AICRP on Palms
वार्षिक प्रतिवेदन
Annual Report
2014-15



भाकृअनुप-अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना

(भारतीय कृषि अनुसंधान परिषद)

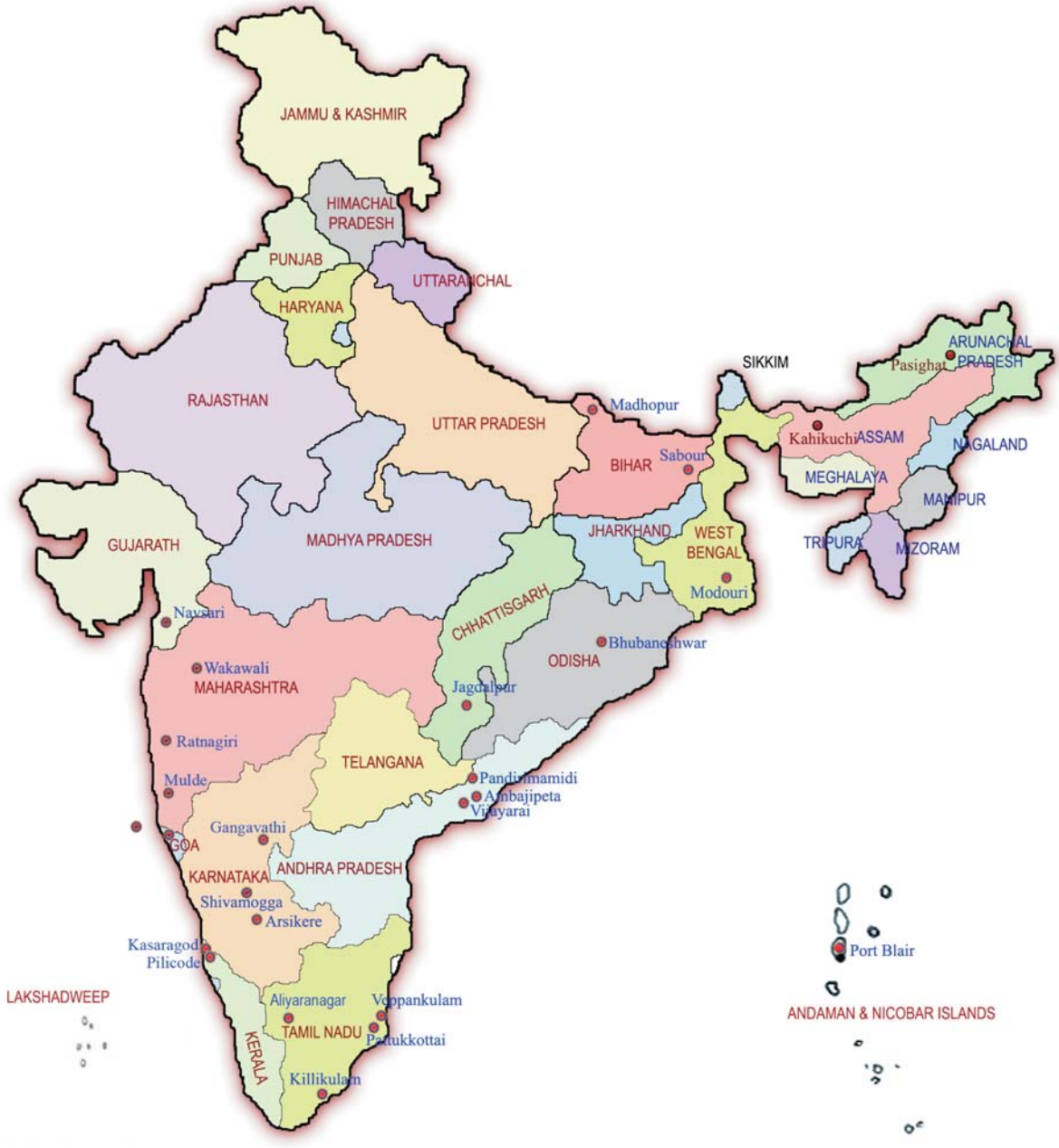
भाकृअनुप-के रो फ अ सं, कासरगोड़, - 671 124, केरल

ICAR- ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

(Indian Council of Agricultural Research)

ICAR-CPCRI, Kasaragod - 671 124, Kerala

MAP SHOWING
AICRP ON PALMS CENTRES



ICAR-AICRP on Palms

वार्षिक प्रतिवेदन

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ICAR-All India Co-ordinated Research Project on Palms
ICAR-Central Plantation Crops Research Institute
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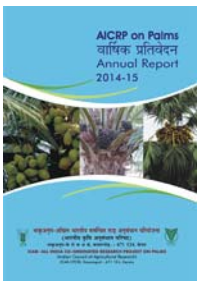

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I. आमुख

अखिल भारतीय समिन्वित ताड़ अनुसंधान परियोजना केंद्र मुख्य फसलों की उत्पादनक्षमता बढाने की स्थानीय विशेष प्रौद्योगिकियों के विकासन में सफलतापूर्वक विभिन्न सस्य जलवायु क्षेत्रों का प्रतिनिधित्व कर 13 राज्यों में स्थित है। आर्थिक प्रमुखता को विचार करते हुए चार नए केंद्रों के साथ इस वर्ष सुपारी को भी मुख्य फसल के रुप में सम्मिलित किया गया और नारियल पर अनुसंधान प्रबल करने के लिए तटीय एवं द्वीप परिस्थितिक तंत्र क्षेत्र के दो केंद्र भी सम्मिलित किया गया। नारियल में फसल सुधार कार्यक्रम के अधीन श्रेष्ठतम उच्च गुठली उपज प्रदत्त (औसत 161 गुठली/ताड/वर्ष) संकर संयुक्त एलसीटी ¬ सीसीएनटी, एक लंबी संयुक्त वेप्पंगुलम (तमिलनाडु) में विकसित किया गया। विभिन्न केंद्रों में समीकृत पोषण प्रबंधन के माध्यम से नारियल के अधीन उचित अंतराफसलन से इकफसल नारियल की अपेक्षा उच्च उत्पादनक्षमता और आय प्राप्त किया गया।

विभिन्न सस्य जलवायु क्षेत्रों के नारियल बागों में अंतर फसल के रुप में गेंदा, हेमपुष्प चीन तारक, अभिसुन्दरा, रजनीगन्धा, कृपाणवर्ण, हेलिकोनिया के वर्धन से नारियल इकफसलन की अपेक्षा ज्यादा उत्पादकीय और और लाभकारी पायी गयी। *गोनियोजस निफान्टिडिस, ब्राकोन ब्रेविकोर्निस* और *बी. हेबाटर* जैसे परजीव्याभ के विमोचन से नारियल विर्द्धत दिक्षणी राज्यों में पाए गए काला सिरवाली कैटरपिल्लर का लक्षण निम्नतम पाया गया। तिमाही अंतराल में 2 मि ली टुबुकोनज़ोल. 100 मि.ली पानी की दर में के मूलवेधन से नारियल में पत्ता चित्ती रोग प्रबंधन में प्रभावी पायी गयी। तेल ताड़ संकरों के बीच तमिलनाडु में एनआरसीओपी 17 संकर (आठ वर्ष आयु के) से उच्चतम ताजा फलगुच्छ उपज (157 कि.ग्रा. /ताड एवं 22.5 टन/हेक्टर) प्राप्त की गयी। समीकृत प्रबंधन पद्धित के साथ पसिघट में वर्ष 2006 के दौरान रोपित तेल ताड से औसत ताजा फल गुच्छ 17.7टन/हेक्टर उपज प्राप्त किया गया जिससे उस क्षेत्र की क्षमता की सूचना प्राप्त की जा सकती है। हितकारियों के लाभ के लिए अनुमोदित प्रौद्योगिकियों के प्रचार हेतु सभी केंद्रों में विभिन्न प्रशिक्षण कार्यक्रम और विस्तार गतिविधियॉं आयोजित की गयी।

मैं डेयर के सचिव महोदय और भारतीय कृषि अनुसंधान परिषद के महानिदेशक, डॉ. एस. अय्यप्पन द्वारा दिए गए प्रोत्साहन और मार्गदर्शन के लिए उनके प्रति आभार प्रकट करना अपना सौभाग्य मानता हँ। डॉ. एन.के. कृष्ण कुमार, उप महानिदेशक (बागवानी विज्ञान) भा.कृ.अनु.प द्वारा दी गई निरन्तर मार्गदर्शन और समीक्षात्मक सुझाव के लिए मैं उनका सहृदय कृतज्ञ हूं। डॉ. टी. जानकीराम, सहायक महानिदेशक (बागवानी विज्ञान।) और बागवानी विज्ञान प्रभाग के स्टाफ द्वारा प्रदान की गई अनवरत सहायता के प्रति आभार प्रकट करता हुँ जिन्होने परियोजना के प्रभावी निष्पादन के लिए मदद किया है।

मुझे अपने पूर्व निदेशक, डॉ. जार्ज वी. थॉमस और डॉ. पी. चौड़प्पा, निदेशक एवं स्टाफ, भा कृ अनु प कें रो फ अ सं, कासरगोड, डॉ. एस. अरुल राज, पूर्व निदेशक, डॉ. पी. कालिदास, कार्यकारी निदेशक और स्टाफ, भारतीय तेल ताड अनुसंधान संस्थान, पेडवेगी द्वारा दिए गए मार्गदर्शन के लिए आभार व्यक्त करता हुँ। विभिन्न कृषि/बागवानी विश्वविद्यालय के कुलपति/अनुसंधान निदेशक/प्रमुख, विभिन्न प्रभाग/स्टेशन के प्रति धन्यवाद प्रस्तुत करता हुँ जिन्होंने परियोजना के प्रभावी निष्पादन में तकनीकी एवं प्रशासनिक मदद किया है।

सभी परियोजना अन्वेषको द्वारा विभिन्न कार्यक्रमों के आयोजन में किए गए प्रयास और दिखाए गए उत्साह के लिए प्रशंसा करता हुँ विशेषता डॉ. टी. बी. बसवराजु , डॉ. ए. सुब्रमण्यन , डॉ. एनबीवी चलप्पति रॉव, डॉ. स्नेहलता रानी, डॉ. संजीवरेड्डी, जी. रेड्डी और अन्य वैज्ञानिकगण को भी धन्यवाद अर्पित करता हुँ जिन्होंने इस रिपोर्ट के संकलन में मदद किया है। डॉ. विनायग हेग्डे, डॉ. बी.ए. जेरार्ड, डॉ. पी. सुब्रमणियन, डॉ. एम. सुजित्रा, भा कृ अनु प कें रो फ अ सं, कासरगोड के प्रति धन्यवाद जिन्होंने विभिन्न गतिविधियों के प्रभावी अनुवीक्षा एवं तकनीकी मार्गदर्शन दिया है। सुश्री एस. सुमिता, वैज्ञानिक, श्रीमती के. नारायणी, निजी सचिव और श्रीमती रुपा मणिकंठन, प्रवर श्रेणी लिपिक, सुश्री एस. सुजित्रा और श्री मोहना को भी साधुवाद देता हुँ जिन्होंने इस रिपोर्ट के निष्पादन में मदद और समन्वयन कार्य किया है। हिंदी अनुवाद के लिए श्रीमती के. श्रीलता को भी धन्यवाद प्रस्तुत करता हुँ।

एच.पी. महेश्वरप्पा

26 जून, 2015

(डॉ. एच.पी. महेश्वरप्पा)

I. Preface

The centres of ICAR-AICRP on Palms established in thirteen states representing different agro-climatic regions have been successful in developing location specific technologies to improve the productivity of mandate crops. Considering the economic importance, arecanut has been included as another mandate crop with four new centres during the year, and in order to strengthen research on coconut, two centres covering Coastal and Island ecosystem were also added. Under the crop improvement programmes in coconut, a superior high yielding cross combination of LCT x CCNT, a Tall x Tall combination has been developed at Veppankulam (Tamil Nadu) centre, with mean annual yield of 161 nuts/palm. Raising suitable intercrops under coconut through integrated nutrient management practices at different centres recorded higher productivity and income compared to monocrop of coconut. Growing flower crops such as marigold, chrysanthemum, chinaster, gerbera, tuberose, gladiolus and heliconia as intercrops in coconut gardens of different agro-climatic regions is highly productive and remunerative than monocropping of coconut. The black headed caterpillar incidence in coconut growing southern states was brought to the minimum level by releasing parasitoids *viz., Goniozus nephantidis, Bracon brevicornis* and *B. hebetor*. Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly intervals was found to be an effective option for management of leaf blight disease in coconut. Among the oil palm hybrids, the hybrid NRCOP 17 recorded significantly higher FFB yield (157 kg/palm & 22.5 t/ha) at the age of eighth year in Tamil Nadu. Oil palm planted during 2006 at Pasighat (Arunachal Pradesh) with integrated management practices produced an average FFB yield of 17.7 t/ha indicating the potential of the crop in the region. Various training programmes and extension activities have been carried out in all the centres to disseminate the proven technologies for the benefit of stake holders.

I consider it a privilege to place on record my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for the encouragement and support given for the project. Constant guidance and critical suggestions provided by Dr. N.K. Krishna Kumar, Deputy Director General (Horticulture Science), ICAR, is highly acknowledged. I thank Dr. T. Janakiram, ADG (Hort. Sci. I) and staff of Horticulture Science Division for all the support given to us for smooth functioning of the project.

I acknowledge the guidance provided by Dr. George V. Thomas, Former Director, Dr. P. Chowdappa, Director and staff of ICAR-CPCRI, Kasaragod, Dr. S. Arulraj, Former Director and Dr. P. Kalidas, Acting Director and staff of ICAR-IIOPR, Pedavegi. 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 appreciate the efforts and zeal shown by all the project investigators during execution of various programmes and I take this opportunity to express my sincere thanks to scientists of AICRP on Palms especially Dr. T.B. Basavaraju, Dr. A. Subramanian, Dr. NBV Chalapathi Rao, Dr. Snehalatha Rani, and Dr. Sanjeevraddi G. Reddi for their help in compilation of this report. I record my my sincere thanks to Dr. Vinayaka Hegde, Dr. B.A. Jerard, Dr. P. Subramanian and Dr. M. Sujithra of ICAR-CPCRI, Kasaragod for their effective monitoring and technical guidance for various activities. The support and coordination of Ms. S. Sumitha, Scientist, Smt. K. Narayani, Private Secretary and Mrs. Rupa Manikandan, UDC, Ms. S. Suchitra and Mr. A. Mohana of PC Cell for bringing out this report and the help rendered by Mrs. K. Sreelatha for Hindi translation are greatly acknowledged.

26th June, 2015

(Dr. H.P. Maheswarappa)

II. कार्य सारांश

अखिल भारतीय समिन्वित ताड़ अनुसंधान परियोजना केंद्र मुख्य फसलों की उत्पादनक्षमता बढाने की स्थानीय विशेष प्रौद्योगिकियों के विकासन में सफलतापूर्वक विभिन्न सस्य जलवायु क्षेत्रों का प्रतिनिधित्व कर 13 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 2014-15 की अवधि में हुई अनुसंधान कार्य की प्रगति इस रिपोर्ट में प्रस्तुत की गई है।

वर्ष 2014-15 की अनुसंधान उपलब्धियाँ

नारियल

आनुवंशिक संसाधन और फसल सुधार

उच्च गुठली उपज, डाब जल, खोपडा और तेल उपज के साथ सूखा सक्षम नारियल के विकास पर लक्षित अनुसंधान कार्यक्रम के फलस्वरूप अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्र, वेप्पंगुलम में उत्तम उच्च उपज संकर संयुक्त एलसी ओटी x सीसीएनटी पहचाना गया। यह एक लंबी x लंबी संयुक्त है, जो 1986 से मूल्यांकनाधीन देश की पहली प्रजाति है। इससे 161 गुठली/ताड़/वर्ष औसत गुठली उपज अंकित किया गया है। यह क्रमशः इसीटी, वीएचसी 2 और वीएचसी 3 से क्रमशः 62.6,43.8 और 11.0 प्रतिशत अधिक है। इसकी खोपड़ा मात्रा 149.8 ग्रा / गुठली और तेल 68.0 प्रतिशत है। इस संकर मे 4.8 डिग्री ब्रिक्स के टीएसएस के साथ 343 मि ली डाब जल निहित है।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के विभिन्न केंद्रों द्वारा विभिन्न सस्य जलवायु क्षेत्रो में नारियल संकरों का मूल्यांकन, विमोचित प्रजातियों का संरक्षण और गुणी रोपाई सामग्रियों का उत्पादन, स्थानीय प्रजातियों का संग्रहण, संरक्षण एवं मूल्यांकन किया जाता है। अम्बाजिपेट में वर्ष 2013-14 के दौरान मूल्यांकनाधीन विमोचित प्रजातियों में गोदावरी गंगा में उच्चतम गुठली उपज 101.4 गुठली/ताड़ रिकार्ड किया गया। और केरा गंगा से 96.4 गुठली/ताड प्राप्त किया गया। चन्द्रलक्षा से उच्चतम फल भार (1233.3 ग्रा) रिकार्ड किया गया। चन्द्रलक्षा में खोपडा मात्रा भी उच्चतम 176.9ग्रा/गुठली थी। मूल्यांकनाधीन बौनी x बौनी संकर में सी ओ डी x एमजीडी संकर में अच्छा गुणयुक्त डाबफल प्राप्त किया गया। अधिकतम डाब जल 450 मि.ली/गुठली और मृदु भ्रूणपोष (100.6ग्रा/गुठली)।

फसल उत्पादन

नारियल आधारित उच्च घनता बहुजातिय फसलन पद्धति

अखिल भारतीय समन्वित ताड अनुसंधान परियोजना में समीकृत पोषण प्रबंधन के अधीन विकसति नारियल आधारित फसलन पद्धति से नारियल के इकफसल की अपेक्षा उच्च उत्पादनक्षमता और आय देखा गया। अलियारनगर में अनुमोदित नाईट्रोजन, फोसफोरस और पोटाश के 75% के समीकृत पोषण प्रबंधन और वर्मीकम्पोस्ट के साथ जैविक पुन चक्रमण के साथ नारियल कोको केला अनानास की फसलन पद्धति से उच्च कुल आय 3.77 लाख प्रति हेक्टर और पूर्ण रुप से जैविक उपचार से 3.46.लाख प्रति हेक्टर आय प्राप्त किया गया।

अरसिकरे केंद्र में पूर्ण जैविक पोषण प्रबंधन के अधीन नारियल कोको, नींबू, सजनाफली फसलन पद्धति से उच्च कुल आय (2.95 लाख/हेक्टर रुपए) और अनुमोदित नाईट्रोजन, फोसफोरस और पोटाश के 50% वर्मीकम्पोस्ट के साथ पुनः चक्रमण + वर्मीवाश प्रयोग पोटाश जैव उर्वरक प्रयोग और हरा खाद प्रयोग से 284410/हेक्टर रुपए प्राप्त किए गए।

नारियल बाग में फूल फसल का अन्तरफसलन

नारियल बाग में फूल फसलों का वर्द्धन नारियल इक फसल की अपेक्षा अधिक उत्पादजनक और लाभदायक है। अलियार नगर में नारियल बाग में पहचान की गई उचित फूल फसल गेंदा, गामफ्रेना, मयूरशिख, सुभगा प्रजाति और हेमपुष्प है। अरसिकरे केंद्र में हेमपुष्प, कनकाम्बर, चीन तारक और गेंदा उचित पाया गया। काहिकुची केंद्र में अभिसुन्दरा प्रजाति, रजनीगन्धा, कृपाणपर्ण प्रजाति और गेंदा, कृपाणपर्ण प्रजाति, रजनीगन्धा और अभिसुन्दरा प्रजाति मन्डौरी केन्द्र में और नलिनी और हेलिकोनिया, और मल्लिका रत्नगिरी केंद्र के लिए उचित पाया गया।

नाशीजीव कीट प्रबंधन

नारियल काला सिरवाली कैटरपिल्लर ओपिसिना एरिनोसेल्ला का निम्न से तीक्ष्ण लक्षण चार राज्यों में अंकित किया गया था। कर्नाटक में तुमकुर और हसन जिले में तीक्ष्ण लक्षण पाया गया। महाराष्ट्र में थाने जिले में पालघाडु तहसिल में और कोल्हापुर जिले में तलसान्डे तहसिल में काला सिखायी कैटर पिल्लर के मुख्य क्षेत्र के रूप में पहचाना गया है।

संक्रमित नारियल बाग में विमोचन के लिए 2,16,300 ब्राकोन हेबेटर और 1,07,800 गोनियोसस निफान्टिडिस परजीव्याभ का बहुगुणन किया गया और पूर्ति की गई। तमिलनाडु में काला सिरवाली कैटरपिल्लर कम दिखाई पड़े है और *बी. ब्रेविकोर्निस* (80,900 सं) और *जी निफान्टिडिस* (8000 सं) आदि कैटरपिल्लर के जैविक नियंत्रण के लिए वितरण किया गया। आन्ध्रप्रदेश में पूर्व एवं पश्चिम गोदावरी जिले के एकलित गॉवों में माध्यमिक एवं उच्च लक्षण देखा गया और 1,19,800 *बी हेबाटर* और 1,35,500 *जी निफान्टिडिस* परजीव्याभ का बहुगुणन किया गया ओर कृषकों को वितरण किया गया।

रोग प्रबंधन

एच आर एस, अरसिकरे इन विट्रो परिस्थिति के अधीन गैनोडेरमा लूसिडम के विरुद्ध परीक्षण किए गए सात जैव नियंत्रण एजेंट में सभी विरोधी गैनोडेरमा लूसिडाम की वृद्धि महत्वपूर्ण रूप से 61.78 प्रतिशत से से 76.00 प्रतिशत तक कम किया गया। और परीक्षित सभी जैव एजेंटों में *ट्रैकोडेरमा आस्पिरिल्लम* (जीकेवीके) उत्तम पाया गया।

गैनोडेरमा लूसिडम के लिए मूल्यांकित 13 कवकानी में कार-बन्टाज़िम 0.1%, कारबोक्सिन + थिरम 0.3%, डिफेनोकोनज़ोल 0.1%, प्रोपिकोनज़ोल 0.1%, टेबुकोनज़ोल 0.15%, टेबुकोनज़ोल ट्रैफ्लोक्सिस्ट्रोबिन 0.04%, टेट्राकोनजाल 0.1%, टेट्राकोनजोल 0.15% और मानक चेक हेक्साकोनजोल 0.1% एच आर एस, अरसिकरे में *गैनोडेरमा लूसिडम* का निरोध शत प्रतिशत पाया गया। एच आर एस अम्बाजिपेट में नई कवकानी का टेस्ट ट्यूब छानबीन अधीन 0.5% गाढापन में टेबुकोनज़ोल और हेक्साकोनज़ोल गैनोडेरमा जाति की वृद्धि का पूर्ण निरोध दिखाया गया।

नारियल का तना स्त्रवण रोग के विरुद्ध *ट्रैकोडेरमा विरिडे* का लेपन प्रयोग की तुलना में *ट्रैकोडेरमा विरन्स* केक का प्रयोग प्रभावी पाया गया और एक महीने के अंदर 53.3 प्रतिशत और पाँच महीने के अंदर 73.3% रोगमुक्ति दिखायी गयी। लेपन प्रयोग से एक महीने के अंदर 26.67 प्रतिशत और पॉच महीने के अंदर 40.0 प्रतिशत रोग मुक्ति पायी गयी।

सी.आर.एस अलियारनगर में *लासियोडिप्लोडिया थियोब्रोमे* के विरुद्ध परीक्षित कवकानी में 0.1% गाढापन में टेबुकोनज़ोल, टेबुकानज़ोल + ट्रैफ्लोक्सिस्ट्रोबिन, प्रोपिकोनज़ोल और कारबेन्डाज़िम के साथ नियंत्रण में 100 प्रतिशत निरोध पाया गया। एच आर एस अरसिकरे में *लासियोडिप्लोडिया थियोब्रोमे* का 100 प्रतिशत निरोध कवकानी जैसे कारबोक्सिन थिरम 0.3% और प्रोपिकोनज़ोल 0.1% में पाया गया। सी आर एस, अलिययारनगर में प्रक्षेत्र मूल्यांकन अध्ययन में तिमाही अंतराल में 2 मि ली टेबुकोनजोल + 100 मि ली जल की दर में मूल वेधन में उपचारित ताडों में रोग तीव्रता में अधिकतम कमी पायी गयी।

तेल ताड़

पाट्टुक्कोटाई (तमिलनाडु) में वर्ष 2006 में प्रक्षेत्र में वृद्धि एवं उपज निष्पादन मूल्यांकन परीक्षण के अधीन रोपित दस संकर में एनआरसीओपी 17 संकर से रोपाई के आठवाँ वर्ष से वर्ष 2014-15 के दौरान उच्चतम ताजा फल गुच्छ (157 कि ग्रा /ताड एवं 22.5 टन/हेक्टर) प्राप्त किया गया।

विजयराय केंद्र में रोपित विभिन्न संकर संयुक्तों के तुलनात्मक निष्पादन के अधीन संकर एनआरसीओपी 4 से उच्चतम ताजा फल गुच्छ (24.9टन/हेक्टर)और एनआरसीओपी5 से 19.8 टन/हेक्टर प्राप्त किया गया।

गंगावती में तरुण तेल ताड़ों के बीच का अंतरफसलन में फसल जैसे भिण्डी, मिर्च, प्याज, क्लस्टर बीन और बीन की वृद्धि अच्छी पायी गयी और 50,000 से 76,000 रुपए प्रति हेक्टर आमदनी प्राप्त की गई। मुल्डे में केला, अनानास और याम से 35,000 से 40,000 रुपए प्रति हेक्टर आय प्राप्त किया गया।

पसिघट (अरुणाचल प्रदेश) में वर्ष 2006 के दौरान समीकृत प्रबंधन पद्धित के साथ रोपित तेल ताड से 9.1 गुच्छ प्रति ताड (अर्थात औसत रुप से 13. 6 कि ग्रा भार) और 17.7 टनप्रति हेक्टर उपज प्राप्त किया गया।

पाँमैरा

उड़िसा के पुरी और खोर्डा जिले के पाँमैरा वर्द्धित क्षेत्रों में सर्वेक्षण किया गया और बौनी प्रकृति के और फल आधार में काला दागा के साथ पीला नारंगीन के छह जर्मप्लाज़म संग्रहित किया गया।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की तेईसवीं वार्षिक समूह बैठक

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की तेईसवीं वार्षिक समूह बैठक तेलबीज अनुसंधान का निदेशालय, हैदराबाद में जुलाई 25से 28, 2014 को आयोजित की गयी। डॉ एन. के कृष्णकुमार, माननीय उप महानिदेशक (बागवानी विज्ञान), भाकृअनुप ने बैठक का उद्घाटन किया। डॉ. बी.एम.सी. रेड्डी, कुलपति ने अध्यक्षता की। डॉ वाईएसआर विश्वविद्यालय, आंध्रप्रदेश, डॉ पी रेतिनम पूर्व कार्यपालक निदेशक, एपी सी सी, जकार्ता, डॉ के यु के नम्पूतिरी, डॉ एमएसएसआरएफ, प्रादेशिक केंद्र जयपुर, उड़ीसा, डॉ टी जानकिराम, सहायक महानिदेशक (बागवानी विज्ञान1), भा कृ

अनु प, नई दिल्ली और डॉ के एस वरप्रसाद, परियोजना निदेशक, डी ओ आर, हैदराबाद उपस्थित थे। डॉ जॉर्ज वी थॉमस, निदेशक, कें रो फ अ सं, डॉ एस अरुलराज, निदेशक तेल ताड अनुसंधान निदेशालय, प्रकाश पटिल, परियोजना समन्वयक (प्रभारी) (फल), डॉ निर्मल बाबु, परियोजना समन्व्यक (मसाला), कें रो फ अ सं के विभिनन अनुभागों के प्रमुख, अ भा स ताड अनु परियोजना के विभिन्न केंद्रों के वैज्ञानिकगण, भा कृ अनु प के विभिन्न संस्थानों के वैज्ञानिक, नारियल के मूल्य वर्द्धित उत्पाद उद्यमों के कार्मिक ने इस बैठक में भाग लिया। डॉ पी रेतिनम, डॉ के यु के नम्पूतिरी और डॉ बी मल्लिक, सेवामुक्त वैज्ञानिक, कृषि विज्ञान विश्वविद्यालय, बेंगलूर ने समूह बैठक में फसल उत्पादन, आनुवंशिक संसाधन और फसल सुधार तथा कीट रोग प्रबंधन आदि तकनीकी सत्रों के विशेषज्ञ सदसस्यों के रुप में भाग लिया। डॉ सी एम मुरलिधरन, खजूर ताड अनुसंधान स्टेशन मुन्द्रा, गुजरात द्वारा खजूर ताड कृषि पर अतिथि व्याख्यान दिया। और डॉ आर डी प्रसाद, प्रधान वैज्ञानिक, तेल ताड अनुसंधान निदेशालय, हैदराबाद ने मृदा जन्म कवक व्याधिजन के प्रबंधन के लिए जैविक कीटनाशिनी के रुप में ट्रैकोडेरमा विषय पर व्याख्यान दिया। इस बैठक में सात तकनीकी सत्र थे और फसल सुधार, उत्पादन, संरक्षण और कटाई उपरांत कार्यक्रमों के तकनीकी सत्रों के क्रमानुगत कार्यक्रम मार्गदर्शकों द्वारा प्रस्तुत किया गया वर्ष 2013-14 की उपलब्धियाँ और वर्ष 2014-15 के कार्यक्रमों का अनुमोदन किया गया।

सिफारिश :-

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

- गंगावती और विजयराय केंद्र में 1200: 600: 1200 ग्रा नाईट्रोजन, फोसफोरस, पोटाश का उर्वरण करना है। मुल्डे केन्द्र में द्विमासिक अंतराल में छह समभाटित मात्रा में 1200: 600: 1800 ग्रा नाईट्रोजन, फोसफोरस, पोटाश का उर्वरण से उच्च ताजा फल गुच्छ उपज और उच्च वित्तीय लाभ प्राप्त किया गया।
- विशाखपट्टनम जिले में काला सिरवाली कैटरपिल्लर के विरुद्ध *ब्राकोन हेबाटर, गोनियोसस निफान्टिडिस, ब्राकैमेरिया नोसाटोइ* और *कार्डियास्टेथस एक्सिग्यूयस* जैस परजीव्याभ और परभक्षी के विमोचन से 4 से 6 महीने में कीट दमन पाया गया।
- तिमाही अंतराल में एफ वाई एम (5 किग्रा/ताड़) के साथ 300 ग्रा दर में *स्यूडोमानस फ्लूरोसेन्स, बेसिलस सब्टिलस* और *ट्रैकोडेरमा विरिडे* का सूक्ष्माणुवीय सहजीविता का मृदा प्रयोग नारियल का पत्ता चित्ती रोग कम करने में प्रभावी पाया गया।

II. Executive Summary

The AICRP centres located in thirteen 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 2014-15 is presented in this report.

Research achievements during 2014-15

Coconut

Genetic resources and Crop improvement

Research programs aimed at development of a coconut hybrid with high nut yield, copra output and oil yield has resulted in identification of a superior high yielding cross combination, LCT x CCNT, at AICRP – Palms centre, Veppankulam. It is a Tall x Tall combination, first of its kind in the country, under evaluation since 1986. It recorded mean nut yield of 161 nuts/palm/year. This is 62.6 and 43.8 per cent higher than checks *viz*., ECT and VHC 1, respectively. It has a copra content of 149.8 g/ nut and oil content of 70.0%. The volume of tender nut water in this hybrid is 285.5 ml with TSS of 4.8^0 Brix.

Further, collection, conservation and evaluation of local ecotypes, evaluation of coconut hybrids in different agro climatic regions, conservation of released varieties and production of quality planting materials are undertaken by different AICRP centres. Among the released varieties under evaluation at Ambajipeta, during the year 2013-14, the highest nut yield of 101.4 nuts/palm was recorded in Godavari Ganga followed by Kera Ganga (96.4 nuts/palm). The highest fruit weight (1233.3 g) was recorded by Chandralaksha. Copra content was significantly the highest in Chandralaksha (176.9 g/nut). Among the D x D hybrids under evaluation, good tender nut quality parameters were observed in the cross CODxMGD at Veppankulam, with maximum volume of tender nut water (450 ml/nut) with high tender endosperm content (100.6 g/nut) during 2013-14.

Crop Production

Coconut based high density multi species cropping system

The coconut based cropping systems under integrated nutrient management developed at different AICRP Centres showed higher productivity and income than monocrop of coconut. At Aliyarnagar Centre, the cropping system of coconut + cocoa + banana + pineapple with integrated nutrient management of 75% of recommended NPK coupled with organic recycling with vermicompost recorded higher net income of Rs. 3.77 lakhs per ha followed by fully organic treatment (Rs. 3.46 lakhs/ha).

At Arsikere Centre, the cropping system of coconut + cocoa + lime + drumstick recorded higher net returns under fully organic nutrient management (Rs. 2.95 lakhs/ha) followed by 50% of recommended NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring (Rs. 2.84 lakhs/ha).

Intercropping of flower crops in coconut garden

Growing of flower crops in coconut garden is highly productive and remunerative than monocropping of coconut. The suitable flower crops identified under coconut are marigold, gomphrena, celosia, zinnia and chrysanthemum at Aliyarnagar Centre; chrysanthemum, crossandra, chinaaster and marigold at Arsikere Centre; gerbera, tuberose, gladiolus and marigold at Kahikuchi Centre and gladiolus, tuberose and gerbera at Mondouri Centre; lily, heliconia and jasmine at Ratnagiri Centre.

Insect pest management

The incidence of coconut black headed caterpillar was recorded in all the four states in the roving surveys which ranged from low to severe. In

Karnataka, severe incidence was noticed in Tumkur and Hassan district, in Maharashtra tahsil Palghar in Palghar district and tahsil Talsande in Kolhapur district were identified as hot spot areas for black headed caterpillar and 2,16,300 *Bracon hebetor* and 1,07,800 *Goniozus nephantidis* parasitoids were multiplied and supplied to the farmers for release in the infested coconut gardens. The black headed caterpillar incidence was low in Tamil Nadu and parasitoids of *B. brevicornis* (80,900 nos.) and *G. nephantidis* (8000 nos.) were supplied for biological control of the caterpillar. In Andhra Pradesh medium to high incidence in isolated villages of East and West Godavari districts was observed and 1,19,800 *B. hebetor* and 1,35,500 *G. nephantidis* parasitoids were multiplied and supplied to the farmers.

Disease management

- Out of seven bio control agents tested against *Ganoderma lucidum* under *in vitro* conditions at HRS, Arsikere, all the antagonists significantly reduced the growth of *Ganoderma lucidum* from 61.78 to 76.00 per cent and *Trichoderma asperillum (GKVK)* was found superior to all the bio agents tested.
- Among the thirteen fungicides evaluated for *Ganoderma lucidum,* Carbendazim 0.1%, Carboxin+Thiram 0.3%, Difenoconazole 0.1%, Propiconazole 0.1%, Tebuconazole 0.15%, Tebuconazole+Trifloxystrobin 0.04%, Tetraconazole 0.1%, Tetraconazole 0.15% and standard check Hexaconazole 0.1% has recorded 100 percent inhibition of *Ganoderma lucidum* at HRS Arsikere. Under *in vitro* screening of new fungicides, Tebuconazole and Hexaconazole at 0.5% concentration showed complete inhibition of growth of *Ganoderma* species at HRS Ambajipeta.
- Application of *Trichoderma virens* cake formulation was found effective when compared to the paste application of *Trichoderma viride* against stem bleeding disease of coconut and it showed 53.3 percent recovery within one month and 73.3 per cent recovery within five months. Paste application showed 26.67 percent recovery within one month 40.0 per cent recovery within five months.
- Among the fungicides tested against *Lasiodiplodia theobromae*, 100 per cent inhibition over control was observed with Tebuconazole, Tebuconazole+Trifloxystrobin, Propiconazole and Carbendazim at 0.1% concentration at CRS, Aliyarnagar. Fungicides like, Carboxin +Thiram 0.3% and Propiconazole 0.1% showed 100 per cent inhibition of *Lasiodiplodia theobromae* at HRS Arsikere. In the field evaluation studies at CRS, Aliyarnagar, maximum reduction in disease severity was observed in root feeding of Tebuconazole @ 2ml+100 ml water at quarterly intervals treated palms in both the trials.

Oil palm

- Among the ten hybrids planted during 2006 at Pattukottai (Tamil Nadu) and evaluated for growth and yield performance, the hybrid NRCOP 17 recorded significantly higher FFB yield (157 kg/palm & 22.5 t/ha) during 2014-15 (at 8th year of planting).
- Under comparative performance of different hybrid combinations planted during 2007, at Vijayarai centre (A.P), the hybrid NRCOP-4 recorded significantly higher FFB yield (24.9 t/ha) followed by NRCOP 5 (19.86t/ha).
- Intercropping in young oil palm at Gangavati indicated that, crops like bhendi, chilli, onion, cluster bean and beans could grow well and provide an additional income of Rs. 50,000 to 76,000/- per ha). At Mulde, banana, pineapple and elephant foot yam are being grown and they could provide additional income of Rs.35,000 to 40,000/ha.
- Oil palm planted during 2006 at Pasighat (Arunachal Pradesh) with integrated management practices produced 9.1 bunches per palm with an average bunch weight of 13.6 kg and the yield recorded was 17.7 t/ha.

Palmyrah

Survey was made in the palmyrah growing areas of Puri and Khorda district of Odisha and six germplasms with dwarf nature and yellowish orange with black blotch at the base fruits were collected.

XXIII Annual Group Meeting

The 23rd Annual group meeting of All India Coordinated Research Project on Palms was organized from 25th to 28th July 2014 at Directorate of Oilseeds Research (DOR), Hyderabad. The annual group meeting was inaugurated by Dr. N. K. Krishna Kumar, Honorable Deputy Director General (Horticulture Science), ICAR. The inaugural function was presided over Dr. B. M. C. Reddy, Vice Chancellor, Dr. YSRHU, Andhra Pradesh. Dr. P. Reithinam, Former Exec. Dir., APCC, Jakarta, Dr. K. U. K. Nampoothiri, Dr. MSSRF, Regional Station, Jeypore, Odisha, Dr.T.Janakiram, ADG (HS-I), ICAR, New Delhi, and Dr. K. S. Varaprasad, Project Director, DOR, Hyderabad graced the occasion. Besides, Dr. George V. Thomas, Director, CPCRI, Dr. S. Arualraj, Director, DOPR, Dr. Prakash Patil, Project Coordinator(I/c) (Fruits), Dr. Nirmal Babu, Project Coordinator (Spices), Head of the divisions of CPCRI, Scientists from different centers of AICRP and scientists from different ICAR institutes and personnel from coconut industries of value added products participated in the programme. Dr. P. Rethinam, Dr. K. U. K. Nampoothiri and Dr. B. Mallik, Emeritus Scientist, UAS, Bangalore participated in the group meeting as expert members for the technical sessions of Crop Production, Genetic Resources and Crop Improvement and Insect Pest Management. Guest lecture on "Date palm cultivation" by Dr. C.M. Muralidharan, Date palm Research Station, Mundra, Gujarath and "*Trichoderma* as Bio-pesticide for management of soil borne fungal pathogens" by Dr. R.D. Prasad, Principal Scientist, DOR, Hyderabad were also organized during the group meeting. There were seven technical sessions organized and the respective programme leaders of the technical sessions of crop improvement, production, protection and post harvest programmes presented the findings of 2013-14 and programmes for 2014-15 were approved.

