7

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

The development of location specific cropping system model was started during 2008-09 or in later years at different centresin 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 were adopted by husk burial and mulching.

During 2012-13, four treatments were imposed in the cropping system. Vermicoposting was done using the wastes of coconut and inter-crops and vermi-wash is collected. The fertilizers and organic manures- vermicompost, coir pith compost, vermiwash and biofertilizers were applied to each crop as per treatments.

Treatments:

T_1: 75% of Rec. NPK + organic recycling with vermicompost.

T_2: 50% of Rec. NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring.

T_3: Fully organic: Organic recycling with vermicompost + vermiwash application + biofertilizer application, *in situ* green manuring &

Table 19: Effect of different drip fertigation on yield of coconut (Veppankulam)

Treatments	Pre experi. cumulative nut yield	Mean annual nut yield (2007-13)						Cumulative mean nut yield	% increase over pre-experi. nut yield
T_1 – Control (No fertilizers)	96.10	91.60	123.70	52.15	76.30	92.82	88.00	87.42	-9.03
T_2 – 25% of RD of NPK	93.10	111.50	140.90	57.10	82.84	109.98	100.00	100.38	7.25
T_3 – 50% of RD of NPK	85.90	88.50	131.90	57.80	87.40	121.98	113.00	100.10	14.18
T_4 – 75% of RD of NPK	85.10	98.20	132.50	62.72	90.63	132.84	118.00	105.81	19.57
T_5 – 100% of RD of NPK	104.60	106.40	145.40	70.35	91.86	139.22	124.6	112.97	7.40
T_6 – 100% of RD of NPK as soil application	86.80	101.80	128.60	75.15	85.30	115.15	108.30	102.38	15.21
SEd	2.16	2.63	13.70	8.90	7.71	1.20	2.64	-	-
CD (P=0.05)	4.82	5.87	NS	NS	NS	2.50	5.88	-	-

green leaf manuring (Glyricidia loppings) + Composted coir pith and mulching with coconut leaves.

T_4: Control (monocrop of coconut with recommended NPK and organic manure).

Aliyarnagar

The coconut based cropping system of coconut + cocoa + banana + moringa + pineapple was started during 2008. Tissue culture plants of banana (Grand Naine), suckers of pineapple (Kew),seedlings of moringa (PKM-1) and cocoa (4 accessions) were planted in the cropping system. Three treatments of integrated nutrient management were imposed during 2012-13 and compared with the control plot of monocropping of coconut.

The number of functional leaves, annual leaf production, number of inflorescences per palm and nut yield in coconut were recorded in all the treatments. The nut yield of coconut was higher in T_3 followed by T_4, T_2 and T_1. The yield in intercrops was also recorded(Table 20). An additional income of Rs. 2,13,060 per ha was obtained from the intercrops in the cropping system.

Among the treatments, the treatment with 50% organic recycling has recorded the highest income followed by fully organic inputs treatment, the reason being inclusion of recycled farm waste as nutrient inputs. The experiment is in the initial phase, hence more concrete information are to be derived in the subsequent years.

Ambajipeta

The crop combinations of cocoa + banana + pineapple + tomato + heliconia were planted in the coconut based cropping system during 2008. Three treatments of integrated nutrient management were imposed during 2012-13 and the performance of coconut based cropping system was compared with the control plot of monocropping of coconut. The fertilizers, organic manures and biofertilizers were applied to each crop as per treatments. The yield data of coconut and intercrops were recorded. Coconut recorded an yield of 139.6 nuts/palm while cocoa recorded an yield of 1.94 kg/tree, banana 23.3 kg/plant, pineapple 1060 g/plant and tomato 490 g fruits per plant. The soil organic carbon, nitrogen, phosphorus and potassium contents were increased in the cropping system compared to initial years.

Arsikere

The crops, cocoa, lime and drumstick were planted in the coconut based cropping system during October, 2008. Banana was added to the cropping system during October, 2012. Three treatments were imposed in the cropping system during 2012-13. Coconut and inter-crops were irrigated through drip system as per recommended schedule. Vermicoposting was done using the wastes of coconut and intercrops and vermi wash was collected. The fertilizers and organic manures VC, CCP, vermiwash and biofertilizers were applied to each crop as per treatments. The pods of drumstick and cocoa, fruits of lime and nuts of coconut were harvested and yield data recorded.

Table 20: Growth and yield of coconut in cropping system (Aliyarnagar)

Treatments	Annual leaf production	No. of functional leaves/ palm	Nut yield (nuts/palm)
T_1	12.1 ± 0.7	31.3 ± 1.7	92 ± 27
T_2	13.0 ± 0.6	32.9 ± 2.6	94 ± 12
T_3	13.0 ± 0.7	33.9 ± 3.3	118 ± 33
T_4 (Control)	12.6 ± 0.4	34.1 ± 2.7	104 ± 47

There was improvement in soil nutrient status and earthworm population in the cropping system compared to monocrop of coconut. The productivity of the cropping system is higher than the monocrop of coconut due to additional yield from the intercrops (Tables 21 & 22).

Bhubaneswar

The whole plot of the trial was divided into three blocks (treatments) with the same crop combinations of coconut + guava+ banana + pineapple. Each block was comprised of 24 coconut palms, 28 guava plants and 24 double paired row pineapple beds, each with 32 nos. of pineapple plants. The restructuring and planting of components in the system were completed in April, 2013. The performance of both main crop as well as the component crops was relatively better in the block receiving fertilizers 50% from inorganic and 50% from organic sources.

Jagdalpur

The experiment with crop combinations of coconut + guava + cinnamon + banana + colocasia + bottle gourd + cowpea during rainy season and coconut + guava + cinnamon + banana + colocasia + mango ginger + elephant foot yam during summer season was initiated during 2008 in a coconut garden of different germplasm accessions. The green manure crop dhaincha was grown in basins of coconut and inter-crops in T_2 and T_3 treatments during rainy season and incorporated into the soil. The available biomass of 17 tons in the cropping system was utilized for vermicomposting. The data on the number of functional leaves, annual leaf production, number of buttons per bunch and nut yield per palm were recorded in coconut palms of different germplasm accessions. The nut yield varied from 52 to 86 nuts/palm/year with an average of 72 nuts/palm/year. The yield of coconut and inter-crops in the cropping system and also the gross returns were maximum in T_2 (50% of Rec. NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring) followed by T_1 (75% of Rec. NPK + organic recycling with vermicompost) and minimum in T_3 (Fully organic).

Table 21: Growth and yield of coconut in the cropping system during 2012-13 (Arsikere)

Treatments	No. of functional leaves	Leaf production/ palm/year	No. of inflorescence per palm	Nut yield (Nuts/ palm)	Copra content (g/nut)	Copra yield (kg/palm)
T_1	31.8	12.3	12.1	108.3	152.5	16.5
T_2	32.3	12.7	12.8	117.7	149.1	17.6
T_3	32.0	12.5	12.6	112.0	152.0	17.0
T_4 (Control)	32.0	12.3	12.4	109.3	147.5	16.1

Table 22: Yield of inter-crops in the cropping system during 2012-13 (Arsikere)

Treatments	Cocoa		Lime		Drumstick	
	Dry beans yield (kg/plot)*	Dry beans yield (kg/ha)	Fruit yield (kg/plot)*	Fruit yield (kg/ha)	Pod yield (kg/plot)*	Pod yield (kg/ha)
T1	18.8	157	123.1	1025	226.4	1886
T2	18.9	158	127.4	1061	235.6	1963
T3	20.4	170	140.5	1170	233.4	1944

*Plot size of each treatment: 0.12 ha.

Kahikuchi

The coconut based cropping system comprising of turmeric, pineapple, Assam lemon, banana, elephant foot yam and black pepper with coconut was started during 2008. The biomass produced from coconut and inter-crops was recycled through vermicomposting. The fertilizers, vermicompost, vermiwash, coir pith compost and biofertilizers were applied to component crops as per treatments.

The yield of coconut and intercrops were highest in T_2 (50% of rec. NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring) followed by T_1 (75% of rec. NPK + organic recycling with vermicompost) and lowest in T_3 (Fully organic). The net returns (Rs. 525,282/ha) and benefit- cost ratio (3.34) was the highest in

Table 23: Yield and economics of coconut based cropping system (Kahikuchi)

Treatments	Crop components	Yield/ha	Gross returns (Rs./ha)
T_1	Turmeric	14800 kg	118,400
	Pineapple	22700 kg	136,200
	Banana	17500 kg	105,000
	Assam lemon	5100 kg	102,000
	Elephant foot yam	13300 kg	93,100
	Black pepper	40 kg	5,000
	Coconut	12250 nuts	98,000
	Total		**657,700**
T_2	Turmeric	15900 kg	127,200
	Pineapple	25800 kg	154,800
	Banana	19600 kg	117,600
	Assam lemon	6900 kg	138,000
	Elephant foot yam	15000 kg	105,000
	Black pepper	44 kg	5,500
	Coconut	12600 nuts	100,800
	Total		**748,900**
T_3	Turmeric	12600 kg	100,800
	Pineapple	18200 kg	109,200
	Banana	16600 kg	99,600
	Assam lemon	4600 kg	92,000
	Elephant foot yam	12700 kg	88,900
	Black pepper	45 kg	5,578
	Coconut	11725 nuts	93,800
	Total		**589,878**

Selling price: Turmeric= Rs. 8/kg, Pineapple = Rs. 6/kg, Banana = Rs. 6/kg, Assam lemon = Rs. 20/kg, Elephant foot yam = Rs. 7/kg, Coconut = Rs. 8/nut.

T_2 followed by T_3 (Rs. 405,218/ha., and 3.19) and the lowest net returns (Rs. 403,832/ha) (Table 23).

Mandouri

The growth of component crops in the cropping system comprising of coconut + black pepper + lime + pine apple + banana + turmeric is satisfactory. Black pepper recorded 234 cm of plant height with 18 branches and 2.8 cm of basal girth. The plants started flowering and fruiting. The banana and lime plants are in vegetative stage and no yield was recorded.The vegetables *viz*. lablab, chilli, cabbage, okra and brinjal were grown in the interspaces of coconut. The yield of coconut was 86 nuts per palm in T_3 (Fully organic) followed by 82 nuts per palm in T_2 and 72 nuts per palm in T_1.

Navsari

The cropping system of coconut + banana + turmeric + cinnamon + black pepper + nutmeg was initiated during December, 2013 in a 20 year old D x T coconut garden. The cinnamon and black pepper were planted during December, 2013 while banana and nutmeg were planted during February, 2014. The turmeric will be planted during May, 2014. The initial soil nutrient status was determined. The soil contains 242 kg N/ha, 45.8 kg P_2O_5/ha and 285 kg K_2O/ha. The pre-treatment yield of coconut was recorded (112 nuts/palm).

Ratnagiri

The cropping system comprising of coconut + black pepper + nutmeg + cinnamon + banana + pineapple was started during June 2008. The data on growth and yield of coconut and component crops, soil nutrient status, leaf nutrient status of coconut and earthworm population were recorded. Significantly higher number of nuts per palm was recorded in treatment T_2 (131.6 nuts) which was at par with T_1 (127.3 nuts) and T_3 (112.8 nuts). The copra and oil yield per palm were significantly higher in T_1 which was on par with T_2 and T_3. The treatment T_4 (monocrop of coconut) recorded the lowest nut, copra and oil yield compared to other treatments. The yield of component crops was higher in T_1 compared to T_2 and T_3. Similarly, the net income and benefit-cost ratio were also higher in T_1 followed by T_2 and T_3. The treatment T_4 (monocrop of coconut) recorded lowest net income and benefit-cost ratio.

Table 24: Yield of coconut in coconut based cropping system (Ratnagiri)

Treatment	Nut yield (kg/palm)	Copra yield (kg/palm)	Oil yield (kg/palm)
T_1	127.3	21.6	14.7
T_2	131.6	21.5	14.5
T_3	112.8	18.9	12.9
T_4	100.0	17.0	11.6
SEm ±	8.0	1.3	0.9
C.D (P=0.05)	24.7	4.1	2.7

Table 25: Yield of component crops in coconut based cropping system (Ratnagiri)

Treatment	Yield of component crops per plot			
	Pine-apple (kg)	Banana (kg)	Cinna-mon bark (kg)	Cinna-mon leaves (kg)
T_1	55.0	187.0	5.0	50
T_2	45.0	179.5	4.0	40
T_3	37.5	96.0	3.0	30

Table 26: Economics of coconut based cropping system (Ratnagiri)

Treatment	Gross Returns (Rs. /ha)	Cost of cultivation (Rs. /ha)	Net returns (Rs. /ha)
T_1	249985	89424	160561
T_2	239616	94439	145177
T_3	201557	77229	104328
T_4	138600	60195	78405

Sabour

The development of coconut based cropping comprising of coconut + pomegranate + banana + turmeric + cowpea was started during 2009. The fertilizers, organic manures and biofertilizers were applied to coconut and intercrops as per treatments. The observations on growth parameters of coconut and inter-crops were recorded. Biomass collected from pruning of pomegranate (456 kg) was used as mulch for coconut and biomass of coconut (178 kg), cowpea (148 kg) and turmeric (215 kg) was used for vermicomposting.

Veppankulam

The cropping system model of coconut + black pepper + banana + elephant foot yam + cocoa was initiated during July, 2009. The fertilizers, organic manures and biofertilizers were applied to crops as per treatments. The nutrient status of the soil was analyzed before experimentation and during experimentation. There was improvement in leaf nutrient content in coconut and organic carbon, nitrogen, phosphorus and potassium contents in the soil. The increase in earthworm population in the top 0-30 cm soil was also observed. The biomass production of 26.4 t per ha was recorded in the cropping system.

Table 27: Biomass production in coconut based cropping system (Veppankulam)

Sl. No.	Crop	Biomass production (kg/ha)
1.	Coconut	6900
2.	Banana	8500
3.	Black pepper	41
4.	Elephant foot yam	1077
5.	Cocoa	9890
	Total	**26408**

Table 28: Economics of integrated nutrient management for coconut based cropping system model (2012-13)

Treatments	Gross return (Rs.ha^{-1})	Cost of cultivation (Rs.ha^{-1})	Net return (Rs.ha^{-1})
T1	260230	90846	169384
T2	267650	98846	168804
T3	269510	94130	175380
T4	116200	71800	54200

The yield and economics of integrated nutrient management for coconut based cropping system model was worked out for the period of 2012-13. Among the different integrated nutrient management treatments T_3- 50 % of RDF + organic recycling with vermicompost, vermiwash application, Biofertilizer application, green manuring, mulching coconut fronds and composted coir pith recorded the highest net return (175380 Rs.ha^{-1}) compared to T_4 control.

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

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

Aliyarnagar

Morinda citrifolia (Noni) seedlings and tissue culture plants (25 each) were planted with a plant spacing of 3.75 m in between two rows of coconut palms of 21 years age as a non replicated trial during 2008. The observations on growth and yield attributes of Noni, plant height, stem girth, number of branches per plant and yield of fruits were recorded. The growth of Noni was better in plants from seedlings compared to tissue culture

Table 29: Growth and yield of *Morinda citrifolia* under coconut (Aliyarnagar)

Planting material	Plant height (cm)	Stem girth (cm)	No. of branches/ plant	Yield/ plant (kg)	TSS (°Brix)
Seedlings	3.1	22.9	82	5.1	10.8
T. C. plants	2.9	23.9	71	5.2	10.1

plants. However, the yield of Noni was higher in tissue culture plants compared to plants from seedlings. The nut yield of coconut was 95 to 105 nuts/palm/year during 2011-12 compared to 91 to 97 nuts/palm/year (pre-expt.).

Ambajipeta

The observational trial on the performance of noni was laid out during August, 2008 and planted 25 each of seedlings and tissue culture plants in the inter spaces of coconut. The growth and yield parameters of noni were recorded. The plant height,number of branches per plant and fruit yield per plant were higher in seedlings compared to tissue culture plants. The coconut yield was improved with the planting of noni in coconut garden. The addition of leaf biomass was higher in plants from seedlings compared to tissue culture plants (Table 30).

Arsikere

The experiment was laid out during August 2008 and planted the seedlings and tissue culture plants of noni on 30.08.2008 in coconut garden. The palms are of 40 years old and planted at a spacing of 7.5 m x 7.5 m. The plant height and number of primary branches per plant in noni at the end of 5th 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. The juice content and the TSS were similar both in seedlings and tissue culture plants. The biomass addition through leaf litter was higher in tissue culture plants compared to plants from seedlings. The coconut yield was unaffected by the intercropping of noni in coconut garden (Table 31).

Bhubaneswar

The observational trial on the performance of noni, was initiated during 2009 in the coconut garden with 25 numbers of each of seedlings and tissue culture plants. The growth and yield of noni was better in seedling plants compared to tissue culture plants as maximum plant height (2.7m), number of lateral branches (54.3), spread of plant (7.1 sq.m), no. of fruits per plant (216.5), average fruit weight (42.3g) and yield of fresh fruit per plant (9.1kg) were recorded in seedling plants. But, as far as quality of fruit was concerned particularly in respect to TSS and acidity contents, the fruits of both seedling and tissue culture plants were almost the same. There was also improve-ment in growth and flowering traits of coconut due to inclusion of *Morinda citrifolia* in coconut garden.

Jagdalpur

The observational trial on 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

Table 30: 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)	Leaf bio-mass (dry) (kg/plant	TSS (°B)	Coconut yield (Nuts/palm/yr)	
								Before planting of noni	After 5 years of planting of noni
Seedlings	6.4	39.2	69.6	209.0	5.3	9.6	10.8	98	134
TC plants	5.3	53.4	54.2	195.0	4.3	8.1	11.8	104	123

Table 31: Growth and yield of *Morinda citrifolia* as a mixed crop in coconut garden (Arsikere)

Sl. No.	Growth or yield parameter	Plants from Seedlings				Tissue culture plants			
		2009-10	2010-11	2011-12	2012-13	2009-10	2010-11	2011-12	2012-13
1	Plant height (m)	1.7	2.8	3.2	3.5	1.7	2.5	3.1	3.6
2	No. of primary branches/plant	15.2	40.5	43.0	61.1	27.0	37.9	42.6	62.2
3	No. of secondary branches/plant	-	26.6	31.6	45.3	-	28.0	49.9	63.2
4	Plant spread (m)	1.2	2.0	2.7	3.3	1.5	2.4	3.2	3.6
5	No. of fruits/plant	26.6	41.4	243.9	526.8	62.5	64.0	359.3	650.2
6	Weight of fruits (kg/plant)	0.2	0.9	11.5	21.6	0.4	1.8	16.1	25.2
7	Fruit yield (kg/ha) (356 plants/ha)	53.2	302.6	4108	7694	154.1	623.0	5717	8968
8	Juice content (%)	-	62.5	60.6	59.0	-	60.9	59.4	59.6
9	TSS (° Brix)	-	11.0	10.9	11.5	-	10.9	11.2	11.7

fruit yield per plant washigher in plants from seedlings (3.5 kg/plant) compared to tissue culture plants (2.6 kg/plant).

Kahikuchi

The seedlings and tissue culture plants of Noni 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, stem girth and number of branches per plant. 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.

Mandouri

The noni seedlings and tissue culture plants

Table 32: Growth and yield of *Morinda citrifolia* in coconut garden (Jagdalpur)

Plants	Plant height (m)	Stem girth (cm)	No. of branches /plant	Fruit yield (kg/ plant)	Juice content (%)	TSS (°Brix)
Seedling plants	2.7	31.4	22	3.6	32.5	10.2
Tissue culture plants	2.4	36.5	28	2.6	29.0	9.2

Table 33: Growth and yield of *Morinda citrifolia* in 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	4.4	22.4	35.8	65.4	104.5	30.2	7.6
Tissue culture plants	4.1	19.5	29.6	44.9	102.2	20.3	7.7

Table 34: Growth and yield of Noni under coconut palms (Mandouri)

Planting material	Plant height (m)	Stem girth (cm)	No. of branches /plant	No. of fruits /plant	Fruit yield (kg/plant)	TSS (°Brix)
Seedlings	3.4	28	42	68	2.2	7.3
Tissue culture plants	3.2	34	49	82	2.9	7.3

were planted in coconut garden during 2008. The seedlings of noni recorded higher plan theight as compared to tissue culture plants, while, the tissue culture plants recorded higher stem girth and number of branches per plant as compared to seedlings. Tissue culture plants also recorded more numbers of fruits and fruit yield per plant as compared to seedlings.

Navsari

The noni seedlings and tissue culture plants were planted in coconut garden during 2011. The seedlings of noni recorded higher plant height, stem girth, number of branches per plant, number of fruits per plant and fruit yield per plant as compared to tissue culture plants. The juice content was 60 per cent with a TSS of 6.5^0 Brix.

Ratnagiri

The noni seedlings and tissue culture plants were planted as intercrop in coconut garden during 2008. The plant height and number of branches per plant were higher in seedlings compared to tissue culture plants after five years of planting. The yield of noni was maximum in seedlings (315 fruits and 7.8 kg) compared to tissue culture plants (178 fruits and 4.4 kg). The juice content and TSS were similar both in seedlings and tissue culture plants. The biomass addition to soil was higher in seedlings compared to tissue culture plants. Growing of noni as mixed crop in coconut garden is remunerative than monocrop of coconut. Mixed cropping of noni plants from seedlings in coconut recorded higher net returns and benefit-cost ratio as compared to mixed cropping of tissue culture noni plants.

Veppankulam

The seedlings and tissue culture plants of *Morinda citrifolia* were planted in between coconut rows with plant spacing of 3 m. The tissue culture plants recorded higher plant height, stem girth,

Table 35: Growth and yield of *Morinda citrifolia* in coconut garden (Navsari)

Planting material	Plant height (m)	Stem girth (cm)	No. of branches /plant	No. of fruits/plant	Fruit weight /plant (kg)	Juice content (%)	TSS (°Brix)
Seedlings	1.4	10.8	12.4	18.4	4.3	60.0	6.5
Tissue culture plants	1.3	8.5	9.0	15.0	2.2		

Table 36: Growth and yield of *Morinda citrifolia* as a mixed crop in coconut garden (Ratnagiri)

Sl. No.	Planting material	Plant height (m)	No. of branches (No.)	No. of fruits /plant	Fruit yield /plant	Juice content (kg/plant)	T.S.S (°Brix)	Biomass addition (kg/plant)
1.	Seedlings	3.4	23.9	315	7.9	52	7.5	3.5
2.	Tissue culture plants	3.1	21.4	178	4.5	51	7.5	1.9

Table 37: Growth and yield of Noni as intercrop in coconut garden (Veppankulam)

Sl. No.	Planting material	Plant height (m)	Stem girth (cm)	No. of branches/ plant	Fruit yield (kg/plant)	Juice content (%)	TSS (°Brix)
1.	Seedlings	2.5	24.1	23.5	22.6	60.0	8.8
2.	Tissue culture plants	3.0	26.3	30.1	35.0	66.0	10.0

number of branches per plant and fruit yield per plant as compared to seedlings. The juice content and TSS and 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

(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 (*Dendranthem agrandiflora*), celosia (*Celosia* sp.), marigold (*Tagetes serecta*), zinnia (*Zinnia* sp.) and gomphrena (*Gompherena-globosa*) were planted during July-Aug., 2013 in a coconut garden of 24 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, celosia, zinnia and gomphrena and rooted cuttings of chrysanthemum were planted in the experiment. The recommended package of practices was followed for all the flower crops and coconut. Among five commercial flower crops raised, marigold recorded a flower yield of 5,948 kg/ha with a net income of Rs. 77,710/ha and B:C ratio of 2.88 followed by gomphrena with a flower yield of

Intercropping *Gompherena globosa* in coconut (Aliyarnagar)

Table 38: Yield and economics of commercial flower crops intercropped in coconut garden (Aliyarnagar)

Flower crops	Yield (kg/ha)	Gross income (Rs./ha)	Net income (Rs./ha)
Chrysanthemum	4,912	98,240	56,990
Celosia	4,118	82,360	41,110
Marigold	5,948	1,18,960	77,710
Zinnia	3,292	65,800	24,550
Gomphrena	5,074	1,01,480	60,230

Note: In Zinnia, Rs. 65800/- gross income was obtained from the sale of 658 kg seeds obtained from the flowers.

5074 kg/ha, net income of Rs.60,230/ha and Chrysanthemum recorded a flower yield of 4,912 kg/ha with a net income of Rs. 56,990/ha. Celosia and Zinnia recorded lower net income compared to other flower crops. The annual leaf production, number of functional leaves and the number of inflorescence per palm in coconut were unaffected by the flower crops grown in the coconut garden.

Arsikere

The experiment was laid out in a 40 years old coconut garden of Tiptur Tall variety planted with a spacing of 10 m x 10 m. Five commercial flower crops *viz*., jasmine, chrysanthemum, crossandra, china aster and marigold were grown in the inter-row spaces of coconut. A control plot of pure crop of coconut was maintained as control. The experiment was laid out in RBD with 4 replications. During 2012-13, the experiment was initiated and all the five crops were planted during Aug.-Sept. 2012 and harvested the flowers in all the crops except jasmine. The jasmine crop started flowering from August, 2013. As crossandra and jasmine are perennial in nature, they yielded flowers during second year also. The second year crop of chrysanthemum was planted during April, 2013 while marigold and china aster were planted during July, 2013 and August, 2013 respectively and flowers were harvested and yield data were recorded. The yield of flowers was 3009 kg/ha in chrysanthemum, 1582 kg/ha in china aster, 1210 kg/ha in crossandra and 4991 kg/ha in marigold during 2012-13. Crossandra recorded highest net income (Rs. 121250/ha) followed by chrysanthemum (Rs. 90250/ha, china aster (Rs. 43200) and marigold (Rs. 41565/ha) (Table 42).

Intercropping Chrysanthemum in coconut (Arsikere)

Jagdalpur

The experiment on intercropping of commercial flower crops in coconut garden was laid out in RBD with four replications. The treatments are: T_1: 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). In Kharif season flower crops, the plant height was maximum in marigold and minimum in gerbera whereas number of leaves wasmaximum in china aster (Kharif). Number of branches was maximum in marigold

Table 39: Yield of flower crops in coconut garden during 2012-13 (Arsikere)

Flower crop	Yield of flowers (kg/plot) 60 m^2	Yield of flowers (kg/ha)	Gross income (Rs./ha)	Cost of production (Rs./ha)	Net income (Rs./ha)
1. Jasmine	Vegetative stage				
2. Chrysanthemum	21.5	3010	150500	60250	90250
3. Crossandra	8.7	1210	242000	120750	121250
4. China aster	11.3	1582	79100	35900	43200
5. Marigold	35.7	4991	74865	33300	41565

Price of flowers (per kg): Chrysanthemum: Rs. 50/-; Crossandra: Rs. 200/-; China aster: Rs. 50/-; Marigold: Rs. 15/-.

Table 40: Growth and yield characters of *Kharif* season flowers (Jagdalpur)

Sl. No.	Treatments	Plant height (cm)	No. of leaves/ plant	No. of branches /plant	Spike or Stalk length (cm)	No. of flowers/ plant
1.	Tuberose	54.6	22.3	1.1	78.6	28.1
2.	Gerbera	20.5	17.3	1.0	40.3	12.4
3.	China Aster	22.6	72.3	10.2	5.5	14.9
4.	Gaillardia	35.8	18.3	9.2	24.2	32.4
5.	Marigold	56.9	58.2	12.6	8.9	44.5
	CD (P=0.05)	6.1	5.7	1.7	8.0	4.1

Table 41: Growth and yield characters of *Rabi* season flowers (Jagdalpur)

Sl. No.	Treatments	Plant height (cm)	No. of leaves/ plant	No. of branches /plant	Spike or Stalk length (cm)	No. of flowers/ plant
1.	Tuberose	65.7	26.5	1.0	64.0	29.5
2.	Gerbera	27.0	22.2	1.0	40.3	15.7
3.	Antirrhinum	38.2	29.5	9.2	13.0	50.9
4.	Gladiolus	45.8	10.5	1.0	72.5	29.5
5.	Zinnia	88.7	25.0	12.3	16.2	46.4
	CD (P=0.05)	8.1	4.6	2.5	34.8	6.6

and lowest in gerbera and tuberose. Spike length was highest in tuberose followed by gaillardia. The number of flowers was maximum in marigold followed by gaillardia. In Rabi season flower crops, the plant height was maximum in zinnia and minimum in gerbera whereas the number of leaves was maximum in antirrhinum. The number of branches was maximum in zinnia and lowest in gerbera and tuberose. The spike length was highest in gladiolus followed by tuberose. The number of flowers was maximum in antirrhinum followed by zinnia.

Kahikuchi

Five commercial flower crops *viz*., tuberose (*Polianthes tuberosa*), gerbera (*Gerbera jamesonii*), bird of paradise (*Strelitzi areginae*), heliconia (*Heliconi apsittacorum*L.) and marigold (*Tagetes erecta*) were planted during March-May in coconut garden. The experiment was laid out in RBD with four replications. The matured 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, 2012. Of the five flower crops, flowers were harvested in all the crops except bird of paradise

Intercropping Gladiolus in coconut (Kahikuchi)

Table 42: Yield and economics of coconut and flower crops (Kahikuchi)

Treatments	Yield of coconut (Nuts/ palm)	Yield of intercrops/ ha	Gross returns (Rs./ha)	Cost of production (Rs./ha)	Net returns (Rs./ha)
Coconut + Tuberose	66.7	3,50,000 (No.'s)	4,68,051	67,750	400,301
Coconut + Gerbera	64.5	9,00,000 (No.'s)	7,14,165	88,500	625,665
Coconut + Bird of paradise	62.8	—	1,11,156	—	—
Coconut + Gladiolus	68.7	80,000 (No.'s)	5,21,599	66,300	455,299
Coconut + Marigold	59.3	21,388 (kg)	3,18,841	63,450	255,391
Coconut alone (Mono crop)	60.4	—	106,908	36,050	70,858

Selling price: Tuberose spike = Rs. 12.00/dozen; Gerbera stalk = Rs. 8.00/dozen; Gladiolus stick = Rs. 60.00/dozen; Marigold = Rs. 10.00 per kg; Coconut = Rs. 10.00 per nut.

which is still in vegetative stage.

