वार्षिक प्रतिवेदन
ANNUAL REPORT
2010 - 11

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

भाकृअनुप
ICAR

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
All India Co-ordinated Research Project on Palms
(Indian Council of Agricultural Research)
CPCRI, Kasaragod - 671 124, Kerala, India

वार्षिक प्रतिवेदन

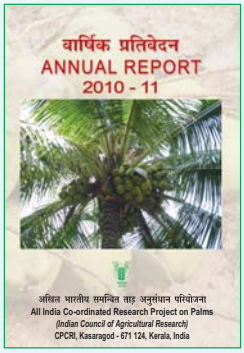
ANNUAL REPORT
2010-11

भाकृअनुप
ICAR

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

(Indian Council of Agricultural Research)
CPCRI, Kasaragod- 671 124, Kerala, India.

Correct citation: AICRP (Palms), 2011. Annual Report 2010-11. All India Co-ordinated Research Project on Palms. CPCRI, Kasaragod. 105 p.



Published by

Dr. George V. Thomas
Director (CPCRI) and Project Coordinator (Palms) (Addl. Charge)
Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
KASARAGOD - 671 124, KERALA, INDIA
Phone : 04994 - 232893733, EPABX: 04994 - 232894, 232895 & 232996;
Fax: 04994-232733, E mail: aicrppalms@yahoo.com
Grams: 'RESEARCH' Kasaragod;
Website: http://www.cpcri.gov.in/

Compiled and edited by

Dr. H.P. Maheswarappa
Dr. S. Arulraj
Dr. George V. Thomas

Hindi Translation

Smt. K. Sreelatha
Dr. Alka Gupta

Cover Photo: GBGDxFJT coconut hybrid

Back Cover: NRCOP 8 oil palm hybrid

Printed at:

Codeword Process & Printers
Mangalore

August, 2011

Contents

I. PREFACE

Coconut, oil palm and palmyrah are the major palms that provide employment and livelihood to more than 20 million people in rural areas. To improve the productivity in these crops and thus the income level of the farmers, the All India Coordinated Research Project on Palms was started in 1972. At present, the All India Coordinated Research Project on Palms, the research network system for palms in the country, comprises of 21 Coordinating Centres based at 12 State Agricultural Universities. The AICRP Centres located in twelve States representing different agro-climatic regions could identify location specific coconut varieties and hybrids that could be widely cultivated in the respective regions. Region specific coconut based cropping systems evolved through the AICRP on Palms Centres could improve the income from an unit area of coconut gardens and also the employment potential. Simultaneously, the integrated nutrient management system as well as integrated pest and disease management systems evolved at different Centres could bring down the cost of production of coconut and oil palm thus ensuring higher profitability. Work on value addition and post harvest technology for palmyrah has started yielding encouraging results.

I have immense pleasure to present the Annual Report 2010-11 of All India Coordinated Research Project on Palms. The 37th Annual Report of the AICRP on Palms covers the research results in coconut, oil palm, palmyrah and sulphi palm in respect of crop improvement, crop production, crop protection and other related information pertaining to the period from April 2010 to March 2011. The report includes results obtained from the 13 Centres that conducted experiments on coconut, six oil palm centres and two palmyrah centres. The entire report reflects the collective wisdom and team efforts of the Scientists and staff of the AICRP Centres. I am thankful to all my Project Scientists and Staff in different Centres for their sincere work and sustained enthusiasm in achieving objectives of the project.

I take this opportunity to express my sincere gratitude to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for the encouragement and guidance given. My sincere thanks are due to Dr. H.P. Singh, Deputy Director General (Horticulture), ICAR for his sustained keen interest, guidance and encouragement in the progress of the Project. I acknowledge the continued support of Dr. S. Rajan, Assistant Director General (Hort. I) and Officers at ICAR, New Delhi with their valuable help and guidance in the functioning of the Project. The support extended by Dr. George V. Thomas, Director and the Scientists from CPCRI is gratefully acknowledged. I express my sincere thanks to the Vice Chancellors, Director of Research, Heads of Stations and Scientists and staff from the Centres for their active involvement in ensuring the smooth conduct of the Project.

I acknowledge with thanks the help rendered by Dr. H.P. Maheswarappa, Principal Scientist (Agronomy), Smt. K. Narayani, Personal Assistant and Shri P. Narayana Naik, UDC in Project Coordinator's Cell in bringing out this report. Help rendered by Mrs. K. Sreelatha for Hindi translation is also gratefully acknowledged.

30/8/11

30.08.2011

(Dr. S. Arulraj)

II कार्य सारांश

भारतीय ग्रामीण आर्थिकता में नारियल, तेल ताड़ और खजूर का स्थान मुख्य है । ग्रामीण क्षेत्रों के 20 करोड़ से अधिक लोग इन फसलों के और उनके उपजों के उत्पादन, प्रक्रमण और विपणन कार्य में लग गए हैं । इन फसलों की उत्पादन क्षमता बढ़ाने के लिए और इसी प्रकार कृषकों के आय स्तर बढ़ाने के लिए अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना सन् 1972 में शुरु की गई ।

ये परियाजनाएँ वर्तमान में 21 केंद्रों में कार्यान्वित किया जाता है । मुख्यालय कासरगोड़ और पिलिकोड (केरल), अलियार नगर, अडुथुरै, किल्लिकुलम, वेप्पंगुलम (तमिलनाडु); अरसिकरे, गंगावती (कर्नाटक) अम्बाजिपेटा, पांडिरिमिडी, विजयराय (आंध्रप्रदेश) ; भुवनेश्वर (उड़ीसा) नवसारी (गुजरात) मधोपुर सावौर (बिहार) पसिघट (अरुनाचलप्रदेश) ; काहिकुची (असम) ; मन्डौरी (पश्चिम बंगाल) ; जगदलपुर (चत्तीसगढ) ; रत्नगिरी और मुल्डे (महाराष्ट्र) । इन 21 केंद्रों में से नारियल पर 13 केंद्र, तेल ताड़ पर छह केंद्र और दो केंद्र पॉमैरा पर अनुसंधान कार्य जारी है ।

बजट : वर्ष 2010-2011 का आय व्यय 460.00 लाख रुपए था जिसमें 345.00 लाख रुपए भा. कृ. अनु. प का है ।

वर्ष 2010-11 की अनुसंधान उपलब्धियाँ

नारियल

फसल सुधार

स्थानीय जजनद्रव्यों के संग्रहण, संरक्षण एवं मूल्यांकन के अधीन तमिलनाडु के दक्षिण राज्य से कुल 11 वासप्ररूप (सी आर पी 735 - सी आर पी 746) का संग्रहण किया गया, और अधोरोपण किया गया ।

वेप्पम्कुलम में, ग्यारह जननद्रव्यों के बीच, सी आर पी 509 (वी पी एम) से वर्ष 2008-09 में उच्चतम गुठली उपज / ताड़ (113) प्राप्त किया गया । वर्ष 2009-10 में उच्चतम वार्षिक उपज सी आर पी 509 (एम बी एम) से और आई एन डी 018 (142) से प्राप्त किया गया ।

अरसिकरा में कर्नाटक के मैदान क्षेत्र के नारियल वर्द्धित आठ स्थानों में ताड़ों को वर्ष 2010-2011 को पहचान लिया गया । किक्केरी, के.आर नगरा तालुक में के.आर. एन-1, के. आर. एन-2 और के.आर. एन-3 और बन्दिहल्ली में बी. ए. पी. - 1 और बी. ए. पी. - 2, गरुडनगिरी में गीजिहल्ली, जी. एन. ए-1 और अरसिकरे तालुक के बैरनाईकनहल्ली में एस. ए. बी. - 1 और हस्सन तालुक के करेबरे कवल में टी. के. बी. पहचान लिया गया ।

भ्रूण संवर्द्धन तकनीकी द्वारा पौध उत्पादन के लिए कोंकण क्षेत्रों में मीठा नारियल का सर्वेक्षण गुहागर तहसिल में किया गया और 14 पौधों को आगे अध्ययन के लिए अंकित किया गया । प्रक्षेत्र में 14 प्रकार के प्रत्येक के तीन पौधों का रोपण जुलाई 2009 में किया गया । कें रो फ अ सं, कासरगोड़ से प्राप्त भ्रूण संवर्द्धित पौध की रोपाई सितंबर 2010 में की गई ।

अम्बाजिपेटा में नए संकरण के उत्पादन एवं मूल्यांकन के अधीन नियंत्रित गोदावरी गंगा की तुलना में गौतमी गंगा x चन्द्र कल्पा (129) और वी एच सी - 1 (123) संकर संयुक्त में उच्चतम गुठली उपज प्रति ताड़ प्रति वर्ष अंकित किया गया । जबकि आँधी के पहले 1989-1996 में संचित उपज प्रति गुठली उपज प्रति ताड संकरण संयुक्त गोदावरी गंगा और कोन्कन भाटिया नारियल संकर 1(123) से प्राप्त किया गया । लेकिन ऑधी तूफान के बाद उच्चतम संचित गुठली चेक गोदावरी गंगा की तुलना में (1469) संकर संयुक्त गौतमी गंगा x चन्द्रकल्पा से (1580) और गौतमी गंगा x डबल सेन्टुरी (1577) अंकित किया गया ।

वर्ष 2009-2010 की गुठली उपज और खोपड़ा उपज विगत चार वर्षो के औसत से अधिक है, जी. बी. डी. x एल. सी. टी. में उच्चतम और उसके बाद जी. बी. डी. x पी. एच. ओ. टी. और जी. बी. डी. x एफ. जे. टी. इसलिए इन संकर संयुक्तों को कर्नाटक के मैदानी क्षेत्रों में कृषि के लिए सिफारिश किया गया ।

फसल उत्पादनः 18 वर्ष आयु के नारियल बाग में वर्द्धित तीन औषधीय पौधों में दो सुगंधी पौधों के बीच सुगंधित पौध नींबूघास से 23,270/- रूपए आय के साथ पत्ता उपज 7,170 कि ग्रा / हेक्टर प्राप्त किया गया और लाभ : मूल्य अनुपात

2.17 है । अलियार नगर (तमिलनाडु) में दूसरे वर्ष के फसल अवधि 2008-2009 में औषधीय पौध सिथारथई (अल्पिनिया गालंगा) से 30,250 रूपए / हेक्टर कुल आय के साथ 6,020 कि ग्रा हेक्टर मूलस्तम्भ अंकित किया गया । और लाभ : मूल्य अनुपात 2.43 है ।

कासरगोड के तटीय रेतीली मृदा में खोपड़ा उपज में उर्वरण के प्रभाव से विशेष परिणाम प्राप्त किया गया । ड्रिप सिंचाई से उर्वरक की अनुमोदित मात्रा के 50% और 75% के प्रयोग की अपेक्षा 100% मात्रा के उपचार से महत्वपूर्ण उपज प्राप्त किया गया । अलियारनगर और अरसिकरे में इसी प्रकार का परिणाम ही प्राप्त किया गया । इन परिणाम स्पष्ट रूप से यह सूचित किया जाता है कि ड्रिप सिंचाई विधि से रासायनिक उर्वरक के 50% बचा जा सकता है ।

रोग प्रबंधन

गैनोडेरमा का संरक्षण और व्यूहाण्विक गुणावगुणन

स्थानीय पॉलि *एक्लिामैड* जेल इलक्ट्रोफोरोसिस द्वारा *गेनोडेरमा* एकलन का ऐसोज़ैम प्रोफाइल का विश्लेषण *गेनोडेरमा* के 24 एकलनों का ऐसोज़ैम प्रोफाइल तीन विकर, एस्टेरेस, काटालेस और पेरोक्सिडेस से किया गया । सभी तीन विकर एकलन के बीच भिन्नता दिखई गई । एस्टरेस अध्ययन में विभिन्न एकलनों के बीच बैंड संख्या दर 0-9 तक पाया गया । अन्य दो विकर काटालेस और पेरोक्सिडेस एकलन के बीच विकर की उपस्थिति या अनुपस्थिति नहीं दिखाया गया । लेकिन विकर अध्ययन में अन्तारवेदिपालेम और वेन्दामुरिलंगा से 4 और 2 बैंड देखा गया । पेरोक्सिडेस अध्ययन में सखिनेटिपल्ली से एकलन 2 बैंड दिखाया गया । उपर्युक्त तीन विकर के साथ परीक्षण पुनरावर्तित किया गया और अन्य विकर जैसे मैलेट डिहाईड्रोजेनेस अम्ल फोसफटेस और पॉली फिनॉल ऑक्सिडेस के साथ ऐसोज़ैम अध्ययन किया गया ।

गेनोडेरमा रोग फैलाव पर नारियल में अन्य ताड़ एवं अन्तर फसलों का प्रभाव

रोग फैलाव पर नारियल में अन्य ताड एवं अन्तर फसलों के प्रभाव पर अध्ययन के लिए पूर्व गोदावरी जिला के गन्नवारम गॉव में केवल नारियल के पचास ताड़ का प्रक्षेत्र और नारियल + केले का प्रक्षेत्र चुन लिया गया । सभी महीनों में चुने गए ताड़ों में रोग का रेखीय और क्षैतिज फैलाव अंकित किया गया । केवल नारियल फसल में पचास ताड़ों में से केवल एक ही ताड़ रोग से संक्रामित पाया गया जबकि केले के साथ अन्तर फसलन किया गया बाग में जनवरी 2011 तक पचास पौधों में चार ताड रोग लक्षण दिखाया गया । फरवरी 2011 में छह, मार्च में सात पौध लक्षण दिखाया गया । रोग का क्षैतिज फैलाव केवल नारियल के खेत की तुलना में केले के साथ अन्तर फसलित नारियल में अधिक और उदग्र फैलाव केवल नारियल मात्र बाग में अधिक पाया गया ।

नारियल में आधार तना सड़न रोग का फैलाव

विभिन्न स्थानों से जैव एजेंट का संग्रहण, संरक्षण एवं गुणावगुणन

ट्रैकोडेरमा जाति का एकलन : पूर्व गोदावरी और पश्चिम गोदावरी जिला विभिन्न गॉवों जैसे गुडपल्ली, केसवदासपालेम, अन्तारवेदी, केशनपल्ली, सखीनेटीपल्ली लंगा, वेदंगी, अल्लावारम, गोडिलंगा, वोडालारेवु, रामेश्वरम, अन्तरवेडिपालेम, गोन्डि, जी पडेपुडी एच कोट्टुरु कडलाई गुडिमेल्लन्गा और तुरुपुपालेम से ट्रैकोडेरमा विशेष माध्यम का उपयोग कर नारियल ताड़ों के राईजोस्पियर क्षेत्र से सत्रह नया ट्रैकोडेरमा एकलन का संग्रहण किया गया । *टी विरिडे, टी हरज़ियानम, टी लॉगिब्रचियाटम, टी वैरन्स और टी पॉली स्पॉरम आदि* पहचान लिया गया । ट्रैकोडेरमा जाति है । द्वय संवर्द्धन माध्य में *गेनोडेरमा अप्लेनाटम और गेनोडेरमा लूसिडम* के विरुद्ध विरोधी क्रियाशीलता के लिए नए एकलित जातियों का परीक्षण किया गया और यह प्रभावी पाया गया और पहचान के प्रक्रियाधीन है ।

आधार तना सड़न रोग प्रभावित ताडों का राईजोस्पियर मैक्रोफ्लोरा की संख्या बाह्य रूप में स्वस्थ और आधार तना सड़न पर उनके प्रभाव पहचानने के लिए स्वास्थ्य ताड़ का अध्ययन किया गया । सर्वेक्षण के समय गुडपल्ली, चिन्तलामोरी गुडीमुला केसानापल्ली, शंकरागुप्तम और सखिनेटिपल्ली गॉव के स्वास्थ्य और रोगबाधित ताड़ों से मृदा का संग्रहण किया गया । स्वास्थ्य और रोग बाधित ताड राईज़ोस्पियर में व्यूहाण्विक संख्या का अध्ययन के लिए लगातार निर्जलीकरण तकनीकी अपनाया गया । राईजोस्पियर माईक्रोफ्लोरा में रोग बाधित मृदा नमूने की तुलना में स्वास्थ्य मृदा नमूने के साथ संबंद्धित मैक्रोफ्लॉरा की संख्या अधिक थी ।

अस्परगिलस नाइज़र, अस्परगिल्लस फ्लावस, राईज़ोपस, पेन्सिलियम जाति और जीवाणुवीय मण्डल आदि अधिक साधारण मैक्लोफ्लोरा आदि सभी नमूनों में मौजूद है । ट्रैकोडेरमा की

मण्डल रोग बाधित ताड़ों की तुलना में स्पष्टतः स्वास्थ्य नारियल ताड़ मे अधिक है । कोमरगिरिपटनम गॉव में त्रैकोडेरमा जाति जब एकलन के लिए रखा जाता है, रोग बाधित निधाय से प्राप्त किया जाता है ।

गेनोडेरमा लूसिडम की टेस्ट ट्यूब वृद्धि पर वनस्पतिय प्रभाव

गेनोडेरमा लूसिडम की वृद्धि पर पौघ उपज का प्रभाव निर्धारण के लिए एक प्रयोगशाला अध्ययन आयोजित किया गया । सोलानम निग्रम का पत्ता निस्सार के कारण गनोडेरमा लूसिडम की वृद्धि पर अधिकतम कमी पाई गई ।

तमिलनाडु में जड़ मुर्झा रोग लक्षण निर्धारण :

अलियार नगर

तमिलनाडु - केरल के सीमावर्ति प्रदेश के कोयम्बत्तूर, थेनी और डिन्डुगल जिलों के नारियल जड मुर्झा रोगबाधा पर सर्वेक्षण आयोजित किया गया । कोयम्बत्तूर में अनाईमलाई ब्लॉक के मनक्कडवु, गोपालपुरम (नेडुम्बराई), और सेतुमडाई गॉव में जड़ मुर्झा रोग लक्षण औसत रूप में क्रमशः 3.3, 1.4 और 0.07% अंकित किया गया । पोल्लाची उत्तर ब्लॉक के तिम्मन्कुत्तु गॉव, नन्जेगौन्डनपुदुर और केट्टिमलान्पुदुर में क्रमशः 0.3, 0.75 और 1.0% रोग लक्षण दिखाया । अधिकतम रोग लक्षण कोयम्बत्तूर जिला में मनकडवु गॉव में और गोपालपुरम (नेडुम्बराई) में देखा गया । थेनी जिला में के के पट्टि, कीलगुडल्लुर और कुम्बुम ब्लॉक के कुम्बुम गॉव में क्रमशः 15.37, 15.24 और 22.32% जबकि थेनी ब्लॉक में रोग लक्षण केवल अल्लिनगरम गॉव में (0.052%) अंकित किया गया ।

नारियल में कली सड़न रोग के विरुद्ध विरोधियों का प्रक्षेत्र मूल्यांकन

नारियल के कली सड़न रोग के विरुद्ध *टी.विरिडे* और *पी. फ्लूरोसेन्स* का विभिन्न संविन्यास के मूल्यांकन पर प्रक्षेत्र परीक्षण पुनरावृत्त किया गया । मनसून प्रारंभ के पहले रोगरोधक उपाय के रूप में 100% और 50% घाटता में *स्यूडोमोनस फ्लूरोसेंस* और *त्रैकोडेरमा विरिडे* का टाल्क संविन्यास और संवर्द्धन पावित लगाया जाता है ।

नारियल पौघ के छत्र क्षेत्र में संविन्यास का प्रयोग किया जाता है । 10 ग्रा दर में *स्यूडोमोनस फ्लूरोसेंस* का टाल्क संविन्यास का प्रयोग 10 ग्रा दर में त्रैकोडेरमा विरिडे की तुलना में प्रभावी पाया गया ।

उपचार के बीच तिमाही अंतराल में *पी. फ्लूरोसेंस* संवर्द्धन पावित 25 मि. ली के साथ मृदा प्रयोग के साथ *पी. फ्लूरोसेंस* टाल्क संविन्यास (50 ग्रा) + नीम केक (5 कि ग्रा) सम्मिलित कर मूलवेधन किया जाता है । यह तीनों स्थानों में उत्तम पाया गया और कम्बलपट्टी, करियनचेट्टीपालयम और समथुर परीक्षण में क्रमशः रोग लक्षण 12.93, 11.87 और 7.87% कम पाया गया । यह परीक्षण से मृदा प्रयोग के साथ मूल वेधन अच्छा पाया गया ।

कीट प्रबंधन

कोयम्बत्तूर, ईरोड, सेलम, तिरुपुर और डिंडिगुल जिलों में नारियल बागों में नारियल काला सिरवाला रोमिल इल्ली *ओपिसिना एरिनोसेल्ला* का संक्रमण का स्तर पर संनिरीक्षण किया जा रहा है । कोयम्बत्तूर जिला में सर्वेक्षण किए गए बागों में बी एच सी का संक्रमण का उच्चतम प्रतिशत स्तर 71.42 सुलुर गॉव में और तलवाडी में 64.00 मरुतमलाई 41.18 दासनाईकेनपालयम 45.7 सत्यमंगलम 39.04 ए नंगूर 22.00 नन्जुन्डपुरम 17.27 और करुमथुर 12.00 अंकित किया गया ।

पूर्व एवं पश्चिम गोदावरी जिला के अधिकांश सभी बागों में पत्ताहारी रोमिल इल्ली फेलेरा जाति और अक्रिया जाति का अधिक लक्षण निरीक्षण किया गया । इन कीट जनवरी, फरवरी और मार्च 2011 में निरीक्षण किया गया । नारियल कीटों के लक्षण की संवीक्षा के लिए विभिन्न नारियल बागों में हल्का ट्राप लगाया गया । मई 2010 से दिसंवर 2010 की भारी लगातार वर्षा के कारण पत्ताहारी रोमिल इल्ली जैसे स्लग रोमिल इल्ली *(पारासा लेपिडा)* जालकृमि फेलेरा जाति और फली छिद्रक आदि नारियल पत्तियों पर प्राशन करते दिखाई पड़ा और हल्का ट्राप में प्रौढ कृमि पकडा गया । (500 वाट्स का उत्तापदीप्त बल्ब 6 बजे शाम से 5 बजे सवेरे तक जल बरतन के ऊपर 45 सें मी ऊँचाई पर रखना)

रत्नगिरी में एरियोफिड कीट संक्रामण के प्रबंधन के लिए समीकृत पहुँच स्वीकार करने से दोनों प्लोट में विभिन्न उपचार के पहले भी कीट संक्रामण दर 92% से 94% तक पाया गया । दूसरी तरफ स्वास्थ्य फलों का प्रतिशत 7.35 से 61.74 तक बढ़ाया गया । नियंत्रित प्लोट में एरियोफिड कीट संख्या में कोई परिवर्तन नहीं दिखाई पड़ा । इसलिए निम्नलिखित पद्धतियों के साथ समीकृत पद्धति से कीट संख्या कम किया जा सकता है ।

1. वृक्ष स्वच्छता उपाय
2. 10 मि. ली. दर में 10000 पी. पी. एम अज़ादिराक्टिन + 10 मि. ली. पानी का मूल वेधन
3. यह उपचार दिसंबर-फरवरी, अप्रैल-जून, सितंबर-अक्तूबर, वर्ष में तीन बार दिया जाता है
4. कार्बनिक कचड़ो का पुनः चक्रमण
5. अलवाल में हरी खाद फसलों की उगाई ।
6. उर्वरकों की अनुमोदित मात्रा का प्रयोग
7. सुपार्शित स्तर की सिंचाई
8. अलवाल में छिलका परतना
9. मृदा नमी परिवर्तन उपाय

फसल उत्पादन

गंगावती में लघु सिंचाई द्वारा तेल ताड़ में उर्वरण पर अध्ययन किया गया और यह देखा गया कि उर्वरण के माध्यम से प्रयोग किए गए विभिन्न मात्रा के नाईट्रोजन फोसफोरस पोटाश के प्रभाव से ताजा फल गुच्छ में कोई महत्वपूर्ण भिन्नता नहीं है । विभिन्न उपचारों के बीच उच्च ताजा फल गुच्छ टी$_1$ के साथ (300 ग्रा नाईट्रोजन : 150 ग्रा फोसफोरसः 300 ग्रा पोटाश) उर्वरण से और टी$_6$ (1200 ग्रा नाईट्रोजन : 600 ग्रा फोसफोरसः 1800 ग्रा पोटाश) मृदा प्रयोग से (क्रमशः 6.12 और 5.82 टन/हेक्टर) मुल्डे केंद्र में वर्ष 2009-2010 उपज ऑकड़े से यह देखा गया है कि विभिन्न उपचारों से उपज गुण में कोई महत्वपूर्ण भिन्नता नहीं है । जबकि उपचार टी$_5$ (1200 ग्रा नाईट्रोजन : 600 ग्रा फोसफोरसः 1800 ग्रा पोटाश उर्वरण) में अधिक ताजा फल गुच्छ की संख्या (5,6) अधिकतम गुच्छ भार (24.0 कि ग्रा / गुच्छ) और ताजा फल गुच्छ (19.3 टन/हेक्टर) पाई गई ।

पॉमैरा

बिहार जिला के बहलपुर और बाका जिलों में पॉमैरा का जननद्रव्यों के संग्रहण के लिए किल्लिकुलम और सावोर केंद्र के वैज्ञानिकों ने 2 से 6 सितंबर 2010 तक एक संयुक्त सर्वेक्षण कार्यक्रम में भाग लिया ।

नीरा और नुन्गु पर निष्पत्रण के स्तर के प्रभाव पर अध्ययन किल्लिकुलम केंद्र में प्रगति पर है । और 30% तक निष्पत्रित नर एवं मादा पेड़ों में अधिकतम नीरा उपज और बाद में 70% स्तर तक के नर पेड़ों में और 50% स्तर तक के मादा पेड़ों में अधिकतम नीरा अंकित किया गया । नियंत्रित (कोई निष्पत्रण नहीं है) नर और मादा पेड़ों में निम्नतम नीरा उपज अंकित किया गया । पिछले वर्ष भी इसी प्रकार का परिणाम अंकित किया गया है ।

• • •

III. Executive Summary

Coconut, oil palm and palmyrah occupy a predominant place in Indian rural economy. More than 20 million people in rural areas are engaged in the production, processing and marketing of these three crops and their products. To improve the productivity in these crops and thus the income level of the farmers, the All India Coordinated Research Project on Palms was started in 1972.

At present, the Project is implemented in 21 Centres including its headquarters at Kasaragod and Aliyarnagar, Aduthurai, Killikulam, Veppankulam (Tamil Nadu); Arsikere, Gangavathi (Karnataka); Pilicode (Kerala); Ambajipeta, Pandirimamidi, Vijayarai (Andhra Pradesh); Bhubaneshwar (Orissa); Navsari (Gujarat); Madhopur, Sabour (Bihar); Pasighat (Arunachal Pradesh); Kahikuchi (Assam); Mondouri (West Bengal); Jagadalpur (Chhatisgarh); Ratnagiri and Mulde (Maharashtra). Out of the 21 Centres, 13 Centres are conducting research on coconut, six on oil palm and two on palmyrah.

Budget: The budget for the year 2010-11 was Rs. 460.00 lakhs, of which the ICAR share was Rs. 345.00 lakhs.

Achievements during 2010-11

COCONUT

Crop Improvement

Under collection, conservation and evaluation of local germplasm, a total of 11 ecotypes (CRP735-CRP746) collected from the southern states of Tamil Nadu were planted.

At Veppankulam, among the eleven germplasm accessions, CRP 509 (VPM) recorded the highest nut yield / palm (113) during the year 2008-09 followed by IND 040 (91) and IND 018 (91). The annual nut yield / palm during the year 2009-10 was the highest in CRP 509 (MBM) (145) followed by IND 018 (142).

Arsikere centre undertook survey in eight locations of coconut growing areas of *maidan* tract of Karnataka during 2010-11. Identified KRN-1, KRN-2 and KRN-3 types at Kikkeri, K.R.Nagara taluk, BAP-1 and BAP-2 at Bandihalli, GAB-1 at Geejihalli, GNA-1 at Garudanagiri, SAB-1 at Byranaikanahalli of Arsikere taluk and TKB at Karebare Kaval of Hassan taluk.