Recommendations

The major recommendations of the XXIII AICRP Group meeting to be passed on to Extension System were;

- Fertigation in Oil palm with 1200:600:1200g $NP_2O_5K_2O$/ palm/year in six equal splits at bimonthly interval for Gangavathi and Vijayarai centre and 1200:600:1800 g $NP_2O_5K_2O$/ palm/year in six equal splits at bi–monthly interval for Mulde centre recorded higher FFB yield and higher monetary returns.
- Release of parasitoids and predators *viz.*, *Bracon hebetor, Goniozus nephantidis, Brachymeria nosatoi* and *Cardiastethus exiguous* against black headed caterpillar outbreak in Visakhapatnam district led to suppression of the pest in 4 to 6 months period.
- 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 of coconut.

III. Profile of AICRP on Palms

Palms such as coconut (*Cocos nucifera L*), arecanut (*Areca catechu*), oil palm (*Elaeis guineensis* Jacq.) and palmyarh (*Borassus flabellifer L.*) are significant for the sustainable livelihoods of millions of small and marginal farmers in the country. 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 Projects on Palms was started in 1972, and the present mandates of the project are as follows:

- 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.
- To evaluate bio-intensive insect pest and disease management strategies, modeling and forecasting of disease incidence and documentation of insect pest dynamics in changing scenario of palm ecosystem.
- Development of post-harvest technologies in palmyrah and to demonstrate and transfer of technologies to the farmers.

During the year, arecanut crop has been added as mandate crop in the project. Accordingly four centres in arecanut, two in coconut, one in oil palm also have been added during the period and hence, at present AICRP on Palms deals with coconut, arecanut, oil palm, palmyrah and fish tail palms in 26 centres spread over 13 states and one union territory (15 centres on coconut, 7 on oil palm, 4 on arecanut, 2 on palmyrah and 1 on sulphi palm).

List of the centres with address and crops

State	Center/Location	Area of Research	University/ Institutions
Andhra Pradesh	Horticultural Research Station, Ambajipeta, East Godavari District-533 214	Coconut: Crop Improvement, Production & Protection	Dr.Y.S.R Horticultural University, West Godavari District (534 101), Andhra Pradesh.
	Agricultural Research Station, Vijayarai, West Godavari District-534 475	Oil Palm: Crop Improvement & Production	
	Horticultural Research Station, Pandirimamidi, Ramapachodaram PO-533 288, East Godavari District	Palmyrah: Crop Improvement, Production & Post Harvest Technology	
	Indian Institute of Oil Palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi – 534 450, West Godavari District.	Oil Palm: Crop Improvement & Production	Indian Council of Agricultural Research

Andamans and Nicobar	Central Island Agricultural Research Institute, Port Blair-744 101	Coconut and Arecanut: Crop Improvement & Production	Indian Council of Agricultural Research
Arunachal Pradesh	College of Horticulture & Forestry, Pasighat - 791102, Arunachal Pradesh.	Oil Palm: Crop Improvement & Production	Central Agricultural University, P.O.Box 23, Imphal - 795 004, Manipur.
Assam	Horticultural Research Station, Kahikuchi, Guwahati-781 017, Kamrup District	Coconut: Crop Improvement & Production	Assam Agricultural University, Jorhat 785 013, Assam
Bihar	Bihar Agricultural College, Sabour, Bhagalpur District - 813 210, Bihar	Coconut:Crop Improvement & Production	Bihar Agricultural University, Sabour, Bhagalpur, Bihar - 813 210.
	Regional Research Station, P.O. Madhopur - 845 454, Majhaulia Via., West Champaran Dist., Bihar.	Oil Palm: Crop Improvement & Production	Rajendra Agricultural University, Pusa, Samastipur - 848 125, Bihar.
Chhattisgarh	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagadalpur - 494 005, Chhatisgarh	Coconut:Crop Improvement and production Sulphi palm: Crop improvement and disease management	Indira Gandhi Krishi Vishwavidyalaya, Raipur - 492 012, Chhattisgarh.
Gujarat	ASPEE College of Horticulture& Forestry, Navsari Agricultural University, Navsari - 396 450, Gujarat.	Coconut:Crop Improvement & Production	Navsari Agricultural University,Navsari - 396 450, Gujarat.
Goa	Central Coastal Agriculture Reaserch Institute, Ela, Old Goa, Distt. Goa-403402	Coconut: Crop Improvement, Production & protection Arecanut : Crop improvement and Production	Indian Council of Agricultural Research
Karnataka	Horticultural Research Station, Arsikere - 573 103, Hassan District	Coconut:Crop Improvement, Production & Protection	University of Horticultural Sciences, Navanagar, Bagalkot - 587 102, Karnataka.
	Agricultural Research Station, Gangavathi - 583 227, Koppal District, Karanataka.	Oil Palm:Crop Improvement & Production	
	University of Agricultural & Horticultural Sciences, Navile, Shivamogga	Arecanut : Crop improvement, Production and Protection	University of Agricultural & Horticultural Sciences, Navile, Shivamogga - 577 225, Karnataka.
Kerala	Central Plantation Crops Research Institute, Kasaragod - 671 124	Coconut:Crop Production	Indian Council of Agricultural Research
	Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670 353	Coconut:Crop Improvement	Kerala Agricultural University, P.O. KAU, Vellanikkara, Thrissur - 680 656, Kerala.

Maharashtra	Regional Coconut Research Station, Bhatye - 421 612, Ratnagiri District	Coconut:Crop Improvement, Production & Protection	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415 712, Ratnagiri District, Maharashtra.
	College of Horticulture, Mulde - 416 520, Kudal Taluk, Sindhudurg District	Oil Palm:Crop Improvement & Production	
	Central Experimental Station , Asond block, Wakavali, Dalopli Tk .	Areanut : Crop improvement & Production	
Odisha	Department of Horticulture, (OUAT), Bhubaneshwar - 751 003, Odisha	Coconut:Crop Improvement & Production	Orissa University of Agriculture & Technology, Bhubaneswar - 751 003, Odisha.
Tamil Nadu	Coconut Research Station, Aliyarnagar - 642 101, Coimbatore District	Coconut:Crop Improvement, Production & Protection	Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu.
	Coconut Research Station, Veppankulam - 614 906, Thanjavur District	Coconut:Crop Improvement, Production & Protection	
	Agricultural Research Station, Pattukkottai-614 602, Thanjvur District, Tamil Nadu	Oil Palm:Crop Improvement & Production	
	Agricultural College & Research Institute, Killikulam-628 252, Vallanad, Tuticorin District	Palmyrah: Crop Improvement & Post Harvest Technology	
West Bengal	Directorate of Research, P.O. Kalyani - 741 235, Nadia District, West Bengal.	Coconut: Crop Improvement & Production	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia - 741 252, West Bengal.

Budget

The budget for the year 2014-15 was Rs. 390.00 lakhs (ICAR Share).

S. No	Head	Expenditure as on 31.3.2015
	Pay and Allowances	177.00
	T.A.	15.63
	RC	184.47
	HRD	12.90
	Total	**390.00**

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 state agricultural universities. The scheme is implemented through 26 coordinating centres distributed in 13 states.

Staff strength

Category	Present strength
Scientific	35
Technical	20
Supporting	17
Total	72

IV. EXPERIMENTAL RESULTS IN COCONUT

4.1 GENETIC RESOURSES AND CROP IMPROVEMENT

Gen.1: Conservation and evaluation of coconut genetic resources in different agro-climatic regions

Expt.2: Collection, conservation and evaluation of location specific germplasms

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

Evaluation materials: 10 - 15 local germplasm collection (CRP series).

Aliyarnagar

A total of 11 germplasm were collected during 2007. Five germplasms were maintained as a replicated trial and the rest were planted as observational trial.

Morphological observations for vegetative growth attributes revealed that among the germplasm, CRP 745 exhibited good vigour with maximum girth (124.1 cm), annual leaf production (11.9), petiole length (107.5 cm), and leaf length (336.6 cm), whereas CRP 742 has recorded significantly lower plant height compared to other germplasms (Table 1).

Table 1. Performance of local germplasm at Aliyarnagar (Year of planting : 2008)

Germ-plasm	IC num-ber	Palm height (cm)	Girth (cm)	Annual leaf pro-duction
CRP 737	610370	221.8	65.6	8.8
CRP 742	610375	204.7	94.6	9.2
CRP 743	610376	251.8	94.5	11.3
CRP 744	610377	231.4	60.1	8.2
CRP 745	610378	254.6	124.1	11.9
Mean		232.8	87.8	9.9
CV (%)		15.4	42.9	31.0
SEm±		25.4	26.6	2.2
CD (P=0.05)		51.0	53.5	4.3

Veiw of local germplasm at Aliyarnagar

Ambajipeta

Thirteen local germplasms were collected from traditional coconut growing districts *viz,* Srikakulam, East and West Godavari districts of Andhra Pradesh and seedlings were planted during February 2013. Five accessions *viz,* CRP 745, CRP 746, CRP 748 , CRP 750 and CRP 749 were planted in RBD with four replications with four palms/ replications. Growth observations recorded among the germplasms showed non-significant difference.

Arsikere

Five germplasms *viz.,* CRP 811, CRP 812, CRP 819, CRP 820, CRP 821 and local check TPT were planted on 2013 in RBD with four replications. Observations recorded for growth parameters showed statistically significant difference for all the traits except for leaf let breadth. CRP 811 has shown better performance compared to other germplasms.

Bhubaneshwar

Eleven local germplasms were planted during December, 2003 as an observational trial with 10 palms per germplasm. The growth parameters recorded during the year 2014 revealed that the maximum plant height was recorded in CRP 790 (8.8m) and minimum plant height was in CRP 800 (7.6m). Flowering was recorded in all the local germplasms, and number of opened

inflorescences produced during the year ranged from 8.0 (CRP792) to 10.0 (CRP790).

Jagdalpur

The seedlings of six germplasms were planted during July 2011 in RBD with four replication and 4 palms per replication and observations on growth parameters were recorded. The genotype CRP 728 showed maximum plant height, petiole length, leaf length and girth of plant.

Kahikuchi

The experiment was initiated with 10 local accessions of coconut in Assam along with two check varieties *viz.*, Kamrupa and WCT (Kera Keralam). The experiment was laid out during 2005 in randomized block design with three replications.

Analysis of observations (Table 2) showed that highest plant height (736 cm), collar girth (171.2cm), number of functional leaves (23.4) and annual leaf production (11.8) were recorded in Kamrupa. The highest petiole length (164 cm) and leaf length (419 cm) were observed in CRP706 and CRP708, respectively. The genotype Kamrupa recorded maximum leaflet length (112.0 cm) and leaf breadth (6.9 cm). Early flowering was recorded in accessions CRP701, CRP703, CRP707 and Kamrupa (67 months from planting). With regard to nut characteristics and nut yield, the genotype CRP702 recoded the biggest nut size (length: 28.6 cm, girth: 49.4 cm) with nut weight (1460 g/nut) and tender coconut water content (380 ml/nut). Significantly the highest yield of 54.0 nuts/palm/year was observed in Kamrupa compared to other germplasms.

Table 2. Performance of local germplasm in replicated trial at Kahikuchi (Year of planting : 2005)

Germplasm / IC No.	Plant height (cm)	Collar girth (cm)	Functional leaves/ palm	Annual leaf production	First flowering (months)	Yield (nuts/ palm/year)
CRP 701 (610353)	642	144.6	21.6	10.8	67	39.6
CRP 702 (610354)	705	167.7	22.0	11.0	68	46.5
CRP 703 (610355)	707	162.2	22.4	11.6	67	44.8
CRP 704 (610356)	697	160.4	21.9	10.4	78	41.4
CRP 705 (610357)	642	151.8	20.7	10.9	70	46.4
CRP 706 (610358)	657	138.5	21.0	11.8	70	40.6
CRP 707 (610359)	642	132.5	20.9	11.0	67	43.8
CRP 708 (610360)	639	140.8	21.7	11.4	70	34.0
CRP 709 (610361)	647	136.6	19.8	10.2	72	39.0
CRP710 (610362)	621	129.4	19.5	11.3	73	48.9
Kera Keralam	725	165.8	21.6	11.5	73	35.6
Kamrupa	736	171.2	23.4	11.8	67	54.0
CD (P=0.05)	27.4	9.45	0.975	0.36	0.88	4.27

View of local germplasm at Kahikuchi

Mondouri

Ten local germplasms from different districts of West Bengal were collected and five germplasms were planted as replicated trial during 2007 in RBD. The data presented in Table 3 showed that annual leaf production (11.2) and trunk height (136.5cm) were maximum in CRP781(IC 612449). Maximum girth (128.6 cm) was recorded in the collection CRP782. While observing the different leaf parameters, the highest length of leaf bearing portion (328.4cm) and leaf scar m^{-1} was recorded in CRP 781. However, leaflet length was maximum (120.4 cm) in CRP779 and leaf breadth was maximum (5.5 cm) in CRP 782 (IC612450).

Table 3. Performance of local germplasm in replicated trial at Mondouri (Year of planting : 2007)

Germplasm	IC No.	Height (cm)	Girth (cm)	Annual leaf production	Leaf length (cm)
CRP779	612447	105.2	132.2	10.1	284.6
CRP780	612448	110.3	127.4	9.9	325.4
CRP781	612449	136.5	120.3	11.2	328.4
CRP782	612450	98.4	128.6	9.8	315.8
CRP783	612451	95.6	123.3	10.1	305.2
SEm±		3.538	4.010	0.324	9.421
CD (P=0.05)		10.90	12.36	1.01	29.05

Navsari

Four local germplasms were planted in RBD with five replications during 2013. Growth parameters showed wide differences among the germplasms. The maximum plant height (550.21 cm), collar girth (50.20 cm), number of functional leaves on the crown (6.60) and petiole length (33.00 cm) were recorded in CRP-729, whereas, the leaf length (195.80 cm), leaflet length (83.40 cm) and leaflet breadth (4.50 cm) were maximum in CRP 730.

Ratnagiri

Six germplasms were collected from different coconut growing clusters in Konkan region and planted during 2007, in RBD with four replications with four palms per replication. The growth parameters *viz*. height (cm), girth (cm), no. of leaves produced / year showed non-significant differences among the treatments (Table 4). It was observed that the accession CRP761 recorded maximum plant girth (136.19 cm) and stem height (99.4 cm) and no. of leaves (12.1) among all germplasms.

Table 4. Performance of local germplasm in replicated trial at Ratnagiri during 2013-14 (Year of planting : 2007)

Germplasms	Girth (cm)	Plant height (cm)	No. of leaves / year
CRP-757 (599111)	121.2	97.0	10.9
CRP-758 (599112)	126.4	92.8	11.9
CRP-759 (599113)	129.2	92.9	12.1
CRP-760 (599114)	131.4	85.5	11.9
CRP-761 (599115)	136.2	99.4	12.1
CRP-762 (599116)	135.2	90.4	11.6
S.Em.±	7.78	9.97	0.38
C.D. (P=0.05)	N.S.	N.S.	N.S

Sabour

Survey was conducted in Katihar and one germplasm was identified for collection. It is tall type, the with medium sized fruit, elongated, green in colour and average nut production is around 95 nuts per year. Bunches were compact and average number of fruits per bunch was 16.

Veppankulam

Five germplasms were collected during 2005 and planted as under planting in existing trial plots during 2005. During 2012, the palms of old trial were felled and the present experiment was continued. The mean yield data and the nut features recorded in the trial are furnished hereunder. Nut weight, nut breadth, de-husked nut weight and shell weight was maximum in CRP716(1560g,17cm, 615g and 230 g, respectively). Kernel thickness was maximum in Arasampatti Tall (1.4 cm). The annual nut yield was maximum in the accession CRP 718 (IC no.599265) (54 nuts/palm / year) followed by CRP 720 (IC No.599267) 48 nuts / palm/year (Table 5).

Table 5. Nut characters and yield of local germplasm (2013-14) (Veppankulam) (Year of planting: 2005)

Genotype	Nut weight (g)	Kernel thickness (cm)	Kernel weight (g/nut)	Annual yield (Nuts/palm/year)
CRP716 (599263)	1560	1.0	250	32.6
CRP717 (599264)	1200	1.2	230	42.3
CRP 718 (599265)	700	1.0	170	54.4
CRP 719 (599266)	1015	0.9	200	43.9
CRP 720 (599267)	1100	1.1	210	47.6
WCT (Kera Keralam)	1150	1.0	220	39.5
Arasampatti Tall (Aliyarnagar Tall)	1350	1.4	300	32.2
Mean	1153.57	1.08	225.71	41.78
CD(P=0.05)	51.95	0.11	11.409	2.854

Veiw of local germplasm at Veppankulam

Gen. 2: Evaluation of coconut hybrids in different agro climatic regions

Expt. 1: Production and evaluation of new cross combinations in coconut

Bhubaneshwar

The trial was initiated during November, 2005 comprising of eight cross combinations and one tall cultivar as a check in RBD with four replications. The data on growth and floral attributes of the palms recorded during the year 2014-15 revealed that

there was no significant variation among the cross combinations and the check except for the girth of the palm at the base level. The maximum girth of the palm (165.1cm) was recorded in GBGD x PHOT hybrid which was on par with the hybrids such as ECT x MYD (162.48cm), ECT x GBGD (155.68cm) and the check, ECT (151cm). The minimum girth of the palm (129.5cm) was recorded in LCT x COD hybrid.

Ambajipeta

The trail was laid out during 1985 with six cross combinations (ECT x MGD, GBGD x ECT, GBGD x FJT, GBGD X PHOT, GBGD x LCOT and ECT x GBGD (Check) in Randomised block design. During the year 2014-15, the experimental results revealed that significant differences were observed among the hybrids evaluated. Significantly the highest number of bunches (14.1 per palm), nut yield (132.5 per palm/year), copra output (23.6 kg/palm) and oil yield (16.5 kg/palm) was recorded in GBGD x LCT cross combination over hybrid check ECT x GBGD.

Arsikere

No. of hybrids planted: 9+1 (Local check); No. of palms/plot: 4

Experimental design: RBD; No. of replications: 3 The evaluation trial was initiated to assess the performance of indigenous and exotic crosses along with local check- TPT. This trial consisting of 9 hybrids and one local cultivar was laid out during 1987 in RBD with three replications. The nut yield per palm was significantly higher in GBGD x PHOT (121.5) followed by GBGD x LCT (120.2) and GBGD x FJT (118.1) compared to other hybrids during 2013-14.

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

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

Evaluation materials: 5-6 location specific cross combinations.

Sl.No	Centres	Location specific combinations evaluated
1.	Aliyarnagar	Arasampatti Tall x MGD, MGD x Arasampatti Tall, Kenthali x Arasampatti Tall, COD x Arasampatti Tall, COD x WCT
2.	Ambajipeta	CRP 509 x Kalpa pratibha, Gauthami ganga x Kalpa pratibha, CRP 509 x Double Century, Gauthami ganga x Double Century, Double Century x Gauthami ganga
3.	Arsikere	Kalpatharu x Kerachandra, Kalpatharu x Chandra Kalpa, Chandra Kalpa x IND 058, Chandra Kalpa x IND 048, Kalpatharu x IND 058, Kalpatharu x IND 048
4.	Bhubaneshwar	SKL x COD, MGD x SKL, SKL x GBGD, GBGD x IND025, COD x CRP 794
5.	Kahikuchi	Kamrupa x Kalpa pratibha, Kamrupa x IND 058, Kamrupa x Kerachandra, CRP502 x Kamrupa, CRP501 x Kerachandra
6.	Mondouri	Kera Chandra x Chandra Kalpa , Chandrakalpa x Kerachandra, CRP509 x Kalyani Coconut-1, CRP509 x Kalpa Mitra, CRP509 x CRP502
7.	Ratnagiri	COD x CRP 513, COD x Pratap, COD x CRP 514, CRP 513 x COD, Pratap x COD, CRP 514 x COD
8.	Veppankulam	WCT x Kenthali, WCT x MOD, MOD x WCT, ADOT x COD, WCT x MGD

Aliyarnagar

Observations on morphological parameters of different combinations planted during 2012 and analysis of data revealed that among the five hybrids studied in the trial, the combination Kenthali x Arasampatti tall recorded the maximum palm height (345.6 cm) and girth (80.3 cm). This was followed by the cross combination Malayan Green Dwarf x Arasampatti tall which recorded mean palm height of 318.2 cm and girth of 67.5 cm.

Apart from the above five hybrids, seedlings of three new hybrids, WCT x KTD, COD x Etamozhi tall and KTD x Etamozhi tall were planted on 16.07.14 in RBD with four replications, with six palms per replication. The seedlings are in establishment phase.

View of Tall x Tall coconut hybrids at Navsari

Ambajipeta

The seedlings of six cross combinations *viz.*, CRP 509 x Kalpa Pratibha, Gauthami ganga x Kalpa Pratibha, CRP 509 x Double Century, Gauthami ganga x Double Century, Double Century x Gauthami ganga and CRP 509 x Gauthami ganga were planted in June 2011 in randomized block design with three replications. However, due to Helen and Philin cyclones during October and November 2013, some of the seedlings were damaged and they subsequently died. Gap filling has been done during February 2014 and the experiment is in establishment stage and the seedling growth is satisfactory.

During the year 2013-14, observations revealed that the cross Gauthami ganga x Kalpa Pratibha recorded the highest plant height (294.7 cm) and leaf length (179.9 cm). The number of functional leaves was the highest in CRP 509 X Kalpa Pratibha (10.8). The maximum leaflet length (71.3 cm) and leaflet breadth (3.8cm) was recorded in Double Century x Gauthami ganga cross combination.

Arsikere

The trial was initiated in 2012 with six cross combinations *viz.*, TPT x PHOT, TPT x LCT, LCT x MYD, LCT x MOD, TPT x MYD and TPT x MOD with one check, TPT. The seedlings were planted in the experimental plot on 25.09.2012. The growth parameters recorded during the 2013-14 showed significant difference for all the traits except cumulative leaves, functional leaves and leaf let length.

Bhubaneshwar

The seedlings of five location specific cross combinations were planted in RBD with four replications during February, 2008. The data on vegetative and floral attributes (Table 6) recorded during the year revealed that there was no significant difference among the palms in different cross combinations except for leaflet length. The palms in SKL x COD, GBGD x Guam and MGD x SKL crosses produced leaves with larger leaflets (87.9cm, 80.3cm and 78.6cm length, respectively). Flowering was initiated in all cross combinations but limited to only 19% palms in the trial.

Kahikuchi

Among the hybrids, maximum plant height (463 cm), girth (125cm), leaf production per year (12.0), no. of functional leaves / palm (21.0) was recorded in CRP501 x Kera Chandra. The cross combination Kamrupa x Kalpa Pratibha recorded the highest leaf length (354 cm), petiole length (101.6 cm), leaflet length (107.0 cm) and breadth (5.50 cm). First flowering was observed in all the cross combinations and it ranged from 54 to 59 months after planting (Table 7).

Mondouri

Analysis of observations showed significant variation among the five different crosses for all

Table 6. Growth characters of location specific hybrids planted at Bhubaneshwar (Year of planting : 2008)

Hybrids	Palm height (m)	Palm girth (cm)	No. of leaves produced /palm/ year	No. of inflorescences/ palm/ year
IND041xIND007 (SKL x COD)	3.7	81.5	11.7	5.9
MGD x IND041	3.1	73.9	10.9	2.4
IND041x Gautami Ganga (SKL x GBGD)	4.3	77.6	11.31	4.7
IND007xCRP794	3.5	72.8	11.1	2.7
Gautami Ganga x IND 025 (GBGD x GUAM-1)	4.1	74.2	11.4	3.4
C.D (P=0.05)	NS	NS	NS	NS

Table 7. Growth characters of location specific hybrids planted at Kahikuchi (Year of planting : 2009)

Hybrids	Plant height (cm)	Collar girth (cm)	Annual leaf production (no.)	No. of leaves	First flowering (months)
Kamrupa x Kalpa Pratibha	448	113	10.6	18.8	54
Kamrupa x Kera Chandra	436	116	10.9	19.2	58
Kamrupa x IND 058	405	108	10.8	19.8	58
CRP502 x Kamrupa	415	118	11.6	18.0	--
CRP501 x Kera Chandra	463	125	12.0	21.0	59
Kamrupa (Check)	450	110	11.4	19.0	--
CD (P=0.05)	15.6	4.72	NS	NS	

the traits studied. Maximum plant height (487.2cm) was recorded by Chandra Kalpa x Kera Chandra. Maximum number of leaves (14.2) was observed in CRP509 x CRP502 and CRP509 x Kalpa Mitra. Maximum girth (89.5cm) was recorded in CRP509 x Kalpa Mitra. (Table 8).

Ratnagiri

Different cross combinations were planted during December, 2006. Significantly maximum girth (128.5 cm) was recorded in Pratap x COD which was on par with CRP 514 x COD (126.9cm), CRP 513 x COD (122.2cm) and COD x CRP 514 (114.3cm). The cross combination COD x CRP 513 recorded significantly maximum (173.1 cm) plant height which was on par with CRP – 513 x COD (142.7cm) and COD x CRP – 514 (138.4cm).

Veppankulam

Five location specific cross combinations *viz.*, West Coast Tall x Kenthali dwarf, West Coast Tall x Malayan Orange Dwarf, Malayan Orange Dwarf x West Coast Tall, Andaman ordinary tall x Chowghat Orange Dwarf and West Coast Tall x Malayan Green Dwarf were planted in the main field during 2006 in four replications. Observations were recorded

Table 8. Growth characters of location specific hybrids planted at Mondouri (Year of planting : 2009)

Hybrids	Height (cm)	Collar girth (cm)	Annual leaf production
Chandra Kalpa x Kera Chandra	494.3	86.8	11.2
CRP509 x CRP502	437.6	78.6	11.6
Kera Chandra x Chandra Kalpa	375.4	76.8	12.0
CRP509 x Kalyani Coconut-1	402.8	79.3	11.8
CRP509 x Kalpa Mitra	428.8	95.2	12.2
ECT	398.4	88.6	11.8
SEm ±	2.45	13.08	0.33
CD (P=0.05)	7.40	NS	1.01

Table 9. Growth characters of location specific hybrids planted at Ratnagiri (Year of planting : 2006)

Hybrids	Girth (cm)	Height (cm)	Annual leaf production (no.)
COD x CRP-513	101.2	173.1	11.0
COD x Pratap	101.2	104.0	11.7
COD x CRP-514	114.3	138.4	11.8
CRP-513 x COD	122.2	142.7	11.2
Pratap x COD	128.5	94.9	10.7
CRP-514 x COD	126.9	114.5	10.5
S.Em.±	5.66	17.29	0.59
CD (P=0.05)	17.07	52.09	N.S

Table 10. Fruit component traits and nut yield of the cross combinations (2013-14) (Year of planting : 2006) (Veppankulam)

Crosses	Kernel weight (g)	Copra content (g/nut)	Copra yield (kg / palm)	Annual nut yield (Nuts/palm/year)
WCT x Kenthali dwarf	210.2	115.7	13.5	43.6
WCT x MOD	140.4	78.2	15.2	27.1
MOD x WCT	180.2	112.4	11.7	56.9
ADOT x COD	150.5	85.8	15.3	32.3
WCT x MGD	130.2	68.9	15.3	44.9
Kenthali dwarf x WCT	165.2	90.7	11.6	20.1
VHC -1	213.5	125.8	13.7	38.6
Mean	170.03	96.79	13.77	37.67
CD (P=0.05)	4.78	3.28	0.22	2.93

regarding annual nut yield and nut characters in each replication and the mean over replications is furnished in Table 10. Analysis of data revealed that the cross Malayan Orange Dwarf x West Coast Tall recorded higher number of nuts (57 nuts/ palm/ year) which was followed by West Coast Tall x Malayan Green Dwarf (45 nuts/palm/year). Among the five cross combinations, Andaman Ordinary Tall x Chowghat Orange Dwarf registered maximum nut weight (950.3 g/nut) with high copra yield (15.3 kg/palm/year) which was on par with West Coast Tall x Malayan Green Dwarf.

Expt. 3: Evaluation of released varieties in coconut

Centres : Ambajipeta and Bhubaneshwar

Experimental detail: RBD with three replications and six palms / variety / replication

Centres	Varieties / Hybrids to be evaluated
Ambajipeta	Chandra Sankara, Chandra Laksha, VHC1, VHC 2, Kera Ganga, Laksha Ganga, Double Century, Godavari Ganga and Chandra Kalpa
Bhubaneshwar	Kera Sankara, Kera Ganga, Chandra Sankara, Kera Chandra and Chandra Kalpa, Sakhigopal

Ambajipeta

Among the different hybrids and varieties evaluated, significant differences were recorded for yield and yield attributing characters. The highest yield of 101.4 nuts / palm was recorded in Godavari Ganga followed by Chandralaksha (96.4 nuts/palm). With regard to nut characters, the highest fruit weight (1233.3 g) was recorded in LCT and copra content was significantly the highest in Chandralaksha (176.9 g/nut) (Table 11).

Table 11. Growth and nut characters of released varieties and hybrids at Ambajipeta(Year of planting : 2002)

Treatments	Functional leaves on the crown	No. of bunches/ palm	Nut yield/ palm/ year	Fruit weight (g)	Kernel weight (g)	Copra content (g/nut)	Oil content (%)
Chandrasankara (COD x WCT)	29.2	9.2	77.2	1127.7	236.7	130.2	65.6
Lakshaganga (LCT x GBGD)	30.8	10.7	85.3	1064.7	231.3	120.4	62.8
Kera ganga (WCT x GBGD)	32.0	10.6	70.9	700.0	147.3	105.6	64.1
Chandralaksha	31.2	11.9	96.4	1047.7	181.3	176.9	65.0
VHC1 (ECT x MGD)	30.3	11.0	72.1	970.0	190.0	120.2	60.8
VHC2 (ECT x MYD)	31.3	9.7	75.6	1219.7	172.7	168.5	69.8
LCT	32.9	9.2	78.3	1233.3	205.3	128.0	62.0
PHOT	28.4	10.5	85.2	1073.7	216.3	148.6	64.7
Godavari ganga (ECT x GBGD)	32.0	14.0	101.4	1100.0	220.0	149.8	64.7
S Em±	1.04	0.86	5.4	34.5	10.64	7.67	2.73
CD (P=0.05)	N.S	2.62	16.2	104.4	32.17	23.19	N.S

Expt. 4: Evaluation of Tall x Tall coconut hybrids

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

Evaluation materials: Five tall x tall hybrids *viz.*, LCT x ADOT, ADOT x ECT, BGR x ADOT, ECT x LCT, WCT x TPT

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

Aliyarnagar

Hybrids were planted during 2011, and observations were recorded on growth parameters in all the palms and statistically analysed. The mean palm height was observed to be 566.2 cm with the maximum of 666.3 cm recorded in the cross LCT x ADOT and a minimum of 485 cm recorded in ADOT x ECT. The cross LCT x ADOT was observed to be numerically superior to all other hybrids for all the characters studied.

Among all the hybids, one palm each in the crosses WCT x TPT and ECT x LCT observed to be early flowering (34 months).

Ambajipeta

Observations on growth attributing traits of hybrids planted during 2011, showed non significant effect among TxT hybrids for total number of leaves, leaf length, leaflet length and leaflet breadth. However, significant differences were observed with regard to plant height. LCT x ADOT recorded significantly the highest plant height of 286.9 cm and was on par with WCT x TPT (284.3 cm). Due to Helen and Philin cyclones in the year 2013, some of the palms were damaged. Gap filling has been taken up during February 2014 and the experiment is in vegetative and the plants are in the initial stage of growth.

Arsikere

The analysis of the growth parameters showed statistical significance for all the traits recorded except for the characteristics like functional leaves and cumulative leaves (Table 12). ECT x LCT recorded significantly lower height compared to other hybrids. Plant girth was significantly superior with LCT x ADOT.

Table 12. Growth attributes of T x T hybrids at Arisikere (Year of planting: 2012)

Hybrids	Plant height (m)	Plant girth (cm)	Cumulative leaves	Functional leaves
WCT x TPT	1.8	27.3	9.6	5.5
LCT xADOT	1.9	29.9	9.9	5.4
BGR x ADOT	1.4	23.3	9.7	5.8
ADOT xECT	1.3	24.7	9.9	5.7
ECT xLCT	1.1	19.6	7.9	5.1
TPT (Check)	1.3	26.7	9.7	5.2
SEm±	0.05	1.77	0.77	0.54
CD (P=0.05)	0.17	5.25	NS	NS
CV (%)	6.7	12.06	14.13	17.07

Kahikuchi

Among the five hybrids evaluated, maximum plant height (171 cm), girth (31.4 cm) and no. of leaves (7.2) were observed in LCT x ADOT whereas, the hybrid ADOT x ECT recorded the lowest plant height (135 cm), girth (24.6 cm) and no. of leaves (5.7) (Table 13).

Table 13. Growth attributes of T x T hybrids at Kahikuchi (Year of planting : August 2013)

Cross combinations	Plant height(cm)	Girth (cm)	No. of leaves
WCT x TPT	152	27.6	6.8
LCT x ADOT	171	31.4	7.2
BGR x ADOT	146	27.8	5.9
ADOT x ECT	135	24.6	5.7
ECT x LCT	138	29.0	6.6
Kamarupa (c)	148	26.2	6.2
CD (P=0.05)	8.44	2.72	0.88

Navsari

The field experiment was laid out under RBD with four replications and six different treatments during 2013. Analysis of the result revealed that, significantly maximum plant height (243.2 cm) was recorded in ECT x LCT and it was at par with WCT x TPT and ADOT x ECT. Maximum collar girth (47.2 cm) and leaflet length (75.00 cm) were recorded in ECT x LCT.

Ratnagiri

Analysis of morphological observations revealed that there were non significant differences with respect to girth, height, and no. of leaves among the hybrids (Table 14) .

Table 14 . Growth attributes of T x T hybrids at Ratnagiri (Year of planting : August 2011)

Hybrids	Girth (cm)	Height (cm)	Leaf production
WCT x TPT	115.5	507.83	11.01
LCT x ADOT	95.2	484.58	10.4
BGR x ADOT	101.6	497.71	11.2
ADOT x ECT	101.2	481.38	11.0
ECT x LCT	114.0	519.17	11.9
Pratap	98.7	461.88	10.5
S.Em.±	7.40	33.47	0.38
C.D (P=0.05)	N.S.	N.S.	N.S.

Veppankulam

Among the five T x T crosses, the performance of ADOT x ECT was superior in terms of annual leaf production (13.3 leaves/year). Regarding the girth, crosses BGR x ADOT and WCT x TPT were on par (1.89 m) (Table 15).

Table 15. Growth attributes of T x T hybrids at Veppankulam (Year of planting : 2011)

Crosses	Plant height (cm)	Annual leaf production	Girth (m)
LCT x ADOT	395	12.0	1.85
ADOT x ECT	422	13.3	1.58

BGR x ADOT	435	12.0	1.89
ECT x LCT	388	12.2	1.49
WCT x TPT	426	12.3	1.89
VHC -3	333	12.6	1.41
SEd±	27.88	1.15	0.12
CD (P=0.05)	-	NS	0.27

Expt. 5: Evaluation of location specific Tall x Tall coconut hybrids

Centres : Ambajipeta, Ratnagiri and Veppankulam

Evaluation materials: Seven location specific tall x tall combinations

Centres	Combinations evaluated
Ambajipeta	Java Tall x ECT, PHOT x ECT, Fiji Tall x ECT, ECT x Java Tall, Laccadive Ordinary x ECT, Cochin China x ECT, ECT x Fiji Tall
Ratnagiri	Kerachandra x Pratap, Pratap x Kera chandra, Kerachandra x CRP 513, CRP 513 x Kera chandra,CRP 514 x Kerachandra, Kerachandra x CRP514, Chandra Kalpa x Pratap
Veppankulam	WCT x Kerachandra, WCT x Cochin China, Kerachandra x WCT, IND034 x CRP509, CRP509 x IND037, CRP509 x CRP511, CRP509 x Kerachandra

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

Ambajipeta

The seed nuts of cross combinations *viz.*, Java Tall x ECT, PHOT x ECT, Fiji Tall x ECT, Laccadive Ordinary x ECT, ECT x Java Tall, Cochin China x ECT, ECT x Fiji Tall were received from CPCRI and raised the nursery and the planting done during August 2011. During the year 2013-14, observations on growth attributing traits showed non significant difference among TxT hybrids except leaflet length. Due to Helen and Philin cyclones in the year 2013, some of the palms were damaged. Gap filling has been taken up during February, 2014 and the plants are in the early stage of establishment.

Ratnagiri

Three growth parameters of seedlings *viz.*, girth (cm) and number of leaves/year were recorded and analysis of the data revealed non significant difference among the different hybrids (Table 16).

Table 16. Growth attributes of T x T hybrids at Ratnagiri (Year of planting : 2009)

Hybrids	Girth (cm)	No of leaves/ year
CRP-514 x Kera Chandra	119.3	10.7
Kera Chandra x CRP-514	119.7	11.1
CRP-513 x Kera Chandra	124.2	11.4
Kera Chandra x CRP-513	140.5	11.9
Pratap x Kera Chandra	133.1	11.7
Kera Chandra x Pratap	130.6	11.8
Chandrakalpa x Pratap	92.3	9.1
Pratap (Local Check)	125.2	11.5
S.Em.±	11.30	0.68
C.D (P=0.05)	N.S	N.S

Veppankulam

Among the seven new crosses , the performance of ECT x Zanzibar was superior in terms of annual leaf production (13.0 leaves/year). Regarding the girth, WCT x PHOT recorded the maximum (1.68m). SR x Zanzibar recorded more leaflet length (116.2 cm) with larger leaf breadth (6.5 cm).

Expt. 6: Evaluation of Dwarf x Dwarf coconut hybrids in different agro climatic Conditions

Centres : Ambajipeta, Mondouri, Ratnagiri, Veppankulam.

Hybrids: 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 in 2011. However, due to Helen and Philin cyclones in 2013, some of the accessions were died. Gap filling was done with planting material received from CPCRI, Kasaragod in March, 2014 and they are in establishment stage. The D x D hybrids have shown non significant differences for plant height, total number of leaves, leaf length, leaflet length and leaflet breadth.

Mondouri

Among the hybrids under evaluation, the minimum plant height (164.6cm) as well as leaf length (145.6cm) was recorded in COD x MYD showing the more dwarfing trend among different combinations. Number of leaves (8.4) was maximum in CGD x MGD. Maximum girth (42.6cm) was recorded in GBGD x MOD. Leaf breadth was the highest in MYD x CGD.

Ratnagiri

The growth parameters recorded at third year after planting of D x D hybrids revealed the non significant differences for no. of leaves / year. Significantly minimum height (290.1cm) was observed in cross combination CGD x MGD, and COD x MYD showed vigorous growth among the dwarf combinations under study.

Table 17. Growth attributes of D x D hybrids of coconut at Ratnagiri (Year of planting : 2011)

Hybrids	Girth (cm)	Height (cm)	No. of leaves/ year
COD X MYD	89.1	455.4	11.6
COD x MGD	81.1	402.7	10.7
MYD x CGD	83.4	369.6	11.7
GBGD x MOD	79.6	361.9	11.3
CGD x MGD	67.9	290.1	11.0
COD (Local check)	63.9	350.6	10.4
S.Em.±	5.73	34.16	0.40
C.D. (P=0.05)	17.26	102.95	N.S

Veppankulam

Five Dwarf x Dwarf crosses were planted during 2011. Among the crosses, MYD x CGD was observed to be early flowering (22nd month after planting). The average number of buttons / inflorescence was found to be higher in the cross COD x MYD. The lowest height of the palm was recorded in the cross COD x MYD(3.5 m) and it was on par with GBGD x MOD.