Mondouri

The experiment was laid out in RBD with four replications in a 30 years old coconut garden planted at a spacing of 7.5x7.5m. Five commercial flowering crops like marigold, tuberose, gerbera, gladiolus and heliconia were planted under coconut. Among the five flowering crops, gerbera recorded higher net returns of Rs. 99000 followed by gladiolus with a net returns of Rs. 82000. Marigold recorded lowest net returns of Rs. 36500 (Table 43).

Ratnagiri

The performance of five commercial flower crops *viz.*, *Jasminum sambac, Jasminum multiflorum, Lily spp., Heliconia spp.,* and *Michelia champaka* are being evaluated in the coconut garden in RBD with four replications. *Jasminum multiflora*, *Jansminum sambac,* Lily and *Heliconia* were planted during December, 2012 and

Table 43: Yield and economics of commercial flower crops intercropped in coconut garden (Mondouri)

Crops	Yield (ha^{-1})	Gross returns (Rs./ha)	Net returns (Rs./ha)
Gladiolus	48000 Nos.	144000	82000
Tuberose	81000 Nos.	121500	56500
Gerbera	84000 Nos.	168000	99000
Heliconia	104000 Nos.	104000	46000
Marigold	6100 kg	91500	36500

Intercropping Lily in coconut (Ratnagiri)

Intercropping Heliconia in coconut (Ratnagiri)

Michelia champaka was planted during May, 2013. Initial soil nutrient status and leaf nutrient content of coconut were determined. The data on pre-experimental yield of coconut was recorded.

4.3 Disease Management

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

Collection of *Ganoderma* isolates from various locations

Ambajipeta

Thirty one isolates of *Ganoderma* isolated from basal stem rot infected coconut palms from Andhra Pradesh, Karnataka and Tamil Nadu and one isolate from basal stem rot infected oil palm were used in the study. Three type cultures of *Ganoderma lucidum* DMR 44, DMR 45 and DMR 86 were obtained from Directorate of Mushroom Research, Solan, Himachal Pradesh. All these thirty five isolates of *Ganoderma* were used for patho-genic virulence and molecular characterization studies.

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

Pathogenic virulence studies were conducted on indicator plant bengal gram. Thirty five isolates were tested for their virulence against bengal gram plants in pot experiment. The isolates Ga, Ga1, Ga2, A2, Gl, Gl2, Gl3, Gl4, Gl6, GW1, GW2, MKW, PVI2, CRS5, DMR 86, DMR 44 and DMR 45 were found to be more virulent when compared to the others and showed more than 90% of the seedling death within 30 days of inoculation. Whereas the isolates Gl5, NJL, KLC, and OP were moderately virulent and showed more than 50% of the dead seedlings during the same period. The remaining isolates ANT, NSP, DGM, VKR, KGP, VP, GP, APP, VPM1, VRM1, PVI1, CRS1, CRS2 and CRS4 were less virulent and showed less than 50% of seedling death within 30 days of inoculation.

Arsikere

Seven isolates namely Shimoga, Gajanur, Honnali, Mathgod, Savalanga, Sagara and Bhadravathi and three isolates from CPCRI were collected. The colony characters were studied. Among the ten isolates tested for radial growth, all isolates from Shimoga district were fast growing and recorded 9.0 cm growth in seven days after inoculation while, CPCRI 2 and CPCRI 1 isolates recorded 4.7 cm and 4.8 cm, respectively. All

Table 44: Cultural and morphological characteristics of *Ganoderma* isolates (Arsikere)

S. No.	Isolate Name	Place of collection	Radial growth (cm) (3 DAI)	Radial growth (cm)
1	SMG1	Shimoga	3.08	9.00
2	SMG2	Gajanur	5.42	9.00
3	SMG3	Honnali	5.36	9.00
4	SMG4	Mathgod	3.32	9.00
5	SMG5	Savalanga	3.42	9.00
6	SMG 6	Sagara	1.80	9.00
7	SMG7	Bhadravathi	4.58	9.00
8	CPCRI 1	Kasdargod	2.74	4.76
9	CPCRI 2	Kasargod	1.78	4.66
10	CPCRI 3	Kasargod	5.46	9.00
SEm ±			0.05	0.06
CD @1%			0.19	0.22
CV %			2.90	1.33

(DAI : Days after incubation)

Plate 1. Morphological variability in *Ganoderma* isolates collected from different locations

isolates have more or similar colony characters, which exhibits white radiating cottony growth and variability was not observed (Table 44, Plate 1).

Conservation and molecular characterization of *Ganoderma*

Ambajipeta

RAPD PCR profile analysis

Ten fungal specific primers were used for RAPD analysis which detected a total of 158 fragments with an average of 15.80 fragments per primer and fragments were 100% polymorphic. The number of scorable bands produced per primer ranged from 13 to 19 and size of the products ranged from 200bp to 3.0kb. The maximum number of polymorphic bands (19) obtained with Rfu-06 and minimum number (13) was with primer Rfu-01. Polymorphism (100%) was observed in all primers.

Genetic similarities based on RAPD markers

The maximum genetic similarity value was 0.884 between isolates Gl and Gl3 followed by 0.839 similarity between Ga2 and A2 isolates, while the lowest genetic similarity value of 0.0 was between isolates of CRS2 and Ga, GW1, VPM1, VRM1, DMR 86, DMR 45, KLC, NSP; ANT and CRS5.

Phylogenetic analysis based on RAPD – PCR

The phylogenetic relationships among 35 isolates of *Ganoderma* were analyzed by an UPGMA method. The cluster results showed that two major clusters having KLC, NSP, MKW, DGM, KGP, VP, APP, VKR and GP in one cluster and remaining isolates in other cluster. The major clusters were separated in to three sub-clusters i.e., Gl, Gl3, Gl2, Gl4, Ga2, A2, Ga, Gl5, Gl6 and GW2 first sub-cluster; KLC, NSP, MKW and DGM second sub-cluster; KGP, VP, APP, VKR and GP third sub-cluster. However, Ga1, GW1, VRM1, NJL, DMR 44, PVI2, OP, VRM1, CRS1, PVI1, CRS4, ANT, CRS5, CRS2, DMR 86 and DMR 45 did not form any sub-cluster (Fig 1 & 2).

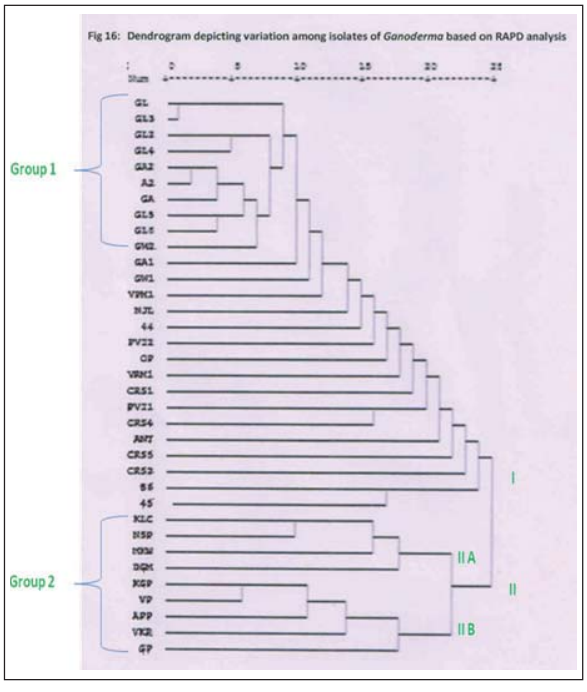
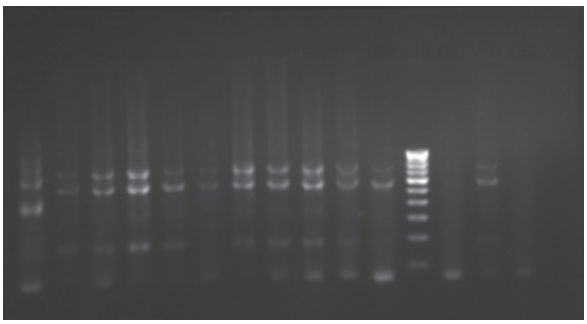
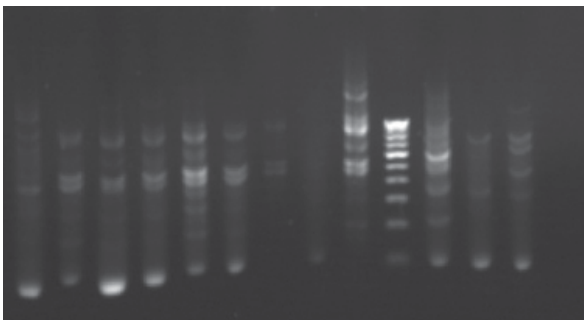


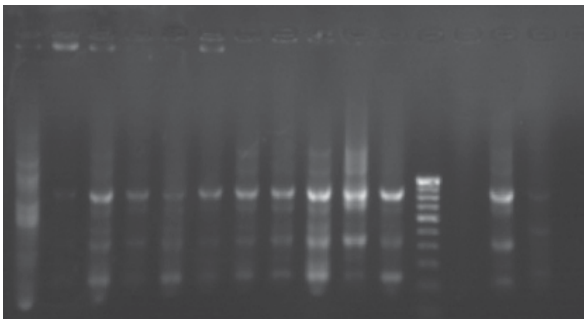
Fig. 1: Dendrogram depicting variation among isolates of *Ganoderma* based on RAPD analysis



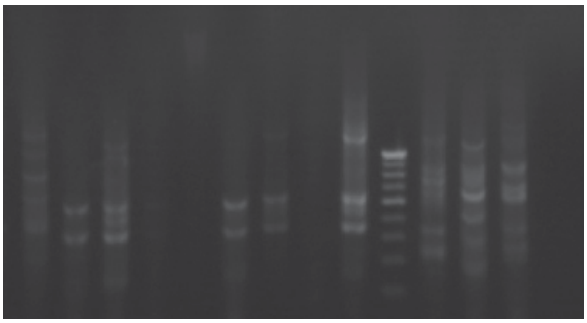
primer 1, 44, ga, ga1, ga2, a2, gl, gl2, gl3, gl4, gl5, gl6, M, gw1, gw2, NJL



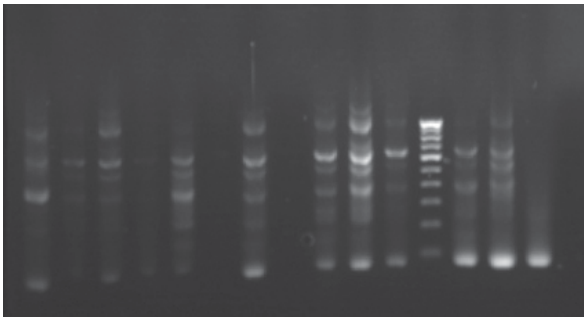
primer 5, 44, vpm1, pvi2, vrm1, pvi1, crs1, crs5, crs2, crs4, M, oilpalm, 86, 45



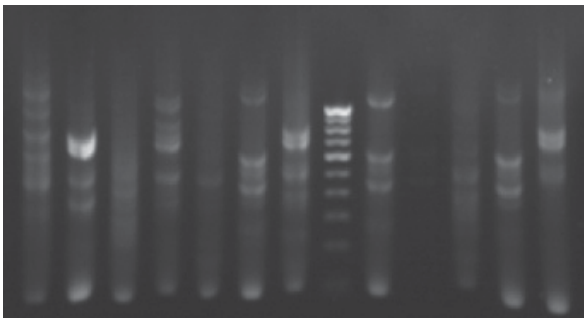
primer 9, 44, ga, ga1, ga2, a2, gl, gl2, gl3, gl4, gl5, gl6, M, gw1, gw2, NJL



primer 3, 44, vpm1, pvi2, vrm1, pvi1, crs1, crs5, crs2, crs4, M, oilpalm, 86, 45



primer 10, 44, ga, ga1, ga2, a2, gl, gl2, gl3, gl4, gl5, gl6, M, gw1, gw2, NJL



primer 3, 44, klc, ant, nsp, dgm, vkr, mk, M, kgp, vp, gp, apl, NJL

Fig 2: PCR banding profile of the isolates with source of the RAPD primers

Grouping *Ganoderma* isolates based on isozyme analysis

Genetic diversity analysis and grouping of the twenty four *Ganoderma* isolates through isozyme analysis was carried out using esterase, catalase, peroxidase and malate dehydrogenase enzymes. The esterase profile of the isolates showed 3 to 7 bands where as that of peroxidase profile from 1 to 3. Majority of the isolates showed 8 bands in the catalase profile except VP (6 bands) and Ga (4 bands). The malate dehydrogenase profile grouped majority of the isolates in to two categories except four isolates. The isolates Ga1, Ga2, Gl2, Gl5, Gl6, GW1, GW2, NJL and A2 produced three bands where as the isolates Gl, Gl3, Gl4, KLC, ANT, KGP, DGM, VKR, MKW and APP showed five bands indicating similarity among them. The remaining isolates NSP, GP and VP

showed four bands and Ga showed two bands indicating variation.

Grouping of *Ganoderma* isolates based on RAPD PCR analysis

The RAPD PCR cluster analysis showed that two major clusters having KLC, NSP, MKW, DGM, KGP, VP, APP, VKR and GP in one cluster and remaining isolates in other cluster. The major clusters were separated in to three sub-clusters i.e., Gl, Gl3, Gl2, Gl4, Ga2, A2, Ga, Gl5, Gl6 and GW2 first sub-cluster; KLC, NSP, MKW and DGM second sub-cluster; KGP, VP, APP, VKR and GP third sub-cluster. However, Ga1, GW1, VRM1, NJL, DMR 44, PVI2, OP, VRM1, CRS1, PVI1, CRS4, ANT, CRS5, CRS2, DMR 86 and DMR 45 did not form any sub-cluster.

Grouping of *Ganoderma* isolates based on RAPD PCR

Grouping based on RAPD PCR:		
Group 1	Group 2	Group 3
Gl, Gl3, Gl2, Gl4, Ga2, A2, Ga, Gl5, Gl6 and GW2	KLC, NSP, MKW, DGM, KGP, VP, APP, VKR and GP	Ga1, GW1, VRM1, NJL, DMR 44, PVI2, OP, VRM1, CRS1, PVI1, CRS4, ANT, CRS5, CRS2, DMR 86 and DMR 45

Grouping of the *Ganoderma* isolates on the basis of isozyme analysis, pathogenic virulence studies and RAPD PCR analysis

Based on the isozyme analysis, pathogenic virulence studies and RAPD PCR analysis, the *Ganoderma* isolates can be grouped in to two major groups. The isolates, Ga2, Gl2, A2, GL6, GW2, Ga1, GW1, Ga, Gl, Gl3 and Gl4 showed more virulence, with three bands in malate dehydrogenase isozyme profile and grouped in to one cluster (Group 1) in RAPD PCR studies. Whereas the isolates, MKW, DGM, VKR, KGP, GP, NSP, APP, VP and KLC showed moderate or less virulence, with 4 or 5 bands in malate dehydrogenase analysis and grouped in to one cluster (Group 2) in RAPD PCR studies.

Epidemiology and disease forecasting

Ambajipeta

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

The study was initiated in November, 2010 to understand the impact of other palms and intercrops in coconut on occurrence and spread of basal stem rot disease. Fifty 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, nine palms were infected during February, 2013 which was increased to ten palms by the end of October, 2013.

A new plot with coconut and banana was selected in the same farmer's garden during July, 2013 as the banana crop was removed in the earlier plot. Out of fifty palms, fifteen palms showed the symptoms during July, 2013 and the diseased palms remained same by the end of March, 2014.

Arsikere

Plot having 50 palms was selected for the study of disease spread in relation to weather parameters during 2013-14. 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 281 to 486 cm. The total monthly rainfall and number of rainy days was found to have negative relationship with vertical spread of disease whereas, temperature is found to have positive correlation with disease spread and there was no horizontal spread of the disease was noticed (Table 45).

Further, the study was also taken to know the impact of intercrops in coconut on occurrence and spread of disease and antagonists and it was noticed that the spread of the basal stem rot was more in sole crop when compared to the coconut intercropped with banana and cocoa (Table 45).

Table 45: Effect of vertical and horizontal spread of the disease in relation to intercrops (Arsikere)

S. No.	Month	Rainfall (mm)	No. of rainy days	Temp (°C)	Rate of VS (cm)			Rate of HS (cm)		
					Sole Crop	Inter-crops		Sole crop	Inter crops	
						Cocoa	Banana		Cocoa	Banana
1	Sep-13	255.8	16	23.47	2.81	3.68	1.66	20.00	18.00	18.00
2	Oct-13	50.4	7	25.49	2.81	3.68	1.66	0.00	0.00	0.00
3	Nov-13	3.0	1	24.91	2.81	3.68	1.66	0.00	0.00	0.00
4	Dec-13	—	—	20.71	2.92	3.68	1.77	0.00	0.00	0.00
5	Jan-14	—	—	20.51	2.92	3.68	1.77	0.00	0.00	0.00
6	Feb-14	—	—	22.36	2.92	3.74	1.77	0.00	0.00	0.00
7	Mar-14	5.4	1	26.31	4.86	4.98	2.95	0.00	0.00	0.00

VS= Vertical spread; HS = Horizontal spread

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

Collection, conservation and characterization of bioagents from different location

Trichoderma viride and *Trichoderma harzianum* were isolated from the rhizosphere region of the coconut garden of HRS, Arsikere.

Ambajipeta

Rhizosphere management

The experiment was initiated in September 2012 and the treatments are being imposed at the specified intervals and the data recorded at monthly intervals. As per the discussions of 22nd Annual group meeting, treatments, T11 (Root feeding of 1 ml of Hexaconazole in 100 ml water thrice in a year + 5 kg of neem cake + soil application of 200 g of *Trichoderma viride*/ palm/ year) and T12 (T_{11} + micronutrient mixture for coconut @ 1 kg / palm / year) were initiated during November, 2013 and are being continued. All the treatments showed drying of the bleeding symptom at least in one palm out of five treated palms in each treatment. The experiment is in progress.

Arsikere:

The new experiment for standardization of dosage frequency and method of application of bio agents was initiated during the November, 2013 with *Trichoderma viride* and *Pseudomonas fluorescens* formulations. Pre-treatment *Trichoderma* population was ranged between 6.0-8.5 cfu /g of soil and the post application observation done after two months on *Trichoderma* showed increase in population and recorded between 15.5-51.0 cfu/g of soil. But, there was no significant difference observed on the BSR disease incidence in all the treatments.

Rhizosphere microbial dynamics

Soil sample of 5 g was collected from the root zone region of 10 diseased, healthy and apparently healthy palms to assess the population of fungi and bacteria by using dilution plate technique. More population of *Aspergillus sp.*and *Pencillium sp*. were recorded from the rhizosphere of BSR affected palms, while antagonistic fungal population (*Trichoderma*) was recorded from the rhizosphere of healthy and apparently healthy palms (Table 46).

In vitro screening of botanicals and bio-agents against basal stem rot pathogen

Screening of five botanicals *viz. Allium sativum, Nerium oleander*, *Tinospora cordifolia*, *Ocimum sanctum* and *Aegle marmelos* were carried against *Ganoderma lucidum* under laboratory conditions. The aqueous leaf extract of botanicals were tested at 5, 10, 15 and 20% concentrations. Among the five botanicals evaluated only *Allium sativum* found significantly superior in inhibiting the growth of the pathogen at all concentration followed by *Ocimum sanctum*

Table 46: Rhizosphere microbial dynamics of BSR affected, healthy and apparently healthy palms (Arsikere)

S. No.	Soil samples	Fungi		Bacteria		*Trichoderma*	
		($x10^4$)	($x10^5$)	($x10^6$)	($x10^7$)	($x10^4$)	($x10^5$)
1	Diseased	21.08	19.04	14.00	11.52	7.08	6.76
2	Healthy	1.72	1.52	22.32	20.08	25.08	22.72
3	Apparently healthy	1.52	1.60	22.04	21.20	23.12	20.48

at the concentration of 15 and 20% which recorded hundred and eighty five per cent inhibition, respectively (Plate 2 and 3).

Nine fungicides were screened against *G. applanatum* under *in vitro* condition. Complete mycelia growth inhibition (100%) was recorded in Pencycuron, Difenoconazole (both at 0.05 and 0.1%), Hexaconazole and Carboxin + Thiram amended plates followed by Mancozeb and Carbendazim which recorded 80.8 and 80.4 per cent inhibition, respectively. The Captan was the least effective and showed 35.33 per cent inhibition (Table 47 and Plate 4).

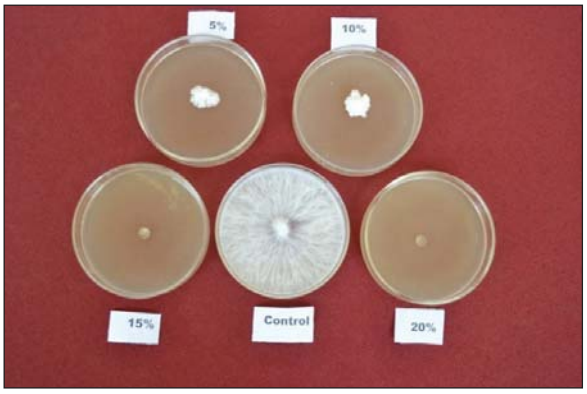


Plate 2. Effect of *Allium sativum* against *Ganoderma applanatum*

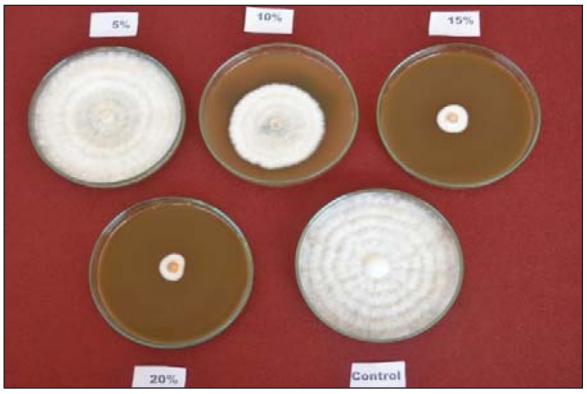


Plate 3. Effect of *Ocimum sanctum* against *Ganoderma applanatum*

To assess the effect of bio-priming with

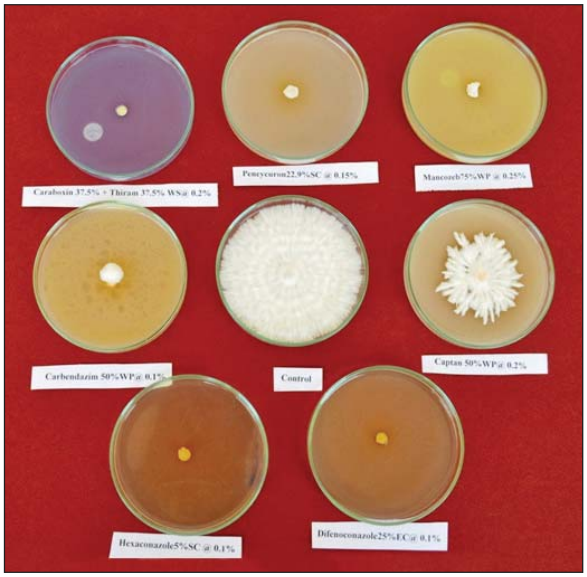


Plate 4. Evaluation of different fungicides against *Ganoderma* under *In vitro* condition

microbial consortia of TNAU against BSR in coconut was initiated in pot culture. The pots were filled with sterilized sand and mixed with *Ganoderma lucidum* inoculums. Tiptur Tall seedlings were dipped in 10% suspension of Microbial consortia of TNAU and planted in pots. The initial observations on plant height, number of leaves and girth of the seedling were recorded. The trial is in progress.

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

In Coimbatore district, Pollachi North, South and Anaimalai blocks were surveyed for root (wilt) disease incidence. Among the blocks surveyed, Pollachi South block recorded a maximum root (wilt) incidence of 1.7% followed by Pollachi North (0.3%) and Anaimalai (0.3%). Farmers were repeatedly advised to remove the severely affected palms in order to prevent further spread of the disease. Three hundred and ten trees in Kettimalanpudur village of Pollachi South and 100 trees in Manakkadavu village of Anaimalai block were removed due to root (wilt) disease severity and low productivity. In Tirupur district, root (wilt) disease symptoms were not observed in all the five villages surveyed.

In Theni district, Cumbum block recorded 5.4% root (wilt) incidence while, no incidence was recorded in Theni block. On an average, Coimbatore district showed 0.78 per cent of root (wilt) disease incidence while, Theni district recorded 4.42 per cent.

Identification of indicator plants

In order to identify a indicator plant for root (wilt) disease, the annual crops *viz.*, Sorghum, groundnut, banana, fodder grasses and the perennial crops like cocoa, nut meg and arecanut grown as intercrop/mixed crop in coconut gardens in the affected areas were periodically observed. Root (wilt) symptoms were not recorded in any of the crops.

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

As a part of AICRP (Palms) programme, a field trial was laid out at Melagudalur village of Cumbum block in Theni district for the validation of root (wilt) disease management strategies recommended by CPCRI in 0.4 ha. The palms were of 20 years old. Following package was implemented.

Location – Melagudalur village, Cumbum block, Theni district

Farmer – Th.D. Murugesan

- 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 sun hemp @ 50 g/palm

Table 47: *In vitro* evaluation of different fungicides against *Ganoderma applanatum*

Treatment	Con. (%)	Mycelial growth (cm)			
		4DAI	% Inhibition	8 DAI	% Inhibition
Hexaconazole 5%SC	0.1	0.00	100	0.00	100
Difenoconazole 25%EC	0.1	0.00	100	0.00	100
Difenoconazole 25%EC	0.05	0.00	100	0.00	100
Pencycuron 22.9%SC	0.15	0.00	100	0.00	100
Captan 50%WP	0.2	1.90	32.62	5.82	35.33
Mancozeb 75%WP	0.25	1.02	63.83	1.72	80.88
Carbendazim50%WP	0.1	0.20	92.90	1.76	80.44
Thiram37.5 + Carboxin37.5 WS	0.2	0.00	100	0.00	100
Control —	2.82		9.00		
SEm ±	0.01		0.04		
CD (P=0.01)	0.03		0.14		
CV%	3.24		2.73		

- Mulching the basin with coconut leaves
- Applying balanced dose of chemical fertilizers (Urea – 1.3 kg; superphosphate – 2.0 kg; Muriate of Potah – 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

c) Applying 20 g Phorate 10G mixed with 200 g fine sand around the base of 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 root (wilt) disease intensity in the trial plot ranged from 8 to 60 in the pre-treatment and the average root (wilt) disease intensity was 26.43. The average nut yield per palm per year was 95. Post treatment observation in this year showed an average disease intensity of 26.57 and the average nut yield per palm was 75 (due to drought also). The treatments were imposed and trial is in progress.

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

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 formulation was tested against stem bleeding disease of coconut on 30 palms each under field conditions from April 2012. The treatments were imposed for two times at four months interval. By the end of March, 2014, 27 palms treated with cake formulation and 22 palms treated with paste formulation were disease free, while, in control, 18 palms were showing disease symptoms (Table 48).

Field evaluation of Vanapalli isolate of Trichoderma viride against bud rot disease of coconut

As per the recommendations of 21st annual group meeting, the identified Vanapalli isolate of *Trichoderma viride* was multiplied in large scale and field evaluation of the isolate was carried out. A total of 300 nursery seedlings were selected and treated with *Trichoderma viride* talc formulation @ 5 g per seedling. The percentage disease

Table 48: Field evaluation of *T. viren* cakes and *T. viride* paste application against stem bleeding disease of coconut

S. No.	Treatments	No. of treated palms	Nov. 2012		July 2013		Nov. 2013		Mar. 2014	
			Disease free palms	Diseased palms	Disease free palms	Diseased palms	Disease free palms	Diseased palms	Disease free palms	Diseased palms
1	*Trichoderma virens* cake application	30	25	5	25	5	20	10	27	3
2	*Trichoderma viride* paste application	30	20	10	20	10	17	13	22	8
3	Control	30	9	21	6	24	10	20	12	18

incidence in the treated plants was 3.33, 2.66 and 1.66 when compared to the 3.66, 4.66 and 2.66 in case of control during August, 2013, November, 2013 and March, 2014 months, respectively.

Arsikere

Field evaluation of antagonists against stem bleeding disease in coconut

Local isolate of *Trichoderma harzianum* was isolated from the rhizosphere region of the coconut garden of HRS, Arsikere and the four treatments *viz*. *Trichoderma* paste, broth, cake formulation and untreated control for stem bleeding management was imposed during last week of January. The observations were recorded at weekly interval and at 7 days after treatment fresh bleeding was not recorded in *Trichoderma* past application. While, broth culture and cake application has recorded 20.0 and 40.0 per cent disease incidence, respectively (Table 49).

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

Ambajipeta

Surveys were conducted in different mandals of East Godavari, West Godavari and Krishna districts of Andhra Pradesh during 2013-14. The major diseases observed in coconut gardens were basal stem rot, bud rot and stem bleeding along with minor incidence of grey leaf spot. Incidence of grey leaf spot disease was also observed to certain extent in East Godavari and West Godavari districts during last year.