Survey for sweet coconut was conducted in Konkan region in Guhagar Tahasil and 14 palms were marked for further studies. Three seedlings each of fourteen types were planted in the field during July 2009. The embryo cultured plantlets received from CPCRI, Kasaragod, Kerala have been planted during September, 2010.

In the trial on production and evaluation of new cross combinations at Ambajipeta, the highest nut yield per palm per year was recorded in cross combinations Gauthami Ganga x Chandra Kalpa (129) and VHC-1 (123) compared to the control Godavari Ganga (121). However, the cumulative nut yield per palm during pre-cyclone period (1989-1996) was highest in cross combinations Godavari Ganga (232) followed by Konkan Bhatye Coconut Hybrid-1 (231), whereas the highest cumulative nut yield during post cyclone period (1997-2010) was in cross combinations Gauthami Ganga x Chandra Kalpa (1580) and Gauthami Ganga x Double Century (1557) compared to 1469 nuts in the check, Godavari Ganga.

The nut yield and copra yield during 2009-10 and also the mean over last four years were significantly higher in GBGD x LCOT followed by GBGD x PHOT and GBGD x FJT and hence these cross combinations could be recommended for cultivation in maidan tract of Karnataka.

Crop production

Among the three medicinal plants and two aromatic plants raised in a 18 year old coconut garden at Aliyarnagar centre the aromatic plant lemongrass (*Cymbopogon flexuosus*) recorded leaf yield of 7,170 kg/ha with a net income of Rs. 23,270/ha and B:C ratio 2.17. The medicinal plant sitharathai (*Alpinia galanga*) recorded 6,020 kg/ha of rhizomes

with a net income of Rs.30,250/ha and B:C ratio of 2.43 during the second year of the crop period (2008-2009).

The impact of fertigation was conspicuous in terms of copra yield in the coastal sandy soil at Kasaragod. The treatment, 100% recommended dose of fertilizer through drip fertigation recorded significantly higher yield which was on par with 50 and 75% of fertilizer application through drip fertigation. The same trend was seen in the Aliyarnagar and Arsikere centres also. These results clearly indicate that 50% saving of chemical fertilizer is possible through drip fertigation method.

Disease management

Isozyme profiles of 24 isolates of *Ganoderma* were carried out with three enzymes, esterase, catalase and peroxidase by native PAGE. All the three enzymes showed variation among the isolates. Esterase isozyme profiles showed the highest variation in the isolates. The number of bands of esterase among the various isolates ranged from 0 to 9. The other two enzymes, catalase and peroxidase showed either the presence or absence of enzyme among the isolates except the isolates from Antarvedipalem and Bendamurilanka which showed 4 and 2 bands in catalase and isolate from Sakhinetipalli which showed 2 bands of peroxidase.

In sole coconut crop, out of fifty palms, only one palm was infected with the disease, whereas, in coconut intercropped with banana, out of fifty four plants, 7 palms showed the symptoms of disease infection. Horizontal spread of the disease was found to be more in coconut intercropped with banana when compared to the sole crop whereas vertical spread was found to be more in sole coconut crop.

Seventeen new *Trichoderma* isolates were collected from rhizosphere region of coconut palms from different villages of East Godavari and West Godavari districts using *Trichoderma* specific medium. *Trichoderma* isolates were identified as *T. viride, T. harzianum, T. hamatum, T. longibrachiatum, T. virens* and *T. polysporum*. The newly isolated species when tested for antagonistic activity against *Ganoderma applanatum* and *Ganoderma lucidum* in dual culture studies were found effective.

Survey was conducted on the occurrence of root (wilt) disease of coconut in Coimbatore, Theni and Dindigul districts in Tamil Nadu - Kerala border areas. Manakkadavu, Gopalapuram (Nedumparai) and Sethumadai villages of Anaimalai block in Coimbatore district recorded an average root (wilt) disease incidence of 3.3, 1.4 and 0.1%, respectively. Thimmankuthu village of Pollachi North block, Nanjegoundanpudur and Kettimalanpudur villages of Pollachi South block showed 0.3, 0.7 and 1.0%, disease incidence, respectively. In Theni district, K.K. Patti, Keelagudalur and Cumbum villages of Cumbum block, showed 15.4, 15.2 and 22.3%, respectively whereas, in Theni block the disease incidence was recorded only at Allinagaram (0.05%) village.

Field experiment on evaluation of various formulations of *T.viride* and *P. fluorescens* against bud rot disease of coconut was repeated. Talc formulation and culture filtrates of *Pseudomonas fluorescens* and *Trichoderma viride* at 100% and 50% concentrations were imposed before the onset of monsoons as prophylactic measure. Formulations were applied in crown region of coconut seedlings. Application of talc formulation of *Pseudomonas fluorescens* @ 10g was found to be effective when compared to *Trichoderma viride* @ 10g and application of culture filtrates of 100% and 50% of both the bioagents.

Pest management

High incidence of leaf eating caterpillars *Phelera* sp and *Acria* sp was observed in almost all the gardens of East and West Godavari district. These pests were observed in the months of January, February and March 2011. Light traps were installed in various coconut orchards for monitoring the incidence of coconut pests. The leaf eating caterpillars like slug caterpillar [*Parasa lepida*], webworm [*Acria sp*], *Phelera sp* and button borer

were observed feeding on the coconut foliage and the adults were mass trapped in the light trap [500 W incandescent bulb arranged at 45 cm high above the water pan] from 6 pm to 5 am.

By adopting integrated approach to manage the eriophyid mite infestation at Ratnagiri, the eriophyid mite infestation was reduced from 92.65 to 38.26%. On the other side, percentage of healthy fruits was increased from 7.35 to 61.74. The eriophyid mite population remained same in control plot.

Oil palm

Crop Improvement

Under the evaluation of oil palm genotypes for drought tolerance at Gangavathi in Karnataka State, the FFB yield differed significantly among the various genotypes during 2009-10. The genotype ZS-3 recorded significantly higher mean FFB yield of 6.14 t/ha over ZS-6, ZS-8, ZS-5 and TS-7. The genotypes ZS-1 and ZS-9 with FFB yields of 4.85 and 3.94 t/ha, respectively were on par with ZS-3.

Crop Production

Studies on fertigation in oil palm through micro irrigation at Gangavathi Centre indicated no significant difference in the FFB yield as influenced by different doses of NPK applied through fertigation. Among different treatments, higher FFB yield was noticed with T1 (300:150:300 g NPK through fertigation) and T6 (1200:600:1200 g NPK through soil application) (6.12 and 5.82 t/ha, respectively).

At Mulde centre in Maharashtra State, yield data during the year 2009-10 revealed no significant difference among the various treatments for yield characters. However, treatment T5 (1200:600:1800g NPK fertigation) recorded more number of FFB (5.6), maximum bunch weight (24.0 kg/bunch) and yield of FFB (19.3 t/ha).

Palmyrah

A joint survey programme for germplasm collection of palmyrah at Baghalpur and Banka districts of Bihar was made by scientist of Killikulam and Sabour centres from 2nd to 6th September 2010 and a total of 13 accessions were assembled.

Studies on influence of levels of defoliation on neera and nungu yield is in progress at Killikulam centre and the results indicated that the trees defoliated to 30% level had the maximum neera yield in both male and female, followed by 70% level in male and 50% in female trees.

• • •

IV. Profile of AICRP on Palms

Coconut, oil palm and palmyrah occupy a predominant place in Indian rural economy. To improve the productivity in these crops and thus the income level of the farmers, the All India Coordinated Research Project on Palms was started in 1972. The broad objectives of the project are:

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

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

List of centres

Sl. No.	Name of the Centre	Address	Crops
1.	Aliyarnagar	Coconut Research Station, Aliyarnagar - 642 101, Coimbatore District, Tamil Nadu. (TNAU, Tamil Nadu)	Coconut
2.	Ambajipeta	Horticultural Research Station, Ambajipeta-533 214, East Godavari District, Andhra Pradesh. (A.P.H.U., Andhra Pradesh)	Coconut
3.	Arsikere	Horticultural Research Station, Arsikere-573 103, Hassan District, Karnataka. (U.H.S. Bagalkot, Karnataka)	Coconut
4.	Bhubaneshwar	Department of Horticulture, (OUAT), Bhubaneshwar - 751 003, Orissa. (O.U.A.T. Orissa)	Coconut
5.	Jagadalpur	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagadalpur - 494 005, Chhatisgarh. (I.G.K.V., Chattisgarh)	Coconut
6.	Kahikuchi	Horticultural Research Station, Kahikuchi, Guwahati - 781 017, Kamrup District (A.A.U., Assam)	Coconut
7.	Kalyani	Directorate of Research, P.O. Kalyani - 741 235, Nadia District, West Bengal. (B.C.K.V., West Bengal)	Coconut

8.	Kasaragod	Central Plantation Crops Research Institute, Kasaragod-671 124. (CPCRI, ICAR)	Coconut
9.	Navsari	ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari - 396 450, Gujarat. (N.A.U., Gujarat)	Coconut
10.	Ratnagiri	Regional Coconut Research Station, Bhatye - 421 612, Ratnagiri District, Maharashtra. (D.B.S.K.K.V., Maharashtra)	Coconut
11.	Sabour	Bihar Agricultural College, Sabour, Bhagalpur District - 813 210, Bihar. (B.A.U., Bihar)	Coconut
12.	Pilicode	Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670 353, Kerala (K.A.U., Kerala)	Coconut
13.	Veppankulam	Coconut Research Station, Veppankulam - 614 906, Thanjavur District, Tamil Nadu. (T.N.A.U., Tamil Nadu)	Coconut
14.	Aduthurai	Tamil Nadu Rice Research Institute, Aduthurai - 612 101, Thanjavur District, Tamil Nadu. (T.N.A.U., Tamil Nadu)	Oil Palm
15.	Gangavathi	Agricultural Research Station, Gangavathi-583 227, Koppal District, Karnataka. (U.H.S., Bagalkot)	Oil Palm
16.	Mulde	Agricultural Research Station, Mulde -416 520, Kudal Taluk, Sindhudurg District, Maharashtra. (D.B.S.K.K.V., Maharashtra)	Oil Palm
17.	Madhopur	Regional Research Station, P.O. Madhopur - 845 454, Majhaulia Via., West Champaran Dist., Bihar. (R.A.U., Bihar)	Oil Palm
18.	Pasighat	College of Horticulture & Forestry, Pasighat - 791102, Arunachal Pradesh. (C.A.U, Imphal)	Oil Palm
19.	Vijayarai	Horticultural Research Station, Vijayarai - 534 475, West Godavari District, Andhra Pradesh. (A.P.H.U., Andhra Pradesh)	Oil Palm
20.	Killikulam	Agricultural College & Research Institute, Killikulam - 628 252, Vallanad, Tuticorin District, Tamil Nadu. (T.N.A.U.,Tamil Nadu)	Palmyrah
21.	Pandirimamidi	Horticultural Research Station, Pandirimamidi, Ramapachodavaram P.O.-533 288, East Godavari District, Andhra Pradesh. (A.P.H.U., Andhra Pradesh).	Palmyrah

Location of AICRP Centres

Budget

The budget for the year 2010-11 was Rs. 460.00 lakhs of which the ICAR share was Rs. 345.00 lakhs.

Head-wise budget (ICAR Share)

(Rs. in lakhs)

Head	Expenditure
Pay and Allowances	222.72
Travelling Allowances	8.48
Recurring Contingencies	79.12
Non Recurring Contingencies	34.68
Total	**345.00**

Mode of implementation

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

Staff Strength

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

• • •

V. Experimental Results in Coconut

5.1 Crop Improvement

Gen 1: Utilization of existing germplasm and description of varieties

(Aliyarnagar, Bhubaneshwar, Navsari, Pilicode, Sabour, Veppankulam)

Aliyarnagar

A collection of 15 germplasm accessions were planted during 1994 under Set III trial of Gen1. Coconut descriptors including palm morphology, reproductive traits and nut characters were recorded for all the genotypes. Palm height in this set had reached a maximum of upto 885cm in CRP 505. Number of functional leaves produced ranged from 26.7 (IND 001) to 41 (IND 032). Maximum leaflet length (150cm) and leaflet breadth (6.2 cm) were recorded in IND 032. The total number of inflorescences produced per year ranged from 12 to 14. Estimated nut yield ranged from 57 (CRP 507) to 241.5 (Kera Bastar). Among the nut characters studied, IND 011 produced large sized nuts followed by IND 032 and IND 001. Dehusked nut weight was highest in IND 011 (1720 g) followed by IND 001 (1407.5g) and IND 032 (1110g). Copra content ranged from 145g/ nut (IND 007) to 295g/nut (IND 001) (Table 1).

Bhubaneshwar

The experiment was initiated in December 2004 with 16 varieties which include 5 dwarf varieties, 10 tall varieties and a check variety. The data on growth characters indicated that, IND 041 recorded the maximum girth, leaves on the crown,

Table 1. Nut observations in Set III germplasm (Aliyarnagar, 2010)

Accession number	Fruit weight (g)	Husk thickness (cm)	Nut weight (g)	Kernel thickness (cm)	Kernel weight (g)	Shell weight (g)	Nut yield (palm)	Copra content (g/nut)
IND 032	3935.0	2.9	1110.0	0.9	622.5	327.5	102.5	175.0
IND 072	1330.0	3.2	570.0	1.1	445.0	287.5	146.2	165.0
CRP 509	1526.7	2.7	835.0	1.1	580.0	355.0	121.0	205.0
Kera Keralam	2647.5	4.0	870.0	1.1	580.0	347.5	172.0	200.0
CRP 505	1835.0	3.4	750.0	1.4	570.0	330.0	137.5	207.5
Kera Bastar	1227.5	3.3	485.0	1.4	412.5	245.0	241.5	147.5
CRP 506	1560.0	3.0	740.0	1.1	480.0	310.0	171.5	172.5
IND 007	1222.5	1.6	670.0	0.8	462.5	242.5	107.0	145.0
IND 011	4077.5	2.9	1720.0	1.1	967.5	567.5	78.0	290.0
IND 001	3275.0	3.7	1407.5	1.2	847.5	557.5	126.0	295.0
VPM 3	1882.5	2.9	815.0	1.2	567.5	347.5	105.5	190.0
CRP 042	1602.5	2.9	662.5	1.3	502.5	285.0	135.0	170.0
IND 018	1807.5	3.2	845.0	1.1	602.5	337.5	93.0	202.5

leaves produced per year, petiole length, leaf let length of the palms i.e. 6.26 m, 143 cm, 20.6, 10.8, 1.39 m, and 198 cm, respectively, whereas, IND 036 recorded the maximum petiole with leaf length i.e. 4.3 m and IND 025 recorded the maximum height and leaflet breadth (6.5 m and 5.4 cm, respectively).

Navsari

Planting materials of 17 accessions, viz.,COD, MYD, GBGD, CGD, Pratap, PHOT, LOCT, ADOT, BGL, BRR, BYL, FMC, Kapadam, Seycheillies, Borneo, San Ramon, Gaum were received from Ratnagiri centre and planted in the nursery on 25th February 2011.

Pilicode

The Pilicode Research Station was added to AICRP on palms as a Voluntary Centre as per ICAR order No. F No. 2-12/2010-Hort-1 dated 29.9.2010.

List of experiments

The Regional Research Station maintains an unique collection of coconut germplasm of 75 types consisting of 35 exotic and 40 indigenous types. The station has released five coconut hybrids viz., Lakshaganga, Keraganga, Ananthaganga, Kerasree and Kera sowbhagya using the promising indigenous Gangabondam and exotic Malayan yellow dwarf and Strait Settlement Apricot as male parents and WCT, APOT, LCOT as female parents. Utilizing the genetic resources available at this station, the following experiments were approved for this voluntary centre of AICRP on Palms.

Expt.1 : Exploitation of dwarf character in coconut by developing new hybrids using dwarf varieties

Parents: Chowghat Green Dwarf (CGD), Chowghat Orange Dwarf (COD), Chowghat Yellow Dwarf(CYD), Malayan Green Dwarf(MGD), Malayan Orange Dwarf (MOD), Malayan Yellow Dwarf (MYD), Laccadive Dwarf (LD), Andaman Dwarf (AD), Gangabondam(GB), Stright Settlement Green (SSG), Thembli and Ayiramkachi.

The mother palms and male parents were identified and marked for crossing programme.

Expt. 2: Survey, collection and utilization of dwarf eco-types suitable for northern region in Kerala State

The dwarf types with quality nuts suitable for tender nut purposes will be located in northern districts and evaluated for popularization in this region. The experiment will be initiated during 2011-12.

Expt. 3: Utilization of second generation selves and sibmated progenies of coconut, development of third generation progenies and development of hybrids

The experimental palms were identified and proper management practices were given. The experiment was started for grouping the parents.

Sabour

Altogether 15 coconut accessions are to be tested under the project. Seed nuts of 5 accessions namely MYD, COD, MOD, KGD and GBDB have been planted in nursery.

Assam Green Tall, Hazari Tall, Sakhi Gopal Tall, LCOT, PHOT, ADOT, Pratap, Tiptur Tall, Arasampatti Tall, ECT, Zanzibar Tall and Gonthembilli Tall are to be planted for their evaluation.

The seedlings are more sensitive to low temperature and fog. Therefore poly tunnels were made to protect them from winter injury. Seedlings were healthy under poly tunnel, but it was observed that incidence of bud rot was more under poly tunnel in due course of time. The incidence was reduced while the tunnels were aerated and the tunnel was kept open during the day time in winter.

Veppankulam

Morphological attributes of germplasm Set III

Morphological characters were recorded for germplasm Set III. Among eleven germplasms, number of functional leaves was highest in IND 050 (41.5) followed by CRP 509 (MBM) (38.0). Kalpa Dhenu recorded the highest length of petiole (1.43 m) followed by IND 034 (1.3m). Length of leaf was highest in Kalpa Dhenu (4.5 m) followed by CRP 509 (MBM) (4.4 m). Kalpa Raksha recorded the highest no. of leaflets (314) followed by IND

050 (243). Length of leaflet was highest in IND 018 (1.6 cm) followed by Kalpa Dhenu (1.2 cm). Chandra Kalpa and CRP 509 (VPM) recorded the highest leaflet breadth of (6.2 cm) followed by CRP 509 (MBM) (6.2). Height of the palm was highest in Kalpa Raksha of 8.8 m followed by CRP 509 (MBM) (8.5 m). IND 034 recorded the highest girth of palm (150.0 cm) followed by IND 050 (101.5 cm).

Nut yield

The annual nut yield for 2008-09 and 2009-10 for germplasm Set III were recorded and presented in Table 2.

Table 2. Nut yield of different germplasm (Veppankulam, 2010)

Accession	Annual nut yield /palm		Cumulative mean
	2008-09	2009-10	nut yield / palm (8 years)
IND 034	68.9	85.4	61.2
Chandra kalpa	52.0	79.0	55.4
Aliyarnagar Tall	71.0	102.6	73.5
Kalpatharu	84.0	87.9	71.0
IND 040	91.0	118.7	66.2
IND 057	59.6	76.4	73
IND 013	70.0	66.8	56.7
IND 018	91.0	142.3	86.8
Kalpa dhenu	84.8	130.7	74.7
CRP 509 (MBM)	57.6	144.8	73.5
CRP 509 (VPM)	113.0	104.86	81.80

Among eleven germplasm types, CRP 509 (VPM) recorded the highest nut yield / palm (113.0) during the year 2008-09 followed by IND 040 and IND 018 (91.0). The annual nut yield / palm during the year 2009-10 was highest in CRP 509 (MBM) (144.8) followed by IND 018 (142.3). The nut yield ranged from 55.4 - 86.8.

Cumulative mean nut yield / palm for eight years indicated that, IND 018 recorded the highest cumulative mean nut yield / palm of 86.8 followed by CRP 509 (VPM) (81.8).

From the nut characters data, it is found that the highest whole nut weight was recorded in Kalpa Dhenu (1200 g) followed by IND 034 (1125 g). Dehusked nut weight was highest in IND 034 (850 g) followed by IND 050 (695 g). Kalpa Dhenu recorded the highest kernel weight (400 g) followed by IND 050 (370 g). Thickness of kernel was found to be highest in Kalpa Dhenu (1.4 cm) followed by Chandra Kalpa (1.3 cm).

Gen.1A. Collection, Conservation and evaluation of local germplasm

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

Aliyarnagar

A total of 12 ecotypes (CRP735 to CRP746) collected from the southern districts of Tamil Nadu were underplanted in Gen 2 trial. The seedlings are in establishment stage. To promote good growth of seedlings, efforts are being taken to remove older palms. Growth observations recorded in those seedlings indicate that, on an average, the seedlings had reached a maximum height of 4.00 m with 9 to 10 leaves.

Ambajipeta

The seed nuts of local germplasm accessions were collected during August, 2005 and the nuts were raised in the nursery. The seedlings of accessions *viz.*, CRP 745 [Pillalakodi green], CRP 746 [Pillalakodi brown], CRP 747 [Jonnalarasi green], CRP 748 [Jonnalarasi brown], CRP 749 [Gangabondam], CRP 750 [AMB ECT-1], CRP 751 [AMB ECT-2] were planted in the main block. Data on growth characters revealed that maximum plant height (3.1 m) and number of leaves per plant (7.7) were recorded by CRP 750 at 5 years after planting.

Arsikere

Survey was undertaken in eight locations of coconut growing areas of maidan tract of Karnataka during 2010-11 as per the criteria given for collection, conservation and evaluation of local germplasm. Identified KRN-1, KRN-2 and KRN-3 types at Kikkeri, K.R.Nagara taluk, BAP-1 and BAP-2 at Bandihalli, GAB-1 at Geejihalli, GNA-1 at Garudanagiri, SAB-1 at Byranaikanahalli of Arsikere taluk and TKB at Karebare Kaval of Hassan taluk. The seed nuts of identified palms of TKB from Karebare Kaval have been collected and planted in nursery. The seed nuts from other locations are to be collected.

Bhubaneshwar

The experiment was planted during December 2003 with 11 local types in RBD with 3 replications viz, CRP 790, CRP 791, CRP 792, CRP 793, CRP 794, CRP 795, CRP 796, CRP 797, CRP 798, CRP 799, CRP 800. Local germplasm CRP 790 showed vigorous growth with respect to height of the palm (6.8 m), girth of the palm (145.5 cm), petiole length (127.2 cm) and leaf length (4.5m). However, the accession CRP 797 produced the highest number of leaves on the crown (17.8). Number of leaves produced per year was maximum (10.6) with the accession CRP 791. Highest length of the leaf let was produced by the accession CRP 791 and maximum breadth of the leaf let was produced by the accession CRP 794.

Jagadalpur

The experiment was initiated in 2006-07 to identify and characterize the *in-situ* cold tolerant coconut palms that will give better performance besides exposure to low temperature of less than 10° C for 2-3 months. In this regard, 10 palms were selected in the year 2006-08 from different parts of Bastar Zone. Observations in selected palms according to proforma for germplasm collection were continued in the year 2010-11. Plantations of coconut is rarely seen in the area, but for gardens like that of State Horticulture Nursery, Kirandul & Barsoor, Distt. Dantewada, Pamalvaya Nursery, Pamalvaya, Distt.-Bijapur and CDB Farm, Kopabeda, Kondagaon, Distt. Bastar is available; therefore household palms were also selected for the purpose. In the year 2010-11, one palm was identified in Kondagaon (Bastar) and observations were recorded for selected traits. Observation as per proforma of germplasm are given in Table 3.

Kahikuchi

Set-I

The experiment was started with 12 local accessions of coconut in Assam including Kamrupa and West Coast Tall as check varieties in a randomized design with three replications. The different accessions of coconut viz., CRP 701 to CRP 710 were collected from different locations of Kamrup, Nalbari, Borpeta and Darrang districts of Assam. Seedlings were planted in the main field during May, 2005.

The data on growth characters such as plant height, number of functional leaves and stem girth were recorded. The highest plant height (5.6 m),

Table 3. Accession data of local germplasm of coconut in Bastar (Jagadalpur, 2010)

Accession No.	Location of collection	Age of palm (Year)	No. of leaves in the crown	Spathe Prodn.	Nut yield	Weight of kernel (g)	Nut water (ml)	Na (ppm)	K (ppm)
		10-11	10-11	10-11	10-11	10-11	10-11		
CRP 723	Geedam Road Jagdalpur	25	35	13	295	190	195	116	2147
CRP 724	Kondagaon	24	28	09	230	155	265	154	2078
CRP 725	Muchanar Nursery, Barsoor	26	30	09	170	155	245	166	2809
CRP 726	Kirandul Distt. Dantewada	23	28	11	220	175	310	653	2491
CRP 727	Karli Dantewada	25	26	9	135	130	280	378	2624
CRP 728	Chitrakote Road Jagdalpur	28 & 37	33	13	298	203	155	241	2536
Not Alloted	Indra Kumar Rathore Kondagaon	26	29	10	210	165	250	248	2110
Not Alloted	Bus Stand Kondagaon	26	30	11	220	175	215	232	2225
Not alloted	Chinna Farm Sukma	30	28	10	255	180	165	210	2052

number of functional leaves (14.7) and stem girth (153.0 cm) were recorded under the collection CRP 703, CRP 702 and Kamrupa, respectively. On the other hand, the lowest plant height of 4.0 m, number functional of leaves (10.2) and stem girth (84.4 cm) were recorded under the collection CRP708, CRP 709 and CRP 707, respectively. First flowering of the palms were observed in the collections CRP701, CRP702, CRP703, CRP705, CRP706 and Kamrupa at the age of 67 to 70 months after planting.

Set-II

A new set of collection of local germplasm of coconut in Assam has been initiated at the centre. For this purpose, new coconut germplasm were collected in areas not covered in the previous collection programme. Altogether, five new local germplasm of coconut viz., CRP 711 to CRP 715 were collected from Nowgaon, Marigaon, Mangaldoi and Kamrup districts and seed nuts of these collections were sown in the nursery during February, 2008. Seedlings of these collections were planted in the main field in the last week of April, 2009 following single row planting with six palms per collection. The experiment is in initial stage and observations on plant height, number of leaves and stem girth at the base were recorded. Highest plant height of 1.7 m, number of leaves (6.7) and stem girth (46.4 cm) were observed in CRP 712, CRP 715 and CRP 711, respectively.

Mondouri

SET:II

Design : Row trial, **Year of planting** : 2009

Treatment (collection) : 5 (MHRS- 6, 7,8,9,10)

Accession No.	Location of collection
CRP - 784	Jagulia, Nadia
CRP - 785	Haringhata, Nadia
CRP - 786	Chakdaha, Nadia
CRP - 787	Diara, Hooghly
CRP - 788	Ramnagar, Midnapore (E)

Navsari

Following local germplasm types were collected and planted in the nursery:

Code No./Name at present used	Accession number	Year of collection	Location of collection
Hazarani	CRP729	2009	Mangarol
Mahuva Orange	CRP730	2009	Mahuva
Mahuva Green	CRP731	2009	Mahuva
Mahuva Orange	CRP732	2009	Mahuva
Mahuva Green	CRP733	2009	Mahuva
Gandevi Selection	CRP734	2009	Gandevi

Ratnagiri

Design : R.B.D.

Treatments : 6 types of local germplasm

Replications : Four.

Plot size : 4 palms/treatment/replication

Date of planting : September, 2007.

In respect of girth, height, no. of leaves and total no. of leaves, there was no significant difference within the treatments, CRP-759 had recorded maximum girth (85.8 cm) and height (374.1 cm). Maximum no. of leaves (6.8) was in CRP-759. The flowering is not yet noticed in any of the experimental palms (Table 4).

Set-II

The survey was conducted in four Taluka's of Ratnagiri district and the seedlings are planted during the month of November, 2010. The growth observations on height, girth, and no. of leaves recorded at planting and Velas has recorded maximum average girth (29.8 cm)and maximum average height (278.9 cm).