Gen. 3: Establishment of mother blocks and production of quality planting material in coconut

Expt. 2: Nucleus seed gardens for released varieties

Objectives: (i) Establishment of nucleus seed garden (ii) Production of quality planting materials

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

Varieties for large scale multiplication

Sl.No	AICRP centre	Varieties
1	Aliyarnagar	Kalpa Prathiba, Kera Keralam, COD
2	Arsikere	Kalpatharu
3	Ambajipeta	Gautami Ganga, Kalpa Prathiba, Kera Bastar
4	Jagdalpur	Kera Bastar
5	Kahikuchi	MYD, Kamrupa
6	Mondouri	Kalyani coconut 1, Kalpa Mitra, Kera Keralam
7	Ratnagiri	Gautami Ganga, East Coast Tall, Kera Bastar
8	Veppankulam	Kera Keralam, Kalpa Pratibha

Aliyarnagar

Seed nuts from Kera Keralam mother palms are being sown in the nursery periodically and seedlings produced are distributed to farmers. Kalpa Prathiba seed garden comprising of 30 seedlings, are in establishment phase. *Inter-se* crossing is also in progress to produce true to type seed nuts of Kalpa Prathiba. During 2014-2015, 3487 seedlings of WCT, 219 seedlings of Kalpatharu, 470 seedlings of COD, 244 seedlings of Kenthali dwarf and 2264 seedlings of Chandrasankara hybrid were distributed to farmers from the mother palms and crossing blocks maintained at CRS, Aliyarnagar.

Seed garden of COD(Aliyarnagar)

Ambajipeta

During 2013-14, the *inter se* crossed seedlings of Gauthami Ganga (300 nos.) and Kalpa Prathibha (150 nos.) were planted at Horticultural Research Station, Ambajipeta for further production of quality planting material. The growth of the seed garden is satisfactory. Further, the mother block (120 nos.) of Double Century (PHOT) is also being maintained, as it is one of the parents in production of new hybrid (GBGD x PHOT) which was proposed for release from Horticultural Research Station, Ambajipeta.

Arsikere

A total of 42 seedlings of Kalpatharu variety of coconut have been planted on 2014 in the nucleus seed garden. Sibbing /selfing has been done in identified palms for production of seed nuts to raise seedlings for extension of nucleus garden of Kalpatharu variety of coconut. During the year 2014 – 15, a total of 7056 seedlings of the variety Kalpatharu were sold to needy farmers. Selfing program has been initiated in selected mother palms of Kalpatharu to generate seed nuts for establishment of mother block.

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.

Mondouri

A total of 50 palms each of three varieties *viz.*, Kalyani Coconut –1, Kera Keralam, and Kalpa Mitra were planted in 2009. From the data it could be observed that the highest plant height (380.2cm) was recorded in Kalpa Mitra followed by 368.4cm in Kalyani coconut 1. Number of leaves (9.8) and girth (56.5cm) were maximum in Kalpa Mitra.

Ratnagiri

For large scale multiplication of newly released coconut hybrids and varieties, mother palms of released varieties are planted on large scale in the orchard. About 175 seedlings each of ECT and Ganga Bondam and 290 seedlings of Fiji Tall have been planted for establishment of mother palm gardens. A total of 363 seedlings of Konkan Bhatye Coconut hybrid – 1 and 361 seedlings of Fiji (Kera Bastar) were sold during the year 2014.

Veppankulam

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

4.2 CROP PRODUCTION

Agron. 5: Studies on fertilizer application through micro-irrigation technique in coconut (Sabour)

Objectives:

To compare efficiency of soil application of fertilizers and fertigation in coconut nutrition

To study the effect of fertigation on the productivities of coconut

To work out the economic viability of fertigation over soil application

Treatments

T_1 : Control (No fertilizer)

T_2 : 25% of Rec. NPK through drip system

T_3 : 50% of Rec. NPK through drip system

T_4 : 75% of Rec. NPK through drip system

T_5 :100% of Rec. NPK through drip system

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

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.

The experiment was initiated during October, 2012 in Sakhigopal Tall variety of coconut aged 4 years. The fertigation levels significantly influenced the growth parameters of palms. Significantly higher plant height of 3.9 m was recorded in 100% RDF through fertigation followed by 75% RDF through fertigation (3.7 m) and 100% RDF as soil application (3.5 m) (Table No.18). Collar girth varied from 64.1 cm in control to 112.4 cm in 100% RDF through drip system. The number of functional leaves was higher in 100% RDF through fertigation followed by 75% RDF through fertigation and 100 % RDF through soil application. First flowering was observed in some of the palms in the treatment of 100% RDF through fertigation and 100% RDF as soil application.

Table 18. Effect of fertigation on growth of coconut palms (Sabour)

Treatments	Plant height (m)	Collar girth (cm)	No. of functional leaves	Annual leaf production
T_1 - Control (No fertilizer)	2.6	64.1	8.2	4.2
T_2 - 25% of Rec. NPK through drip system	2.9	93.6	10.5	5.8
T_3 - 50% of Rec. NPK through drip system	3.4	87.9	13.6	6.4
T_4 - 75% of Rec. NPK through drip system	3.7	107.4	14.8	6.7
T_5 - 100% of Rec. NPK through drip system	3.9	112.4	16.7	7.5
T_6 - 100% of Rec. NPK as soil application	3.5	103.4	13.8	7.0
C.D (P=0.05)	0.17	12.7	0.67	1.2

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

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

Objectives

- To develop location specific coconut based integrated cropping system models for different agro – climatic regions.
- To assess the effect of the cropping system model on the productivity of coconut
- To elucidate the effect of soil moisture conservation practices on the growth of coconut and intercrops.
- To assess the impact of integrated nutrient management technology (with major emphasis on organic wastes recycling process) on soil fertility status and plant nutrient content in coconut.
- To workout the economics of the model.

The development of location specific cropping system model was started during 2008-09 at different centres in an area of 0.40 ha. The crops were planted as per the combinations suggested for different agro – climatic regions. Soil and water conservation practices were adopted by husk burial and mulching. During 2012-13, three nutrient management treatments were imposed in the cropping system. Vermicomposting was done using the wastes of coconut and intercrops and vermiwash was 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 & 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 annual Moringa was removed during this year due to its poor performance and the layout was modified by accommodating more number of banana plants. The earthworm and microbial population was higher in cropping system compared to monocrop of coconut. Among the cropping systems, the earthworm population was higher in T_3 and microbial population was higher both in T_2 and T_3. The nut yield of coconut was higher in T_1 followed by T_3, T_4 and T_2. Among the integrated nutrient management treatments, the net income was higher in T_1 (Rs. 3.7 lakh/ha) followed by T_3 (Rs. 3.46 lakh/ha) and T_2 (Rs. 3.36 lakh/ha). The monocrop of coconut (T_1) recorded the lowest net returns of Rs.1.31 lakh/ha (Table 19 to 22).

CBCS model at Aliyarnagar

Table 19 . Growth and yield of coconut in cropping system (Aliyarnagar)

Treatment	Annual leaf production	No. of functional leaves	No. of bunches per palm	Nut yield per palm
T-1	12.6	36.1	13.5	182
T-2	12.5	36.8	13.5	142
T-3	12.5	37.0	13.9	150
T-4	12.5	35.1	12.4	150

Table 20. Economics of coconut based cropping system (Aliyarnagar)

Treatment	Gross income (Rs.in lakhs/ha)	Cost of cultivation (Rs.in lakhs/ha)	Net income (Rs.in lakhs/ha)	B:C ratio
T-1	5.97	2.20	3.8	2.71
T-2	5.28	1.92	3.4	2.74
T-3	5.44	1.98	3.5	2.74
T-4	2.62	1.31	1.3	2.00

Table 21 . Earthworm population in the coconut based cropping system (Aliyarnagar)

Treatment	Coconut basins (no./ m^2)	Cocoa basins (no./ m^2)	Banana basins (no./m^2)
T-1	5	8	7
T-2	9	10	7
T-3	12	12	9
T-4	2	--	--

Table 22 . Microbial population in the coconut based cropping system (Aliyarnagar)

Treat-ment	Bacteria (10^4 CFU/g soil)	Fungi (10^3 CFU/g soil)	Actinomy-cetes (10^5 CFU/g soil)
T-1	52.2	12.4	15.2
T-2	68.2	15.7	15.8
T-3	65.4	14.1	16.3
T-4	46.6	10.1	14.2

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. The nut yield was higher in T-1 (124.8 nuts/palm) followed by T-2 (112.9 nuts/palm), T-3 (110.8 nuts/palm) and the least in T-4 (108.9 nuts/palm) (Table 23).

CBCS model at Ambajipeta

Table 23 . Yield of coconut and intercrops in the cropping system (Ambajipeta)

Crops	T_1	T_2	T_3	T_4
Coconut				
No. of bunches per palm	13.4	12.8	11.7	11.5
No. of buttons per bunch	24.5	23.5	22.7	22.5
Nut yield per palm	124.8	112.9	110.8	108.9
Copra content (g)	158.6	156.4	152.8	148.6
Oil percentage	69.0	68.4	68.0	68.0
Intercrops				
Cocoa [dry bean yield (kg/tree)]	2.5	2.45	2.3	
Banana (kg/plant)	22.0	20.0	18.0	
Pineapple (kg/plant)	1.1	1.0	1.1	
Tomato (g/plant)	510	495	485	

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 including control during 2012-13. The vermicompost production in the cropping system was 3.6 tonnes /ha from fresh biomass of cocoa (600 kg/ha) and banana (5200 kg/ha) and from sundried biomass of coconut (3800 kg/ha). The fertilizers and organic manures- VC, CCP, vermiwash and biofertilizers were applied to each crop as per treatments.

CBCS model at Arsikere

The number of functional leaves, leaf production rate and the number of bunches and buttons per palm were similar in all the treatments. However, the nut yield, copra content and copra yield per palm were higher in T-2 and T-3 compared to T-1 and T-4 (Monocrop) (Table 24). The productivity of the cropping system was higher than the monocrop of coconut due to additional yield from the intercrops. The earthworm and microbial population were higher in cropping system compared to monocrop of coconut both in the coconut basin and in the inter-space. Among the cropping systems, the earthworm and microbial population were higher in T-3 (Fully organic) followed by T-2 and T-1 both in the coconut basin and in the inter-space. The economic analysis during the second year of imposition of treatments indicated that the net returns and B:C ratio were higher in the cropping system under all the three nutrient management practices compared to monocrop of coconut. Among the nutrient management practices, the net returns were higher in T-3 (Rs. 2.95 lakhs/ha) followed by T-2 (Rs. 2.84lakhs/ha) and T-1 (Rs. 2.74 lakh/ha). The B:C ratio was higher in T-1 (4.83) followed by T-3 (4.72) and T-2 (4.55). The monocrop of coconut recorded lowest net returns (Rs. 68200) and B:C ratio (3.34) (Table 25).

Table 24 . Growth and yield of coconut in the cropping system during 2013-14 (Arsikere)

Treatment	No. of functional leaves	Leaf production rate	No. of bunches per palm	No. of buttons per palm	Nut yield/ palm)	Copra content (g/nut)	Copra yield (kg/palm)
T_1	30.1	12.0	12.2	238.4	98.8	149.0	14.7
T_2	30.1	12.2	12.6	246.5	112.1	154.5	17.3
T_3	31.4	12.6	12.1	241.6	104.2	155.5	16.2
T_4	30.6	12.1	12.3	237.1	97.3	149.6	14.6

Table 25. Yield and economics of coconut based cropping system during 2013-14 (Arsikere)

Treatment	Crop components	Yield/ha	Gross returns (Rs./ha)	Cost of production (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
T_1	Coconut	9880 no.	98800			
	Cocoa	171 kg	17100			
	Lime	868 kg	21700			
	Drumstick	948 kg	18960			
	Banana	12642 kg	189630			
	Total		**346190**	**71600**	**274590**	**4.83**
T_2	Coconut	11210 no.	112100			
	Cocoa	190 kg	19000			
	Lime	966 kg	24150			
	Drumstick	1082 kg	21640			
	Banana	12508 kg	187620			
	Total		**364510**	**80100**	**284410**	**4.55**
T_3	Coconut	10420 no.	104200			
	Cocoa	195 kg	19500			
	Lime	986 kg	24650			
	Drumstick	988 kg	19760			
	Banana	13800 kg	207000			
	Total		**374110**	**79300**	**294810**	**4.72**
T_4	Coconut	9730 no.	97300	29100	68200	3.34
	Total		**97300**	**29100**	**68200**	**3.34**

Selling price: Coconut: Rs. 10/-nut; Cocoa: Rs. 100/- kg; Lime fruits: Rs. 25/-kg; Drumstick: Rs. 20/- kg; Banana: Rs. 15/- kg

Bhubaneshwar

The crop combination of Coconut + Guava + Banana + Pineapple was restructured during 2013 and three treatments were imposed in the cropping system including control (sole crop of coconut). Mulching was done for moisture conservation as per treatments. *In situ* green manuring was done in the basins of coconut and intercrops. Vermicomposting was prepared using the wastes of coconut and intercrops. The fertilizers and organic manures were applied to both main crop and intercrops as per the treatments. The yield of coconut was almost similar in all the nutrient management treatments. The yield of banana and guava was higher in T-2, whereas, the yield of pineapple was higher in T-1(Table 27).

Table 26. Growth and yield of coconut in the cropping system under different nutrient management practices (Bhubaneshwar)

Treatment	No. of functional leaves/palm	Leaf production per year	No. of bunches/ palm	Nut yield /palm
T1	24.5	12.1	7.9	21.6
T2	26.9	12.4	8.4	22.5
T3	26.3	12.2	8.3	21.5
T4 (Sole crop)	23.5	11.6	7.9	22.3

Table 27. Yield of intercrops in the cropping system under different nutrient management practices (Bhubaneshwar)

Treatment	Guava	Banana	Pineap-ple
	Yield/plant (kg)	Yield/plant (kg)	Yield/plant (kg)
T1	5.6	13.8	1.03
T2	6.8	14.4	0.96
T3	6.0	14.0	1.06

Jagdalpur

The cropping system with crop combinations of Coconut + Guava + Cinnamon + Banana + Colocasia + Mango ginger + Bottle gourd + Elephant foot yam + Cowpea was initiated during 2008 in coconut garden. The integrated nutrient management treatments were imposed during 2012-13. The green manure crop- dhaincha was grown in the basins of coconut and intercrops in T_2 and T_3 treatments during rainy season and incorporated into the soil. The available biomass of 19.5 tons in the cropping system was utilized for vermicomposting. The yield of coconut and intercrops and also the gross returns in the cropping system 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 28).

CBCS model at Jagdalpur

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 and nutrient management treatments were imposed in the cropping system during 2012-13. The biomass produced from coconut and intercrops was recycled through vermicomposting. The fertilizers, vermicompost,

Table 28. Yield and returns from component crops in coconut based cropping system (Jagdalpur)

Treatment	Crop	Yield per ha	Gross returns (Rs. /ha)
T-1	Elephant foot yam	1584 kg	39600
	Mango ginger	1032 kg	30960
	Colocasia	645 kg	9675
	Cowpea	774 kg	7740
	Bottle gourd	1290 kg	10320
	Banana	3600 kg	18000
	Guava	-	
	Cinnamon	-	
	Coconut	10500 nuts	63000
	Total		**179295**
T-2	Elephant foot yam	2112 kg	52800
	Mango ginger	1290 kg	38700
	Colocasia	774 kg	11610
	Cowpea	970 kg	9700
	Bottle gourd	1550 kg	12400
	Banana	4320 kg	21600
	Guava	-	
	Cinnamon	-	
	Coconut	11900 nuts	71400
	Total		**218210**
T-3	Elephant foot yam	1056 kg	26400
	Mango ginger	800 kg	24000
	Colocasia	516 kg	7740
	Cowpea	645 kg	6450
	Bottle gourd	1030 kg	8240
	Banana	2880 kg	14400
	Coconut	9625 nuts	57750
	Total		**144980**

Selling rates: Elephant foot yam- Rs. 25/- per kg; Mango ginger - Rs. 30/- per kg; Colocasia- Rs. 15/- per kg ; Cowpea- Rs. 10/- per kg; Bottle gourd- Rs.8/- per kg; Banana- Rs. 5/- per kg, Coconut Rs. 6/- per nut

vermiwash and biofertilizers were applied to component crops as per treatments. The yield of coconut was not influenced by the nutrient management practices followed in the cropping system. The yield of intercrops was the 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. 4.17 lakh/ha) and benefit- cost ratio (3.28) were the highest in T_2 followed by T_1 (Rs. 3.75 lakhs/ha. and 3.14) and T_3 (Rs. 3.55 lakhs/ha and 3.07). The monocrop of coconut recorded the lowest net returns of Rs. 58,000/ha and benefit-cost ratio of 2.04 (Table 29).

Table 29. Yield and economics of coconut based cropping system (Kahikuchi)

Treat.	Crop components	Yield/ha	Gross returns (Rs./ha)	Cost of production (Rs./ha)	Net returns (Rs./ha)	B:C ratio
T1	Turmeric	12,224 kg	97,792			
	Pineapple	16,670 kg	100,020			
	Banana	12,397 kg	74,382			
	Assam lemon	4629 kg	74,064			
	Elephant foot yam	11,330 kg	67,980			
	Black pepper	72 kg	7,200			
	Coconut	12,950 nuts	1,29,500			
		Total	**5,50,938**	**175,550**	**3,75,388**	**3.14**
T2	Turmeric	12,593 kg	100,744			
	Pineapple	17,330 kg	103,980			
	Banana	15,289 kg	91,734			
	Assam lemon	5370 kg	85,920			
	Elephant foot yam	12,330 kg	73,980			
	Black pepper	86 kg	8,600			
	Coconut	13,650 nuts	136,500			
		Total	**601,458**	**183,650**	**417,808**	**3.28**
T3	Turmeric	11,852 kg	94,816			
	Pineapple	16,484 kg	98,904			
	Banana	13,636 kg	81,816			
	Assam lemon	4167 kg	66,672			
	Elephant foot yam	10667 kg	64,002			
	Black pepper	69 kg	6,900			
	Coconut	12,075 nuts	113,750			
		Total	**526,860**	**171,450**	**355,410**	**3.07**
T4	Coconut monocrop	11,375 nuts	113,750	55,750	58,000	2.04

Selling price: Turmeric= Rs. 8/kg, Pineapple = Rs. 6/kg, Banana = Rs. 6/kg, Assam lemon = Rs. 16/kg, Elephant foot yam = Rs. 6/kg, Coconut = Rs. 8/nut.

CBCS at Kahikuchi

Mondouri

The performance of component crops in the cropping system comprising of coconut+ black pepper + banana + lemon + onion (Kharif and Rabi) + potato was satisfactory. The yield of coconut was higher in treatment T_3 (99.5 nuts/palm) followed by T_4 (98.2 nuts/palm) and T_1 (97.5 nuts/palm) (Table 30). The copra yield also followed the same trend. The cropping system recorded a net income Rs. 7.34 lakh/ha as against Rs. 40592 per ha from the monocrop of coconut.

Table 30. Growth and yield of coconut in the coconut based cropping system (Mondouri)

Treatment	No. of functional leaves	Annual leaf production	No. of bunches per palm	Nut yield per palm	Copra content (g /nut)	Copra yield (kg/ palm)
T_1	32.6	1 1.6	10.6	97.5	143.0	13.9
T_2	31.3	11.3	9.3	94.6	135.2	12.8
T_3	32.3	11.3	10.3	99.5	145.6	14.4
T_4 (Monocrop)	32.6	11.6	9.4	98.2	143.0	14.0

Navsari

The cropping system of coconut+banana+turmeric +cinnamon+black pepper+nutmeg initiated during December 2013 in a 20 year old D x T coconut garden has been modified to coconut+nutmeg+cinnamon+banana+turmeric during February 2014. The number of functional leaves, leaf production, number of bunches and buttons per palm, yield of nuts per palm, copra content and copra yield were higher in T_2 (50% RDF+remaining through organic source) as compared to other treatments (Table 31). The nutmeg and cinnamon are in vegetative stage. The rhizome yield of turmeric was higher in T-3 followed by T-2 and T-1(Table 32).

Table 31. Growth and yield parameters of coconut in cropping system under different nutrient management practices (Navsari)

Parameter	T_1	T_2	T_3	T_4 (Monocrop)
No. of functional leaves/ palm	21.10	23.07	20.40	19.00
Leaf production rate	12.08	13.17	12.00	11.59
No. of bunches/palm	12.00	13.00	11.75	11.00
No. of buttons/ palm	150.33	171.10	154.85	145.86
Nut yield/palm	118.00	138.71	130.92	110.50
Copra content (g/nut)	169.49	182.97	174.15	166.12
Copra yield (kg/palm)	20.00	25.38	22.80	18.35

Table 32. Yield of turmeric in cropping system under different nutrient management practices (Navsari)

Yield parameter	T-1	T-2	T-3
Fresh rhizome yield (g/plant)	189.6	204.7	245.2
Dry rhizome yield (g/plant)	81.0	100.9	139.2
Number of fingers per plant	16.9	20.56	25.8
Yield (kg/ha)	4090	5260	6224

CBCS at Navsari

Ratnagiri

The cropping system comprising of coconut + black pepper+nutmeg+cinnamon+banana + pineapple was started during June 2008 and integrated nutrient management treatments were imposed during 2012-13. The data on growth and yield of coconut and intercrops and earthworm population were recorded. The number of functional leaves and annual leaf production were not significantly influenced by the nutrient management practices followed in the cropping system. However, the nut yield was significantly higher in T_2 (126.0 nuts/palm) followed by T_1 (120.4 nuts/palm) and T_4 (102.4 nuts/palm). The copra and oil yield per palm were significantly higher in T_2 followed by T_1 and T_4 (Table 33). The nut yield, copra yield and oil yield were lowest in T_3. Maximum earthworm population was recorded in treatment T_3 followed by T_2 and T_1. Pineapple and banana yield was higher in T_2, where as, cinnamon yield was higher in T_3 trearment. The economics of the coconut based cropping system revealed that in the second year of experimentation higher net income was recorded in T_1 (Rs. 6.29 lakh/ha) followed by T_2 (Rs. 6.21 lakh/ha) and T_3 (5.04 lakh/ha). The treatment T_4 – monocrop of coconut recorded lowest net income of Rs. 1.57 lakh/ha (Table 34 & 35).

Table 33. Yield of coconut in the coconut based integrated cropping system (Ratnagiri)

Treatment	Pre expt. yield (nuts/palm)	Nut yield per palm	Copra yield/ palm (kg)	Oil yield/ palm (kg)
T_1	105	120.43	20.40	13.87
T_2		126.03	21.44	14.57
T_3		98.60	16.76	11.39
T_4 (Monocrop)		102.40	17.38	11.82
S.Em ±		6.25	1.06	0.73
CD (P=0.05)		19.24	3.28	2.24

Table 34. Yield of component crops in coconut based integrated cropping system (Ratnagiri)

Treatment	Yield of component crops/block (1125 m²)			
	Pineapple (kg)	Banana (kg)	Cinnamon bark (kg)	Cinnamon leaves (kg)
T_1	45	400	8.0 kg	40
T_2	50	450	8.4 kg	42
T_3	40	350	9.0 kg	45

Table 35. Economics of coconut based integrated cropping system (Ratnagiri)

Treatment	Gross returns (Rs./ha)	Cost of Production (Rs. /ha)	Net returns (Rs./ha)	B:C ratio
T_1	784120	154260	629860	5.08
T_2	830650	208696	621954	3.90
T_3	781650	276904	504746	2.82
T_4	214200	57000	157200	3.75

CBCS model at Ratnagiri

Sabour

The coconut based cropping system of coconut + pomegranate + banana + turmeric + cowpea started during 2009 has been modified to coconut + banana + turmeric + cowpea + pea + mustard during 2014-15. The fertilizers, organic manures and biofertilizers were applied to coconut and intercrops as per treatments. The observations on growth parameters of coconut and yield of intercrops were recorded. Biomass of coconut, cowpea, mustard and banana was used for vermicomposting. The vemicompost production during the year was 2.8t. Data on growth parameters of coconut showed that palm height was maximum under T-2 followed by T-1 and T-4. Similar trend was noticed for other growth paramters of coconut (Table 33). The yield of banana and mustard were higher with T-2 (50 % RDF + remaining through organic sources) whereas yield of turmeric was higher with T-1 (75% RDF + remaining through organic sources) (Table. 37).

Table 36. Growth parameters of coconut in the cropping system (Sabour)

Treatment	Palm height (m)	Palm girth (cm)	No. of functional leaves	Leaf production /year
T1	4.08	121.6	14.5	8.0
T2	4.23	127.8	16.3	9.3
T3	3.92	97.25	11.8	6.7
T4	4.01	105.2	12.2	7.7

Table 37. Yield of intercrops in cropping system under different nutrient management practices (Sabour)

Treatment	Yield per ha				
	Banana (t)	Cowpea (q)	Pea (q)	Mustard (q)	Turmeric (t)
T1	8.36	2.68	1.37	2.35	12.97
T2	10.02	3.32	1.52	3.08	11.55
T3	8.87	3.57	1.72	2.73	10.84

Veppankulam

The cropping system model of coconut + black pepper + banana + elephant foot yam + cocoa was initiated during July 2009 and nutrient management treatments were imposed during 2012-13. The fertilizers, organic manures and biofertilizers were applied to crops as per treatments. The earthworm and microbial population were higher in the cropping system compared to monocrop of coconut. The fertilizers, organic manures and biofertilizers were applied to coconut and intercrops as per treatments. T_1 – 75 % of Recommended NPK + organic recycling with vermicompost recorded yield of (18500 nuts /ha of coconut, 200 kg dry bean/ ha of cocoa and 24500 kg /ha banana followed by T_2 coconut nut yield 17200 nuts/ha, cocoa-225 kg dry bean/ha and banana – 24200 kg/ha. The net return (Rs.22.62 lakh/ha) and benefit cost ratio (2.42) were the highest in T_2 followed by T_3 (Rs.24.63 lakhs/ha) and benefit cost ratio (2.32) and lowest in monocrop of coconut T_4 (Rs.90000 with 1.98 B:C ratio).

CBCS at Veppankulam

Agron. 10 A: Development of Coconut - Livestock integrated farming system models (Arsikere)

Objectives:

1. To develop location specific coconut - Livestock integrated farming system models
2. To study the effect of integration of livestock on the productivity of coconut
3. To assess the impact of integration of livestock on soil fertility and plant nutrient content in coconut.
4. To workout the economics of the model

I. Integration of cows in coconut based cropping system

Treatment details:

T_1: Coconut + Fodder crops – Cows

T_2: Monocrop of coconut

Area for each treatment: 0.40 ha., Cows: 5

Design: Coconut + Fodder crops – Cows system is compared with the monocrop of coconut.

Fodder grass: Hybrid Napier (Co-3) in the inter space of coconut

Fodder legumes: *Stylosanthes hamata* in intraspace of coconut

Fodder trees: Drumstick and Agathi (*S. grandiflora*) (in the border of the plot).

The experiment was laid out during September 2013. The rooted slips of napier hybrid grass (Co-3) were planted in the inter space of coconut at a spacing of 90cm x 60 cm on 14.09.2013. The fodder legume- *Stylosanthes hamata* was sown in the intra space of coconut on 16.09.2013. The fodder trees-drumstick and *Sesbania grandiflora* were planted in the border of the plot. The establishment of napier hybrid grass is satisfactory. Soil samples were drawn before the start of the experiment and analyzed for nutrient content. Similarly, leaf samples of coconut were drawn and analyzed for leaf nutrient status. The observation on the number of functional leaves, number of bunches and buttons produced during the year were recorded in coconut. Nuts of coconut were harvested at maturity and yield data recorded. Fodder was harvested from 27.12.2013 and yield data recorded. The income generated in the IFS was higher compared to monocrop of coconut (Table 39).

Table 38 . Growth and yield of coconut in the Coconut - Livestock integrated farming system during 2013-14 (Arsikere)

Sl.no.	Parameter	Pre-experimental period (Mean of 2 years (2011-12 to 2012-13)	Experimental period (2013-14)	
			IFS	Monocrop
1	No. of functional leaves	31.3	31.1	30.6
2	No. of bunches per palm	12.3	12.1	12.3
3	No. of buttons per palm	250.4	236.7	237.1
4	Nut yield per palm	103.8	101.8	97.3
5	Copra content (g/nut)	143.0	146.3	149.6
6	Copra yield per palm (kg)	14.8	14.9	14.6
7	Oil content (%)	65.4	65.8	66.1
8	Oil yield per palm (kg)	9.7	9.8	9.6

Table 39. Output from the Integrated Farming System with cows during 2013-14 (Arsikere)

Sl.no.	Output (0.40 ha)	Quantity	Value	Remarks
	IFS			
1	Coconut	7126 no.	Rs. 71260	Sold at Rs. 10/- each
2	Green fodder	7900 kg		Fed to 5 cows
3	Milk	5416.9 l	Rs. 125389	Rs. 25 to Rs. 29 per litre
4	Cow dung	24090 kg		Used for composting
5	Urine	5500 l		Used for composting
	Monocrop			
1	Coconut	6810 no.	Rs. 68100	Sold at Rs. 10/- each

Note: Area- 0.40 ha; Coconut palms: 70; Nut yield- 101.8 nuts/palm in IFS and 6810 in Monocrop; No. of cows: 5; Cow dung: 13.2 kg/cow/day.

II. Integration of sheep in coconut based cropping system

Treatment details:

T_1: Coconut + Pasture crops – Sheep

T_2: Monocrop of coconut

Area for each treatment: 0.40 ha; Sheep: 20

Fodder crops: Pasture crops: Anjan grass + *Stylosanthes hamata* (3:1)

Design: Coconut + Pasture crops – Sheep system is compared with the monocrop of coconut.

The experiment was laid out during May 2014. The pasture crops: anjan grass (*Cenchrus ciliaris*) and stylo (*Stylosanthes hamata*) were sown in the inter space of coconut on 30.05.2014. The establishment and growth of pasture is satisfactory. Soil samples were drawn before the start of the experiment and analyzed for nutrient content. Similarly, leaf samples of coconut were drawn and analyzed for leaf nutrient status. The observations on the number of functional leaves, bunches and buttons produced during the year were recorded in coconut. Nuts of coconut were harvested at maturity and yield data recorded. The sheep were allowed to graze the pasture from 20.11.2014. The pasture production and the sheep manure are being quantified (Table 40).

Table 40. Growth and yield of coconut in integration of sheep in coconut based cropping system during 2013-14 (Arsikere)

Sl.no.	Parameter	Pre-experimental period		
		2012-13	2013-14	Mean
1	No. of functional leaves	29.2	30.8	30.0
2	No. of bunches per palm	11.9	12.0	12.0
3	No. of buttons per palm	190.8	193.3	192.1
4	Nut yield per palm	84.3	88.2	86.2
5	Copra content (g/nut)	142.2	146.6	144.4
6	Copra yield per palm (kg)	12.0	12.94	12.47
7	Oil content (%)	66.3	68.9	67.6
8	Oil yield per palm (kg)	7.95	8.53	8.24

Agron. 11: Coconut based cropping systems for different agro-climatic regions

Expt. 1: Performance of flower crops under coconut garden

(Aliyarnagar, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Ratnagiri)

Objective: To develop an appropriate cropping system with flower crops as intercrops compatible with coconut.

Aliyarnagar

Five commercial flower crops *viz.*, chrysanthemum (*Dendranthema grandiflora*), celosia (*Celosia* sp.), marigold (*Tagetes erecta*), zinnia (*Zinnia* sp.) and gomphrena (*Gomphrena globosa*) were planted during July-August, 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. Coconut pure crop was maintained as control. The experiment was laid out in RBD with four replications. The flower yield recorded was 5812 kg/ha in marigold, 4295 kg/ha in gomphrena, 4016 kg/ha in celosia, 3726 kg/ha in zinnia and 3245 kg/ha in chrysanthemum. The cropping system of coconut + marigold recorded higher net income of Rs. 278,350/ha and B:C ratio of 2.77 followed by coconut + gomphrena (Rs. 230,975/ha and 2.53), coconut + celosia (Rs.214,550/ha and 2.48), coconut + zinnia (Rs. 182,160 and 2.25), coconut + chrysanthemum (Rs. 182,125 and 2.19). The number of functional leaves, annual leaf production, number of inflorescence and yield of nuts per palm were not significantly affected by the flower crops grown in the coconut garden (Table 41).

Table 41. Yield and economics of coconut based cropping system with flower crops (Aliyarnagar)

Treatments	Coconut yield (nuts/palm)	Flower yield (kg/ha)	Gross income (Rs./ ha)	Net income (Rs./ha)	B:C ratio
Coconut + Gomphrena	157	4295	382125	230975	2.53
Coconut + Chrysanthemum	145	3245	334875	182125	2.19
Coconut + Marigold	166	5812	435800	278350	2.77
Coconut + Celosia	148	4016	359400	214550	2.48
Coconut + Zinnia	149	3726	327710	182160	2.25
Coconut alone	130	-	227500	113750	2.00
S. Ed±	17.3	-	-	-	-
CD (P=0.05)	NS	-	-	-	-

Arsikere

The experiment was laid out during 2012-13 in a 40 year 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 plot of sole crop of coconut was maintained as control. The experiment was laid out in RBD with four replications. Chrysanthemum, china aster and marigold were planted every year and the flowers harvested. Crossandra and jasmine are perennial in nature and they started yielding flowers from first and second year respectively. The yield of flowers was 896 kg/ha in jasmine, 5754 kg/ha in chrysanthemum, 1075 kg/ha in crossandra, 2695 kg/ha in china aster, and 5250 kg/ha in marigold during 2013-14. The cropping system of coconut + chrysanthemum recorded significantly higher net income (Rs. 256400/ha) followed by coconut + crossandra (Rs. 163300/ha), coconut + jasmine (Rs.149000/ha), coconut + china aster (Rs. 144350/ha) and coconut + marigold (Rs.104150/ha). The monocrop of coconut recorded significantly the lowest net income of Rs. 53400 per ha. The growth and yield of coconut were not significantly influenced by the flower crops grown in coconut garden (Table 42).

Table 42. Yield and economics of intercropping system of flower crops in coconut garden during 2013-14 (Arsikere)

Sl. No.	Treatment	Yield of flowers (kg/ha)	Yield of coconut (Nuts/ha)	Gross income (Rs./ha)	Cost of production (Rs./ha)	Net income (Rs./ha)	B:C ratio
1	Coconut + Jasmine	896	8040	259600	110600	149000	2.4
2	Coconut + Chrysanthemum	5754	8505	372750	116350	256400	3.2
3	Coconut + Crossandra	1075	8310	298000	134700	163300	2.2
4	Coconut + China aster	2695	8590	220650	76300	144350	2.8
5	Coconut + Marigold	5250	8930	168050	63900	104150	2.6
6	Coconut alone (Control)	-	8250	82500	29100	53400	2.8
	S. Em ±		407	8766		8766	0.1
	CD (P=0.05)		NS	26417		26417	0.3

Price of flowers (per kg): Jasmine (Kakada): Rs. 200/-; Chrysanthemum: Rs. 50/-;
Crossandra: Rs. 200/-; China aster: Rs. 50/-; Marigold: Rs. 15/-. Coconut: Rs. 10/- nut

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 + Gaillardia (Kharif) - Antirrhinum (Rabi), T_4: Coconut + Zinnia (Kharif) - Gladiolus (Rabi), T_5: Coconut + Marigold (Kharif) - China Aster (Rabi). The net income was higher with Gerbera (Rs. 90135/ ha) followed by Gaillardia-Antirrhinum (Rs. 80700/ ha), Zinnia- Gladiolus (Rs.80468/ ha) and Marigold- China Aster (Rs. 70604/ha) (Table 43).

CBCS with Gladiolus flower

Table 43. Yield and economics of flower crops in coconut garden (Jagdalpur)

Sl. No.	Flower crops	Yield of flowers / ha	Gross income (Rs./ha)	Cost of cultivation (Rs./ha)	Net income (Rs./ha)	B:C ratio
1.	Tuberose	86400 No.	86400	45200	30950	1.91
2.	Gerbera	105600 No.	158400	68265	90135	2.32
3.	Gaillardia- Antirrhinum	6000 kg 3600 kg	180000	99300	80700	1.80
4.	Zinnia- Gladiolus	3200 kg 55200 No.	174400	93932	80468	1.86
5.	Marigold- China Aster	5500 kg 1500 kg	127500	56896	70604	2.24

Selling price: Marigold- Rs. 15/- per kg, Tuberose- Rs. 1/- per spike, Gerbera- Rs. 1.50/- per flower stick, Gaillardia- Rs. 15/- per kg, Zinnia- Rs. 20 /- per kg, Gladiolus –Rs. 2/- per stick, Antirrihnum-Rs. 25/- per kg, China Aster- Rs. 30/- per kg,

Kahikuchi

Five commercial flower crops *viz.*, Tuberose, Gerbera, Bird of Paradise, Gladiolus and Marigold 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, while the tissue culture plants of bird of paradise and rooted cuttings of marigold were planted during May and corms of gladiolus were planted during December. Growing of flower crops in coconut garden is remunerative than monocrop of coconut. The net returns and B:C ratio were higher with Coconut + Gerbera (Rs. 514,216/ha and 5.20) flowed by Coconut + Tuberose (Rs. 367,550/ha and 4.14), Coconut + Gladiolus (Rs. 325,000/ha and 3.92) and Coconut + Marigold (Rs. 243,494/ha and 3.72). The monocrop of coconut recorded the lowest net returns of Rs. 67800/ha and B:C ratio of 1.77 (Table 44).

Gladiolus intercrpping in coconut garden

Table 44. Yield and economics of commercial flower crops under coconut (Kahikuchi)

Crop components	Coconut yield (nuts/ palm)	Yield of intercrops per ha	Total coconut equivalent yield (nuts/ha)	Gross returns (Rs./ha)	Cost of production (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
Coconut + Tuberose	68.6	336,200 No.	45,625	456,250	88,700	367,550	4.14
Coconut + Gerbera	66.0	74,6200 No.	61,296	612,966	98,750	514,216	5.20
Coconut + Bird of paradise	64.0	30,067 No.	26,234	262,340	64,850	197,490	3.04
Coconut + Gladiolus	69.0	57,400 No.	40,775	407,750	82,750	325,000	3.92
Coconut + Marigold	62.0	20,044 kg	30,894	308,944	65,450	243,494	3.72
Coconut alone	60.6	-	10605	106,050	38,250	67,800	1.77

Selling price: Tuberose spike = Rs. 12.00/dozen; Gerbera stalk = Rs. 8.00/dozen; Gladiolus stick = Rs. 60.00/dozen; Bird of Paradise = Rs. 60/dozen; Marigold = Rs. 10.00 per kg; Coconut = Rs. 10.00 per nut.

Mondouri

The experiment was laid out in RBD with four replications in a 30 years old coconut garden planted at a spacing of 7.5 x 7.5 m. Five commercial flowering crops *viz.*, marigold, tuberose, gerbera, gladiolus and heliconia were planted under coconut. Among the flowering crops, gladiolus recorded higher net returns (Rs. 196369/ha) followed by tuberose (Rs. 95305/ha), gerbera (Rs. 85673/ha) and marigold (Rs. 67987/ha) (Table 45).