Table 49: Effect of different formulation of *Trichoderma* for stem bleeding of coconut

Treatment	Stem bleeding incidence		
	7 DAT	15 DAT	21 DAT
Trichoderma paste	0.0	20.0	40.0
Trichoderma broth	20.0	40.0	60.0
Trichoderma cake	40.0	40.0	60.0
Control	100.0	100.0	100.0

DAT - Days after treatment

Arsikere

Roving survey was taken at Shimoga, Tumkur and Hassan district for the incidence of different diseases of coconut. Among the different diseases recorded bud rot incidence was more in SagaraTaluk which has recorded 2.61% followed by Shimoga recorded 075% incidence. The maximum basal stem rot incidence was recorded from Sagara, Sorabha and Bhadravathi compared to other taluks.

In Tumkur district maximum basal stem rot incidence was recorded at Tipturtaluk (6.0%) followed by Chikkanayakanahalli (5.7) and highest stem bleeding incidence was recorded at Tiptur followed by Chikkanayakanahalli. Leaf blight incidence was more in Turvekere taluk which has recorded 12.0 % and no incidence of bud rot was noticed in Tumkur district.

In Hassan district maximum basal stem rot incidence was recorded at Arsikere taluk (10.47%) followed by 5.57% at Channaraynapattana taluk. The highest stem bleeding incidence of 5.25 % was recorded at Arsikere taluk followed by Channarayapattana. Leaf blight incidence was 10.0% in all taluks and no incidence of bud rot was noticed in Hassan district (Table 51).

The fixed plot survey was taken at Arsikere, the first observations on incidence of basal stem rot, stem bleeding and leaf blight were recorded during the month of August, 2013. The initial incidence of 8.68% of basal stem rot and 3.72% of stem bleeding and 23.60 PDI of leaf blight was recorded. The observation were recorded at the bimonthly interval and it was found that the incidence of basal stem rot and leaf blight incidence were increased to 9.9% and 26.6 PDI respectively during the month of March, 2014.

Veppankulam

Survey was conducted in Thanjavur and Thiruvarur districts to assess coconut disease incidence. Stem bleeding incidence was not

Table 50: Incidence of major diseases of coconut in Andhra Pradesh

S. No	District	Village	Percent disease incidence		
			Basal stem rot	Stem bleeding	Bud rot
1	East Godavari	Gannavaram	27.5	2.0	1.5
		Kalavacharla	34.5	2.0	2.0
		Kesanapalli	25.0	1.5	2.0
		Antarvedi	26.0	2.0	1.0
		Munganda	5.5	2.5	2.0
		Bandarulanka	6.0	3.5	1.5
		Kadali	11.0	2.0	1.0
		Degalavaripalem	6.5	4.0	2.0
2	West Godavari	Narsapuram	17.5	3.4	1.5
		Dagguluru	15.0	1.0	1.0
		Lankalakoderu	12.0	2.3	1.0
		Yelamanchili	11.0	2.5	2.5
3	Krishna	Pallepalem	5.5	1.5	0.5
		Kruttivennu	7.2	1.5	1.0
		Pendurru	7.0	1.0	1.0
		Bantumilli	8.0	2.0	1.5
		Mean	14.07	2.17	1.44

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

Table 51: Survey on diseases of coconut in major coconut growing areas of Karnataka (Arsikere)

Name of the District	Disease status (%)			
	Basal stem rot	Stem bleeding	Leaf blight (PDI)	Bud rot
1. Shimoga				
Sagara	5.28	1.11	12.50	2.61
Shikaripur	1.00	1.33	13.33	0.00
Sorbha	1.92	0.00	12.50	0.50
Bhadravathi	2.50	0.25	15.00	0.00
Shimoga	3.38	0.00	10.00	0.75
Mean	**2.81**	**0.54**	**13.23**	**0.77**
2.Tumkur				
Tiptur	6.00	4.6	10.00	0.0
Turveker	2.60	2.40	12.00	0.0
Chikkanayakanahalli	5.77	4.12	10.00	0.0
Mean	**4.79**	**3.71**	**10.66**	**0.00**
3.Hassan				
Hassan	1.53	0.33	10.00	0.00
Channarayapattana	5.57	2.37	10.00	0.00
Arsikere	10.47	5.25	10.00	0.00
Mean	**5.86**	**2.65**	**10.00**	**0.00**

noticed in any of the places where survey was undertaken. Out of 7970 palms surveyed 164 palms were affected by BSR showing 5.8 % infection. During the survey 12 palms were found affected by bud rot disease. In Thanjavur district BSR is prevalent in Madukkur, Chozhagankudi-kadu, Peravurani, Pappanadu, Pallathur, Kandiyankadu villages, whereas, in Thiruvarur district it is prevalent in Mannargudi, Vadaseri, Melanatham, Paravakkottai, Aavikottai.

Fixed plot survey

Vendakottai

A fixed plot survey was initiated in a farmer's holding at Vendakottai village in Thanjavur district during the year 2008. The area of plot was 1.5 acres. The variety planted is ECT and is 20 years old. Fourth observation was taken on 06.06.2013 and the per cent infection was 88.

Aliyarnagar

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

The survey results showed that the leaf blight was the predominant disease in all the areas surveyed which ranged from 0 to 31.0 percent. The maximum incidence of 30.7 per cent was recorded in Ponnachiyur village followed by 28.80

Table 52: Effect of microbial consortia against leaf blight disease of coconut during 2012-2013

Treat-ments	Treatments details	Reduction in disease severity (PDI)	
		Angalakurichi	Pethanaickanur
T_1	MC @ 150g at quarterly interval + FYM 5 kg	6.00^{bc}(13.98)	5.73^{bc}(13.77)
T_2	MC @ 150g at half yearly interval + FYM 5 Kg	4.13^{cd}(11.57)	4.27^{cd}(11.70)
T_3	MC @ 150g once in a year + FYM 5 Kg	3.02^{d}(9.75)	3.07^{de}(9.49)
T_4	MC @ 150g once in a year + FYM 5 Kg + Neem Cake 5 Kg	2.73^{d}(9.08)	3.20^{de}(10.01)
T_5	MC @ 300g at quarterly interval + FYM 5 Kg	8.00^{ab}(16.28)	8.27^{ab}(16.48)
T_6	MC @ 300g at half yearly interval + FYM 5 Kg	5.90^{bc}(13.84)	5.87^{bc}(13.62)
T_7	MC @ 300g once in a year + FYM 5 Kg	3.80^{cd}(11.07)	3.87^{cd}(11.09)
T_8	MC @ 300g once in a year + FYM 5 Kg + Neem Cake 5 Kg	3.98^{ab}(11.46)	3.47^{de}(10.28)
T_9	BS1 mixture - TNAU (300g @ quarterly interval) + FYM 5 Kg	8.07^{ab}(16.39)	8.13^{ab}(16.52)
T_{10}	BS1 mixture -TNAU (300g @ quarterly interval) + FYM 5Kg + Neem cake 5Kg	8.00^{ab}(16.38)	8.00^{ab}(16.34)
T_{11}	Neem cake alone – 5 kg/ palm/ year	1.20^{e}(6.20)	1.90^{e}(7.14)
T_{12}	Carbendazim (2g/100ml water) RF 3 times at 3 months interval	8.67^{a}(17.06)	9.47^{a}(17.90)
T_{13}	Control	2.80 (+)	3.03(+)

MC: Microbial consortia; FYM: Farm Yard Manure; RF: Root Feeding

Values in the parentheses are Arcsine transformed values. The alphabet represents the treatment significance based on DMRT

per cent in Odayakulam village of Coimbatore district and 27.3 per cent in Devanurpudur village of Tirupur district. Maximum incidence of basal stem rot disease incidence was found in Sembianallur (3.3%), Sundakkampalayam (2.48%) and Devanurpudur (2.3%) villages of Tirupur district, while Coimbatore and Theni districts, the incidence was 0.1 and 0.82 per cent, respectively. There was no stem bleeding incidence in Theni and Tirupur district while, Coimbatore district showed 0.01 per cent disease incidence.

Bud rot disease incidence was recorded in Coimbatore (0.01%) and Theni (0.06%) districts, while, there was no bud rot incidence observed in Tirupur district.

Path.9: Studies on the management of leaf blight disease in coconut

Aliyarnagar:

Development of microbial consortia for the management of leaf blight of coconut incited by *Lasiodiplodia theobromae*

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 among the antagonists screened. Hence, all the three antagonists were combined together to develop microbial consortia and the same was evaluated under field conditions during 2012-2013 (Table 13) at Angalakurichi and Pethanaickanur villages of Pollachitaluk.

The chemical treatment T_{12} (root feeding of Carbendazim @2g/100ml water for 3 times at 3 months interval) was found to be the best treatment among the other treatments including microbial consortia and recorded 8.67 per cent and 9.47 per cent reduction in leaf blight disease incidence in Angalakurichi and Pethanaickanur trials, respectively. The treatment T_{12} was followed by T_5 (Soil application of microbial consortia @ 300g at quarterly interval + FYM 5 kg/palm/year), T9 (BS1 mixture - TNAU consortia (300g @ quarterly interval) + FYM 5 kg) and T_{10} (BS1 mixture -TNAU @300g at quarterly interval + FYM 5kg and Neem cake 5kg/palm/year) in both the trials and showed 8.00, 8.07, 8.00 per cent and 8.27, 8.13, 8.00 reduction in the disease intensity both in Angalakurichi and Pethanaickanur trials, respectively.

Further, two field trials each at N. M. Sungam, Pollachi taluk, Ravanapuram and Udumalpet taluk were laid out and the treatments are imposed at appropriate time. Initial disease incidence in both the trial plots was recorded. The trials are in progress.

Arsikere

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

In vitro evaluation of *Trichoderma harzianum* and *Pseudomonas fluorescens* was carried out by dual culture technique against *Lasiodiplodi atheobromae*. The observations were recorded at 3DAI and 7 DAI and it was found that among the different bioagents evaluated *Trichoderma harzianum* has recorded 54.0% inhibition followed by *Pseudomonas fluorescens* which has recorded 40.0.

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

Activity I: Development of diagnostic kit for early detection of basal stem rot disease

Ambajipeta

Identification of specific markers for detection of *Ganoderma* pathogen:

From the literature, the *Ganoderma* specific primers for the available genomic sequence of *Ganoderma boninense* accession no. X78749 was used for identification. Primers designed for the ITS 1 region of ribosomal DNA of *G. boninense viz.*, GAN 1 (5′ – TTG ACT GGG TTG TAG CTG-3′) and GAN 2(5′ – GCG TTA CAT CGC AAT ACA-3′) were used for analysis as left and right primer, respectively.

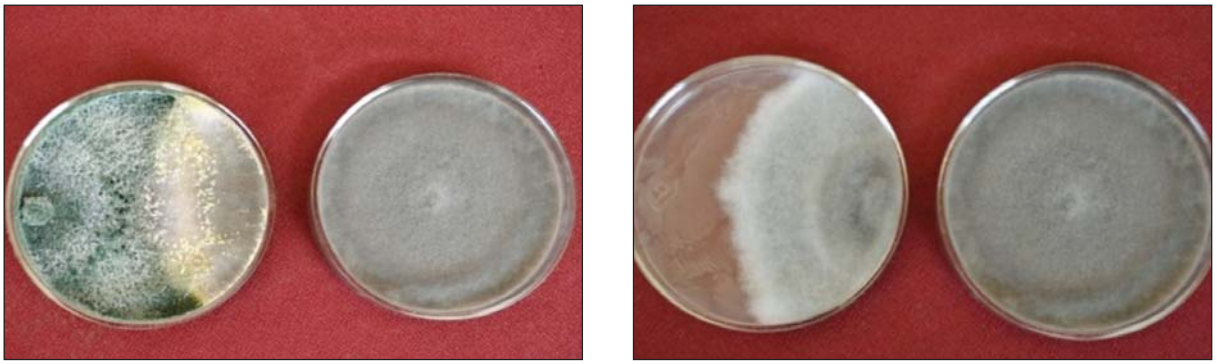


Plate.5. Evaluation of *Trichoderma harzianum and Pseudomonas fluorescens* against *L. theobromae*

PCR reaction conditions were as follows

An initial denaturation cycle was carried out at 95°C for 10 min. it was followed by the three step cycle of denaturation temperature at 94°C for 1minute, annealing temperature at 58°C for 1minute and expansion temperature at 72°C for 1 minute. These three steps were repeated for 35 numbers of cycles and the final extension was carried out at 72°C for 10 min. After amplification, the PCR mix was loaded in the 0.8% agarose gel and observed under UV transilluminator.

All the fifteen *Ganoderma* isolates showed amplification at the expected size of 167bp confirming the specificity of the primer sequences in detection of *Ganoderma* pathogen. Further studies are in progress for identification of the pathogen from diseased palms.

Identification of indicator plants for basal stem rot disease

Studies were repeated for validating bengal gram plant as indicator plant for basal stem rot disease during 2013-14. Artificial inoculation of 35 pure cultures of *Ganoderma* pathogen to the sterilized soil was done with each isolate before planting bengal gram seedlings in pots. Infected plants showed withering, yellowing, browning of the lower set of leaves followed by upper leaves and drying of the plants. When the infected 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. Entire symptoms were visible within a month under artificial inoculation studies. Pure culture of *Ganoderma* was re-isolated from the basal stem regions of infected bengal gram plant. Indicator plant studies are being carried out at Gannavaram village of East Godavari District in sick soil. Bengal gram seeds were sown in BSR infected coconut palm basins for their reaction (Plate 6).

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

Aliyarnagar

Monthly weather data including maximum temperature, minimum temperature, relative humidity and rainfall and the leaf blight disease incidence were recorded regularly. The results showed that the leaf blight disease intensity was increased with increase in temperature and the maximum disease intensity was observed during March-April 2013. Disease intensity was found to be low during October-December 2013 (Fig. 3. and Table 53). Correlation studies between the weather parameters and disease incidence revealed that the weather parameters *viz*., morning relative humidity, evening relative humidity, minimum temperature and rainfall showed a negative correlation with the disease incidence while, maximum temperature (°C) and evaporation (mm) were 53 and 63 per cent positively correlated with the disease development.

Ten different isolates of leaf blight pathogen *viz*., Aliyar, Angalakurichi, Karianchettipalayam, Kambalapatti, Vakkampalayam, Samathur,

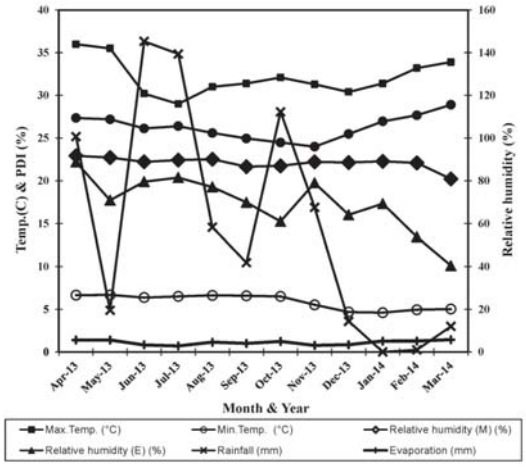


Fig. 3. Effect of weather factors on Leaf blight disease incidence

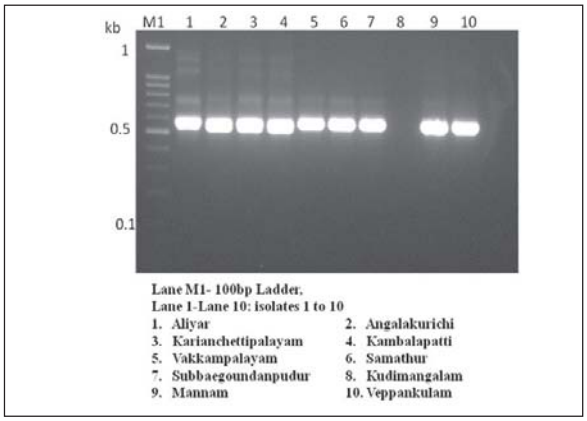


Plate 7. PCR analysis of *L. theobromae* isolates (with ITS1 and 4 primers)

Subbaegoundanpudur, Kudimangalam, Mannam villages of Pollachi Taluk of Coimbatore district and Veppankulam village of Thanjore district in Tamil Nadu were studied for genetic variability. DNA from all the isolates was subjected to PCR analysis with ITS 1 and ITS 4 primers. A PCR product of 500bp was obtained from all the isolates and which have to be sequenced for further analysis (Plate 7). The experiment is in progress.

Arsikere

Collection of *Lasiodiplodia theobromae* isolates from various locations

Five Isolates from Arsikere, Channrayapattana, Shimoga, Chikkanayakanahalli and CPCRI were collected and studied cultural variability of among the isolates. All the isolates produce grayish colonies and there is no difference with respect to time taken for complete radial growth.

Epidemiology and disease forecasting

The study on survival and spread leaf blight incidence in relation to weather parameters was carried out during 2013-14. The disease incidence was recorded at monthly intervals and it was noticed that it was ranging from 23.6 to 30.6 PDI. The total monthly rainfall and number of rainy days was found to have negative relationship with the development of leaf blight incidence whereas, temperature is found to have positive correlation with disease development (Table 53 & 54).

Further, the study was also taken to know the impact of inter crops in coconut on survival and spread of leaf blight disease and it was noticed that inter crops will not have any relation with

Plate 6. Ganoderma infection on Bengal gram seedlings under artificial and natural conditions

Table 53: Relationship between weather parameters and incidence of disease

Percent Disease incidence Vs	R value	R2 value	Regression equation
Maximum Temperature	0.53	0.024	y = -0.092x + 32.81
Minimum Temperature	-0.27	0.073	y = -0.120x + 26.46
Relative humidity (Morning)	-0.25	0.036	y = -0.068x + 90.05
Relative humidity (Evening)	-0.21	0.325	y = -2.716x + 141.9
Rainfall	-0.35	0.281	y = -3.687x + 148
Evaporation	0.63	0.012	y = 0.032x + 4.193

Table 54: Effect of weather parameters and intercrops on survival and spread of leaf blight disease (2013-14)

Sl No.	Months	Rainfall (cm)	Rainy days	Temp. (°C)	Per cent disease index		
					Sole crop	Banana	Cocoa
1	Sep-13	255.8	16	23.4	23.6	22.8	25.1
2	Oct-13	50.4	7	25.4	23.6	22.8	25.1
3	Nov-13	3.0	1	24.9	24.7	22.8	25.1
4	Dec-13	—	—	20.7	26.4	22.8	25.1
5	Jan-14	—	—	20.5	28.8	23.1	25.7
6	Feb-14	—	—	22.3	28.8	23.1	25.7
7	Mar-14	5.4	1	26.3	30.6	24.5	27.0

respect to development of the disease. The disease development in sole crop and coconut inter cropped with banana and cocoa is more are less in similar line.

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

Ambajipeta

The seedlings planted at Gannavaram village of East Godavari district were lost because of the cyclonic rains during 2013. Six seedlings each of available germplasm (ECT, GB x ECT, Pillalakodi, Jonnalaraasi) at Horticultural Research Station, Ambajipeta were again planted in basal stem rot sick garden at Gannavaram village. Seed nuts of Laccadive Micro, Spicata, Chandra kalpa, Java Giant and Ceylon Red were collected and are being raised in nursery. The study is in progress.

Arsikere

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

Veppankulam

On farm trials are in progress in four places namely Veppankulam, Melasembalur, Pulichan-kadu and Thennankudy for the evaluation of resistance of coconut germplasm against basal stem rot disease in coconut.

4.4 Insect 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).

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Roving survey

A roving survey was carried out in Coimbatore, Tiruppur, Cuddalore, Theni, Villupuram, Dindigul, Erode and Namakkal districts. Extent of damage in terms of per cent incidence and intensity were recorded for key insect pests of coconut.

The infestation of rhinoceros beetle was noticed in newly planted gardens in the age group of 4 to 10 years. Hundred per cent incidence was noticed in Pollachi (North) block of Coimbatore district with a mean incidence of 43.3 per cent in the district. In Cuddalore district the mean incidence was 50.2 per cent. The extent of damage in Tiruppur district was 17.4 per cent.

The incidence of red palm weevil was maximum (up to 8.5%) in Thathur village of Anaimalai block of Coimbatore district. The mean incidence of this pest recorded in the district was 2.9 per cent. Gardens planted with dwarfs and hybrids were prone to attack by red palm weevil. Highest incidence of (4.7 per cent) of red palm weevil was observed in Udumalpet block of Tiruppur district (mean incidence 1.9 per cent). The incidence was also noticed in Dindigul (2.8%), Erode (0.7%), Namakkal (1.2%), Theni (2.4%), Tirunelveli (2.1%) and Cuddalore (1.4%) districts.

Infestation by black headed caterpillar was noticed in isolated pockets of Coimbatore district to an extent of 34.8 per cent. An outbreak of this pest was observed in over seventy acres in Sethumadai village of Anaimalai block and continuous release of parasitoids has resulted in scaling down the pest incidence by April, 2014. An outbreak of *O. arenosella* was also reported from Harur block of Dharmapuri district with 66.7% palms affected by the pest. Parasitoids were supplied from CRS, Aliyarnagar to contain the infestation. The pest was also noticed in Dindigul (7.0%), Erode (10.0%), Namakkal (18.0%), Tirunelveli (19.2%) and Tiruppur (18.5%).

The infestation of eriophyid mite was also noticed in all major districts of Tamil Nadu and in most cases, the incidence was as high as 100 per cent in the harvested nut samples. In Coimbatore and Tiruppur districts, the mean incidence was 88.1 and 81.5 per cent respectively. However, the harvested nut samples collected from Coimbatore district recorded a maximum Mean Grade Index (MGI) of 1.43 in Eripatti village of Pollachi North block. One hundred per cent incidence was noticed in Cuddalore, Theni and Erode districts (Table 55).

Minor pests

The minor pests observed in location surveyed are bagworm, Manatha and mealybug, *Pseudococcus* spp. were noticed in Udumalpet block of Tiruppur district Infestation by mealy bug was confined to in the spindle leaf and bunches. In Pollachi (North), Anaimalai block of Coimbatore district and Theni district, termite incidence was noticed in the range of 6.7 to 24 per cent . The outbreak of the slug caterpillar , *Macroplectra nararia* was noticed in Erode district to an extent of 69 per cent.

Fixed plot survey

To record the incidence and intensity of infestation of pests of coconut, fixed plot survey was carried out at quarterly intervals from April 2013 to March 2014 in farmer's field in Anaimalai block of Coimbatore district. Five coconut gardens in Aliyarnagar were fixed for this survey. All the palms in gardens except that in Avalchinam-palayam village fell in the age group of 20 to 30 years. Rhinoceros beetle incidence was not observed in plots surveyed. In Avalchinam-

Table 55: Mean Incidence of major coconut pests in important districts of Tamil Nadu 2013-14

District	Rhinoceros beetle (%)	Red palm weevil (%)	Black headed caterpillar (%)	Eriophyid mite (%)
Coimbatore district	43.3 ± 9.07	2.9 ± 0.7	34.8 ± 15.7	88.1± 5.1
Tiruppur district	17.4 ± 7.4	1.9 ± 0.8	18.5 ± 19.3	81.5
Namakkal district	31.6 ± 4.4	1.2	18.0	Nil
Theni district	22.8 ± 1.7	2.4 ± 0.7	Nil	100.0
Cuddalore district	50.2 ± 5.8	1.4	Nil	100.0
Dindigul district	Nil	2.8	7.0 ± 4.3	Nil
Erode district	Nil	0.7	10.0	100.0
Tirunelveli district	Nil	2.1	19.2	Nil

Mean values are expressed as Mean ± SE

palayam the rhinoceros beetle incidence was noticed to an extent of 100% along with red palm weevil incidence (5.9%). Black headed caterpillar was noticed in Sethumadai with 100 per cent incidence during April 2013. Parasitoids were released in the affected gardens pest damage came down to negligible levels by March 2014. Though the incidence of eriophyid mite was recorded up to 100 per cent, the MGI revealed a mild (Grade = 0 to 1.0) to medium scale (Grade = 1.0 to 2.0) level of infestation in the surveyed gardens (Table 56).

Ambajipeta

Roving survey

Roving survey was carried out in major coconut growing districts of Andhra pradesh *viz.*, East Godavari, West Godavari, Visakhapatnam and Srikakulam districts. Rhinoceros beetle, red palm weevil, black headed caterpillar and eriophyid mite are major pests infesting coconut in this region. The infestation by rhinoceros beetle was in the range of 5.5 to 35.0 per cent all the four districts. Maximum incidence was observed

Table 56: Extent of infestation by different pests in fixed plot surveys in Tamil Nadu (2013-14)

Name of the village	Rhino-ceros beetle incide-nce (%)	Rhinoceros beetle intensity		Red palm weevil	Black headed caterpiller incidence (%)	Eriophyid mite	
		Leaf damage (%)	Spindle damage (%)			Inciden-ce (%)	Intensity (MGI)
Avalchinam-palayam	100.0	36.4 ± 0.94	20.5 ± 6.2	5.9 ± 0.7	nil	70.0 ± 0.8	0.12 ± 0.02 (Mild)
Sethumadai	-	No incidence was observed during fixed plot surveys		2.0 ± 0.5	40.0 ± 6.9	100.0	0.95 ± 0.03 (Mild)
Thathur	-			3.5 ± 1.2	nil	100.0	1.25 ± 0.05 (Medium)
Angalakurichi	-			3.0 ± 0.7	nil	100.0	1.37 ± 0.11 (Medium)
Kottur Malayandi-patnam	-			3.2 ± 0.4	nil	90.0 ± 4.1	0.92 ± 0.04 (Mild)

Values represent Mean ± Standard error

in Srikakulam district while minimum incidence was observed in East Godavari district. The incidence of red palm weevil was maximum in Srikakulam district (22.0 per cent) followed by Visakhapatnam district (5.0 %).

The infestation of black headed caterpillar was noticed in all the districts. Incidence was in isolation in Chittavaram village of West Godavari district and (65.0%) and in Rayavaram village of East Godavari district (45.0%). The incidence in Srikakulam district was 55.0 per cent and in Visakhapatnam it was 50.0 %. The infestation of eriophyid mite was recorded from all the plantations in all districts. It was in the range of 46.6 to 66.6 per cent, the maximum incidence was observed in Srikakulam district (66.6 per cent) while minimum incidence was observed in Visakhapatnam district (46.6 per cent). Intensity of mite was mild to medium in all the districts (Fig. 4).

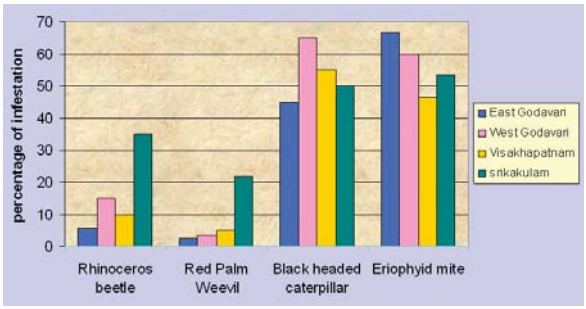


Fig. 4: Incidence of major pests of coconut in Andhra pradesh (Roving survey)

Fixed plot survey

Fixed plot survey was under taken in Palivela village in Kothapeta mandal and Korlapativaripalem in Ambajipeta mandal of East Godavari district. Low intensity of rhinoceros beetle leaf damage was noticed in both the gardens and it ranged from 6.4 to 9.6 per cent at Korlapativaripalem and 12.3 to 18.2 per cent at Palivela Village. No spindle damage was observed in the fixed plot gardens. Hundred per cent incidence of eriophyid mite was observed. The intensity of the mite incidence was medium upto November 2013 and mild scale in February, 2014. No

Table 57: Extent of infestation by different pests in fixed plot surveys in Andhra Pradesh (2013-14)

Month	Black headed caterpillar incidence (%)	Red palm weevil incidence (%)	Rhinoceros beetle incidence (%) (Leaf damage)		Eriophyid mite incidence (%) and intensity	
			Korlapativaripalem	Palivela	Korlapativaripalem	Palivela
May, 2013	No incidence was observed at the two fixed plot survey villages		8.4± 1.2*	18.1 ± 0.7	100% (1.7) Medium	100% (1.6) Medium
September, 2013			6.4 ± 0.6	13.7 ± 0.5	100% (1.5) Medium	100% (1.4) Medium
November, 2013			8.9 ± 1.3	13.2 ± 0. 9	100% (1.5) Medium	100% (1.6) Medium
February, 2014			9.5 ± 1.6	12.3 ± 0. 9	100% (0.8) Mild	100% (0.7) Mild

* Values are Mean ± S.E

incidence of red palm weevil and coconut black headed caterpillar was recorded in fixed plot survey villages (Table 57).

Ratnagiri

Roving survey

Roving survey was carried out in major coconut growing districts of Konkan region of Maharashtra *viz.*, Ratnagiri, Raigad, Sindhudurga and Thane districts. Rhinoceros beetle, red palm weevil, black headed caterpillar and eriophyid mite are major pests infesting coconut in the surveyed region. The infestation of the rhinoceros beetle ranged from 12.7 to 16.8 per cent in all the villages surveyed. Maximum incidence was observed in Raigad and minimum incidence in Thane district. High spindle damage was observed in Sindhudurga district (5.08 per cent) whereas maximum leaf damage was observed in Thane district (13.6 per cent) followed by Raigad district (13.0 per cent). The incidence of red palm weevil was maximum in Sindhudurga district (15.1 per cent) followed by Thane district (13.3 per cent). Maximum dead palms were observed in Sindhudurga district (4.1 per cent) followed by Thane district (3.4 per cent).