Survey of sweet coconut

The survey was conducted in Guhagar Tahasil and 14 palms were marked for further study. The seed nuts were collected for raising the seedlings. Three seedlings each of fourteen types were planted in the field in July, 2009. The embryo cultured plantlets received from C.P.C.R.I. Kasaragod, Kerala have been planted during September, 2010.

Growth observation on girth and number of leaves were recorded. CRP 776 had recorded maximum average girth of 26.8 cm. CRP 770 had recorded maximum average height 308.7 cm and

Table 4. Growth characters of local germplasm of coconut (Ratnagiri, 2010)

Sr. No.	Accession No.	Girth (cm)		Height (cm)		No. of leaves produced		Total no. of leaves
		At planting	Dec.-10	At planting	Dec.-10	At planting	Dec.-10	
1	CRP 757	14.5	76.3	1.5	322.4	5.7	6.2	24.9
2	CRP 758	12.7	83.4	1.3	355.4	4.8	6.6	25.9
3	CRP 759	15.5	85.8	1.7	374.1	5.5	6.8	25.6
4	CRP 760	14.7	74.2	1.9	318.1	5.9	6.1	24.0
5	CRP 761	13.6	80.4	1.8	355.6	5.1	6.7	24.9
6	CRP 762	16.2	74.2	1.9	298.2	5.8	6.1	24.5
	S.E.	0.52	6.5	1.2	22.91	0.20	0.27	0.97
	C.D.	1.58	N.S.	N.S.	N.S.	0.61	N.S.	N.S.
	Mean	-	79.06	-	337.30	-	6.41	337.30
	Range	-	45 - 121	-	152 - 530	-	4 - 9	152-530

CRP 772 recorded maximum number of leaves (10.7). CRP 725 recorded maximum number of leaves (19.3).

Sabour

Survey for local germplasm types has been conducted in Purnea, Katihar, Madhepua, Khagaria and Bhagalpur districts. Survey was also conducted in association with the scientists from CPCRI, Kasaragod from 13th January, 2011 to 15th January, 2011. Altogether 13 types were collected. All these thirteen samples were from talls and very less variation was noticed amongst them. Leaf samples of all these plants were taken for DNA isolation in order to study the variability.

Seed nuts of Konkan Bhatye Coconut Gybrid, Kera Bastar and Kahikuchi Hybrid-1, received from RCRS, Ratnagiri were planted in nursery. Prophylactic measures were taken to protect the seedlings from bud rot as well as cold injury. A bamboo based poly tunnel has been made to protect the seedlings from frost during winter.

Twenty seven seed nuts of Gouthami ganga were received on 17th March, 2011 from Ambajipeta centre in Andhra Pradesh.

Veppankulam

The data on morphological characters indicated that number of functional leaves was highest in Aliyarnagar Tall (32.0) followed by Kera Keralam (31.3). CRP 718 recorded the highest petiole length of 4.3 m followed by Kera Keralam with 4.1 m. CRP 716 registered the highest length of leaf (165 cm) followed by CRP 720 (160 cm). The leaflet length was highest is CRP 718 (1.3 m) followed by CRP 717 (1.2 m). CRP 719 showed the highest leaf breadth (6.0 cm) followed by Kera Keralam (5.9 cm). No. of leaflets was highest in CRP 716 (222.7) followed by CRP 719 (210.0). First flowering in local germplasm has been recorded. Among five local germplasm types, CRP 719 and CRP 716 showed first flowering in R1 at 54 and 55 months after planting, respectively. Out of 4 palms per replication in CRP 719, three showed flowering and two out of four palms in CRP 716 showed flowering. In RII, out of four palms, one palm in CRP 718 showed first flowering in 54 months after planting.

Two checks viz., Kera Keralam and Aliyarnagar Tall were included in the trial. Kera Keralam showed flowering in all replications. The first flowering in Kera Keralam was recorded at 50 months after planting, whereas, Aliyarnagar Tall recorded first flowering in RI at 51 months after planting. Out of four palms in RI, one palm has shown flowering.

The Seedlings of local germplasm viz., CRP 721 & CRP 722 collected from Marandahalli (Dharmapuri dt.) and Paramativellur (Namakkal dt) were planted on 13.09.2010.

Gen. 2: Production and evaluation of new cross combinations

(Ambajipeta, Arsikere, Bhubaneshwar)

Ambajipeta

The trial was laid out during 1985 with six cross combinations in RBD replicated thrice. The data on yield parameters was recorded during the year 2009-10 and presented in Table 5 and Fig.1.

Data on vegetative characters during 2009-10 revealed that the highest number of leaves on crown was recorded in cross combination Gauthami Ganga x Chandra Kalpa(32.7) followed by Gauthami Ganga x Kera Bastar (32.2) and Konkan Bhatye Coconut Hybrid-I (31.9). Maximum number of spadices per palm per year was recorded in cross combinations Gauthami Ganga x Chandra Kalpa (12.8) and Gauthami Ganga x Double Century (11.7) and maximum number of female flowers per palm per year was recorded in cross combination Gauthami Ganga x Chandra Kalpa (305.6) and Gauthami Ganga x Double Century (296.2).

It was observed from the Table 5 that the highest nut yield per palm per year was recorded in cross combinations Gauthami Ganga x Chandra Kalpa (129 nuts) & VHC - 1 (123 nuts) compared to the control Godavari Ganga (120 nuts). However, the cumulative nut yield during pre-cyclone period was highest in cross combination Godavari Ganga (232.3 nuts) followed by Konkan Bhatye Coconut Hybrid-1 (231.2 nuts), whereas the highest cumulative nuts yield during post cyclone period was recorded in cross combinations Gauthami Ganga x Chandra Kalpa (1580.1 nuts) and Gauthami Ganga x Double Century (1557.0 nuts) compared to 1469.0 nuts in the check Godavari ganga.

Significant differences were observed among the cross combinations with respect to nut quality characters. The highest nut weight was recorded in Gauthami Ganga x Double Century (1650.1 g/nut) and Gauthami Ganga x Kera Bastar (1245.0 g/nut) and dehusked nut weight was recorded in cross combination Gauthami Ganga x Kera Bastar (630.2g/nut) and Gauthami Ganga x Chandra Kalpa (620.8 g/ nut) compared to 1140.56 g/nut & 510.8 g/nut in Godavari Ganga (check).The highest husk weight was recorded in Gauthami Ganga x Double Century (879.6) followed by Godavari ganga (check (622.6 g/nut). Maximum water content in matured nut was recorded in the cross combination Gauthami Ganga x Double Century (247.5 ml/nut) and Gauthami Ganga x Kera Bastar (210.9 ml/nut) compared to 162.52 ml/ nut in Godavari Ganga (check) during 2009-10.

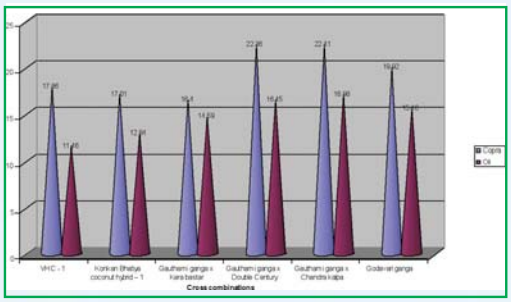


Fig. 1: Copra and oil content in cross combinations (Ambajipeta, 2010)

Table 5. Mean nut yield and cumulative nut yield of coconut crosses (Ambajipeta, 2010)

Treatment	Mean nut yield (2009-10)	Cumulative nut yield	
		Pre cyclone period (1989-1996)	Post cyclone period (1997-2010)
VHC -1	123.2	141.1	1344.3
Konkan Bhatye coconut hybrid - 1	115.9	231.2	1123.3
Gauthami Ganga x Kera Bastar	107.2	224.6	1380.5
Gauthami Ganga x Double Century	116.5	152.4	1557.0
Gauthami Ganga x Chandra Kalpa	129.5	165.4	1580.1
Godavari Ganga	120.7	232.3	1469.0
S Em ±	0.75	2.84	11.21
CD at 5%	2.28	8.57	33.79

Gautami Ganga x Double Century

Gautami Ganga x Chandra Kalpa

In respect of copra yield during the year 2009-10 (Fig.1), the highest copra content was recorded in the cross combination, Gauthami Ganga x Chandra Kalpa (22.4/kg/palm/year) followed by Gauthami Ganga x Double Century (22.4 kg/palm/year) compared to 19.9 kg/palm/year in the check Godavari ganga. Maximum oil yield was recorded in Gauthami Ganga x Chandra Kalpa (16.9kg/palm/year) and Gauthami Ganga x Double Century (16.4 kg/palm/year) and Godavari Ganga (15.5 kg/palm/year).

Arsikere

Set-I

The hybrid evaluation trial was initiated to assess the performance of indigenous and exotic crosses along with local check- Tiptur Tall.

Gauthami Ganga x LCOT

This trial consisting of 9 hybrids and one local cultivar was laid out during 1987 in RBD with three replications. Observations on growth parameters, yield of nuts and copra were recorded.

Table 6. Yield of hybrid coconuts (Arsikere, 2010)

Hybrids	Coconut yield (nuts/palm/year)				
	2006-07	2007-08	2008-09	2009-10	Mean (4yrs)
CCNT x LCOT	49.2	62.0	62.8	52.8	56.7
LCOT x PHOT	70.1	78.1	73.8	80.7	75.7
LCOT x CCNT	78.0	90.2	80.6	66.8	78.9
WCT x COD	76.3	85.3	90.2	98.7	87.9
WCT x GBGD	70.8	89.2	85.6	91.9	84.4
WCT x MYD	89.8	92.8	79.1	99.2	90.2
GBGD x FJT	97.8	121.2	118.8	111.2	112.3
GBGD x PHOT	107.0	114.1	117.1	144.6	120.7
GBGD x LCOT	107.6	123.4	112.7	147.6	122.8
Tiptur tall	76.4	96.8	101.2	81.8	89.1
S.Em +	6.9	6.44	5.47	9.12	4.17
CD (P=0.05)	20.55	19.15	16.26	27.13	12.40

The palm height and leaf production rate did not differ significantly between different cross combinations. The palm girth was significantly higher in WCT x GBGD while the number of functional leaves and cumulative leaf production were significantly higher in GBGD x PHOT cross compared to other cross combinations. The nut yield and copra yield during 2009-10 and also the mean yield over last 4 years were significantly higher in GBGD x LCOT followed by GBGD x PHOT and GBGD x FJT. Hence, these cross combinations could be considered for recommendation for cultivation in maidan tract of Karnataka (Table 5).

Set-II

The hybrid trial consisting of four hybrids and one local check- Tiptur Tall was laid out during 1992 in RBD with four replications. The palm height, number of functional leaves and cumulative leaf production were significantly higher in the hybrid MYD x TPT compared to other hybrids and local check- Tiptur Tall (Table 7). The nut yield and copra yield per palm during 2009-10 were significantly higher with MYD x TPT followed by LCOT x GBGD and LCOT x COD crosses. The mean data over last 4 years also showed higher nut yield and copra yield in MYD x TPT compared to other hybrids and Tiptur Tall (Table 7).

Bhubaneshwar

The seed nuts of cross combinations for this experiment were collected from C.P.C.R.I., Kasaragod and AICRP on Palm Centre, Veppankulam during 2004 and seedlings were planted during November 2005. The experiment was laid out in R.B.D. with 9 treatments and 4 replications having 6 palms per plot.

All the varieties showed an increase in the growth characters. Konkan Bhatye Coconut Hybrid-1 recorded the maximum height (5.0 m). Maximum girth was recorded in the palms of the cross combination Gouthami ganga x Kerachandra (117.4 cm). Maximum number of leaves on the crown (13.9) was observed in Laksha ganga. CRP 509 produced the highest number of leaves (7.2 leaves). VHC-2 recorded the maximum petiole length (131.3 cm) followed by CRP 509 (129.5 cm). Maximum leaf let length was recorded in VHC-I (192.0 cm), whereas maximum leaf let breadth was recorded in the cross combination of Gauthami Ganga x Kerachandra (5.1 cm).

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

(Aliyanagar, Ambajipeta, Arsikere, Bhubaneshwar, Kahikuchi, Ratnagiri, Veppankulam)

Aliyarnagar

In this project, five location specific cross combinations involving ALR (CN) 1 as a common parent are evaluated. The trial comprises of four replications with 6 palms per replication. Of these, four combinations were underplanted in the field in two replications during 2008. Seedling characters of these hybrids are presented in Table 8. The additional two replications of the five cross combinations including Kenthali Dwarf x ALR (CN) 1 have been underplanted in the field during October 2010. Crossing programme is being continued to ensure enough seedlings for gapfilling.

Ambajipeta

The seedlings of cross combinations viz., CRP 909 x Kalpa Pratibha, Gauthami Ganga x Kalpa Pratibha, CRP 509 x Double Century, Gauthami Ganga x Double Century, Double Century x Gauthami Ganga were in nursery and to be planted in June, 2011.

Table 7. Yield of hybrids of coconut(Arsikere, 2010)

Hybrids	Coconut yield (nuts/palm/year)				
	2006-07	2007-08	2008-09	2009-10	Mean
COD x WCT	41.3	40.7	59.8	54.2	49.0
LCOT x COD	32.6	55.2	64.9	67.4	55.0
MYD x TPT	65.6	74.2	81.4	87.5	77.2
LCOT x GBGD	34.2	61.7	65.2	66.7	57.0
Tiptur Tall	23.8	52.2	64.4	64.0	51.1
S.Em +	4.87	3.79	2.75	5.45	1.74
CD (P=0.05)	15.01	11.69	8.46	16.79	5.36

Table 8. Seedling characters of location specific cross combinations (Aliyarnagar, 2010)

Cross combination	No. of functional leaves	Girth at base (cm)	Height (m)	Leaf length (m)	No. of leaflets (Right)	No. of leaflets (left)	Leaflet length (cm)	Leaflet breadth (cm)
COD x ALR	6.5	32.0	1.7	1.6	29.0	29.2	51.5	2.7
ALR x MYD	6.2	29.6	2.1	19.5	27.8	26.6	60.6	2.5
MGD x ALR	7.0	34.5	1.6	1.5	36.0	36.7	52.2	2.9
ALR x MGD	9.5	59.5	3.7	3.6	58.7	60.5	84.2	3.4
WCT (Check)	8.3	52.6	2.5	2.3	48.0	48.6	58.0	2.7

Arsikere

Experimental design : RBD
No. of hybrids to be planted : 5 +1
No. of palms/plot : 6
No. of replications : 4
Cross combinations:
1. Kalpatharu x Kera Chandra
2. Kalpatharu x Chandra Kalpa
3. Chandra Kalpa x Kalpa Raksha
4. Chandra Kalpa x IND 048
5. Kalpatharu x IND 058
6. Kalpatharu x IND 048
7. Kalpatharu

The palms for male and female parents were identified and the crossing programme was initiated during August 2009. The combination, Kalpatharu x IND 058 (TPTxMYD) had 172 nuts, Kalpatharu x IND 048 (TPTxMOD) had 83 nuts, Kalpatharu x Chandra Kalpa (TPTxLCT) had 70 nuts, Kalpatharu x Kera Chandra (TPT x PHOT) had 88 nuts, Chandra Kalpa x Kalpa Raksha (LCTxMYD) had 88 nuts and Chandra Kalpa x IND 048 (LCTxMOD) had 48 nuts. Observations on nuts set in different cross combinations were recorded. The seed nuts were harvested and sown in nursery during February-March 2011.

Bhubaneshwar

Crossing programme was carried out in the following five cross combinations. IND 041 x IND 007, Kalpa raksha x IND 041, IND 041 x Gouthami ganga, IND 007 x CRP 794 and Gouthami ganga x IND 025. The seedlings were planted in the field during February 2008 by adopting RBD with four replications having 6 palsms per plot.

The data recorded revealed that the hybrid produced by the crossing of IND 041 x Gauthami ganga recorded maximum height i.e. 2.3 m and maximum girth of the plant 33.2 cm. The hybrid produced by the crossing of Kalpa raksha x IND 041 recorded the maximum no. of leaves on the crown i.e. 8.5 and the hybrid of Gauthami ganga x IND 025 produced the maximum number of leaves per palms per year i.e. 5.2. This hybrid also produced the maximum petiole length of 66.4 cm and petiole with leaf length of 1.5 m was produced by IND 041 x Gauthami ganga. The data pertaining to the length and breadth of the leaflet revealed out that the maximum leaflet length and breadth were recorded in the hybrid of IND 041X Gauthami ganga.

Kahikuchi

The experiment was undertaken with 5 cross combinations of coconut i.e., Assam Green Tall (Kamrupa) x Kalpa Prathiba, Kamrupa x Kera Chandra, Kamrupa x IND 058, CRP 502 x Kamrupa and CRP 501 x Kera Chandra. For this purpose, better performing types of female as well as male parents of the above cross combinations available in the centre were identified. Hybridization work was initiated from 1st week of March, 2005 following standard procedure as recommended by CPCRI, Kasaragod. Seed nuts of the above crosses were sown in the nursery and seedlings were raised. About one year old seedlings were planted in the main field during 2008-09 following randomized block design with six palms per replication.

The experiment is in the initial stage and observations on palm height, number of leaves/palm and stem girth were recorded. The data revealed that the plant height varied significantly among different crosses which ranged from 1.40 m to 1.70 m. No significant difference was observed on number of leaves/palm; however, the maximum number of leaves (7.0) was recorded in CRP501 x Kera Chandra. With regards to stem girth, the highest stem girth of 41.5 cm

was recorded in CRP501 x Kera Chandra followed by Kamrupa x Kera Chandra (36.0 cm) and lowest value of 27.3 cm was noted in Kamrupa) x Kalpa Prathiba.

Ratnagiri

Experimental Details :-

Design : R.B.D.
Treatments : 6 hybrids
Replications : Four
Plot Size : 6 palms/treatment/ replication
Date of planting : December 2006.

Growth observations recorded are presented in Table 9. In respect of girth, there was significant difference within various cross combinations. The BYRxIND007 has recorded maximum girth (89.9 cm) which was significantly superior over IND 007xBGR (54.2 cm) and at par with rest of the treatments. In respect of no. of leaves, there was no significant difference within various cross combinations.

Veppankulam

Among the five crosses, IND 048 x Kerakeralam recorded the highest number of functional leaves (27.2) followed by Kerakeralam x Kalpa Raksha (26.2). Length of the petiole was highest in VPM 3 x IND 007 (1.6) m followed by Kerakeralam x IND 048 (1.5 m). Kerakeralam x IND 048 recorded the highest length of leaf of (3.5 m) followed by Kerakeralam x IND 074 (3.4 m). No. of leaflets was found to be highest in Kerakeralam x IND 074 (194.67) followed by Kerakeralam x Kalpa raksha of (193.50). Kerakeralam x IND 074 recorded the highest length of leaflet (1.2 m) followed by Kerakeralam x Kalpa Raksha (1.1m). Breadth of the leaflet was highest in both Kerakeralam x IND 074 and Kerakeralam x IND 048 (5.6 cm).

Quality parameters of tender nut from new crosses were studied and results indicated that, among six hybrids, the total soluble sugars were highest in the hybrids IND 048 x Kerakeralam (5.80 brix) followed by IND 074 x Kerakeralam (5.75 brix) (Table 10). Highest volume of tender nut water was observed in hybrid VPM 3xIND 007 (380 ml) followed by IND 074 x Kerakeralam (300 ml). Hybrid IND 074 x Kerakeralam recorded the highest quantity of tender nut meat of 130 g followed by hybrid Kerakeralamx Kalpa raksha (125 g). Organoleptic scores for tender nut water and meat were highest in the hybrid IND 048 x Kerakeralam (8.0 and 7.0).

Nut characters of new coconut hybrids were studied. Four nuts of each were collected for this purpose and mean of the four nuts revealed that, among new hybrids IND 048xKera Keralam recorded the highest whole nut weight (1193 g), kernel weight (360 g) and kernel thickness of 1.13 cm. Dehusked nut weight was highest in Kera Keralam x IND 074 (580 g).

Nut yield was recorded for the new hybrids planted during 2005-06. Hybrid IND 048 x Kera Keralam and Kera Keralam x IND 074 recorded nut

Table 9. Growth observations of different crosses (Ratnagiri, 2010)

IND 007 x BYR	14.5	77.3	154.8	389.9	5.7	7.7
IND 007 x BGR	12.7	54.2	134.7	273.0	4.8	7.0
IND 007 x BGL	15.5	82.2	170.2	409.5	5.5	7.4
BYR x IND 007	16.2	89.9	188.7	420.0	5.8	7.1
BGR x IND 007	14.7	79.8	176.6	380.6	5.9	6.8
BGL x IND 007	13.6	85.2	196.0	402.5	5.1	6.9
S.E. 0.52	6.25	5.65	29.28	0.20	0.29	
C.D. 1.58	18.84	17.02	88.24	0.61	N.S.	
Mean	80.50		391		7.15	
Range	28-138		120-630		5-11	

Table 10. Quality parameters for tender nut (Veppankulam, 2010)

Hybrid	TSS (° brix)	Quantity of tender nut water (ml)	Tendernut meat (g)	Organoleptic score	
				Tendernut water	Tendernut meat
IND 048 x Kera keralam	5.80	245	90	8.0	7.0
Kera keralam x Kalpa raksha	5.55	275	125	4.0	5.0
VPM 3 x IND 007	4.80	380	65	4.0	4.5
Kera keralam x IND 048	4.80	220	25	3.3	3.3
IND 074 x Kera keralam	5.75	300	130	6.0	5.5
Kera keralamx IND 074	5.45	256	115	5.5	6.0

Kera Keralam x IND 074

IND 048 x Kera Keralam

yield of 31.27 and 15.17 nuts/palm during first harvest. There were no nuts to harvest in other hybrid combinations.

Gen-3: Trial of promising seed material

(Ambajipeta, Bhubaneshwar)

Ambajipeta

The details of the pre bearing performance of the coconut hybrids / varieties & nut characters are given in the Tables 11, 12 and Fig 2.

The pre-bearing performance of the coconut hybrids and varieties showed that during 2009-10, the highest total number of leaves on crown was recorded in check VHC-I (36.5) followed by Godavari Ganga (33.8) & Chandralaksha (31.7). The highest rate of leaf production was recorded in Chandrakalpa (13.8) followed by VHC-I (13.7) and VHC-I (13.3).Entries viz., VHC-I (12.2) & Chandrakalpa (10.6) recorded higher number of spadices/palm/year. The differences among the varieties/hybrids with respect to number of female flowers per palm and number of nuts per palm per year were found to be significant. Maximum number of female flowers/palm/year was recorded in Godavari ganga (355.5) followed by VHC-II (327.9) and Chandralaksha (320.7). In regard to nut yield/ palm/year (2009-10), the highest was recorded in Laksha ganga (66.4) and Kera ganga (66.1 nuts) compared to the check Godavari Ganga (63.1nuts).

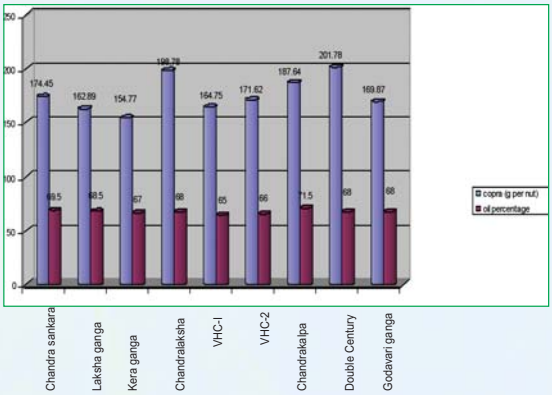


Fig. 2. Copra and oil content in coconut hybrids /varieties (Ambajipeta, 2010)

Table 11. Vegetative growth characters and yield in coconut hybrids/varieties (Ambajipeta, 2010)

Cross combination	Total no. of leaves on crown	Rate of leaf production	Mean no. of spadices/ palm/year	Mean female flowers/ palm/year	Mean nut yield/palm/ year
Chandrasankara (COD x WCT)	29.9	12.3	9.8	257.3	57.0
Lakshaganga (LCOT x GBGD)	30.6	11.9	9.5	312.5	66.4
Keraganga (WCT x GBGD)	29.7	11.8	9.8	298.2	66.1
Chandralaksha	31.7	12.7	10.0	320.7	58.8
VHC-I (ECT x MGD)	36.5	13.7	12.2	194.9	44.5
VHC-II (ECT x MYD)	31.7	13.3	10.4	327.9	47.2
Chandrakalpa	30.2	13.8	10.6	223.0	41.8
Double Century	30.3	11.6	10.2	263.6	47.1
Godavari ganga (ECT x GBGD)	33.8	13.1	10.6	355.5	63.1
SEm ±	-	-	-	10.5	1.93
CD at 5%	NS	NS	NS	31.59	5.78

Table 12. Nut quality characters in coconut hybrids / varieties (Ambajipeta, 2010)

Cross combination	Wt. of whole nut (g/nut)	Husked nut wt. (g/nut)	Husk wt. (g/nut)	Water content (ml/nut)	Meat wt. (g/nut)
Chandrasankara (COD x WCT)	1254.2	625.1	629.1	142.6	296.2
Lakshaganga (LCT x GBGD)	1048.4	647.4	399.6	128.9	253.3
Keraganga (WCT x GBGD)	1012.4	597.2	409.8	113.5	248.4
Chandralaksha	1238.4	710.2	526.3	156.4	308.4
VHC-I (ECT x MGD)	945.5	504.9	439.7	125.9	216.5
VHC-2 (ECT x MYD)	946.5	591.4	433.9	170.9	248.2
Chandrakalpa	1247.6	624.3	618.7	145.5	315.4
Double Century	1498.7	715.5	769.9	156.8	345.3
Godavari ganga (ECT x GBGD)	1045.8	588.6	455.1	164.9	288.5
S Em ±	21.59	8.04	13.2	1.60	8.19
CD at 5%	64.71	24.09	39.72	4.80	24.56

There were significant differences among the varieties/hybrids with respect to nut quality characters (Table 11). The highest nut weight was recorded in Double Century (1498.7 g/nut) followed by Chandrasankara (1254.21 g/nut) compared to 1045.8 g/nut in check (Godavari ganga). The highest dehusked nut weight was recorded in Double Century (715.5 g/nut) and Chandralaksha (710.2g/ nut) compared to 588.6 g/nut in Godavari ganga. The husk weight ranged from 399.6 to 769.9g/nut and maximum was recorded in Double Century (769.8 g/ nut). Water content in matured nut ranged from 113.5 to 170.9 ml/nut in various hybrids. Double Century (345.3g/nut) and Chandrakalpa (315.4 g/nut) recorded highest kernel weight compared to 288.5 g/nut in check (Godavari ganga).

In respect of copra content during the year 2009-10 [Fig-2], it was found that the highest copra content was registered in Double Century (201.8 g/ nut) followed by Chandralaksha (198.8g/nut) and Chandrakalpa (187.6 g/nut) compared to 169.9 g/ nut in check ECTxGBGD (Godavari ganga). Maximum oil content was recorded in Chandra kalpa (71.50%) followed by Chandra sankara (69.5%) and Laksha ganga (68.5%).

Bhubaneshwar

The experiment was laid out with two promising varieties, three hybrids with IND 041 as check in August 2004. Chandra kalpa recorded the maximum height (5.1m). However, for all other

vegetative growth characters like girth of the palm, total number of leaves on the crown, number of leaves produced per year, petiole length, leaf length, leaf let breadth, Kera sankara produced the maximum i.e. 89.2 cm, 12.1, 6.8, 109.7 cm, 3.6m and 5.1 cm, respectively.