Table 45. Yield and economics of flower crops intercropped in coconut garden (Mondouri)

Crop	Yield of flower crops	Gross returns (Rs./ha)	Cost of cultivation (Rs.ha)	Net returns (Rs/ha)	B:C ratio
Gladiolus	131250 No.'s	643125	446756	196369	1.44
Tube Rose	183750 No.'s	380625	285320	95305	1.35
Gerbera	257276 No.'s	321595	235922	85673	1.36
Marigold	8976 kg	224400	156413	67987	1.43

Selling price: Gladiolus @ Rs. 2.50/stick, Tuberose @ Rs. 2.00/stick, Gerbera @ Rs. 1.00/stick and Marigold @ Rs. 25/kg.

Ratnagiri

The performance of five 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 *Michelia champaka* was planted during May 2013. The number of functional leaves, annual leaf production and number of buttons per palm were not significantly influenced by the flower crops grown as intercrop with coconut. The number of nuts per palm was significantly higher in Coconut + Lily system (131.9 nuts/palm) followed by Coconut + *J. multiflorum* system (122.0 nuts/palm) and Coconut + Heliconia system (116.2 nuts/palm). The monocrop of coconut recorded significantly lowest nut yield of 96.8 nuts per palm. The net returns and B:C ratio were significantly higher in Coconut + Lily (Rs. 391427/ha and 4.35) followed by Coconut + Heliconia (Rs. 236449/ha and 3.64) and Coconut + *J. multiflorum* (Rs. 207640/ha and 3.19). The cropping system of Coconut + *M. champaka* (Rs. 140818/ha) and monocrop of coconut (Rs. 146455/ha) recorded significantly lower net returns compared to other cropping systems (Table 46).

Table 46. Yield and economics of cropping system of flower crops with coconut (Ratnagiri)

Crop components	Coconut yield (nuts/palm)	Yield of Flower crops per ha	Coconut equivalent yield (nuts/ha)	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Coconut + *J. sambac*	114.4	292 kg	23668	284010	86623	197387	3.28
Coconut + *J. multiforum*	122.0	1404 kg	25199	302388	94748	207640	3.19
Coconut + *Lily* spp	131.9	1291950 No.	42362	508346	116919	391427	4.35
Coconut + *Heliconia* spp	116.2	24300 No.	27178	326136	89687	236449	3.64
Coconut + *M. champaka*	102.5	Vegetative stage	17916	214989	74172	140818	2.90
Coconut monocrop	96.8	-	16931	203175	56720	146455	3.58
S.Em.±	1.87	-	2468	29619	8343	21317	0.10
CD(P=0.05)	5.64	-	7438	89263	25140	64244	0.30

Expt. 2: Performance of cocoa varieties as intercrop in coconut gardens

(Ambajipeta, Kasaragod, Navsari, Veppankulam)

Ambajipeta

Cocoa clones: 6: VTLCC -1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4 and VTLC-1 (Control)

Design: RBD; Replications: 4; No. of plants/ plot: 6

Spacing: Coconut: 7.5 m x 7.5 m and Cocoa: 3.0 m x 7.5 m; Year of start: 2008

Six cocoa clones *viz.*, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4 and VTLC-1 (Control) were planted during November, 2008 in RBD with four replications. Data on vegetative and fruit characters was recorded. Maximum plant height was recorded by VTLCH-1 (2.41 m) followed by VTLCH-3 (2.21 m) and VTLC-1 (2.20 m). The highest plant girth was recorded in VTLCH-1 (25.21 cm) followed by VTLCH-2 (23.59 cm) and VTLCH-3 (23.49 cm). The height at first branching and canopy spread were higher in VTLCH-1. The dry bean yield was significantly higher in VTLCH-2 (2.80 kg/tree) followed by VTLCH-4 (2.52 kg/tree) and VTLCH-3 (2.00 kg/tree) (Table 47).

Table 47. Growth and yield of cocoa clones as intercrop in coconut garden (Ambajipeta)

Treatments	Plant height (m)	Girth (cm)	Canopy spread E-W (m)	Canopy spread N-S (m)	Pod weight (g/pod)	No. of beans per pod	Dry bean yield (kg/ tree)
VTLC - 1	2.2	20.9	2.55	2.70	87.00	23.29	1.55
VTLCC – 1	2.0	19.8	2.08	2.12	90.50	25.10	1.00
VTLCH – 1	2.4	25.2	2.92	2.90	154.75	25.51	1.25
VTLCH – 2	2.2	23.6	2.78	2.65	138.50	31.45	2.80
VTLCH – 3	2.2	23.5	2.84	2.75	104.50	25.62	2.00
VTLCH – 4	1.9	19.3	2.06	2.14	98.50	26.62	2.52
S Em ±	0.15	2.30	0.31	0.28	5.56	1.60	0.28
CD (P=0.05)	N.S	N.S	N.S	N.S	16.91	4.86	0.87

Kasaragod

Among the seven year old plants of 13 clones planted at Kasaragod, the yield ranged from 17.5 to 34.8 pods/plant/year and in the six year old seedlings the yield ranged from 17.6 to 30.4 pods/plant/ year. The dry bean yield ranged between 0.38 to 0.91 kg among the clones and 0.37 to 0.77 kg among seedlings. The highest dry bean yield 0.91 and 0.77 kg/ plant/ year was recorded in the clone VTLC-1A and the parent VTLC-5 (Table 47a).

Cocoa clones as intercrop in coconut garden (Kasaragod)

Table 47a .Yield of cocoa in Kasaragod

Genotypes	Dry bean yield (kg/plant/ year)	
	Clones	Seedlings
VTLCH-2	0.89	0.62
VTLCH-1	0.43	0.45
VTLCH-3	0.66	0.59
VTLCH-4	0.59	0.42
VTLCC-1	0.54	0.50
VTLC-61	0.38	0.65
VTLC-66	0.46	0.56
VTLC-11	0.44	0.49
VTLC-5	0.55	0.77
VTLC-19A	0.51	0.66
VTLC-30A	0.40	0.37
VTLC-1A	0.91	0.43
MH-1	0.38	0.69
CV% SEd CD (P=0.05)	2.18 0.01 NS	7.95 0.01 NS

Navsari

Cocoa clones: 5: VTLCC -1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4.

Design: RBD; Replications: 4; No. of plants/ plot: 5

Spacing: Coconut: 7.5 m x 7.5 m and Cocoa: 3.0 m x 7.5 m; Year of start: 2009

Yield of cocoa as intercrop with coconut (Navasari)

Six cocoa clones *viz.*, VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4 were planted during 2009-10 in RBD with four replications. The plant height, stem girth and number of branches were significantly higher in VTLCC-1 compared to other clones. The number of pods per tree was higher in VTLCC-1 (45.25 pods) followed by VTLCH-4 (43.10 pods) and VTLCH-2 (35.88 pods). The pod weight was significantly higher in VTLCH-3 (42.51 g/pod), whereas the number of beans per pod was significantly higher in VTLCH- 4 (20.38 beans/pod). The dry bean yield was significantly higher in VTLCC-1 (1.59 kg/tree) followed by VTLCH-4 (1.42 kg/ha) and VTLCH-3 (1.31 kg/ha).

Table 48. Growth and yield of cocoa clones as intercrop in coconut garden (Navsari)

Clones	Plant height (m)	No. of branches per tree	No. of pods/ tree	Weight of pod (g)	No. of beans/ pod	Dry bean yield (kg/ tree)
VTLCC – 1	4.5	7.0	45.2	28.2	20.0	1.59
VTLCH – 1	4.3	5.4	31.1	36.0	19.0	1.21
VTLCH – 2	3.4	5.8	35.9	31.2	16.2	1.25
VTLCH – 3	3.5	6.8	28.5	42.5	14.3	1.31
VTLCH – 4	4.0	4.2	43.1	36.8	20.4	1.42
S. Em. ±	0.09	0.22	1.32	2.91	0.64	0.07
CD (P=0.05)	0.29	0.68	4.05	8.97	1.98	0.22

Veppankulam

Cocoa grafts of five hybrids and one cultivar were planted on 14.08.2008. The trial was laid out in RBD with four réplications. The growth performance of VTLCH-1 is better compared to other clones as indicated by higher plant height (3.8 m), stem girth (85.8 cm), number of branches (5.0) and canopy spread (3.7 m) (Tabel 49).

Cocoa clones as intercrop in coconut garden (Veppankulam)

Table 49. Growth of cocoa clones as intercrop in coconut garden (Veppankulam)

Sl. no.	Cocoa varieties/ hybrids	Plant height (m)	Girth (cm)	Canopy spread (m)
1	VTLC-1	2.8	31.5	2.8
2	VTLCH-1	3.8	85.8	3.7
3	VTLCH-4	2.7	38.5	3.2
4	VTLCH-2	2.6	20.2	2.9
5	VTLCC-1	2.6	31.2	2.2
6	VTLCH-3	2.6	17.3	2.6

Expt. 3: Multilocation (MLT) trial of cocoa clones under palms

(Aliyarnagar, Arsikere, Ratnagiri, Vijayarai)

Objective: To assess the performance of different cocoa clones under coconut in different agro climatic regions

Aliyarnagar

Treatments: 14 (Cocoa clones-14)

VTLCP-1, VTLCP-3, VTLCP-5, VTLCP-6, VTLCP-8, VTLCP-9, VTLCP-10, VTLCP-11, VTLCP-12, VTLCP-13, VTLCP-14, VTLCP-15, VTLC-16 and VTLC-9 (Control).

Design: RBD; Replication: 2, No. of plants/ Replication: 6; Date of planting: 26.08.2013

Spacing: Coconut: 7.5 m x 7.5 m and Cocoa: 3.75 m x 7.5 m.

The cocoa clones were planted on 26.08.2013 in the experiment laid out in RBD with two replications.

The observations on growth parameters of cocoa were recorded. The plant height, girth, and number of branches did not differ significantly between different clones of cocoa.

Cocoa clones as intercrop in coconut garden (Aliyarnagar)

Arsikere

Treatments: 15 (Cocoa clones-15)

VTLC-1, VTLC-9, VTLC-13, VTLC-15, VTLC-17, VTLC-18, VTLC-25, VTLC-36, VTLC-37, VTLC-57, VTLC-65, VTLC-128, VTLCC-1, VTLCH-3 and VTLCH-4.

Design: RBD; Replications: 2, No. of plants/ Replication.: 6; Date of planting: 03.09.2012

Spacing: Coconut: 7.5 m x 7.5 m (175 palms/ha) and Cocoa: 3 m x 7.5 m (444 trees/ha).

Age of palms: 35 years; Soil type: Red sandy loam

The cocoa clones were planted in the experiment on 03.09.2012 in RBD with two replications. The observations on the number of functional leaves, bunches and buttons, leaf production rate, nut yield, copra content, copra yield, oil content and oil yield were recorded in coconut. There was improvement in growth and yield of coconut with the intercropping of cocoa compared to previous year. The plant height, girth, number of branches, height at first branching and canopy height at the second year of planting did not differ significantly between cocoa clones. The canopy spread was significantly higher with VTLC-13 followed by VTLC-128, VTLCH-4, VTLC-25, VTLC-17 and VTLC-36 (Table 50).

Table 50. Growth of different clones of cocoa in coconut garden: 2013-14 (Arsikere)

Sl.No.	Cocoa clones	Plant height (cm)	Girth (cm)	No. of branches	Canopy spread (cm)
1	VTLC-1	100.3	6.5	2.6	47.3
2	VTLC-9	121.8	6.7	2.5	63.7
3	VTLC-13	116.0	8.8	2.8	85.2
4	VTLC-15	104.7	6.2	2.3	44.6
5	VTLC-17	107.2	8.7	3.1	68.7
6	VTLC-18	109.2	8.4	2.5	53.6
7	VTLC-25	109.7	9.9	3.4	68.8
8	VTLC-36	96.3	7.3	2.1	68.1
9	VTLC-37	69.5	6.7	2.2	44.8
10	VTLC-57	100.6	7.9	2.4	49.2
11	VTLC-65	102.7	7.4	2.3	53.9
12	VTLC-128	122.2	9.9	2.5	74.9
13	VTLCC-1	105.4	8.2	2.8	64.2
14	VTLCH-3	117.8	7.3	2.6	50.6
15	VTLCH-4	108.3	8.8	2.9	74.1
	S. Em ±	10.67	0.87	0.32	7.24
	CD (P=0.05)	NS	NS	NS	21.97
	CV (%)	14.23	15.58	17.23	16.86

Ratnagiri

Treatments : 21 Clones (VTLCP-1, VTLCP-3, VTLCP-5, VTLCP-6, VTLCP-8, VTLCP-9, VTLCP-10, VTLCP-11, VTLCP-12, VTLCP-13, VTLCP-14, VTLCP-15, VTLCP-16, VTLC-1, VTLC –13, VTLC –15, VTLC –17, VTLC –18, VTLC –25, VTLC –37, VTLC –128.

Design: RBD; Replications: Two; No. of plants / replication: 6

Spacing: Coconut: 7.5 m x 7.5 m and Cocoa: 3 m x 7.5 m; Year of start: February 2014.

Planting of clones provided by CPCRI-Regional Station, Vittal was carried out during February 2014. The experiment was laid out during 2014 with two replications. The experimental site is located in Konkan region of Maharashtra representing humid tropical region.

Vijayarai

Cocoa varieties as intercrop in Oil palm plantations (Vijayarai)

Evaluation of performance of cocoa varieties in the interspaces of oil palm was taken up during 2012-13. There were 14 treatments (varieties) *viz*., VLTC-1, VLTC-9, VLTC-13, VLTC-17, VLTC-18, VLTC-20, VLTC-25, VLTC-36, VLTC-37, VLTC-57, VLTC-65, VLTC-128, VTLCH-3 and VTLCH-4. The experiment was laid out in RBD with two replications. The growth parameters of cocoa did not differ significantly between varieties (Table 51).

Table 51. Growth of cocoa varieties as intercrop in Oil Palm plantations (Vijayarai)

Varieties	Plant height (m)	Stem girth (cm)	Plant spread (EW) (cm)	Plant spread (NS) (cm)
VTLC-1	157.5	12.5	138.2	154.4
VTLC-9	197.6	15.5	196.3	201.9
VTLC-13	179.9	16.3	170.3	169.4
VTLC-17	178.3	15.9	163.1	174.5
VTLC-18	200.4	16.4	192.4	212.5
VTLC-20	185.8	15.2	176.8	187.5
VTLC-25	144.2	12.9	134.6	140.0
VTLC-36	197.9	17.1	202.7	225.0
VTLC-37	121.7	11.2	109.3	131.9
VTLC-57	153.2	12.9	174.9	170.7
VTLC-65	161.9	13.3	160.7	169.2
VTLC-128	181.8	13.8	138.0	139.8
VTLCH-3	130.4	12.1	133.5	161.1
VTLCH-4	189.3	15.0	177.6	212.8
SE(d)	35.18	3.25	9.23	46.67
CD (P=0.05)	NS	NS	NS	NS
CV (%)	20.69	22.73	23.80	15.48

4.3 DISEASE MANAGEMENT

Path. 1: Survey and surveillance of coconut diseases

Aliyarnagar

Roving survey

A survey on the occurrence of coconut diseases *viz*., stem bleeding, basal stem rot, leaf blight and bud rot was conducted in different villages of Coimbatore, Dindigul, Tirupur and Theni districts. The results showed that leaf blight was the predominant disease in all the areas surveyed, and the disease incidence ranged from 1 to 32.00 per cent. The maximum incidence of 32.00 per cent was recorded in Thanthoni village followed by 30.68 per cent in Ganapathypalayam village of Dharapuram block in Tirupur district.

Maximum incidence of basal stem rot disease was found in Manupatti (35.29 %) village of Udumalaipet block in Tirupur district followed by Nalluthukuli (16.67 %) village of Anaimalai block in Coimbatore district. No basal stem rot incidence was observed in Dindigul and Theni districts. There was no stem bleeding incidence in Theni district while, maximum incidence was observed in Kudimangalam (2.50 %) village of Dharapuram block in Tirupur district. Maximum bud rot disease incidence was recorded in Ammapatti village (3.15%) of Theni district followed by Kurinjipalayam village (2.50 %) of Coimbatore district.

Fixed plot survey

To record the incidence of different coconut diseases in Puliyankandi and Karainchettiplayam villages of Anaimalai block in Coimbatore district, fixed plot survey was carried out at quarterly intervals from April 2014 to March 2015 in farmer's field locations. Observations on the incidence of major coconut diseases *viz.,* leaf blight and *Pestolotia* leaf blight were recorded in respective coconut gardens. *Pestolotia* leaf blight was observed only in January month at Karianchettipalayam village.

Ambajipeta

Roving survey

Surveys were conducted in different mandals of East Godavari, West Godavari and Visakhapatnam districts of Andhra Pradesh during 2014- 15. Major diseases observed in coconut gardens were basal stem rot, bud rot and stem bleeding along with minor incidence of grey leaf spot. Mean percent incidence of basal stem rot, stem bleeding and bud rot diseases were 7.81, 1.77 and 0.81 respectively in the surveyed villages.

Fixed plot survey

For stem bleeding and bud rot diseases, fixed plot survey was taken up at Horticultural Research Station, Ambajipeta. For basal stem rot disease, fixed plot survey was taken up in farmer's field at P. Gannavaram village in East Godavari District. Per cent disease incidence was recorded each month for all the three diseases. Per cent incidence of basal stem rot during August 2014 was recorded as 16 which was increased to 20 by the end of December 2014. Per cent incidence of stem bleeding disease varied between 2.28 to 2.82 during the year. Bud rot disease incidence was very low during this year. 1.63% of disease incidence was recorded during October, November and December months of the year.

Arsikere

Roving survey

The survey on the incidence and intensity of different diseases of coconut was carried out at Gubbi and Tumkur taluks of Tumkur district and different taluks of Mysuru district. In Tumkur district, among the different diseases recorded, basal stem rot incidence was more in Gubbi Taluk which has recorded 2.96 % and the maximum incidence of stem bleeding (1.37%) was recorded at Tumkur taluk. The incidence of bud rot was noticed in both the taluks and the leaf blight was 46.00 PDI and 41.80 PDI in Gubbi and Tumkur taluks respectively.

In Mysuru district, maximum basal stem rot incidence was recorded at KR Nagara taluk (2%) followed by 1.67 % at Hunsur taluk. The highest stem bleeding incidence of 1.67 % was recorded at Hunsur taluk followed by KR Nagar. Leaf blight incidence was 20.00 PDI in all taluks and the maximum bud rot incidence of 0.17% was recorded in Hunsur taluk followed by 0.14% in Periyapattana district.

In Mandya district, maximum basal stem rot of 2.80% and stem bleeding of 2.80% incidence was recorded at Nagamangala taluk followed by 0.90 % at KR Pete taluk. The highest leaf blight incidence of 48.00 PDI was recorded in KR Pete followed by 30.00 PDI in Pandavapura and remaining taluks has recorded 20.00 PDI. The bud rot incidence was not noticed in any of the taluks.

Fixed plot survey

The fixed plot survey was taken at Harnalli, Arsikere Taluk, the first observations on incidence of basal stem rot, stem bleeding, bud rot and leaf blight were recorded during April'14 (Table 52). The initial incidence of 26.40 % of basal stem rot and 16.50% of stem bleeding and 30.60% of leaf blight was recorded. The observations were recorded at quarterly intervals and it was found that the incidence of basal stem rot and leaf blight incidence were increased to 27.5 % and 38.60% respectively during March 2015. The stem bleeding incidence remains 16.50% for throughout the period.

Table 52. Fixed plot survey on incidence of coconut diseases at quarterly interval (Arsikere)

Month	Disease status			
	Basal stem rot (%)	Stem bleeding (%)	Bud rot (%)	Leaf blight (PDI)
Apr'14	26.4	16.5	0.00	30.6
July'14	26.4	16.6	0.00	24.8
Oct'14	27.5	16.5	0.00	24.5
Jan'15	27.5	16.5	0.00	38.6
Mar'15	27.5	16.5	0.00	38.6
Mean	27.06	16.50	0.00	31.42

Veppankulam

Roving survey

Survey was conducted in four districts of Tamil Nadu *viz.*, Thanjavur, Thiruvarur, Trichy and Pudukkottai to assess the incidence of basal stem rot, stem bleeding and bud rot diseases in coconut.

Out of 5257 palms inspected, 131 palms and 19 palms were infected by basal stem rot and bud rot showing 2.30 and 0.72 per cent infection, respectively. Stem bleeding disease incidence was not noticed in any of the places where survey was undertaken.

Path. 2: Basal stem rot disease

Expt. 1: Etiology and epidemiology of basal stem rot disease of coconut

Collection of various isolates from various locations to analyze diversity

Arsikere

The roots and stem portions from the infected palms were collected from eleven locations of Mysuru, Mandya and Tumkur districts and kept for incubation to get the growth of the culture.

Pathogenic virulence of *Ganoderma* isolates to coconut seedlings

A pot culture experiment was initiated to prove pathogenicity of *Ganoderma* isolates to the coconut seedlings through soil inoculation during October, 2014. Nine isolates (CPCRI-1 ,CPCRI-II,CPCRI-III, ASK-I, ASK-II, SMG-I, SMG-III, SMG-VI & SMG-V) of the *Ganoderma* were mass multiplied separately on sorghum grains in poly bags and were used for

soil inoculation by mixing 200g culture/pot with pot mixture at the time of planting. The treatments were replicated three times and the seedlings used were Tiptur Tall. Result revealed that the seedlings inoculated with isolate G_7 (CPCRI-III) showed complete wilting of one seedling at 30 DAI. It clearly indicated that among the nine isolates tested, only one isolate G_7 (CPCRI-III) was found to be pathogenic. The causal organism was re-isolated and was compared with original culture. Thus, the pathogenicity of *Ganoderma* culture to coconut seedlings (Tiptur Tall) was established through soil inoculation technique.

Veppankulam

Three *Ganoderma* sporophores from coconut were collected from different locations *viz.,* Mangadu, Vendakkottai and Puichankadu, isolated the organism and named as MCG_1, VCG_1 and PCG_1 respectively. One *Ganoderma* sporophore was collected from Ottankadu and the isolated organism was named as OPG_1.

Four isolates of *Ganoderma lucidum* were mass multiplied using sorghum grains and was inoculated into the pots containing sterilized soil. ECT seedlings were planted and observations on symptom expression will be recorded in due course of time.

Molecular characterization and conservation of *Ganoderma* spp.

Ambajipeta

Grouping of *Ganoderma* isolates based on molecular characters, sero types and pathogenic races and establishing relationship between molecular characters and virulence of the pathogen

Based on the isozyme analysis, pathogenic virulence studies and RAPD PCR analysis, the *Ganoderma* isolates from all the three states were grouped. Isolates of Karnataka state were found to be virulent. Five out of six Arsikere (GI2, GI3, GI4, GI6, A2) isolates showed more virulence nature and one isolate (GI5) showed moderate virulence in the pathogenic virulence studies conducted with bengal gram indicator plant. Isolates from Andhra Pradesh belonged to all the three categories such as more virulent (7 out of 18 isolates), moderately virulent (3 out of 18 isolates) and less virulent (8 out of 18 isolates). Six, out of eight *Ganoderma* Isolates from Tamil Nadu showed less virulence nature. The other two isolates PVI 2 and CRS 5 showed more virulent nature. The type cultures, DMR 44, DMR 45 and DMR 86 from Directorate of Mushroom Research, Solan, Himachal Pradesh, showed more virulent nature with pathogenic studies on bengal gram plants.

Most of the more virulent isolates showed 2-3 bands with malate dehydrogenase profile and belonged to Group 1 category in RAPD PCR profiling. Most of the less virulent isolates showed 4-5 bands with malate dehydrogenase profile and belonged to Group 2 category in RAPD PCR profiling. All the isolates from Tamil Nadu and type cultures from Directorate of Mushroom Research, Solan did not show any grouping pattern with RAPD PCR. Most of the isolates of Karnataka were clustered in to one group (Group 1), whereas, the isolates of Andhra Pradesh were clustered into two groups (Group 1 and Group 2).

Grouping based on Laccase activity in *Ganoderma* isolates:

Combination of a number of different identification and characterization methods can provide complimentary information for studying the processes of fungal plant disease establishment and spread.

Fungal laccase, one of the lignolytic enzymes produced by *Ganoderma* spp play an important role in lignin biosynthesis, plant pathogenesis, degradation of plant cell wall, pigment production, insect sclerotization, bacterial melanization, etc. So, an *in vitro* assay for laccase activity in the *Ganoderma* isolates was carried out. Laccase activity was assessed by growing the fungi on GYP agar medium amended with 0.05% 1-naphthol at pH 6. Change in color of the medium from clear to blue indicated laccase activity.

All the isolates except two (PVI 2 and CRS 5)

grouped under more virulent nature showed blue color production with *in vitro* laccase activity test (Plate 1). Two of the four (NJL, KLC) isolates showed blue color production in the laccase activity under moderately virulent group of isolates. All the isolates except two (NSP, GP) under less virulent group showed no color formation in laccase activity test. Studies are in progress to estimate the laccase activity of the isolates.

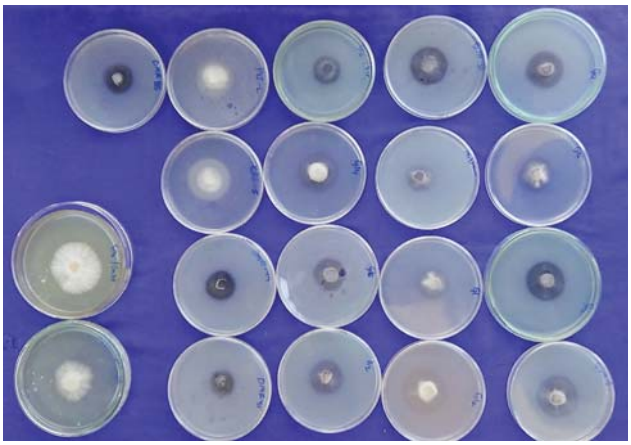

Plate 1. Blue color production from *Ganoderma* isolates that belonged to more virulence group in laccase activity test

Assessment of genetic similarity using somatic compatibility testing

A study on somatic compatibility among the *Ganoderma* isolates was initiated to assess the genetic similarity within them. Somatic compatibility was tested by pairing the isolates in all combinations and self pairing as control. Mycelia plugs (8mm) were transferred on to standard 9cm PDA plate and placed 2cm apart. The plates were incubated for 10 to 15 days at ambient temperatures, assessed and rated as either compatible or incompatible. Isolates merged into single colony were named as compatible, whereas, isolates that formed inhibition zone or barrage were described as incompatible.

Initial studies were taken up using Gl, Gl3, Gl2, Gl4, Ga2, A2, Ga from Group 1 of RAPD PCR profile and KLC, NSP, MKW, DGM of Group 2A and KGP from Group 2B of RAPD PCR profile. All the possible combinations with the above isolates were taken up and all the isolates showed compatible reaction except KGP isolate (Plate 2). KGP isolate from Group 2B showed incompatible barrage with the above tested isolates that belonged to Group 1 and Group 2A (Plate 3). Study is in progress with other isolates of Group 2B and the remaining isolates.

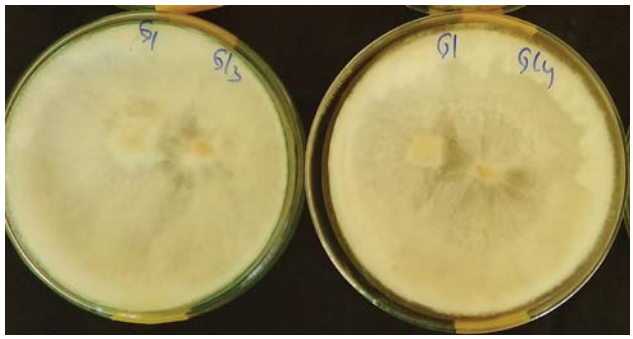

Plate 2. Compatible reaction between *Ganoderma* isolates, Gl and Gl3 and Gl and Gl4

Plate 3. Incompatible reaction between *Ganoderma* isolates, Gl and KGP

Activity III: Epidemiology and disease forecasting

Ambajipeta

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

The study on the impact of other palms and intercrops in coconut on occurrence and spread of basal stem rot disease was initiated in November 2010. Fifty palms in the field with sole coconut and field with coconut + banana were selected in Gannavaram village of East Godavari district. Horizontal and vertical spread of the disease in sole coconut as well as coconut intercropped with banana during the time period was recorded and are given in Table 53.

In sole coconut, the per cent disease incidence of 2 during November 2010 was increased to

18 by the end of February 2013. The per cent disease incidence of 8 during November 2010 was increased to 22 by the end of February 2013 in case of coconut intercropped with banana. Mean vertical spread of 63cm in November 2010 was increased to 118.1cm by the end of February 2013 in case of sole coconut. Mean vertical spread of 139cm in November 2010 was increased to 129.8cm by the end of February 2013 in case of coconut intercropped with banana. The difference in PDI or the mean vertical spread between sole crop and coconut intercropped with banana was observed to be due to the method of irrigation followed by the farmer but not the cropping system.

Table 53. Impact of other palms and intercrops in coconut on occurrence and spread of the disease (Nov 2010 to Feb 2013) (Ambajipeta)

Sl. no.	Month/year	Mean vertical spread (cm)		Per cent Disease Incidence (Horizontal spread)	
		Sole coconut	Coconut with Banana	Sole coconut	Coconut with Banana
1	Nov 10	63.0	139	2	8
2	Oct 11	95.6	119.8	6	14
3	Nov 11	120.3	123.9	8	18
4	Mar 12	114.2	124.0	10	18
5	Sep 12	109.9	131.0	18	20
6	Feb 13	118.1	129.8	18	22

This year, a new plot was selected for taking observations for coconut intercropped with banana as the banana crop was removed in the earlier plot. In sole coconut plot, the PDI of 16% during April 2014 was increased to 20% by the end of March 2015. Mean vertical spread in sole coconut crop was recorded as 121.0cm in April 2014 and as 112.25cm in March 2015.

In the new plot selected with coconut and banana, 26% PDI was recorded during June 2014 which was increased to 30% by the end of March 2015. Mean vertical spread in coconut + banana plot was recorded as 90.46 cm in June 2014 and as 77.46cm in March 2015 (Table 54).

Table 54. Impact of other palms and intercrops in coconut on occurrence and spread of the disease (2014-15) (Ambajipeta)

Sl. no.	Month	Rainfall (mm)	Rainy days (no.)	Temp °C (Max.)	Percent Disease Incidence (PDI) (Horizontal spread)		Mean vertical spread (cm)	
					Sole coconut	Coconut + Banana	Sole coconut	Coconut + Banana
1	Apr,'14	-	-	39.2	16	--	121.0	--
2	May,'14	42.4	4	42.0	16	--	121.0	--
3	Jun,'14	27.7	4	40.3	16	26	121.0	90.4
4	Jul,'14	266.3	13	38.1	16	26	121.0	89.0

Sl. no.	Month	Rainfall (mm)	Rainy days (no.)	Temp °C (Max.)	Percent Disease Incidence (PDI) (Horizontal spread)		Mean vertical spread (cm)	
					Sole coconut	Coconut + Banana	Sole coconut	Coconut + Banana
5	Aug,'14	113.8	7	35.5	16	26	124.3	89.8
6	Sep,'14	150.2	9	33.7	16	26	124.3	89.2
7	Oct,'14	73.7	9	34.3	16	26	124.3	89.2
8	Nov,'14	17.0	1	33.5	16	26	124.3	89.6
9	Dec,'14	2.5	1	32.0	20	30	112.2	77.4
10	Jan,'15	-	-	30.1	20	30	112.2	77.4
11	Feb,'15	-	-	31.6	20	30	112.2	77.4
12	Mar,'15	-	-	34.0	20	30	112.2	77.4
	Total	**693.6**	**48**					

Arsikere

Plot having 50 palms was selected for the study of disease spread in relation to weather parameters during 2014-15. Vertical and horizontal spread of disease in coconut palms was recorded at monthly intervals and the disease spread was correlated with rainfall, number of rainy days and temperature recorded at monthly intervals (Table 55). The rate of vertical spread ranged from 286 to 619 cm in sole crop and 5.00% Horizontal spread was also recorded in solo crop. The incidence of vertical spread was less in banana intercropped compared to cocoa intercropped and sole crop.

Table 55. Effect of Vertical and horizontal spread of the disease in relation to Weather parameters and intercrops (2014-15)(Arsikere)

Sl.no.	Months	Rainfall (mm)	Rainy days (no.)	Temp. (°C)	Rate of vertical spread (cm)	Rate of horizontal spread (cm)
1	Apr-14	104.4	4	27.3	486	20
2	May-14	87.3	5	26.9	486	20
3	June-14	45.0	3	25.7	486	20
4	July-14	39.0	6	23.9	486	20
5	Aug-14	151.5	10	24.5	605	20
6	Sep-14	142.2	4	23.8	583	21
7	Oct-14	268.8	10	23.6	585	21
8	Nov-14	12.0	2	20.6	611	21
9	Dec-14	2.8	1	20.5	619	21
10	Jan-15	0.0	0	20.0	619	21
11	Feb-15	0.0	0	21.3	622	21
12	Mar-15	34.8	2	23.9	7.76	21

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 56).

Table 56. Vertical and horizontal spread of the disease in relation to Intercrops

Sl No.	Month	Rainfall (mm)	Rainy days (no.)	Temp (°C)	Rate of VS (m)			Rate of HS (m)		
					Sole crop	Cocoa	Banana	Sole crop	Cocoa	Banana
1	Apr-14	104.40	4	27.3	4.8	4.9	2.9	0.00	0.00	0.00
2	May-14	87.30	5	26.9	4.8	4.9	2.9	0.00	0.00	0.00
3	June-14	45.0	3	25.7	4.8	4.0	3.2	0.00	0.00	0.00
4	July-14	39.00	6	23.9	4.8	4.0	3.2	0.00	0.00	0.00
5	Aug-14	151.5	10	24.5	6.0	3.9	2.8	0.00	0.00	0.00
6	Sep-14	142.20	4	23.8	5.8	3.8	2.8	5.00	0.00	0.00
7	Oct-14	268.8	10	23.6	5.8	3.8	2.8	5.00	0.00	0.00
8	Nov-14	12.00	2	20.6	6.1	3.9	3.1	5.00	0.00	0.00
9	Dec-14	2.8	1	20.5	6.1	4.4	3.2	5.00	0.00	0.00
10	Jan-15	0.00	0	20.0	6.1	4.4	3.2	5.00	0.00	0.00
11	Feb-15	0.00	0	21.3	6.2	4.4	3.3	5.00	0.00	0.00
12	Mar-15	34.80	2	23.9	7.7	4.6	4.0	5.00	5.00	0.00

Expt. 2: Studies on minimum inoculum load required for successful infection of basal stem rot disease

Ambajipeta

The pot experiment on minimum inoculation load required for successful infection of BSR was initiated in December 2014 at HRS, Ambajipeta with four treatments and four replications each under irrigated and moisture stress conditions. Basal stem rot pathogen was multiplied in sorghum grains as mushroom spawn for 20 days and mixed as per treatment details to the sterilized soil and two year old East coast tall seedlings were planted in the pots. Symptom development and rate of mortality in different treatments were observed continuously.

Plants were observed at weekly intervals for number of leaves, symptom development and mortality of the plant. Out of the four seedlings in T1 treatment, with inoculum load of 100g/ pot in moisture stress condition, one plant was dead at 70 DAI and one more plant was wilting at 90 DAI. Under set II, normal conditions also the T1 treatment *i.e.* with inoculum load of 100g/ pot showed dead plant at 90 DAI.

Arsikere

The pot experiment on minimum inoculation load required for successful infection of BSR was initiated on 2014 at HRS, Arsikere with four treatments and four replications. Two years old seedlings of Tiptur Tall were planted to pot filled with sterilized soil. The soil was then inoculated with *Ganoderma lucidum* culture grown on sorghum grain as per the treatment. Result revealed that the seedlings inoculated with inoculum load 100g/ pot in moisture stress condition and inoculum load 300g/pot in normal condition have showed complete wilting of one seedling at 30 DAI.

Expt. 3: Management of basal stem rot disease in coconut

Biological management – Collection, conservation and characterization of bioagents from different locations

Arsikere

Seven Biocontrol agents collected from the different location *ie., Trichoderma viride (GKVK), Trichoderma harzianum (GKVK), Trichoderma asperillum (GKVK), Trichoderma harzianum (HRS), Trichoderma harzianum (NBAII), Trichoderma harzianum (KRN)* and *Trichoderma harzianum (HRS)* were tested against *Ganoderma lucidum* by dual culture method. Radial growth of *Ganoderma lucidum* was measured at different days after inoculation and the per cent inhibition was calculated.

The results revealed that, all the antagonists significantly reduced the growth of *Ganoderma lucidum* by recording mycelial inhibition ranging from 61.78 to 76.00 per cent (Table 57). Among the antagonists tested *Trichoderma asperillum (GKVK)* was found superior over all other bio agents by recording maximum inhibition of 76.00 per cent followed by *Trichoderma viride (GKVK)* which has recorded 74.89 per cent. The least inhibition of 61.78 per cent was recorded in *Trichoderma harzianum (KRN)*.

Table 57. *In vitro* evaluation of biocontrol agents against *Ganoderma lucidum*

No.	Biocontrol agents	Inhibition of *G. lucidum* (%)		
		3 days after inoculation	6 days after inoculation	9 days after inoculation
1	*Trichoderma viride(GKVK)*	42.72 (40.81)	73.95 (59.31)	74.89 (59.93)
2	*Trichoderma harzianum (GKVK)*	19.93 (26.44)	73.67 (59.13)	64.67 (53.53)
3	*Trichoderma asperillum(GKVK)*	19.07 (25.88)	70.59 (57.16)	76.00 (60.67)
4	*Trichoderma harzianum (HRS)*	20.85 (27.11)	76.19 (60.80)	73.11 (58.77)
5	*Trichoderma harzianum (NBAII)*	19.89 (26.37)	61.62 (51.72)	67.78 (55.41)
6	*Trichoderma harzianum (KRN)*	16.30 (23.72)	57.70 (49.43)	61.78 (51.81)
7	*Trichoderma harzianum (HRS)*	26.30 (30.82)	65.27 (53.89)	72.00 (58.08)
	SEm±	0.73	0.30	0.37
	CD(P=0.01)	2.65	1.08	1.34

Figures in parenthesis are arcsine transformed values

Veppankulam

Rhizosphere soil from different crops *viz.*, coconut, banana and noni was collected from various locations. The biocontrol agents were isolated by serial dilution using *Trichoderma* selective medium for *Trichoderma viride*, King's B medium for *Pseudomonas fluorescence* and nutrient agar (NA) for *Bacillus* spp.

Seven isolates of *Pseudomonas fluorescence*, six isolates of *Bacillus* spp. and four isolates of *T. viride* were isolated and to be tested against basal stem rot causing pathogen *Ganoderma lucidum* by dual culture technique.