The infestation of black headed caterpillar was noticed in all the districts. Maximum incidence observed in Thane district (39.9 per cent). The incidence of this caterpillar was recorded afresh in Sindhudurga district and at present is on a low scale. The infestation of eriophyid mite was recorded from all the plantations observed in all districts and was in the range of 43.9 to 48.5 per cent. Maximum incidence was observed in Thane district (48.5 per cent) while minimum incidence was observed in Sindhudurga district (43.9 per cent). Intensity of mite was mild to medium in all the districts. Tahsil Palghar in Thane district and Talsande in Kolhapur district were identified as hot spot areas for black headed caterpillar and the farmers were supplied with parasitoids from R.C.R.S. Bhatye, Ratnagiri to manage the pest (Table 58).

Fixed plot survey

Fixed plot survey was carried out at quarterly interval from April, 2013 to March, 2014 at farmer's field in Ratnagiri taluka of Maharashtra. The infestation of rhinoceros beetle was in the range of 17.6 to 30.4 per cent and maximum infestation (30.4 per cent) was observed in the month of April, 2013. The mean spindle damage was 4.4 per cent and leaf damage was 18.1 per cent. The infestation of red palm weevil was in the range of 1.6 to 4.8 per cent and maximum infestation (4.8 per cent) was recorded in the month of March, 2014. The incidence of black headed caterpillar was noticed in the month of April, 2013 (14.0 per cent). After rainy season the incidence was noticed in the month of December, 2013 and increased up to the extent of 13.2 per cent in March, 2014. The infestation of eriophyid mite was in the range of 29.2 to 33.2 per cent and maximum infestation (33.2 per cent) was in the month of August, 2013 and the intensity of this pest was from low to medium (Fig. 5).

Table 58: Mean Incidence of major coconut pests in important districts of Maharashtra during (2013-14)

District	Black headed caterpillar Mean Incidence (%)	Rhinoceros beetle Mean Incidence (%)	Red palm weevil Mean Incidence (%)	Eriophyid mite Mean Incidence (%)
Ratnagiri	6.34±0.82*	12.67±1.35	5.76±0.93	46.22±3.35
Raigad	6.58±1.24	16.80±1.88	4.58±1.22	46.53±2.67
Sindhudurga	2.27±0.67	16.52±1.44	15.12±4.99	43.95±3.73
Thane	39.90±6.83	16.43±0.33	13.27±1.21	48.47±1.72

*Mean values are expressed as Mean ± Standard error

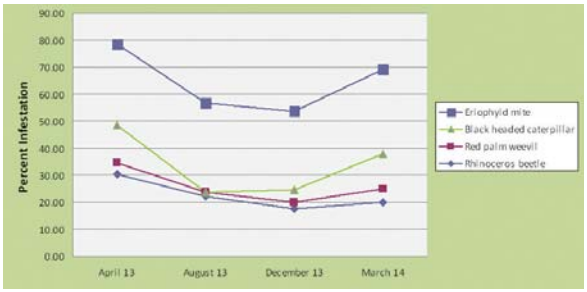


Fig. 5: Intensity of major coconut pests in Maharashtra (Fixed Plot)

Ent. 5: Management of eriophyid mite in coconut gardens

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

The trial was laid out in farmers field at Kottur Malayandipatnam, Anaimalai block, Coimbatore district. The pre-treatment observations were recorded before imposing the treatments. Post treatment observations were recorded at four and eight month's intervals. Simultaneous observations were also made in control plot.

The per cent nut damage was assessed in the experimental plots prior to the experiments and later at four months interval. The per cent nut damage ranged between 40.3 and 42.3 before imposition of the treatments (Table 59). Upon imposing the treatments, the per cent nut damage gradually reduced and by fourth month, the per cent nut damage recorded was in the range of 25.5 to 29.6 per cent in the treatments as against 40.6 per cent in control. By eighth month, the IPM and INM treatments with and without root feeding were on par with each other with 24.0 and 24.5% nut damage as against 41.3% nut damage in control plot.

A similar trend was also noticed in the Mean Grade Index due to eriophyid mite infestation. After eight months of imposing treatments, the IPM+INM (with root feeding) treatment imposed gardens exhibited the least MGI (0.68) and was on par with IPM+INM (without root feeding) gardens with a MGI of 0.74 and were significantly superior to the control plot (MGI = 1.45) (Table 59).

Ambajipeta

The trial was conducted on farmer's field in Korlapativaripalem village of East Godavari district. The pre-treatment observations were recorded before applying the treatments. Post-treatment observations were recorded at four, eight and twelve month's intervals. Simultaneous observations were also made in control plot. Before application of treatments, it was observed that the eriophyid mite infestation was 58.9, 68.6 and 62.2 per cent in different gardens. After four months interval, the mite infestation gradually decreased from 58.9 per cent to 48.4 per cent in treatment T_1 and from 68.6 per cent to 48.4 per cent in treatment T_2. But in control the mite

Table 59: Per cent nut damage due to eriophyid mite infestation in experimental plots in Coimbatore district (2013-14)

Treatment	Damaged nuts (%)		
	Pre treatment	After 4 months	After 8 months
T_1 (IPM without root feeding)	40.3(39.4)	25.5 a(30.3)	24.0 a(29.3)
T_2 (With root feeding)	42.6(40.7)	29.6 a(33.0)	24.5 a(29.7)
T_3 (Control)	42.3(40.6)	40.6 b(39.6)	41.3 b(40.0)
Significance	NS	Sig	Sig
CD (P=0.05)		3.45	4.09
CV (%)		4.48	5.48

Figures in parenthesis are arc sine transformed values
Values followed by a common letter are not significantly different by LSD (P=0.05)

Table 60: Mean damage grade index of eriophyid mite in experimental plots Coimbatore district (2013-14)

Treatment	Mean Grade Index		
	Pre treatment	After 4 months	After 8 months
T_1 (IPM + INM without root feeding)	1.24(1.31)	1.16 b(1.28)	0.74 a(1.11)
T_2 (IPM + INM With root feeding)	1.15(1.28)	0.94 a(1.2)	0.68 a(1.08)
T_3 (Control)	1.37(1.37)	1.35 c(1.36)	1.45 b(1.40)
Significance	NS	Sig	Sig
CD (P=0.05)		0.08	0.11
CV (%)		3.21	5.27

Sig – Significant; NS – Not significant
Figures in parenthesis are square root transformed values
Values followed by a common letter are not significantly different by LSD (P=0.05)

infestation increased from 62.2 to 73.3 per cent. After eight and twelve months a similar decrease in per cent mite infested nuts in both T_1 and T_2 treatments and increase in control was recorded (Table 61).

Regarding eriophyid mite intensity, the initial MDGI was in the range 1.62 to 2.15 with scale being medium to severe. After four, eight and twelve month's interval, the grade index in treated plots gradually declined to mild. However severe scale after eight months and medium scale after twelve months was recorded in control indicating significant effect of the treatments over control from fourth month after treatments imposition. After twelve months, Treatment T_1 (IPM with root feeding) and T_2 IPM garden (without Root feeding) recorded lower mite grade index (mild). (Table 62).

Ratnagiri

The trial was conducted in a farmer's field in Karla village of Ratnagiri district. The pre-treatment and post treatment observations were recorded at four months interval upto twelve month's from 3rd bunch in the selected plots. Before imposing the treatment eriophyid mite infestation was 82.7, 83.0 and 84.1 per cent in different blocks. After four months, the mite infestation decreased from 82.7 per cent to 67.7 per cent in treatment T_1 and from 83.0 per cent to 73.5 per cent in treatment T_2. But in control

Table 61: Per cent nut damage due to eriophyid mite infestation in experimental plots Korlapativaripalem village of East Godavari district (2013-14)

Treatment	Per cent infestation of mite			
	Pre treatment	1st Quarter After 4 months	2nd Quarter After 8 months	3rd Quarter After 12 months
T_1 (With root feeding)	58.94(50.13)	40.48(36.32)	46.63(43.06)	48.42(44.08)
T_2 (Without root feeding)	68.66(56.08)	48.45(44.10)	49.26(43.79)	48.45(44.10)
T_3 (Control)	62.20(51.95)	70.62(61.39)	69.33(59.02)	73.3(61.31)
SEm ±	—	6.17	1.39	2.39
CD (P=0.05)	N.S.	17.8	4.04	6.93
CV (%)	—	45.1	11.1	18.6

Figures in parenthesis are arc sine transformed values

Table 62: Mean damage grade index of eriophyid mite in experimental plots Korlapativaripalem village of East Godavari district (2013-14)

Treatment	Mean damage grade index (2013-14)			
	Pre treatment	1st Quarter after 4 months	2nd Quarter after 8 months	3rd Quarter after 12 months
T_1 : IPM garden (With Root feeding)	1.62(1.25)	0.42(0.95)	0.50(1.00)	0.60(1.02)
T_2 : IPM garden (Without Root feeding)	1.49(1.22)	0.88(1.16)	0.60(1.05)	0.75(1.08)
T_3 : Control	2.15(1.62)	1.82(1.10)	2.10(1)	1.53(1.17)
SEm ±	0.07	0.04	0.02	
CD (P=0.05)	0.20	0.14	0.07	N.S.
CV(%)	20.3	17.6	7.5	

Figures in parenthesis are square root transformed values

plot the mite infestation increased from 84.1 to 86.2 per cent. T_1 and T_2 treatments were significantly superior over control. Similar trend in mite infestation was observed after eight and twelve month's interval. In treatment T_1, mite infestation decreased up to 36.08 per cent while in treatment T_2 it decreased up to 46.40 per cent (Table 63).

The eriophyid mite intensity initially was in the range 2.90 to 3.02 with mean damage grade index being severe. After four, eight and twelve month's interval, intensity in treated plots gradually declined to mild. However the grade index remained severe in control indicating significant effect of the treatments over control from fourth month after treatments. After twelve months, Treatment T_1 (IPM with root feeding) followed by treatment T_2 (IPM with out root feeding) recorded lower mite infestation than control (Table 64).

Ent.11: Evaluation of parasitoids (Braconid) (*Goniozus nephantidis* – larval parasitoids) in the field against *O. arenosella*

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

The larval parasitoid *Goniozus nephantidis*

Table 63: Per cent nut damage due to eriophyid mite infestation in experimental plots in Karla village of Ratnagiri district (2013-14)

Treatment	Per cent infestation of mite			
	Pre treatment	1st Quarter after 4 months	2nd Quarter after 8 months	3rd Quarter after 12 months
T_1 (With root feeding)	82.70(65.47)	67.67(55.35)	50.44(45.25)	36.08(36.91)
T_2 (Without root feeding)	83.07(65.76)	73.53(59.06)	53.76(47.15)	46.40(42.94)
T_3 (Control)	84.10(66.54)	86.16(68.17)	84.17(66.56)	87.24(69.09)
SEm ±	0.56	0.52	0.29	0.45
CD (P=0.05)	N.S.	1.69	0.94	1.45
CV(%)	1.90	1.90	1.21	2.01

Figures in parenthesis are arc sine transformed values

Table 64: Mean damage grade index of eriophyid mite in experimental plots in Karla village of Ratnagiri district (2013-14)

Treatment	Mean damage grade index (2013-14)			
	Pre treatment	1st Quarter after 4 months	2nd Quarter after 8 months	3rd Quarter after 12 months
T_1 : IPM garden (With Root feeding)	2.90(severe)	2.35(severe)	1.15(medium)	0.90(mild)
T_2 : IPM garden (Without Root feeding)	3.67(more severe)	2.40(severe)	1.60(medium)	1.32(mild)
T_3 : Control	3.02(more severe)	3.08(more severe)	2.18(severe)	2.51(severe)
SEm ±	0.06	0.03	0.03	0.04
CD (P=0.05)	N.S.	0.10	0.11	0.12
CV (%)	6.99	3.57	4.62	5.39

was mass multiplied in the laboratory were pre-conditioned in the laboratory prior to release. The parasitoids were exposed to odor from larval frass for about 48 to 72 hours for olfactory conditioning. Pre-treatment count on the no. of larva/ leaflet was recorded prior to release of parasitoids. Parasitoids were released at 20 per palm. Four releases were made at 10 days interval during the experimental period. Ten palms were maintained per replicate. An untreated control check was also simultaneously maintained.

The pre-treatment count on the no. of larvae per 10 leaflets was of the range of 16.2 to 17.0 larvae/ 10 leaflets. After one month of release, the larval population came down to 8.4 to 8.6 per 10 leaflets in the treatments. Control plot also showed a decrease in population level (12.0/ 10 leaflets). Upto 2nd month, there was no significant difference in the larval population between the treatment (where parasitoids were released) and control plots, though there was a gradual reduction (up to 36.5 % reduction) in the treated palms. By the third month, the larval population decreased to (2.5/ 10 leaflets (71.6% reduction) in palms released with conditioned parasitoids as against 8.4/ 10 leaflets in the control palms. The conditioning of parasitoids prior to release was found to make a significant impact upon the parasitization as evident from the results (Table 65).

Ambajipeta

The field trail was conducted in coconut black headed caterpillar out break garden in Chitavaram village of Yelamanchali mandal in West Godavari district in the month of November 2013. The larval population ranged from 29.1 to 41.3 numbers per ten leaflets during November 2013 and gradually decreased to 28.2, 9.4 and 0.2 numbers/ten leaflets in T_1 (Conditioned) and 37.7, 21.3 and 1.2 numbers/ten leaflets in treatment T_2 (Unconditioned). In untreated control the larval population of 29.1 numbers /ten leaflets increased to 42.8 and 35.7 numbers/ten leaflets in first and second months and later decreased in third month. The Conditioning of parsasitoids treatment had impact on reducing black headed caterpillar population when compared to unconditioned parsasitoids (Table 66).

Ratnagiri

The field trail was conducted in coconut black headed caterpillar out break garden in Regional Coconut Research Station, Bhatye Dist. Ratnagiri. The larval population ranged from 17.10 to 17.90 per ten leaflets in October 2013. Larval population

Table 65: Evaluation of pre-conditioned parasitoid *G.nephantidis* against *O. arenosella* in Tamil Nadu (2013-14)

Average of ten palms

Treatment	No. of larva/ 10 leaflets	Avg. No. of parasitized larvae/10 leaflets (Post release count)					Per cent reduction #
		After one month	Per cent reduction #	After second month	Per cent reduction #	After third month	
T_1 (Conditioned - OS)	17.0 (4.2)	8.6 (3.0)	31.7	5.6 (2.5)	36.5	2.5 a (1.7)	71.6
T_2 (Unconditioned - Non-OS)	16.7 (4.1)	8.4 (2.9)	32.1	6.7 (2.7)	22.6	4.5 a (2.2)	48.0
T_3 (Control)	16.2 (4.1)	12.0 (3.5)	-	8.4 (2.9)	-	8.4 b (3.0)	-
Significance	NS	NS		NS		**	
SEd						0.25	
CD (P=0.05)						0.55	
CV (%)						21.6	

Figures in parenthesis are square root transformed values
Values followed by a common letter are not significantly different by LSD (P=0.05)
Per cent reduction derived through Henderson & Tilton formula

decreased to 13.90, 12.70 and 3.30 numbers/ ten leaflets in T_1(Conditioned parasitoids) and 13.20, 10.80 and 6.70 numbers/ten leaflets in T_2(Unconditioned parasitoids) . In untreated control the larval population of 17.40 numbers / ten leaflets was recorded and showed an increase to 18.60 and 20.30 numbers/ten leaflets in first and second months and later decreased in third month. The conditioning of parsasitoids treatment had impact on reducing black headed caterpillar

Table 66: Evaluation of pre-conditioned parasitoid *G.nephantidis* against *O. arenosella* in Andhra Pradesh (2013-14)

Average of ten palms

Treatment	Avg. no. of larvae/ten leaflets (Pre release count)	(*O. arenosella* larval population/ ten leaflets) (Post release count)		
		After one month	After second month	After third month
T_1 (Conditioned)	33.8(5.83)	28.2(5.35)*	9.4(3.16)	0.2(1.07)
T_2 (Unconditioned)	41.3(6.43)	37.7(6.19)	21.3(4.62)	1.2(1.34)
T_3 (Control)	29.1(5.62)	42.8(6.56)**	35.7(5.79)	5.4(2.30)
SEm ±		0.26	0.49	0.26
CD (P=0.05)	N.S	0.78	1.44	0.77
CV (%)		13.9	34.1	52.7

*Fig. in parenthesis are square root transformed
** Increase in pest population

Table 67: Evaluation of pre-conditioned parasitoid *G. nephantidis* against *O. arenosella* in Maharashtra (2013-14)

Average of ten palms

Treatment	Avg. no. of larvae/ten leaflets (Pre release count)	(*O. arenosella* larval population/ ten leaflets) (Post release count)		
		After one month	After second month	After third month
T_1 (Conditioned)	17.10(4.23)	13.90(3.84)	12.70(3.69)	3.30(2.05)
T_2 (Unconditioned)	17.90(4.33)	13.20(3.74)	10.80(3.41)	6.70(2.76)
T_3 (Control)	17.40(4.28)	18.60(4.42)	20.30(4.60)	10.10(3.31)
SEm ±		0.11	0.11	0.10
CD (P=0.05)	N.S.	0.33	0.35	0.28
CV%		8.68	9.59	11.07

• Figures in parenthesis are converted into square root transformation

population when compared to non conditioned parsasitoids (Table 67).

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Studies on the field efficacy of red palm weevil pheromone lures (Ferrolure) was carried out with three lures *viz.,* Central Plantation Crops Research Institute (Nanoporous matrix NPM CPCRI-T_1), Pest Control India (PCI-T_2) and blank trap (T_3) . As per the XXII Annual Group Meeting of AICRP on Palms at IGKV, Raipur on 22nd to 25th July 2013 two more treatments in case of red palm weevil *viz.*, NPM CPCRI lure + Kairomone blends and Food bait alone were included in the evaluation.

Among the traps the CPCRI NPM lure trapped significantly higher number of red palm weevils (23.5 / trap) as against PCI lure (7.5/ trap) and control (1.0/ trap). The traps containing NPM CPCRI lure along with kairomone blends however were found to trap 20.3 weevils and was next only to NPM CPCRI lure (Fig. 6).

In case of rhinoceros beetle, the CPCRI NPM lure trapped significantly higher number of rhinoceros beetles (51.0/trap) as against PCI lure (31.8/ trap) and control (1.0/ trap) (Fig. 7). Across the treatments PVC traps were used as suggested in the protocol.

Ambajipeta

Red palm weevil

The CPCRI NPM lure trapped significantly higher number of red palm weevils (150.25 / trap) as against PCI lure (68.25/ trap) and control (2/ trap) during the period from April to December 2013. (Fig. 8). When NPM CPCRI lure was evaluated along with the kairamoal blends from January 2014, it trapped higher number of weevils

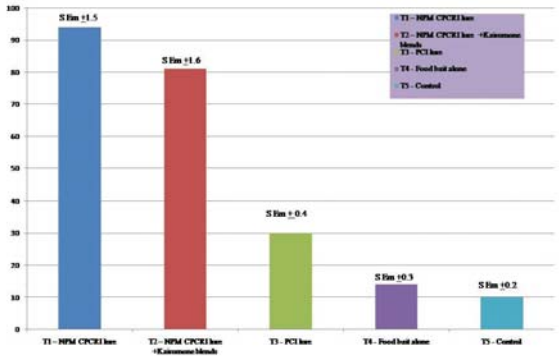


Fig. 6: Efficacy of red palm weevil lures in Tamil Nadu (October 2013 to March 2014)

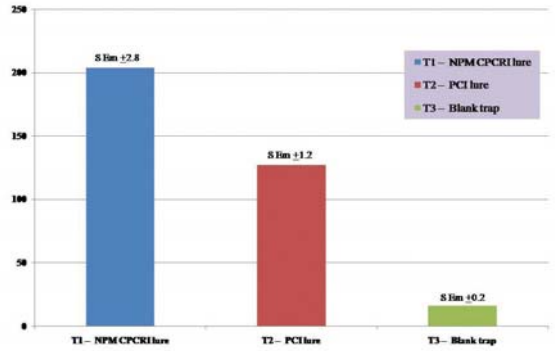


Fig. 7: Efficacy of rhinoceros beetle lures in Tamil nadu (July 2013 to March 2014)

(34 no./trap) as compared to the use of NPM CPCRI lure (23.25 no./trap). Use of kairomonal blends with NPM CPCRI lure aids to increase the number of weevils trapped (Fig. 8).

In case of rhinoceros beetle, the CPCRI NPM lure trapped significantly higher number of rhinoceros beetles (27 / trap) as against PCI lure (4.75/ trap) (Fig. 10).

Ratnagiri

Red palm weevil

The CPCRI NPM treatment trapped significantly higher number of weevils (26 weevils/trap) as compared to the commercial lure from PCI which trapped 13.75 weevils/trap. No catches were observed in control trap (Fig. 11).

CPCRI NPM with kairomonal blends, provided by CPCRI were installed in various farmers field in the month of January 2014 along with the other

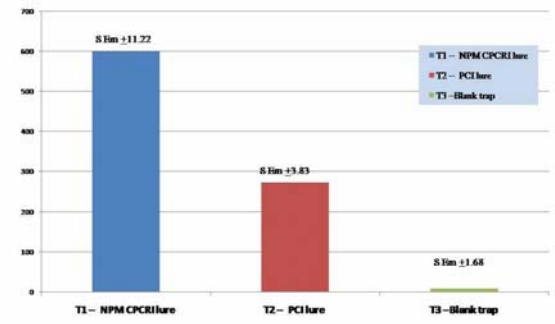


Fig. 8: Efficacy of red palm weevil lures in Andhra Pradesh (April 2013 to December 2013)

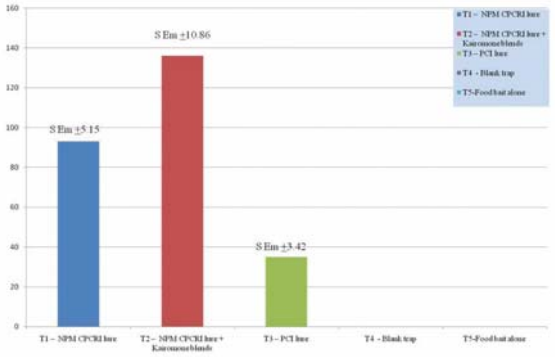


Fig. 9: Efficacy of red palm weevil lures in Andhra Pradesh (January 2014 to March 2014)

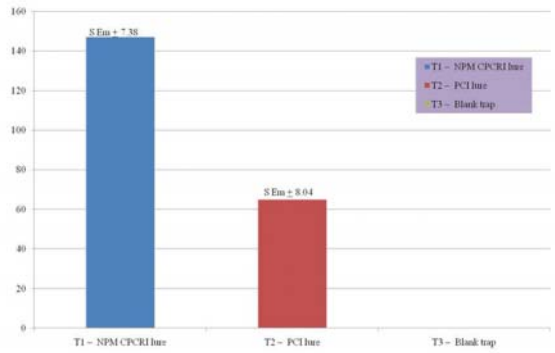


Fig. 10: Efficacy of rhinoceros beetle lures in Andhra Pradesh (June 2013 to March 2014)

treatments. The results reveal that NPM CPCRI lure + Kairamone blend treatment trapped more number of weevils as compared to use of NPM CPCRI lure alone (Fig. 11).

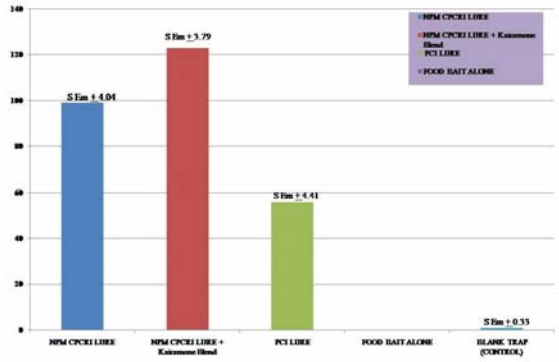


Fig. 11: Efficacy of red palm weevil lures in Maharashtra (January 2014 to March 2014)

In case of rhinoceros beetle CPCRI NPM trapped significantly trapped higher number of beetles (58.00 beetles / trap) as compared PCI lures (24.75 beetles / trap). No catches were recorded in control trap (Fig. 12).

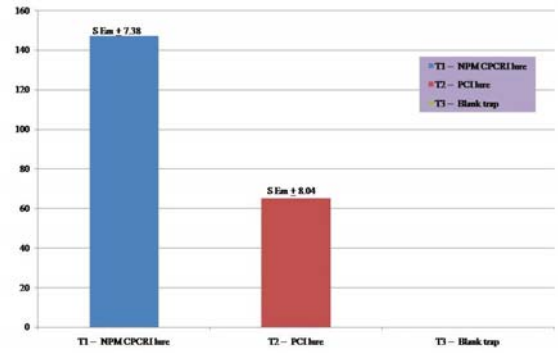


Fig. 12: Efficacy of rhinoceros beetle lures in Maharashtra (January to March 2014)

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

The IPM package including use of pheromone, *Baculovirus*, naphthalene balls and *Metarhizium anisopliae* was applied on a large contiguous area of 10.00 ha was conducted in farmers' field in, Avalchinnampalayam in Anaimalai block of Coimbatore district. The palms in the garden were 3-4 years old Chowghat Orange Dwarf. The observations were made on leaf and spindle damage cuased by rhinoceros beetle at four monthly intervals. Incidence of the pest prior initiation of the experiments was over 85.4%. Observations afer four and eight months indicated that, the incidence level came down to 38.5% and 22.9% respectively. Similarly the leaf damage was reduced from 42.9 to 35.4% and 29.7% after four and eight months respectively. The spindle damage was 56.3% at the time of initiating the experiment which reduced to 39.5 and 29.2% after four and eight months respectively (Fig. 13).

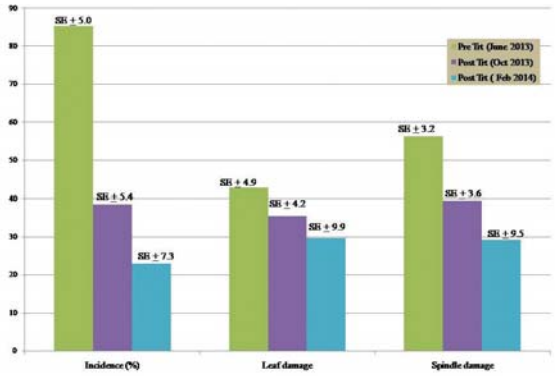


Fig. 13: Pre and post treatment infestation levels of Rhinoceros Beetles in the experimental garden in Tamil Nadu (2013-14)

Ambajipeta

Validation of the IPM strategy was implemented in Nagulanka village, P.Gannavaram Mandal, East Godavari district. The pre treatment infestation data showed 100 per cent incidence and 65.46 and 30.00 percent leaf and spindle damage. In January 2013 the damage incidence was reduced by fifty percent. The reduction in leaf, and spindle damage was 8.5 and 5.00 % respectively. By January 2014 the intensity came to down to a low of 11 per cent and leaf and spindle damage reduced to 4.40 and 2.00 respectively in the experimental field (Fig. 14).

Ratnagiri

The IPM package including use of pheromones, *Baculovirus*, Naphthalene balls and *Metarhizium*

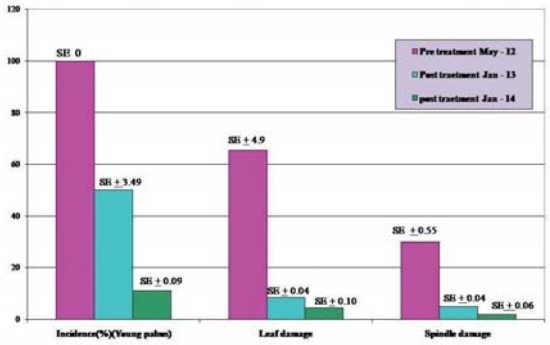


Fig. 14: Pre and Post treatment infestation levels of rhinoceros beetle in the experimental garden in Ambajipeta

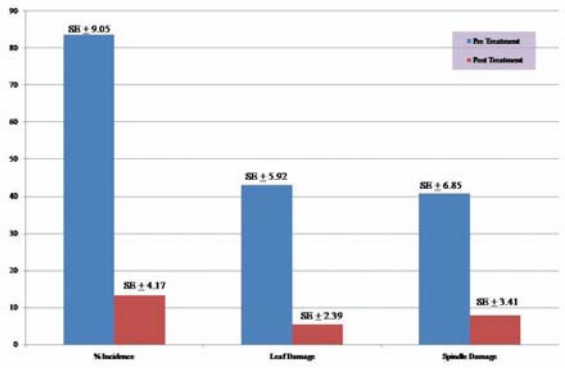


Fig. 15: Pre and Post treatment infestation levels of rhinoceros beetle in the experimental garden in Ratnagiri

anisopliae was applied on large contiguous area of 10.00 ha in village Kalbadevi in Ratnagiri district on farmer's field. Five newly planted coconut gardens were selected impose the treatments. Initial observations on incidence, spindle and leaf damage by rhinocerous beetle was taken. IPM package the per cent incidence of rhinoceros beetle reduced from 83.64 % up to 13.33 %. Leaf damage and spindle damage was reduced up to 5.45 % and 7.88 % respectively from a initial high of 43.03 and 40.61 per cent (Fig. 15).