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

(Aliyarnagar, Ambajipeta, Arsikere, Ratnagiri, Veppankulam)

Cross combinations to be tested;

1. Kera Keralam x Kalpatharu
2. Chandra Kalpa x VPM-3
3. Pratap x VPM-3
4. VPM-3 x CRP 509
5. CRP 509 x Chandra Kalpa
6. Local check of the Centre

Design: RBD;
Replications : 4

No. of cross combinations: 5 + 1;
No. of palms per plot : 6

Aliyarnagar

A total of five tall x tall hybrid combinations are to be evaluated at CRS, Aliyarnagar. Seednuts received from CPCRI were sown in the nursery. Observations on germination percentage, seedling height, girth and number of leaves were recorded. Among the eight month old seedlings, LCOT x ADOT was found to be the most vigorous, recording highest values for germination percentage, mean height, girth and leaf production. Ten month old seedlings were transplanted in the main field in RBD for two replications along with WCT as check. For cross combinations, where seedlings are still younger, transplanting would be done at a later stage.

Ambajipeta

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of the cross combinations viz., BGRxADOT, ADOTxECT, ECTxLCOT were received from CPCRI, Kasaragod and nursery was raised.

Arsikere

The seed nuts of Kera Keralam x Kalpatharu (WCTxTPT) and Chandra KalpaxVPM-3 (LCOTx ADOT), Pratap x VPM-3 (BGR x ADOT), CRP 509 x Chandra Kalpa (ECT x LCOT) have been received from CPCRI, Kasaragod during June 2010 and March 2011 and were sown in nursery on 19.06.2010 and 31.03.2011.

Ratnagiri

Seednuts have been received from CPCRI and sown in the nursery.

Veppankulam

Cross combinations of the TxT hybrids were planted along with check in A 4 Block at CRS, Veppankulam on 4.1.2011. The trial is in progress.

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

(Ambajipeta, Ratnagiri, Veppankulam)

Ambajipeta

The crossing programme was initiated during 2008 with released varieties viz., Philippines Ordinary, Laccadeev Ordinary, Fiji Tall, Java and Cochin China as parents. The cross combinations were Kalpa Mitra x CRP 509, Double Century x CRP 509, Kera Bastar x CRP 509, Chandra Kalpa x CRP 509, CRP 509 x Kalpa Mitra, Kalpa Pratibha x CRP 509, CRP 509 x Kera Bastar.

It was observed that, the setting percentage among the seven cross combinations ranged from 39.8 to 50.0 and the per cent setting was highest in Kalpa Pratibha x CRP 509 (50.0) followed by Kera Bastar x CRP 509 (48.9 %). Among the seven crosses made, a total of 1821 flowers were crossed, 846 flowers got fertilized and about 700 nuts were harvested. A total of 365 nuts were sown in the nursery.

Ratnagiri

Design : R.B.D.

Treatments : 6 hybrids (T x T)+1 Local Check

1) Kerachandra x Pratap 2) Pratap x Kerachandra
3) Kerachanrda x BGL 4) BGL x Kerachandra
5) BYR x Kerachandra 6) Kerachandra x BYR
7) Pratap (Local check)

Replications : Three.
Plot size : 6 palms/treatment/replication
Year of start : August, 2009

The six monthly growth observations recorded in December 2010 revealed that the maximum girth (27.1cm), height (153.1 cm) and total no. of leaves (17.2) were recorded by Kerachndra X BYR cross combination, while Pratap X Kera-chandra has recorded maximum no. of leaves (3.5).

Veppankulam

Design : RBD
No. of cross combinations : 7
Replications : 3
No. of palms per plot : 6

Eight T x T crosses *viz*., CRP 509 x Kera Chandra, CRP 509 x Kalpa Prathiba, Kera Keralam x Kalpa Prathiba, IND 034 xCRP 509, CRP 509 x IND 037, CRP 509xCRP 511, IND 034xIND 037, Kera Keralam x Kera Chandra made at Veppankulam were planted at 14B block on 21.03.2010.

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

(Ambajipeta, Mondouri, Ratnagiri, Veppankulam)

Cross combinations to be tested:

IND007 X IND 058
IND007 X Kalpa Raksha
IND 058 X Kalpa Sree
Gauthami Ganga X IND 048
Kalpa Sree X Kalpa raksha

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of the above cross combinations are supplied by CPCRI, Kasaragod for further raising of nursery and evaluation.

The seednuts of above hybrids have been received in Ambajipeta, Mondouri, Ratnagiri and Veppankulam centers and nuts have sown in the nursery.

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

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

List of newly released Coconut variety / hybrids and multiplication centre.

Name of coconut Variety / hybrids	Multiplication centre
Kalyani Coconut -1	Aliyarnagar
Gauthami Ganga	Ambajipeta
Konkan Bhatye Coconut Hybrid -1	Ratnagiri
CCS-6 (Kalpa Dhenu)	CPCRI
CCS-9 (Kera Keralam)	Veppankulam
CCS 8 (Kera Bastar)	Ratnagiri
CCS 4 (Kalpa Pratibha)	CPCRI
CCS 5 (Kalpa Mitra)	CPCRI
CCS 7 (Kalpa Raksha)	CPCRI
Kahikuchi Coconut Hybrid -1	Ratnagiri

No. of coconut varieties / hybrids to be tested : 10
Replication : 01
No. of palms per plot : 10

Aliyarnagar

Ten genotypes representing eight varieties and two hybrids supplied by different AICRP centres need to be evaluated for their performance at CRS, Aliyarnagar. A total of five genotypes viz., Kera keralam, Konkan Bhatiye Coconut Hybrid 1, Kahikuchi Hybrid, Gautami Ganga and Kera Bastar received from Veppankulam, Ratnagiri and Ambajipeta Centres were sown in the nursery. Observations on germination percentage, seedling height, girth and number of leaves were recorded (Table 13). Germination percentage among the five genotypes varied from 42.4 to 60.0. Kahikuchi Hybrid showed the highest vigour among the genotypes for seedling height, girth and leaf production. In general, the mean height of seedlings ranged from 28.8 to 140.3 cm and girth ranged from 4.6 to 10.3cm. Maximum leaf production (7.4 numbers) was observed in the Kahikuchi Hybrid. The wide variation in the parameters recorded could be attributed to the time taken for germination and age of the seedlings.

Inter se crossing programme is being continued to produce adequate quantity of Kalyani Coconut 1 seed nuts for supply to the various AICRP centres. So far, seed nuts have been supplied to eight AICRP centres.

Table 13. Seedling parameters of released varieties/hybrids (Aliyarnagar, 2010)

Genotypes	Seedling age (months)	Germination percentage	Seedling height (cm)	Seedling girth (cm)	No. of leaves
Kera keralam	14	42.4	140.3	10.3	5.9
Konkan Bhatiye hybrid-1	10	60.0	93.8	9.7	5.1
Kahikuchi hybrid -1	10	50.0	101.3	12.6	7.4
Gautami Ganga	8	57.6	81.2	7.2	3.8
KeraBastar	7	42.8	28.8	4.6	2.4

Ambajipeta

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

Arsikere

The seed nuts of coconut variety Kera Keralam from Veppankulam Centre, Konkan Bhatye Coconut Hybrid-1, Kera Bastar and Kahikuchi Coconut Hybrid -1 from Ratnagiri Centre, Gauthani Ganga from Ambajipeta Centre and Kalpa Prathibha, Kalpa Mitra and Kalpa Dhenu from CPCRI, Kasaragod, Kalyani Coconut - 1 from Aliyarnagar Centre have been received. The seed nuts have been sown in the nursery.

Jagadalpur

Ten varieties are to be planted in west side of the Gen - III experiment. Seednuts of Kera Keralam was received from Veppankulam and Konkan Bhatye Coconut Hybrid -1 (KBCH-1) from Regional Coconut Research Station, Bhatye, Ratnagiri.

Navsari

Seed nuts of Kokan Bhatye Coconut Hybrid-1 and Kera Keralam were received and planted in nursery. The seedlings were planted in the field.

Seed nuts of Kera Bastar were received from Ratnagiri and planted in the nursery. Coconut variety Gauthami Ganga was received from Ambajipeta and planted in the nursery on 1/03/2011.

Ratnagiri

The Research Station has supplied seed nuts of Konkan Bhatye Coconut Hybrid-1, Kera Bastar and Kahikuchi Hybrid-1 to different centres during the year.

The Research Station has received the seed nuts of newly released varieties and hybrid of coconut. From Veppankulam, 30 seednuts of Kera Keralam and Gautami Ganga from Ambajipeta (25 Nos.) were received and sown in the nursery.

Sabour

Seed nuts of Konkan Bhatye Coconut Hybrid, Kera Bastar and Kahikuchi Hybrid-1 received from RCRS, Ratnagiri were sown in the nursery. Bud rot infection was observed in three varieties namely Kera Bastar, Kera Keralam and GBGD. These plants were treated with Bordeaux paste.

A bamboo based poly tunnel has been made to protect the seedlings from frost during winter.

27 (Twenty seven) seed nuts of Gouthami Ganga were received on 17th March, 2011 from Ambajipeta centre.

Veppankulam

Selfed seed nuts of Kera Keralam were dispatched to all the fourteen AICRP on Palms Coordinating Centres @ 30 seed nuts/ centre as per the technical programme.

The following seedlings were planted on 02.09.2010 and 15.09.2010 at CRS, Veppankulam : Kera Keralam, Konkan Bhatye Coconut Hybrid -1, Kera Bastar, Kahikuchi hybrid and Gauthami Ganga.

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

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

(Ambajipeta, Navsari, Veppankulam)

Ambajipeta

Six cocoa clones viz., VTLCC - 1, VTLCH - 1, VTLCH - 2, VTLCH - 3, VTLCH - 4, VTLC - 1 (Control) were planted in November, 2008, in RBD with four replications and the clones have established in the field. Data on plant height was recorded. Maximum height (82.75 cm) was recorded by VTLC - 1 followed by VTLCH - 1 (80.5 cm).

Navsari

Five cocoa clones were planted in old coconut garden in RBD with four replications. However, some gaps are there which needs to be filled. Pruning was done. Maximum (1.5 m) height was recorded by CC1, whereas maximum girth was noted in CH2 (3.1 cm).

Veppankulam

Cocoa grafts of 5 hybrids and one cultivar were received from CPCRI, RS, Vittal, Karnataka on 06.08.2008 and the seedlings were planted on 14.08.2008. The establishment of crop is good. Observations on plant height and stem girth were recorded.

The culture VTL CH4 recorded maximum plant height of 227.0 cm followed by VTL CH2 (210 cm). Plant girth was highest in VTL CH2 (12.5 cm) followed by VTL CH4 (10.5 cm).

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

(Kahikuchi, Mondouri, Sabour)

Kahikuchi

Five pepper varieties viz., IISR Thevam, IISR Shakti, IISR Malabar Excel, Sreekara and Panniyur-1 were selected for the trial. The planting materials of the first three varieties i.e., IISR Thevam, IISR Shakti and IISR Malabar Excel were brought from Indian Institute of Spices Research, Calicut. Sreekara was collected from CPCRI Research Centre, Kahikuchi and Panniyur-1 from HRS, Kahikuchi. The materials were first multiplied and established in the nursery. The saplings of the above varieties were planted in the main field under coconut garden on 10th September, 2008 following randomized block design replicated into 4 times. Six numbers of palms were taken for each variety in each replication.

Pre-experimental yield data of the base crop, coconut for last three years were recorded which ranged from 51 to 57 nuts/palm/year. The growth characters with regard to vine length and number of branches/vine of the pepper varieties were also recorded. Significant differences were observed among the varieties on vine length. The highest vine length of 2.90 m was recorded in IISR Malabar Excel whereas lowest of 2.65 m was observed in Sreekara. No significant variation was observed due to number of branches/vine among the varieties. However, the highest number of branches (9.6) was recorded in IISR Shakti and the lowest of 8.3 was found in IISR Thevam.

Mondouri

Collection of black pepper varieties has been taken up from IISR for further multiplication by quick multiplication technique. Multiplication of planting material has been done. The rooted cuttings have been planted in the experimental plot during monsoon this year as per technical programme.

Sabour

- Eight rows of coconut var. Shakhigopal has been planted for this project at a distance of 7.5m x 7.5m in 14 lines.
- Black pepper varieties brought from Kalyani and Mohitnagar are under multiplication. Planting will be done after getting sufficient number of planting materials.
- A bamboo based structure has been made for multiplication of all 8 pepper varieties. A small polyethylene structure has been made to protect these pepper plants. Growth was slow during winter due to low temperature.
- Poly tunnel was used to protect these pepper varieties from chilling injury. Still some plants got damaged due to low temperature and some lost due to incidence of leaf spot. Panniyur-1

and Panniyur -2 were found to be more sensitive to cold injury. Besides, infestation of diseases was more under poly tunnel.

- *Daincha* has been planted in between two rows of coconut at a distance of 2.5m x 2.5m to use as standard for growing black pepper in coconut plantations.

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

(Aliyarnagar, Arsikere, Jagadalpur, Mondouri, Ratnagiri, Veppankulam)

Aliyarnagar

Three varieties namely Kalpa Dhenu, Kera Keralam and Kalpa Prathiba have been assigned to CRS, Aliyarnagar for large scale multiplication. Mother palms of Kera Keralam have been selected and multiplication of seednuts is in progress. Mother palm gardens of Kalpa Prathiba released as a national variety is under establishment stage. *Inter-se* crossed seed nuts of Kalpa Dhenu have been requested from CPCRI for mother palm garden establishment.

Arsikere

6500 seed nuts were collected from 300 mother palms of Kalpatharu variety and 5500 seed nuts were sown in nursery during February-March 2011.

Jagadalpur

Coconut variety Kera Bastar, released for Chhattisgarh, Maharashtra, Andhra Pradesh and Tamil Nadu is to be multiplied for production of planting material for the farmers of Chhattisgarh. The seed gardens established in the year 2008 are being monitored and observations on morphological characters and survival percentage were continued. The details of available planting materials and established seed gardens are as below.

Kera Bastar seedlings planted - 252
No. of seed gardens established - 04

Mondouri

Newly released coconut varieties and hybrids to be multiplied in Mondouri centres are Kalyani Coconut, Kera Keralam and Kalpa Mitra.

Ratnagiri

For large scale multiplication of newly released coconut hybrids i.e. Konkan Bhatye Coconut Hybrid - 1, mother orchard with 70 seedlings of Gangabondam Green Dwarf and 50 East Coast Tall have been planted in the field.

The details of the mother palms of released/ recommended varieties/ hybrids are given below:

Details of mother palms

Name of the parents	Bearing palms	Pre bearing palms	Total
ECT	20	100	120
Gautami Ganga	10	70	80
Kera Bastar	08	00	08

The work of production of seed nuts of Konkan Bhatye Coconut Hybrid - 1 and Kera Bastar is in progress.

Veppankulam

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

• • •

5.2 Crop Production

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

(Aliyarnagar, Ambajipeta, Kahikuchi, Jagadalpur, Mondouri, Ratnagiri, Veppankulam)

Aliyarnagar

The three medicinal plants viz., Karisalanganni (*Eclipta prostrata*), Siriyanangai (*Andrographis paniculata*) and Sitharathai (*Alpinia galanga*) and two aromatic plants viz., Lemongrass (*Cymbopogon flexuosus*) and Patchouli (*Pogostemon patchouli*) were grown in 19 year old coconut garden from April 2009. The crops were applied with vermicompost as organic manure and no source of inorganic fertilizers were used.

During the year 2009-10, among the three medicinal plants, Sitharathai (*Alpinia galanga*) was found to be remunerative which has recorded 5640 kg/ha of rhizomes with a net income of Rs.26425/ ha with a B:C ratio of 2.66 than Siriyanangai and Karisalankanni. Between the two aromatic plants raised, lemongrass (*Cymbopogon flexuosus*) was found to record the highest leaf yield of 7850 kg/ha with a net income of Rs. 19,000/ha and B:C ratio of 2.53 (Table 14).

Though the nut yield was found to be sustained over the period of study, there was a declining trend with regard to per cent increase over the pre-treatment yield in Sitharathai (- 4.2 %), Patchouli (-1.5%) and Lemongrass (-2.5%) plots.

The same medicinal and aromatic plants were also grown in open space for comparative analysis. Biometric observations and analysis of active principle and oil content are being carried out.

Intercropping of Alpinia galanga in coconut garden (Aliyanagar, 2010)

The essential oil content was analyzed one week before the harvest of the plants. Lemon grass (*Cymbopogon flexuosus*) and Sitharathai (*Alipinia galanga*) recorded the maximum oil content of 0.72 % and 0.62 %, respectively, when compared to other three crops.

Ambajipeta

The experiment was laid out in June, 2006 with four aromatic and one medicinal plants as intercrops in coconut garden in randomized block design with four replications. The data on nut yield of coconut, yield data of intercrops and economics of the cropping system revealed that the highest nut yield (Table 15) was recorded in crop combination of patchouli with coconut (104.8 nuts/palm/ year) followed by crop combination of coconut+Palmarosa (93.5 nuts/palm/year) as against 65.7 nuts/palm/year in the crop combination of coconut + mango ginger. The economic analysis of medicinal and aromatic plants as intercrops in coconut revealed that the highest net returns of Rs.53384 was recorded in crop combination of coconut + patchouli with benefit - cost ratio of 2.84 followed by coconut + citronella (Rs.48,038) with benefit - cost ratio of 2.12.

Table 14. Economics of medicinal and aromatic plants asa intercrops (Aliyarnagar, 2010)

Treatment	Economic part	Yield (kg/ha)	Net income (Rs/ha)	B:C ratio
Medicinal plant				
Siriyanangai (*Andrographis paniculata*)	Leaves	2150	2,300	1.27
Sitharathai (*Alpinia galanga*)	Rhizomes	5640	26,425	2.66
Karisalankanni (*Eclipta prostrata*)	Leaves	1860	2790	1.25
Aromatic plants				
Patchouli *(Pogostemon patchouli)*	Leaves	1520	11,660	1.62
Lemongrass *(Cymbopogon flexuosus)*	Leaves	7850	19,000	2.53

Table 15. Yield and returns from intercrops under coconut (Ambajipeta, 2010)

Crop combination	Nut yield	Yield of intercrop (t/ha)	Gross returns (Rs. / ha)	Net returns (Rs. / ha)	B:C Ratio
Coconut + Citronella	92.7	33.57	69677	48038	2.22
Coconut + Lemon grass	89.7	44.75	55333	35781	1.83
Coconut + Palmarosa	93.5	29.75	56121	41506	1.95
Coconut + Patchouli	104.8	33.83	80760	53384	2.84
Coconut + *Mango ginger*	65.8	20.95	30983	19878	1.79

The intercrops were also planted in the open field. Some of the gaps, formed owing to the recent heavy rains and consequent inundation, have been gap filled and the experiment is being continued.

Kahikuchi

The species selected for the trial are: Citronella (*Cymbopogon winterianus*), Pipali (*Piper longum*), Vedailota (*Paederia foetida*), Patchouli (*Pogostemon cablin*) and Sarpagandha (*Rauvolfia serpentina*).

The yield data (economic parts) of the intercrops and the main crop for four years (2006-07 to 2009-2010) have been pooled and the average values of these crops were taken for working out the economics of the cropping system. It is clear from the Table 16 that the crop combination of patchouli with coconut (T2) recorded the highest total coconut equivalent yield of 33023.48 and net return of Rs. 97,117.40 and benefit cost ratio of 2.43, while treatment T5 i.e. Sarpagandha + coconut has given the second highest net return (Rs. 65,316.40) and benefit cost ratio of 2.00.

During the year 2010-2011, all the aromatic and medicinal plants were up-rooted and replanted with fresh saplings due to their poor growth because of continuous cultivation for four years. The experiment is in progress.

Jagadalpur

Treatments

T1- Coconut + Stevia
T2- Coconut + Amahaldi
T3- Coconut + Sarpagandha
T4- Coconut + Tikhur
T5- Coconut + Patchouli

The experiment was initiated during 2006, Data in Table 17 shows that highest yield and gross return was obtained in Tikhur (2890 kg and Rs.80920), whereas the lowest yield (455 kg) and lowest gross return (Rs. 15925/-) was obtained under Stevia.

Table 16. Economics of medicinal and aromatic crops in coconut garden (Average of 4 years) (Kahikuchi, 2010)

Treatments	Coconut yield/ha	Intercrop yield/ha	Total Coconut Eq. yield(nuts)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C
T1: Coconut(nos) + Pipali(kg dry fruit)	10839.5	601.1 kg dry fruit	19,856.1	99,280	44,280	1.81
T2: Coconut(nos) + Patchouli(kg dry)	10218.8	3800.8 kg dry leaf	33,023.5	1,65,117	97,117	2.43
T3: Coconut(nos) + Citronella(kg oil)	10428.2	157.3 kg oil	19866.8	99,334	46,334	1.87
T4: Coconut(nos) + Vedailota(kg fresh leaf)	8884.8	3702.4 kg fresh leaf	13,327.7	66,638	16,638	1.33
T5: Coconut(nos.) + Sarpagandha(kg dry root)	10228.2	1979.4 kg dry root (in 2 yrs.)	26063.3	1,30,316	65,316	2.00

Rate of the commodities: Coconut (Rs.5/nut); Patchouli(Rs.30/kg dry leaf); Pipali (Rs.75/kg dry fruit); Citronella oil (Rs. 300/kg); Vedailota (Rs.6/kg fresh) and Sarpagandha (Rs. 80/kg dry root)

Table 17. Yield and returns of different intercrops (Jagadalpur, 2010)

Model	Main crop yield (Nuts/ha)	Intercrop yield (kg/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
Coconut sole	8496	-	50976	24553
Coconut	9912	-	59472	33049
+Stevia	-	455	15925	-5600
Coconut	8496	-	50976	24553
+Amahaldi	-	1455	34920	23720
Coconut	7788	-	46728	20305
+Sarpgandha	-	585	28080	9320
Coconut	7434	-	44604	18181
+Tikhur	-	2890	80920	56020
Coconut	8850	-	53100	26677
+Patchouli	-	1265	31625	10575

Mondouri:

Model I : Coconut + Sarpagandha
Model II : Coconut+ Aswagandha
Model III : Coconut+ Arrowroot
Model IV : Coconut+ Kalmegh
Model V : Coconut+ Bhringaraj
Model VI : Coconut+ Ekangi

The survey on the cultivation of medicinal and aromatic plants with their market potential in different districts of West Bengal was conducted. Based on the survey fifteen important species of medicinal and aromatic plants having economic potential were selected. The best performing six species were grown under replicated trial. The net return was highest with coconut +Ekangi system (Table 18).

that the yield of coconut for four years (2002-06) was found non significant within the treatment and ranged from 72 to 89 nuts/palm/year. However, the yield of coconut was increased after growing different intercrops and it was significant and ranged from 85 to 100 nuts/palm/year. The highest yield was recorded in T1:Coconut+Shatavari plot (100 nuts/palm) followed by T_3 (Coconut + Arrow root) (93 nuts/palm) and they were at par. The treatment T_1 was significantly superior over other treatment like T_2, T_4, T_5 and T_6.

Further, the per cent increase in nut yield over pre treatment yield was maximum in Coconut+Arrow root (19.49%) followed by Coconut + Adulsa (18.14%), Coconut + Lemon grass (15.26%) and Coconut + Citronella (14.95%) and Coconut + Shatavari (12.44%).

Table 18 . Economics of medicinal crops based cropping system (Rs/ha) (Mondouri, 2010)

Crop combination	Yield/ha (q)	Cost of cultivation	Gross return	Net return	B:C ratio
Coconut Monocrop	8.75	27300	53625	26325	1.96
Coconut +Sarpagandha	8.00	72800	144625	71825	1.98
Coconut +Aswagandha	50.00	40950	99125	58175	2.42
Coconut +Arrowroot	31.25	66950	131625	64675	1.96
Coconut +Kalmegh	40.50	45500	80925	35425	1.77
Coconut +Vringaraj	17.25	66950	134875	67925	2.01
Coconut +Ekangi		71175	160875	89700	2.26

Ratnagiri

The coconut equivalent yield was calculated and it was found that the intercrop yield in terms of coconut equivalent yield was higher with Lemon grass (23752) followed by Arrow root (23132) and Shatavari (22071).

The yield data presented in Table 19 revealed

The data presented in Table 19 on economics of coconut based intercropping system revealed that the highest net return per ha was recorded under coconut + lemon grass model (Rs. 88125/-), followed by coconut + arrow root (Rs.86925/-) and coconut + shatavari (Rs. 80000/-). The B:C ratio was maximum from model, coconut + Arrowroot (2.16),

Table 19. Economics of coconut based medicinal crops intercropping system (Ratnagiri, 2010)

Sr. No.	Treatment (Model)	Yield/ha		Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C Ratio
		Coconut	Inter crops				
1.	T_1 - Coconut + Shatavari	17500	8 q.	154500	74500	80000	2.07
2.	T_2 - Coconut + Adulasa	14875	21 q.	141925	74500	67125	1.90
3.	T_3 - Coconut + Arrowroot	16275	16 t.	161925	75000	86925	2.16
4.	T_4 - Coconut+ Lemon grass	14895	31 t.	166125	78000	88125	2.13
5.	T_5- Coconut + Citronella	15050	21 t.	136850	78000	58850	1.75
6.	T_6 -Coconut	14000	-	98000	62500	35500	1.57

1)	Coconut - Rs 7 per nut	2)	Shatavari Rs. 40/- per kg	3)	Adulsa Rs 18/- per kg
4)	Arrow root Rs. 3/- per kg	5)	Lemon grass Rs. 2/- per kg	6)	Citronella Rs. 1.5/- per kg

followed by coconut + lemon grass (2.13) and coconut + shatavari (2.07).

Soil analysis

The soil samples were collected from coconut basin and medicinal plant growing area at three different depths, 0-25, 25-50, 500-100 cm during May 2010 and these samples were analyzed for pH, EC, and NPK.

Soil analysis from coconut basin

Soil analysis data revealed that there was no significant difference in soil pH, EC, NPK content at different depth in different treatments.

The soil pH in coconut basin at 0-25, 25-50, 50-100 cm depth ranged from 5.98 to 6.55, 6.08 to 6.70 and 5.86 to 6.55, respectively. Further it was observed that the EC ranged from 0.06 to 0.08, 0.05 to 0.07 and 0.06 to 0.09 at 0-25, 25-50 and 50-100 cm depth, respectively.

The nitrogen content of soil in coconut basin was ranged from 265 to 333 kg /ha at 0-25 cm depth, 187 to 292 kg/ha at 25-50 cm depth and 121 to 281 kg /ha at 50-100 cm depth. The phosphorus at 0-25 cm depth ranged from 24.1 to 35.5 kg/ha where as it was ranged from 12.3 to 39.0 kg/ha and 11.0 to 27.9 kg /ha at 25-50 cm & 50-100 cm depth, respectively. The potassium content in the coconut basin ranged 850 to 1285, 805 to 1290 and 748 to 1339 kg/ha at 0-25 , 25-50, and 50-100 cm depth, respectively.

Soil analysis from medicinal plant growing area

The soil analysis data from medicinal plant growing area revealed that there was no significant difference in pH, EC and NPK content of soil in different treatment at different depth except potassium at 50 -100 cm depth.

The pH data from medicinal plant growing area ranged from 6.55 to 7.06, 6.51 to 6.96 and 6.63 to 7.03 at 0-25, 25-50 and 50-100 cm depth, respectively, where as EC ranged from 0.07 to 0.10, 0.08 to 0.12 and 0.08 to 0.10 at 0-25, 25-50, 50-100 cm depth respectively. Nitrogen content in the soil of medicinal plant growing area ranged from 230 to 339 kg/ha at 0-25 cm depth whereas it was 244 to 282 and 204 to 282 kg/ha at 25-50 and 50-100 cm depth, respectively. Phosphorus at 0-25, 25-50 and 50-100 cm depth ranged from 34.2 to 55.1, 32.3 to 51.9 and 31.5 to 46.7 kg/ha, respectively. Potassium content in medicinal plant growing area at 0-25 and 25-50 cm was ranged from 374 to 506, 317 to 656 kg /ha, respectively and were statistically on par. However, significant difference was recorded in potassium content at 50-100 cm depth. The treatment T_4 recorded highest potassium (674 kg / ha) followed by T2 (502 kg/ha), T_5 (475 kg/ha), T_3 (471 kg/ha) and they were at par and significantly superior over T1.