Integrated management of BSR – involving fungicides, bioagents and INM

Ambajipeta

The experiment on field management of basal stem rot was initiated with the new treatments in the earlier selected garden at P. Gannavaram village of East Godavari District of Andhra Pradesh during September 2014 for standardization of dosage frequency and method of application of

Trichoderma viride, Pseudomonas fluorescens along with neem cake (5kg/palm/year), root feeding with Hexaconazole @3ml/100ml of water/palm/quarter and micronutrient application @1kg/palm/yr. Soil application of talc based formulation of *Trichoderma viride* was found effective in suppressing the basal stem rot disease of coconut. Majority of the treatments involving *T.viride* and neem cake or *T.viride, P. fluorescens* and neem cake reduced the mean disease spread except T_7. In treatments involving *Pseudomonas fluorescens*, quarterly application effectively reduced the mean vertical spread, whereas, half yearly and yearly applications recorded increase in mean vertical spread. Control palms recorded death of one palm and increase in mean vertical spread.

Arsikere

The experiment was initiated during second fortnight of June, 2014 in a farmer's field at Gandsi, Arsikere taluk. The pre application observation for the incidence of BSR was recorded before imposition of treatments and post application observations were recorded four months after treatment imposition. No differences in the disease symptoms were found among the treatments both in pre and post treatment application of treatments.

Veppankulam

The IDM practices were imposed as per the treatment schedule. The results revealed that the soil application of talc based formulation of 125g each of *Trichoderma viride* and *Pseudomonas fluorescens* + 1.25 kg of neem cake per palm at quarterly intervals recorded the lowest per cent disease index of 5.46 and 5.68 as compared to the per cent disease index of 64.17 and 20.10 in control palm at Sanakkarai and CRS Veppankulam respectively.

Screening of new fungicides

Ambajipeta

Screening of six fungicides *viz.*, Azosystrobin 23% SC, Kresoxim methyl 44.3% SC, Tebuconazole 25.9% EC, Difenconazole 25% EC, Hexaconazole 5% EC and Thiphanate methyl 70% WP was carried out with pure culture of *Ganoderma* under *in vitro* conditions. Various concentrations of the chemicals such as 0.05%, 0.1%, 0.2% and 0.5% were screened with the pathogen. Three replications per each chemical were maintained along with control. Of the chemicals tested, Tebuconazole and Hexaconazole at all the four concentrations showed 100 per cent inhibition of *Ganoderma* mycelial growth.

These two chemicals were selected for *in vivo* evaluation as root feeding at the rate of 2ml / 100ml of water for the management of basal stem rot disease.

Arsikere

Experiment on *in vitro* evaluation of ten systemic and three contact fungicides were carried out against *Ganoderma lucidum* and it was noticed that among the thirteen fungicides evaluated Carbendazim 50% WP @ 0.1%, Carboxin 37.5 + Thiram 37.5%

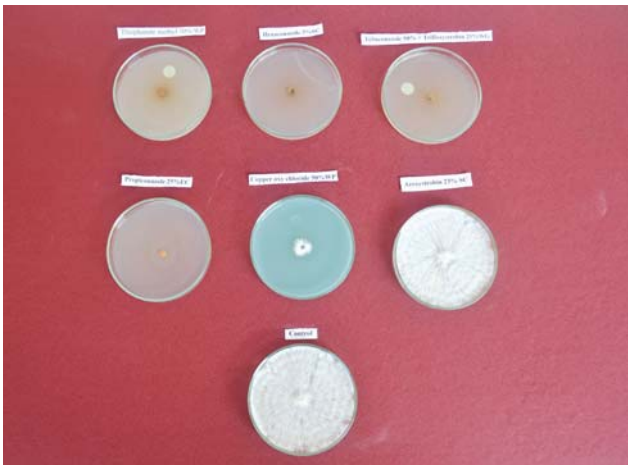

Plate 4. *In vitro* evaluation of biocontrol agents against *Ganoderma lucidum*

Plate 5. *In vitro* evaluation of Fungicides against *Ganoderma lucidum*

@DS @ 0.3%, Difenoconazole 25%EC @0.1%, Propiconazole 25%EC@0.1%, Tebuconazole 25.9% EC@ 0.15%, Tebuconazole + Trifloxystrobin 75%WG@0.04%, Tetraconazole 3.8%w/w EW@0.1%, Tetraconazole 3.8%w/w EW@0.15% and standard check Hexaconazole 5%SC@0.1% has recorded 100 per cent inhibition and showed superior over other fungicides (Plate 4 & Plate 5). Azoxystrobin 23%SC@0.1% has recorded zero per cent inhibition followed by 30.66% in Pencycuron 22.9%SC@0.1 % on 9 DAI (Table 58).

Based on the results of *in vitro* evaluation, four systemic fungicides along with standard check Hexaconazole 5%EC were selected for *in vivo* evaluation as root feeding for the management of *Ganoderma*.

Table 58. *In vitro* evaluation of fungicides against *Ganoderma lucidum*

Fungicide	Dosage (%)	Inhibition of *G. lucidum* (%)		
		3DAI	6DAI	9DAI
Azosystrobin 23%SC	0.1	0.0 (0.0)	0.00 (0.00)	0.00 (0.0)
Carbendazim50%WP	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Carboxin 37.5 + Thiram 37.5%DS	0.3	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Copper oxy chloride50%WP	0.3	86.0 (79.0)	76.6 (61.1)	84.4 (66.7)
Difenoconazole 25%EC	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Hexaconazole 5%SC	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Pencycuron 22.9%SC	0.1	26.1 (30.6)	23.6 (29.0)	30.6 (33.6)
Propiconazole 25%EC	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Tebuconazole 25.9%EC	0.15	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Tebuconazole+ Trifloxystrobin75%WG	0.04	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Thiophanate Methyl 70%WP	0.28	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Tetraconazole3.8% w/w(4%w/v)EW	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
Tetraconazole3.8% w/w(4%w/v)EW	0.15	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
SEm±		0.29	0.98	0.27
CD(P=0.01)		1.07	3.55	1.00

Figures in parenthesis are arcsine transformed values

Expt. 4: Early detection of basal stem rot disease in coconut

Ambajipeta

Polyclonal antibodies were raised in New Zealand White Rabbits against *Ganoderma lucidum*. Pure cultures of *Ganoderma lucidum* were used to develop polyclonal antibodies. The developed antibodies were tested with the pure cultures as antigen in glass capillary tube assay, slide agglutination test and by indirect ELISA. Positive reaction of developed antiserum of *G. lucidum* with their respective antigens was observed in glass capillary tube assay and slide agglutination tests by the formation of precipitations. The antiserum was then used to detect its sensitivity against the pathogens in indirect ELISA method.

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

Cross reactivity test was carried out with two other pathogens, *Thielaviopsis paradoxa* and *Penicillium sp.* using the antibodies developed for *Ganoderma lucidum*. The protocol used for antigen preparation with respect to *Ganoderma* isolates was used the mycelia mat of *Thielaviopsis paradoxa* and *Penicillium sp.* Results revealed the cross reaction of polyclonal antibodies developed for *Ganoderma lucidum* with *Penicillium* species and *Thielaviopsis paradoxa*.

PCR and Specific primers

Ganoderma specific primers Gan 1 and Gan 2 were used for specific amplification of 167bp product with all the available *Ganoderma* isolates. Most of the *Ganoderma* isolates showed amplification at the expected size of 167bp. Further studies are in progress.

Path. 3: Stem bleeding and bud rot diseases

Expt. 1: Management of bud rot and stem bleeding disease in coconut

Biological management

Ambajipeta

Field evaluation of antagonists against stem bleeding disease in coconut:

Effect of *Trichoderma virens* cake formulation as well as *Trichoderma viride* paste application was tested against stem bleeding disease of coconut under field conditions. Thirty *Trichoderma virens* cakes were used for the study in the month of August 2014 along with paste application of *Trichoderma viride*. In case of cake application, the treatment was given only once during the study period, while the paste application was carried out every month.

The treated palms were observed for every month for the disease symptom and the per cent recovery of the treated palms were observed. From the results, application of *Trichoderma virens* cake formulation was found effective when compared to the paste application of *Trichoderma viride* against stem bleeding disease of coconut. Cake application showed 53.33 % recovery within one month which was increased to 73.33% by the end of March 2015 (Table 59).

Table 59. Field evaluation of cake and paste formulations of *Trichoderma species* against stem bleeding disease of coconut

Sl. no.	Treatment	No of treated palms (Sep,'14)	Percent recovery				
			Oct,'14	Nov,'14	Dec,'14	Jan,'15	Mar,'15
1	*Trichoderma virens* cake (T_1)	30	53.33	53.33	60.00	66.67	73.33
2	*Trichoderma viride* paste (T_2)	30	26.67	26.67	26.67	40.00	40.00
3	Control (T_3)	30	0.00	20.00	26.67	26.67	33.33

Field evaluation of Vanapalli isolate of *Trichoderma species* against bud rot disease of coconut

For field evaluation of vanapalli isolate of *Trichoderma* species against bud rot disease in coconut seedlings, an experiment was initiated in July 2014 at HRS Ambajipeta. Sixty coconut seedlings were selected each for talc application of vanapalli isolate of *Trichoderma* (T_1), positive control (copper oxy chloride (3g/lit of water)) (T_2) and control (T_3). Treatment imposition was carried out each month and the number of infected / dead seedlings was recorded every month. This year incidence of bud rot was very less and only two seedlings fount dead in control whereas, T_1 and T_2 did not show any seedling death.

Management through fungicides

Ambajipeta

Screening of systemic fungicides against stem bleeding disease of coconut

Screening of six available fungicides *viz.*, Azosystrobin 23% SC, Kresoxim methyl 44.3% SC, Tebuconazole 25.9% EC, Difenconazole 25% EC, Hexaconazole 5% EC and Mancozeb 75%WP was carried out with pure culture of *Thielaviopsis paradoxa* under *in vitro* conditions. Various concentrations of the chemicals such as 0.05%, 0.1%, 0.2% and 0.5% were screened with the pathogen. Three replications per each chemical were maintained along with control. Of the chemicals tested, Tebuconazole and Mancozeb at all the four concentrations showed 100 per cent inhibition of *Thielaviopsis paradoxa*. These two chemicals were selected for *in vivo* evaluation and the study was initiated.

Screening of latest fungicides against bud rot disease of coconut

Screening of seven available fungicides *viz.*, Azosystrobin 23% SC, Kresoxim methyl 44.3% SC, Mancozeb 75%WP, Pyroclostrobin + Metiram 60% WG, Fenamidone + Mancozeb 60% WP, Metalaxyl + Mancozeb 68% WP and Copper oxy chloride 50% WP was carried out with pure culture of *Phytophthora palmivora* under *in vitro* conditions. Various concentrations of the chemicals such as 0.05%, 0.1%, 0.2% and 0.5% were screened with the pathogen. Three replications per each chemical were maintained along with control. Of the chemicals tested, Copper oxy chloride, Mancozeb, Pyroclostrobin + Metiram, Metalaxyl + Mancozeb, Fenamidone + Mancozeb showed complete inhibition of growth of *Phytophthora palmivora*.

Arsikere

Experiment on *in vitro* evaluation of twelve fungicides was carried out against *Thielaviopsis paradoxa* and it was noticed that among the twelve fungicides evaluated, Carbendazim50%WP@0.1%, Difenoconazole 25%EC@0.1%, Propiconazole 25%EC@0.1% Tebuconazole 25.9%EC@0.15% and Thiophanate Methyl 70%WP@0.2% have recorded 100 per cent inhibition compared to other fungicides and showed significant difference among the treatments in inhibiting the growth of the pathogen. Azoxystrobin 23%SC@0.1% has recorded least inhibition of 1.56% followed by 1.82% in Pencycuron 22.9%SC@ 0.15% on 9 DAI (Table 60 & Plate 6).

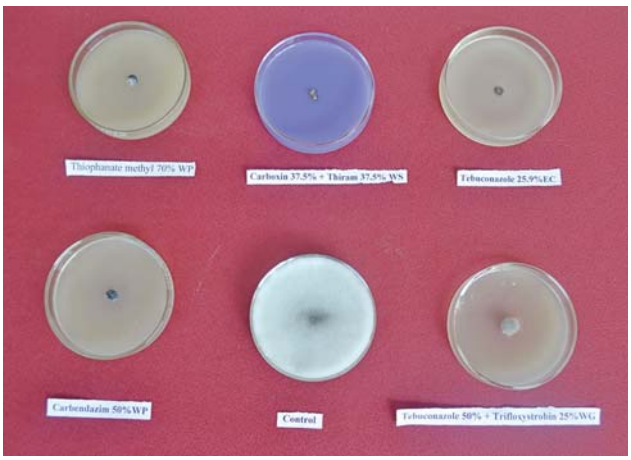

Plate 6. *In vitro* evaluation of Fungicides against *Thievaliopsis paradoxa*

Table 60: In vitro evaluation of fungicides against *Thielaviopsis paradoxa*

No.	Fungicide	Dosage (%)	Inhibition of *Thielaviopsis paradoxa* (%)		
			3DAI	6DAI	9DAI
1	Azosystrobin 23%SC	0.1	35.7 (36.6)	4.00 (8.98)	1.5 (6.2)
2	Carbendazim50%WP	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
3	Carboxin 37.5% + Thiram 37.5%DS	0.3	100.0 (90.0)	100.0 (90.0)	85.3 (67.5)
4	Difenoconazole 25%EC	0.1	100.0(90.0)	100.0 (90.0)	100.0 (90.0)
5	Hexaconazole 5%SC	0.1	100.0 (90.0)	78.1 (62.1)	67.3 (55.1)
6	Pencycuron22.9%SC	0.1	32.8 (34.9)	0.0 (0.0)	1.8 (7.5)
7	Propiconazole25%EC	0.1	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
.8	Tebuconazole 25.9%EC	0.15	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
9	Tebuconazole50% + Trifloxystrobin25%WG	0.04	77.7 (61.8)	82.1 (65.0)	81.1 (64.3)
10	Thiophanate Methyl 70%WP	0.2	100	100.0 (90.0)	100.0 (90.0)
11	Tetraconazole3.8% w/w(4%w/v)EW	0.1	100.0 (90.0)	74.4 (59.6)	63.4 (52.8)
12	Tetraconazole3.8% w/w(4%w/v)EW	0.15	100.0 (90.0)	76.0 (60.6)	67.1 (55.0)
	SEm±		0.67	1.07	0.63
	CD(P=0.01)		2.43	3.92	2.28

Figures in parenthesis are arcsine transformed values

Path. 4: Leaf blight disease of coconut

Expt. 1: Etiology and epidemiology of leaf blight disease of coconut

Collection of *Lasiodiplodia theobromae* isolates from various locations to analyse diversity

Aliyarnagar

Twelve different isolates of leaf blight pathogen *viz.*, Puliyankandi, Angalakurichi, Koomangalampudur, Paethanayakanoor, Kudimangalam, Aval chinnampalayam, Karianchettipalayma villages of Pollachi Taluk in Coimbatore district and Kuppankkovil, Moolimangalam, Manupatti, Ponnaiyanoor, Kuppanankkovil villages in Tirupur district and Puliangudi village of Tirunelveli district and Tiruchencode of Erode district in Tamil Nadu were studied for genetic variability.

Arsikere

Seven isolates from Hunsur, Mysuru, Gubbi, Mandya, Srirangapatna, Kanakapura and Magadi were collected and cultural variability among the isolates was studied. All the isolates produced grayish colonies and there was no difference with respect to time taken for complete radial growth.

Epidemiology and disease forecasting

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

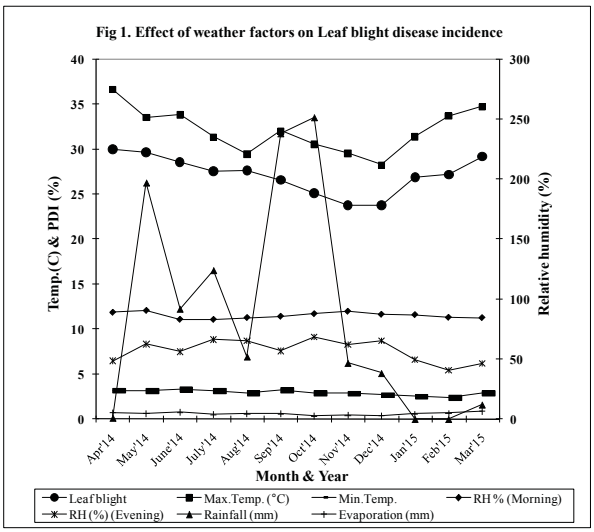

Fig. 1: Effect of weather factors on leaf blight disease incidence

maximum disease intensity was observed during March-April. Disease intensity was found to be low during November-December (Table 61 & Fig 1).

Arsikere

The study on survival and spread of leaf blight incidence in relation to weather parameters was initiated during 2014-15. The initial disease incidence ranged from 22.90 to 40.30 PDI (Table 62).

Further, the study was also taken to know the impact of inter crops in coconut on occurrence and spread of disease and antagonists and it was noticed that the spread of the leaf blight was more or less uniform in all intercrops (banana and cocoa).

Table 61. Month wise weather data and leaf blight per cent disease incidence

Month	Leaf blight PDI	Max. temp. (°C)	Min. temp. (°C)	Rainfall (mm)	Relative humidity (%)		Evaporation (mm)
					Morning	Evening	
Apr,'14	30.00	36.7	23.9	1.0	89.2	48.6	5.3
May'14	29.68	33.6	23.7	197.3	90.8	62.7	4.7
Jun,'14	28.56	33.9	25.0	92.0	83.2	56.3	5.6
Jul,'14	27.60	31.4	23.5	124.2	83.1	66.4	3.9
Aug,'14	27.65	29.5	21.7	52.1	84.7	65.6	4.4
Sep,'14	26.60	32.1	24.2	238.4	85.8	56.9	4.5
Oct,'14	25.15	30.6	21.5	251.8	88.0	68.6	2.6
Nov,'14	23.83	29.6	21.4	46.8	90.1	62.2	3.3
Dec,'14	23.80	28.3	20.1	38.3	87.5	65.5	2.8
Jan,'15	26.88	31.44	18.75	0.00	87.19	49.56	4.36
Feb,'15	27.20	33.76	17.7	0.00	84.9	40.70	4.89
Mar,'15	29.20	34.8	21.7	12.0	84.62	46.20	6.5

Table 62. Effect of weather parameters and intercrops on survival and spread of leaf blight disease (2014-15)

Sl. no.	Months	Rainfall (mm)	Rainy days	Temp. (°C)	Per cent Disease Index		
					Sole crop	Banana	Cocoa
1	Apr-14	104.40	4	27.36	30.60	24.50	27.00
2	May-14	87.30	5	26.93	30.60	24.50	27.00
3	June-14	45.0	3	25.75	24.80	23.90	25.10
4	July-14	39.00	6	23.95	24.80	24.00	25.20
5	Aug-14	151.5	10	24.5	24.50	24.00	25.00
6	Sep-14	142.20	4	23.84	22.90	22.60	23.00
7	Oct-14	268.8	10	23.65	22.90	22.60	23.00
8	Nov-14	12.0	2	20.66	40.30	39.30	40.10
9	Dec-14	2.8	1	20.55	38.90	38.10	38.60
10	Jan-15	0.00	0	20.00	38.90	38.10	38.60
11	Feb-15	0.00	0	21.35	39.20	38.90	38.90
12	Mar-15	34.8	2	23.90	40.00	40.00	40.00

Expt. 2: Studies on management of leaf blight disease in coconut

Screening of available systemic fungicides against leaf blight pathogen

Aliyarnagar

Several fungicides (Tebuconazole + Trifloxystrobin (50+25% WG), Tebuconazole (25.9% EC), Tetraconazole (3.8v/w), Difenoconazole (25% EC), Kresoxim methyl (44.3 % SC), Propiconazole (25 % EC), Thiophanate methyl (70 % WP), Azoxystrobin (23.0 % SC) and Carbendazim (50 % WP) were screened against *Lasiodiplodia theobromae* at recommended concentration (0.1%) using poisoned food technique. Among the fungicides tested, 100 percent inhibition over control was observed for Tebuconazole, Tebuconazole+ Trifloxystrobin, Propiconazole and Carbendazim at 0.1 % concentration (Plate.7). Based on the *in vitro* screening, the effective fungicides were selected for field evaluation at different time intervals.

Plate 7. In vitro evaluation of fungicides against *Lasiodiplodia theobromae*

Field evaluation

Two management field trials each at Puliyankandi village of Anaimalai block and Koomangalampudur village of Pollachi North block in Coimbatore districts were laid out and the treatments were imposed at appropriate time. Pre-treatment and midterm observation (8 months after) were recorded in both the trial plots and are presented in Tables 63 and 64. Maximum reduction in disease severity was observed in root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval treated palms in both the trials.

Table 63. Effect of systemic fungicide (Tebuconazole) against leaf blight disease of coconut (Location – Puliyankandi, 2014-15)

Treatments	Pre-treatment PDI	Post-treatment PDI	Reduction in disease severity
T_1 Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval	25.52	21.12	4.40[b] (12.11)
T_2 Root feeding of Tebuconazole @ 2ml + 100 ml water at half yearly interval	29.84	26.48	3.36[c] (10.56)
T_3 Root feeding of Tebuconazole @ 2ml + 100 ml water once in a year	26.56	24.24	2.32[d] (8.76)
T_4 Root feeding of 2 g of Carbandazim in 100 ml water thrice at 3 months interval	29.92	25.36	4.56[a] (12.33)
T_5 Control	32.40	33.20	+0.80

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

Table 64. Effect of systemic fungicide (Tebuconazole) against leaf blight disease of coconut (Location – Koomangalampudur, 2014-15)

Treatments	Pre-treatment PDI	Post-treatment PDI	Reduction in disease severity
T_1 Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval	28.02	24.85	3.17[b] (10.26)
T_2 Root feeding of Tebuconazole @ 2ml + 100 ml water at half yearly interval	24.52	21.96	2.56[c] (9.21)
T_3 Root feeding of Tebuconazole @ 2ml + 100 ml water once in a year	27.92	26.16	1.76[d] (7.26)
T_4 Root feeding of 2 g of Carbandazim in 100 ml water thrice at 3 months interval	32.32	28.80	3.52[a] (10.81)
T_5 Control	31.84	32.96	+1.12

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

Arsikere

Experiment on *in vitro* evaluation of ten fungicides was carried out against grey blight of coconut caused by *Pestalotiopsis palmarum* and it was noticed that among the ten fungicides evaluated, Carbendazim 50%WP @0.1%, Carboxin 37.5%+ Thiram 37.5%@0.3%,Difenconazole 25%EC@0.1%, Propiconazole 25%EC@0.1%,Tebuconazole 25.9%EC@0.15%, Tebuconazole50% + Trifloxystrobin 25%WG and Thiophanate Methyl 70%WP@0.2% has recorded 100 per cent inhibition and showed significant difference compared to Pencycuron 22.9%SC. (Table 65).

In vitro evaluation of twelve fungicides was carried out against leaf blight of coconut caused by *Lasiodilpodia theobromae* and it was noticed that among the fungicides evaluated, Carboxin 37.5%+Thiram 37.5%@0.3% and Propiconazole 25% EC@0.1% showed significantly superior over other fungicides and recorded 100 per cent inhibition of test fungus followed by 83.43% inhibition in Hexaconazole 5%SC@0.1%. The least inhibition of 30.76% and 31.36% was recorded in Thiophanate methyl 70%WP@0.15% and Carbendazim 50% WP@0.1%, respectively on 12 DAI (Table 66).

Table. 65: *In vitro* evaluation of fungicides against *Pestalotiopsis palmarum*

No.	Fungicide	Dosage (%)	% inhibition of *Pestalotiopsis palmarum*		
			3DAI	6DAI	9DAI
1	Azosystrobin 23%SC	0.1	100 (90.0)	100 (90.0)	79.19 (62.8)
2	Carbendazim50%WP	0.1	100 (90.0)	100 (90.0)	100 (90.0)
3	Carboxin 37.5% + Thiram 37.5%	0.3	100 (90.0)	100 (90.0)	100 (90.0)
4	Difenoconazole 25%EC	0.1	100 (90.0)	100 (90.0)	100 (90.0)
5	Hexaconazole 5%SC	0.1	100 (90.0)	100 (90.0)	100 (90.0)
6	Pencycuron22.9%SC	1.5	10.00 (16.7)	3.86 (8.5)	1.61 (4.3)
7	Propiconazole25%EC	0.1	100 (90.0)	100 (90.0)	100 (90.0)
.8	Tebuconazole 25.9%EC	0.15	100 (90.0)	100 (90.0)	100 (90.0)
9	Tebuconazole50% + Trifloxystrobin25%WG	0.04	100 (90.0)	100 (90.0)	100 (90.0)
10	Thiophanate Methyl 70%WP	0.2	100 (90.0)	100 (90.0)	100 (90.0)
SEm±			1.39	1.20	0.94
CD(P=0.01)			5.07	4.36	3.41

Figures in parenthesis are arcsine transformed values

Table. 66: *In vitro* evaluation of fungicides against *Lasiodiplodia theobromae*

No.	Fungicide	Dosage (%)	% inhibition of *Lasiodiplodia theobromae*			
			3DAI	6DAI	9DAI	12DAI
1	Azosystrobin 23%SC	0.1	12.3 (14.7)	40.6(39.6)	48.2 (43.9)	39.9 (39.1)
2	Carbendazim50%WP	0.1	33.0 (34.7)	20.6(27.0)	24.11 (29.4)	31.3 (34.0)
3	Carboxin 37.5% + Thiram 37.5%	0.3	100 (90.0)	100 (90.0)	100 (90.0)	100 (90.0)
4	Copper Oxy chloride50%WP	0.3	100 (90.0)	59.2 (50.3)	65.62 (54.1)	69.2 (56.3)
5	Difenoconazole 25%EC	0.1	26.3 (30.2)	57.2 (49.17)	72.7 (58.5)	76.9 (61.2)
6	Hexaconazole 5%SC	0.1	100 (90.0)	100 (90.0)	100 (90.0)	83.4 (65.9)
7	Propiconazole25%EC	0.1	100 (90.0)	100 (90.0)	100 (90.0)	100 (90.0)
8	Tebuconazole 25.9%EC	0.15	100 (90.0)	100 (90.0)	69.6 (56.5)	63.9 (53.0)
9	Tebuconazole50% + Trifloxystrobin25%WG	0.04	100 (90.0)	64.7 (53.6)	73.2 (58.8)	73.2 (58.8)
10	Tetraconazole3.8% w/w(4%w/v)EW	0.1	100 (90.0)	100 (90.0)	66.0 (54.3)	53.5 (47.3)
11	Tetraconazole3.8% w/w(4%w/v)EW	0.15	100 (90.0)	100 (90.0)	72.3 (58.2)	63.9(53.0)
12	Thiophanate Methyl 70%WP	0.2	100 (90.0)	27.5 (31.6)	25.4 (30.2)	30.7 (33.6)
SEm±			3.38	0.48	0.33	0.21
CD(P=0.01)			12.33	1.75	1.19	0.76

Figures in parenthesis are arcsine transformed values

Path. 5: Root (wilt) disease of coconut

Expt. 1: Assessing the incidence of root (wilt) disease in Tamil Nadu

Aliyarnagar

A survey on the occurrence of root (wilt) disease was conducted in different villages of Coimbatore, Dindigul, Tirupur and Theni districts. 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 17.1% followed by Anaimalai (6.5%) and no incidence was observed in Pollachi North. Farmers were repeatedly advised to remove the severely affected palms in order to prevent further spread of the disease. Two hundred and forty five trees in Nanjaegoundanpudur village, 200 tress in Ambarampalayam village of Pollachi South and 120 trees in Manakkadavu village of Anaimalai block were removed due to root (wilt) disease severity and low productivity. In Tirupur and Dindigul districts, root (wilt) disease symptoms were not observed in all the villages surveyed. In Theni district, Cumbum block recorded 27.3 per cent root (wilt) incidence while, no incidence was recorded in Theni and Bodi block. On an average, Coimbatore district showed 8.06 per cent of root (wilt) disease incidence while, Theni district recorded 11.4 per cent in all the villages surveyed.

Validation of root (wilt) disease management practices

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 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 sunnhemp @ 50 g/ palm
- Mulching the basin with coconut leaves
- Applying balanced dose of chemical fertilizers (Urea – 1.3 kg; superphosphate – 2.0 kg; Muriate of potash – 2.0 kg/palm/year)
- Basin irrigation - 200 litres of water once in four days
- Leaf rot management
- Cut and remove the rotten portions of the spindle and the adjacent two leaves
- Pouring 300 ml of fungicidal solution containing 2 ml of Contaf 5% EC around the spindle leaf
- Applying 20 g Phorate 10G mixed with 200 g fine sand around the base of the spindle leaf

In 2014-15, the post treatment observation showed average disease intensity ranged from 6 to 58 per cent, average disease intensity of 25.33 and the average nut yield per palm was 86.

As a part of AICRP (Palms) programme, another field trial was initiated at Manakkadavu village of Coimbatore district for the validation of root (wilt) disease management strategies based on site specific recommendation given by ICAR-CPCRI RS, Kayankulam in 0.4 ha. The palms are 26 years old. Following package was implemented.

- Addition of organic manure @ 25 kg per palm.
- Application of *Trichoderma viride* @ 50 gram per palm.
- Sowing dhaincha seeds@ 100 g per palm basin and incorporation with the initiation of flowering.
- Application of recommended dose of fertilizers.
- Addition of 50 g of Zinc sulphate per palm

4.4 INSECT PEST MANAGEMENT

Ent.3: Survey and monitoring of pest problems in coconut

(Aliyarnagar, Ambajipeta, Arsikere, Ratnagiri)

Aliyarnagar

Roving Survey:

Roving survey was carried out in four districts of Tamil Nadu, *viz.,* Coimbatore, Tiruppur, Dindugal and Theni. The extent of damage by different insect pests was recorded in terms of per cent incidence as well as intensity.

Major pests

The incidence of rhinoceros beetles was noticed in young plantations in the age group of 3-6 years. The incidence of rhinoceros beetle damage was in the range of 21.0 % (Tiruppur district) to 36.3% (Dindigul district). However, the maximum leaf damage was noticed in Coimbatore district (19.7%) whereas, the highest spindle damage was noticed in Dindigul district (26.3%).The red palm weevil infestation was noticed in the age group of 4-20 years old palms. Comparatively more incidence was noticed in Dindigul district (3.13%) followed by Theni district (1.53%).

Low level of infestation (less than 20%) by black-headed caterpillar was noticed in Thoppampatti block of Dindigul district and Satyamangalam block of Erode district. The infestation of eriophyid mite was also noticed in all the coconut growing districts of Tamil Nadu. A high nut damage of 66.6% was noticed in Dindigul district followed by 66.1 % in Theni district. However, the extent of mite damage according to the mean grade index (in the rating scale of 0.0 to 4.0) was noticed up to a maximum of 0.91 (Dindigul district) which is categorized as mild scale (Table 67).

Table 67. Mean incidence of major coconut pests in coconut growing districts of Tamil Nadu 2014-15

District	Rhinoceros beetle mean incidence (%)			Red palm weevil mean Incidence (%)	Nut damage due to eriophyid mite (%)	Eriophyid mite (Grade index)
	Incidence	Leaf damage	Spindle damage			
Coimbatore	30.5 ± 2.7	19.7 ± 3.2	20.5 ± 2.7	0.22 ± 0.04	57.3 ± 2.7	0.79 ± 0.06
Tiruppur	21.0 ± 4.0	10.6 ± 2.7	11.0 ± 4.0	0.82 ± 0.17	69.0 ± 2.5	0.85 ± 0.05
Dindigul	36.3 ± 3.8	18.9 ±4.1	26.3 ± 3.8	3.13 ± 0.71	66.6 ± 2.1	0.91 ± 0.06
Theni	34.4 ± 2.9	13.1 ±2.5	24.4 ± 2.9	1.53 ± 0.38	66.1 ± 3.4	0.84 ± 0.07

Mean values are expressed as Mean ± Standard error

Minor pests

The outbreak of a drepanid, *Phalacra vidhisara* was noticed in Thimmmanguthu block of Coimbatore district. The population of the larva was reduced drastically due to the natural occurrence of the pupal parasitoid, *Brachymeria lasus*. Occurrence of *P. vidhisara* was also noticed in Satyamangalam block of Erode district but not in outbreak proportion. Infestation by termites, *Odontotermes obesus* up to 44.7% incidence was recorded in Coimbatore district and 14.0% in Tiruppur district on tree trunks only in red soil type. An outbreak of slug caterpillar, *Macroplectra nararia* up to 75% was recorded in Saminathapuram village of Thoppampatti block in Dindigul district .

Incidence of *Phalacra vidhisara* in Nadhegoundanur village, Pollachi (South), Coimbatore district

Fixed plot survey

Fixed plot surveys were conducted in two villages in Coimbatore district *viz.*, Avalchinnampalayam and Kottur malayandipattinam. The Avalchinnampalayam garden was nearly seven years old (var: Chowghat Orange Dwarf). The red palm weevil incidence was recorded on a low scale (0.56%) during June 2014 and gradually reduced by March, 2015. Similarly, the leaf damage due to rhinoceros beetle, which was recorded as 24.6% during June 2014 declined to 6.5% during March, 2015. No eriophyid mite and black-headed caterpillar infestation was noticed in this garden.

The coconut garden at Kottur Malayandipattinam was more than 20 years old (var: West Coast Tall) and damage due to insect pests was low in the garden. The nut damage due to eriophyid mite was noticed up to 71.2% and a grade index of 1.31(Moderate) was recorded during March 2015 (Table 68).

Table 68. Extant of infestation by different pests in fixed plot surveys in Tamil Nadu (2014-15)

Month	Red palm weevil incidence (%)		Rhinoceros beetle (% leaf damage)		Nut damage (grade index) due to eriophyid mite (%)	
	A. palayam	Kottur	A. palayam	Kottur	A. palayam	Kottur
June 2014	0.56	No RPW incidence was observed	24.6 ± 4.8	No incidence was observed		69.1 (1.20)
Sept. 2014	0.34		12.3± 3.4			67.8 (1.12)
Dec. 2014	0.11		8.8 ± 1.6			60.7 (1.02)
March 2015	0.0		6.5 ± 0.8			71.2 (1.31)

values represent Mean ± standard error (S.E). A. palayam - Avalchinnampalayam

Ambajipeta

Roving survey was carried out in East Godavari and West Godavari districts. The incidence of Rhinoceros beetle was 10 per cent in the surveyed districts and the leaf damage by the beetle was 10.27, 10.43 per cent and spindle damage was 5.93,6.40 per cent, respectively in these two districts. No incidence of red palm weevil was observed in the survey. The infestation of black headed caterpillar was observed in Dosakayapalli village of East Godavari up to 48.82 per cent and in West Godavari up to 68.18 per cent. The infestation of eriophyid mite was recorded from all the plantations observed in the surveyed districts and was in the range of 67.34 to 78.82 per cent. Intensity of mite was mild to moderate in all the districts surveyed (Table 69).

Coconut black headed caterpillar infested field in Dosakayalapalli village in East Godavari , Andhra Pradesh

Fixed plot survey

Fixed plot survey was undertaken in Palivela village in Kothapeta mandal and Korlapativaripalem in Ambajipeta mandal

Table 69 . Mean Incidence of major coconut pests in important districts of Andhra Pradesh 2014-15 (Roving survey)

District	Black headed caterpillar Mean incidence (%)	Rhinoceros beetle			Red palm weevil Mean incidence (%)	Eriophyid mite Mean incidence (%)
		Incidence (%)	Intensity (%)			
			Leaf damage	Spindle damage		
E.Godavari	48.82 ± 2.55	10.27 ±1.77	8.99±1.21	5.93±0.62	Nil	78.82±3.26
W. Godavari	68.18 ± 3.81	10.43 ± 0.87	10.89±0.87	6.40±1.03	Nil	67.34 ± 2.79

*Values represent Mean ± Standard error

of East Godavari district. Low intensity of rhinoceros beetle leaf damage was noticed in both the gardens and it ranged from 7.27 to 8.83 per cent at Korlapativaripalem and 8.42 to 15.75 per cent at Palivela Village . No spindle damage was observed in the fixed plot gardens. Hundred per cent incidence of eriophyid mite was observed, however, mild to moderate scale of mite intensity up to September 2014 and severe scale in January 2015 was noticed in both the fixed plot survey villages. No incidence of red palm weevil and coconut black headed caterpillar was observed in fixed plot survey gardens (Table 70) .

Table 70. Extent of infestation by different pests in fixed plot surveys in Andhra Pradesh (2014-15)

Month	Rhinoceros beetle Incidence (%) (Leaf damage)		Eriophyid mite incidence (%) and intensity	
	Korlapa-tivari palem	Palivela	Korlapa-tivari palem	Pali-vela
Jun. 14	8.53 ± 1.29	8.88 ± 0.99	100% (1.17) Mild	100% (2.0) Mod-erate
Sept. 14	7.27 ± 1.29	15.75 ± 1.95	100% (1.91) Moderate	100% (1.45) Mode-rate
Dec. 14	8.82 ± 1.24	14.02 ± 1.16	100% (2.25) High	100% (2.17) High
Mar. 15	8.83± 0.97	8.42± 1.08	100% (1.84) Moderate	100% (2.19) High

Arsikere

Roving survey

The roving survey was carried out in Hassan, Tumkur, Mysuru and Mandya districts. The infestation of rhinoceros beetle was noticed mostly in all newly planted gardens in all the age group of 4 to 40 years. The highest incidence of 78.9 per cent was recorded in Hassan district and low incidence of 29.5 per cent was recorded in the Tumkur district. The incidence of red palm weevil was maximum (up to 10.8 %) in Tumkur district followed by 4.1% infestation in Mysuru district. The incidence of red palm weevil was also noticed in Mandya (2.1%) and Hassan (0.98 %) districts on a lower scale (Fig.2).

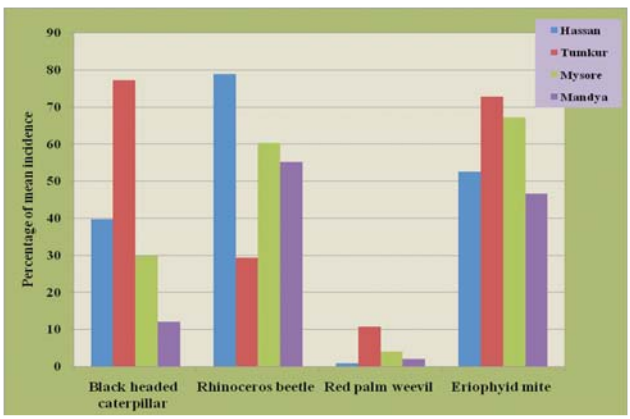

Fig.2: Mean Incidence of major coconut pests in important districts of Karnataka (2014-15)

The infestation by coconut black headed caterpillar was noticed in all the four major coconut growing districts of Karnataka, and severe (77.4 %) incidence was noticed in Tumkur district throughout the year and was followed by Hassan (39.9%), Mysuru (29.9%) and Mandya (12.1%). The infestation of eriophyid mite was also noticed in all major districts of Karnataka and in most cases, the incidence was as high as 100 per cent in the harvested nut samples. The highest incidence of mite incidence was recorded in Tumkur district (72.9%) followed by Mysuru (67.3%) and Hassan (52.6%), Mandya (46.7%) district.

Minor pests

In addition to the major pests, there were some minor pests noticed during the surveys. In Hassan district mealybug, termite and scale were noticed as a spot occurrence, the mealybug, *Pseudococcus* spp. was observed up to 35 % and its infestation in the spindle leaf as well as in harvested bunches was observed. In Tumkur, Mysuru and Mandya district, termite incidence was noticed .