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

The experiment with the following four treatments has been imposed

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 population of eriophyid mite ranged between 16.3 to 18.9/ 4mm^2 before initiation of spraying. After six months of spraying, all the treatments showed significant reduction in mite population (13.0 to 14.5 / 4mm^2) when compared to control (18.8/ 4 mm^2). The extent of nut damage in different treatments ranged from 71.4 to 75.7% with a mean grade index of 1.01 to 1.20 before the initiation of the experiment. After three months of spraying, the treatment T1 *H. thompsonii* treated palms registered the least damage (67.5%) and mean grade index (0.85). After six months the damage further declined to 59.6% and the mean grade index fell to 0.83 as against 82.3% damage and an MGI of 1.45 in the control palms. The population of predators exhibited non-significant difference between the treated and untreated palms.

Ambajipeta

The experiment was initiated during February 2012 with four treatments having 20 palms per treatment (total 80 palms for the experiment). Pre treatment population that ranged from 0.69 to 1.36/1mm^2 in February 2013 decreased in all the treatments by February 2014 except in control. However, an increase in predator population was observed in the nuts sampled during November 2013 and February 2014 compared to the nuts sampled during February 2012. The lowest mite population of 0.57, 0.51 and 0.43 /1mm^2 was continuously recorded in Treatment T3 (Spraying Palm oil – sulphur emulsion) during the entire observational period (Table 69).

Data on Grade index of harvested nuts revealed that in all the treatments T1 and T2 medium scale of mite intensity was recorded in February and December 2013 harvested nuts as compared to severe scale of mite intensity

Table 68: Grade index of harvested nuts, mite intensity and mite population per 4mm² in experimental garden (2013-14) (Aliyarnagar)

Tr. No.	Pre-treatment observation (Sept. 2013)			Post-treatment observation (3 months after spraying) (Dec. 2013)			Post-treatment observation (6 months after spraying) (Mar. 2014)		
	Damaged nuts	MGI**	mite / 4mm²**	Damaged nuts	MGI**	mite / 4mm²**	Damaged nuts	MGI**	mite / 4mm²**
T1	74.2 (59.5) (Severe)	1.16 (1.3) (Medium)	17.3 (4.2)	67.5 a (55.2) (Severe)	0.85 (1.2) (Mild)	14.0 ab (3.8)	59.6 a (50.5) (Severe)	0.83 (1.2) (Mild)	13.8 a (3.8)
T2	73.8 (59.2) (Severe)	1.20 (1.3) (Medium)	18.9 (4.4)	72.7 b (58.5) (Severe)	1.02 (1.2) (Medium)	18.3 b (4.3)	71.2 b (57.5) (Severe)	0.92 (1.2) (Medium)	14.5 a (3.9)
T3	75.7 (60.5) (More Severe)	1.01 (1.2) (Medium)	16.3 (4.1)	72.3 b (58.2) (Severe)	1.07 (1.3) (Medium)	12.0 a (3.5)	75.8 c (60.5) (More Severe)	0.99 (1.2) (Medium)	13.0 a (3.7)
T4	71.4 (57.7) (Severe)	1.14 (1.3) (Medium)	18.8 (4.4)	75.1 b (60.1) (More severe)	1.43 (1.4) (Medium)	19.2 b (4.4)	82.3 d (67.1) (More Severe)	1.45 (1.4) (Medium)	18.4 b (4.3)
CD(P=0.05)	NS	NS	NS	2.86	0.12	0.24	1.44	0.09	0.46
C.V (%)				3.02	7.21	14.8	1.54	5.63	14.5

Figures in parenthesis are arcsine transformed values
** Figures in parenthesis are square root transformed values
Values followed by a common letter are not significantly different by LSD (P=0.05)

observed in February 2012. However, in Treatment T3 Mild scale was recorded in December 2013 harvested nuts as compared to severe scale observed in February 2012. Interestingly the

Table 69: Population count of eriophyid mite and its predators / 1mm² during the observational period in the experimental garden (Ambajipeta)

	February 2013		November 2013		February 2014	
Tr. No.	Mite population	Predator population	Mite population	Predator population	Mite population	Predator population
T_1	0.69(1.09)	0	0.65(1.05)	0.30(0.84)	0.70(1.08)	1.00(1.15)
T_2	0.94(1.20)	0	0.81(1.13)	2.30(1.57)	0.66(1.04)	4.00(2.00)
T_3	0.57(1.03)	0	0.51(0.99)	2.20(1.50)	0.43(0.95)	1.80(1.44)
T_4	1.36(1.36)	0	1.40(1.35)	2.50(1.56)	1.37(1.34)	5.70(2.20)
SE(m)	NS	NS	0.06	0.19	0.07	0.26
CD	-	-	0.18	0.55	0.20	0.76
CV	-	-	17.9	43.8	19.6	48.8

Fig. in parenthesis are square root transformed values.

percent mite incidence nuts increased in February 2013 in all the treatments and again decreased in February 2014.

Ratnagiri

The experiment was initiated in the year 2012 with four treatments with 20 palms in each treatment. The spraying results revealed that the treatment T_3 recorded significantly lowest mite infestation i.e. 36.27 per cent after 12 months period which was initially 56.40 per cent. Data on Mean Damage Grade Index of harvested nuts

Table 70: Grade index of harvested nuts and mite intensity from February 2013 to February 2014 in the experimental garden (Ratnagiri)

Tr. No.	Pre treatment harvested nuts scale Feb 2013	Per cent mite infested nuts Feb 2013	Grade index and mite intensity for Feb 2013 sprayed and Dec 2013 harvested	Grade index for nuts May 2013 sprayed and Feb 2014 harvested nuts	Per cent Mite infested nuts Feb 2014
T1	2.43 (1.85) (Severe)	54.25 (47.45)	1.29 (1.51) (Medium)	1.46 (1.57) (Medium)	45.38 (42.35)
T2	2.64 (1.90) (Severe)	51.68 (45.98)	1.79 (1.67) (Medium)	0.59 (1.26) (Mild)	38.84 (38.55)
T3	2.48 (1.86) (Severe)	56.40 (48.70)	1.75 (1.65) (Medium)	0.61 (1.27) (Mild)	36.27 (37.02)
T4	2.65 (1.91) (Severe)	57.58 (49.38)	2.50 (1.87) (Severe)	2.55 (1.88) (Severe)	61.03 (51.37)
S.E.	-	-	0.05	0.04	0.50
CD (P=0.05)	N.S.	N.S.	0.17	0.11	1.40
C.V.%	-	-	7.33	5.58	2.50

Table 71: Average population of mite and predator population / 1mm^2 (Ten nuts of 3 months age) in the experimental garden (Ratnagiri)

	Pre-treatment (February 2013)		Post-treatment (May 2013)		Post-treatment (November 2013)		Post-treatment (March 2014)	
Tr. No.	mite	predator	mite	predator	mite	predator	mite	predator
T_1	2.71 (1.93)	0.36 (1.16)	1.53 (1.59)	1.07 (1.44)	1.16 (1.47)	0.00 (1.00)	1.26 (1.50)	1.23 (1.49)
T_2	2.94 (1.98)	0.54 (1.23)	1.60 (1.61)	0.96 (1.38)	1.44 (1.56)	0.00 (1.00)	1.14 (1.46)	1.38 (1.54)
T_3	2.77 (1.94)	0.50 (1.22)	2.60 (1.90)	0.14 (1.06)	1.40 (1.55)	0.00 (1.00)	1.24 (1.50)	1.29 (1.51)
T_4	2.58 (1.89)	0.59 (1.26)	3.35 (2.08)	1.19 (1.48)	3.40 (2.10)	0.00 (1.00)	3.45 (2.11)	1.36 (1.53)
S.E.	0.04	0.06	0.03	0.07	0.04		0.03	0.04
CD (P=0.05)	N.S.	N.S.	0.10	0.22	0.12	N.S.	0.08	0.13
C.V.%	4.77	11.08	4.11	11.94	5.13		3.71	6.18

revealed that the reduction of Mean Damage Grade Index was observed in Treatment T_2 and T_3. Both treatments recorded Mild MDGI followed by Treatment T_3 recorded Medium MDGI whereas it was severe in Control (Table 70).

The mite pre treatment population which ranged from 2.58 to 2.94 mites/1mm^2 in February 2013 decreased to 1.14 to 1.26 mite/1mm^2 in March 2014 except control. Mite population increased in control plot. However no predator population was observed in November 2013 as compared to other months (Table 71).

V. Experimental Results in Oil Palm

5.1 Crop Improvement

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

Centre: Pattukkottai

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

Ten hybrid combinations:

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

Significant differences were observed for palm height, palm girth, annual leaf production/palm, number of female inflorescence, number of male inflorescence and fresh fruit bunch yield among different hybrids. The palm height ranged from 1.7 to 2.8 m. The hybrid NRCOP 11 recorded significantly the higher palm height of 2.8 m and palm girth of 3.3 m. The lowest palm height (1.7 m) was recorded in the hybrid NRCOP 16. Number of leaves produced per year (20.5) and number of female inflorescences (12.7) were the highest in NRCOP 14. The highest number of male inflorescences was recorded in NRCOP 13. Observations on yield attributes were recorded and presented below. Data on yield attributes revealed that the highest FFB yield (135.5 kg/ palm) and yield / ha (19.4 t) was registered in the hybrid NRCOP 17 during the period under report.

Table 72: Performance of oil palm hybrids (Pattukkottai, 2013-14)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production/ palm/ year	No. of male inflorescences/ palm	No. of female inflorescences/ palm	Percent of female inflorescences/ palm	FFB yield (kg/ palm)	FFB yield (t/ha)
NRCOP 11	2.8	3.3	19.5	6.9	11.1	61.7	105.9	15.1
NRCOP 12	2.0	2.4	17.0	6.2	10.3	60.5	90.3	12.9
NRCOP 13	2.4	2.5	20.3	7.1	11.8	62.4	78.7	11.2
NRCOP 14	2.4	2.7	20.5	6.2	12.7	67.4	111.6	16.0
NRCOP 15	2.0	2.7	20.2	6.4	10.7	62.5	90.1	12.9
NRCOP 16	1.7	2.2	18.0	6.6	12.1	64.7	95.3	13.6
NRCOP 17	1.9	2.4	19.7	6.3	11.6	64.8	135.5	19.4
NRCOP 18	1.9	2.4	18.0	6.6	10.4	61.1	114.4	16.3
NRCOP 19	2.3	2.6	18.2	6.3	12.0	65.6	89.1	12.7
NRCOP 20	2.8	2.7	19.1	6.6	11.4	63.2	134.9	19.3
SEm±	0.1	0.1	0.5	0.2	0.5	-	1.1	-
CD(P=0.05)	0.2	0.2	1.3	0.6	1.2	-	2.4	-

View of Gen. 8 trial (Pattukkottai)

Bunch of NRCOP 17 (Pattukkottai)

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

Centres: Gangavati and mulde

Gangavati: The treatments consisted of six Zambian (ZS) and three Tanzanian (TS) selections planted during October 1998 by adopting Randomized Block Design with three replications.

Zambian (ZS) selections		Tanzanian (TS) selections
ZS 1	ZS 8	TS 4
ZS 3	ZS 6	TS 5
ZS 5	ZS 9	TS 7

FFB yield and Yield parameters

Number of bunches

Significant difference in the number of bunches per palm was observed for oil palm genotypes and it was the highest in ZS 3 (4.2).

Bunch weight

The mean bunch weight differed significantly among the various genotypes. The genotype TS 4 (14.5 kg/bunch) recorded significantly higher mean bunch weight over ZS 1 (11.7 kg/bunch), ZS 5 (11.6 kg/bunch), ZS 8 (9.2 kg/bunch), ZS 6 (11.8 kg/bunch), TS 7 (9.8 kg/bunch) and remaining genotypes are on par with TS 4.

FFB Yield per palm

The FFB yield per palm differed significantly among the various genotypes. The genotype ZS 3 recorded significantly higher FFB yield (53.7 kg/palm) over all other genotypes.

FFB Yield

The FFB yield differed significantly among the various genotypes. The genotype ZS 3 (7.7 t/ha) recorded the significantly higher FFB yield over all other genotypes.

Table 73: FFB yield and yield attributes of different drought tolerant oil palm genotypes (Gangavati, 2013-14)

Geno-types	Number of bunches	Mean bunch weight (kg/ palm)	FFB yield (kg/palm)	FFB yield (t/ha)
ZS 1	2.3	11.8	27.0	3.9
ZS 3	4.2	12.8	53.7	7.7
ZS 5	2.6	11.6	29.7	4.3
ZS 8	3.2	9.2	29.1	4.2
ZS 6	2.5	11.8	29.6	4.2
ZS 9	2.5	12.6	31.3	4.5
TS 4	2.2	14.5	32.2	4.6
TS 5	2.4	13.8	32.3	4.6
TS 7	2.2	9.8	21.6	3.1
SEm±	0.3	0.8	3.0	0.3
CD (P=0.05)	0.9	2.4	8.9	0.9
CV%	18.9	12.0	16.5	11.8

General view of Gen 8A (Gangavati)

Mulde:

Experiment was initiated during June 1999 by planting 18 genotypes in RBD with three replications and six palms per treatment.

G.B. 25/314	G.B. 22/311	G.B. 21/310
ZS 1	ZS 2	ZS 3
ZS 5	ZS 6	ZS 9
TS 2	ZS 8	TS 4
TS 5	TS 7	TS 8
TS 9	TS 10	TS 11
(G.B. - Guinea Bissau, TS - Tanzania, ZS- Zambia)		

The genotypes differed significantly for number of bunches per palm under irrigated condition. The highest number of FFB were recorded by the genotype TS 2 (9.1) followed 8.2 bunches in ZS 3.

Average weight of FFB revealed that genotypes have shown significant effect on average weight of bunch under irrigated and rainfed condition. Under irrigated conditions. Average weight of bunch was maximum in genotype ZS 8 (13.1 kg) followed by 11.3 kg in genotype TS 5. Under rainfed condition genotypes ZS 8 and ZS 5 produced bunch weight having average weight of 12.3 kg followed by 12.2 kg in genotype TS 8. Genotype G.B. 25/314 produced lower bunch weight under both the conditions *i.e.* 2.7 kg under irrigated and 3.1 kg under rainfed condition.

FFB revealed that there was significant difference among the genotypes under irrigation and rainfed condition. Under irrigation Genotype ZS 3 recorded the highest yield of FFB i.e., 89.1kg/palm (12.7t/ha) followed by ZS 8 i.e., 78.9 kg/palm (11.3t/ha). Under rainfed condition, ZS 5 recorded highest yield (74.9 kg/palm/year & 10.7 t/ha/year).

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

Centres: Gangavati, Madhopur, Mulde, Pasighat, Pattakkottai and Vijayarai

Gangavati:

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

Hybrid cross combinations

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

Vegetative growth parameters

Palm girth:

Palm girth differed significantly among different hybrids. The palm girth was significantly higher with the hybrid NRCOP 2 (2.5 m) over NRCOP 6 (2.0m). The other hybrids were on par with NRCOP 2.

Inflorescence production

Number of female inflorescences

The number of female inflorescences significantly differed among the hybrids. The significantly higher number of female inflorescence was recorded with the hybrid NRCOP 1 (8.8) over NRCOP 3 (6.5), NRCOP 9 (6.7) and NRCOP 6 (6.5). The other hybrids were on par with NRCOP 1.

Table 74: Yield performance of drought tolerant genotypes (Mulde, 2013-14)

Genotypes	Av. number of FFB		Av. weight of FFB (kg)		Av. yield of FFB (kg/palm)		Av. yield of FFB (t/ha)	
	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
G.B. 25/314	1.8	2.5	3.1	2.7	8.3	11.2	1.2	1.6
G.B. 22/311	4.0	5.3	5.9	7.0	23.8	37.0	3.4	5.3
G.B. 21/310	2.1	2.4	5.5	6.0	11.5	13.6	1.6	1.9
ZS 1	6.8	7.0	8.3	10.6	55.3	77.3	7.9	11.0
ZS 2	6.8	6.3	7.6	10.3	52.0	66.7	7.4	9.5
ZS 3	6.3	8.2	8.5	11.0	52.8	89.1	7.6	12.7
ZS 5	6.3	7.0	12.3	9.5	74.9	68.1	10.7	9.7
ZS 6	5.1	6.7	9.4	9.6	47.2	62.4	6.8	8.9
ZS 9	6.8	7.6	7.3	7.2	46.8	55.0	6.7	7.9
TS 2	5.3	9.1	7.2	8.3	38.0	75.8	5.4	10.8
ZS 8	4.7	6.2	12.3	13.1	58.2	78.9	8.3	11.3
TS 4	5.1	7.1	9.3	9.8	47.8	67.9	6.8	9.7
TS 5	4.5	4.8	9.0	11.3	41.1	55.6	5.9	8.0
TS 7 (Control)	6.7	5.5	9.5	10.8	67.8	58.3	9.7	8.3
TS 8	4.8	3.3	12.2	9.1	51.3	30.2	7.3	4.3
TS 9	4.4	6.3	10.8	7.7	45.4	48.7	6.5	7.0
TS 10	5.3	7.8	11.7	10.0	59.8	77.8	8.5	11.1
TS 11	4.9	5.7	8.8	10.8	42.4	62.4	6.1	8.9
SEm ±	1.0	1.1	1.5	1.2	9.5	13.3	1.4	1.9
CD(P=0.05)	N.S.	3.3	4.3	3.4	27.3	38.3	3.9	5.5

FFB yield and yield parameters

Number of bunches per palm

The number of bunches per palm differed significantly among the various hybrids. The highest number of bunches per palm was recorded with hybrid NRCOP 4 (5.8) and it was significantly superior over all other hybrids.

Bunch weight

Mean bunch weight was differed significantly among the various hybrids. The hybrid NRCOP 2 (14.9 kg) recorded the significantly higher mean bunch weight over NRCOP 3 (11.6 kg) but it was on par with the remaining hybrids.

FFB yield

The FFB yield differed significantly among the various hybrids. The hybrid NRCOP 4 (10.6t/ha) recorded the significantly higher mean FFB yield over NRCOP 3 (5.9 t/ha) and NRCOP 6 (7.3 t/ha) and it was on par with remaining hybrids.

Genereal view of Gen 8C (Gangavati)

Bunch yield of NRCOP 1 (Gangavati)

Bunch yield of NRCOP 4 (Gangavati)

Bunch yield of NRCOP 8 (Mulde)

Table 75: Vegetative growth parameters, FFB yield and yield attributes of different oil palm hybrids (Gangavati, 2013-14)

Hybrids	Palm girth (m)	Annual leaf production	No. of female inflorescences/ palm	Sex ratio	No. of bunches/ palm	Mean bunch weight (kg)	FFB yield (t/ha)
NRCOP 1	2.3	17.7	8.8	59.0	4.7	14.6	10.4
NRCOP 2	2.5	18.7	8.2	54.8	4.6	14.9	10.0
NRCOP 3	2.3	17.2	6.5	52.7	3.7	11.6	6.0
NRCOP 4	2.4	18.2	8.5	62.7	5.8	12.8	10.6
NRCOP 5	2.4	18.1	7.5	61.9	4.2	13.3	8.0
NRCOP 6	2.0	16.7	6.5	60.9	3.9	12.8	7.3
NRCOP 7	2.1	16.8	7.1	64.7	4.5	13.1	8.4
NRCOP 8	2.2	17.9	7.3	55.0	4.2	14.5	8.7
NRCOP 9	2.3	17.4	6.7	53.4	3.9	14.3	8.0
NRCOP 10	2.3	19.7	8.6	62.4	4.7	13.0	8.7
SEm ±	0.1	1.4	0.6	3.9	0.3	0.8	1.0
CD(P=0.05)	0.4	NS	1.8	11.6	1.0	2.4	2.8
CV%	11.0	14.0	13.8	11.6	13.2	10.3	19.2

Mulde:

Oil palm seedlings were planted during September, 2007 in RBD design with three replications and nine plams per treatment.

Ten cross combinations of oil palm did not show significant variation for average height, girth and number of leaves.

The ten cross combinations of oil palm did not show significant variation for production of average number of male, hermaphrodite and total inflorescences.

Bunch weight was the highest in genotype NRCOP 8 (7.8 kg/bunch) whereas it was the lowest in NRCOP 10 (5.0 kg). Genotype NRCOP 8 recorded the highest yield (4.3 t/ha) whereas it was lower (2.1 t/ha) in genotype NRCOP 4 (Table 76).

Pasighat:

The secondary nursery seedlings were transplanted in the main field in the month August, 2010.

The growth of the plants with respect to plant height and number of leaves produces per plant in the entire cross combinations was at on par over a period of one year and difference in collar girth was observed. The collar girth recorded maximum (168.0 cm) in NRCOP 29, and statistically on par with the cross combinations 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 (146.5 cm) in NRCOP-26. Flowering and fruiting commenced during the period. The number of male flowers per plant was more than the female flowers. Maximum number of FFB (1.9) was recorded in NRCOP-22 and the FFB recorded was minimum (0.2) in NRCOP-30 (Table 77).

Pattukkottai:

Ten new oil palm hybrids developed from DOPR, Regional Station, Palode were planted during September, 2007 by adopting RBD with three replications and six palms per treatment. Soil of the experimental field is red sandy loam.

The results revealed that the highest palm height (1.9 m), palm girth (2.5 m), number of leaves produced per palm per year (23.2) and number of female inflorescence (12.4) was recorded in the hybrid NRCOP 5. The lowest palm height (1.3 m) was recorded in the hybrid NRCOP 10. Hybrid NRCOP 3 recorded significantly the highest number of male inflorescences (8.1). Data on yield attributes revealed that the highest FFB yield (81.8 kg/palm) and yield / ha (11.7 t) was recorded in the hybrid NRCOP 9 during the period.

Table 76: Vegetative growth parameters of different oil palm hybrids (Mulde, 2013-14)

Hybrids	Palm height (m)	Annual leaf production	No. of female Inflore scences/ palm	Sex ratio	No. of bunches/ palm	Mean bunch weight (kg)	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP 1	1.9	18.4	1.9	38.8	3.1	6.8	21.4	3.1
NRCOP 2	2.1	18.7	3.2	60.4	4.3	6.5	28.8	4.1
NRCOP 3	1.9	17.7	2.3	46.0	4.4	5.1	23.8	3.4
NRCOP 4	1.7	17.4	1.8	42.9	2.9	5.2	14.7	2.1
NRCOP 5	1.5	15.8	2.4	53.3	3.6	5.6	20.6	2.9
NRCOP 6	1.8	19.2	1.6	37.2	4.3	5.5	23.9	3.4
NRCOP 7	1.8	17.9	2.4	42.9	3.9	5.9	23.4	3.4
NRCOP 8	2.2	18.0	2.5	48.1	3.9	7.8	30.3	4.3
NRCOP 9	2.2	19.2	1.8	38.3	4.3	6.5	27.9	4.0
NRCOP 10	1.7	16.7	1.5	37.5	3.4	5.0	18.3	2.6
SEm ±	0.3	0.9	0.5		0.8	0.6	5.4	0.8
CD(P=0.05)	N.S.	N.S.	N.S.		N.S.	N.S.	N.S.	N.S.

Vijayarai:

Hybrids were planted during September 2007 by adopting RBD with three replications and six palms per treatment.

Table 77: Growth parameters of Oil palm hybrids (Pasighat)

Cross Combination	Plant height (cm)	Collar girth (cm)	No. of leaves produced	No. of FFB/ (palm)
NRCOP 21	32.6	157.0	12.9	1.6
NRCOP 22	32.5	156.3	11.1	1.9
NRCOP 23	33.4	163.8	11.7	1.2
NRCOP 24	28.6	148.0	10.4	0.3
NRCOP 25	26.9	149.8	10.5	1.0
NRCOP 26	30.5	146.5	11.4	0.7
NRCOP 27	30.3	159.7	14.9	1.1
NRCOP 28	30.5	153.9	12.0	0.5
NRCOP 29	33.8	168.0	11.1	0.7
NRCOP 30	25.2	151.5	11.4	0.2
CD(P=0.05)	NS	11.839	NS	NS
CV (%)	12.638	4.439	20.551	77.186

Palm height and annual leaf production per palm were significantly influenced by various cross combinations. The highest palm height (1.2 m) was recorded in NRCOP-4 and NRCOP-6 recorded significantly higher number of leaves per palm (56.8). None of the hybrids had significant influence on palm girth, number of male inflorescences and sex ratio (Table 78).

Yield parameters

Yield parameters differed significantly among different hybrids NRCOP 4 recorded significantly higher number of harvested bunches per palm (10.1). The highest yield of FFB per palm was recorded in NRCOP 4 (128.2 kg/palm/year). Average bunch weight per palm per year was significantly the highest (23.0 kg/palm/year) in the variety NRCOP 4. The hybrid NRCOP 4 recorded significantly the highest FFB yield (19.6 t/ha) (Table 79).

Table 78: Growth performance of oil palm hybrids (Pattukkottai, 2013-14)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production per palm	No. of male inflorescences/ palm	No. of female inflorescences/ palm	Total no. of inflorescences	Per cent of female flowers	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP 1	1.6	2.0	22.5	7.9	11.1	19.0	58.4	56.4	8.1
NRCOP 2	1.6	2.4	20.0	7.2	9.3	16.5	56.2	59.8	8.6
NRCOP 3	1.5	2.3	23.2	8.1	10.8	18.9	57.2	38.1	5.5
NRCOP 4	1.6	2.3	22.2	7.2	11.1	18.3	60.8	56.6	8.1
NRCOP 5	1.9	2.5	23.2	7.4	12.4	19.8	62.6	72.3	10.3
NRCOP 6	1.6	2.2	21.0	7.6	11.8	19.4	60.7	48.9	7.0
NRCOP 7	1.5	2.3	22.7	7.3	10.6	17.9	59.2	68.3	9.8
NRCOP 8	1.9	2.3	21.0	7.6	10.1	17.7	57.1	51.9	7.4
NRCOP 9	1.6	2.2	23.0	7.3	11.7	19.0	61.6	81.8	11.7
NRCOP 10	1.3	2.2	22.1	7.6	10.4	18.0	57.7	38.3	5.5
SEm ±	0.0	0.1	0.5	0.2	0.4	0.7	0.7	0.8	-
CD (P=0.05)	0.1	0.2	1.1	0.4	0.8	1.4	1.5	1.6	-

Table 79: Influence of different hybrids on growth and yield parameters of oil palm (Vijayarai, 2013-14)

Name of the hybrid	Palm height (m)	No. of leaves per palm per year	Palm girth (m)	No. of female inflore-scences/ palm	Sex ratio (%)	No. of bunches/ palm/ year	FFB yield (kg/ palm/ year)	Av. bunch weight (kg/palm/ year)	FFB yield (t/ha)
NRCOP 1	1.1	43.7	2.6	3.8	59.9	5.5	75.2	12.3	10.8
NRCOP 2	0.9	43.4	2.4	4.5	64.5	7.3	92.2	12.0	15.1
NRCOP 3	0.9	35.9	2.5	3.2	53.2	5.8	80.4	11.2	11.5
NRCOP 4	1.2	43.1	2.7	8.1	69.8	10.1	128.2	23.0	19.6
NRCOP 5	1.0	42.8	2.5	5.8	77.4	3.4	105.7	21.2	14.8
NRCOP 6	1.0	56.8	2.5	6.6	45.6	5.4	77.5	12.7	10.6
NRCOP 7	1.2	43.8	2.7	7.0	55.3	4.3	57.6	12.1	8.2
NRCOP 8	1.1	41.2	2.6	3.1	54.0	8.0	75.9	9.9	10.9
NRCOP 9	0.8	42.6	2.6	5.5	65.7	6.4	91.5	15.2	13.0
NRCOP 10	0.9	45.3	2.5	4.2	64.0	6.3	83.2	12.9	10.9
S. Em ±	0.1	1.3	0.1	0.5	6.8	0.7	11.3	2.4	1.3
CD(P=0.05)	0.2	3.8	NS	1.6	NS	2.1	33.9	7.1	3.9

Gen. 8D: Progeny evaluation trial in oil palm

Centres: Gangavati, Madhopur, Mulde, Pasighat, Pattakkottai and Vijayarai

Gangavati:

Treatments details:

NRCOP 31 (257 CDx14 P)	NRCOP 36 (99 CDx14 P)
NRCOP 32 (254 CDx17 P)	NRCOP 37(66 CDx17 P)
NRCOP 33 (198 CDx129 P)	NRCOP 38 (66 CDx14 P)
NRCOP 34 (124 CDx14 P)	NRCOP 39 (42 CDx14 P)
NRCOP 35 (124 CDx17 P)	NRCOP 40 (92 CDx129 P)

Hybrids were planted during 2012 in RBD with three replications and six palms per plot.

Vegetative growth parameters: (Table 80)

Significant difference in the palm height was observed among different hybrids. The palm height was significantly superior with the hybrid NRCOP 32 (34.0 cm) over NRCOP 33, NRCOP 39 and NRCOP 40 (25.3, 27.1 and 26.1cm, respectively).

Bunch yield of NRCOP 04 (Vijayarai)

Bunch yield of NRCOP 02 (Vijayarai)

Similarly, palm girth differed significantly among different hybrids. The palm girth was significantly higher with the hybrid NRCOP 37 (28.6 cm) over NRCOP 31 and NRCOP 39 (23.3 cm and 23.9 cm, respectively).

The number of leaves per palm differed significantly among hybrids. The hybrid NRCOP 32 (13.9) recorded significantly higher number of leaves per palm over NRCOP 39 (11.2) but the remaining hybrids were on par with NRCOP 32.