Leaf analysis

The data regarding NPK in leaf content revealed that there was no significant difference in NPK content of leaf in all treatments. However Nitrogen content was maximum in T3 (2.24%) followed by T5 (1.82%). Further it was observed that phosphorus content was maximum in T4 (0.12%) followed by T5 (0.11%) and T1 and T3 (0.07%), respectively. The potassium was maximum in T5 (0.78%) followed by T4 (0.73%), T2 and T3 (0.68%) whereas it was minimum in T1 (0.58).

Veppankulam

A field trial with three medicinal and two aromatic plants were laid out in 36 years old ECT coconut garden in A3 block of Coconut Research Station, Veppankulam.

Intercropping of medicinal plants (Veppankulam, 2010)

All the five medicinal plants viz., *Alpinia galangal*, *Aloe vera*, *Ocimum sanctum*, *Cymbopogan flexuosus* and *Pogestemon patchouli* were planted and the harvesting of *Aloe vera*, *Ocimum sanctum*, *Cymbopogan flexuosus* and *Pogestemon patchouli* is in progress. The annual nut yield was analyzed and the result revealed that only the numerical increase in nut yield was observed in the plots of *Cymbopogan flexuosus* followed by *Ocimum sanctum* but the overall effect on nut yield was not significantly influenced by different medicinal and aromatic plants. The trial is in progress.

The better performance in yield was observed in different medicinal and aromatic plant tried in adult coconut garden. *Alpinia galangal* recorded an yield of 2740 kg of dry tuber / ha, while *Aloe vera* recorded 12350 kg of fresh leaf and *Ocimum sanctum* 13400 kg of fresh leaf / ha, respectively. In case of *Cymbopogan flexuosus* and *Pogestemon patchouli* recorded 7250 kg and 1210 kg of dry leaf / ha, respectively (Tabel 20).

The different medicinal and aromatic plants recorded better net return and B:C ratio as intercrop. *Alpinia galangal* recorded a net return of Rs. 72145/ ha with B:C ratio of 2.92, while *Aloe vera* and *Ocimum sanctum* recorded of Rs. 42535/- ha, B:C ratio of 3.21 and net return of 34780 kg/ha and B:C ratio of 2.84, respectively. Among the aromatic plants, *Cymbopogan flexuosus* recorded the net return of Rs.17125/- ha with BC ratio of 2.32 and *Pogestemon patchouli* recorded the net return of Rs. 21575 with the BC ratio of 2.46.

Alpinia galangal recorded 0.74 per cent essential oil when grown as intercrop and it was 0.82 per cent when grown in open space. In *Ocimum sanctum,* the essential oil was 83 per cent in open space when compared to 71 per cent in intercrop. Regarding *Cymbopogan flexuosus* grown in open space, the essential oil recorded was 1.00 per cent when compared to 0.93 per cent under intercropping. *Pogestemon patchouli,* when grown as intercrop had essential oil content of 0.55 per cent as against 0.65 per cent when grown in open space. The reduction in essential oil recovery per cent in intercrops might be due to the shade effect of coconut over intercrops.

The mean annual nut yield was anlaysed and the results revealed that only marginal increase in nut yield was observed in the plots of *Cymbopogan flexuosus* followed by *Ocimum sanctum,* but the overall effect was not significantly influenced by different medicinal and aromatic plants as intercrops in coconut garden.

Table 20. Economics of raising medicinal and aromatic plants as intercrops in coconut (Veppankulam, 2010)

S. No	Particulars	Yield (kg/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio
1.	*Alpinia galangal*	2740	109600	37455	72145	2.92
2.	*Aloe vera*	12350	61750	19215	42535	3.21
3.	*Ocimum sanctum*	13400	53600	18820	34780	2.84
4.	*Cymbopogan flexuosus*	7250	29000	12475	17125	2.32
5.	*Pogestemon patchouli*	1210	36300	14725	21575	2.46

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

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

Ambajipeta

The trial was initiated during November, 2007 in a 25 years old garden of CRP 509 variety. It is evident from the data (Table 21) that the maximum nut yield (81.2 nuts/palm) was recorded by 100% Recommended Dose of Fertilizers (RDF) through fertigation, and was on par with 75% RDF through fertigation and significantly lower yield was observed in control. The data on yield attributes revealed that the highest number of leaves on crown (38.9), number of spadices per palm (13.3) number of female flowers per spadix (28.7) were recorded by 100% RDF through fertigation. However, application of 75% RDF was also found to be at par with the above treatment.

Table 21. Yield attributes of coconut as influenced by fertigation (Ambajipeta, 2010)

Treatment	No. of leaves on crown	No.of spadices/ palm	No. of female flowers /spadix	Nut yield/palm	
				Pre-treatment (2005-07)	Experimental period (2009-10)
Control	30.1	8.9	14.5	58.2	57.7
25% of rec. NPK (drip)	32.2	11.8	19.7	57.1	65.8
50% of rec. NPK (drip)	33.2	12.3	18.7	62.2	73.1
75% of rec. NPK (drip)	38.8	13.2	28.6	60.7	79.2
100% of rec. NPK (drip)	38.9	13.3	28.7	61.1	81.2
100% of rec. NPK (soil application)	32.2	10.9	10.6	59.8	71.1
CD at 5%	3.15	1.95	2.15	3.75	2.45

Aliyarnagar

The fertilizers are being applied through drip fertigation in 10 splits from Dec. to Sept. with Urea, Diammonium phosphate and Muriate of potash as sources of nitrogen, phosphorus and potassium, respectively. The experiment is being conducted in a 15 year old coconut garden.

The number of functional leaves and annual leaf production were optimum in all the treatments and they did not vary among the treatments. The treatments 50% RDF through drip was found to be on par with 100% RDF through soil application of fertilizers. Significant response in nut yield was observed at 50% of RDF through fertigation and after that, there was no significant response by increased levels of fertigation dose. The 100% basal (soil) application of the fertilizer is on par with 50% of the RDF through drip.

Analysis of data on the number of functional leaves, annual leaf production and number of inflorescence revealed that the parameters were found to be statistically significant. Drip fertigation at 50, 75, 100 and 125 per cent of RDF were found to be on par with 100 per cent RDF through soil application.

The nut yield did not vary among the treatments statistically during the year 2007-08 (Table 22). During the year 2008-09, significant response in nut yield was observed at 50% of RDF through fertigation and after that, there was no significant response by increased levels of fertigation dose. The same trend was followed in the year 2009-10 also. Drip fertigation at 50, 75, 100 and 125 per cent of RDF were found to be on par with 100 per cent RDF through soil application. The treatment with 25 per cent RDF through drip fertigation was found to be on par with 100 RDF through soil application.

The per cent increase over the pre-treatment nut yield was calculated which revealed that the 125 per cent of the RDF through drip fertigation recorded a 22 per cent increase followed by 75 per cent of the RDF through drip fertigation, whereas the treatment without fertilizer application and 25 per cent of the RDF through drip fertigation recorded a negative increase over the pre-treatment nut yield.

Table 22. Mean annual and cumulative nut yield in fertigation (Aliyarnagar, 2010)

Treatment	Mean pre-treatment cumulative mean yield	Mean annual nut yield			Cumulative mean nut yield	% increase over pre-treatment nut yield
		2007-08	2008-09	2009-10		
T1 - Control (No fertilizer)	105	104	89	95	96	-8.6
T2 - 25 % of rec. NPK (drip)	110	108	104	114	109	-1.2
T3 - 50 % of rec. NPK (drip)	119	115	146	142	134	12.9
T4 - 75 % of rec. NPK (drip)	115	118	144	153	138	20.3
T5 - 100 % of rec. NPK (drip)	116	118	146	152	139	19.5
T6 - 100 % of rec. NPK (soil application)	112	116	143	145	138	20.1
T7 - 125% of rec. NPK (drip)	117	118	145	165	143	21.9
SEd ±	—	NS	18.4	13.4	—	—
CD (p=0.05)	—	—	38.3	28.2	—	—

During the year 2009-10, significant response in nut yield was observed at 50 per cent of RDF through fertigation and after that, there was no significant response by increased levels of fertigation dose. Drip fertigation at 50, 75, 100 and 125 per cent of RDF were found to be on par with 100 per cent RDF through soil application. The treatment with 25 per cent RDF through drip fertigation was found to be on par with 100 RDF through soil application.

Arsikere

The experiment was maintained by green manuring, basin cleaning, mulching and applying fertilizers as per treatment through drip system. Observations on number of functional leaves, bunches and buttons per palm were recorded. The nuts were harvested at two months interval and yield data were recorded.

The pre-experimental yield data of coconut during 2005-06 and 2006-07 showed that there was no significant differences between different fertigation treatments. During 2009-10, the number of functional leaves, bunches and buttons per palm were not significantly influenced by the fertigation treatments. However, the nut setting per cent was significantly higher with the application of 100% NPK through drip system. Application of 100% NPK through drip irrigation recorded significantly higher yield of nuts and was on par with the application of 50% and 75% NPK through drip irrigation and soil application of 100% NPK as per recommended schedule. The mean data over three years from 2007-08 to 2009-10 also followed the same trend (Table 23).

Table 23. Yield of coconut as influenced by fertigation treatments (Arsikere, 2010)

Treatments	Pre-experiment mean yield (Nuts/palm/yr)	Experimental period (Nuts/palm/yr)			
	2005-07	2007-08	2008-09	2009-10	Mean
T_1 : Control (No fertilizer)	58.7	57.3	59.9	65.1	60.7
T_2 : 25% of Rec. NPK (Drip)	58.2	58.9	62.2	74.7	65.3
T_3 : 50% of Rec. NPK (Drip)	58.2	64.8	66.4	80.1	70.5
T_4 : 75% of Rec. NPK (Drip)	59.2	62.5	72.8	82.3	72.6
T_5 :100% of Rec. NPK (Drip)	60.2	70.5	82.2	87.8	80.1
T_6 :100% of Rec. NPK (Soil)	61.3	64.2	70.6	84.4	73.1
S. Em (±)	3.7	3.77	4.7	3.8	2.6
CD (P=0.05)	NS	NS	14.0	11.6	8.0

Kahikuchi

Data on yield attributing characters and nut yield were recorded during the year. Soil and leaf samples were drawn at the beginning of the experiment and after two years and analysed for NPK content.

Pre-experimental yield data of coconut showed that there was no significant difference between different fertigation treatments (Table 24). The nut yield also did not vary among the treatments significantly during 2009-10 after imposition of different fertigation treatments. However, during the year 2010-11, application of 100% NPK through drip irrigation (T5) recorded significantly highest no. of nuts (76.8 nut/palm/year) followed by 75 % NPK through drip and the lowest nut yield of 52.4 nuts/ palm/year was recorded under control (T_1). It was observed that the highest number of leaves on the crown (34.6), number of spadices/palm/year (11.0), female flowers/palm/year (204.0) were recorded in T_5 (100 % RDF of NPK through drip) followed by T_4 (75 % RDF of NPK) and the lowest values of these characters were obtained under control (T_1). Soil nutrient status (NPK) as well as leaf nutrient content after two years of experimentation indicated higher nutrient status for both the cases with application of 100% NPK through drip system compared to other fertigation treatments. The lowest soil and leaf nutrient status was recorded under control.

Ratnagiri

The experiment was initiated in WCT coconut palm in sandy soil of Konkan region of Maharashtra during 2006. The pre treatment, transit and post treatment yield data are presented in Table 25. In the year 2002-06 and 2006-09, nut yield of coconut recorded among the different treatments was nonsignificant. However, an increase in nut yield during transit period over pretreatment yield was recorded during 2006-09. Per cent increase was maximum in treatment T6 i.e. 100% RDF of NPK as soil application (20%), followed by T5 i.e 100% RDF of NPK through drip irrigation (15%) and T_4 i.e 75% RDF of NPK through drip irrigation (9%) (Table 25). Further, it was observed that yield of 2009-10 when compared with pre treatment yield, per cent increase was maximum in Treatment T_5 i.e. 100 % RDF of NPK through drip irrigation (43%), followed by T_3 i.e.50 % RDF of NPK through drip (37%) and T_4 (31%), respectively.

Further, the copra yield recorded was highest in T_5 (100% RDF of NPK through drip) i.e. 19.87 kg/palm followed by T_3 (50% RDF of NPK through drip) i.e.17.65 kg/palm and significantly superior over T_1 and T_2 (25% RDF through drip). The treatments T_3, T_4, T_5, and T_6 were at par.

Table 24. Yield of coconut as influenced by fertigation treatments (Kahikuchi)

Treatments	No. of leaves on crown	No. of spadices/ palm	No. of female flowers/ palm	Mean pre-experimental yield (average of 3 yrs)	Nut yield/palm/year	
					2009-10	2010-11
T_1 : Control (No fertilizer)	30.8	9.0	162.6	50.0	51.6	52.4
T_2 : 25 % of rec. NPK (drip)	31.5	9.6	178.0	51.8	52.3	55.0
T_3 : 50% of rec. NPK (drip)	32.6	10.3	186.6	52.0	56.0	61.7
T_4 : 75 % of rec. NPK (drip)	32.8	10.7	190.3	53.2	58.8	66.7
T_5 : 100% of rec. NPK (drip)	34.6	11.0	204.0	54.6	64.5	76.8
T_6 : 100% of rec. NPK (soil application)	31.0	10.8	188.6	50.6	54.6	64.3
CD at 5%	1.02	0.73	12.61	NS	NS	8.42

Table 25. Yield of coconut as influenced by fertigation treatments (Ratnagiri, 2010)

Tr. No.	Treatment	Pre treatment yield (no. of nuts/palm/ year)(2002-06) (mean of four years)	Transit period yield (no. of nuts/ palm/year) (2006-09) (mean of three years)	Per cent increase over pre treatment period yield (no. of nuts /palm/ year)	Post treatment yield (no. of nuts/palm/ year) (2009-10)	Per cent increase over pre treatment yield	Copra yield (kg/palm)
T_1	Control (No fertilizer)	99	97	-2	86	-15	10.99
T_2	25% of rec. NPK (drip)	81	89	8	96	19	12.89
T_3	50% of rec. NPK (drip)	85	91	7	116	37	17.65
T_4	75% of rec. NPK (drip)	88	96	9	115	31	16.07
T_5	100% of rec. NPK (drip)	84	99	15	120	43	19.87
T_6	100% of rec. NPK (soil application)	93	103	20	113	22	16.15
	SE ±	7.54	5.29	-	9.22	-	1.48
	C.D. 5%	N.S.	N.S.	-	N.S.	-	4.47

Soil analysis

Soil analysis data for initial stage (2006) and after three years (2009) were carried out. The data revealed that there was no significant difference in pH. The pH ranged from 5.77 to 7.67 for both years at different depths. The Ec was statistically significant during 2006 at 25-50 cm depth. However, it was non significant for both the years at other depths.

Non significant difference in nitrogen content was observed during 2006 for all the three depths (0-25, 25-50 and 50-100) whereas it was significant at 0-25 and 50-100 cm depth during 2009 after application of the different doses of fertilizer through drip. The highest nitrogen level was recorded at 0-25 cm depth in treatment T5 (330kg/ha) and significantly superior over treatments T_1 and T_2 where as it was at par with T_3, T_4 and T_6. Further, highest N was recorded at 50-100 cm depth in T_5 (298 kg/ha) and it was significantly superior over T_3 and T_4 and at par with T_1, T_2, T_6. Phosphorus content was also non significant at all the three depths in different treatments during 2006 and 2009. Whereas it was highest in T_5 (25.71 kg/ha) at 0-25 cm depth and 8.94 kg/ha at 25-50 cm depth during 2009. However, P_2O_5 was highest in T_3 (7.50 kg/ha) followed by T_4 (7.40 kg/ha) and T_5 (7.02 kg/ha) at 50-100 cm depth during 2009.

Further, the potassium content was recorded non significant difference in all the three depths during 2006 and 2009 except 0-25 cm during 2006. The highest K_2O was recorded at T5 treatment during 2009 i.e. 535 kg/ha at 0-25 cm depth, 549 kg /ha at 25-50 cm depth and 536 kg/ha at 50-100 cm depth.

Leaf analysis

The data regarding NPK content in leaf revealed that there was no significant difference in NPK content in all the treatments for both the years (2006 & 2009). However, there was an increase in NPK after receiving different fertilizer doses through drip. Nitrogen content was highest in leaf at T5 (1.90%) followed by T_3 (1.82%) and T_4 (1.76%) where as phosphors was highest in T_5 (0.13%) followed by T_6 (0.11%) and T_4 (0.10%) and potassium was highest at T_5 (1 %) followed by T_2 & T_4.

Veppankulam

Drip irrigation and fertigation are being given as per the technical programme. The fourth year experiment is in progress.

The biometric observations like number of functional leaves / palm, number of bunches / palm, number of female flowers / bunch and annual nut yield were recorded. Among the drip fertigation treatments, T_4 (75% of RD of NPK) recorded the highest annual nut yield (91.60 nuts) when compared to the T_1 - Control (No fertilizers) of (76.40 nuts). This yield expression may be due to the higher number

of functional leaves/ palm, number of bunch / palm and increase in number of flowers/bunch when compared to the control (Table 26).

The result of soil analysis on available N content revealed that T_6 recorded significantly higher N content (246 kg / ha) when compared to Control (T_1) (122 kg / ha) followed by T_5 and T_4. Regarding available soil P, higher P (7. 6 kg / ha) was recorded in T_6 when compared to T_1 (control), but it was on par with T_5 and T_4. In case of available soil K, T_5 had recorded significantly higher K content (130.51 kg / ha) than T_1 (Control), but it was on par with T_6 and T_4 .

Drip fertigation (Veppankulam, 2010)

The result of plant analysis revealed that, leaf N content was significantly higher in T_5 treatment (1.66%) when compared to T_1 control, but it was on par with T_6 and T_4. Regarding leaf P, T_5 recorded significantly higher percentage (0.07) than control followed by T_4 and T_6. Leaf K content was significantly higher with T_5 (1.26) than T_1 control followed by T_6 and T_4.

Kasaragod

The impact of fertigation has brought conspicuous result in terms of copra yield in the coastal sandy soil. The treatment, 100% recommended dose of fertilizer through drip fertigation recorded significantly higher yield which was on par with 50 and 75 per cent of fertilizer application through drip fertigation. These results clearly indicating that 50% saving of chemical fertilizer through drip fertigation method. The treatment, 100 % recommended dose NPK through soil application recorded lower yield and on par with 25 % NPK through drip fertigation. Further application through soil (twice in a year 1/3rd during June and 2/3rd during September/ October) in the conventional method of application could not withhold the applied fertilizer. The soil NPK also was found to be more in drip fertigation samples compared to conventional method of application though there was no significant difference was observed. The pollen study undertaken has shown that during winter season, the germination percentage was more compared to monsoon and summer months. However, the different fertigation doses did not bring a definite trend in pollen germination per cent.

Table 26. Biometric observations, mean annual nut yield and soil analysis

Treatments	No. of functional leaves/palm	No. of bunches /palm	Mean annual nut yield	Available N P K (kg / ha)		
				N	P	K
T_1 - Control (No fertilizers)	27.30	6.7	76.4	122	3.30	68.46
T_2 - 25% of rec. NPK (drip)	31.62	8.2	81.8	162	5.33	116.04
T_3 - 50% of rec. NPK (drip)	30.70	8.0	87.5	219	6.88	121.93
T_4 - 75% of rec. NPK (drip)	31.82	8.7	91.6	230	7.27	126.75
T_5 - 100% of rec. NPK (drip)	32.00	8.1	90.9	235	7.48	130.51
T_6 - 100% of rec. NPK (soil application)	31.30	8.0	86.2	246	7.60	128.95
SEd ±	1.23	0.70	7.72	2.48	0.46	2.03
CD (p=0.05)	2.62	1.49	16.44	5.29	0.99	4.34

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

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, 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

Aliyarnagar

Plot size	:	0.40 ha
Replication	:	Non-replicated
Crop combination	:	Coconut + pepper + cocoa + elephant foot yam

The initial soil analysis of the experimental field revealed that the available N was low in 0-15, 15-30 and 30-45 cm depth of soil. The P and K were medium at 0-15 cm and 15-30 cm depth and available P was high at 30-45 cm soil depth. The organic carbon was low and the soil was deficient in iron and zinc.

As a measure of soil and water conservation, husk burial before planting perennial/component crops like, black pepper and cocoa was done. As a component of integrated nutrient management, four sheds for vermicomposting were erected as per the specifications and started functioning. The green manure crop *Sesbania rostrata* was grown in coconut basin and incorporated *in situ* during the flowering stage. For irrigating the whole field, microsprinkler system was laid out. The pre-treatment yield was recorded and all the observations on coconut (20 years old) and other component crops are being recorded as per the guidelines.

Proper pruning was done on one year old cocoa plants and swabbed with bordeaux paste and support was given. For the black pepper cuttings planted at 45 cm in 3 pits, vermicompost was applied @ 2 kg/pit; for elephant foot yam. FYM @ 1 kg and neem cake (1 kg) and vermicompost @1 kg were applied. Cocoa accessions, CCRP-1, CCRP-8, CCRP-9 and CCRP-10 were planted on 25.7.2008 and biometrical observations were recorded. Among the various accessions, CCRP-9 was found to record higher plant height (64.8 and 137.0 cm) than the other accessions. The stem girth recorded in CCRP-10 was 9.3 cm followed by 9.1 cm in CCRP-9. The number of leaves was also found to be more in CCRP-9 and CCRP-10.

Coconut based cropping system (Aliyarnagar, 2010)

The coconut palms are of different germplasm collections and hence the nut yield varied from 72 nuts to 176 nuts/palm/year during pre-treatment period 2007-08 and from 77 nuts to 144 nuts/palm/year during (2008-09). Number of functional leaves, annual leaf production, number of bunches and nut yield were recorded. The nut yield varied from 70 in PHOT to 130 in SSG variety. The nut yield per palm per year was not consistent over the years.

Ambajipeta

The trial was initiated during November 2008 in 20 years old Godavari ganga plot as an observation trial. The intercrops viz., cocoa, banana, pineapple, elephant foot yam, heliconia were planted during November, 2008 and the experimental plot is being maintained. Some of the

crops are being harvested. The data on yield attributes viz., the mean number of leaves on crown was 32.8, mean number of bunches (12.4 per palm) and mean number of female flowers (buttons) per spadix (21.4 female flowers) were recorded during May, 2010.

Coconut based cropping system (Ambajipeta, 2010)

In the data on soil nutrient analysis, the contents of organic carbon, nitrogen, phophorus and potassium have increased in June, 2010 compared to initial values. An examination of soil temperature at different depths suggested that it decreased on the surface layer and difference between the temperature values of both the depths was narrowed down. The population of earth worms was found to increase as compared to that of June 2009 under cropping system.

Arsikere

The experiment was initiated during October 2008 in an area of 0.40 ha to develop location specific coconut based integrated cropping system models. Pepper, cocoa, lime and drumstick were planted as inter crops on 10.10.2008. The establishment of intercrops except black pepper is satisfactory. Vermicoposting is being done using the wastes of coconut and glyricidia leaves grown all along the border of the plot. The experiment has been maintained by green manuring, basin making and mulching. Irrigation was provided through sprinkler system. Vermicomposting of coconut waste, vermiwash collection and application to coconut and intercrops is being done. The coconut wastes, green leaf from glyricidia, vermicompost and vermi wash production have been quantified. The nuts were harvested at two months interval and yield data were recorded. The pre-experimental yield data (2006-08) of coconut and yield data during 2008-09 and 2009-10 have been recorded. There was improvement in yield of coconut over years due to cropping system.

Bhubaneshwar

In a plot size of 0.40 ha with 72 coconut palms, (Sakhigopal) intercrops like Guava (variety Arka Mridula 24 Nos. Arka Amulya 24 Nos.) and tissue culture banana (Gajabantala) (132 Nos.) were planted in 2009. Tuberose and guava were planted in the interspace while banana was planted in the intraspace.

Since it is a young coconut garden, the average height of the coconut palms was 6.5 m, girth was 109 cm and number of leaves was 16.

Kahikuchi

The model comprised of five crop components such as turmeric (var. Prova), pineapple (var.Kew), Assam lemon and banana (Chenichampa) and black pepper (Var Panniyur-1). A compact coconut block covering 0.4 ha was taken for the model. Planting of the above crops under coconut has been done step by step as per the layout of the model. Turmeric and pineapple were planted in the interspaces surrounded by the coconut palms. Banana was planted along the row of the coconut palms keeping two banana plants in between two palms. In the middle of four coconut palms, there was an Assam lemon plant and for black pepper coconut palms were taken as standard. The biomass produced was being recycled by converting into vermicompost so as to reduce the inorganic nutrient requirement of the coconut palms. For this purpose, low cost vermicompost units have been prepared in the experimental field itself. Soil samples in the coconut basin from four different sites of the experimental block were drawn and analyzed for their initial and after two years of experimentation on nutrient (NPK) contents and soil microbial population. Pre-experimental yield of coconut(average of 3 years) has been recorded and found to be 55 nuts/palm/year. The experiment is in initial stage and harvesting of pineapple and Assam lemon has not started. In case of banana, 40% harvesting has completed. There was an increase of nut yield of coconut from 55 nuts/palm/year to 61.2 nuts/palm/year with a per cent nut yield increase of 11.27%.

As regard to soil nutrient status and soil microbial population, it indicated that there was an increase in trend for soil nutrient (NPK) as well as soil microbial population (bacteria, fungi and actinomycetes) after two years of experimentation over the initial status.

Jagadalpur

Plot Size : 0.40 ha

Replication : Unreplicated

Crop combination: -

Summer season- Coconut + Drumstick + Bottle gourd + Cowpea

Rainy season-Coconut + Drumstick + Colocasia + Elephant foot yam + Amahaldi

Experiment was initiated during the year 2008. Initial nutrient status and soil moisture levels were recorded.

Drumstick, bottle gourd and cowpea were sown in the month of November 2008. The data revealed that, intercrop yield, NEY for CBCS and gross return from intercrops was highest in Coconut+Elephant foot yam and Coconut +Amahaldi. The Benefit cost ratio was highest in Elephant foot yam followed by Amahaldi. Banana, Lime and cocoa crops were planted in interspace and the growth of lime and banana was encouraging.

Mondouri

Plot size : 0.40ha , Non-replicated trial

Model : Coconut+black pepper+lime+pineapple+ heliconia/banana+turmeric

Irrigation : Sprinkler irrigation

The experiment was already been started and performing satisfactorily. Black pepper cuttings have been planted in the basin.

Navsari

Plot size: 0.40ha

Coconut based cropping systems

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

Banana Variety Grand Naine was planted in July 2009. Turmeric Variety Sugandhum was planted in May 2010. Cinnamon variety Konkan Tej -1 was planted in July 2009. Black Pepper variety, Pennuyur-5 will be planted during 2011.

Turmeric as intercrop in coconut (Navsari, 2010)

Integrated Nutrient Management

Vermicompost pits were made for recycling biomass. Sunn hemp green manure crop was grown and incorporated in the soil.

Soil and water conservation measures

Husk burial in the trenches was made at the centre of each set of four coconut palms.

Ratnagiri

Plot size : 0.40 ha., Non - replicated trial.

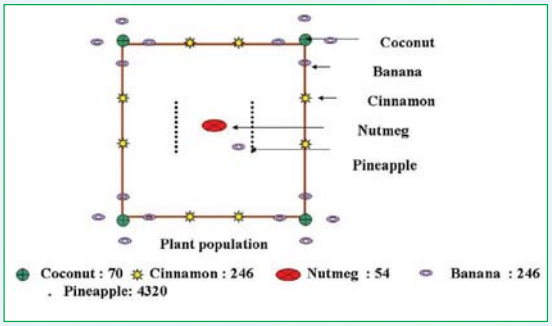
Crop combination: Coconut+Nutmeg+Cinnamon + Banana + Pineapple

Plant Population in coconut based integrated cropping system

Crop	Variety /hybrid	No. of plants/ grafts
Coconut	D x T	70
Nutmeg	Konkan Swad	54
Cinnamon	Konkan Tej	246
Banana	Konkan Safed Velchi	246
Pineapple	Kew	4320

The data regarding total number fronds on the crown and rate of fronds production per year revealed that there was slightly an increase in total

number of fronds and production of frond after planting the intercrops. The growth of Cinnamon and Nutmeg found to be satisfactory.