Fixed plot survey:

To record the incidence and intensity of infestation of different pests of coconut, fixed plot survey was carried out at quarterly intervals from March 2014 to February 2015 in farmer's field located at Chikkanallikoppalu and Doddenahally villages of Hassan district. The palms are in the age group of 20 to 30 years. In Doddenahally, a high incidence of rhinoceros beetle (58.0%) and mite infestation (85.7%) was observed, whereas, at Chikkanallikoppalu village 41.7% leaf damage, 20% spindle damage by rhinoceros beetle and 33.6% mite infested nuts was recorded (Table 71).

Coconut black headed caterpillar infested field in Kaidalu village Tiptur Taluq (Karnataka)

Table 71. Extent of infestation by different pests in fixed plot surveys in Karnataka (2014-15)

Village	Black headed caterpillar mean incidence (%)	Rhinoceros beetle mean incidence (%)	Red palm weevil mean incidence (%)	Eriophyid mite mean incidence (%)	Leaf damage (%)	Spindle damage (%)	Nut infected (%)
Chikkanallikoppalu *							
Average	0.0	56.67	0.0	66.25	41.71	20.00	42.30
SEm±	0.0	5.08	0.0	1.27	1.88	1.82	2.82
Doddena hally *							
Average	0.0	58.02	0.0	85.73	36.84	10.53	41.18
SEm±	0.0	3.32	0.0	2.21	2.00	1.07	2.41

Ratnagiri

Roving survey work was carried out in major coconut growing districts of Konkan region of Maharashtra *viz.,* Ratnagiri and Sindhudurg districts. Rhinoceros beetle, red palm weevil, black headed caterpillar and eriophyid mite are major pests of coconut in this region. The infestation of rhinoceros beetle was in the range of 11.1 to 20.8% with a high spindle damage(7.5%) and leaf damage (13.3%) in Sindhudurg district .The incidence of red palm weevil was similar in both Ratnagiri (8.67 %) and Sindhudurg districts (8.3%). Maximum dead palms percentage was observed in Sindhudurg district (5.38) followed by Ratnagiri district (4.42). The infestation of black headed caterpillar was noticed in both the districts and ranged from 1.6 to 6.1%. The incidence of eriophyid mite was in the range of 41.4 to 48.4% and intensity of mite ranged from mild to moderate in the districts surveyed (Fig.3).

Fixed plot survey

Fixed plot survey was carried out at quarterly intervals from April 2014 to March 2015 at farmer's field in Ratnagiri taluka of Maharashtra. The infestation of rhinoceros beetle was in the range of 21.6 to 29.6 per cent and maximum infestation (29.6 per cent) was observed in the month of April 2014. The mean spindle damage was 4.4 per cent and leaf damage was 20.3 per cent. The infestation of red palm weevil was in the range of 7.2 to 14.00 per cent and maximum infestation (14.0 per cent) was recorded in the month of December 2014. The incidence of black headed caterpillar was noticed in the month of April 2014 and was 16.0 % . During rainy season, incidence had decreased and was recorded as 6.8 per cent in the month of August 2014 and again slowly increased up to the extent of 13.6 per cent in March 2015 . The infestation of eriophyid mite was in the range of 27.2 to 37.6 per cent and maximum infestation (37.6 per cent) was in the month of August 2014. The intensity of this pest was from low to moderate (Fig.4).

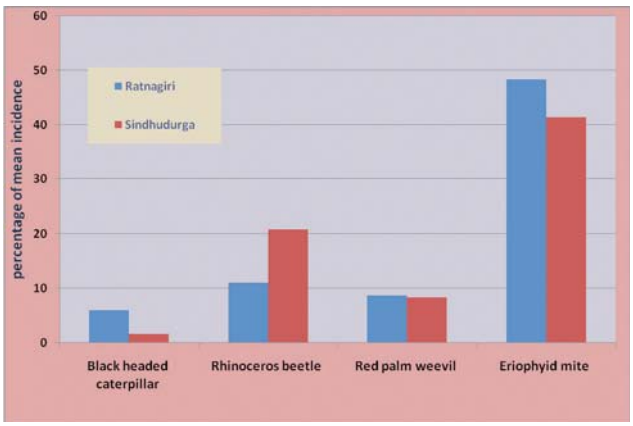

Fig. 3: Mean Incidence of major coconut pests in important districts of Maharashtra (2014-15)

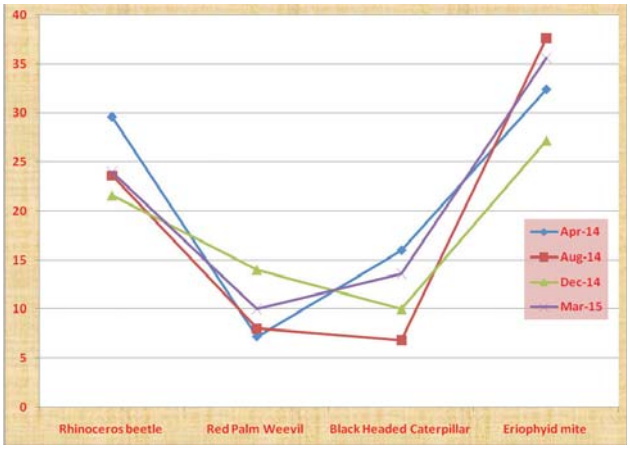

Fig. 4: Extent of infestation by different pests in fixed plot surveys in Maharashtra (2014-15)

Ent. 5: Management of eriophyid mite in coconut gardens

(Aliyarnagar, Ambajipeta, Arsikere, Ratnagiri)

Aliyarnagar

The trial is being continued in the farmers' field at Kottur Malayandipattinam, Anaimalai block, Coimbatore district. In the pre treatment, the per cent nut damage ranged from 30.2 to 32.1 in different treatments. Upon imposing the treatments, there was a gradual reduction in the per cent nut damage along with a decrease in mean grade index. After four months of imposing the treatments, the INM treatments with and without root feeding stood on par with each other with a grade index of 0.68 and 0.84, respectively, while in control garden a grade index of 1.12 was recorded. Eight months after imposing the treatments, the INM treatment with root feeding showed the least grade index (0.59) while the control plot showed a grade index of 1.19 (Table 72).

Table 72. Per cent nut damage and mean damage grade index due to eriophyid mite infestation in experimental plots in Coimbatore district (2014-15)

Treatment	Pre treatment		After 4 months		After 8 months	
	Damaged nuts (%)*	Mean Grade Index**	Damaged nuts (%)*	Mean Grade Index**	Damaged nuts (%)*	Mean Grade Index**
T_1 : (With root feeding)	30.2 (33.3)	0.83 [a] (1.15)	22.6 [a] (28.4)	0.68 [a] (1.09)	20.4 [a] (26.9)	0.59 [a] (1.04)
T_2 : (INM, IPM, without root feeding)	31.2 (34.0)	0.76 [a] (1.12)	29.6 [b] (33.0)	0.84 [a] (1.16)	27.4 [b] (31.6)	0.78 [a] (1.13)
T_3: (Control)	32.1 (34.5)	1.27 [b] (1.27)	31.3 [b] (34.0)	1.12 [a] (1.27)	34.5 [c] (36.0)	1.19 [ab] (1.30)
Significance			Sig	Sig	Sig	Sig
SE (Mean)			2.15	0.07	3.52	0.09
't' value			1.55	0.50	1.06	0.67

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

Ambajipeta

The trial was conducted in farmer's field in Korlapativaripalem village of East Godavari district. The pre treatment observation revealed that the eriophyid mite infestation was 48.4, 48.4 and 73.3 per cent, respectively in the T1, T2 and T3 treatments. After four months interval, the mite infestation increased in all the treatments *i.e.,* from 48.4 per cent to 62.3 per cent in treatment T_1, from 48.4 per cent to 62.81per cent in treatment T_2 and in control from 73.3 per cent to 78.4 per cent. After eight and twelve months a similar increase in mite infested nuts was recorded in all the treatments from 48.4 per cent to 97.0 per cent in treatment T_1, from 48.4 per cent to 97.7 per cent in treatment T_2 and in control from 73.3 per cent to 98.9 per cent was recorded. Regarding eriophyid mite intensity, the initial MDGI was in the range 0.60 to 1.53 with scale being mild to moderate. After four, eight and twelve months interval, the grade index in treated and control plots also gradually increased (Table 73).

Table 73. Per cent nut damage and mean damage grade index due to eriophyid mite infestation in experimental plots in East Godavari district (2014-15)

Treat-ment	Pre treatment (March 14)		1st Quarter (May 14)		2nd Quarter After 4 months (September 14)		3rd Quarter After 4 months (March 15)	
	Percent infestation of mite*	Mean damage grade index**	Percent infestation of mite	Mean damage grade index	Mean damage grade index	Mean damage grade index	Percent infestation of mite	Mean damage grade index
T_1 : INM, IPM garden (With Root feeding)	48.42 (44.08)	0.60 (1.02)	62.29 (56.29)	1.02 (1.41)	65.82 (54.64)	1.11 (1.45)	97.02 (84.27)	1.15 (1.46)

T_2 : INM, IPM garden (Without Root feeding)	48.45 (44.10)	0.75 (1.08)	62.81 (56.37)	1.12 (1.45)	66.32 (56.09)	1.35 (1.46)	97.74 (86.87)	1.13 (1.46)
T_3 : Control	73.3 (61.31)	1.53 (1.17)	78.40 (62.35)	1.13 (1.46)	75.68 (61.65)	1.65 (1.62)	98.87 (86.13)	1.70 (1.64)
SEm±	2.39	0.03	5.82	0.41	2.45	0.02	1.69	0.03
CD (P=0.05)	6.93	N.S.	NS	NS	NS	0.05	NS	NS

* Figures in parenthesis are arcsine transformed values, ** Figures in parenthesis are square root transformed values

Arsikere

The trial was conducted at Horticulture Research Station, Arsikere. The per cent nut damage and mean damage grade index was assessed in the experimental plots prior to the experiments and later at four months interval. The per cent nut damage ranged between 86.1 and 87.8 before treatment imposition. 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 71.2 to 78.8 in the treatments T_1 & T_2 as against 89.1 in control. By eighth month, the IPM and INM treatments with and without root feeding were effective in reducing mite infestation with 63.4 and 71.2% nut damage as against 91.2% nut damage in control plot. Similarly, after 12 months of imposing the treatments, the per cent nut damage gradually reduced to 57.1 to 66.6 in the treatments (T_1 and T_2) as against 92.3 in control (Table 74).

A similar trend was also noticed in the mean grade index due to eriophyid mite infestation. After twelve months of imposing treatments, the IPM+INM (with root feeding) treatment imposed gardens exhibited the least MGI (1.65) and was on par with IPM+INM (without root feeding) gardens with a MGI of 2.28 and were significantly superior to the control plot (MGI = 3.84).

Table 74. Per cent nut damage and mean damage grade index due to eriophyid mite infestation in experimental plots in Hassan district (2014-15)

Treatment	Pre treatment		After 4 months		After 8 months		After 12 months	
	Damaged nuts (%)*	Mean Grade Index**	Damaged nuts (%)*	Mean Grade Index**	Damaged nuts (%)*	Mean Grade Index**	Damaged nuts (%)*	Mean Grade Index**
T_1 (INM, IPM With root feeding)	87.84 (69.59)	3.65 (1.91)	71.19 (57.54)	2.91 (1.71)	63.41 (52.78)	2.44 (1.56)	57.15 (49.11)	1.65 (1.28)
T_2 (INM, IPM without root feeding)	86.11 (68.12)	3.81 (1.95)	78.84 (62.61)	3.05 (1.75)	71.22 (57.56)	2.74 (1.66)	66.64 (54.72)	2.28 (1.51)
T_3 (Control)	87.03 (68.89)	3.72 (1.93)	89.12 (70.74)	3.81 (1.95)	91.18 (72.72)	3.88 (1.97)	92.33 (72.93)	3.84 (1.96)
Significance	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig
SE m±	0.30	NS	1.22	0.02	0.91	0.047	1.64	0.16
CD (P=0.01)	0.91	NS	3.67	0.06	2.75	0.14	4.89	0.48

*Figures in parenthesis are arcsine transformed values, **Figures in parenthesis are square root transformed values

Ratnagiri

The trial was conducted in farmer's field in Karla village of Ratnagiri district. The pre treatment and post treatment observations were recorded at four months interval up to twelve months from 3rd bunch in the selected plots. Before imposition of treatments it was observed that the eriophyid mite infestation was 50.9, 49.3 and 53.6 per cent in different blocks. After four months interval, the mite infestation gradually decreased from 50.9 per cent to 45.4 per cent in treatment T_1 and from 49.3 per cent to 48.9 per cent in treatment T_2. Similar trend in mite infestation was observed even after eight and twelve months interval. In treatment T_1, mite infestation decreased up to 32.5 per cent while in treatment T_2 it decreased up to 45.2 per cent. The treatment T_1 (INM with root feeding) was significantly superior over rest of the treatments followed by T_2.

The eriophyid mite intensity initially was in the range of 2.8 to 3.4 with mean damage grade index being high to severe. After four, eight and twelve months interval, in treated plots it gradually declined to mild. However, the grade index remained under severe scale in control indicating significant effect of the treatments over control from fourth month after treatments. After twelve months, treatment T_1 followed by treatment T_2 recorded lower mite infestation compared to control(Table 75).

Table 75 . Per cent infestation of Eriophyid mite and mean damage grade index in experimental plots in Ratnagiri district (2014-15)

Treatment	Pre treatment		1st Quarter After 4 months		2nd Quarter After 8 months		3rd Quarter After 12 months	
	Per cent infestation of mite*	Mean damage grade index**	Per cent infestation of mite*	Mean damage grade index**	Per cent infestation of mite*	Mean damage grade index**	Per cent infestation of mite*	Mean damage grade index**
T_1 : (INM, IPM With root feeding)	50.96 (45.55)	2.85 (High)	45.44 (42.38)	2.20 (High)	42.69 (40.80)	1.10 (Moderate)	32.50 (34.76)	0.85 (Mild)
T_2 : ((INM, IPMWithout root feeding)	49.32 (44.61)	3.25 (Severe)	48.93 (44.39)	2.60 (High)	51.32 (45.76)	1.40 (Moderate)	45.24 (42.27)	1.20 (Moderate)
T_3 (Control)	53.64 (47.09)	3.45 (Severe)	50.91 (45.52)	3.16 (Severe)	51.89 (46.08)	3.40 (Severe)	76.67 (61.12)	3.20 (Severe)
SEm±	0.33	0.08	0.80	0.04	0.32	0.05	0.32	0.07
CD (P=0.05)	1.07	N.S.	N.S.	0.12	1.06	0.15	1.06	0.22

*Figures in parenthesis are arc sin transformation., **Figures in parenthesis are square root transformed values

Ent.11: Evaluation of olfactory conditioned larval parasitoid (*Goniozus nephantidis*) in the field against *O. arenosella*

Arsikere

The field trial was conducted in coconut black headed caterpillar out break garden in a farmer field of Kaidalu, Tiptur Tq. Tumkur Dist. The larval parasitoid *Goniozus nephantidis* was mass multiplied in the laboratory for conducting the experiments. The parasitoids were pre-conditioned in the laboratory prior to release in the field. For olfactory conditioning, the parasitoids were exposed to odor of larval frass for about 48 to 72 hours. Before releasing the parasitoid, a pre treatment count on the no. of larva/ leaflet was recorded. Then, parasitoids were released @ 20 per palm. Four releases were made at 10 days interval during the experimental period. Each treatment was replicated on 10 palms. An untreated control check was also simultaneously maintained.

There was a high initial larval population ranging from 21.6 to 22.4 / ten leaflets in October 2014 and gradually decreased to 16.25, 5.12 and 1.86/ten leaflets in treatment T_1(Conditioned) and 18.22, 8.66 and 4.53 /ten leaflets in treatment T_2(Unconditioned). In untreated control, the larval population of 21.9 /ten leaflets was recorded and showed an increase to 23.45 and 25.22/ten leaflets in first and second months and later decreased to 16.44 in third month. The conditioning of parasitoid treatment had more impact on reducing black headed caterpillar population when compared to un-conditioned parasitoid (Table 76).

Table 76. Evaluation of pre-conditioned parasitoid *G. nephantidis* against *O. arenosella* in Karnataka (2014-15)

Treatment	Avg. no. of larvae/ ten leaflets (Pre release count) October 2014	(*O. arenosella* larval population/ ten leaflets) (Post release count)		
		After one month (November- 2014)	After second month (December- 2014)	After third month (January- 2015)
T_1(Conditioned)	21.65 (4.65)	16.25 (4.03)	5.12 (2.26)	1.86 (1.36)
T_2(Unconditioned)	22.4 (4.73)	18.22 (4.27)	8.66 (2.94)	4.53 (2.13)
T_3 (Control)	21.97 (4.69)	23.45 (4.84)	25.22 (5.02)	16.44 (4.05)
SE M+	0.02	0.15	0.9	1.2
CD (P=0.05)	0.06	0.45	2.66	2.8

* Figures in parenthesis are converted into square root transformed values

Ent.12: Studies on field efficacy of commercially available pheromones against Rhinoceros beetle

(Aliyarnagar, Ambajipeta, Arsikere, Ratnagiri)

Aliyarnagar

The NPM CPCRI lure recorded the maximum trap catch (209 beetles) with a mean catch of 52.3/ trap and the PCI lure recorded a trap catch of 44.0./ trap (176 beetles from four traps). The placement of saw dust inside the PVC pipes resulted in trapping of the virgin female beetles. The sex ratio in both NPM CPCRI as well as PCI lures were biased towards females. The sex ratio was 2.02 (Female: Male) in NPM CPCRI lure while it was 2.59 in case of PCI lures. The NPM CPCRI lures were changed one time while the PCI lures were changed two times during the experimental period (Table 77).

Eggs of rhinoceros beetle obtained in CPCRI rhinolure trap

CPCRI designed Rhinolure pipe trap for beetle attaraction

Table 77. Comparative efficacy of different lures against rhinoceros beetle in Tamil Nadu (2014-15)

Month	Total no. of beetles trapped in 4 traps		
	T_1 – NPM CPCRI lure	T_2 – PCI lure	T_3 – Blank trap
April, 2014 To March 2015	209	176	0
Mean nos./ trap	52.3 ± 5.2	44.0 ± 4.2	0
Sex ratio	2.02	2.59	-
Lure installation date	24th June 2014	24th June 2014	-
Lure replacement	14th January 2015	7th October,2014 6th January, 2015	-

Values represent Mean ± Standard Error
Chi square = 8.5; df 2; Kruskall-Wallis test (Sig <0.05)

Ambajipeta

Studies were conducted with NPM CPCRI lure and PCI lure arranged in two different gardens. From the data it was found that the highest number of beetles was trapped in CPCRI lure (trapped 87 beetles/4 traps with an average of 1.81 beetles/trap/month) whereas, in PCI lure, 77 beetles /4 traps with an average of 1.60 beetles/trap/month during the experimental period were trapped. No catch was recorded in control trap (Table 78).

Table 78. Comparative efficacy of different lures against rhinoceros beetle in Andhra Pradesh (2014-15)

Sr. No	Month	Total no. of beetles trapped in 4 traps								
		T_1 – NPM CPCRI lure			T_2 – PCI lure			T_3 – Blank trap		
		M	F	T	M	F	T	M	F	T
1.	April 2014 to March 2015	30	57	87	32	45	77	0	0	0
	Mean ± SE	7.25 ± 1.76			6.42 ± 1.41					

Arsikere

The experiment was carried out at Chikkanahally koppalu village in farmers' field with two lures *i.e.*, NPM CPCRI-T_1 and PCI-T_2 and Blank trap (T_3). The results revealed that NPM CPCRI lure trapped significantly higher number of rhinoceros beetles (45.50 beetles / trap) as compared PCI lures (18.50 beetles / trap). No catch was recorded in control trap (Table 79).

Table 79. Comparative efficacy of different lures against rhinoceros beetle in Karnataka (2014-15)

Month	Total no. of beetles trapped in 4 traps		
	T_1 – NPM CPCRI lure	T_2 – PCI lure	T_3 – Blank trap
August 14 To March 15	182	74	0
Mean nos./ trap	45.50 ± 2.83	18.50 ± 1.82	0.0 ± 0.0

Values represent Mean ± Standard Error
Chi square = 30.1; df 2; Kruskall-Wallis test (Sig <0.05)

Ratnagiri

The results of the lure studies revealed that NPM CPCRI lure significantly trapped higher number of beetles (243 beetles) with a mean catch of 30.38 per trap as compared to PCI lures (162 beetles) with a mean of 20.38. No catch was recorded in control trap. It was observed that NPM CPCRI lure trapped more number of beetles than PCI lure (Table 80).

Table 80. Comparative efficacy of different lures against rhinoceros beetle in Maharashtra (2014-15).

Month	Total no. of beetles trapped in 4 traps		
	T_1 – NPM CPCRI lure	T_2 – PCI lure	T_3 – Blank trap
August 14 To March 15	243	162	0
Mean nos./ trap	30.38±4.72	20.38 ± 4.32	0

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

Arsikere

The IPM package including use of pheromones, *baculovirus*, naphthalene balls and *Metarhizium anisopliae* was applied on a large contiguous area of 10.00 ha. This trial was conducted in farmers' field at Doddenahally village of Arsikere Taluk, Hassan district in 9-10 years old coconut garden. Pre-treatment observations on incidence of rhinoceros beetle, leaf and spindle damage were recorded. The garden had 85 % incidence, 48.14 % leaf damage and 32.05 % spindle damage before the initiation of the experiment. The observations recorded after four months indicated that, incidence was reduced to 38.09 %, the leaf damage came down from 48.14 % to 38.09% while the spindle damage reduced from 32.05 to 19.07 %. The second observation recorded after eight months indicated that the incidence had reduced up to 24.21 %, the leaf damage came down from 26.14% to 21.08% while the spindle damage reduced from 19.07% to 12.31 % (Fig.5).

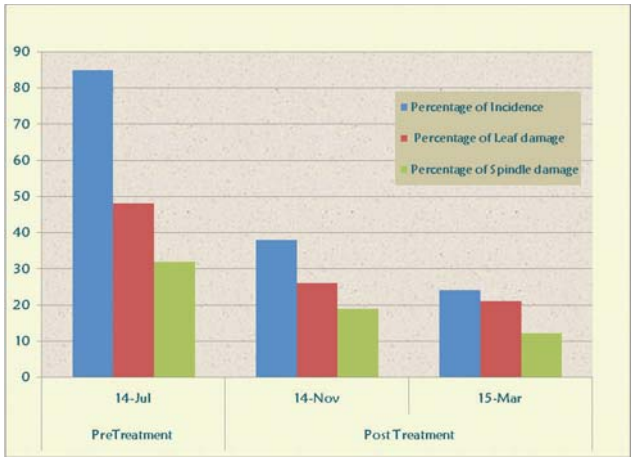

Fig.5: Pre and post treatment infestation levels of rhinoceros beetles in the experimental garden in Karnataka (2014-15)

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

(Aliyarnagar, Ambajipeta, Arsikere, 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 varied between

12.4 to 16.0/ mm^2 in different treatments. Upon imposing the treatments, the population gradually reduced to 11.0/mm^2 (T1) at four months after spraying and 10.9/ 4 mm^2 (T1) at eight months after spraying. The percentage of damaged nuts also showed a similar trend, the treatment T1 recorded a initial nut damage of 49.6% which reduced to 39.6 % at eight months after spraying, while the control registered a nut damage of 74.2%. The mean grade index also gradually reduced from 0.77 to 0.70 (4 MAS) and 0.66 (8 MAS) while the control registered a mean grade index of 1.64 at eight months after spraying (Table 81). The predator population varied non significantly from 0.3 to 1.0 per nut through out the study period.

Table 81. Grade index of harvested nuts, mite intensity and mite population per 4mm^2 in experimental garden (2014-15) (Aliyarnagar)

Treat-ment	Pre treatment observation (August 2014)			Post treatment observation (4 months after spraying) (Dec 2014)			Post treatment observation (8 months after spraying) (March 2015)		
	Damaged nuts (%)#	MGI **	mite / 4mm^2 **	Damaged nuts (%)#	MGI **	mite / 4mm^2 **	Damaged nuts (%)#	MGI **	mite / 4mm^2 **
T1	49.6	0.77	12.4	39.5 ^{a} (38.9)	0.70 ^{a} (1.10)	11.0 ^{a} (3.39)	36.2 ^{a} (37.0)	0.66 ^{a} (1.08)	10.9 ^{a} (3.38)
T2	57.4	0.82	13.0	43.6 ^{a} (41.3)	0.71 ^{a} (1.10)	11.5 ^{a} (3.46)	42.9 ^{b} (40.9)	0.69 ^{a} (1.09)	11.2 ^{a} (3.42)
T3	66.1	1.17	12.5	56.4 ^{b} (48.7)	1.35 ^{a} (1.36)	11.9 ^{a} (3.52)	59.5 ^{c} (50.5)	1.33 ^{b} (1.35)	11.1 ^{a} (3.41)
T4	76.4	1.52	16.0	70.5 ^{c} (57.1)	1.59 ^{ab} (1.45)	13.5 ^{a} (3.74)	74.2 ^{d} (59.5)	1.64 ^{b} (1.46)	13.9 ^{a} (3.79)
Sig	-	-	-	NS	Sig	NS	Sig	Sig	NS
SE (Mean)	-	-	-	1.61	0.07	0.39	2.91	0.08	0.16
t value	-	-	-	6.11	0.26	3.85	3.16	0.13	10.75

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 paired t test (P=0.05)

Ambajipeta

The experiment was initiated in the month of February 2012 with four treatments with 20 palms in each treatment (total 80 palms for the experiment). The pre treatment mite population which ranged from 0.70 to 1.37/ 1mm^2 in February 2014 increased in all the treatments by February 2015 along with an increase in predator population was observed in the November 2014 and February 2015 sample nuts as compared to February 2013 months sample nuts. The lowest mite population of 0.13 and 1.22 /1mm^2 was continuously recorded in treatment T1: Spraying talc formulation of *H. thompsonii* @20g/palm during the entire observational period (Table 82 and 83) .

Table 82. Grade index of harvested nuts and mite intensity from Feb.14 to Feb. 2015 (Ambajipeta)

Tr. No.	Pre treatment harvested nuts scale Feb 2014	Grade index for November 2013 sprayed and September 2014 harvested nuts	Grade index and mite intensity for Feb2014 sprayed and Nov 2014 harvested nuts	Grade index for May 2014 sprayed and Feb 2015 harvested nuts
T1	1.67 (1.63) (moderate)	1.16 (1.46) (moderate)	1.0 (1.41) (Mild)	1.36 (1.53) (moderate)
T2	1.85 (1.67) (moderate)	0.88 (1.36) (Mild)	1.07 (1.43) (moderate)	1.89 (1.70) (moderate)
T3	1.03 (1.39) (moderate)	1.15 (1.46) (moderate)	1.20 (1.48) (moderate)	2.60 (1.89) (High)
T4	2.0 (1.69) (moderate)	1.44 (1.56) (moderate)	1.04 (1.43) (moderate)	2.48 (1.85) (moderate)
SEm±.	0.09	0.05	0.04	0.07
CD (P=0.05)	N.S.	NS	NS	0.22

Table 83. Average population of mite and predator and percentage of intensity (Ambajipeta)

Tr. No.	Pre treatment (February 2014)			Post treatment (November 2014)			Post treatment (February 2015)		
	Avg. population		% intensity	Avg. population		% Int ensity	Avg. population		% Int ensity
	mite / 1mm²	Preda-tor/nut		mite / 1mm²	Predator/ nut		mite / 1mm²	Predator/ nut	
T_1	0.70 (1.08)	1.00 (1.15)	66.22 (55.00)	0.13 (1.06)	5.0 (0.241)	67.71 (56.22)	1.22 (1.48)	12.5 (3.49)	74.28 (63.10)
T_2	0.66 (1.04)	4.00 (2.00)	62.89 (52.89)	0.21 (1.10)	3.0 (1.96)	76.51 (62.97)	2.85 (1.95)	10.80 (3.35)	84.86 (73.51)
T_3	0.43 (0.95)	1.80 (1.44)	53.96 (47.37)	0.56 (1.24)	2.0 (1.68)	76.08 (63.65)	3.65 (2.09)	3.2 (1.95)	66.62 (60.71)
T_4	1.37 (1.34)	5.70 (2.20)	66.75 (55.62)	0.53 (1.23)	2.0 (1.66)	80.28 (66.04)	3.92 (2.18)	1.9 (1.68)	88.05 (76.040
SEm±.	0.07	0.26	2.54	0.03	0.13	2.65	0.13	0.28	7.16
CD (P=0.05)	0.20	0.76	N.S.	0.09	0.38	NS	0.37	0.80	NS

Figures in parenthesis are square root transformed values

Arsikere

The trial was conducted at HRES, Arsikere Hassan district. The pre-treatment observations were recorded before imposing the treatments. Post treatment observations were recorded at three, six months intervals. Simultaneous observations were also made in the control plot. Before application of treatments, it was observed that the population of eriophyid mite ranged between 17.54 to 19.12 /4mm^2. After three months of spraying, all the treatments showed significant reduction in mite population (14.57 to 15.85/4mm^2) when compared to control (20.25/4 mm^2). The extent of nut damage in different treatments ranged from 71.20 to 74.13% with a mean grade index of 1.6 to 2.00 before the initiation of the experiment. After three months of spraying, the treatment T_2 *H. thompsonii* treated palms registered the least damaged nuts (67.92 %) and mean grade index (1.25), whereas after six months of spraying *H. thompsonii* treated palms recorded the least damaged nuts (61.32%) and mean grade index (0.84) (Table 84). The predator population varied non significantly from 0.0 to 1.2 per nut through out the study period.

Spraying operation of *H. thompsonii* in experimental gardens

Table 84. Grade index of harvested nuts, mite intensity and mite population per 4mm^2 in experimental garden at Arsikere (2014-15)

Tr. No.	Pre treatment observation(Oct. 2014)			Post treatment observation (3 months after spraying) (Jan 2014)			Post treatment observation (6 months after spraying) (April 2015)		
	Damaged nuts (%)#	MGI**	mite / 4mm^2**	Damaged nuts (%)#	MGI**	mite / 4mm^2**	Damaged nuts (%)#	MGI**	mite / 4mm^2**
T1	73.35 (58.92)	1.8 (1.34)	18.52 (4.30)	68.44 (55.82)	1.3 (1.14)	14.84 (3.85)	61.32 (51.54)	0.84 (0.92)	11.81 (3.44)
T2	71.2 (57.54)	1.6 (1.26)	18.32 (4.28)	67.92 (55.50)	1.25 (1.12)	14.57 (3.82)	65.19 (53.84)	1.12 (1.06)	12.25 (3.50)
T3	74.13 (59.43)	2 .00 (1.41)	17.54 (4.19)	72.02 (58.06)	1.8 (1.34)	15.85 (3.98)	70.58 (57.15)	1.45 (1.20)	13.77 (3.71)
T4	73.66 (59.12)	1.9 (1.38)	19.12 (4.37)	76.41 (60.94)	2.2 (1.48)	20.25 (4.50)	79.44 (63.04)	2.4 (1.55)	19.63 (4.43)
SE m±	0.3	0.04	0.03	0.8	0.03	0.01	1.2	0.08	0.21
CD (P=0.05)	0.9	0.12	0.09	2.4	0.09	0.03	3.6	0.24	0.63

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

Ratnagiri

The experiment was initiated with four treatments with 20 palms/treatment. The spraying results revealed that the treatment T_3 recorded significantly the lowest mite infestation i.e. 32.70 per cent after 12 months period which was initially 36.27 per cent. A reduction of Mean Damage Grade Index was observed in Treatments T_2 and T_3. Both the treatments recorded Mild MDGI followed by T_1 which recorded Moderate MDGI whereas, it was high in Control. The pre treatment mite population ranged from 2.78 to 2.82 mites/1mm^2 in February 2014 and decreased to 1.38 to 1.40 mite/1mm^2 in March 2014 except control. Mite population increased in control plot. However, predator population was very low (Table 85).

Table 85. Grade index of harvested nuts and mite intensity from February 2014 to March 2015 (Ratnagiri)

Treatments	Pre treatment harvested nuts scale Feb 2014	Per cent Mite infested nuts Feb 2014	Grade index and mite intensity for Feb 2014 sprayed and Dec 2014 harvested nuts	Grade index for May 2014 sprayed and Feb 2015 harvested nuts	Per cent Mite infested nuts Feb 2015
T1	2.44 (1.85) (High)	45.38(42.35)	1.20 (1.48) (Moderate)	1.55 (1.60) (Moderate)	40.98(39.79)
T2	2.71(1.92) (High)	38.84(38.55)	1.79(1.67) (Moderate)	0.55(1.24) (Mild)	38.32(38.24)
T3	2.49 (1.87) (High)	36.27 (37.02)	1.80 (1.67) (Moderate)	0.75 (1.32) (Mild)	32.70 (34.87)
T4	2.46 (1.86) (High)	61.03 (51.37)	2.59 (1.89) (High)	2.57 (1.89) (High)	61.93 (51.91)
S.E.	0.04	0.50	0.05	0.03	0.80
C.D. (P=0.05)	N.S.	1.40	0.15	0.10	2.31

Ent. 17: Evaluation of insecticides against the red palm weevil, *Rhynchophorus ferrugineus*

(Aliyarnagar, Ambajipeta, Arsikere, Ratnagiri)

Aliyarnagar

Gardens with adequate damage by *R. ferrugineus* were selected for the experiment. Initial observations on the effect of different insecticides against red palm weevil revealed that crown application of imidacloprid and indoxacarb registered 70% and 50% recovery of affected palms. Trunk application (through the affected bore hole) with chlorantraniliprole also registered a recovery of 66.7%, while trunk application of carbosulfan was not found to be effective (Table 86).

Ambajipeta

The experiment was initiated during December 2014 in red palm weevil affected coconut garden at Yarramsettivaripalem village of P.Gannavaram mandal of East Godavari district with five treatments with one palm in each treatment. The experimental garden is of one acre (80 palms) with East Coast Tall (ECT) variety palms aged between 10-15 years. In the experimental garden, red palm weevil pre infestation was 6.25 percentage *i.e.*, 5 palms out of 80 palms. Each treatment was imposed in one palm each. After three months, fresh infestation was noticed only in Imidacloprid and Chlorantraniliprole treatment imposed palms and the treatments were reimposed on the affected palms in these two treatments .

Table 86. Efficacy of newer insecticides against red palm weevil infestation in Tamil Nadu (2014-15)

Treatment	Dose (ml per 500 ml of water)	No. of trees treated	No. of trees recovered	Recovery (%)
Imidacloprid 17.8 SL Crown application	0.5	10	7	70.0
Indoxacarb 14.5 SC Crown application	2.0	6	3	50.0
Chlorantraniliprole 18.5 SC Trunk application	2.0	3	2	66.7
Carbosulfan 25 E C Trunk application	2.5	3	0	0.0
Untreated control	-	8	0	0.0

Arsikere

An experiment was intiated at Bidarammanagudi kaval (25 km away from HRES, Arsikere) in farmers' field. To evaluate insecticides against the red palm weevil, *Rhynchophorus ferrugineus* with four chemicals.The chemicals were imposed on the affected palms once in a month through crown region as well as through bored hole by weevil on trunk portion. Post treatment observations were recorded at three and six months intervals. Simultaneous observations were also made in control plot. After 6 months, the recovery was highest in chlorantraniliprole application (85%) followed by Indoxacarb application (80%) (Table 87).

Table 87. Per cent recovered palms by the chemicals insecticides against the red palm weevil, at Bidarammanagudi kaval, Arsikere (2014-15)

Age of palm (Year)	Total number of palms	No. of Red palm weevil infected palm	Red palm weevil Mean Incidence (%)	% Recovered palms by the chemicals			
				Carbosulfan 25 EC : (2.5 ml + 500 ml of water)	Indoxacarb 14.5 SC : (2.0 ml + 500 ml of water)	Imidacloprid 17.8 SL: (0.5 ml + 500 ml of water)	Chlorantraniliprole 18.5 SC: (2.0 ml + 500 ml of water)
Before initiation of the experiment							
08	65	53	81.53	0%	0 %	0%	0%
After 3 months							
08	65	53	81.53	15%	30 %	25%	35%
After 6 months							
08	65	53	81.53	55%	80%	65%	85%

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 in the farmer's field 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 x66 (NRCOP 16)
25 x214 (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 x214 (NRCOP 15)	28 x 68 (NRCOP 20)

Significant differences were observed for palm height, palm girth, number of leaves, number of female inflorescence, number of male inflorescence and fresh fruit bunch yield among hybrids. The palm height ranged from 2.3 to 3.3 m. The lowest palm height (2.3 m) was recorded in the hybrid NRCOP 16 and the hybrid NRCOP 11 recorded significantly the highest palm height (3.3 m). Number of leaves produced per year was the highest in NRCOP 14 (26.8) and number of female inflorescence was the highest in NRCOP17(13.7). Data on FFB yield revealed that, significantly the highest yield (157.3 kg/palm), (22.5 t/ha) was registered in the hybrid NRCOP 17 during the period under report (Table 87).

Table 87. Growth performance of oil palm hybrids (2014-15)

Hybrids	Palm height (m)	Palm girth (m)	No. of leaves produced/ palm/year	No. of female inflorescence	Sex Ratio	FFB yield (kg/palm)	Yield / ha (t/ha)
NRCOP 11	3.3	3.4	25.7	12.3	67.2	117.5	16.8
NRCOP 12	2.4	2.6	23.2	12.0	70.2	91.6	13.1
NRCOP 13	3.2	2.7	26.3	12.1	63.8	89.9	12.9
NRCOP 14	3.1	2.8	26.8	13.2	69.3	119.6	17.1
NRCOP 15	2.5	2.9	26.4	11.7	65.4	97.6	13.9
NRCOP 16	2.3	2.4	24.2	13.0	67.0	101.8	14.6
NRCOP 17	2.5	2.7	25.9	13.7	73.3	157.3	22.5
NRCOP 18	2.5	2.6	24.4	11.6	64.8	122.4	17.5
NRCOP 19	3.0	2.7	24.3	12.7	69.4	97.2	13.9
NRCOP 20	3.2	2.9	25.5	11.0	63.6	155.6	22.3
S. Em±	0.39	0.27	1.17	0.3	3.14	24.71	3.53
CD (P=0.05)	0.80	0.60	2.36	0.8	6.30	50.40	7.08

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 IIOPR, Regional Station, Palode were planted during 2007 by adopting RBD with 3 replications and 6 palms per treatment.

Hybrid cross combinations

NRCOP-1 (78Dx435P)	NRCOP-6 (173D x435P)
NRCOP-2 (90Dx577P)	NRCOP-7 (183D x577P)
NRCOP-3 (158Dx116D)	NRCOP-8 (70 Dx577P)
NRCOP-4 (131Dx435P)	NRCOP-9 (28Dx435P)
NRCOP-5 (5D x 577P)	NRCOP-10 (345Dx577P)

During 2014-15, significant difference in palm height was observed for different oil palm hybrids. The palm height was significantly lower with the hybrids NRCOP-6 and NRCOP-8 over NRCOP-1 (1.91m) and it was on par with other hybrid combinations (Table 88). Palm girth did not differ significantly among hybrids. The number of female inflorescence significantly differed among the hybrids. The significantly higher number of female inflorescence was recorded with the hybrid NRCOP-4 (13.7) over NRCOP-1 (10.7), NRCOP-2 (9.7), NRCOP-3 (10.4), NRCOP-6 (11.3), NRCOP-9 (11.6) and NRCOP-10 (10.9). The other hybrids were on par with NRCOP-4.