Table 80: Vegetative growth parameters of different oil palm hybrids (Gangavati 2013-14)

New Hybrids	Palm height (cm)	Palm girth (cms)	Annual leaf production
NRCOP 31	30.3	23.3	12.2
NRCOP 32	34.0	27.7	13.9
NRCOP 33	25.3	24.2	12.1
NRCOP 34	28.8	26.4	12.8
NRCOP 35	29.3	24.9	13.2
NRCOP 36	29.6	26.2	12.8
NRCOP 37	33.6	28.6	13.3
NRCOP 38	27.6	25.9	12.8
NRCOP 39	27.1	23.9	11.2
NRCOP 40	26.1	25.7	11.9
SEm ±	2.3	1.6	0.9
CD(P=0.05)	6.6	4.6	2.6
CV%	13.4	10.4	12.3

Mulde:

Planting was done in the experimental field during October, 2011 by adopting RBD with three replications and six palms per treatment/plot. Ten cross combinations of oil palm did not show significant variation for average number of leaves. Plant height was the lowest (0.62 m) in genotype NRCOP 38 (Table 81).

Pasighat:

Layout and planting of this trial was done in August 2012.

The growth of the plants with respect to plant height, stem girth and number of leaves produced in the main field over a period of one year was found to be statistically at par, in all the cross combinations.

Pattukkottai:

Nine hybrids *viz*., NRCOP 31, 32, 33, 34, 35, 36, 37, 38 and 39 were planted on 26.02.2013 in ARS, Pattukkottai. Among 9 hybrids

General field view of Gen. 8D (Gangavati)

View of Gen 8D. (Gangavati)

received, only five hybrids (NRCOP 31, 32, 33, 38 and 39) had sufficient seedlings for the replicated trial. Other four hybrids *viz*., NRCOP 34, 35, 36 and 37 were planted as non replicated

Table 81: Growth performances of different hybrid combinations (Mulde, 2013-14)

Hybrids	Palm height (m)	Annual leaf production
NRCOP 31	0.72	21.4
NRCOP 32	0.69	19.6
NRCOP 33	0.66	19.8
NRCOP 34	0.72	19.7
NRCOP 35	0.69	18.9
NRCOP 36	0.66	19.2
NRCOP 37	0.68	19.0
NRCOP 38	0.62	18.4
NRCOP 39	0.67	21.1
NRCOP 40	0.63	19.4
SEm ±	0.02	0.9
CD (P=0.05)	0.06	N.S.

View of the experimental field (Mulde)

trial for observation. The biometric data revealed that the lowest palm height was recorded in the hybrid NRCOP 31. Hybrid NRCOP 36 registered the highest values for palm girth (59.2 cm), leaf breadth (93.8 cm) and number of leaflets / leaf (92.3) (Table 82).

Vijayarai:

Among various hybrids, Significantly the highest palm height of 40.4 cm was recorded in NRCOP-33. The hybrid NRCOP-39 produced significantly higher number of leaves per palm per year (43.3).

Table 82: Growth parameters of oil palm plants in secondary nursery

Cross Combination	Plant height (cm)	Collar girth (cm)	No. of leaves produced
NRCOP-31	187.0	58.1	12.5
NRCOP-32	212.3	55.7	11.1
NRCOP-33	214.5	54.9	11.1
NRCOP-34	231.4	56.0	10.6
NRCOP-35	221.5	57.1	11.1
NRCOP-36	213.0	59.2	11.6
NRCOP-37	214.9	54.2	10.4
NRCOP-38	216.1	58.6	11.8
NRCOP-39	217.9	52.2	11.9
NRCOP-40	197.5	49.3	9.8
CD(P=0.05)	NS	NS	NS
CV(%)	7.21	11.58	15.30

Gen. 8 D: Set II: Evaluation of new cross combinations in oil palm

Centre: Pattukkottai

The data pertaining to biometric observations indicated that, different hybrids tried show significant influence on biometric observations. Among various hybrids, the highest palm height of 4.6 cm was recorded in NRCOP 41. The hybrid NRCOP 41 produced significantly higher number of leaves per palm (31.9). The highest palm girth of 49.1 cm was recorded in NRCOP 44.

Gen. 8 E : Dura improvement programme

Centre: Pattukkottai

Breeding material in secondary nursery

SET I

Sprouts of eight types were received from DOPR Regional Station, Palode on 15. 06. 2013 and raised in primary nursery on 15. 06. 2013 and transferred to secondary nursery on 04. 10. 2013 as detailed below.

A. Exotic source

1) 48 dura x 61 dura

2) 48 dura x 48 dura

3) 80 dura x 61 dura

4) 47 dura x 61 dura

5) 84 dura x 61 dura

Field view of Gen. 8 D trial (Pattukkottai)

B. Indigenous source

6) 20 dura x 23 dura
7) 20 dura x 35 dura
8) 58 dura x 58 dura

SET II: Received the sprouts of four types from DOPR Regional Station, Palode on 07.10.2013 and raised in primary nursery on 07.10.2013 and transferred to secondary nursery on 06.03.2014 as furnished below;

1. 85 dura x 61 dura
2. 47 dura x 85 dura
3. 84 dura x 61 dura
4. 48 dura x 61 dura

Gen. 8B: Development and evaluation of D x P, D x D crosses by utilising drought tolerant African dura types (New trial)

1. Centres: Gangavati and Mulde

Objectives:

1. Development of mother palm
2. Development of D x D and D x P crosses.
3. Evaluation of these new cross combinations for yield and other parameters
4. Development of hybrids for commercial exploitation

Gen. 8B [A]. Development of Dura x Dura crosses

Female/Male	2(ZS-1-R-3-2)	3(ZS-6-R-2-2)	4(ZS-3-R-2-6)	5(TS-5-R-3-3)
1(ZS-3-R-3-3)	*	*	*	*
2(ZS-1-R-3-2)		*	*	*
3(ZS-6-R-2-2)			*	*
4(ZS-3-R-2-6)				*

Gen. 8B [B]. Development of Dura X Pisifera crosses.

1. (ZS-3-R-3-3) x P1	1. (ZS-3-R-3-3) x P2
2. (ZS-1-R-3-2) x P1	2. (ZS-1-R-3-2) x P2
3. (ZS-6-R-2-2) x P1	3. (ZS-6-R-2-2) x P2
4. (ZS-3-R-2-6) x P1	4. (ZS-3-R-2-6) x P2
5. (TS-5-R-3-3) x P1	5. (TS-5-R-3-3) x P2

Nursery view of 8 E trial (Pattukottai)

P1 & P2 are two Pisifera parents,

Based on last ten years data of experiment Gen 8A: Evaluation of oil palm genotypes for drought tolerance, for hybridization programme, the five genotypes viz., (ZS-3-R-3-3), (ZS-1-R-3-2), (ZS-6-R-2-2), (ZS-3-R-2-6) and (TS-5-R-3-3) are selected as mother palms for crossing programme for further development and evaluation of new crosses.

5.2 Crop production

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

Centres: Mulde, Madhopur and Pasighat

Objectives:

i) To compare efficiency of soil application of fertilizers and fertigation in oil palm

ii) To study the effect of fertigation on the productivity of oil palm

iii) To work out the economic viability of fertigation over soil application

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

Date of start of the experiment: July, 2008 with RBD and six palms per treatment.

Data revealed that there was no significant

Table 83: Yield parameters as influenced by fertigation and soil application treatments (Mulde, 2013-14)

Treatments	Bunch weight (kg/palm)	No. of FFB/palm	FFB yield (kg/palm)	FFB yield (t/ ha)
T_1 - 300; 150; 300g NPK through fertigation	21.7	4.2	90.3	12.9
T_2 - 600; 300; 600g NPK through fertigation	18.6	4.4	83.1	11.8
T_3 - 900; 450; 900 g NPK through fertigation	21.1	5.2	110.5	15.8
T_4 - 1200; 600;1200g NPK through fertigation	20.9	4.7	98.2	14.0
T_5 - 1200; 600; 1800g NPK through fertigation	24.9	5.2	127.9	18.3
T_6 - 1200; 600; 2700g NPK through fertigation	24.9	4.2	106.6	15.2
T_7 - 1200; 600; 2700g NPK through Soil application	25.3	4.8	122.2	17.5
SEm ±	1.6	0.5	14.0	2.0
CD (P=0.05)	N.S.	N.S.	N.S	N.S.

difference among the various treatments for yield characters. However, treatment T_5 recorded highest number of bunches (5.2) and highest yield 18.3 t/ha (Table 83).

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

Pasighat:

Treatments

During the Annual Group Meeting held at IGKV, Raipur on 22nd July 2013 to 25th July 2013 it was proposed to modify the treatment details. The modified treatments are as follows:-

T_1: 100% RDF through chemical fertilizers.

T_2: 100% RDF through organic manure (FYM or Vermicompost)

T_3: 50% RDF through organic manure + 50% RDF through chemical fertilizers.

T_4: 75% RDF through chemical fertilizers + 25% RDF through organic manure.

T_5: 75% RDF through organic manure + 25% RDF through chemical fertilizers.

Replications: 4

Nos. of palms per plot: 6

Design: RBD

Installation of drip irrigation system for this trial was completed during February, 2014. The recommended treatments were imposed in March 2014. Pre-experimental soil and leaf samples have been collected and analysis is in progress.

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

Pasighat:

The 29 oil palm seedlings planted in the year 2006 is being taken up as the material for this "maximization plot and all the recommended crop management practices are being adopted to harvest maximum yield. The average plant height collar girth and number of leaves per plant recorded in month of April 2014 was 110.0 cm, 246.2 cm and 14.8 leaves per palm respectively. Flowering and fruiting in all the palms have been observed. Pollinating weevil brought in January-2013 from DOPR, Pedavegi and was released in the plantation. After releasing the pollinating agents in the plantations, fruit setting was improved. The number of FFB produced per plam was 6.5.

VI. Experimental Results in Palmyrah

6.1 Genetic Resources

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

(Killikulam, Pandirimamidi)

Survey and collection of palmyrah germplasm was done to develop dwarf and superior palmyrah genotypes for high neera and nungu yield. The survey was conducted at Dakshina Kannada district of Karnataka, from 22nd to 26th April, 2013. Potential palm growing areas of Dakshina Kannada district were covered and seven germplasm lines were assembled and planted in the new area of the orchard of Agricultural college and Research Institute, Killikulam and Pandrimamidi.

The palmyrah trees of Dakshina Kannada (D.K.) district of Karnataka were robust, sturdy with big sized leaves with long petioles with good neera yield when compared to the palmyrah trees in other sites in the country.

Details of Palmyrah germplasm collected from D.K. District of Karnakata during April 2013

S. No.	Accession No.	Village Name	Taluk
1	KNK -13 – 01	Hosabettu paddai	Mangalore
2	KNK -13 – 02	Chokkabettu	Mangalore
3	KNK -13 – 03	Kurel	Puttur
4	KNK -13 – 04	Panekkal	Buntwal
5	KNK -13 – 05	Maddial	Buntwal
6	KNK -13 – 06	Mangalore	Mangalore
7	KNK -13 – 07	Kuvettu	Beltangadi

Performance of Palmyrah during 2013-14 at Killikulam

Performance of Palmyrah germplasm was evaluated during January 2014. Much variation

Collection from Karnataka - KNK -13 – 01

Collection from Karnataka - KNK -13 – 02

KNK -13 – 03

KNK -13 – 04

KNK -13 – 05

KNK -13 – 06
Collection from Karnataka

was observed among the 1995 planted germplasm accessions. Among the collection of germplasm planted during 1995, accession 18 has recorded maximum palm height (368.0 cm).

KNK -13 – 07

Accession 01 recorded higher number of leaves (23.6). Accession 27 recorded maximum values in terms of leaf length and accession 21 recorded higher stalk length (124.0 cm). Accession 38 recorded lower values for palm height and number of leaves. Accession 17 recorded lower values for leaf length. Accession 34 recorded lower values for stalk length (Abstract Table).

The data recorded from the germplasm planted in 1997 indicated that the accession 67 recorded maximum palm height (460 cm) and accession 58 recorded more number of leaves (28.6). The length of the leaf was found to be the highest in the accession 41 (108.0). The length of the stalk was found to be the highest in the accession 60 (102.0). Accession 48 recorded lower values for number of leaves and stalk length. Among the germplasm collected during 1999, the accession 73 recorded of increased plant height (221.0), number of leaves (16.15), stalk length (170.0 cm) and leaf length (79.0 cm). The accessions planted during 2001 showed maximum palm height (320.0 cm), and number of leaves (18.0) with accession 92. The maximum leaf length (82.0 cm) and stalk length was also recorded in the accession 92. Accession 96 recorded lower values for all the characters. Among the germplasm accessions planted during the year 2003, the maximum palm height, number of leaves, leaf length and stalk length was recorded in accession 153.

The data collected from germplasm planted during 2004 showed variations for palm height, number of leaves and stalk length. Among the

2004 planted germplasm accessions, the accession 160 recorded higher palm height (113.2 cm) and accession 164 recorded the lowest plant height. The stalk length was found to be the highest in the accession 169 and leaf length was the highest in the accession 165. Among the 2005 planted accessions, accession 174 showed the maximum palm height, number of leaves, leaf length and stalk length and the lowest plant height, number of leaves and stalk length was recorded with the accession 179.

The data collected from germplasm accessions planted during 2006 showed maximum palm height, leaf length and stalk length with the accession 192. The accession 180 has recorded lowest plant height. Among the germplasm collected during 2007, the accession 203 recorded maximum palm height (110.0), number of leaves (8.0) and stalk length (54.0). Among the 2008 planted accessions, the accession 209 has recorded maximum values for plant height, number of leaves, leaf length and stalk length.

Much variation was observed among the accessions planted during 2009. Palm height was the highest in the accession 237 and it was the lowest in the accession 249. However, the leaf length was maximum in the accession 234 and stalk length recorded maximum with accession 243. Among the accessions planted during 2010, accession 256 has recorded maximum palm height, number of leaves and stalk length. Minimum palm height was recorded in the accession 249. Among the germplasm planted during 2011, the accession 274 recorded maximum palm height (73.0), leaf length (52.0) and minimum palm height was recorded in the accession 263 (18.0). The number of leaves (5.6) was the highest in the accession 275.

Among the germplasm planted during 2012, the accession 285 recorded maximum palm height (54.0). Minimum palm height was recorded in the accession 282. However the number of leaves was maximum in the accession 279 and minimum with accession 284. The results showed that the germplasm lines planted during 1997 recorded the maximum values for all the parameters studied. The flowering data of 1997 germplasm accessions indicated that the male flower initiation was observed in the accession 9 and accession 26 during the month of March 1997.

Flowering particulars in accessions of 1997

Accession	Plant number	Date of initiation of flowering	No of flowers in the spadix	Mean length of the male flower
Acc - 26	2	3.3.14	2	12.5
Acc - 9	1	3.3.14	3	11.3

Abstract of germplasm assembled at Killikulam

Block in which planted	Year of collection	Number of collections maintained
Block I (E)	1995	35
Block II (NA)	1997	26
Block III (NA)	1999	23
Block IV (EO)	2001	40
Block IVa (EO)	2001	8
Block V (EO)	2002	13
Block Va (EO)	2002	8
Block VI (EO)	2003	2
Block VII (EO)	2004	12
Block VIII (NA)	2005	9
Block VIII (NA)	2006	14
Block IX (NA)	2007	10
Block IX (NA)	2008	9
Accs. Transferred from Pandirimamudi	2009	22
Block X (NA)	2009	9
Block X (NA)	2010	13
Block X (NA)	2011	15
Block X (NA)	2012	9
Block X (NA)	2013	7
Total		254

Abstract of biometrical observations recorded during January 2014 at Agricultural college and Research Institute, Killikulam

Year of Planting	Plant height (cm)		Number of leaves		Leaf length (cm)		Stalk length (cm)	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1995	[368.0] Acc.18	[150.0] Acc.38	[23.6] Acc.01	[6.6] Acc.38	[85.0] Acc.27	[67.0] Acc.17	[124.0] Acc.21	[78.0] Acc.34
1997	[460.0] Acc 67	[183.0] Acc 46	[28.6] Acc 58	[6.4] Acc 48	[108.0] Acc 41	[76.0] Acc 46	[170.0] Acc 60	[106.0] Acc 48
1999	[221.0] Acc 73	[75.0] Acc 83	[16.15] Acc 73	[3.0] Acc 79	[79.0] Acc 73	[38.1] Acc 81	[102.0] Acc 73	[24.0] Acc 86
2001	[320.0] Acc 92	[66.0] Acc 96	[18.0] Acc 92	[4.0] Acc 96	[82.0] Acc.92	[41.50] Acc 96	[123.0] Acc 92	[41.0] Acc 96
2001	[246.0] Acc 102	[47.0] Acc 107	[17.3] Acc 102	[2.8] Acc 107	[84.0] Acc 102	[47.5] Acc 112	[97.0] Acc 102	[20.0] Acc 108
2002	[200.6] Acc 115	[93.0] Acc 125	[9.2] Acc 124	[4.6] Acc 114	[82.2] Acc 115	[48.3] Acc 125	[92.0] Acc 116	[54.0] Acc 125
2002	[193.0] Acc 134	[86.0] Acc 132	[11.4] Acc 130	[7.3] Acc 132	[68.2] Acc 134	[54.0] Acc 132	[91.0] Acc 134	[53.0] Acc 138
2003	[163.1] Acc 153	[71.0] Acc 149	[9.2] Acc153	[5.1] Acc 149	[52.1] Acc 153	[43.6] Acc 149	[32.4] Acc 153	[21.4] Acc 149
2004	[113.2] Acc 160	[36.0] Acc 164	[10.3] Acc 168	[4.3] Acc 173	[48.0] Acc 165	[29.0] Acc 164	[58.0] Acc 169	[22.0] Acc 164
2005	[147.0] Acc 174	[76.0] Acc 179	[10.2] Acc 174	[5.4] Acc 179	[63.0] Acc 174	[47.2] Acc 179	[75.2] Acc 174	[26.4] Acc 179
2006	[132.0] Acc 192	[60.0] Acc 180	[11.6] Acc 193	[4.8] Acc 196	[55.3] Acc 192	[35.0] Acc 196	[59.1] Acc 192	[21.0] Acc 190
2007	[110.0] Acc 203	[79.0] Acc 208	[8.0] Acc 203	[5.8] Acc 197	[59.0] Acc 203	[46.0] Acc 198	[54.0] Acc 203	[32.0] Acc 202
2008	[68.0] Acc 209	[56.0] Acc 212	[8.2] Acc 209	[3.4] Acc 214	[61.6] Acc 209	[24.0] Acc 214	[35.0] Acc 209	[20.0] Acc 217
2009	[68.1] Acc 218	[54.0] Acc 248	[6.0] Acc 220	[2.0] Acc 224	[49.0] Acc 219	[38.0] Acc 225	[16.0] Acc 220	[9.5] Acc 223
2009	[73.0] Acc 237	[44.0] Acc 249	[3.5] Acc 241	[1.9] Acc 244	[55.0] Acc 234	[48.0] Acc 236	[53.0] Acc 243	[42.0] Acc 237
2010	[91.0] Acc 256	[44.0] Acc 249	[5.6] Acc 256	[2.2] Acc249,	[55.0] Acc 258	[51.0] Acc 255	[31.0] Acc 256	[15.0] Acc 258
2011	[73.0] Acc 274	[18.0] Acc 263	[5.6] Acc 275	[1.6] Acc 263	[52.0] Acc 274	[30.0] Acc 264	[27.0] Acc 272	[12.0] Acc 275
2012	[54.0] Acc 285	[28.0] Acc 282	[2.4] Acc 279	[1.4] Acc 284	-	-	-	-

Performance of Palmyrah germplasm accessions at Horticultural Research Station, Pandirimamidi during 2013-14

The data was collected from five trees in each accession in all the germplasm blocks. Among the 1991 planted germplasm collections, maximum plant height, lamina width and stem girth was recorded with 4/91 accession and maximum number of leaves was produced by Acc.9/91. The lowest plant height was recorded with the accession 11/91. Flower initiation was started in the month of October and was continued up to March. Mean number of bunches as well as fruits among all the 1991 germplasm accessions are 6.2 and 49, respectively (Abstract Table).

The data recorded from the 1993 planted accessions showed maximum stem girth and number of leaves with 16/93 accession and accession 17/93 has recorded the highest plant height and lamina width and the lowest was recorded with accession 14/93. The flowering data of 1993 germplasm indicated that the flower initiation was started during November and was continued up to March. In all the accessions, the mean number of bunches recorded was five and average number of fruits per bunch was 28.

The results from the data collected from 1994 planted accessions showed that maximum mean palm height was recorded with 26/94, lamina length and petiole length was the highest with 27/94. The lowest plant height and the highest number of leaves was recorded with Accession 24/94. In all the 1994 planted accessions, flower initiation was noticed during October and among all, the mean number of bunches and the average number of fruits per bunch recorded was 4.8 and 31, respectively.

Among the 4 accessions of 1995 block, the accession 41/95 has recorded the lowest mean values in all the parameters which was very slow in growth. The maximum mean values in terms of stem girth and number of leaves was recorded with accession 38/95. Flower initiation was observed during October and overall mean number of bunches recorded is 6 and the average number of fruits per bunch is 13. The results of the data recorded from the germplasm planted in 1998 indicated that the accession 57/98 recorded maximum values for stem girth, lamina length and lamina width. The palm height and number of leaves recorded was maximum with accession 56/98 and 52/98, respectively. The mean number of bunches recorded was five and the average number of fruits per bunch recorded was 11 in all the accessions.

Among the 1999 planted germplasms, flowering was observed for the first time during this year in accession 60/99. The accession 60/99 has recorded the the highest palm height and more number of leaves recorded with accession 64/99 and the lowest was recorded with the accession 59/99. The accessions planted during 2000 showed maximum palm height with accession 83/00, lamina width with the accession 81/00. The maximum values in terms of number of leaves was recorded with the accession 84/00. The lowest plant height was recorded with the accession 79/00.

Flowering details in germplasm blocks

	Flower initiation period	Mean No. of bunches/palm	Mean number of fruits per bunch	Average yield/ accession
1991 Block	Oct - Mar	8.5	17	Neera tapping is in progress
1993 Block	Nov - Mar	7.3	17	
1994 Block	Oct - Mar	8.7	15	
1995 Block	Oct - Mar	6.0	13	
1998 Block	Nov - Mar	5.0	11	

Abstract on the performance of Palmyrah germplasm accessions at Horticultural Research Station, Pandirimamidi during the year 2013-14

Block	Acc Value	Palm Height (m)		Stem Girth (m)		No. of Leaves		Lamina Length (cm)		Lamina Width (cm)		Petiole Length (cm)	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1991	Acc	11/91	4/91	11/91	4/91	11/91	9/91	11/91	2/91	13/91	4/91	13/91	1/91
	Meters	8.3	11.0	1.4	2.0	10.6	11.8	98.8	150.0	140.0	180.0	120.0	160.0
1993	Acc	14/93	17/93	18/93	16/93	14/93	16/93	14/93	23/93	20/93	17/93	16/93	14/93
	Meters	5.90	8.40	1.4	1.6	10.6	12.0	0.8	120.0	130.0	150	120.0	160.0
1994	Acc	24/94	26/94	24/94	28/94	28/94	24/94	27/94	25/94	24/94	27/94	28/94	27/94
	Meters	6.9	8.9	1.5	1.8	5.4	11.8	110.0	130.0	150.0	160.0	140.0	160.0
1995	Acc	41/95	39/95	41/95	38/95	41/95	38/95	41/95	38/95	41/95	38/95	41/95	38/95
	Meters	3.1	7.5	1.23	1.7	7.6	11.8	100.0	100.0	120.0	160.0	120.0	150.0
1998	Acc	58/98	56/98	53/98	57/98	58/98	52/98	54/98	57/98	52/98	57/98	58/98	55/98
	Meters	4.9	8.1	1.5	1.8	10.7	11.6	110.0	130.0	130.0	160.0	90.0	160.0
1999	Acc	59/99	60/99	59/99	66/99	59/99	64/99	60/99	66/99	62/99	66/99	61/99	65/99
	Meters	3.6	9.2	1.48	1.6	10.0	11.6	80	90.0	90.00	140.0	100.0	150.0
2000	Acc	79/00	83/00	-	-	79/00	84/00	79/00	68/00	79/00	81/00	77/00	82/00
	Meters	1.1	4.5	-	-	5.0	11.9	60.0	120.0	90.0	140.0	100.0	160.0
2001	Acc	108/01	121/01	-	-	95/01	115/01	108/01	121/01	108/01	119/01	108/01	126/01
	Meters	1.5	5.5	-	-	8.0	12.0	50.0	100.0	70.0	130.0	40.0	130.0
2002	Acc	131/02	144/02	-	-	132/02	142/02	131/02	144/02	131/02	144/02	131/02	144/02
AP	Meters	2.5	4.1	-	-	9.0	12.0	80.0	120.0	110.0	160.0	90.0	180.0
2002	Acc	157/02	155/02	-	-	157/02	155/02	157/02	146/02	157/02	146/02	160/02	146/02
TN	Meters	1.3	4.3	-	-	5.0	12.0	60.0	100	80.0	160.0	50.0	160.0
2003	Acc	165/02	161/02	-	-	173/02	161/02	165/02	172/02	165/02	162/02	165/02	163/02
	Meters	1.7	4.9	-	-	7.0	11.8	60.0	100.0	80.0	140.0	80.0	160.0
2004	Acc	184/04	176/04	-	-	187/04	179/04	184/04	174/04	187/02	174/04	184/04	174/04
TN	Meters	1.6	3.0	-	-	6.8	11.8	60.0	150.0	70.0	180.0	80.0	170.0
2006	Acc	188/06	192/06	-	-	188/06	193/06	188/06	197/06	191/06	197/06	188/06	197/06
	Meters	80.0	2.2	-	-	2.5	10.2	40.0	80.0	80.0	130.	30.0	140.
2007	Acc	202/07	203/07	-	-	202/07	206/07	202/07	206/07	211/07	203/07	205/07	208/07
	Meters	1.1	1.9	-	-	5.4	8.4	60.0	90.0	80.0	110.0	50.0	100.0
2008	Acc	214/08	217/08	-	-	219/08	218/08	219/08	218/08	214/08	220/08	219/08	217/08
	Meters	0.7	1.3	-	-	3.5	7.4	40.0	70.0	60.0	90.0	20.0	60.0
2009	Acc	231/09	224/09	-	-	227/09	225/09	231/09	230/09	227/09	226/09	227/09	223/09
	Meters	0.6	1.0	-	-	3.8	7.2	40.0	60.0	50.0	80.0	30.0	60.0

The data collected from the accessions planted during the year 2001 indicated that the highest values in terms of palm height and lamina length was recorded with accession 121/01. The maximum number of leaves was recorded in the accession 115/01. The lowest values in terms of palm height, petiole length, lamina length and lamina breadth was recorded with accession 108/01.The germplasms collected from Nalgonda district of Andhra Pradesh during 2002 showed the maximum lamina length, lamina breadth and petiole length with the accession 131/02 and accession 142/02 has recorded the maximum number of leaves. The lowest plant height was recorded with accession 131/02. The germplasm collected during the year 2002 from Tamil Nadu showed that the accession 155/02 recorded maximum palm height and number of leaves. The lowest values in terms of all the observations recorded was with accession 160/02.

The results from the data collected from 2003 planted accessions showed that maximum mean palm height and the highest number of leaves was recorded with accession 161/03 and the lowest plant height was recorded with accession 165/03. Among the 2004 year collection of germplasm, accession 174/04 has recorded maximum values in terms of lamina length, lamina breadth and petiole length. The the highest number of leaves was recorded with the accession 179/04. Whereas the lowest plant height was recorded in the accession 184/04.

The accessions planted during 2006 showed maximum palm height with accession 192/06. The maximum values in terms of lamina breadth, lamina width and petiole length was recorded with accession 197/06. The lowest plant height was recorded with accession 188/06. Among the germplasm accessions planted during the year 2007, the maximum palm height as well as lamina width was recorded with the accession 203/07. The accession 206/07 has recorded maximum values for number of leaves and lamina length.

The data collected from germplasm planted during the year 2008 showed maximum palm height and petiole length with accession 217/08. The accession 218/08 has recorded maximum values in terms of number of leaves lamina length. Among the germplasm accessions collected during the year 2009, accession 224/03 has recorded maximum palm height. The highest number of leaves was recorded with 225/09. The lamina length was maximum with accession 230/04 and lamina breadth was recorded maximum with accession 226/04.

Gen. 16: Growth and development studies in palmyrah

Experiment I. Root studies in Palmyrah

Under growth and development studies in Palmyrah root studies was initiated to know the growth pattern of roots in different root zones around the Palmyrah tree. Palms of various age groups i.e., 5,10,15,20 and 25 years were selected for the study. The number of trees per age group was four.

A trench was dug from the base of the palmyrah tree to a distance of 90 cm with a dimension of 30 cm width and 90 cm length. Again the trench was divided in to three equal linear zones of 30cm (Zone A), 60cm (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 i.e., 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 are filled with coir pith and irrigation was provided to the above trees at regular intervals.

Pandirimamidi: The data was recorded at three months intervals on the number of roots in each of the nine zones regard less of their origin after excavating the coir pith. After recording the data the trench was refilled with the coir pith.

The data in the (Table 84) indicates that among all age groups 20 year old trees produced

Table 84: Average root distribution in different age groups of trees in different zones (Pandirimamidi)

Age of trees (Years)	A1	A2	A3	B1	B2	B3	C1	C2	C3
5	21	12	3	—	—	1	—	—	—
10	38	25	10	2	2	5	—	—	—
15	56	32	5	8	4	8	—	2	—
20	102	88	49	26	35	6	—	4	2
25	64	25	16	12	10	2	—	3	—

more number of roots in all zones. The average root distribution in twenty year old trees is 102 in zone A1, 88 in zone A2, 49 in zone A3, 26 in zone B1, 35 in zone B2, 6 in zone B3, 4 and 2 in zone C2 and C3 respectively and no roots are present in zone C1. Twenty five year old trees have produced 64 roots in zone A1, 25 in zone A2, 16 in zone A3, 12 in zone B1, 10 in zone B2, 2 in zone B3, 3 in zone C2 and no roots are present in the zones C1 and C3. Fifteen year old trees have produced 56 average number of roots in zone A1, 32 in zone A2, 5 in zone A3, 8 in zone B1, 4 in zone B2, 8 in zone B3, 2 in zone C2 and no roots are present in C1 and C3 zones. Five year old trees have recorded the lowest average number of roots compared to other age groups of trees and the average root distribution is 21 in zone A1, 12 in zone A2, 3 in zone A3, 1 in zone B3 and no roots are present in B1, B2, C1, C2 and C3 zones.