Schematic presentation of coconut based cropping system (Ratnagiri, 2010)

Soil nutrient status data as influenced by coconut based cropping system indicated that there was slightly an increase in soil NPK after planting different intercrops. The data regarding leaf nutrient status of coconut in coconut based cropping system indicated that there was slightly an increase in NPK in the leaf of coconut after planting an intercrops.

The pre treatment and post treatment yield of coconut revealed that the pre-treatment yield was 13300 nuts/ha, whereas it was 14055 nuts/ha after planting the intercrops. Further it was observed that the per cent increase in yield was 24 % after planting the intercrops.

Sabour

- Coconut var. Shakhi Gopal Tall has been planted in16 rows with 6 palms in each row.
- As per approved technical programme, Pomegranate and guava were planted in between two rows of coconut. Elephant foot yam var. Gajendra was planted at inter row space between two coconut and pomegranate. Turmeric Var. Sonia was planted in the intra-row space of coconut.
- Biomass collected from pruning of pomegranate and guava was used as mulch for coconut.
- Turmeric and elephant foot yam were harvested in the month of January, 2011 & February, 2011, respectively.
- Wastes of harvest of elephant foot yam and turmeric were used as mulch for coconut palms.
- Harvested turmeric and elephant foot yam have been kept as seed for further multiplication.

Veppankulam

Five numbers of vermicompost pits were formed and the vermiwash was being collected and applied to the crops in the system as per the requirement. The Elephant foot yam was harvested and processed and the yield recorded was 18700 kg/ha. The banana harvest was completed and yield recorded was 6650 kg / ha.

Recording the soil nutrients status, the available nitrogen, phosphorus and potassium were marginally increased in 2010-11 when compared to 2009 - 2010. The pH level was reduced from 6.52 to 6.48 in 2010-11. The organic carbon was raised in 2010-11 when compared to previous year. The plant nitrogen, phosphorus and potassium content were marginally increased in 2010-11 when compared to 2009-10.

The earthworm population has increased during 2010-11 when compared to 2009-10. Among the intercrops, banana recorded the net income of Rs. 20500 with B:C ratio of 2.60. Elephant foot yam recorded the net income of Rs. 51025 with B:C ratio of 2.20. Coconut recorded the net income of Rs. 81930 with B:C ratio of 2.56.

Cocoa in CBCS (Veppankulam, 2010)

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

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

Objectives

- To study the performance of *Morinda citrifolia* as mixed crop in coconut garden.
- To study the impact of mixed cropping of *Morinda citrifolia* with coconut on the productivity of coconut palms and soil fertility status.

Treatment details

- *Morinda citrifolia* mixed cropping in single hedge system (one row of Morinda - with 3.75 metres plant to plant spacing at the centre of two rows of coconut palms.

Design: Non-replicated

No. of *Morinda citrifolia* plants :

Seedlings: 25, Tissue culture materials : 25

Aliyarnagar

In a coconut garden of 20 years, *Morinda citrifolia* plants, 25 each of tissue culture and seedlings were planted on 31.7.2008 as hedge system in between two rows of coconut palms as non replicated trial. Standard package of practices for Noni as recommended in the biennial group meeting held at Navsari are being followed. Pruning was done to make 1 m height from ground level and debudding is being practiced. The number of functional leaves, annual leaf production, number of bunches, female flowers and nut yield are being recorded in coconut. The seedlings were found to perform better than the tissue culture plants. Plants are applied with 5 kg of vermicompost and no inorganic fertilizers were applied. The crop is at vegetative stage. The newly emerged flowers are removed to facilitate vegetative growth only.

Biometric observations on the growth attributes of the intercrop *Morinda citrifolia* viz., plant height, stem girth, number of branches per plant and numbers of leaves per plant in the tissue culture plants and as well as normal seedlings were recorded. The plants were found to be frequently infested by red ants and sooty mould for which suitable plant protection measures were taken.

The biometric observations revealed that the performance at vegetative growth stage was found to be better in the normally propagated seedlings than the tissue culture seedlings (Table 27). All the growth attributes viz., plant height, stem girth, number of branches per plant and numbers of leaves were found to be more in normal seedlings than the tissue culture plants. A gradual increasing trend in vegetative growth was observed in the normal seedlings after two years of planting. The normal seedlings recorded a plant height of 179.4 cm as against 136.9 cm in tissue culture plants. The girth of plant in tissue culture plants was found to be less (10.4 cm) than the normal seedlings (12.9 cm).

Though there was an increase in coconut yield as observed between pre-planting (2007-08) and one year after planting (2008-09) of *Morinda citrifolia* as intercrop in coconut, during the year 2009-10, the nut yield was found to be lower than the pre-treatment yield.

Ambajipeta

The observation trial on the performance of Noni was planted during August, 2008 with 25 no's seedlings grafts and 25 tissue culture plants in the inter spaces of coconut. The preliminary growth parameters viz, plant height, number of branches were recorded and the highest plant height (2.1 m)

Table 27. Biometric observations in *Morinda citrifolia* (Aliyarnagar, 2010)

	1 year after planting			2 years after planting		
Plants	**Height (cm)**	**Stem girth (cm)**	**No. of branches /plant**	**Height (cm)**	**Stem girth (cm)**	**No. of leaves /plant**
Tissue culture	75.2	3.6	3.3	136.9	10.4	154
Seedlings	113.4	5.3	7.7	179.4	12.9	257

and mean number of branches per plant (25.3) were recorded in seedlings. In tissue culture plants, only 1.5 m of height and 11.7 branches per plant were recorded (Table 28).

During 2009-10, the plant height of *Morinda citrifolia* at the end of second year of planting was similar both in seedlings and tissue culture material. However, the increment in plant height was higher with tissue culture material compared to seedlings. The number of branches, number of leaves and plant spread were higher with tissue culture material compared to seedlings indicating the better growth performance of tissue culture material. The number and weight of fruits per plant were also higher with the tissue culture material compared to seedlings.

Table 28. Growth parameters of *Morinda citrifolia* under coconut (Ambajipeta, 2010)

Planting material	Plant height (m)	Stem girth (cm)	No. of branches per plant	Fruits per plant	Total fruit weight per plant (kg)	Coconut yield per palm per year	
						Before planting	After planting
Tissue cultured plants	1.5	11.1	11.7	14.6	7.5	104	108
Seedlings	2.1	15.2	25.3	32.1	13.5	98	102

Arsikere

The experiment was laid out during August 2008 and the seedlings/ tissue culture materials of Indian Noni were planted on 30.08.2008. The establishment of *Morinda citrifolia* was satisfactory. The data on number of flowers, fruits set and fruit yield in Noni have been recorded (Table 29).

Noni as intercrop (Arsikere, 2010)

Table 29. Growth performance of *Morinda citrifolia* as a mixed crop in coconut gardens (Arsikere, 2010)

Parameter	Seedlings	Tissue culture
Plant height (cm)- At planting	98.8	50.8
2nd year	175.9	173.6
No. of branches/plant	15.2	27.0
No. of leaves/plant	174.1	426.1
Plant spread (cm)	114.8	147.6
No. of fruits/plant	26.6	62.5
Weight of fruits (g/plant)	149.5	433.0
Fruit yield (kg/ha) (356 plants/ha as intercrop in coconut)	53.2	154.1

Bhubaneshwar

25 numbers of seedlings and 25 numbers of tissue cultured noni plants were supplied by the World Noni Research Foundation, Chennai. Seedling noni performed better than the tissue cultured one. The data are presented in Table 30.

Table 30. Growth characters of *Morinda citrifolia* after one year of planting (Bhubaneshwar, 2010)

Type of Planting Material	Height (cm)	Stem girth (cm)	No. of branches	Days taken for first flowering
Seedling	0.90	8	8	290
Tissue Cultured	0.82	6	6	305

Kahikuchi

Seedlings of Noni plants (25 nos normal seedlings and 25 nos. tissue culture seedlings) were received from World Noni Research Foundation, Chennai on 25th July, 2008. The seedlings were cured and then planted under coconut garden on 1st August, 2008 as per the layout of the trial fixed in the 'Group Meeting' held at Thanjavur on 15-16th July, 2008.

The growth characters as well as reproductive

characters were recorded and presented in the Table- 31 revealed that normal seedlings plants (grafts) attained more plant height(1.8 m) and number of branches/plant (15.6) as compared to the plants raised from tissue culture. Grafted plants also took less duration for first flowering (305 days) than the tissue cultured plants (310 days). With regard to flower diameter, flower stalk length, number of fruits/plant, individual fruit weight and fruit yield, the higher values of all these characters were obtained from graft plants compared to tissue culture plants.

Table 31. Growth characters of *Morinda citrifolia* (Kahikuchi, 2010)

Types of plant	Plant height (m)	No. of branches/ plant	Stem girth (cm)	Leaf area (sq. cm)
Normal seedlings	1.8	15.6	13.1	197.5
Tissue culture	1.3	14.8	12.5	147.5

Jagadalpur

The experiment was initiated during the year 2008. Data in the Table 32 showed that plant height and stem girth were more in seedling plants but number of branches was more in tissue cultured plants, while flowering started in month of December - January in both plants and debudding at the time of flowering , training and pruning were done at one metre height.

Table 32. Growth observations on *Morinda citrifolia* (Jagadalpur, 2010)

Type	Plant height (cm)	Stem girth (cm)	No. of branches
Seedling plants	217	5.6	15
Tissue cultured plants	195	5.4	27

Mondouri

Morinda citrifolia plants have been collected and planted according to lay out of the experiment. Morphological and yield parameters of coconut and Noni are presented in Table 33. The performance of seedlimg was superor compared to tissue culture plants.

Table 33. Growth observations on *Morinda citrifolia* (Mondouri, 2010)

Type of plants	Plant height (cm)	No. of branches
Seedling	210.2	10.1
Tissue culture	135.6	12.3

Ratnagiri

The Noni has been planted in coconut garden during 2008. The yield data of coconut before planting and after planting the Noni as a intercrop revealed that the yield of coconut was increased by 21 percent after planting the intercrop.

It was observed from the data (Table 34) that the seedling height ranged from 113 - 155 cm with an average of 130 cm in seedling plants whereas it ranged from 23 - 83 cm with average of 55 cm in the tissue culture plants at the time of planting. However. it ranged from 180 - 270 cm with average of 206 cm in the seedling whereas it ranged from 89 - 125 cm with average of 137 cm in the tissue culture plants after two years of planting. Further, it was observed from the data that the numbers of branches ranged from 1 - 5 with an average of 2 in the seedling plants, whereas, it ranged from 0 - 1 with average of 1 in the tissue culture plants at the time of planting. However, number of branches ranged from 3-23 with average of 10 in the seedling plants. Whereas, it ranged from 2 - 11 with average of five in the tissue culture plants after two year of planting.

Table 34. Growth observations of *Morinda citrifolia* seedlings (Ratnagiri, 2010)

Sl. No.	Type of plant	Growth observations							
		At the time of planting				After two years of planting			
		Height (cm)		No. of branches		Height (cm)		No. of branches	
		Range	mean	Range	mean	Range	mean	Range	mean
1.	Seedling plants	113-155	130	1-5	2	180-270	206	3-23	10
2.	Tissue culture plants	23-83	55	1	1	89-215	137	2-11	5

Veppankulam

25 numbers of tissue culture seedlings and 25 numbers of normal seedlings were planted on 23.07.2008 in non replicated design with a spacing of 3m x 3m between 2 coconut rows in field No. B4 of Coconut Research Station, Veppankulam.

The crop is in maturity stage. The newly emerged flowers were allowed for fruiting. The biometric observations viz., plant height, girth of plant, no. of branches, no. of leaves / plant in tissue culture seedlings as well as normal seedlings were recorded and presented in Table 35.

Regarding the plant height, the tissue culture materials recorded better plant height (202.1 cm) when compared to normal seedlings (192.2 cm). The mean girth of the plant was higher in tissue culture materials (19.9 cm) when compared to normal seedlings (16.0), while mean number of branches/plant was higher in tissued culture materials (21.1) than in normal seedlings (15.0). The tissue culture materials recorded higher number of leaves/plant (335.4) when compared to normal seedlings (238.2).

***Morinda citrifolia* as intercrop (Veppankulam, 2010)**

Table 35 . Biometric observations of tissue culture plantlet and seedlings (Veppankulam, 2010)

S. No.	Plant type	Plant height (cm)	No. of branches	No. of leaves	Girth (cm)
1.	Tissue culture plantlet	202.1	21.1	335.4	19.9
2.	Seedlings	192.2	15.0	238.2	16.0

5.3 Disease management

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

(Ambajipeta, Veppankulam)

Ambajipeta

Twenty three new isolates of *Ganoderma applanatum and Ganoderma lucidum* were collected from different mandals of East Godavari District and from different districts of Andhra Pradesh like Srikakulam, West Godavari and Krishna. The pathogen *Ganoderma* was also isolated from other hosts like Citrus, Mango, Oil palm, and Palmyrah for better analysis of the Ganoderma isolates through molecular studies.

Identification of pathogenic virulence of Ganoderma isolates : Studies were conducted to validate the Bengal gram plants as indicator plant to basal stem rot disease during this year. Bengal gram plants did not show the bark splitting symptoms as in the case with red gram. It showed various symptoms like reddish brown spots on the basal stem region, which enlarged in size and girdled the stem. At later time, withering, yellowing and drying of the plants followed by complete rotting of the basal stem region and death of the plants (Fig 3). Pathogenic virulence studies were conducted on these Bengal gram and Red gram plants. Fourteen Ganoderma isolates were inoculated separately in pots to the sterilized soil and the germinated Red gram and Bengal gram seeds were transferred to the pots. The isolates NJL, Gl3, Ga1, Gl2, NPG1, Gl6 and Ga2 were found to be more virulent when compared to the others and showed the symptoms within 21-24 days after planting. The other isolates G wilt 1, Gl5, A2 and Gudapalli took 30-35 days for seedling death. The isolates G2wilt , Ga and Gl showed symptoms after 54 days of planting (Table 36) and found to be less virulent when compared to others.

Fig. 3. Symptoms of *Ganoderma* infection on Bengal gram indicator plant (Ambajipeta, 2010)

Table 36. Pathogenic virulence studies of *Ganoderma* on Bengal gram indicator plant (Ambajipeta, 2010)

Isolate	Number of seeds germinated	No. of days taken for seedling death	
		One seedling	2 or 3 seedlings
G wilt 1	5	30	34
NJL	7	21	34
Gl3	8	22	34
Gl5	7	34	54
Ga1	6	22	—
G wilt 2	6	54	—
Gl2	4	22	34
A2	6	32	54
Ga	5	54	—
Gl	6	54	—
Gudapalli	6	35	—
NPG1	4	23	34
Gl6	6	23	34
Ga2	7	24	34

Analysis of isozyme profile of *Ganoderma* isolates by native PAGE: Isozyme profiles of 24 isolates of Ganoderma were carried out with three enzymes, Esterase, Catalase and Peroxidase (Table 37) by native PAGE. All the three enzymes showed variation among the isolates. Esterase isozyme showed the highest variation in the profiles of isolates. The number of bands among the various isolates in Esterase studies ranged from 0 to 9. The other two enzymes, Catalase and Peroxidase showed either the presence or absence of enzyme among the isolates except the isolates from Antarvedipalem and Bendamurilanka which showed 4 and 2 bands in Catalase studies and isolate from Sakhinetipalli which showed 2 bands in Peroxidase studies.

Table 37. Isozyme profile of twenty four *Ganoderma* isolates (Ambajipeta, 2010)

Name of isolate	Number of bands in isozyme profile		
	Esterase	Catalase	Peroxidase
Gk	0	1	1
GLK	1	1	1
GDag	1	0	1
GJag	1	0	1
GSakh	0	0	2
GAnt	7	4	1
GPada	2	0	0
GGML	2	0	0
GKad	1	1	0
GCP	3	1	0
GPonn	1	0	0
GHRS	3	1	1
GGann	3	0	1
GHkott	2	0	1
GSatt	3	1	1
GPidim	2	1	1
GGodi	0	0	0
GBenda	3	0	1
GVodal	6	2	1
GAlla	3	1	1
Ga2	9	1	1
Gwilt1	9	0	1
Gl5	9	0	1
Gl6	9	0	1

Epidemiology and disease forecasting:

The rate of linear spread of the basal stem rot disease with respect to the weather parameters was recorded for the period April 2010 to March 2011.

To study the impact of other palms and intercrops in coconut on occurrence and spread of disease, fifty palms in field with sole coconut and field with coconut + banana were selected in Gannavaram village of East Godavari District. Every month linear and horizontal spread of the disease in the detected 50 palms were recorded. In sole coconut crop, out of fifty palms, only one palm was infected with the disease. Where as in coconut intercropped with banana, out of fifty plants four plants showed the symptoms till January 2011. In February 2011, six plants and in March 2011, 7 plants out of fifty plants showed the symptoms of disease. Horizontal spread of the disease was found to be more in coconut intercropped with banana when compared to the sole crop where as vertical spread was found to be more in sole coconut crop.

Correlation studies between weather factors and spread of basal stem rot disease for the period from January, 2000 to Mar 2011 indicated that number of rainy days, rainfall and relative humidity at 2 pm were found to have significantly negative relationship with vertical spread of basal stem rot disease in coconut (Fig-4). The following regression equation was developed to predict the *Ganoderma* wilt disease spread in coconut.

Y = 21.99 + 5.42 (MIN TEMP) - 1.00 (MAX TEMP) + 0.848 (RH EVE) - 1.579 (RH MOR)

$R^2 = 0.5417$; R = (-) 0.7360; F = 5.31.

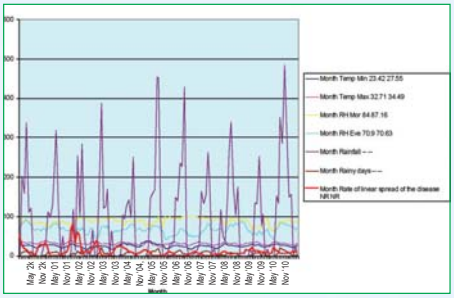


Fig. 4. Effect of weather factors on rate of linear spread of Basal stem rot disease of coconut (Ambajipeta, 2010)

Veppankulam

The cultures of 17 isolates of *Ganoderma lucidum viz.,* CRS 1, CRS 3, CRS 4, CRS 5, CRS 6, CRS 7, MSL 1, KKD 1, VK 1, TKT 1, PV 1, PV 2, VRM 1, VPM 1, VKD 1, PKK 1& TTI 1 collected from different places and isolated were mass multiplied separately on sorghum grains in poly bags (as mushroom spawn). They were used for soil inoculation by mixing it with sterilized sand at the time of planting at 300 g/pot to identify the pathogenic virulence of *Ganoderma* isolates to coconut. The pots which were filled with sterilized sand + 300 g of sorghum grain based inoculum of each of the 17 isolates were planted with ECT seedlings @ 1 seedling / isolate on 28.05.2008. For control, two pots filled with sterilized sand alone were planted with ECT seedlings @ 1 seedling/ pot. Observations were recorded on 06.04.2011 and VPM I isolate is found to be more virulent and it killed the plant.

The trial was repeated with more number of replications with 12 isolates of *Ganoderma lucidum viz.,* CRS 1, CRS 3, CRS 4, CRS 5, CRS 6, CRS 7, TKT 1, PV 1, PV 2, VRM 1, VPM 1 & KKD1 available at CRS, Veppankulam were mass multiplied on sorghum grains in poly bags (as mushroom spawn) and mixed with sterilized sand in cement pot @ one packet of 300 g of inoculum / pot. ECT seedlings were planted on 06.01.2011. The trial is in progress.

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

(Ambajipeta, Veppankulam)

Ambajipeta

Isolation of Trichoderma spp: Seventeen new *Trichoderma* isolates were collected from rhizosphere region of coconut palms from different villages of East Godavari and West Godavari districts viz., Gudapalli, Kesavadasupalem, Antarvedi, Kesanapalli, Sakhinetipalli lanka, Vedangi, Allavaram, Godilanka, Vodalarevu, Rameswaram, Antarvedipalem, Gondi, G. Pedapudi, H. Kotturu, Kadali, Gudimellanka and Turupupalem using *Trichoderma* specific medium. The identified *Trichoderma* spp are *T. viride, T. harzianum, T. hamatum, T. longibrachiatum, T. virens* and *T.polysporum*. The newly isolated species when tested for antagonistic activity against *Ganoderma applanatum* and *Ganoderma lucidum* in dual culture studies were found effective and are under the process of identification (Table 38) (Fig. 5).

Table 38. Antagonistic activity of *Trichoderma* spp on *Ganoderma applanatum* (Ambajipeta, 2010)

S. No	Radial growth of *Ganoderma applanatum* after 4 days of inoculation (diameter in mm)	Radial growth of *Trichoderma* spp after 4 days of inoculation (diameter in mm)	Radial growth of *Trichoderma* spp after 8 days of inoculation (diameter in mm)
T_1	1.3	6.9	8.8
T_2	1.7	4.8	9.0
T_3	2.1	5.5	8.6
T_4	1.6	5.0	8.7
T_5	1.5	6.2	8.9
T_6	1.8	4.7	8.8
T_7	1.7	4.8	8.5
T_8	1.4	5.2	9.0
T_9	1.4	6.1	8.7
T_{10}	1.3	5.9	8.9
T_{11}	1.8	4.8	8.2
T_{12}	1.8	4.7	8.8

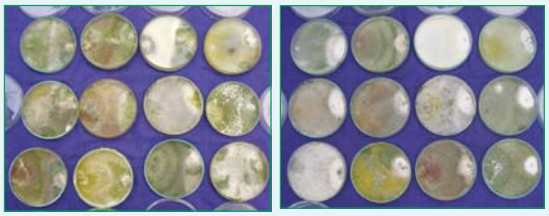


Fig.5: Antagonistic activity of 12 isolates of Trichoderma against *Ganoderma applanatum* and *Ganoderma lucidum* (Ambajipeta, 2010)

Two new isolates of *Pseudomonas fluorescens* were isolated by using King's B media from Vodalarevu village of East Godavari and Vedangi village of West Godavari districts.

Population dynamics of rhizosphere microflora of basal stem rot disease affected palms, apparently healthy and healthy coconut palms were studied to find out their influence on basal stem rot. Soil samples were collected from diseased and healthy palms of Gudapalli, Chintalamori, Gudimula, Kesanapalli, Sankaraguptam and Sakhinetipalli villages during the surveys. Serial dilution technique was adopted to study the microbial population in diseased and healthy palm rhizospheres. The mycoflora associated with healthy soil sample were found to be more in rhizosphere mycoflora and their number when compared to the diseased soil sample. *Aspergillus niger, Aspergillus flavus, Rhizopus, Penicillium spp* and bacterial colonies were the most common mycoflora present in all the samples. The colonies of *Trichoderma* were more in case of apparently healthy diseased coconut palms when compared to the diseased palms. In Komaragiripatnam village, *Trichoderma* spp was obtained from the diseased brackets itself when kept for isolation.

Veppankulam

Management of basal stem rot disease of coconut through biocontrol agents and neem cake

In the on going field trial on the management of BSR disease of coconut using *Trichoderma viride and Pseudomonas fluorescens* and neem cake at Mahizhankottai in

a farmer's field which was initiated during February 2008 as per the recommendations of the group meeting of the coconut Pathologists of All India Co-ordinated Research Project on Palms held at Agricultural Research Station, Ambajipet on January 31, 2007 with the treatments mentioned in Table 39.

Replication: 2 ; Plot size: 2 palms / replication
Design : CRD

The trial was initiated on 05.02.2008.

The disease index, nut yield and the population of bio-control agents recorded after three years of starting the experiment were presented in the Table 39.

Table 39. Disease index, nut yield and population of bio-control agents (Veppankulam, 2010)

Treatments	Disease index (mean)		Nut yield (Palm / Year)		Population of biocontrol agents			
					T. viride (cfu x 10^3 / g / dry soil		*P. fluorescens* (cfu x 10^5 / g / dry soil	
	Initial	After three years	Initial	After three years	Initial	After 3 months	Initial	After 3 months
T_1 = Root feeding of 100% culture filtrate of *Trichoderma viride* (25 ml) at quarterly interval	1.16	1.45	90	109	2.0	4.0	1.0	2.0
T_2 = Root feeding of 100% culture filtrate of *T. viride* (25 ml) at 6 months interval	1.34	1.52	105	116	2.0	3.0	0.7	2.0
T_3 = Root feeding of 100% culture filtrate of *T. viride* (25 ml) / year	1.25	1.70	92	106	2.0	3.0	0.5	1.5
T_4 = Basal application of *T. viride* (50 g) + neem cake (5 kg) / year	1.13	1.32	100	121	1.5	3.5	0.5	2.0
$T_5 = T_1 + T_4$	1.05	1.27	110	128	2.0	4.5	0.7	1.5
$T_6 = T_2 + T_4$	0.92	1.27	112	118	1.5	4.0	0.5	1.0
$T_7 = T_3 + T_4$	1.16	1.40	108	126	1.5	4.5	0.7	2.0
T_8 = Root feeding of 100% culture filtrate of *Pseudomonas fluorescens* (25 ml) at quarterly interval	1.53	1.80	101	110	1.0	2.5	1.0	1.5
T_9 = Root feeding of 100% culture filtrate of *P. fluorescens* (25 ml) at 6 months interval.	1.25	1.55	90	85	1.0	3.0	0.7	2.0
T_{10} = Root feeding of 100% culture filtrate of *P. fluorescens* (25 ml) / year	1.37	1.70	91	103	1.0	2.5	1.0	1.5
T_{11} = Basal application of *P. fluorescens* (50 g) + neem cake (5 kg) / year	1.32	1.67	102	114	1.0	3.5	0.5	4.0
T_{12} = T8 + T11	1.09	1.42	113	122	1.0	2.5	0.5	4.0
T_{13} = T9 + T11	1.12	1.44	110	116	1.0	2.0	0.7	3.5
T_{14} = T10 + T11	2.02	2.55	103	107	1.0	2.5	1.0	3.0
T_{15} = Neem cake @ 5 kg / palm / year	2.33	2.77	85	92	1.5	2.0	0.5	2.0
T_{16} = Control	1.35	2.70	88	98	1.5	2.0	1.0	2.0
CD (P=0.05)	NS	NS	5.69	15	0.5	1.3	NS	1.1

There was no further increase in disease index during the third year of the experiment. The nut yield and the population of bio-control agents increased over the initial nut yield and bio-control agents respectively.

Effect of botanicals on the *in vitro* growth of *Ganoderma lucidum*

A laboratory study was conducted to assess the effect of plant products on the growth of *Ganoderma lucidum*. Ten gram of the leaf material from each of the test plant was macerated in 10 ml of water. The plant extracts were tried at 10% concentration (10 ml per 100 ml of PDA). The extracts were mixed with the medium separately. After autoclaving, the medium was poured in Petri plates. A mycelial disc (8 mm) of *Ganoderma lucidum* was placed in the centre of the Petri plate. The plates were incubated at room temperature for five days. The Mycelial growth of the fungus was measured and the results are given in the Table 40.