FFB yield and yield parameters

During 2014-15, the number of bunches per palm differed significantly among the various hybrids and the highest value was recorded with hybrid NRCOP-4 (5.61) and it was significantly superior over all other hybrids. Mean bunch weight differed significantly among the hybrids. The hybrid NRCOP-2 (19.84 kg) recorded the significantly higher mean bunch weight over NRCOP-7 (16.32 kg) but it was on par with the remaining hybrids. The FFB yield during 2014-15 differed significantly among the various hybrids. The hybrid NRCOP- 4 (14.58 t/ha) recorded the significantly higher FFB yield over NRCOP-3 (10.55 t/ha), NRCOP-2 (11.48 t/ha) and NRCOP-9 (11.66 t/ha) and it was on par with the remaining hybrids (Table 88).

Table 88. Vegetative growth parameters, FFB yield and yield attributes of different oil palm hybrids (Gangavati, 2014-15)

Hybrids	Palm girth (m)	Annual leaf production	No. of female inflorescence	Sex ratio	Number of bunches	Mean bunch weight (kg)	FFB yield (t/ha)
NRCOP-1	2.6	18.8	10.7	66.3	4.3	19.7	12.3
NRCOP-2	2.8	19.1	9.7	61.4	4.0	19.8	11.5
NRCOP-3	2.5	17.9	10.4	67.7	4.2	17.6	10.6
NRCOP-4	2.7	18.9	13.7	70.1	5.6	18.2	14.6
NRCOP-5	2.7	17.0	12.3	70.7	5.4	18.5	14.3
NRCOP-6	2.5	17.3	11.3	68.7	5.3	18.3	13.9
NRCOP-7	2.4	17.9	12.8	70.6	5.4	16.3	13.2
NRCOP-8	2.4	17.8	12.3	72.2	5.2	17.3	12.9
NRCOP-9	2.6	18.6	11.6	69.9	4.5	18.7	11.7
NRCOP-10	2.6	18.4	10.9	66.6	4.8	17.5	12.1
S. Em ±	0.2	0.5	0.7	4.3	0.1	1.1	0.86
CD(P=0.05)	NS	1.35	1.99	12.71	0.18	3.24	2.54
CV%	11.32	4.37	10.10	10.94	2.34	10.47	11.77

View of NRCOP-4 (Gangavati)

Madhopur

Oil palm hybrids were planted during May 2011 in RBD design with 3 replications and 6 plants per treatment. The highest palm height was recorded in NRCOP8 (4.3m) whereas, NRCOP9 recorded the lowest height (3.1m). Leaf production was the highest in NRCOP10 (12.0) and lowest was in NRCOP7 (10.0). NRCOP10 recorded more number of bunches (4.3) and bunch weight was the highest in NRCOP8(13.4) (Table 89).

Table 89. Growth and yield parameters of palms (Madhopur 2014-15)

Treatments	Palm height (m)	Palm girth (m)	Annual leaf production	No. of bunches/palm	Bunch weight (kg)
NRCOP1	3.2	1.9	11.3	3.0	7.4
NRCOP2	3.4	1.8	11.7	2.0	9.8
NRCOP3	3.2	1.9	12.3	2.3	12.2
NRCOP4	3.2	1.8	12.0	4.0	13.3
NRCOP5	3.3	1.9	10.3	3.7	9.4
NRCOP6	3.2	1.9	10.7	3.3	10.7
NRCOP7	3.5	1.9	10.0	2.0	10.2
NRCOP8	4.3	2.0	9.7	2.7	13.4
NRCOP9	3.1	1.9	10.7	3.7	11.5
NRCOP10	3.8	1.9	12.0	4.3	12.0
CD (P=0.05)	0.51	0.26	5.03	1.87	2.91
CV%	8.82	8.17	26.75	35.5	15.56

View of Gen. 8C (Madhopur)

Mulde

Oil palm seedlings were planted during September 2007 in RBD with 3 replications and 9 palms per treatment.

Ten cross combinations of oil palm did not show significant variation for average height and girth. However, they showed significant variation for production of female, male, total inflorescences and sex ratio (Table 90). Sex ratio was the highest

View of NRCOP-7 (Mulde)

(69.6%) in NRCOP-7, whereas it was the lowest (44.2 %) in NRCOP-10. No. of bunches was the highest in NRCOP-7(5.6) whereas it was the lowest in NRCOP 2 (2.3). NRCOP-7 recorded the highest yield (5.7 t/ha),and was on par with NRCOP-8, NRCOP-9, NRCOP-6 and NRCOP-2 .NRCOP-1 recorded the lowest FFB yield (2.4 t/ha).

Table 90. Vegetative growth parameters and FFB yield & Yield attributes of different oil palm hybrids (Mulde, 2014-15)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	No. of female inflo-res-cences	Sex ratio	Num-ber of bunch-es	Mean bunch weight (kg)	FFB yield (kg/ palm)	FFB yield (t/ha)
NRCOP-1	2.2	2.4	23.5	4.0	47.2	2.3	7.5	17.3	2.4
NRCOP-2	2.4	2.8	21.6	5.2	55.9	4.3	8.1	35.2	5.0
NRCOP-3	2.2	2.6	20.4	5.1	55.3	3.5	5.9	20.6	2.9
NRCOP-4	1.9	2.4	21.1	4.9	59.1	3.5	6.9	23.9	3.4
NRCOP-5	1.9	2.5	21.6	3.6	48.1	2.8	6.5	17.8	2.5
NRCOP-6	2.2	2.5	22.3	6.3	61.2	5.0	6.8	34.3	4.9
NRCOP-7	2.1	2.5	23.4	7.1	69.6	5.6	7.3	40.1	5.7
NRCOP-8	2.4	2.5	19.1	5.3	59.8	4.3	9.3	39.9	5.7
NRCOP-9	2.4	2.7	21.7	5.4	55.7	4.8	7.0	33.9	4.8
NRCOP-10	2.0	2.5	21.6	3.5	44.2	3.0	6.5	19.4	2.8
S. Em±	0.3	0.2	0.7	0.6	4.4	0.6	0.7	4.7	0.7
CD (P=0.05)	N.S.	N.S.	2.0	1.9	13.1	1.8	N.S.	14.0	2.0

Pasighat

The secondary nursery seedlings were planted in the main field in August 2010 as per the above mentioned experimental details. The growth parameters of the palms recorded in main field during March 2015 is presented in Table 91.

The growth of the plants with respect to palm height and number of leaves produced per plant in the entire cross combinations was on par over a period of one year. The collar girth recorded was maximum (1.98 m) in NRCOP-24 which was statistically on par with NRCOP-29, NRCOP-23, NRCOP-27 and NRCOP-26. Collar girth recorded was minimum (1.78 m) in NRCOP-21. The maximum number of leaves per plant was recorded in NRCOP-21 (23.4) and minimum recorded in NRCOP-25(20.9).

View of the experimental field (Pasighat)

Pattukkottai

Ten new oil palm hybrids developed from ICAR - IIOPR, Regional Station, Palode were planted during Sept. 2007 by adopting RBD with 3 replications and 6 palms per treatment. Soil of the experimental field is red sandy loam.

Table 91. Growth & yield parameters of Oil palm hybrids (Pasighat, 2014-15)

Cross Combination	Palm height (m)	Palm girth (m)	Annual leaf production	No. of FFB/ plant	No. of male inflorescence /plant	No. of female inflorescence /plant
NRCOP-21	0.34	1.78	23.4	1.7	8.4	0.8
NRCOP-22	0.34	1.84	21.9	2.9	7.4	0.6
NRCOP-23	0.34	1.95	22.3	1.3	6.9	1.0
NRCOP-24	0.30	1.98	21.4	0.8	4.9	1.2
NRCOP-25	0.29	1.85	20.9	1.8	7.5	0.6
NRCOP-26	0.32	1.89	21.0	1.5	5.4	1.0
NRCOP-27	0.34	1.91	22.0	2.2	5.6	1.6
NRCOP-28	0.30	1.86	21.7	1.9	7.5	0.8
NRCOP-29	0.34	1.96	22.8	0.9	7.4	1.8
NRCOP-30	0.35	1.81	21.6	1.3	7.2	0.2
CD at (P=0.05)	NS	9.876	NS	NS	NS	NS
CV (%)	15.86	3.05	4.54	69.46	20.44	65.61

Significant differences were observed for palm height, palm girth, number of leaves produced per palm per year, number of female inflorescence, number of male inflorescence and fresh fruit bunch yield among the hybrids. The results revealed that the highest palm height (2.9 m), palm girth (2.7 m), number of leaves produced per palm per year (28.0) was recorded in the hybrid NRCOP 5 and number of female inflorescence (13.8) was recorded in the hybrid NRCOP 9. The lowest palm height (2.2 m) was recorded in the hybrid NRCOP 10. Hybrid NRCOP 3 recorded significantly the highest number of male inflorescence (7.2). Data on yield attributes revealed that the highest FFB yield (91.9 kg/tree) and yield / ha (13.2 t) was recorded in the hybrid NRCOP 9 (Table 92).

Table 92. Growth and yield performance of oil palm hybrids (Pattukkottai, 2014-15)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production per palm	No. of male inflorescence	No. of female inflorescence	Per cent of female flowers	FFB yield (kg/ tree)	Yield (t/ha)
NRCOP 1	2.7	2.2	26.5	6.3	13.1	67.7	63.6	9.1
NRCOP 2	2.9	2.5	26.2	6.4	10.8	62.8	68.2	9.8
NRCOP 3	2.8	2.5	23.2	7.2	12.4	63.3	46.5	6.7
NRCOP 4	2.6	2.5	26.2	6.7	12.9	66.0	65.0	9.3
NRCOP 5	2.9	2.7	28.0	6.2	13.3	68.1	82.2	11.8
NRCOP 6	2.8	2.4	27.0	6.8	12.6	65.1	56.9	8.2
NRCOP 7	2.5	2.5	25.6	6.2	11.8	65.6	76.2	10.9
NRCOP 8	2.7	2.5	26.3	6.8	11.1	62.0	60.8	8.7

NRCOP 9	2.8	2.4	27.2	6.1	13.8	69.4	91.9	13.2
NRCOP 10	2.2	2.4	26.1	6.6	11.5	63.5	47.9	6.9
S. Em ±	0.21	0.12	1.27	0.34	0.99	2.34	14.39	2.06
CD (P=0.05)	0.45	0.52	2.55	0.70	1.99	4.70	28.80	4.12

View of NRCOP 17 (Pattukkottai)

View of NRCOP 9 (Pattukkottai)

Vijayarai

Hybrids were planted during Sept. 2007 by adopting RBD with 3 replications and 6 palms per treatment.

Palm height and annual leaf production per palm was significantly influenced by various cross combinations. NRCOP-3 recorded significantly higher number of leaves per palm (26.8). None of the hybrids had significant influence on palm girth, number of male & female inflorescences and sex ratio.

View of NRCOP 04 (Vijayarai)

Yield parameters

Yield parameters differed significantly among different hybrids NRCOP-4 recorded significantly higher number of bunches harvested per palm (12.6). The highest yield of fresh fruit bunches per palm was recorded in NRC OP-4 (174.0 kg/palm/year). Average bunch weight per palm per year was significantly the highest (13.9 kg) in the variety NRC OP-4. The hybrid NRC OP-4 recorded significantly the highest FFB yield (24.9 t/ha) (Table 93).

Gen. 8D: Progeny evaluation trial in oil palm

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

Gangavati:

Treatments details

Year of planting: 2012

During 2014-15, significant difference in the palm

Sl. No.	Cross combination	Sl. No.	Cross combination
1	NRCOP-31 (257 CDx14 P)	6	NRCOP-36 (99 CDx14 P)
2	NRCOP-32 (254 CDx17 P)	7	NRCOP-37(66 CDx17 P)
3	NRCOP-33(198 CDx129 P)	8	NRCOP-38(66 CDx14 P)
4	NRCOP-34(124 CDx14 P)	9	NRCOP-39(42 CDx14 P)
5	NRCOP-35(124 CDx17 P)	10	NRCOP-40(92 CDx129 P)

Table 93 . Influence of different hybrids on growth and yield parameters of Oil Palm (Vijayarai, 2014-15)

Hybrids	Palm height (m)	Annual leaf production	Palm girth (m)	No. of female inflorescences	Sex ratio (%)	No. of bunches/ palm/ year	FFB yield (kg/ palm/ year)	FFB Yield (t/ha)
NRCOP-1	7.78	26.4	2.77	11.6	56.3	10.4	105.4	15.1
NRCOP-2	6.80	24.7	2.62	11.9	54.2	9.8	106.9	15.3
NRCOP-3	7.30	26.9	2.75	7.4	54.5	10.7	112.9	16.1
NRCOP-4	7.77	25.3	2.77	14.6	73.8	12.6	174.0	24.9
NRCOP-5	7.58	26.4	2.97	6.5	45.9	11.1	138.9	19.9
NRCOP-6	7.01	26.6	2.74	8.3	54.9	10.9	124.7	17.8
NRCOP-7	7.73	25.2	2.85	13.1	64.6	10.6	121.9	17.4
NRCOP-8	7.56	26.2	2.80	7.3	48.9	10.8	120.6	17.3
NRCOP-9	7.23	25.9	2.69	11.4	59.9	10.9	131.5	18.8
NRCOP-10	7.07	26.7	2.71	12.6	65.7	10.5	110.8	15.8
S. Em ±	0.45	0.78	0.10	3.54	-	1.00	14.6	2.1
CD (*P=0.05*)	NS	NS	NS	NS	-	NS	30.6	4.4
CV [%]	7.48	3.69	4.74	41.41	-	11.36	14.30	14.57

height was observed among the different hybrids. The palm height was significantly superior with the hybrid NRCOP-32 (68.17 cm) over NRCOP-33 and NRCOP-39 (54.17 and 53.50 cm, respectively).

Similarly, palm girth differed significantly among the different hybrids. The palm girth was significantly higher with the hybrid NRCOP-34 (67.28 cm) over all the other hybrid combinations except NRCOP-37 (64.41 cm) (Table 94).

The number of leaves per palm differed significantly among the different hybrids. The hybrid NRCOP-32 (11.44) & NRCOP-38 (11.44) recorded significantly higher annual leaf production per palm compared to NRCOP-31 (10.39), NRCOP-33 (10.33), NRCOP-36 (10.06) & NRCOP-40 (10.06) and the remaining hybrids were on par with NRCOP-32 & 38.

General field view of Gen. 8D (Gangavati)

Table 94. Vegetative growth parameters of different oil palm hybrids during 2014-15 (Gangavathi)

Hybrids	Palm height (cm)	Palm girth (cm)	Annual leaf production
NRCOP-31	62.3	58.6	10.4
NRCOP-32	68.2	60.6	11.4
NRCOP-33	54.2	55.1	10.3
NRCOP-34	67.6	67.3	11.3
NRCOP-35	62.4	53.9	11.1
NRCOP-36	59.8	54.1	10.1
NRCOP-37	62.1	64.4	10.8
NRCOP-38	62.8	60.4	11.4
NRCOP-39	53.5	50.7	10.7
NRCOP-40	61.4	55.7	10.1
S. Em ±	3.34	1.48	0.34
CD(P=0.05)	9.83	4.36	1.01
CV%	9.42	4.42	5.52

Madhopur

Planting of diffrent hybrids was carried out during June, 2013 by adopting RBD with 3 replications and 6 palms per treatment/plot. Among the hybrids, NRCOP35 recorded lower plant height followed by NRCOP 34. The girth was higher with NRCOP 32 and number of leaf production was higher with NRCOP 35 (Table 95).

General field view of Gen. 8D (Madhopur)

Table 95. Growth parameters of oil palm (Madhopur, 2014-15)

Hybrids	Palm height (m)	Palm girth (m)	No. of leaves
NRCOP31	2.00	0.42	10.3
NRCOP32	2.37	0.60	11.3
NRCOP33	1.90	0.56	9.0
NRCOP34	1.59	0.54	11.3
NRCOP35	1.58	0.51	11.7
NRCOP36	1.67	0.55	11.0
NRCOP37	2.03	0.47	10.7
NRCOP38	1.87	0.49	10.0
NRCOP39	1.82	0.56	9.7
NRCOP40	1.83	0.44	9.3
CD (P=0-05)	0.33	0.13	3.30
CV%	10.33	15.37	18.6

Mulde

Planting was done in the experimental field during October, 2011 by adopting RBD with 3 replications and 6 palms per treatment/plot. Various cross combinations of oil palm did not show significant variation for average height and number of leaves. Plant height ranged between 0.9 to 1.0 m and number of leaves ranged between 20.5 (NRCOP-40) to 23.2 (NRCOP-33) in Table 96.

Table 96. Growth performances of different hybrid combinations (Mulde, 2014-15)

Hybrids	Palm height (m)	Annual leaf production (No.)
NRCOP 31	1.0	22.8
NRCOP 32	0.9	22.4
NRCOP 33	1.0	23.2
NRCOP 34	1.0	22.6
NRCOP 35	1.0	22.6
NRCOP 36	0.9	21.8
NRCOP 37	1.0	22.5
NRCOP 38	0.9	21.9
NRCOP 39	1.0	22.6
NRCOP 40	0.9	20.5
S. Em ±	0.04	0.9
CD (P=0.05)	N.S.	N.S.

Pasighat

Layout and planting of this trial was carried out during August 2012. Growth parameters of the plants recorded during March 2015 are presented in Table 97.

General field view of Gen. 8D (Pasighat)

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.

Table 97. Growth parameters of Oil Palm hybrids (Pasighat 2014-15)

Cross combination	Palm height (cm)	Palm girth (cm)	No. of leaves
NRCOP-31	248.6	94.2	24.7
NRCOP-32	254.8	92.9	24.3
NRCOP-33	236.8	76.4	24.3
NRCOP-34	248.4	85.1	22.3
NRCOP-35	247.4	77.1	22.1
NRCOP-36	258.5	92.7	22.5
NRCOP-37	254.7	97.3	22.8
NRCOP-38	265.2	86.4	23.3
NRCOP-39	258.9	92.6	25.3
NRCOP-40	238.3	86.2	22.9
CD(P=0.05)	NS	NS	NS
CV (%)	4.31	13.48	8.57

Pattukkottai

Nine hybrids *viz.*, NRCOP 31, 32, 33, 34, 35, 36, 37, 38 and 39 were planted on 26.02.2013 in ARS, Pattukkottai. 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 trial for observation. Biometric observations on palm height (cm), palm girth (cm), total number of leaves, leaf

View of the experimental field (Pattukkottai)

length (m), leaf breadth (cm) and number of leaflets / leaf were recorded in five hybrids and furnished in the Table 98.

The results revealed that the highest palm height (72.5cm), total number of leaves (19.3) and leaf length (2.8 m) was recorded in the hybrid NRCOP 32. Hybrid NRCOP 31 registered the highest values for palm girth (1.4 m), leaf breadth (1.1 m) and number of leaflets / leaf (144.3).

Table 98. Growth parameters of oil palm (Pattukkottai, 2014-15)

Hybrids	Palm height (cm)	Palm girth (m)	Total number of leaves
NRCOP 31	68.3	1.3	18.6
NRCOP 32	72.5	1.1	19.3
NRCOP 33	59.6	1.1	17.1
NRCOP 38	55.5	1.2	16.8
NRCOP 39	54.8	1.2	16.6
Mean	62.1	1.2	17.60
SEd±	7.88	0.09	1.18

Vijayarai

Among various hybrids, significantly the highest palm height of 6.03 m was recorded in NRC OP-32. There was no significant differences for number of leaves per palm per year and palm girth (Table 99).

Table 99. Performance of different cross combinations on vegetative parameters of Oil Palm (Vijayarai, 2014-15)

Hybrids	Palm height (m)	Annual leaf production (No.)	Palm girth (m)
NRC OP -31	4.8	25.2	2.5
NRC OP – 32	6.0	26.1	2.5
NRC OP - 33	5.0	26.1	2.5
NRC OP - 34	5.5	26.0	2.5
NRC OP - 35	5.6	25.4	2.5
NRC OP - 36	5.0	25.6	2.5
NRC OP - 37	5.1	25.9	2.4
NRC OP - 38	4.7	25.3	2.4
NRC OP - 39	5.0	25.6	2.6
NRC OP - 40	5.3	24.7	2.6
S. Em ±	2.68	0.74	0.84
CD (*P=0.05*)	5.64	NS	NS

5.2 CROP PRODUCTION

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

Pasighat

In order to demonstrate the cultivation of oil palm in North Eastern region, oil palm was planted in the year 2006 with recommended crop management practices. The average plant height, collar girth and number of leaves per plant was 113.1 cm, 249.3 cm and 21.8 leaves per palm, respectively. The number of FFB produced per plant was 9.1 with an average bunch weight of 13.6 kg and the estimated yield recorded to be 17.70 t/ha. An yield increase of 77% was recorded as compared to previous year (2013-14) yield of 10 t/ha.

Demonstration on oil palm production potential plot in Pasighat

Agr. 15. Intercropping in young oil palm garden

Gangavati

Treatment Details:

Inter crops

T_1: Brinjal
T_2: Tomato
T_3: Bhendi /Okra
T_4: Chilli
T_5: Onion
T_6: Cluster bean
T_7: Beans

Pooled data of two years (2013-14 & 2014-15) indicated that, the treatment T3 of growing okra as intercrop recorded significantly higher fruit yield (3.8 t/ha) over all other vegetable treatments as intercrops in juvenile oil palm garden. The yield potential of Tomato was 2.7 t/ ha, Brinjal (1.7 t/ ha), Chilli (2.0 t/ha) and Cluster Beans (1.1 t/ha). The gross returns received from the intercropping okra in Oil palm was higher (Rs. 76,540/- per ha) followed by Chilli (Rs. 40,500 /- per ha) and Brinjal (Rs. 34,820 /- per ha).

Okra intrecropping in oil palm garden

VI. EXPERIMENTAL RESULTS IN PALMYRAH

6.1. GENETIC RESOURCES

Gen.9 : Survey, Collection and Evaluation of Palmyrah germplasm

Centre : Killikulam and 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 Puri and Khurdha districts of Odisha, from 20 -25th August 2014. Potential palm growing areas of these districts were covered and six germplasm lines were assembled and planted in the F block of the orchard of Agricultural college and Research Institute, Killikulam as well as in the farm of Horticultural Research Station, Pandirimamidi centre.

Details of specific traits considered for collection of Palmyrah germplasm accessions from Puri and Khurdha Districts of Odisha

Germplasm OR-02/14

Germplasm OR-05/14

S. No.	Accession No.	Specific traits
1	OR-01/14	Dwarf tree with more number of leaves (47 and with long petiole length
2	OR-02/14	Big sized fruits(46 cm circumference with 15.5 cm length)
3	OR-03/14	More number of bunches with big sized fruits
4	OR-04/14	Dwarf nature of trees (around 7 m)
5	OR-05/14	Big sized fruits
6	OR-06/14	Dwarf type (around 7 m) with more trunk girth (1.9 m) and more number of fruits/bunch

Performance of Palmyrah germplasm accessions at Pandirimamidi

Among the 13 accessions planted during 1991, plant height and stem girth were maximum in accession 4/91 (10.78 m and 1.99 m, respectively). Maximum number of leaves produced was by accession 7/91. The highest average number of bunches per tree was recorded in accession 6/91 (11.3) and the highest average number of fruits per bunch was recorded with Acc. No. 3/91, which has recorded 23 number of fruits per bunch.

Germplasms planted during 1995 have shown a large variation in terms of plant height. The accession 5/95 exhibited dwarfness and has recorded only 2.24 m height. However, no flowering was observed till now, whereas, accession 1/95 planted during the same year, has recorded a height of 7.38m which is flowering since last three years.

Among the 1993 accessions, maximum palm height was recorded with accession 4/93(8.29 m). Accession 8/93 recorded a maximum stem girth of 1.41 m. Maximum number of leaves was produced

by accession 9/93. Among the 18 accessions collected from Nalgonda district (AP), plant height and number of leaves produced was the highest in accession 6/02, while the highest number of leaves and petiole length was observed in accession 13/02. Of the 16 accessions collected from Tamil Nadu, the palm height was the highest in 11/02, and the maximum number of leaves and other leaf parameters recorded were the highest in accession 2/02.

Germplasm planted during 1991 showing maximum number of fruit bunches along with big sized fruits

Among the 2003 planted accessions, the maximum palm height and the highest number of leaves was recorded with accession 1/03. From the 2004 planted germplasm accessions, accession 1/04 has recorded the highest palm height, number of leaves and leaf length. The germplasm collected and planted during 2007 has recorded the highest palm height with accession 5/07, whereas, the highest number of leaves was produced by accession 3/07. Among the germplasm accessions collected during 2008, the highest palm height was recorded in accession 1/08, while, the highest number of leaves was recorded with accession 3/08.

Performance of palmyrah at Horticultural College & Research Institute, Killikulam

Among the collections of germplasm planted during 1995, accession 18 has recorded maximum palm height (372.0 cm) and leaf length (93.0 cm). Accession 01 recorded higher number of leaves (29.0). Accession 18 recorded maximum leaf length and accession 21 recorded higher stalk length (132.0 cm). The data recorded from the germplasm planted in 1997, indicated that the accession 67 recorded maximum palm height (480 cm) and accession 58 recorded more number of leaves (33.0). Among the germplasm collected during 1999, the accession 73 recorded more plant height (231.0cm) and leaf length (87.0cm).The accession 88 recorded more numbers of leaves.

The accessions planted during 2001 showed maximum palm height (334.0 cm), and number of leaves (28.0), leaf length (86.0 cm) with accession 92. The data collected from germplasm planted during the year 2004 showed variations for palm height, number of leaves and stalk length. Among the accessions, the accession 160 recorded increased palm height (127.0 cm). Among the 2005 planted accessions, accession 176 showed the maximum palm height, while accession 174 had number of leaves and leaf length. The stalk length was maximum in accession 180, while the lowest plant height, number of leaves and stalk length was recorded with in accession 179.

The data collected from germplasm accessions during 2006 showed maximum palm height in accession 196. The accession 180 has recorded the lowest plant height. Accession 184 recorded more number of leaves and accession 192 recorded more leaf length.

Variations in plant growth were observed among the accessions planted during 2009. Palm height and number of leaves were the highest in accession 219 and it was the lowest in accession 249. However, the leaf length was maximum in accession 234 and stalk length recorded was maximum in accession 243. Among the accessions collected during the year 2010, accession 256 has recorded maximum palm height, number of leaves and stalk length.

Among the germplasm collected during 2012, the accession 285 recorded maximum palm height (54.0 cm), while palm height was the minimum in accession 282. However, the number of leaves was maximum in accession 279 and minimum with accession 284. The germplasm lines planted during 1997 recorded the maximum values for all

the parameters studied. Male flower initiation was noticed in accessions 9 and 26 of the germplasm planted during 1997.

Agron. 16: Growth and development studies in palmyrah

Root studies in Palmyrah (Pandirimamidi centre)

In palmyrah, growth and development studies were conducted at Pandirimamidi centre to understand the growth pattern of roots in different root zones around the Palmyrah base.

The average root distribution in 15 years old trees indicated that the roots were spread to a distance up to 150 cm from the bole and to a depth of 150 cm from the surface. 68.5 % root spread was observed in 30-60 cm distance and only 16 % roots were spread beyond 90cm distance from the bole. Over 80 % of root growth was found at a depth of 30-90 cm and only 10 % roots were found on the top 30 cm depth.

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. Storage stability of RTS sap under different conditions

Inflorescence sap of male palmyrah palm was stored under ambient, refrigerated conditions (4-8°C) and freezing (- 4°C) conditions. The sap was collected by adopting CPCRI method was filled in 200 ml glass bottles and PET bottles and stored under the respective storage condition. The changes in pH, TSS, total sugars and reducing sugars and sensory quality were determined during storage and it was observed that pH, TSS, total sugars reducing sugars decreased during storage. The shelf life of sap under ambient conditions was 3 h, whereas, under refrigerated condition it was up to 10 h, and there was no significant change in quality parameters indicating that the shelf life can be extended beyond one week using freezing conditions.

2. Standardization of process method for inflorescence sap based products

Process development for home based crystal jaggery was attempted with inflorescence sap collected through traditional as well as CPCRI methods.

Crystal jaggery from Inflorescense sap

The sap collected was concentrated to 70%, 80% and 90% brix and cooled to room temperature. The syrup can be used as sweetener and the syrup was dried at low temperature to produce jaggery in powder form/crystal jaggery. It was found that the syrup collected through CPCRI method alone formed crystals, whereas, the sap collected from the traditional method can be used only for syrup.

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

1. Development of tuber based food products

Pandirimamidi

Development of RTE cubes

Osmotic dehydration of tuber pieces was carried out in the sugar syrup solution having different concentrations (40%, 50% and 60% w/w), with different tuber thickness (mm) and different 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 osmotic time of 5 to 6 hours was required to attain maximum weight loss and solid gain by tuber pieces. The optimum combination of tuber pieces for weight loss (water removed) and solid gain were found to be 60% sugar syrup solution + 4 mm tuber thickness + 1: 6 sample to sugar syrup solution ratio.

2. Process development for removal of bitterness in flour extracted from tuber

Flour was extracted from palmyrah tuber and soaked in water for 4, 6, 8 and 10 h, steamed in autoclave for 10, 20 and 30 min and converted into flour by drying at low temperature for removal of bitterness.

The sensory score showed that the bitterness was removed completely with soaking water for 6 h.

3. Preparation of tuber flour based products and sensory evaluation

Bakery products *i.e.*, cake, cookies and noodles were prepared with tuber flour of 25%, 50% and 75% of tuber flour (raw flour), flour soaked in water and steam cooked flour. Sensory evaluation was done for quality of product. Flour soaked in water gave the best product up to 75% flour and bitterness was observed in raw flour. Steam cooked flour can be used up to 25% to avoid the bitterness.

Noodles prepared from tuber flour

PHT-3: Utilization of palmyrah plant parts for the extraction of fibre and fuel

Modification of feeding in fiber extractor machine was carried out. Two columns were provided for fitting the two horizontal self propelled rollers for guiding the rollers which enables for the easy movement of the leaf base into the main rotating drum. The springs are fitted for easy holding of the different thickness of the leaf base material. The gap between the two self propelled rollers is 3mm. The diameter of two self propelled rollers of 4.0cm was designed so as to enable to hold the leaf base firmly. 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. 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. Since, the center of the leaf base is thicker than the edges, it causes difficulty in feeding inside the roller, and hence, further modification is needed for feeding roller to increase the efficiency of fiber extraction and the same is in progress. From existing fiber extractor, 58g of fiber was obtained from 1.0 kg of raw leaf base (recovery percentage was 5.80). From Modified fiber extractor, 81g of fiber was obtained from 1.0 k of raw leaf base (recovery percentage was 8.10).

Engineering properties of fiber

The physical properties of the fiber were studied and are given below:

a. The density of palmyarh fiber is 39.14 kg/ m^3

b. The porosity of palmyarh fiber is 98.55%

The mechanical properties of the fiber were also studied.

a. The below graph shows the cutting load of palmyarh fiber which is 20.56N, Time 4.310 and Elongation- 8.621mm.

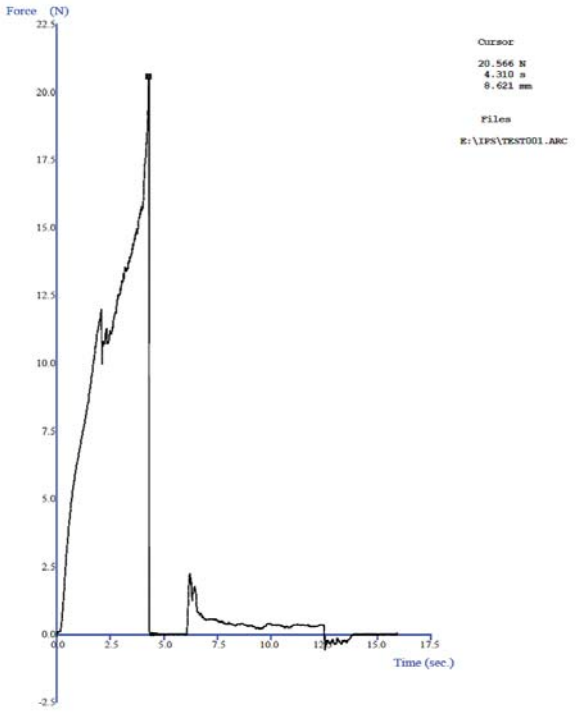

Fig. 6. : Mechanical properties of the fiber

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

Pandirimamidi

Standardization of medium for preservation of *nungu*

Tender fruit endosperm (*nungu)* was peeled and kept in brix of 40, 50 and 60 in deep freezer. The quality of *nungu* treated with 50^0 brix was good up to one year. The peeled *nungus* were kept in brix of 40 and 50 and packed with polypropylene (PP), aluminium foil and multilayer pouch and kept in deep freezer. It was observed that within 15 days all the samples in deep freezer were good in condition and under refrigeration (4°C) the sample packed in PP was slightly changed flavour. *Nungu* packed in aluminium and multilayer pouch maintained quality except sweetness.

Killikulam

Preliminary trial on vacuum packaging of *nungu*

Preliminary trials on vacuum packaging of *nungu* were carried out, but texture of *nungu* was collapsed due to the high pressure of vacuum created inside the packaging materials. It was observed that during the first 15 days of storage, fresh peeled *nungu*, fresh peeled *nungu* with 40^0 brix sugar syrup and fresh peeled *nungu* with 50^0 brix sugar syrup were packed in multi layer, aluminium foil and polypropelyne pouches were good in refrigerated condition. After 30 days of storage, fresh peeled *nungu* and fresh peeled *nungu* with 50^0 brix sugar syrup which were packed in multi layer, aluminium foil and polypropelyne pouches got fermented both in refrigerated and atmospheric storage condition.

Tender fruit endosperm stored in polypropylene and aluminium foil

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 Chhati, Chidumuru and Suddagudem from Andhra Pradesh state, border of Chhattisgarh State during November-December 2014. Potential sulphi growing areas of these districts were covered and three germplasm have been marked for further observation and the seeds were collected during May 2015 from each germplasm. Among the germplasm collected, light yellow colour seed, dark black colour seed and dwarf type were the traits.

Sulphi palm selected from Andhra Pradesh

Standardization of tapping techniques for extraction of inflorescence sap from Sulphi

Design : RBD, Replications : Four,
Angle of the spathe cut

Independent variable

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

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

Treatment 2: 1-5 days 30°, 6-10 days 45°, 11-15 days 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

Dependent variable: Yield of sap

The influence of shape of cut on surface of spathe on the yield of sap from inflorescence was studied.

Table 100. Yield of sap as influenced by tapping techniques

Treatments	Yield of Sap (l) (Oct-Nov)	Yield of Sap (l) (Dec- Jan)	Yield of Sap (l) (Feb-March)
T-1	10.55	15.75	12.44
T-2	15.85	20.80	17.85
T-3	12.77	18.60	15.45
T-4	11.25	16.45	13.77
SEm+	0.27	0.45	0.31
CD (P=0.05)	0.83	1.38	0.96

Yield of sap was maximum in the month of December-January and the treatment T-2 showed highest significant yield of sap (20.80 l/day) followed by T-3 treatment (18.60 l/day). Same trend was observed in the month of October-November and February-March, but yield was the lowest in the month of October-November in comparison with February-March (Table 100).

Path. 6: Management of sulphi wilt disease

The trail was laid out in farmers field at Baster region in RBD design with seven treatment and three replication. The treatment are T-1: Basal application of *Trichoderma harzianum* powder 1kg /palm 2 times in a year, T-2: Basal application of *Trichoderma harzianum* powder 2kg /palm 2 times in a year, T-3: Basal application of *Trichoderma harzianum* powder 1kg /palm 3 times in a year, T-4: Basal application of *Trichoderma harzianum* powder 2kg /palm 3 times in a year, T-5: Basal application of Carbendazim 75 WP 1.0 g/l. water 2 times in a year, T-6: Basal application of Benomyle 2.0 g/l. water 2 times in a year and T-7: Control (Maintain check plant with each treatment without any treatment). Observation on disease severity was recorded at monthly interval. Among different treatment tested, the Basal application of *Trichoderma harzianum* powder 2kg/palm, 3 times in a year (T4) was found better (9.44 per cent disease increased) followed by treatment no. 3 (12.22 per cent disease increased) were found superior to compare the check plant (without treatment), the wilt symptoms is increased 23.44 percent over the initial symptoms in sulphi palm at farmer's field (Table 101).

Table 101. Effect of different treatments on disease severity

Treatment	Initial disease severity %	Disease severity (%)			Mean value of all	Per cent increase severity over initial
		60 DAT (Ist)	60 DAT (IInd)	60 DAT (IIIrd)		
T-1	15.67	27.33	40.00	45.33	37.56	21.89
T-2	13.67	24.00	30.67	36.00	30.22	16.56
T-3	14.67	21.67	27.67	31.33	26.89	12.22
T-4	15.67	21.33	24.67	29.33	25.11	9.44
T-5	17.33	29.67	36.00	41.67	35.78	18.44
T-6	20.00	27.00	31.67	40.00	32.89	12.89
T-7	19.33	32.67	42.67	53.00	42.78	23.44
SEm±	1.83	1.63	1.7	1.63	-	-
CD (P=0.05)	16.38	9.19	7.55	6.41	-	-
CV (%)	7.22	6.4	6.67	6.12	-	-

VIII. Centre wise budget for 2014- 15 (ICAR share)

(Rupees in lakhs)

Centre	Grant in-aid Salaries	Grant in-aid General			Grant in-aid Capital	Total
	Pay and Allowances	TA	RC	HRD	NRC	
Aliyarnagar	26.00	1.00	6.50	0.50	1.56	35.56
Ambajipeta	13.00	1.00	5.75	0.50	5.25	25.50
Arsikere	6.00	1.00	6.25	0.50	7.87	21.62
Jagdalpur	2.75	0.30	3.00	0.20	2.93	9.18
Kahikuchi	18.00	1.50	5.50	1.13	0.00	26.13
Bhubaneshwar	8.50	0.57	4.00	0.38	3.68	17.13
Mondouri	18.00	0.75	5.50	0.38	0.98	25.61
Ratnagiri	11.00	0.80	6.00	0.30	3.00	21.10
Veppankulam	22.00	1.35	6.50	0.50	3.39	33.74
Killikulam	14.85	0.56	2.80	0.56	0.44	19.21
Pandirimamidi	5.50	0.75	4.00	0.20	1.24	11.69
Pattukottai	11.80	0.50	3.00	0.20	0.00	15.50
Gangavathi	2.00	0.40	3.00	0.15	7.13	12.68
Mulde	3.00	0.40	3.00	0.20	8.50	15.10
Vijayarai	2.50	0.40	3.00	0.20	1.50	7.60
Navasari	1.85	0.40	3.00	0.30	1.50	7.05
Sabour	9.00	0.45	3.10	0.20	3.03	15.78
Pasighat	-	0.40	3.50	0.10	5.00	9.00
Madhopur	-	0.30	3.00	0.20	2.25	5.75
Pilicode	-	0.30	2.50	0.20	0.75	3.75
Kasaragod	-	-	2.92	-	-	2.92
PC cell	-	-	0.15	-	-	0.15
Port Blair (Coconut & Arecanut)	-	0.50	3.50	0.50	-	4.50
Goa (Coconut & Arecanut)	-	0.50	3.50	0.50	-	4.50
Shivamogga (Arecanut)	1.25	0.50	3.75	0.50	-	6.00
Wakawali (Arecanut)	-	0.50	3.75	0.50	-	4.75
DOPR, Pedavegi (Oil Palm)	-	0.50	3.00	-	-	3.50
Jagdalpur TSP	-	-	5.50	1.00	-	6.50
Navasari TSP	-	-	5.50	1.00	-	6.50
Bhubaneswar TSP	-	-	5.00	1.00	-	6.00
Ratnagiri TSP	-	-	5.00	1.00	-	6.00
	177.00	15.63	124.47	12.90	60.00	390.00

TA: Travelling Allowance, RC: Recurring Contingency, HRD : Human Resources Development, NRC : Non Recurring Contingency, TSP: Tribal Sub Plan

IX. Monitoring centres and Meetings

Monitoring

In order to execute the technical programme in all the centres, 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 advice 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 2014 – March 2015)

Killikulam	30.04.2014 to 01.05.2014, 21.01.2015
Pattukkottai	15.05.2014
Veppankulam	16.05.2014
Mondouri,	13.10.2014 26.03.2015
Sabour, Bihar	16.10.2014
Madhopur	19.10.2014
Gangavathi	11-12 Nov.2014
Navsari	21.11.2014
Arsikere	29-30 Dec.2014
Shivamogga	30.01.2015 13.02.2015
Pasighat	26.03.2015
Kahikuchi	27-28 March, 2015
Vijayarai	07.02.2015
Ambajipeta	04.02.2015 and 03.03.2015
Pandirimamidi	04.02.2015

Visit made to different centres

Arsikere

Gangavathi

Mondouri

Pandirimamidi

Pasighat

Veppankulam

Meetings

XXIII Annual Group Meeting

The XXIII Annual Group meeting of AICRP on Palms was held at Directorate of Oilseeds Research, Hyderabad during 25-28 July, 2014. The group meeting was attended by 80 delegates from 21 centres of AICRP on Palms, State Agricultural Universities, Central Plantation Crops Research Institute (CPCRI), Directorate of Oil Palm Research (DOPR), Coconut Development Board and State Department of Horticulture covering 12 states of the country. The group meeting discussed the progress of ongoing research programmes in coconut, oil palm, palmyrah and fish tail palm (sulphi palm)

The inaugural session of the XXIII 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. J. Dilip Babu, Director of Research, DRYSRHU. 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.