Killikulam:

The number of roots in each zone of different age group of trees were recorded. The number of roots was more as the age of the tree advanced. Zone A1 recorded higher number of roots for all age group of palms compared to other zones. The the highest number of roots was recorded in 20 year old trees (Table 85). The number of roots was 97 in AI Zone, 93nos in A2 Zone and 67 in A3 Zone. Similarly 20 year old trees also recorded higher number of roots in B Zone also, 34 in BI Zone, 51 in B2 Zone and 14 in B3 Zone. In case of C zone only few root were recorded i.e., 5 roots in C2 level and 4 roots in C3 level. In 25 year old trees, only 4 number of roots were recorded in C2 zone level. No roots were found in 5, 10 and 15 year old palm trees in C Zone level.

Experiment II. Feasibility study on transplanting of palmyrah trees of varying age groups

Feasibility study on transplanting of palmyrah trees of varying age groups were carried out in the month of June and September. The age of trees selected were 1,3,5,7 and 10 years. The number of trees per age group was five. The trial was an observational trial. The trees of 1,3,5,7 and 10 years were gently uprooted using JCB and were transplanted in prepared pits of size 90x90x90 cm. The roots and leaves were trimmed sufficiently. The trees were treated with IBA @ 1000 ppm concentration for encouraging rooting. Fungicidal treatments with Copper oxy chloride @ 2.5 g /l of water as soil drench was also given.

Table 85: Average root distribution in different age groups of trees in different zones (Killikulam)

Age of trees (Years)	A1	A2	A3	B1	B2	B3	C1	C2	C3
5	12	8	7	—	2	2	—	—	—
10	19	11	9	—	4	2	—	—	—
15	27	15	—	6	4	—	—	—	—
20	97	93	67	34	51	14	—	5	4
25	29	17	5	19	6	—	—	4	—

The percent establishment of seedlings in various age of transplanting was assessed and the results are given below.

Pandirimamidi:

Among the one year old transplanted trees, out of five trees transplanted three has put forth new leaf at 30 to 40 days after transplanting and in October transplanting only one was survived. Among the 3 year old transplanted trees, out of five trees only one tree could survive in July and remaining four trees died within 10 days and in October all the five were died. Among the 5, 7 and 10 year old transplanted trees during both the seasons all the five trees of each group were died within 10 days and no success is recorded (Table 86).

The data pertaining to the July transplanted trees showed that, in the one year old established trees the number of days taken for completing the active growth of leaf was 85 and in three year old trees has taken 69 days. Three year old plants has taken 63 days for completion of active growth of stalk. The number of days taken for successive leaf production was 49 days in one year old trees and 36 days in three years old plants. Number of days taken for successive stalk production was 50 in three years old plants (Table 87).

The data of October transplanted trees showed that in one year old established trees the number of days taken for completing the active growth of leaf was 80 and the number of days taken for successive leaf production was 45 (Table 87).

Killikulam:

The per cent establishment of seedlings in various age of transplanting was assessed and the results are given below.

In the month of June, among the one year old transplanted trees, out of five trees, one has put forth new leaf after transplanting and survived. Among the 3 year old transplanted trees, out of

Table 86: Per cent establishment after 30 days of transplanting during the months of July and October, 2013 (Pandirimamidi)

Age of trees (Years)	No. planted		No. survived		% survival	
	July	October	July	October	July	October
One	5	5	3	1	60	20
Three	5	5	1	-	20	-
Five	5	5	-	-	-	-
Seven	5	5	-	-	-	-
Ten	5	5	-	-	-	-

Table 87: Biometrical observations of Palmyrah trees transplanted during the months of July and October 2013 (Pandirimamidi)

Age of the trees (Years)	Number of leaves		Time taken for completion of active growth of leaf (days)		Time taken for completion of active growth of stalk (days)		Number of days taken for successive leaf production		Number of days taken for successive stalk production	
	July	October	July	October	July	October	July	October	July	October
One	3	2	85	80	-	-	49	45	-	-
Three	3	-	69	-	63	-	36	-	50	-
Five	-	-	-	-	-	-	-	-	-	-
Seven	-	-	-	-	-	-	-	-	-	-
Ten	-	-	-	-	-	-	-	-	-	-

five trees, only one tree could survive and remaining four trees died within 10 days. Among the 5 year old transplanted trees, four trees died within one week and one has survived (Table 88).

In October, out of five trees transplanted in one, three and five years old trees, all trees have died. Among the seven year old transplanted trees, out of five trees, only one tree could survive and remaining four trees died. Among the ten year old transplanted trees, two trees have survived.

The results pertaining to June transplanting showed that the number of days taken for completing the active growth of leaf was 73 days in one year old, 65 days in three years old palms. Five year old palm took 62 days for completing the active growth of leaf (Table 89).

The results also showed that the number of days taken for completing the active growth of stalk was 69.3 days for one year and 72.6 days for three years old palms. Five year old palm took longer days(134.8 days) for completing the active growth of stalk. The five year old palm took the maximum number of days to complete the active growth of stalk. This is an opposite and reverse trend as compared to the growth of leaves. The growth of stalk commenced only after the cessation of leaf growth. Generally a gradual reduction was noticed in the number of days taken for successive leaf production as the growth phases of the palms advanced.

The results pertaining to October transplanting showed that the number of days taken for completing the active growth of leaf was 87.6 days for seven year and 68.9 days for ten year. The results revealed that a steady reduction was noticed as the age of the crop advanced. The number of days taken for completing the active growth of stalk was 148.7 days for seven year and 166.9 days for ten year (Table 90).

Table 88: Percent establishment after 30 days of transplanting during the months of June and October (Killikulam)

Age of trees (Years)	No. Planted		No. survived		% survival	
	June	October	June	October	June	October
One	5	5	1	-	20	-
Three	5	5	1	-	20	-
Five	5	5	1	-	20	-
Seven	5	5	-	1	-	20
Ten	5	5	-	2	-	40

Table 89: Biometrical observations on feasibility of transplanting during the months of June and October (Killikulam)

Age of the trees (Years)	Number of leaves		Time taken for completion of active growth of leaf (days)		Time taken for completion of active growth of stalk (days)		Number of days taken for successive leaf production		Number of days taken for successive stalk production	
	June	October	June	October	June	October	June	October	June	October
One	1	-	73.	-	69.3	-	35	-	39	-
Three	2	-	65	-	72.6	-	31	-	34	-
Five	4	-	62	-	134.8	-	26	-	32	-
Seven	-	5	-	87.6	-	148.7	-	25	-	28
Ten	-	8	-	68.9	-	166.9	-	22	-	25

The ten year old palm took the maximum number of days to complete the active growth of stalk. This is an opposite and reverse trend as compared to the growth of leaves. The growth of stalk commenced only after the cessation of leaf growth. Generally a gradual reduction was noticed in the number of days taken for successive leaf production as the growth phases of the palms advanced during transplanting in October.

Experiment III. Studies on use of growth inhibiting substances for induction of early flowering in Palmyrah (*Borassus flabellifer* L.)

The objective is to study the effect of various chemical substances in induction of early flowering and also to get dwarf statured palms for countering the drudgery in climbing up.

A total of 63 number of palms of uniform age group of 2,4 and 6 years was selected for imposing the treatments. Chlormequat chloride in two concentrations i.e., 2 ppm and 4 ppm, Mepiquat chloride in two concentrations i.e., 2 ppm and 4 ppm and Triacontanol in two concentrations i.e., 2 ppm and 4 ppm along with control was applied at three months interval starting from October 2013. The chemicals were poured in the apical buds @ 50 ml per application (at varied concentrations). This process will be continued for three years i.e., four in a year and totally 8 applications in two years.

6.2 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 the tapping techniques for extraction of inflorescence sap from palmyrah

To study the influence of shape of cut on surface of spathe on the yield of inflorescence sap, four angles 15°, 30°, 45° and 60° were followed for inflorescence sap collection in both male and female palms. Total of 32 spathes were taken with each 16 from male and 16 from female palms. All spathes sliced for 20 days for sap collection in which 5 days for each angle at various stages as per experimental design. Yield of Neera for male palms at 30° angle of cut gave more yield (26.7 l) followed by 45° angle of cut and control (23.1 l). Incase of female palms 45° cut gave more yield (31.4 l) followed by 60° and control (27.5 l).

2. Development of RTS Neera

RTS beverages by collecting inflorescence sap using CPCRI method and traditional method by using lime was evaluated. In general, sap collected with CPCRI method was preferred over its lime coated and traditional beverages. However, for male palms it is not effective as compared to female palms. Colour retention was observed to be more in lime coated beverages than in CPCRI method beverages.

Neera collection using CPCRI method

3. Storage stability of RTS sap under different conditions

Storage study of different RTS sap was carried out under ambient and refrigerated conditions (8-10°C). The sap collected through CPCRI method was selected for this purpose. RTS was filled in 200 ml glass bottles and PET bottles stored under the respective condition. The changes in pH, TSS, total sugars and reducing sugars and sensory quality were determined during storage. The results revealed that odd flavour increased with the progression of storage period. pH, TSS, total sugars, reducing sugars decreased during storage but under refrigerated condition up to 10 h there was no significant change (Fig. 17). RTS sap

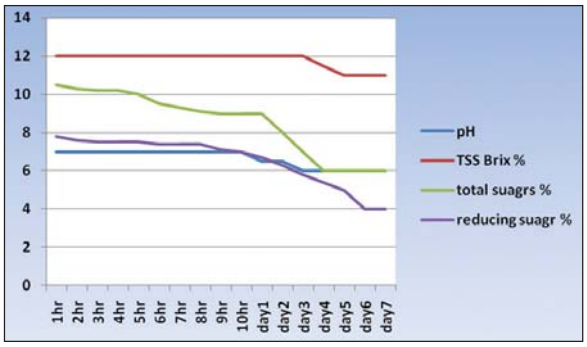


Fig.16: Female Neera quality up to 7 days under ambient conditions

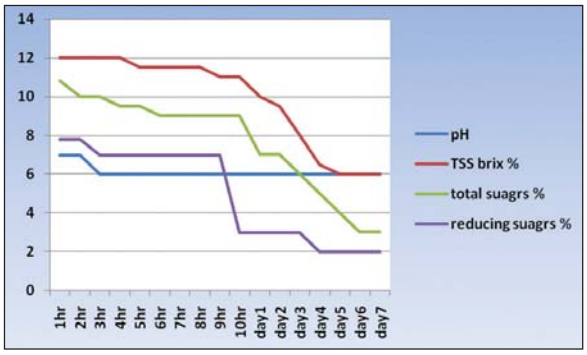


Fig.17: Female Neera quality up to 7 days under refrigerated conditions

through CPCRI method had a storage life of 10 h without any preservative. The study suggested that the RTS beverages maintained under refrigerated condition, showed minimum deviation in quality from their initial value. These beverages remained in acceptable condition for one day.

PHT-2: Standardization of Tuber Flour Based Food Products (Like Pizza, Bakery items, confectionery, health mix etc.)

Pandirimamidi

I. Standardization of Maturity stage of palmyrah tuber (apicolon)

Palmyrah tubers were collected at different stages i.e 120, 135 and 150 days from the planting and analysed for proximate composition and physical properties. The protein and fat content was more at age of 120 days as compared to others. Fibre content was more in 150 days tubers (Table 90).

Physical properties of palmyrah tubers were studied at 120, 135 and 150 days from planting and it is found that 120 days tubers having more weight and length as compared to others both whole tuber and peeled tubers (Table 91).

From the data it is found that the tuber of 120 days to 135 days is suitable for flour production.

2. Development of Tuber based products (osmotic dehydration)

Osmotic dehydration of tuber pieces was carried out in the sugar syrup solution having different concentrations (40, 50 and 60% w/w), tuber thickness (mm) and sample to sugar syrup solution ratio (1: 2, 1: 4 and 1: 6). Experiments were evaluated for weight loss and solid gain of tuber pieces due to the effect of sugar syrup concentration, size of the tuber piece and sample to sugar syrup solution.

Weight loss and solid gain were observed to increase with increase in sugar syrup concentration and sample to sugar syrup solution ratio and it increased with decrease in tuber thickness. The experimental design of osmotic dehydration of tuber pieces was prepared and the combinations of different parameters were studied. Two factor ANOVA of weight loss and solid gain of all experiments indicated that osmosis time of tuber sample and sugar syrup solution concentration, sample to sugar ratio and tuber piece thickness were highly significant where as combination of osmosis time and sugar syrup solution concentration, sample to sugar ratio and tuber thickness were non significant. The experiment on tuber piece osmosis, the osmotic time of 5 to 6 h was required to attain maximum weight loss and solid gain by tuber pieces. Further optimisation and rehydration studies are in progress.

Table 90: Proximate composition of palmyrah tubers at different stage of harvesting

Age of tubersDays	Mc (%w.b)	Protien (%)	Fat (%)	Ash (%)	Fibre (%)
120	10.3	2.1	0.50	2.17	10.2
135	7.8	2.9	0.45	1.92	11.0
150	8.0	1.8	0.36	2.53	11.6

Table 91: Physical properties of palmyrah tubers at different stage of harvesting

	Whole tuber			Peeled tuber		
Age of tuber (days)	120	135	150	120	135	150
Weight, g (10 tuber)	2216	2016	1912	2024	1800	1710
Length(cm)	48.3	45.5	43.6	30.5	30.6	28.8
Diameter	9.5	9	9.1	8.2	8	7.6

3. Storage Studies of tuber flour

Storage study was carried out with two packaging materials *viz*., low density polyethylene (LDPE) and high density polyethylene (HDPE) were used to study the storage behavior of developed composite flour under accelerated study condition i.e., 90% RH and 40 °C temperature. Fifty grams each of the composite flour samples were filled in separate packets and the mouth of the packet closed by heat sealing, taking care that minimum possible air space remained in the packets. One packet each of different packaging materials was taken out from the desiccators at an interval of 10 days upto 90 days and was analyzed for moisture content and infestation. The increase in moisture content with time was the highest in case of those packed in LDPE as compared to HDPE. Infestation was observed after 30 days in LDPE and after 50 days of storage in HDPE.

4. Preparation of tuber Flour based products and sensory evaluation

Bread and cookies were prepared with developed composite flours and the results showed that bitterness was increased with increase of tuber flour. The proximate composition of composite flour and cookies and bread prepared from the composite flours were studied. Variations was observed in proximate composition of composite flour and their respective breads and cookies. This might be mainly due to variation in moisture content of composite flours after baking. Protocol for extraction of flour and preparation flour based products are in progress and final process for product development.

Tuber flour based products

PHT.3: Utilization of palmyrah plant parts for the Extraction of fibre and fuel

Killikulam

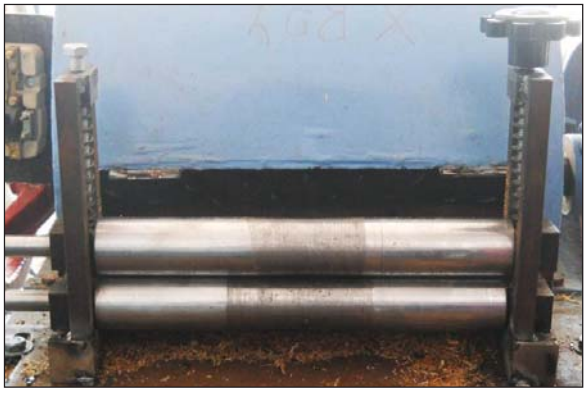
I. Adoption and refining of existing fiber extraction machineries.

2. Ergonomic design of feed hopper and speed of the shaft existing machine in improving the recovery of fiber.

Modification of feed hopper in existing fiber extractor

1. Base plate was fixed in the front side of main rotating roller so that the palmyrah leaf base is placed conveniently in resting position which enables easy holding of the leaf base during extraction of fiber. By this way the efficiency of fiber extractor is increased.

Base plate of the fiber extractor



Self propelled roller

2. Two columns are provided for fitting the two horizontal self propelled rollers for guiding the rollers which enables for the easy movement of the leaf base in to the main rotating drum

3. The springs are fitted for easy holding of the different thickness of the leaf base material.

4. The gap between the two self propelled rollers is 3mm.

Springs fitted in columns

5. The diameter of two self propelled rollers of 4.0cm was designed so as to enable to hold the leaf base firmly.

6. The center of the leaf base thickness is more compared to the side end of the leaf base. The feed hopper is modified in such a way that the gap between the self propelled rollers in the center is 8mm with arch like shape i.e. half the length of the self propelled roller.

7. The gap between the pegs of the main rotating drum which was fixed with a gap of 5cm in the existing fiber extractor, was modified with a peg gap of 3cm. By this way the efficiency of the fiber extraction is increased.

Comparison of fiber extractor

Sl. No.	Existing fiber extractor	Recently developed fiber extractor
1.	58g of fiber is obtained from 1.0 kg of raw leaf base (Recovery percentage is 5.80)	81g of fiber is obtained from 1.0 kg of raw leaf base (Recovery percentage is 8.10)

VII. Experimental Results in Sulphi Palm (*Caryota urens*)

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

Survey for identification of germplasm was carried out at Jaipore and Koraput district of Odissha during November - December 2013. Potential sulphi growing area of these districts were covered and three new germplasm have been marked for further observation and the seeds were collected under each gemplasm. The total germplasm maintained at Jagdalpur is fourteen out of which eight germplasm is tall type three is semidwarf, two is dwarf type and one is of two seeded fruit collected from Raipur and three new germplasm selected from Odishha one which have dwarf in type and two were difference in spike length.

Table 92: 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	21 months	63.5	43.5	5.0	8.0	5.0
2	24 months	85.0	72.5	6.0	8.0	5.5

Gen. 18: Growth and development studies in Sulphi palm.

The growth observation of seedlings palms were undertaken and 5.0-6.0 leaf number where as root number 8.0 observed in 21 & 24 months old seedlings palm. The length of root is 63.5 cm to 85.0 cm, shoot length is 43.5 cm to 72.5 cm and root girth is 5.0 to 5.5 cm of 21 & 24 months old seedlings plants.

Title: Studies on use of growth regulators for induction of early flowering in sulphi palm

Design: RBD

No. of treatments: Seven

No. of replications : Three

No. of palms/treatments: Three

Treatments:

T1- Chlormequat chloride 250 ppm

T2- Chlormequat chloride 500 ppm

T3- Mepiquat chloride 250 ppm

T4- Mepiquat chloride 500 ppm

T5- Triacontonal 500 ppm

T6- Triacontonal 1000 ppm

T7- Control

Chlormequat chloride in two concentration i.e., 250 ppm and 500 ppm and Mepiquat in two concentration i.e., 250 ppm and 500 ppm and Tricontonal in two concentration i.e., 500 ppm and 1000 ppm along with control. Chemical will be applied at three months interval with an age group of two years seedlings. The growth observation like plant height, girth of plant as well as no. of leaves and leaf length has been taken and showed non-significant results among them.

Title: Standardisation of tapping techniques for extraction of inflorescence sap

Design : RBD

Replications : Four

Angle of the spathe cut

Angle of cut: a. 15°
b. 30°
b. 45°
c. 60°

Treatment 1: 1-5 days 15°, 6-10 days 30°, 11-15days 45° and 16-20 days 60° cut

Treatment 2: 1-5 days 30°, 6-10 days 45°, 11-15days 60° and 16-20 days 15° cut

Treatment 3: 1-5 days 45°, 6-10 days 60°, 11-15 days 15° and 16-20 days 30° cut

Treatment 4: 1-5 days 60°, 6-10 days 15°, 11-15 days 30° and 16-20 days 45° cut

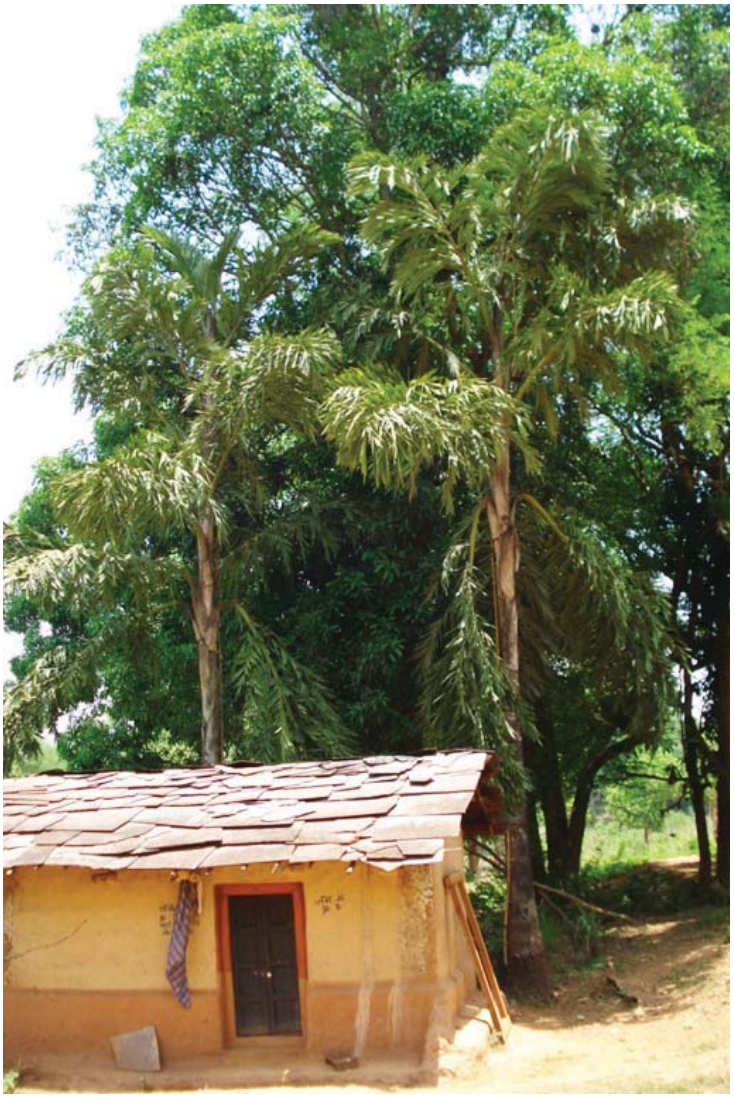
Table 93: Yield of sap

Treatments	Yield of Sap (l) (Oct-Nov)	Yield of Sap (l) (Dec- Jan)	Yield of Sap (l) (Feb-March)
T1	8.45	12.55	10.33
T2	13.89	18.97	15.99
T3	11.67	17.70	13.55
T4	10.15	14.55	11.67
SEm ±	0.23	0.40	0.28
CD (P=0.05)	0.74	1.29	0.88

Yield of sap is maximum in the month of December-January and the treatment T-2 shows highest significant yield of sap (18.9 l. sap per day) followed by T-3 treatment (17.7 l. sap per day) and lowest yield (12.5 l. sap per day) was observed in treatment T-1. Same trend was observed in the month of October-November and February-March. But the yield was lowest in the month of October-November in comparison with February-March

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

Sulphi saps in different form for the treatment of gastric, stomach and urinary problems. The sulphi sap is used for controlling the body temperature during hot summer month. The leaves of tree are used for thatching purpose, it yield fibre and also used for making quality rope. Tribal people also belief that heating of sap will stop the production of flow of sap from the palm. The sap is collected with earthen pot after collecting the sap is transferred to the other utensils and takes downwards with the rope and this process is being carried out twice a day early in the morning and evening for a period of about 3-4 months. In Odissha sulphi sap is known as *Salap*. The leaves were used to control insects during rainy season. The tree bole is used for making of roof structure and the hollow tree bole is used for irrigation purpose. Sulphi sap is used early in the morning to control stionic person. When the baby is born they plant the sulphi tree and during marriage time the sulphi tree is donated to their daughter.



Sulphi palm selected from Odissha

VIII. Centre-wise budget for 2013-14 (ICAR Share)

(Rupees in lakhs)

Centre	Pay	TA	RC	HRD	NRC	Total
Aliyarnagar	26.96	2.45	10.38	1.12	0.00	40.91
Ambajipeta	30.75	2.60	10.88	0.98	0.00	45.21
Arsikere	13.76	2.30	9.85	0.98	0.00	26.89
Jagadalpur	14.06	1.05	3.68	2.40	0.00	21.19
Kahikuchi	15.75	1.33	7.10	0.75	0.00	24.93
Bhubaneshwar	7.88	1.25	9.17	1.65	0.00	19.95
Mondouri	17.35	0.98	4.50	0.90	0.00	23.73
Ratnagiri	42.75	2.40	14.75	1.85	0.00	61.75
Veppankulam	23.78	2.80	11.40	1.10	0.00	39.08
Navsari	5.44	0.83	5.06	1.93	0.00	13.26
Sabour	5.44	0.75	3.85	0.85	0.00	10.89
Killikulam	14.40	0.98	4.62	0.90	0.00	20.90
Pandirimamidi	14.76	1.30	4.09	1.15	0.00	21.30
Pattukottai	9.83	0.95	5.00	0.90	0.00	16.68
Gangavathy	8.03	1.11	4.75	0.90	0.00	14.79
Mulde	10.23	1.06	5.10	0.90	0.00	17.29
Vijayarai	7.83	0.75	4.00	0.90	0.00	13.48
Pasighat	0.00	0.75	6.30	1.00	0.00	8.05
Madhopur	0.00	0.56	4.22	0.70	0.00	5.48
Pilicode	0.00	0.56	3.38	0.30	0.00	4.24
Total	269.00	26.76	132.08	22.16	0.00	450.00

TA : Travelling Allowance

RC : Recurring Contingency

HRD : Human Resource Development

NRC : Non Recurring Contingency

IX. 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 2013 – March 2014)

Kahikuchi, Assam	24 April 2013 04 Sept. 2013 10-11 Dec. 2013 – along with QRT
Arsikere, Karnataka	17 May 2013 14 Sept. 2013 30 Dec. 2013 – along with QRT
Aliyarnagar, Tamil Nadu	4 July 2013, 6 March 2014 - along with QRT
Jagdalpur, Chhattisgare	25 July 2013 31 Jan. 2014 - along with QRT
Mondouri, West Bengal	02- 03 Sept. 2013, 12-13 Dec. 2013 - along with QRT
Gangavathi, Karnataka	29 Sept. 2013
Bhubaneswar, Odisha	09 Oct. 2013 27-12-13 – along with QRT
Navsari, Gujarat	28 Oct. 2013
Ratnagiri, Maharashtra	15-16 Nov. 2013 29 Jan. 2014 - along with QRT
Mulde, Maharashtra	18 Nov. 2013 28 Jan. 2014 - along with QRT
Vijayarai, Andhra Pradesh	12 Feb. 2014 - along with QRT
Ambajipeta, Andhra Pradesh	13 Feb. 2014

Visit to Veppankulam

Visit to Killikulam

Visit to Ratnagiri

XXII Annual Group Meeting

The XXII Annual Group meeting of AICRP on Palms was held at College of Agriculture, IGKV, Raipur during 22-25 July, 2013. 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 Oilpalm 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 tril palm (sulphi palm).

XXII Annual Group meeting

The inaugural session of the XXII annual group meeting of AICRP on Palms commenced with the ceremonial lighting of the lamp by the Guests of Honour, Chief Guest and delegates, followed with welcome address by Dr. D. A. Sarnaik, Director of Research, Indira Gandhi Krishi Vishwavidyalaya, Raipur. Dr. H.P. Maheswarappa, Project Coordinator (AICRP-Palms) presented the Coordinator's report, narrating the salient findings and research achievements that emanated from 21 AICRP-Palms centres, converging various agro-climatic regions of the country.

Address by Dr. N.K. Krishna Kumar, DDG (H.S.)

Dr. S.K. Patil, Vice Chancellor, IGKV, Raipur while delivering Chairman's address acclaimed the contribution of small farmers for the food security and emphasized the need to take the long term benefits of research to the farming community. He opined that, Sulphi palm stands as an icon of the tribal community of Chhattisgarh, significantly reinforcing their livelihood. He also stressed that non-traditional areas should be brought under coconut cultivation with suitable location specific germplasm, to meet out the higher demand for oil production by 2030 AD.

Dr. N.K. Krishna Kumar, Deputy Director General, ICAR, New Delhi in his Chief Guest's address, highlighted the importance of horti-cultural crops in meeting the nutritional security and in turn the food security of the country. He accentuated the abysmally low productivity of coconut in the major coconut producing states of the country. He suggested that the research priorities should focus on diversification and value addition in coconut. He also suggested to exploring the possibilities of growing date palms beyond arid zones and include the same under AICRP on palms. He highlighted the market potential of ornamental palms which have good business as integral part of rural and urban areas requires and urged the group meeting to pay adequate attention to them under AICRP on Palms. The tissue culture technology development has to go a long way in coconut in spite of developments

made in arecanut and oil palm. Though arecanut cultivation is profitable, the devastating pests and diseases pose greater threat. He urged all the AICRP centres to focus their research on key issues *viz*., converting insecticide to non-insecticide farming with the use of bioagents, technologies addressing labour scarcity and introducing integrated farming system in coconut. With respect to palmyrah, he emphasized that though palmyrah research is turning out a success, the future plan has to be worked out by setting priorities. He also stressed that, it is a prime time to look into the gaps and strategies for technology transfer.