Table 40. Effect of botanicals on the *in vitro* growth of basal stem rot pathogen (Veppankulam, 2010)

Plant products	Radial growth of *G. lucidum* in cm	Per cent reduction over control
Solanum nigrum	2.2	75.5
Pongamia glabra	2.9	67.8
Azadirachta indica	3.0	66.7
Prosopis juliflora	3.1	65.5
Tephrosia purpurea	3.5	61.1
Ocimum sanctum	4.1	54.4
Glyricidia lucida	4.3	52.2
Vitex negundo	4.3	52.2
Musa sp (Rhizome extract)	4.5	50.0
Calotropis gigantea	4.5	50.0
Eucalyptus globulus	4.6	48.9
Phyllanthus niruri	4.9	45.5
Tridox procumbens	5.1	43.3
Acalypha indica	5.2	42.2
Coriandrum sativum	5.3	41.1
Mentha arvensis	5.5	38.9
Sesbania grandiflora	6.0	33.3
Murraya koeningii	6.8	24.4
Solanum xanthocarpum	7.0	22.2
Hibiscus rosasinensis	7.2	20.00
Leuceana leucocephala	7.5	16.66
Calapaconium sp.	7.5	16.66
Cynodon dactylon	7.6	15.55
Control	9.0	-

Leaf extracts of *Solanum nigrum* caused maximum reduction on the growth of *Ganoderma lucidum*.

Biopriming with PGPRs for disease resistance:

To asses the effect of biopriming with *Pseudomonas fluorescens* and *Trichoderma viride* on BSR resistance in coconut, a new experiment was set up under glasshouse conditions. The pots were filled up with sterilized sand and mixed with *Ganoderma lucidum* inoculum. The ECT seedlings were dipped in 10 per cent suspension of *Pseudomonas fluorescens* and *Trichoderma viride* and planted in the pots. Proper control is also being maintained and the experiment is in progress.

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

Aliyarnagar

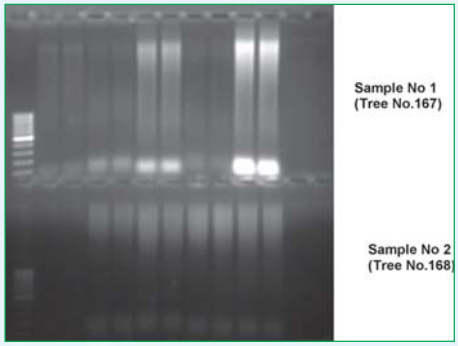
Survey was conducted on the occurrence of root (wilt) disease of coconut in Coimbatore, Theni and Dindigul districts in TamilNadu - Kerala border areas. Manakkadavu, Gopalapuram (Nedumparai) and Sethumadai villages of Anaimalai block in Coimbatore district recorded an average root (wilt) disease incidence of 3.3, 1.4 and 0.07%, respectively. Thimmankuthu village of Pollachi North block, Nanjegoundanpudur and Kettimalanpudur villages of Pollachi South block showed 0.3, 0.75 and 1.0%, disease incidence respectively. Maximum incidence was noticed in Manakkadavu village followed by Gopalapuram (Nedumparai) villages in Coimbatore district.

In Theni district, K.K. Patti, Keelagudalur and Cumbum villages of Cumbum block showed 15.4, 15.2 and 22.3%, respectively where as, in Theni block, the disease incidence was recorded only at Allinagaram (0.05%) village. In Dindigul district, there was no incidence of root (wilt) disease in the villages surveyed. Among the districts surveyed, Cumbum block of Theni district was severely affected by root (wilt) disease.

Molecular detection of root (wilt) disease

DNA extracted from different parts of the infected trees viz., matured leaf, spindle leaf, inflorescence, stem and root portions revealed that the spindle leaf samples were more suitable for the

detection of phytoplasma than the other portions. Hence, DNA was extracted from the spindle leaf samples collected from Cumbum area and analyzed for the presence of phytoplasmal bodies, which showed positive results for phytoplasma. However, some palms found free from root (wilt) disease symptom were identified at Gudalur area of Theni district (Root (wilt) affected area). DNA extracted from spindle leaf samples of disease free palms were also subjected to PCR analysis. The results revealed that the palms were free from phytoplasma infection. The palms will be periodically observed for the persistent nature of resistance to root (wilt) disease.



PCR analysis results for the samples (spindle leaves) collected from Gudalur (Aliyarnagar, 2010)

Samples (spindle leaves) collected from Gudalur palms (tree No. 167 and 168) were tested using PCR technique. Both trees were free from phytoplasma infection (No bands at 890 bp).

Identification of indicator plants

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

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

Ambajipeta

Incidence of bud rot disease on coconut seedlings in nursery was recorded at monthly interval. Incidence of the disease was high in rainy season and the incidence percentage of bud rot in nursery seedlings ranged from 7.93 to 9.8 during August 2010 to December 2010. Seedling death due to bud rot was found higher in Godavari Ganga (Hybrid coconut) when compared to the seedling death of East Coast Tall.

Field evaluation of antagonists against bud rot disease in coconut: Field experiment on evaluation of various formulations of *T.viride* and *P.fluorescens* against bud rot disease of coconut was repeated. Talc formulation and culture filtrates of *Pseudomonas fluorescens* and *Trichoderma viride* at 100% and 50% concentrations were imposed before the onset of monsoons as prophylactic measure. Formulations were applied in crown region of coconut seedlings. Application of talc formulation of *pseudomonas fluorescens* @ 10g was found effective when compared to *Trichoderma viride* @ 10g and application of culture filtrates of 100% and 50% of both the bioagents.

Field evaluation of antagonists against stem bleeding disease in coconut: Field experiment on evaluation of various formulations of *T.viride* against stem bleeding disease of coconut was carried out. Application of *Trichoderma viride* paste on the stem bleeding patches was continued on the diseased palms of HRS, Ambajipeta and by the time of June 2010, the diseased palms of the palm were reduced to 35. Incidence of stem bleeding by June was reduced to 1.28. but after that the number of diseased palms was again increased because of the heavy rains as they washed out the *Trichoderma viridae* paste that was applied. The incidence of stem bleeding was again increased to 4.48% by October 2010. The results presented in Table 41 revealed that smearing of *T. viride* paste on stem bleeding patches was effective in containing the disease.

Table 41. Effect of *T. viride* paste on stem bleeding in coconut (Ambajipeta, 2010)

Month	Total No. of palms	Stem bleeding diseased palms	Percentage incidence
April.2010	2719	44	1.61
May. 2010	2719	35	1.28
Jun. 2010	2719	35	1.28
Jul. 2010	2719	38	1.39
Aug. 2010	2719	42	1.54
Sep. 2010	2719	37	1.36
Oct. 2010	2719	49	1.80
Nov. 2010	2719	75	2.75
Dec. 2010	2719	122	4.48
Jan. 2011	2719	107	3.93
Feb. 2011	2719	115	4.22
Mar. 2011	2719	85	3.12

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

(Aliyarnagar, Ambajipeta, Veppankulam)

Aliyarnagar

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

The survey results showed that the leaf blight disease caused by *Lasiodiplodia theobromae* was the predominant disease in all the areas surveyed which ranged from 2.3 to 14.8 per cent. The maximum incidence of 14.8 per cent was recorded in Samathur village of Coimbatore district followed by 10.4 per cent in Cumbum village. Severe incidence of basal stem rot disease incidence was found in Poosaripatti village of Coimbatore (4.8%) and in Peramiyam village of Dindigul district. In Coimbatore district, the spread of leaf blight disease is more in the villages surveyed. There was no stem bleeding incidence in Dindigul and Theni districts, while Coimbatore district showed 0.04 per cent disease incidence. Similarly, bud rot incidence was also at very low level in Coimbatore (0.03%) and Theni (0.12%) districts while, Dindigul district was found free from bud rot incidence.

Ambajipeta

Surveys were conducted in different mandals of East Godavari, West Godavari, Krishna and Srikakulam districts of Andhra Pradesh during 2010-11. The major diseases observed in coconut gardens were basal stem rot, bud rot and stem bleeding along with minor incidence of grey leaf spot. Survey indicated that mean per cent incidence of basal stem rot, bud rot and stem bleeding diseases on coconut recorded 11.01, 2.6 and 2.8 percent respectively. Incidence of Grey leaf spot disease was also observed to certain extent in East Godavari District during last year because of heavy rains and improper cultural management of fields because of the continuous rains.

Veppakulam

Survey was conducted at the following places in Thanjavur and Thiruvarur districts to assess the incidence of basal stem rot, stem bleeding and bud rot in coconut.

Stem bleeding incidence was not noticed in any of the places where survey was undertaken. Bud rot incidence was noticed in 2 places out of 32 places surveyed. Altogether 6,442 palms were covered in the survey and among them 212 palms were affected by BSR showing 3.29% infection. Among the 6,442 palms surveyed, only 26 palms were affected by bud rot disease showing 0.40 % infection.

Fixed plot survey

A fixed plot survey was initiated in a farmer's holding at Vendakottai village in Thanjavur district during the year 2008. The area of plot was 0.60 ha. The variety planted is ECT and is 20 years old. The first observation was taken on 22.01.2008 and the per cent infection was 48. Second observation was taken on 31.03.2011 and the per cent infection was 77 showing 29 per cent increase in infection of palms by BSR pathogen over a period of 3 years and 2 months.

Disease maps

Disease maps for basal stem rot disease in coconut was prepared for Thanjavur, Thiruvarur and Nagappattinam districts. In Thanjavur district, BSR is prevalent in Orathanadu, Madukkur, Pattukkottai, Peravurani, Adirampattinam and Thiruvonam, whereas in Thiruvarur district the disease prevalent at Needamangalam, Mannargudi, Thiruthuraipoondi and Muthupettai. In Nagappattinam district the disease is prevalent in Vedharanyam block.

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

Aliyarnagar

In vitro studies revealed that *Pseudomonas fluorescens* was highly effective in inhibiting the *Lasiodiplodia theobromae* compared to other bioagents. Field experiments were laid out at farmer's field in Kambalapatti, Karianchettipalayam and Samathur villages of Pollachi taluk, Coimbatore to find out the efficacy of both the talc-based powder

formulation as well as liquid culture of *Pseudomonas fluorescens* against leaf blight disease. Pre treatment and post treatment observations on leaf blight disease were made and the difference between the two indicated reduction in disease severity.

Root feeding of *P. fluorescens* liquid culture was done @ 25 ml at an interval of quarterly, half yearly and once in a year. The root feeding was also combined with soil application of *P. fluorescens* talc formulation @ 50g/palm/yr + Neem cake 5 kg/palm/yr. About 25 leaflets were selected randomly from the lower 10 leaves in each palm and the disease was graded based on the 0-5 scale score chart (0 - No infection; 1 - < 10% ; 2 - 11 to 25% ; 3 - 26 to 50%; 4 - 51 to 75% ; 5 - > 75% leaf area infected) and the percent disease index (PDI) was calculated.

Among the treatments, root feeding of *P. fluorescens* culture filtrate (25 ml) at quarterly interval combined with soil application of *P. fluorescens* talc formulation (50g) + Neem cake (5 kg/palm) was found to be the best in all the 3 locations and significantly reduced the incidence from 30.3 to 12.9, 28.5 to 11.9 and 30.1 to 7.9% in Kambalapatti, Karianchettipalayam and Samathur trials, respectively. The experiments revealed that the root feeding combined with soil application was found to be the best when compared to the individual application as either root feeding or soil application.

Ten *Bacillus* sp. isolates were also collected from different locations of Pollachi taluk to develop suitable microbial consortia for the management of leaf blight disease of coconut. Among them, the kambalapatti isolate was found to be highly inhibitory to *L. theobromae*. The development of microbial consortia is completed with the effective fungal (*T. viride* TNAU strain) and bacterial (*P. fluorescens* Pf1 and *Bacillus* sp.) antagonists and this will be evaluated under field conditions.

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

(Ambajipeta, Veppankulam)

Ambajipeta

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

Sero detection of *Ganoderma applanatum*: Indirect form of ELISA (I-ELISA): *Ganoderma applanatum*: The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2X10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (anti rabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added & absorbance's were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the *Ganoderma applanatum* with antisera dilution of 1 : 10000 and with antigen dilution up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2X10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.152 - 2.969 and 0.113 - 0.600 respectively in ELISA reader (Fig. 6).

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

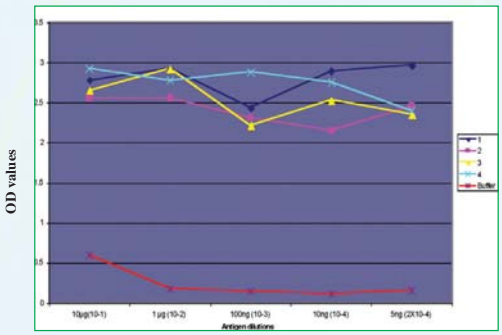


Fig. 6. Sero detection of *G. applanatum* by indirect ELISA (Ambajipeta, 2010)

Sero detection of *Ganoderma lucidum* : Indirect ELISA (I-ELISA): *Ganoderma applanatum*: The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (antirabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added & absorbance's were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the Ganoderma applanatum with antisera dilution of 1 : 10000 and with antigen dilution up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.133-2.916 and 0.287-1.805, respectively in ELISA reader (Fig. 7).

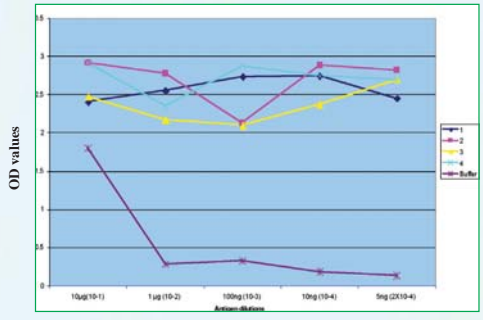


Fig. 7. Sero detection of *G. lucidum* by indirect ELISA (Ambajipeta, 2010)

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

Identification of indicator plants for basal stem rot disease: Studies were conducted for validating Bengal gram plant as indicator plant for basal stem rot disease along with red gram during 2010-11. Artificial inoculation of pure cultures of *Ganoderma* pathogen to the sterilized soil was done with each isolate before transferring of the germinated Bengal gram and red gram seedlings in pots. Bengal gram plants did not show the bark splitting symptoms as the case with red gram. It showed various symptoms like reddish brown spots on the basal stem region, which enlarged in size and girdled the stem. At later time, withering, yellowing, browning of the leaves and drying of the plants followed by complete rotting of the basal stem region and death of the plants were observed. Entire symptoms were visible with in a month under artificial inoculation studies when compared to Red gram. Pure culture of *Ganoderma* was isolated from the basal stem regions showing reddish brown spots and rotting (Fig. 8).

Fig. 8: *Ganoderma* isolated from infected Bengal gram plant and infected palms (Ambajipeta, 2010)

Indicator studies were also conducted with naturally sick soil of Ganoderma in pots along with artificial inoculation of the cultures. These plants also showed similar symptoms and culture of Ganoderma was isolated from the diseased plants.

Veppankulam

In order to find out the reaction of some crop plants to act as indicator plants for the early detection of BSR, seeds of Red gram, Bengal gram, Brinjal, Tomato, Bhendi, Cowpea, Green gram, Black gram, Chillies & Cluster beans were sown in pots filled with sterilized sand and inoculated with *Ganoderma lucidum* (multiplied on sorghum grains) on 12.11.2010 for testing the suitability of these crops as an indicator host for the early detection of BSR. Observations were recorded on 12.03.2011 and the plants were observed for bark splitting symptom at the base of the stem and Ganoderma sporophore formation at collar region and none of the plant species exhibited these symptoms.

Early detection of BSR pathogen through ELISA

Root samples from both BSR infected and healthy coconut palms were collected and the early diagnosis technique *viz.*, Direct Antigen Coating - Enzyme Linked Immuno Sorbant Assay (DAC - ELISA) was done for the root samples as per the method described by Viswanathan *et al.* (1998). The antiserum used in the present study was specific to *Ganoderma* and it was obtained from the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore. Absorbance value (A_{405}) was recorded and presented in Table 42.

Table 42. Absorbance value (A_{405}) for root samples (Veppankulam, 2010)

Type of root samples	Absorbance value (A_{405})				
	R_1	R_2	R_3	R_4	Mean
Infected	0.310	0.324	0.316	0.326	0.319
Healthy	0.182	0.166	0.175	0.169	0.173

The absorbance of the root samples from BSR infected palm was more when compared to healthy roots.

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

Aliyarnagar

Leaf blight pathogen was isolated from the samples collected from eleven different locations *viz.*, Subbaegoundanpudur, Samiyarpudur, Aliyarnagar, Angalakurichi, Kudimangalam, Karianchetipalayam, Samathur, Mannam, Kambalapatti, and Vakkampalayam villages of Pollachi Taluk of Coimbatore district and Veppankulam village of Thanjore district in Tamil Nadu. The associated fungal pathogen, *Lasiodiplodia theobromae* was isolated using potato dextrose agar medium to study about the genetic variability. The leaf blight disease incidence was recorded at monthly interval. Weather parameters *viz.*, maximum temperature, minimum temperature, relative humidity and rainfall were also recorded. Correlation studies revealed that the leaf blight disease intensity was increased with increase in temperature and the maximum disease intensity was observed during March-April. Disease intensity was reduced after the receipt of rainfall. Disease intensity was found to the lowest during November-December (Fig. 9).

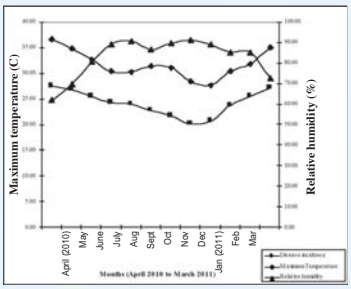


Fig. 9. Influence of weather parameters on leaf blight disease incidence

Leaf blight affected palm

Virulence studies

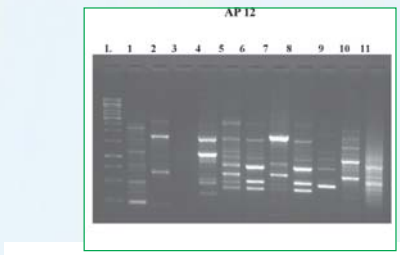
All the eleven isolates were inoculated on one and half years old seedlings raised in polybags using sterilized soil. The symptom development was observed periodically. Aliyarnagar, Angalakurichi and Subbaegoundanpudur isolages were found highly virulent and showed a lesion size of 18.33, 18.25 and 17.11 cm on the leaf with in 15 days while, the Vakkampalayam and Veppankulam isolates showed poor development and recorded 2.33 and 3.00 cm, respectively (Table 43).

Table 43. Lesion development by different isolates of *L. theobromae* 15 days after ' inoculation on coconut leaf

Name of the isolate	Lesion size (cm)
Subbaegoundanpurur	17.1
Samiyarpudur	11.0
Aliyarnagar	18.3
Angalakurichi	18.3
Kudimangalam	10.2
Karianchettipalayam	12.3
Samathur	15.3
Mannam	5.7
Kambalapatti	15.9
Vakkampalayam	2.3
Veppankulam	3.0

Studies on genetic variability

DNA was isolated from all the eleven isolates and subjected to PCR analysis with 20 random primers. Among them, 5 random primers namely OPF 6, OPF 10, OPC 8, OPA 5 and AP12 showed variability among the isolates analysed. A range of 42 to 66 percentage of similarity was observed among the *L. theobromae* isolates collected from different parts of Tamil Nadu (Plate A to E). The experiments needs to be continued with more number of random primers.



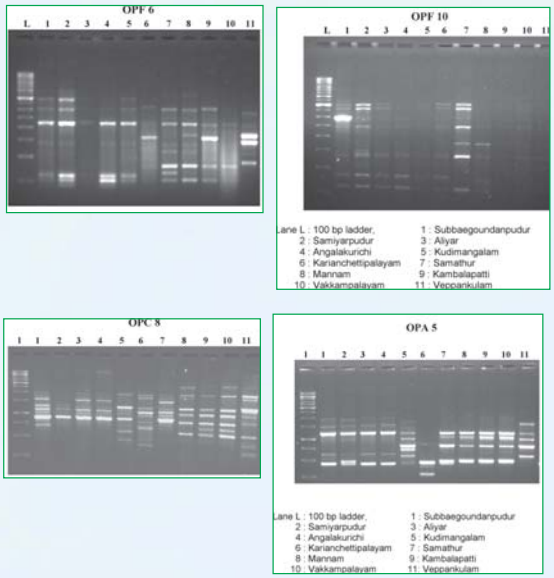


Plate A to E. Genetic variability studies of *L. theobromae* isolates with Random primers

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

Ambajipeta

The experiment was carried out by raising polyclonal antibodies in New Zealand White Rabbits against *Phytophthora palmivora*. Pure cultures of *Phytophthora palmivora* strain was used to develop polyclonal antibodies. The developed antibodies were tested with the pure cultures as antigen in glass capillary tube assay, slide agglutination test and by indirect ELISA. Positive reaction of developed antiserum of *Phytophthora palmivora* with the pure culture of *Phytophthora* was observed in glass capillary tube assay and slide agglutination tests by the formation of precipitations. The antiserum was then used to detect its sensitivity against the pathogens in indirect ELISA method. The method was standardized and found to be sensitive to detect the antigen up to 1:20,000 dilution. Antiserum with its dilution of 1:10,000 was able to detect the antigen in 1:10, 1:100, 1:1000, 1:10000, 1:20000 dilutions.

Sero detection of *Phytophthora palmivora:* Indirect ELISA (I-ELISA): *Phytophthora palmivora:* The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various

concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2X10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (antirabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added & absorbance's were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the *Phytophthora palmivora* with antisera dilution of 1 : 10,000 and with antigen dilution up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.306 - 2.969 and 0.114 - 0.156 respectively in ELISA reader (Fig. 10). The experiments are being repeated.

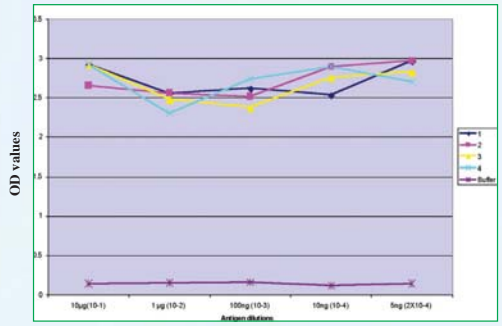


Fig. 10. Sero detection of *Phytophthora palmivora* by indirect ELISA (Ambajipeta, 2010)

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

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

(Ambajipeta, Veppankulam)

Ambajipeta

Seed nuts of seven new varieties (Java giant, Chandra Kalpa, Spicata, Laccadive micro, ECT, Ceylon red and GBxECT) were obtained and planted in sick soil at Gannavaram, East Godavari District at 3x3 m spacing as on farm trial in October 2010. In addition, two local varieties, Pillalakodi and Jonnalarasi were also collected and planted along with the above varieties and the trial is in progress.

Veppankulam

Seed nuts collected from the basal stem rot resistant palms from hot spot area of Thambikkottai were planted in the nursery for screening purpose. The seedlings obtained from this were used for laying out of an On Farm Trial in a farmer's holdings at Thennankudi village in Peravurani taluk of Thanjavur district. In this trial the seedlings of twelve coconut varieties/hybrids were planted to verify for basal stem rot resistance. The seedlings have been planted in a CRBD on 04.08.2010. The trial is in progress.

Path. 17: Studies on post harvest diseases of coconut

(Aliyarnagar, Ambajipeta, Veppankulam)

Aliyarnagar

Aspergillus flavus was found to be the predominant mycoflora on the copra as well as on unhusked nuts. Various chemical preservatives were screened against *A. flavus*. Among them, Potassium metabisulphite and Benzoic acid were found to be effective and showed 62.22 and 46.67 per cent mycelial growth inhibition compared to the control (Fig. 11).

Among the fungal antagonists tested, *T. viride* was found to be effective in inhibiting *A. flavus in vitro*. *In vitro* studies were conducted to record the effect of volatiles released by different strains of *T. viride* and *T. harzianum* using the specially made partitioned plates. None of the strains could inhibit the growth of *A. flavus*. The isolates might have not either produced volatiles or the produced volatiles were ineffective against *A. flavus*.

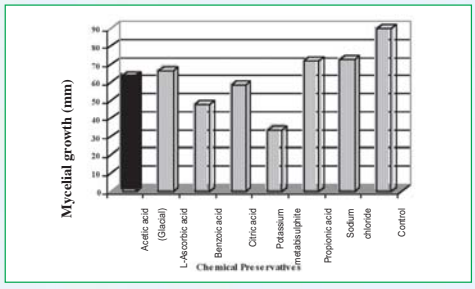


Fig. 11. Effect of chemical preservatives on the mycelial growth of *A. flavus* (Aliyarnagar, 2010)

Ambajipeta

Survey and identification of Mycoflora associated with coconut: Survey conducted on losses due to storage rot in coconut indicated that percentage of rotting in coconut is ranged from 3 to 20% depending upon the type of storage condition. Percentage of coconut rotting is maximum (15 to 20%) under home storage conditions. Isolation studies revealed that *Aspergillus flavus, A.niger, Rhizopus* spp, *Drechelera* spp, *Botyodiplodia* spp and *Penicillium* spp are the commonly associated mycoflora on copra during storage.

Estimation of aflatoxin contamination in copra: To estimate the aflatoxin contamination in copra, polyclonal antibodies were developed in New Zealand White Rabbits using *Aspergillus flavus* pure culture as antigen. The developed antibodies were tested with the pure culture of *Aspergillus flavus* as antigen in glass capillary tube assay, slide agglutination test and by indirect ELISA in the initial studies. Positive reaction of developed antiserum of *Aspergillus flavus* with the pure culture of *Aspergillus flavus* was observed in glass capillary tube assay and slide agglutination tests by the formation of precipitations. The antiserum was then used to detect its sensitivity against the pathogens in indirect ELISA method. The method was standardized and found to be sensitive to detect the antigen up to 1:20,000 dilution. Antiserum with its dilution of 1:10,000 was able to detect the antigen in 1:10, 1:100, 1:1000, 1:10000, 1:20000 dilutions.

Sero detection of *Aspergillus flavus:* Indirect form of ELISA (I-ELISA): *Aspergillus flavus:* The developed polyclonal antisera diluted in carbonate buffer (pH 9.6) were first added to the ELISA plate. Then test samples at various concentrations of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2X10^{-4}$ were added to the same plate. After two hours of incubation, secondary antiserum conjugate (antirabbit IgG ALP conjugate) at the concentration of 1:10,000 was added to the plate. Then the substrate was added & absorbance's were recorded with ELISA reader at 405 nm. The Indirect form of ELISA was found to be more sensitive in detecting the Aspergillus flavus with antisera dilution of 1 : 10,000 and with antigen dilution up to 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, $2x10^{-4}$. The range of absorbance values for the antigen and buffer samples were between 2.174-2.965 and 0.108-0.148 respectively in ELISA reader (Fig. 12). The experiments are being repeated.

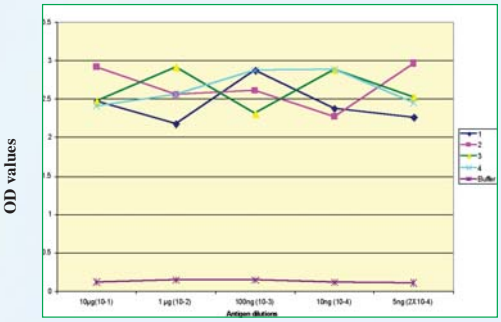


Fig. 12. Sero detection of *Aspergillus flavus* by indirect ELISA (Ambajipeta, 2010)

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

Management of post harvest diseases of coconut: The following nine *Trichoderma isolates* were tested against the *Aspergillus flavus* pathogen in dual culture studies. All the isolates were found to have major effect on *Aspergillus flavus* in dual culture studies (Table 44 & Fig. 13).