On this occasion, publications from various AICRP centres was released by the dignitaries

1. Research highlights of AICRP on Palms by PC cell , CPCRI Kasargod
2. Coconut based cropping system for Assam by Kahikuchi centre , Assam
3. Research at a glance by Ratnagiri , Maharashtra
4. Pest management and disease management in telugu by Ambajipeta
5. Drip irrigation and disease management in kannada by Ariskere

The best AICRP centre award was awarded to AICRP, Kahikuchi, Assam for their work on coconut based cropping system and coconut improvement programmes .

Later Dr George V. Thomas, Director, CPCRI, and Dr. S Arulraj, Director, DOPR were felicitated for their achievement in the field of plantation crops.

Dr. N. K. Krishna Kumar, DDG (Hort. Sci.,), ICAR in his inaugural speech stated that two important sectors in Indian agriculture are pulses and oil seeds. He stressed on exploitation of value added products in palms especially in the context of increase in demand of tender coconut water and tender coconut milk. The production of quality planting material of plantation crops particularly in coconut, arecanut and oil palm has to be taken

up on large scale. The need for technology in oil palm is in the field of tissue culture. Among insects an insect similar to *Brontispa* was reported to cause damage in Andaman and needs to be looked out. Eriophyid mite damage in Bangladesh is causing concern there. The Koleroga rot of arecanut needs to be addressed. One has to think about how to translate science in to technology into commerce and market. Effective monitoring of AICRP centres is necessary and non performing centres are to be culled.

Dr. B.M.C. Reddy, Vice Chancellor, Dr. YSR Horticultural University, Andhra Pradesh, stressed upon popularizing value added products of coconut and palmyrah, and providing technology for introducing cocoa as intercrop in coconut and oil palm. The problem of cyclones on plantation crops along with black headed caterpillar, basal stem rot and eriophyid mite are a cause of concern to coconut farmers. The importance of oil palm is more as it yields 4 to 7 tons instead of 0.5 tons as in vegetable oils. The availability of quality planting material of coconut and oil palm is required. Palmyrah is important because it provides livelihood to poor, there is need to develop palm sugar and palm jaggery because of its high medicinal value. There is a need for more cocoa beans and the quality of cocoa beans in East and West Godavari districts is high and equal to beans from Ghana and hence there is a need for area expansion. In oil palm increase of spacing to 10 x 10 m or 11x 11m in order to promote cocoa as a inter crop

Dr. T. Janakiram, Assistant Director General, (HS-I), ICAR, stated that rural economy depends on palms, the intercropping of China aster in coconut and arecanut is very much remunerative.

Formulation of Technical programmes for New centres

Centres : CIARI, Port Blair, CCARI, Goa, Wakavali and Shivamogga

A Group Meeting for formulation of technical programme for the New Centres (AICRP on Palms) was convened at CPCRI, Kasaragod on January 8th , 2015 to discuss the details for conducting

Dignitaries on the dais of XXIII AGM

Release of publication by the dignitaries

Best AICRP centre award to Kahikuchi

the experiments in coconut and arecanut and to prepare the technical programme for different Centres under AICRP on Palms. Meeting was chaired by Dr. P. Chowdappa and Co-chaired by Dr. P. Narayanaswany, DoR, UAHS, Shivamogga. Dr. H.P. Maheswarappa, Project Coordinator (Palms) indicated the purpose of convening this meeting as to finalize the detailed technical programme for the new centres in coconut and arecanut to be taken up at AICRP Centres. Dr. P. Chowdappa,

Director, CPCRI in his special address stressed that, there is no need for area expansion in arecanut crop and need to increase the productivity with new technologies. Director of Research, Dr. P. Narayanaswany emphasized the, need to address the location specific problem in arecanut plantation in particular to diseases management in Malnad region. Scientists from each centre presented the technical programme and after thorough discussion, the same was approved.

Mid term review of Oil palm centres technical programme

Meeting of the scientists of AICRP on palms working on oil palm with the scientists of IIOPR was held on 7-2-2015 at IIOPR, Pedavegi to review the progress of the technical programmes of centres. The meeting was chaired by Dr. S. Arulraj, Director, IIOPR, Pedavegi along with Dr. H.P. Maheswarappa, Project Coordinator (Palms) and all the scientists of the centres and IIOPR were present. Scientists from each centre have presented their progress of technical programme and suggestions were given for further monitoring of the programmes.

Mid term review of coconut centres at CPCRI, Kasaragod

The mid term review meeting was held on 10th February, 2015 at Project Coordinator Cell, CPCRI, Kasaragod. The project coordinator (Palms) reviewed the technical programme under the crop improvement projects of coconut.

View of the meeting and felicitation to Dr. S. Arulraj

X. Extension and Popularization of Technologies

Coconut

Aliyarnagar

Training programmes conducted:

- Scientists of the centre delivered a lecture on improved coconut varieties and integrated pest and disease management to farmers of Udumalparai settlement, Valparai at CRS, Aliyarnagar on 17.09.2014. Leaf blight awareness programme jointly organized by ADA, Pollachi (South) and CRS, Aliyarnagar at Seelakkampatti village on 14.08.2014 to 22.08.2014.
- Organized an awareness programme on coconut defoliator at Nadhegounden pudur, Coimbatore on 18.09.2014. AICRP on palms Aliyarnagar displayed latest coconut varieties in Horti. Intex at CODDISIA complex from 7th to 9th Nov. 2014. Scientists visited coconut orchards at Kollapatti village, Thiruchengodu on 17.11.14 as part of a team to sensitize farmers regarding management of Red palm weevil.
- Organized an awareness programme on coconut root (wilt) at Nanjegoundan Pudur, Pollachi Taluk on 23.07.2014.

Training on Integrated pest and disease management to farmers at Samarayapatti

Awareness programme on defoliator management at Mannur

Ambajipeta

Training programmes organized

- Organized three days training and awareness programme on Cocoa at GMC Balayogi Community Hall, Mukkamala from 30th June – 2nd July, 2014 funded by DCCD, Kochi. Dr. B.A. Jerard, Principal Scientist (Hort.) and Dr.P. Subramanian, Principal Scientist (Agro.) from Central Plantation Crop Research Institute, Kasaragod, Kerala acted as distinguished guests in the programme and enlightened the farmers with the cocoa situation in Kerala.

Scientist from CPCRI addressing the farmers during the training programme

- Farmer-Scientist interaction meeting was conducted at Munganda village of East Godavari District on 4.2.2015. Dr. H.P. Maheswarappa, Project Coordinator (Palms) inaugurated the programme and technologies developed by ICAR-CPCRI and

Dr. H.P. Maheswarappa, Project Co-ordinator (Palms) addressing the Farmer's Scientist interaction meeting

Ambajipeta centre were briefed. The queries of farmers were answered by the scientists.

- Horticultural Research station, Ambajipeta and Central Plantation Crops Research Institute, Kasaragod, Kerala organized a Stakeholders meeting on coconut and cocoa farming at Mukkamala village of Ambajipeta mandal of East Godavari district on 3rd March, 2015. Dr. B.M.C. Reddy, Hon'ble Vice Chancellor, Dr. YSRHU, VR Gudem and Dr. P. Chowdappa, Director, CPCRI, Kasaragod. Dr. H.P. Maheswarappa, Project Coordinator AICRP on Palms, CPCRI, Kasaragod and Dr. J.Dileep Babu, Director of Research, Dr.YSRHU, VR Gudem participated in the meeting. Approximately 250 farmers participated in the programme, interacted with scientists and shared their experiences on coconut and cocoa cultivation.

Inauguration of Stakeholders meeting on coconut and cocoa on 3rd March, 2015

Friends of coconut tree (FOCT)

Imparted training to the coconut climbers (20 Nos.) in the FOCT programme 6 batch for week days on 25.11.14 to 30.11.14.

FOCT Training organized at HRS in November' 14

Exhibitions:

- Provided material for theme based exhibition at KVK, Undi in connection with the visit and interaction of Hon'ble minister for industries Smt. Niramala Sitaraman with farmers on agro processing and agro based industries (export oriented) on 17.11.14.

Visit of Hon'ble minister for Industries Smt. Niramala Sitaraman to exhibition stall of Dr.YSRHU

Visit of Honorable CM Sri. N. Chandrababu Naidu of Andhra Pradesh to exhibition stall

- Participated and displayed exhibits in the exhibition on production technology and value addition on coconut in connection with launching of Rythu sadikarika Sadassu by the Hon'ble Chief Minister, Andhra Pradesh Sri. N. Chandrababu Naidu at Kaikaram village of West Godavari district on 12.12.14 for the benefit of farming community.

Visit of Dr. S. Ayyappan, Secretary (DARE) & Director General (ICAR), New Delhi to exhibition stall organized by AICRP on Palms on 27-03-2015

Diagnostic visit

Scientists were deputed for survey to assess the nature and extent of damage caused by Hudhud cyclone and to suggest the mitigation measures to the Horticultural crops in Visakhapatnam, Vizianagaram and Srikakulam Districts of Andhra Pradesh from 14th to 19th Oct'2014.

Scientist visited the hudhud affected gardens in Visakhapatnam district of Andhra Pradesh

ARSIKERE

Training programme on Improved cultivation practices for coconut

Training programme on improved cultivation practices for coconut

- A training programme on "Improved cultivation practices for coconut" was organized for farmers on 16.10.2014. About 60 progressive farmers of Arsikere taluk participated in the training programme. During training programme, method demonstrations on

Training programme on coconut climbing and plant protection at HRES Arsikere

Moisture conservation in coconut, Fertigation in coconut, Black headed caterpillar management in coconut and Basal stem rot disease management in coconut were arranged.

- Organized CDB sponsored FoCT Coconut climbing and plant protection training programme for 20 rural youths during 22-27, December 2014. The training was given on climbing of coconut palm using coconut climbing device, crown cleaning, coconut harvesting, plant protection and production technologies of coconut. Scientists of HRES, Arsikere served as resource persons.

Training programme on Pest and disease management in horticulture crops

A training programme on Pests and disease management in horticulture crops was conducted on 23.12.2014 for 50 farmers of Arsikere taluk. Integrated pest and disease management practices for coconut, potato, tomato, brinjal, mango and pomegranate were discussed in the training programme.

Workshop on Recent technologies of coconut for higher yields at Godekere, CN Hally taluk

- The scientists of AICRP on Palms, HRES, Arsikere participated in the workshop on Recent technologies of coconut for higher yields at Godekere, CN Hally taluk of Tumkur district on 30.12.2014 along with Project Coordinator (Palms). The workshop was organized by UAS, Bengaluru and Taluk coconut growers association, CN Hally. 100 farmers of CN hally taluk participated in the workshop. The scientists of AICRP on Palms, Arsikere Centre served as resource persons and discussed on advanced production and protection technologies of coconut.

Workshop at Godekere, CN Hally taluk

Participation in Krishimela/ Horticulture Mela/ Exhibitions

Participated in World coconut day at Bengaluru on 02.09.2014, Krishi Saptaha at KVK, Kandali, Krishi Mela at UAS, GKVK, Bengaluru from 19.11.2014 to 21.11.2014, Horticulture Mela at UHS, Bagalkot from 12.12.2014 to 15.12.2014, Krishimela at JSS Fair, Suttur, Mysuru from 17.01.2015 to 21.01.2015 and Krishi Mela at Tiptur on 05.02.2015 to 07.02.2015. Exhibited specimens of different varieties and value added products of coconut and information on production and protection technologies of coconut in the exhibition stall.

Exhibition stall of HRES, Arsikere on World Coconut Day at Bangalore

Bhubaneshwar

- The centre had organized four off campus one- day farmer's training programme on 'Livelihood improvement through integrated coconut farming' for tribal farmers under TSP Programme in Keonjhar, Mayurbhanj and Sundargarh districts of Odisha. Out of total 215 participant tribal farmers, women farmers were more than 40%. Resource persons clarified all the queries raised by the tribal farmers during interaction session of the training programme
- New coconut plantations were developed by the centre in the year with 2500 coconut seedlings

in 17 villages involving 528 tribal farmers including 181 women farmers particularly in non-traditional areas in three tribal districts (Keonjhar, Mayurbhanj and Sundargarh) under TSP programme. Besides these coconut seedlings planted during last year in Keonjhar district were also being maintained by the centre .

Planting of coconut seedling under TSP

Jagdalpur

Different extension activites were carried out such as conducting programmes on improved coconut cultivation, integrated pest and disease management and distribution of healthy coconut seedlings, biofertilizers to the tribal farmers for improving the livelihood of the tribal farmers.

Farmers training at Palm field at SGCARS, Jagdalpur on 15/03/2015

Planting of coconut at SGCARS, Jagdalpur

Field day at Bodanpal, Bastar

Kahikuchi

The technologies developed under AICRP on Palms, Kahikuchi centre have been transferred by conducting (i) Training and demonstration and (ii) Exhibition.

Training

Training on "Improved production technology of coconut" are being conducted at different locations of Kamrup district. During the year 2014-15, six number of training on "Improved production technology of coconut" have been conducted at Sikarhati, Boko, Hajo, Dampur, Chaigaon and Chansari.

Training on Improved production technology of coconut in Kamrup District

Demonstration

Four demonstrations on nursery raising technique in coconut, integrated nutrients management practices in coconut, diseases and pests management in coconut were organised at Hajo, Rani, Lapatul and Boko were given during the period.

Coconut Block Plantation

Coconut block plantation has been initiated in the farmers' field namely by Sri Umesh Bora of Lapatul

having 40 palms and Sri Milon Bora of Rani having 20 palms. Intercropping of turmeric and banana has been taken up in the block plantation by both the farmers.

Exhibition

The major technologies developed also have been transferred by holding and participating in the various exhibitions like State level Annual Horticultural Show, Agri-Horti Show and North East Agri Fair.

Navsari

Participated and delivered the lectures about production technology of horticultural crops to the farmers during *Krushi Mohastav* programme in different villages during the month of June-2014 for 8 days. Advisory services provided through 'Cell phone' as and when required. Celebrated Agriculture Education Day by planting of coconut seedlings at primary school, Gujarat Vidhyapith, Ambheti (Valsad). Two districts covered for coconut plantation under Tribal Sub Plan. About 1309 No. of farmers, entrepreneurs, students of other SAU's and Govt. officials visited to RHRS, Navsari centre .

Training programmes/seminar organized

Organized three one day training programmes on Production technology of Coconut on 11.08.14 at KVK Dediyapad village. A one day training programme was conducted on different aspects of coconut including organic farming on the occasion of World Coconut Day on 02-09-14 at KVK, Ambheti and High Tech Horticulture on 20-12-2014 at ASPEE College of Horticulture & Forestry NAU, Navsari (Gujarat). A total of 300 farmers participated in the programme.

Training programme on Production technology of Coconut

Field demonstrations organized

Six field demonstrations on nutrient management practices in coconut and diseases and pest management in coconut were organized during the period. Total of 323 participants attended the programmes.

Participation in Agri. Exhibitions/Fairs

The scientist of the centre participated in Horticulture fair/ exhibition and Agriculture exhibition at ASPEE College of Horticulture & Forestry, NAU, Navsari during this period.

TV/Radio talk

A video programme on "Production technology of Coconut " has been recorded and telecasted by DD Girnar TV. Also a programme on "Production technology of Coconut " has been broadcasted on Daman Radio Station.

DD programme

Ratnagiri

Tribal Sub Plan (TSP) Programmes

Total six farmers rallies were organized in Suryanagar village, Chandranagar village in Jawhar Tahsil, Mahim and Chinchani villages in

Coconut seedling distribution to tribal farmers and planting in the field

Coconut seedling distribution to tribal farmers and planting in the field

Palghar Tahsil and Sayade, Jogalwadi and Nashere villages in Mokhada Tahsil in Palghar district of Maharashtra. Training programmes on cultivation practices in coconut garden, integrated pest and disease management in coconut were organized from October to December 2014. Total 613 male and 130 female farmers were participated in different training programmes.

Farmers School Programme on "Hybridization in coconut"

Organized six days farmers School programme on "Hybridization in Coconut" at Regional Coconut Research Station, Bhatye, Ratnagiri from October 2014 to November 2014 for 30 coconut growers. Detailed information regarding hybridization in coconut were imparted to coconut growers with hands on training.

Demonstrations on release of parasitoids for the management of coconut black headed caterpillar

Organized demonstrations on release of parasitoids *Bracon* and *Goniozus* against black headed caterpillar in heavily infested coconut gardens in Palgahr tahsil in Palghar district for creating awareness among coconut growers on 21st and 22nd November 2014. Total 52 coconut growers were participated in this programme.

Release of parasitoids to control the Black headed caterpillar

Sabour

Training Programme organized by the centre

AICRP on Palms Sabour centre in association with CDB organized Field Day –cum Training Programme at KVK, Madhepura on 2-09-2014 and 45 farmers were participated in the training.

Conducted one day training at KVK, Katihar. A total of 42 farmers were participated in the programme on 24-03-2015. The scientist of AICRP on palms, Sabour delivered lecture on "Prospects of coconut cultivation in Bihar" "Scientific cultivation of coconut in Bihar" at KVK, Sabour ATMA, Kisanganj through Directorate of Extension Education, B.A.U. A total of 50 farmers were participated from Kisanganj district.

Training programme at KVK, Madhepura

Veppankulam

World coconut day and one day seminar on coconut cultivation was celebrated at CRS, Veppankulam, Tamil Nadu on 11.9.2015, nearly 1500 participants representing Farmers, Scientist, official from department of Agriculture and Horticulture, press and media personnel participated in the event. Later a group discussion cum seminar was organized. Chief Guest of the function Dr. N. Subbaiyan IAS, District collector, highlighted the status, significant and prospects of coconut in the agrarian scenario

India. Vice chancellor of TNAU Dr. K. Ramaswamy, stressed upon the industrial uses of coconut in the country as well as in the region. In the afternoon session, deliberated on the scientific production practices, post harvest management and product diversification of coconut in order to make its cultivation more remunerative for the farming community.

Release of publication

Coconut day celebration

Extension / Outreach Programmes attended

- Organized training on "Coconut Production Technologies" to 25 ATMA Farmers from Sathankulam block, Sulthanpettai block Thuthukudy and "Coconut cultivation aspects" to 50 Farmers from Pollachi north block on 04.03.2015, Coimbatore. One day state level seminar on Coconut Production Technologies sponsored by ICAR on 11.09.2014.
- Conducted training programme on hybridization techniques in Coconut to 100 farmers of Nagapattinam sponsored by MSSRF on 31.10.2014.
- Scientist took part in Exhibition on coconut and explained about hybrids and disease management in coconut at SICCI, Trichy during 12-15th March, 2015.

Oil Palm

Gangavati

Horticulture Mela/ Krishi Mela/Campaigns/ Exhibitions participated

- Participated and exhibited stall in Krishimela 2014-15 of UAS, Raichur on8- 9 and 14 -16th and November-2014 Organized by UAS, Raichur. exhibited stall in Bruhat Udyana mela 2014-15 of UHS, Bagalkot on 12th - 15th December-2014. Organized by UHS, Bagalkot.

Krishimela 2014-15 of ARS, Gangavati

Two days training programmes organised

- State Level Training Programme on Oil palm at Gangavathi on 6 training programme, under NMOOP & DOPR Pedavegi, AP was organised.

Training at Udyanagiri,UHS, Bagalkot on 6th & 7th January, 2015.

Participation in the training programmes for farmers

The scientists of AICRP on Palms, Gangavathi participated as resource persons in four training

Inauguration of workshop at Shivamogga

programmes for farmers organized by the department of Horticulture, Shivamogga & Bhadravathi Balaji Oil Palm Ltd., Bhadravathi on Oil Palm-Development and Delivered lecture on Oil Palm scenario in world, India & Karnataka and cultivation practices of Oil Palm on 13.10.2014 to 14.10.2014.

Visit to Progressive farmer's (Purushottam Nadagoud) plot

Radio talks/ TV interviews

Delivered a lecture on Intercropping in Oil Palm garden, importance of Oil Palm and Basin management of Oil Palm in Krishi varthe, organized by DD 1 Chandana TV Channel .

Mulde

Training for Govt. Officers and Farmers

5 training programmes of 2 days duration for 20 Govt. officers, field staff of SAU, Processors and KVKs from Maharashtra and Goa States in each programme were oganized during December, 2014 under National Mission on Oil Palm and Oil Seeds. The programme was inaugurated by the Dr. S. Arulraj, Director, IIOPR, Pedavegi, (A.P.). Technical bulletin on "Oil Palm Cultivation and Management" was published and released during the inaugural session. Dr. E. K. Lawande, Vice Chancellor, D. B.S.K.K.V. Dapoli, Dr. U.V.Mahadkar. Director of Research D. B.S.K.K.V. Dapoli and Dr. P. M. Haldankar, Associate Dean, College of Horticulture, Mulde were chief guest and resource persons for the training programme. Field visit to oil palm growers was also arranged. Demonstrations on fertilizer applications, ablations and harvesting were given to the participants.

View of the trainings conducted at Mulde centre

Farmers Visit

Sixty students along with two staff members of College of Horticulture, Mulde visited A. I. C. R. P. Oil Palm Project at Mulde for studying floral biology and hybridizing technique. Total 155 framers and

Visit of officers to Mulde centre

16 Officers from the office of Taluka Agriculture Office, Radhanagari, Kolhapur district visited A.I.C.R.P. Oil Palm Project at Mulde.

Pasighat

Farmer's days – 02 nos.

Two number of farmer's day was organized at this center. Farmers of East Siang and Papumpare districts were trained for cultivation of oil palm in Arunachal Pradesh. Three Exposure visit to AICRP on Palms Pasighat center was organized for the Officers of Agri. Dept. Govt. of Arunachal Pradesh accompanying the farmers from the district of East Siang, West Siang Papumpare and Lohit district.

Progressive farmers from different districts of Arunachal Pradesh visited the AICRP on Palm center Pasighat to acquire Knowledge about oil palm. The scientist Incharge of the center interacted with the farmers and explained the scope of oil palm in NE region.

Visit of farmers club members to Pasighat centre

Visit of district Horticulture officer and Ruchi soya staff along with PC (Palms) at Pasighat centre

Pattukottai

Training

Organized six State Level Training Programme on Oil palm under from NMOOP & DOPR Pedavegi, AP, from Feb, 19th To March 19th, 2015 for Agricultural officers and KVK scientists and Processing company officials from Trichy, Karur, Perambalur, Ariyalur, Thirunelveli, Thanjavur, Cuddalore, Villupuram, Theni and Thiruvarur district of Tamil Nadu.

Training to the Agricultural officers and KVK scientists and Processing company officials

Exhibition Activities

- Participated in Indian Horticulture Congress-2014 at CODISSIA Trade Fair Complex, Coimbatore, Organized by Department of Horticulture, TNAU, Coimbatore (7th - 9th Nov. 2014).
- Charts and live specimen of oil palm were displayed during the national farmers meet at Paiyur on 13th - 15th March 2015.

- Honorable vice chancellor visited the exhibition stall at Trichy 5th SICCI Agri-Summit 2015(13.03.15 to15.03.15).

Radio Talk

Scientist from AICRP on palms Pattukottai, gave radio talk on the topic, Integrated nutrient and water management in oil palm and broad casted in All India Radio on 18.10.2014.

Vijayarai

- Five trainings of two days programmes conducted to 100 horticultural officers on "Production technology for oil palm". One day training programme on fertigation in oil palm and field demonstration of cocoa as an intercrop in oil palm were conducted. Field demonstration of cocoa as an intercrop in Oil Palm.

Training on oil palm production technology

Palmyrah Centres

Killikulam

- A two days training programme on the " Use of palmyrah tree climbing devices " has been conducted for 100 rural youths and farmers of Thoothukudi, Tirunelveli and Kanyakumari districts under the grant from Tamil Nadu Agricultural University and Indian Council of Agricultural Research on 18.4.13 and 19.4.13. More than 100 rural youths and farmers were trained on palm climbing devices.
- Demonstration on palmyrah tree climbing devices and palmyrah fiber extractor was given to the framers on 2.1.2014 during Regional Agricultural Mela conducted at Agricultural College & Research Institute, Killikulam International HORT INTEX, CODISSIA Complex, Coimbatore from 7.11.14 to 9.11.14.

Training on Use of palmyrah tree climbing devices

Pandirimamidi

Training programmes conducted

Scientists from AICRP on Palmyrah, Pandirimamidi participated in 9 training programmes as a part of Polam pilusthondhi programme organized by the state Agricultural Department in East Godavari district from August 2014 to October, 2014 and gave training to the farmers on utilization of palmyrah.

Demonstration of palmyrah fiber extractor machine

Exhibition stall at International HORT INTEX, CODISSIA Complex, Coimbatore

Visit of students to centre

Representatives from the Ecobuddy Exports, Tamil Nadu visited Pandirimamidi and interacted with tribal farmers at villages of D.N Palem, Pamugandi about jaggery processing on 10.10.14.

- Participated in the survey in the Hud hud cyclone affected areas in different parts in Visakhapatnam district of Andhra Pradesh and gave trainings to the farmers on the aspects of rejuvenation of damaged Horticultural crops including coconut and palmyrah.
- Training was conducted for tribal youth for bakery item from palmyrah tuber flour for 7 members on 03.11.14.

XI. Publications

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XIII. Weather data of co-ordinated centres

(January to December, 2014)

COCONUT CENTRES

Aliyarnagar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	30.9	18.4	89.1	69.3	--
February	33.5	19.8	88.4	51.1	1.0
March	33.8	20.9	83.6	42.1	12.0
April	36.7	23.9	89.2	48.6	1.0
May	33.6	23.7	90.8	62.7	197.3
June	33.9	25.0	83.2	56.3	92.0
July	31.4	23.5	83.1	66.4	124.2
August	29.5	21.7	84.7	65.6	52.1
September	32.1	24.2	85.8	56.9	238.4
October	30.6	21.5	88.0	68.6	251.8
November	29.6	21.4	90.1	62.2	46.8
December	28.3	20.1	87.5	65.5	38.3
Total					1054.9

Ambajipeta

Month	Temperature (° C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	30.9	18.7	74.2	51.0	-
February	31.0	19.6	65.9	52.2	-
March	33.5	33.6	69.9	48.8	-
April	39.2	25.3	68.4	47.8	-
May	42.0	27.9	69.7	47.7	42.4
June	40.3	28.0	63.0	46.0	27.7
July	38.1	24.9	77.3	60.0	266.3
August	35.5	25.2	71.4	66.3	113.8
September	33.7	24.0	81.3	66.8	150.2
October	34.3	23.8	76.1	60.3	73.7
November	33.5	21.5	70.5	54.3	17.0
December	32.0	18.7	48.0	42.0	2.5
Total					693.6

Arsikere

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	28.6	12.5	55.8	28.0	0.0
February	30.5	14.1	47.7	30.0	0.0
March	32.9	19.5	53.1	37.4	5.4
April	34.0	20.8	65.8	35.1	104.4
May	32.6	21.7	62.3	40.4	87.3
June	30.0	21.5	63.0	46.4	45.0
July	27.2	21.3	64.5	52.1	39.0
August	27.3	21.1	66.3	52.1	151.4
September	28.0	20.5	62.9	44.4	144.4
October	27.5	19.7	71.1	52.1	268.8
November	26.6	14.6	66.4	43.3	12.0
December	26.8	14.2	61.1	38.5	2.80
Total					860.5

Bhubaneshwar

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	28.8	15.1	92	45	0.0
February	32.0	17.0	92	46	21.8
March	35.0	21.4	91	50	53.2
April	39.8	24.4	88	40	9.4
May	39.6	25.7	87	48	202.2
June	36.6	26.3	87	61	111.0
July	31.4	24.7	94	82	410.5
August	33.1	24.8	94	76	261.2
September	31.6	24.3	95	77	383.1
October	31.8	20.8	93	64	163.1
November	30.9	18.0	90	44	0.0
December	27.7	13.9	88	45	0.0
Total					1615.5

Jagdalpur

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	28.5	11.3	91.8	40.4	0.0
February	32.2	15.0	96.0	45.0	0.0
March	32.5	19.3	90.4	41.9	76.2
April	37.4	22.5	79.3	33.4	26.6
May	36.9	25.4	80.0	37.0	73.0
June	36.0	26.1	79.7	44.9	151.3
July	28.8	23.9	89.4	73.6	336.0
August	29.4	24.4	91.8	75.4	338.9
September	29.2	23.2	94.0	74.2	321.7
October	29.4	20.4	95.1	68.1	112.4
November	29.3	14.3	95.1	45.6	0.8
December	27.1	10.5	93.7	39.8	0.0
Total					1436.9

Kahikuchi

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	24.4	10.0	81.8	70.6	7.2
February	28.1	12.2	76.0	58.0	15.4
March	28.9	15.9	69.8	55.6	21.6
April	30.5	20.6	72.8	61.6	101.0
May	32.3	21.7	78.9	71.6	233.6
June	32.5	25.2	90.0	82.8	278.8
July	33.0	26.1	91.0	84.5	264.2
August	33.4	26.0	89.4	82.0	249.0
September	32.8	25.2	86.7	81.2	152.0
October	31.0	22.3	81.8	79.1	115.6
November	28.2	17.0	80.0	79.5	6.20
December	25.7	13.1	83.7	81.6	7.40
Total					1452.0

Mondouri

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January,	24.3	10.4	86	63	0.0
February	28.5	13.7	85	53	28.5
March	33.9	18.9	86	46	26.2
April	39.4	24.9	86	38	0.0
May	37.6	26.7	88	57	80.5
June	35.4	27.0	93	76	329.5
July	32.9	26.9	96	83	278.1
August	34.2	26.5	95	77	281.4
September	34.0	25.8	95	77	330.5
October	33.6	23.1	88	68	81.9
November	32.2	15.9	80	50	0.0
December	26.7	12.0	86	58	0.0
Total					1436.6

Navsari

Month	Temperature(°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	28.7	14.4	80	51	14.0
February	30.0	15.1	82	33	0.0
March	33.4	17.8	81	34	0.0
April	35.3	22.2	84	42	0.0
May	34.9	25.8	83	56	0.0
June	33.7	27.9	81	64	36.0
July	30.8	25.7	89	78	719.0
August	30.3	25.1	93	79	324.0
September	31.2	24.4	93	76	380.0
October	35.9	22.6	82	41	0.0
November	33.7	19.2	85	41	67.0
December	30.0	14.0	73	38	0.0
Total					1540.0

Ratnagiri

Month	Temperature(°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	31.7	15.4	68.9	55.6	0.0
February	32.4	17.2	71.2	59.1	0.0
March	33.9	19.8	64.7	58.0	0.0
April	32.5	20.9	71.4	65.6	0.0
May	33.8	25.6	75.1	66.9	5.6
June	32.5	24.9	83.7	73.9	164.4
July	28.8	23.8	89.5	91.6	1101.4
August	28.8	23.9	90.6	86.4	624.7
September	30.3	23.5	81.4	89.1	423.8
October	33.2	22.9	69.1	78.3	33.1
November	34.2	21.1	63.1	67.8	23.0
December	33.1	19.5	53.6	59.5	10.8
Total					2386.8

Sabour

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	20.2	10.4	95.0	69.0	4.3
February	22.7	10.9	916	59.7	32.5
March	30.0	15.3	77.2	41.0	2.8
April	37.0	20.0	62.2	29.9	0.00
May	37.8	24.3	65.1	41.2	163.2
June	34.2	24.5	83.6	61.4	125.2
July	32.3	25.3	88.8	77.2	512.0
August	32.4	24.9	89.3	78.0	233.0
September	32.2	23.0	88.0	77.1	135.0
October	32.3	20.5	87.2	67.8	3.2
November	30.5	14.3	86.2	49.0	0.00
December	21.33	5.5	93.38	64.7	0.4
Total					1207.3

Veppankulam

Month	Temperature(°C)		Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	26.9	23.7	78	17.3
February	28.5	25.3	82	32.5
March	30.0	26.6	87	0.0
April	29.9	30.4	82	0.0
May	32.6	30.6	79	115.7
June	34.0	29.0	87	11.0
July	34.0	31.0	83	14.0
August	31.5	29.6	93	138.0
September	30.5	28.0	74	60.0
October	36.0	26.0	86	215.4
November	29.0	25.0	82	261.0
December	30.0	22.0	76	150.5
Total				1015.4

OIL PALM CENTRES

Gangavathi

Month	Temperature(°C)		Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	30.1	17.5	63.5	0.00
February	32.0	18.4	60.2	13.00
March	34.8	21.3	56.4	13.00
April	38.1	23.9	55.2	9.40
May	36.4	23.4	64.2	128.80
June	34.5	23.3	73.2	38.00
July	30.2	22.2	83.8	117.90
August	30.4	21.6	83.5	192.50
September	30.1	21.5	83.4	80.00
October	31.1	21.1	76.1	132.00
November	29.3	17.8	70.6	28.20
December	28.2	16.7	70.7	11.00
Total				763.8

Mulde

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	32.7	16.6	90	48	0.0
February	33.9	16.8	88	37	0.0
March	35.9	19.2	85	49	0.0
April	35.8	22.2	84	54	0.0
May	35.9	23.9	89	63	65.4
June	33.2	26.1	93	80	381.8
July	29.1	21.1	95	86	1295.3
August	29.6	22.0	94	83	603.1
September	30.6	26.6	92	81	351.8
October	33.4	26.5	91	65	177.8
November	34.5	22.6	89	57	120.4
December	34.1	20.0	89	70	200.0
Total					2889.6

Pasighat

Month	Temperature(°C)		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	FN	AN	
January	25.4	12.6	83.3	64.5	19.0
February	23.6	12.9	83.5	72.1	102.6
March	26.8	8.0	80.1	67.3	39.6
April	27.4	-	77.4	68.7	68.9
May	28.8	-	88.0	82.0	514.6
June	30.17	-	88.4	80.4	493.5
July	30.1	-	83.6	80.6	312.5
August	27.6	-	92.1	91.8	100.3
September	30.2	11.9	83.2	82.3	385.9
October	30.3	10.2	83.1	82.5	385.9
November	25.3	10.0	80.0	64.8	21.5
December	21.7	9.2	78.8	67.9	0.0
Total					2444.3

Pattukottai

Month	Temperature(°C)		Relative Humidity (%)	Rainfall (mm)
	Max.	Min.		
January	26.9	23.7	78	17.3
February	28.5	25.3	82	32.5
March	30.0	26.6	87	0.0
April	29.9	30.4	82	0.0
May	32.6	30.6	79	115.7
June	34.0	29.0	87	11.0
July	34.0	31.0	82.	14.0
August	31.5	29.6	93	138.0
September	30.5	28.0	74	60.0
October	36.0	26.0	86	215.4
November	29.0	25.0	82	261.0
December	30.0	22.0	76	150.5
Total				1015.4

Vijayarai

Month	Temperature (°C)		Relative Humidity (%)		Pan Evaporation (mm/day)
	Max.	Mini.	FN	AN	
January	29.2	19.3	96.2	51.1	2.9
February	29.8	19.0	96.7	49.8	3.5
March	33.3	21.5	94.9	41.3	4.3
April	36.1	24.5	94.6	41.6	4.2
May	38.0	26.4	91.7	38.8	4.0
June	38.5	28.5	79.8	37.8	3.5
July	33.7	25.9	88.9	53.2	2.8
August	33.3	25.5	94.4	57.5	3.3
September	33.2	24.9	96.4	61.9	3.0
October	32.8	24.0	94.9	53.3	4.9
November	31.8	21.5	92.7	45.8	2.3
December	31.6	18.9	90.5	40.3	2.5

PALMYRAH CENTRES

Killikulam

Month	Temperature (°C)		Rainfall (mm)
	Max.	Min.	
January	31.6	20.6	32.0
February	33.7	21.7	15.8
March	34.5	22.5	27.0
April	37.6	24.8	-
May	38.8	26.0	77.6
June	36.7	24.8	-
July	36.6	26.8	-
August	36.2	25.2	56.8
September	35.6	25.7	31.2
October	32.8	23.0	260.8
November	30.3	22.5	235.8
December	29.6	22.4	40.4
Total			625.0

Pandirimamidi

Month	Temperature (° C)		Relative Humidity %		Rainfall mm
	Max.	Min.	FN	AN	
January	29.7	16.2	97	42	4.2
February	27.7	14.6	95	35	2.0
March	38.5	28.2	76	42	0.0
April	35.2	27.3	96	52	17.6
May	39.7	26.0	75	52	127.4
June	33.3	24.6	96	70	29.4
July	30.3	23.8	97	77	135.8
August	31.8	23.9	98	73	322
September	31.7	22.5	95	56	201.6
October	31.1	23.0	98	73	152.4
November	29.1	18.0	95	49	65.8
December	27.4	14.0	75	52	6.2
Total					1064.4

Visit to Vijayarai along with scientists from oil palm centres

Visit to Sabour centre

Visit to Navsari centre

Visit to Ambajipeta centre

XXIII ANNUAL GROUP MEETING

A I C R P ON PALMS (CPCRI, KASARAGOD)

25 - 28 JULY, 2014

VENUE : D O R, Rajendranagar, Hyderabad

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