Address by Dr. S.K. Patil, V.C.

During this session, a document entitled 'IGKV 2030' prepared by Dr.S.K.Patil, Vice Chancellor, IGKV, Technical bulletin on "Coconut based cropping systems for maidan tract of Karnataka" prepared by the scientists of AICRP-Arsikere centre, "Wilt management in Sulphi palm" and "Coconut cultivation" (In Hindi) prepared by the scientists of AICRP-Jagdalpur centre, CD on "Pest management in coconut" prepared by CPCRI, Kasaragod and bilingual extension pamphlet on "Coconut pest management and Cocoa cultivation" were released by Dr. N.K. Krishna Kumar, Deputy Director General, ICAR, New Delhi and Dr. S.K. Patil, Vice Chancellor, IGKV. The best AICRP-Palms centre award that is being given based on the evaluation was presented to HRS, Arsikere for their outstanding contributions towards coconut research and the inaugural session ended with the vote of thanks.

Release of Publications

The major recommendations of the XXII AICRP Group meeting to be passed on to Extension System:

1. The hybrids like GBGD x LCOT, and GBGD x PHOT are performing well in Ambajipeta and Arsikere Centres. These hybrids are proposed for release during this group meeting. GBGDx FJT is performing well in Arsikere centre and proposed for release for Karnataka.
2. Based on the studies taken up on fertigation in coconut at different Centres of AICRP on Palms from 2007-08 to 2012-13, the following recommendations have been made for different regions of the country.
   - **Aliyarnagar, Veppankulam, Mandouri, Ratnagiri and Kasaragod Centres:** The nut and copra yield per palm per year in fertigation of 50% RDF was on par with fertigation of 75% RDF and soil application of 100 per cent RDF. Hence, fertigation of 50% RDF can be recommended.
   - **Ambajipeta, Arsikere Centre:** Application of 75% RDF through fertigation recorded significantly higher nut and copra yield per palm per year compared to soil application of 100% RDF and on par 100% RDF through fertigation. Hence, drip fertigation of 75% RDF can be recommended.
3. The performance of Noni as intercrop in coconut is better in tissue culture plants compared to seedlings at Arsikere, Ambajipeta, Mandouri and Veppankulam Centres,

while, seedlings are performing better at Aliyarnagar, Bhubaneshwar, Jagadalpur, Kahikuchi and Ratnagiri Centres.

Stem bleeding management

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

Biological management of leaf blight

5. Root feeding of *P. fluorescens* culture filtrate @ 25ml/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.

Management of black headed caterpillar

6. Studies conducted at all three centres on olfactory conditioning of parasitoids of coconut black headed caterpillar, *O. arenosella* by exposing them to the odor of larval frass and larval damaged leaves revealed that parasitisation levels of *O. arenosella* was found to be significantly more in conditioned parasitoid release treatment than in the unconditioned parasitoids release treatments. Hence, while releasing parasitoids against *O. arenosella* they should invariably olfactory conditioned for 72 hours.

7. Studies conducted at all three centres on the implementation of IPM package including use of pheromones, *Baculovirus*, naphthalene balls and *Metarhizium anisopliae* revealed that per cent incidence of rhinoceros beetle along with reduction in leaf and spindle damage was noticed in the experimental gardens one year after implementation of IPM package.

Management of sulphi wilt

8. Among the combination of different bio agent, biofertilizers, farmyard manure combination with basal application of *T. harzianum* (1000g)+Organic manure (10 kg) followed by crown application of 100% culture filtrate of *T. harzianum* were found superior to check the wilt disease in sulphi palm.

Meeting on disease management of AICRP on Palms Scientists

In order to modify the disease management technical programme, a meeting was organized at CPCRI, Kasaragod on 25.02.2014. The technical programme under each project was re-oriented and modified based on the suggestions received from the external experts as well as present need.

Mid term review meeting of insect pest management programmes under AICRP centres

The Mid Term Review Meeting was held on 27th March, 2014 at Project Coordinator Cell, CPCRI, Kasaragod. The Project Coordinator (Palms) reviewed the technical programme under each project and progress was appraised thereon. The following decisions were taken during the review meeting.

- Technical session name should be modified as 'Insect Pest Management'
- In each experiment, year of start, treatment details along with design and replications should be mentioned.
- Scales for reporting the major/minor insect pests damage has to be re-modified with discussion with Dr. Chandrika Mohan, Pr. Scientist, CPCRI RS, Kayangulam.
- Database in insect pests surveillance is to be prepared and presented by every AICRP centre.
- Expt. No. Ent.3, Ent.5, Ent.12 & Ent.16 will be continued as per technical programme.
- Ent.11, Ent.14 and Ent.15 will be closed. Final report needs to be presented during the forthcoming Annual Group meeting.
- Based on the results obtained in various programmes, data needs to be statistically analysed and research papers may be prepared and submitted to high impact journals.

X. Extension and Popularization of Technologies

Coconut

Aliyanagar

Training programme on coconut cultivation and integrated pest and disease management

Scientists of Aliyanagar were involved in transferring the technologies generated from the centre by conducting series of training progrmmes on coconut production and protection technologies for the benefit of the farmers and local extension workers. These programmes were organized to create awareness among the growers about available scientifically validated technologies at local agro-climatic conditions and its timely interventions to enhance the production and productivity of the coconut.

Under National Bank for Agriculture and Rural Development (NABARD) two capacity building 3-days training programme entitled **"Resource conservation technologies to enhance the coconut productivity and livelihood of farmers"during** 29.01.2014 to 31.01.2014 and 17.03.2014 to 19.03.2014.

TV programmes

A video programme on "Cocoa - A remunerative intercrop in coconut gardens" has been recorded and telecasted by Makkal TV.

Training programmes conducted

Delivered a lecture on coconut production technology with emphasis to leaf blight disease management to the farmers (35 Nos), **leaf blight awareness programme jointly organized by ADA, Pollachi (South) and CRS, Aliyarnagar** at Samathur, Ponnachiyur village on 12.11.2013

Organized an awareness programme on coconut leaf blight and its management at Manjanaickanur village, Pollachi taluk on 11.12.13.

Organized an awareness programme on coconut root (wilt) at Ramanathapuram village, Pollachi taluk on 17.12.13.

Root (wilt) awareness programme organized by HC&RI and ADA (Bodi) and Meenatchipuram, Bodinaickanur and also to survey on root (wilt) disease incidence on 19.02.2014 and 20.02.2014.

Demonstration on leaf blight disease management

A field demonstration programme was organized at Angalakurichi village on 05.03.2014 for the management of leaf blight disease of coconut. The Registrar, Director (CPPS), Director (WTC), Prof. and Head, Dept. of Pl. Path, Prof. and Head, CRS, Aliyarnagar, scientists from CRS, Aliyarnagar, and Officials from Dept. of Agriculture including DD and JDA, Coimbatore had attended the programme. Leaf blight management strategies were emphasized to the farmers and the spraying and root feeding of fungicides were demonstrated. A detailed report was prepared and submitted to the Registrar through Director (CPPS), TNAU, Coimbatore.

Ambajipeta

Training programme on cocoa cultivation, post harvest technology and marketing of cocoa beans

Organized a three day training programme on cocoa cultivation in collaboration with DCCD, Kochi from 27th -29th June 2013 to selected cocoa farmers from the Andhra Pradesh major cocoa growing areas. Dr. M.B. Nageswara Rao, Director Extension, Dr. YSR Horticultural University (YSRHU), was the chief guest to inaugurate the training programme. Dr. D.V. Raghava Rao, Ex-Dean, Dr. YSRHU, Dr. B.V. K. Bhagavan, Zonal Research Head, Dr. YSRHU and Dr. M. Bharata

Lakshmi, ADR, APRRI & ARS, Maruteru, ANGRAU were participated in the programme. Dr. D. V. Raghava Rao enlightened the farmers regarding the cocoa scenario in Andhra Pradesh. Dr. M.B. Nageswara Rao briefed the importance of cocoa as intercrop in coconut. Dr. B. V. K. Bhagvan explained the fertilizer schedule of cocoa. Dr. M. Bharata Lakshmi briefed the importance of soil nutrient analysis and weed management in cocoa. Dr. G. Ramanandam explained the scientific management of cocoa for better returns. Dr. NBV Chalapathi Rao addressed the integrated pest and disease management strategies raised by the cocoa farmers and Smt. E. Padma demonstrated the pruning methodology and its importance in overall cocoa plant health and productivity of cocoa production per plant to the farmers.

Training programme on cocoa at HRS, Ambajipeta

Friends of coconut tree (FOCT)

Organized total three training programmes on ''Friends of Coconut Trees ''(FOCT) of 6 days duration to 63 rural unemployed youth selected from the region on 17.06.13 to 22.06.13, 8.07.2013 to 13.07.2013 and 3.03.2014 to 8.03.2014. All the trainees were provided hostel cum boarding facilities to stay in the campus and motivated them to get acquaint with the climbing device. All the participated youths and women were shown interest to come forward to take up coconut cultivation and harvest the nuts with coconut climbing device to reduce the labour cost and timely harvest of the nuts to get market advantage.

FOCT training at HRS Ambajipeta

Field day for the students

A field day was organized on integrated farming system model in coconut on 23rd March, 2014. Total 50 students of Horticulture polytechnic course from Ramachandrapuram of Andhra Pradesh.

Awareness on coconut black headed caterpillar management

The scientists of AICRP on palms Ambajipeta centre imparted training cum awareness programme on integrated pest management in coconut black headed caterpillar management strategies to the farmers of Thotada Junction of Anakapalli on 28.05.13 and extension officials of horticultural department of Godavari (East & West) Districts on 29.05.13.

Arsikere

Celebration of World Coconut Day at HRS, Arsikere on 02.09.2013

World Coconut Day was celebrated at HRS, Arsikere on 02.09.2013. Farmers-Scientists interaction was also arranged. Dr.T.B.Basavaraju, Head, Dr.M.Prashanth, Associate Professor, Mr.G.K.Sudarshan, Assistant Professor, Mr.B.Boraiah, Assistant Professor and Mr.Umesh, AHO discussed with farmers on production technologies and PHT & Value addition in coconut. About 50 farmers of Arsikere taluk participated in the programme. Demonstration on integrated

Field day on Integrated farming system for students (Ambajipeta)

Farmers attending awareness programme on coconut black headed caterpillar management (Ambajipeta)

Extension officials training programe on coconut black headed caterpillar management

management of Basal stem rot disease management was also arranged.

Awareness cum Demonstration on Management of Black Headed Caterpillar in Coconut at Arsikere on 10.10.2013.

"Awareness cum Demonstration on Management of Black Headed Caterpillar in Coconut" was organized at Arsikere by CPCRI, Kasaragod and AICRP on Palms, HRS, Arsikere on 10.10.2013. Dr.George V. Thomas, Director, Central Plantation Crops Research Institute, Kasaragod inaugurated the programme. Prof. Syed Basha, Principal, Govt. First Grade College, Arsikere presided over the function. The scientists of CPCRI, Kasaragod- Dr.Chandrika Mohan, Dr.Ravi Bhat and Dr.Vinayaka Hegde and Dr.T.B.Basavaraju, Head, HRS, Arsikere were participated in the programme. About 100 farmers of Arsikere taluk were participated.

World Coconut Day Celebration at HRS, Arsikere

Demonstration on BSR management in coconut

Participation in Krishimela/ Horticulture Mela/ Exhibitions

The AICRP on Palms, HRS, Arsikere participated in Mysore Dasara Exhibition from 05-10-2013 to 15-10-2013, Krishi Mela at UAS, GKVK, Bangalore from 07.11.2013 to 11.11.2013, Horticulture Mela at UHS, Bagalkot

Awareness cum Demonstration on Management of Black Headed Caterpillar in Coconut at Arsikere

from 22.11.2013 to 25.11.2013 and Krishimela at JSS Fair, Suttur, Mysore from 27.01.2014 to 01.02.2014. Dr.T.B.Basavaraju, Professor & Head, Dr.M.Prashanth, Associate Professor, Mr.G.K.Sudarshan, Assistant Professor and Mrs. Sunita Patil, STA participated in the Krishimela/ Horticulture Mela. Exhibited specimens of different varieties and value added products of coconut and information on production and protection technologies of coconut in the exhibition stall. Information on varieties, cultivation, pest and disease management in coconut was provided to the farmers visited the exhibition stall.

Participation in the training programmes for farmers as resource persons

The scientists of AICRP on Palms, Arsikere participated as resource persons in the training programmes for farmers organized by the Karnataka State Department of Horticulture/

Participation in Horticulture Mela at UHS, Bagalkot (Arsikere)

Agriculture, Krishi Vignana Kendras, Karnataka State Agricultural Marketing Board, Dharmastala Gramabhivruddi Yojane etc. Discussed with the farmers on the varieties of coconut, moisture conservation, water and nutrient management, cropping system, pest and disease management and value addition in coconut.

Visit of Farmers to HRS, Arsikere

The farmers from different coconut growing areas of Karnataka visited Horticulture Research Station, Arsikere individually or in groups through KVKs, Extension Education Units, Karnataka State Department of Horticulture/ Agriculture and NGOs and obtained information on coconut varieties, water and nutrient management in coconut, coconut based cropping system, integrated pest and disease management and value addition in coconut by the scientists of the research station.

Kahikuchi

Training programme on coconut cultivation and integrated pest and disease management

Various training programmes on production technology of coconut" were conducted in different districts of Assam namely Kamrup, Nalbari, Darrang, Morigaon, Nagoan and in the Zirang district of Meghalaya. During the year 2012-13, twelve number of training programme on "Improved production technology of coconut" were conducted at Boko, Hajo, Dampur, Sikarhati, Chaigaon, Mongaldoi and Jagiroad.

Training programme (Kahikuchi)

World coconut day

Organized 'World Coconut Day' on 2nd September, 2013 in the farmers' field and created awareness on importance of coconut in India and health benefits of its value added products to the consumers. A good number of farmers and youth participated there by tried to transfer the technologies in the farming community.

World coconut day celebration (Kahikuchi)

Five demonstrations on nursery raising technique in coconut, integrated nutrient management practices in coconut, diseases and pests management in coconut (Bordeaux mixture preparation and application, root feeding, drenching, application of pesticides on crown) at Damdama, Hajo, Rampur, Dampur and Chaigoan were organized during the period.

Demonstration of technologies (Kahikuchi)

Navasari

Tribal Sub Plan (TSP)

Different extension activities were carried out such as conducting training programmes on improved coconut and intercrop cultivation practices. Distribution of healthy coconut seedlings, fungicides, bio-fertilizers and bio-control agents to the tribal farmers for improving soil health and better seedling establishment free from pest and disease attack at main field.

Distribution of coconut seedlings to tribal farmers

Bhubneshwar

Scientist of the centre imparted training programme on coconut production technologies, harvesting and nursery management, integrated disease and pest management to the farmers and extension officials of state. A total 898 farmers and local extension workers were participated in the programme.

Oil palm

Pattukkottai

Training programme on oil palm cultivation, alternate cropping system and exhibitions on oil palm cultivation

The scientists of the centre participated as resource person in various training programme/

Visit of Shri. Damodaran, Hon. Minister (Agriculture) Tamil Nadu to oil palm stall

field days organized by the state agricultural department for updating recently developed crop production technologies in oil palm cultivation. Involved in delivering of lecture and panel discussion on scientific cultivation of oil palm and alternate cropping system for the benefit of the farmers and local extension stakeholders.

Vijayarai

Training programme on oil palm cultivation

Organized two days on campus training programme on oil palm cultivation, crop protection and marketing of oil palm harvest. A total 75 farmers and students participated in the training programme and visits to demonstration plots were conducted to show the yield potential of the plot after practicing all available scientific technologies in oil palm cultivation.

Mulde

Organized training on oil palm cultivation and its technology to the state government officers (Maharashtra) on 10.5.2013. A total 60 officers along with 20 farmers participated in the programme and they have shown keen interest to know about oil palm cultivation and transfer the technology to the needy farmers of the state. On 6th August, 2013 training for farmers was organized on oil palm cultivation in which 360 farmers participated. Attended farmers rally organized by Krishi Vignayan Kendra under technology week in which 160 farmers attended the programme on oil palm cultivation.

Training programme to officers and farmers at Mulde

XI. Publications

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XII. Staff Position

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XIII. Weather data of Co-ordinated centres (January to December 2013)

COCONUT CENTRES

Aliyarnagar

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.	FN	AN		
January	32.0	21.0	89.5	74.1	0.0	5.6
February	32.4	23.5	89.7	75.3	45.0	4.4
March	34.5	25.9	88.0	67.0	18.2	4.7
April	36.0	26.6	91.7	88.8	100.7	5.6
May	35.5	26.7	90.9	70.9	19.5	5.6
June	30.2	25.5	88.9	79.6	145.3	3.3
July	29.0	26.0	89.7	81.5	139.4	2.8
August	31.0	26.5	90.1	77.1	58.3	4.6
September	31.4	26.3	86.6	69.9	41.8	4.0
October	32.1	26.0	87.0	61.0	112.3	4.9
November	31.3	22.1	88.9	79.0	67.6	3.1
December	30.4	18.7	88.6	64.1	14.4	3.4
				Total	762.5	52.0

Ambajipeta

Month	Temperature (° C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	31.6	19.5	78.5	45.7	10.0
February	31.2	19.7	91.1	89.6	13.0
March	33.7	21.8	79.0	53.0	0
April	35.8	24.8	78.2	50.4	22.2
May	39.4	26.8	72.9	41.3	9.0
June	33.8	25.8	74.7	56.7	167.0
July	29.7	24.5	75.6	65.2	107.2
August	31.7	25.9	73.2	58.9	139.9
September	32.4	25.0	73.0	61.0	219.3
October	30.8	24.5	78.7	67.9	341.0
November	30.6	20.9	70.0	57.4	31.7
December	30.0	18.6	63.0	48.4	0
				Total	1060.3

Arsikere

Month	Temperature (° C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	30.1	16.9	66.6	38.7	-
February	31.9	19.2	66.9	36.0	23.6
March	34.4	19.7	65.4	29.8	-
April	37.4	19.0	60.9	32.9	10.5
May	36.4	18.9	69.0	37.8	46.6
June	31.9	21.3	75.6	62.9	24.0
July	23.9	21.9	81.6	68.9	45.8
August	24.1	21.9	79.2	69.8	107.6
September	26.0	20.0	82.1	69.8	255.8
October	30.5	20.4	81.0	64.4	50.4
November	30.5	19.2	73.7	53.1	3.0
December	29.9	11.1	74.3	55.9	-
				Total	567.3

Bhubaneshwar

Month	Temperature (° C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	29.7	15.1	91.0	43.0	0.0
February	32.3	16..7	90.0	37.0	2.8
March	37.8	21.6	89.0	32.0	0.0
April	38.8	24.5	90.0	44.0	42.2
May	38..6	26.9	88.0	54.0	78.0
June	34.8	25.7	90.0	68.0	235.5
July	32.2	25.3	93.0	82.0	268.5
August	32.2	25.2	94.0	77.0	156.1
September	32.6	24.4	95.0	77.0	345.6
October	30.5	22.9	96.0	78.0	720.1
November	29.9	18.0	85.0	51.0	0.5
December	28.9	14.4	87.0	38.0	0.0
				Total	1849.3

Mondouri

Months	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	24.8	9.6	93.6	48.6	1.9
February	29.3	13.5	91.3	44.6	9.0
March	36.2	20.0	88.5	34.2	0.0
April	37.6	24.2	87.9	43.4	113.0
May	34.8	25.6	90.9	68.2	114.8
June	34.2	26.4	94.7	78.0	207.3
July	33.4	26.5	95.2	80.8	180.3
August	32.8	26.0	96.8	81.7	354.1
September	34.1	26.0	95.3	75.4	228.4
October	31.4	23.9	97.0	76.7	240.5
November	30.0	16.4	84.0	55.6	0.0
December	27.0	12.5	84.5	58.8	0.0
				Total	1449.3

Kahikuchi

Months	Temperature (°C)		R.H. (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.	FN	AN		
January	23.8	9.2	82.4	71.0	6.5	3.2
February	26.1	12.1	77.0	56.7	0.0	3.8
March	29.0	15.4	70.0	54.6	10.5	5.1
April	31.7	20.9	72.7	62.3	50.8	6.3
May	32.4	23.4	78.5	69.6	167.0	4.2
June	32.8	26.0	86.7	82.4	224.0	4.3
July	33.5	26.7	91.0	86.8	289.5	5.0
August	33.4	26.3	89.8	86.0	306.2	4.5
September	31.1	24.9	86.2	80.6	150.6	3.7
October	28.2	23.0	82.1	79.7	58.0	3.5
November	26.3	17.4	81.5	80.1	15.6	3.1
December	23.1	10.3	84.6	82.0	0.0	3.5
				Total	1278.7	

Navsari

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.	FN	AN		
January	29.7	12.3	81.0	41.0	0.0	4.4
February	31.7	16.0	74.0	28.0	0.0	4.6
March	35.2	18.6	74.0	30.0	0.0	6.1
April	34.6	22.3	83.0	44.0	3.2	6.5
May	34.6	27.0	84.0	62.0	0.4	7.1
June	31.4	25.9	92.0	82.0	567.4	4.2
July	30.2	25.3	93.0	87.0	821.0	2.9
August	28.9	24.9	92.0	83.0	362.0	3.0
September	30.5	23.6	89.0	74.0	643.0	28
October	32.5	22.8	86.0	55.0	45.0	3.2
November	33.6	19.3	72.0	38.0	0.0	4.0
December	30.9	14.8	80.0	49.0	0.0	3.5
				Total	2442	

Pilicode

Month	Tempreature (°C)		RH (%)	Rainfall (mm)
	Max.	Min.		
January	32.7	20.1	73.7	0.0
February	33.3	22.0	74.1	21.1
March	33.9	23.5	74.7	3.2
April	33.8	24.2	72.5	24.6
May	33.5	25.4	74.8	79.9
June	29.9	22.5	88.9	1343.9
July	29.3	23.0	89.3	1222.2
August	29.4	23.0	86.8	382.3
September	30.0	23.0	85.4	185.3
October	31.5	23.5	84.0	229.1
November	32.5	22.7	78.5	5.2
December	32.4	19.1	73.9	13.8
			Total	3510.6

Ratnagiri

Month	Temperature (° C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	31.9	15.5	69.7	56.2	0
February	32.4	16.9	69.7	57.5	0
March	33.0	19.5	65.0	58.4	0
April	32.3	20.9	71.5	65.5	0
May	33.9	23.3	74.8	68.0	13.8
June	30.0	23.4	87.6	84.3	780.2
July	28.6	24.0	91.9	90.5	1032.3
August	28.7	23.5	89.1	86.9	279.8
September	29.6	23.2	90.1	82.3	230.5
October	31.5	23.1	77.7	67.3	198.6
November	34.6	21.2	64.3	63.5	0
December	33.2	16.8	63.0	57.1	0
				Total	2535.0

Sabour

Month	Temperature (° C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	20.3	5.2	91.0	58.0	0
February	25.2	9.7	87.0	53.0	14.6
March	31.3	17.1	71.0	40.0	0
April	35.0	18.1	68.0	40.0	47.9
May	37.7	23.9	81.0	62.0	174.1
June	32.3	26.2	84.0	72.0	160.2
July	33.5	26.9	87.0	75.0	150.8
August	34.6	26.1	88.0	80.0	201.4
September	32.3	26.1	87.0	76.0	197.2
October	28.8	22.6	89.0	80.0	291.6
November	26.9	15.3	89.0	59.0	14.2
December	23.4	10.1	98.0	62.0	0.0
				Total	1252.0

Veppankulam

Month	Tempreature (°C)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.		
January	35.2	27.6	44.0	2.9
February	31.0	26.9	13.8	2.8
March	26.5	25.6	113.4	2.2
April	37.0	34.5	0	4.4
May	40.0	37.0	0	4.0
June	40.0	38.0	24.0	4.0
July	40.0	39.0	10.0	4.5
August	38.0	36.0	30.0	4.0
September	36.0	35.0	33.0	4.0
October	37.0	35.5	19.0	4.5
November	33.5	31.0	19.0	3.0
December	32.5	31.5	31.2	2.5
		Total	337.5	

OILPALM CENTRES

Pattukuttai

Month	Tempreature (°C)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.		
January	35.2	27.6	44.0	2.9
February	31.0	26.9	13.8	2.8
March	26.5	25.6	113.4	2.2
April	37.0	34.5	0	4.4
May	40.0	37.0	-	4.0
June	40.0	38.0	24.0	4.0
July	40.0	39.0	10.0	4.5
August	38.0	36.0	30.0	4.0
September	36.0	35.0	33.0	4.0
October	37.0	35.5	19.0	4.5
November	33.5	31.0	19.0	3.0
December	32.5	31.5	31.2	2.5
		Total	337.54	

Gangavathi

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.	AN	FN		
January	31.2	16.9	65.7	49.9	0.0	3.95
Feburuary	31.76	16.7	60.4	49.1	0.0	4.42
March	34.6	15.9	54.3	34.6	0.0	5.07
April	36.9	17.6	59.1	39.7	5.5	6.01
May	38.0	20.7	73.7	46.7	102.0	5.72
June	32.5	20.3	80.6	65.4	96.5	3.60
July	29.2	18.8	76.4	70.5	34.5	2.80
August	29.7	18.3	74.0	65.2	22.5	3.10
September	30.1	18.0	79.4	66.4	118.5	2.50
October	29.8	17.1	72.8	66.8	108.5	3.40
November	29.2	14.7	72.6	52.7	2.0	3.25
December	29.0	12.2	60.9	42.8	0.0	3.95
				Total	490.0	

Mulde

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.	FN	AN		
January	34.8	15.9	90.3	44.6	0.0	3.2
February	35.3	17.6	88.4	43.5	13.0	3.6
March	36.7	19.4	87.1	39.4	0.0	4.6
April	36.5	21.8	88.5	49.0	0.0	5.0
May	36.1	24.8	82.8	57.2	162.8	5.0
June	30.7	23.3	94.0	84.9	780.6	2.7
July	27.4	22.9	93.5	91.5	1854.4	2.5
August	29.0	23.3	94.0	86.0	853.0	3.0
September	29.8	22.9	93.0	84.0	330.3	2.8
October	31.9	23.0	92.3	68.5	123.4	2.9
November	34.1	19.4	87.8	46.7	0.0	3.0
December	33.4	15.4	89.6	38.1	0.0	2.9
				Total	3917.5	

Vijayarai

Month	Tempreature (°C)		RH (%)	Rainfall (mm)
	Max.	Min.		
January	33.9	23.4	69.5	0.0
February	34.1	23.7	65.9	52.0
March	36.9	22.5	63.5	0.0
April	37.9	20.7	68.3	33.0
May	40.9	23.1	61.9	8.0
June,	39.6	20.7	67.4	151.4
July	35.5	19.1	71.3	255.0
August	34.4	20.5	66.6	116.5
September	37.4	20.5	68.0	253.0
October	35.4	18.0	71.2	462.6
November	34.2	16.5	64.5	17.0
December	31.6	15.5	61.2	47.0
			Total	1395.5

Pasighat

Month	Temperature (° C)		RH (%)	Rainfall (mm)	Evaporation (mm)
	Max.	Min.			
January	26.4	12.0	49.4	0.0	6.0
February	29.8	14.8	55.6	7.5	5.5
March	30.2	17.2	58.8	49.5	6.4
April	32.8	18.0	59.8	0.0	4.4
May	30.3	18.4	75.6	154.3	5.1
June,	31.8	27.9	77.9	525.9	3.3
July	29.3	23.2	83.0	907.7	4.4
August	28.6	23.0	81.1	403.9	3.6
September	30.4	23.0	73.5	456.2	5.1
October	26.0	20.2	77.0	222.9	4.1
November	22.3	15.9	68.6	23.0	4.5
December	17.1	13.4	68.2	4.3	3.9
			Total	2755.2	

PALMYRAH CENTRES

Killikulam

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Evaporation (mm)
	Max.	Min.				
January	32.1	20.4	95	73	8.4	-
February	33.3	21.4	92	72	33.2	5.7
March	34.6	22.9	91	69	58.0	6.1
April	38.3	24.7	85	59	4.0	5.7
May	38.8	26.0	84	58	16.0	6.6
June	35.5	24.7	88	72	-	6.8
July	35.5	25.4	88	70	1.0	5.9
August	36.3	25.6	89	69	15.6	6.6
September	35.8	25.5	90	69	-	7.8
October	36.2	24.0	90	67	76.6	7.4
November	31.7	23.2	94	79	137.2	7.7
December	30.7	21.2	92	79	38.4	5.1
				Total	388.4	

Pandirimamidi

Month	Temperature (° C)		RH (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	31.6	22.1	97.0	42.0	0.0
February	32.8	22.4	95.0	35.0	0.0
March	38.5	28.2	76.0	42.0	0.0
April	35.2	27.3	96.0	52.0	36.8
May	39.7	26.0	75.0	52.0	48.2
June	33.3	24.6	96.0	70.0	216.8
July	30.3	23.8	97.0	77.0	445.8
August	31.8	23.9	98.0	73.0	231.4
September	31.7	22.5	95.0	56.0	191.8
October	31.1	23.0	98.0	73.0	339.0
November	29.1	18.0	95.0	49.0	15.8
December	27.4	14.0	75.0	52.0	54.3
				Total	1579.9

QRT at Pandirimamidi centre

QRT visit to Kahikuchi centre

QRT at Aliyarnagar centre

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
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Agrisearch with a human touch