Table 44. Antagonistic activity *of Trichoderma spp* on *Aspergillus flavus*

S. No	Radial growth of *Aspergillus flavus* after 4 days of inoculation (diameter in mm)	Radial growth of *Trichoderma* spp after 4 days of inoculation (diameter in mm)	Radial growth of *Trichoderma* spp after 8 days of inoculation (diameter in mm)
T_1	2.1	4.5	8.9
T_2	1.8	4.4	8.9
T_3	2.2	4.0	9.0
T_4	2.1	4.4	9.0
T_5	2.0	4.2	8.3
T_6	1.3	4.9	8.0
T_7	4.0	3.8	8.8
T_8	1.0	4.8	9.0
T_9	1.8	3.8	8.8

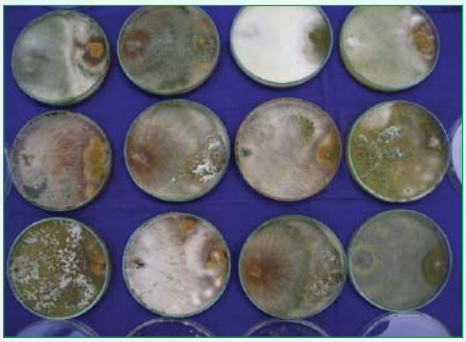


Fig 13: Antagonistic activity of 12 isolates of Trichoderma against *Aspergillus flavus* (Ambajipeta, 2010)

Studies on the inhibition effect of chemical preservatives on *Aspergillus flavus, A.niger, Rhizopus spp, Penicillium spp* revealed that chemical preservative Menadione at 500ppm concentration was found to be effective against *A.niger, A.flavus and Penicillium spp,* while Benzoic acid at 1000. ppm concentration was effective against *Rhizopus spp*.

Veppankulam

The effect of culture filtrates of *Pseudomonas fluorescens* on the *in vitro* growth of fungal pathogens of copra was assessed and the results are presented in the Table 45.

Among the five fungal pathogens, the growth of *A. niger* was highly inhibited by the culture filtrates of *P. fluorescens*.

Table 45. Effect of culture filtrates of *P. fluorescens* on fungal pathogens of copra *in vitro* (Veppankulam, 2010)

Pathogen	Dry wt. of biomass (g)		% reduction over control
	Treated	Control	
Botryodiplodia theobromae	0.232	0.915	74
Penicillium sp.	0.169	1.989	91
Rhizopus sp.	0.149	0.374	60
Aspergillus flavus	0.203	1.796	88
A. niger	0.113	2.344	95

The effect of culture filtrates of *Trichoderma viride* on the growth of post harvest fungal pathogens viz., *Botryodiplodia theobromae, Penicillium sp., Rhizopus sp., Aspergillus flavus* and *A. niger* were studied and the results are presented in the Table 46.

Table 46. Effect of culture filtrate of *Trichoderma viride* on the *in vitro* growth of fungal pathogens of copra (Veppankulam, 2010)

Pathogen	Dry wt. of biomass (g)		% reduction over control
	Treated	Control	
Botryodiplodia theobromae	70	888	92
Penicillium sp.	187	1338	86
Rhizopus sp.	148	905	83
Aspergillus flavus	60	919	93
A. niger	160	1079	85

The culture filtrate of *Trichoderma viride* reduced the growth of *A. flavus* to the maximum of 93 per cent over control.

An experiment was conducted to assess the age of coconuts in relation to susceptibility to *Botryodiplodia theobromae*. Unhusked 7, 10, 11 and 12 months old nuts were inoculated with 6 mm diameter mycelial inoculum of *Botryodiplodia theobromae* grown on PDA by making a small hole on the top of the nuts. The nuts were stored at room temperature and the percent disease index (PDI) was worked out at different days after inoculation and the results are presented in Table 47.

Table 47. Age of coconuts in relation to susceptibility to *Botryodiplodia theobromae* (Veppankulam, 2010)

Age of coconut (in months)	Extent of spoilage (PDI) - days after inoculation			Mean
	10	15	20	
7	27.77 (31.74)	47.22 (43.38)	69.44 (56.46)	48.14 (43.86)*
10	13.88 (21.64)	22.22 (28.01)	47.22 (43.38)	27.77 (31.01)
11	0.0 (16.77)	0.0 (16.77)	2.77 (9.46)	0.92 (14.33)
12	0.0 (16.77)	0.0 (16.77)	0.0 (16.77)	0.0 (16.77)

* Indicates angular transformed values

The result indicates that the younger nuts are more susceptible than the matured nuts to infection by *Botryodiplodia theobromae*.

5.4 Pest Management

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Black headed caterpillar: In Coimbatore District, among the gardens surveyed, in Sulur village has recorded the highest percent level of infestation of black headed caterpillar (71.4) followed by Thalavady (64.0), Maruthamalai (41.2), Dasanaickenpalayam (45.7), Sathyamangalam (39.04), A.Nagoore (22.0), Nanjundapuram (17.3), and Karumathur (12.0). In Erode District, the coconut palms located in Paravalasu village of Erode dt. had recorded the highest per cent level of infestation (60.0) followed by, Velampalayam (56.59), Nasianur (20.8) and Pangalivalasu (15.0). In Tirupur District, the coconut palms located in Chickanathu village has recorded the highest level of infestation (41.6%) followed by Cheripatty (35.7%), Pathappampatty (16.53%), Kattampatty (11.0%) and Sencherimalai (8.0%). In Salem District, the coconut palms located in Narasingapuram village had recorded the highest per cent level of infestation (18.0). In Dindugal District, the coconut palms located in Vadamadurai village had recorded the highest per cent level of infestation (48.5) followed by Dharmathupatty (29.9), Oddanchattiram (7.0) and Raddiyarchattiram (3.0).

Rhinoceros beetle

In Coimbatore District, among the gardens surveyed, the per cent infestation of Rhinoceros beetle was found to be highest in Dasanickenpalayam of Coimbatore district (30.5) followed by A. Nagoor (28.0), Sathyamangalam (20.0), Thalavady (15.4), Sethumadai (15.0), Maruthamalai -East of Coimbatore district (15.0), Sulur (14.1), Maruthamalai (11.2), Karumathur (9.0) and Nanjundapuram (8.2). In Erode District, the coconut palms located in Paravalasu village recorded the highest per cent level of infestation of Rhinoceros beetle (21.6) followed by 63, Velampalayam (20.9), and Nasianur (15.3) and Pangalivalasu (14.0). In Tirupur District, the coconut palms located in Chenaripatty village recorded the percent level of infestation of Rhinoceros beetle (27.4) followed by, Pathappampatty (13.7), Chickanathu (11.472), Kattampatty (9.0), and Sencherimalai (6.0). In Salem District, the coconut palms located in Narasingapuram village recorded the highest per cent level of infestation of Rhinoceros beetle (13.0). In Dindugal District, the coconut palms located in Vadamadurai village of Dindugal dt. recorded the highest percent level of Rhinoceros beetle (23.6) followed by, Dharmathupatty (5.9), Oddanchattiram (5.0) and Raddiyarchattiram (2.0).

Red palm weevil

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

Eriophyid mite

The per cent infestation of Eriophyid mite in all the above mentioned places was found to be moderate to high ranging from 42.0 to 90.0.

Ambajipeta

Fixed Plot Survey: Two villages were selected for fixed Plot survey in East Godavari district i.e., Sakinetipalli and Yedurulanka. Mild to medium intensity of rhinoceros beetle damage was noticed in both the villages and the gardens have been recovered completely from the out break of coconut slug caterpillar which occurred in 2008-09. Further, out break of leaf eating caterpillars *Phelera sp* and *Acria sp* on coconut is observed in the months of January, February and March 2011 (Table 48).

Table 48. Monitoring of coconut pests in of East Godavari district Fixed plot survey (Ambajipeta, 2010)

Date of Survey	Incidence of different pests and intensity							Other pests
		Mite *			Rhinoceros beetle			
	Incidence	Intensity		Mite population / 4 mm^2	Incidence (%)	Intensity		
		Young	Harvested			Leaf damage (%)	Spindle damage (%)	
Sakinetipalli village								
02-May-10	100%	1.90 (Mild)	3.05 (Medium)	12.3	20	23.7	Nil	Bagworm
03-Jun-10	100%	2.96 (Medium)	3.25 (Medium)	24.8l	56	33	50	Bagworm
6-Nov-10	100%	2.08 (Mild)	3.13 (Medium)	13.5	20	4.15	Nil	Bagworm
07-Jan-11	100%	2.30 (Mild)	3.20 (Medium)	11.97	40	23.1	Nil	Bagworm, Acria sp
Yedurlanka village								
29-May-10	100%	2.25 (Mild)	2.44 (Mild)	14.6	Nil	Nil	Nil	Bagworm
07-Aug-10	100%	1.41 (Mild)	2.40 (mild)	16.8	Nil	Nil	Nil	Nil
16-Nov-10	100%	2.7 (Medium)	3.0 (Medium)	22.8	20	12.8	Nil	Bagworm
09-Feb-11	100%	2.6 (medium)	3.25 (Medium)	21.65	25	6.2	Nil	Phelera
04-Mar-11	100%	2.6 (Mild)	3.5 (medium)	14.32	—	9.7	Nil	Phelera

* No incidence of red palm weevil, black headed caterpillar and slug caterpillar was noticed.

Rowing survey: Rowing survey was conducted in 52 villages of East Godavari, 16 villages in West Godavari and 1 village in Visakhapatnam districts of Andhra Pradesh.

Infestation of coconut black headed caterpillar in East Godavari [5 villages], West Godavari [2 villages], Visakhapatnam [1 village] and slug caterpillar in East Godavari [1 villages] was also recorded during the rowing survey. Medium infestation of red palm weevil in 10 villages in East Godavarai district was noticed. Medium incidence of rhinoceros beetle was noticed in East Godavari, West Godavari and Visakhapatnam districts. Mild to medium intensity of coconut mite was recorded in all the districts surveyed.

High incidence of leaf eating caterpillars *Phelera* sp and *Acria* sp was observed in almost all the gardens of East and West Godavari district. These pests were observed in the months of January, February and March 2011.The light traps were installed in various coconut orchards for monitoring the incidence of coconut pests. Due to incessant heavy rainfall from May 2010 to December 2010 the leaf eating caterpillars like slug caterpillar [*Parasa lepida*], webworm [*Acria sp*], *Phelera sp* and button borer were observed feeding on the coconut foliage and the adults were mass trapped in the light trap [500 W incandescent bulb arranged at 45 cm high above the water pan] from 6 pm to 5 am (Table 49).

Table 49. Number of coconut leaf eating caterpillar moths caught in the light traps (Ambajipeta, 2010)

Month & Year	*Phelera sp*	*Acria sp*	*Parasa lepida*
December - 2010	83	258	—
January - 2011	727	1948	22
February - 2011	377	1120	18
March - 2011	284	395	—
Total	**1471**	**3721**	**40**

Phelera **larvae**

Leaf damage by Phelera sp

Light trap arrangement for mass trapping of adults

Severe defoliation caused by *Phelera* sp in coconut gardens

Bagworm infestation in coconut

Ratnagiri

To record the intensity of infestation of various pests of coconut, a rowing survey was carried out in Thane and Ratnagiri districts of Konkan region of Maharashtra from April 2010 to March 2011. Minimum two gardens in each village and two villages in each taluka were selected for recording the infestation. Observations on the incidence and intensity of rhinoceros beetle, red palm weevil, black headed caterpillar and eriophyid mite were recorded. The observations recorded during the survey are summarized in Table 50.

The infestation of Rhinoceros beetle was more or less similar in all the two districts in the range of 13 to 14%. The intensity of Red Palm Weevil was maximum in Ratnagiri district (3.15%) followed by Thane district (1.20%). The infestation of eriophyid mite was recorded from all the orchards observed in all districts. The maximum incidence of eriophyid mite was 54.76 per cent in Thane district followed by Ratnagiri (54.40%). The infestation of Black headed caterpillar was noticed only in Thane district to the extent of 6.49 per cent.

Fixed plot survey was carried out at three months interval from April 2010 only in Ratnagiri district at farmer's field. Observations on the incidence and intensity of all the pests were recorded. The observations recorded during the survey are summarized in Table 58. The infestation of Rhinoceros beetle was in the range of 7 to 11%. Maximum infestation (10.22%) was in the month of July 2010. The infestation of Eriophyid mite was in the range of 53 to 57%. Maximum infestation (56.62%) was in the month of April 2010. The incidence of Black headed caterpillar was not noticed during fixed plot survey (Table 51).

Table 50. District wise coconut pests situation in Konkan region of Maharashtra (Ratnagiri, 2010)

Sr. No.	Districts	No. of palms inspected	Per cent infestation		
			Rhinoceros beetle	Red palm weevil	Eriophyid mite
1	Thane	2003	13.1	1.2	54.8
2	Ratnagiri	2158	13.9	3.1	54.4

Table 51. Fixed plot survey of coconut pests from April 2010 to April 2011 (Ratnagiri, 2010)

Sr. No.	Month	No. of palms observed	Per cent infestation			
			Rhinoceros beetle	Red palm weevil	Eriophyid mite	Black headed caterpillar
1	April 10	30	8.3	1.1	56.6	0.0
2	July 10	30	10.2	2.8	53.1	0.0
3	Oct 10	30	9.8	3.1	54.0	0.0
4	Jan 11	30	7.5	1.8	55.17	0.0
5	April 11	30	7.3	1.5	54.9	0.0

Ent. 5. Management of eriophyid mite in coconut gardens

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Integrated management trial on eriophyid mite in coconut garden was carried out in farmers holdings at Aliyarnagar. The following mentioned IPM inputs were applied to the experimental plot containing 100 experimental palms.

i. Phytosanitary measures

ii. Root feeding of azadirachtin 10,000 ppm @ 10 ml + 10 ml water

The treatments are given three times in a year i.e., December - February,

April - June, September - October.

iii. Recycling of organic waste

iv. Raising of green manure crops in the basin

v. Application of recommended dose of fertilizers

vi. Recommended level of irrigation

vii. Husk burial in basin

viii. Soil moisture conversation measures

The pre-treatment observations on the population of the eriophyid mite and its natural enemies were recorded. The population of the eriophyid mite in two month old buttons of treated palms was reduced after imposing the IPM package. The percent reduction of eriophyid mite over the untreated palms was also worked out (Table 52).

Ambajipeta

The experiment was conducted in a plot having 100 palms of 0.5 ha in Munganda village. IPM package for coconut mite is being implemented in the plot.

The data was recorded on the intensity of eriophyid mite from 3rd bunch of coconut in the selected plot at quarterly intervals. Mild intensity of mite i.e., 2.30 grade index was observed in the

Table 52. Effect of IPM on population of Eriophyid mite (Aliyarnagar, 2010)

S.No.	Locations	Population of eriophyid mite (No./4 sq.mm.)			
		Pre-treatment	Post treatment		
			1st root feeding	2nd root feeding	3rd root feeding
1.	Aliyar	43.55 (6.55)	30.67 (5.53)	22.30 (4.72)	16.33 (4.04)
2.	Chinna kombu	40.55 (6.36)	29.50 (5.43)	20.15 (4.48)	14.15 (3.76)
3.	P.Naickanur	37.86 (6.15)	24.56 (4.95)	19.32 (4.39)	16.95 (4.11)
4.	Angalakurichi	4130 (6.42)	27.20 (5.21)	17.50 (4.18)	12.70 (3.56)
5.	Kottur	36.50 (6.04)	21.45 (4.63)	18.65 (4.32)	15.25 (3.91)
6.	Control	51.20 (7.15)	53.50 (7.31)	4930 (7.020)	50.15 (7.08)

T_1 - treatment [IPM implemented garden] and in the T_2 - treatment [IPM treatment without root feeding]recorded 2.48 grade index [mild] whereas 2.96 grade index [medium] was recorded in control plot (T 3) [Table 53].

intervals. Simultaneous observations were also made in control plot. Data was recorded on pretreatment and post treatment intensity of eriophyid mite from 3rd bunch in the selected plot.

Table 53. Management of eriophyid mite in coconut gardens (Ambajipeta, 2010)

Month/Year	Treatment	Mite 3rd bunch	
		Grade index	Intensity
April-July, 2010	T_1	2.10	Mild
	T_2	2.14	Mild
	T_3 (control)	2.85	Medium
August-Nov, 2010	T_1	2.57	Medium
	T_2	2.65	Medium
	T_3 (control)	3.08	Medium
Dec, 2010-Mar, 2011	T_1	2.24	Medium
	T_2	2.61	Medium
	T_3 (control)	2.95	Medium
Mean	T_1	2.30	Mild
	T_2	2.48	Mild
	T_3 (control)	2.96	Medium

Ratnagiri

The trial was conducted at farmer's field in Karla village of Ratnagiri district. One block was treated with IPM package and another block was kept as a control plot. The pre treatment observations were recorded before applying the treatments. Post treatment observations were also recorded at three, six and nine month's

From Table 54, it was observed that the eriophyid mite infestation was in the range of 92 to 94% in both the plot before application of various treatments. The eriophyid mite infestation was reduced from 92.65% to 38.26% after applying integrated package. On the other side, percentage of healthy fruits was increased from 7.35% to 61.74%. The eriophyid mite population remained same in control plot.

Table 54. Percentage of healthy and infested nuts (Ratnagiri, 2010)

Sr. No.	Observations	Control plot		Treated plot	
		Infested nuts (%)	Healthy nuts (%)	Infested nuts (%)	Healthy nuts (%)
1	Pre count	93.57	6.43	92.65	7.35
2	After 3 months	90.94	9.06	66.85	33.41
3	After 6 months	90.42	9.58	52.97	47.03
4	After 9 months	88.33	11.67	38.26	61.74

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Mass culturing of Braconid parasitoid Viz., *Bracon bvrevicornis* and Bethylid parasitoid is being continued on the alternative host of rice grain moth larvae *Corcyra cephalonica* in the bicontrol laboratory for conducting bioassay studies.

The Relative toxicity of Dichlorvos, Monocrotophos, Carbaryl, Phorate and malathion on Braconid parasitoids was also worked out in Entomology Laboratory of CPCRI, Kasaragod, Kerala.

The Relative toxicity of monocrotophos, Dichlorvos, carbofuran and dimethoate on braconid parasitoids was also worked out. The Median Lethal dose of insecticides to *Bracon brevicornis* was found to be lower for monocrotophos than dichlorvos followed by dimethoate and carbofuran.

Based on LD50 studies, it could be inferred that monocrotophos was the most toxic followed by malathion, carbosulfan, phorate and carbaryl for parasitoid *Bracon brevicornis* (Table 55).

Table 55. Median lethal dose of insectcides to *Bracon brevicornis* (Aliyarnagar, 2010)

Chemical	LD 50 Value ng / cm^2
Malathion	23.02
Phorate	41.60
Carbosulfan	37.67
Monocrotophos	18.91
Carbaryl	49.80

Ambajipeta

The culture of the test organism i.e., pupal parasitoid, *(Brachymeria Sp.)* of *Opisina arenosella* are being multiplied in the laboratory for conducting bio-assay studies.

Ratnagiri

The culture of the test organism i.e., larval parasitoid *(Goniozus nephantidis.)* of *Opisina arenosella* was multiplied in the laboratory for conducting bio-assay studies. Culture so obtained was used to conduct studies on behavioural activity of the parasitoid.

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

A field experiment on the evaluation of predator *Cardiostethus exiguss* on *O.arenosella* was initiated at Ekatampalayam village of Chennimalai TK of Erode dt as per the following details during the year 2010-11.

Location	:	Chennimalai
Season	:	Three
Period	:	2010-11
No. of adults/nymphs per release	:	50 - 75
No. of trees/replication	:	10
No. of releases made	:	4 - 6
Interval of time	:	15 - 21 days

***Anthocorid* bug** *Caridiostethus exiguus* is an efficient egg larval predator of *O. arenosella* and could effectively suppress the caterpillar population, when released @ 50 nos. / tree at 15 days interval for six times consecutively. However, it should be seen that the releases should coincide with the egg laying by the pests. The releases of *Cardiostethes* should not be combined with other larval parasitoids.

Improved strains of *Bracon brevicornis* and *G. nephantidis* were evaluated at two different hot spot areas of black headed caterpillar in Salem and Dindugal districts as per evaluation protocol from CPCRI, Kasaragod, Kerala.

Management of *Opisina arenosella*

Spraying of Azadirachtin TS1% i.e. 10,000ppm @5ml+ Sandovit 1ml/litre of water followed by release of improved strains of two larval parasitoids Braconids, Bethylids and pupal parasitoid Chalcid @20:10:1 at 21 days interval for four times have shown significant effect on reduction of *Opisina arenosella* population.'The estimated mean population of pest per palm was significantly reduced from 830.00 to 510.00 per palm at 21 days after spraying of Azadirachtin TS1%.

Drastic reduction in mean pest population per palm was achieved from 290.00 to 5.50 palms after the release of bio agents for six times consecutively at 21 days interval of time.

Consequently there was an increase in the level of parasitisation of improved strains of larval parasitoids *viz.,* Braconids, Bethylids and Chalcids from 3.30, 1.95 and 1.06% to 29.26, 19.50 and 4.16, respectively.

Effect of improved strains of larval Biological Agents against *Opisina arenosella*

Location: Virupakshi, Dindugal

Release of improved strains of larval parasitiods *Bracon brevicornis, Goniozus nephantidis* and pupal parasitoid *Brachymeria nosatoi* at 21 days interval each for 5 times consecutively have shown significant reduction pest population from 327.15 to 2.21/ palm.

Population build up of Braconids, *Bracon brevicornis*, Bethylids, *Goniozus nephantidis* and Chalcids, *Brachymeria nosatoi* was observed from 4.75, 2,15, 1.17 to 26.79, 15.16, 7.47, respectively.

Ambajipeta

The Field trial was carried out in the Matlapalem village of East Godavari district, as the pest intensity has reduced in the Gundepudi village where the experiment was initiated. Plot size and sampling procedures were followed as per CPCRI guidelines. The results showed that the pest incidence was reduced by 100 per cent at third week after release in the T_1 - treatment [conditioned parasite treatment], whereas in T_2- treatment [the unconditioned parasite treatment], the pest incidence reduced by 83.7 percent after third week of release of parasite.

Ratnagiri

Methodology

Treatments

T_1 - Release of pre-conditioned parasitoids

T_2 - Release of un-conditioned parasitoids

T_3 - No release

Results

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

The data given in Table 56, indicated that the pest incidence reduced by 100 per cent at third week after release of conditioned parasite (T_1), whereas the pest incidence reduced by 84.73 percent at third week after release of unconditioned parasite (T_2). In Control, increasing trend was observed in pest population and only 4.31% parasitization was observed after 2nd week.

Table 56. Evaluation of pre-conditioned parasitoid *[Goniozus nephantidis]* in the field against *Opisina arenosella* (Ratnagiri, 2010)

Treatment	Pre-release count	Post-release count					
		No. of larvae/ leaf let/palm			Per cent parasitization		
		1st week	2nd week	3rd week	1st week	2nd week	3rd week
T_1[Conditioned]	11.9	5.2	2.3	0.0	72.4	76.2	100.0
T_2[Unconditioned]	11.3	10.3	8.2	4.1	52.1	70.1	84.3
T_3 [Control]	11.9	12.9	12.3	16.8	2.2	4.3	-

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Efficacy of various commercially available pheromone traps against red palm weevil

Studies on field efficacy of commercially available Pheromones viz., Chemtica Ferrolure, CPCRI-Lure, Brookland and PCI against red palm weevil *Rhhynchophorus ferrugineus* is being continued in three locations namely Pethanaickanur, Nallur and Kanniyur.

During October-March, among the four different aggregation pheromone traps tried, Chemtica - Ferolure was found to trap significantly the highest number of Red weevils upto 146 (102 female + 44 males), followed by CPCRI Lure trap upto 115 (84females + 31 males), Brookland trap upto 99 (72 females + 27 males) and PCI lure trap upto 75 (57 females + 18 males).

Efficacy of pheromone lure traps against coconut rhinoceros beetle

Studies on the field efficacy of pheromone lure traps against coconut rhinoceros beetle was carried out in Anaimalai, Pethanaickanur village with the following three treatments and six replications.

T1 - Chemtica Rhinolure : T2- Brookland - Rhinolure : T3 - PCI - Rhinolure

Data on the number of adult rhinoceros beetles attracted and trapped in each trap was recorded at monthly intervals.

During October to March, among the three different aggregation pheromone traps tried, Chemtica - Ferolure was found to trap significantly the highest number of rhinoceros beetle upto 82 (60 female + 22 males), Brookland lure trap upto 51 (36 females + 15 males) and PCI lure trap upto 30 (23 females + 7 males).

Ambajipeta

Studies on red palm weevil pheromone lures were conducted during the year with three available lures i.e., Central Plantation Crops Research Institute (CPCRI-T_1), Chem Tica (T_2) and Pest Control India (PCI-T_3) Maximum number of weevils were trapped in the month of May and throughout the year the highest number of weevils were trapped in Chem Tica lure catching 18.60 weevil/trap/month followed by PCI lure 17.69 weevils/trap/month. Whereas in the T4 [Brook lands Lure], an average of 11.45 weevils were trapped from November, 2010 to March, 2011.

Similar studies were conducted with rhinoceros beetle lures (Rhino lures) with two available commercial firms i.e., Chem Tica (T_1) and Pest Control India Ltd. (T_2) arranged in two different gardens. From the data, it was found that highest number of beetles were trapped in Chem Tica lure (2.21 beetles/trap/month) while PCI lure trapped 1.52 beetles/trap/month during the experimental period. The per cent reduction in the leaf and spindle damage was 89.6% and 100 per cent in the Chem tica installed gardens while, it was 81.3 and 100 per cent in the PCI lure installed gardens.

Ratnagiri

Method of recording observations

Three gardens were selected and single trap of each treatment was installed at each location. The observations on adults trapped were recorded at weekly interval.

Treatments : (A) For Rhinocerous beetle :

T_1 - Lure from Chemm Tica
T_2 - PCI Lure.
T_3 - Brookland Lure.

(B) For Red palm weevil :

T_1 - Ferro Lure +
T_2 - PCI Lure.
T_3 - CPCRI Lure.

It was observed that total number of rhinoceros beetles trapped in Chem tica lure were 81, PCI lure were 93 and Brookland lure were 76.

The per cent leaf and spindle damage was 22.12% and 22.28% in the PCI lure installed gardens followed by 26.25% and 43.23% in Chem tica lure installed garden.

Total red palm weevils trapped in Ferro lure + were 75, PCI lure were 88 and CPCRI lure were 54.

Infestation levels were reduced after one year in all the gardens. Only 1.23% dead palms were observed in CPCRI lure installed garden.

Ent. 13. Screening of coconut germplasm for tolerance/resistance to *O.arenosella*
(Aliyarnagar, Ambajipeta, Ratnagiri)
Aliyarnagar

The experiment will be initiated as and when the black headed caterpillar incidence is observed in different coconut varieties.

Ratnagiri

Work has been initiated for screening coconut germplasm for tolerance/ resistance to *O. arenosella*. Total 125 different banawali types were screened during survey work and incidence of *O. arenosella* was recorded.

Ent. 14. Validation of integrated pest management technology for *Oryctes* rhinoceros in different regions
(Aliyarnagar, Ambajipeta, Ratnagiri)
Aliyarnagar

Large scale demonstration plot on validation of integrated pest management technology for *Oryctes* rhinoceros was initiated in a contiguous area of 15 ha identified at Odayakulam, Pollachi.

The trial plot has 1200 palms with an age of 3 to 3½ years including D x T, T x D and local tall varieties.

Pre treatment observations the intensity of coconut rhinoceros beetle damage on recorded upto 35 to 40% on leaf, spindle and spathe. Post treatment observations on the reduction of damage on leaf, spindle and spathe are being recorded at six month intervals of time. Simultaneously, the percent intensity of baculovirus disease infection and GMF(*Matarhizium anisopliae*) are also being recorded at six month intervals of time.

Ambajipeta

Survey was conducted and Vudimudi village[P.Gannavaram Mandal] has been selected with the rhinoceros beetle infested coconut garden [10 ha area] and the treatments were imposed.

Ratnagiri

The IPM package is to be validated in a contiguous area of 10.00.

The trial was initiated in village Kalbadevi in Ratnagiri district on farmer's field. Five different newly planted coconut gardens were selected for this trial. Initial observations regarding incidence of Rhinocerous beetle was taken. Treatments were imposed as per schedule. Till now, 79.09% leaf damage and 75.72% spindle damage reduction was observed in respective gardens.

Ent. 15. Effect of management practices on the incidence and intensity of coconut pests
(Aliyarnagar, Ambajipeta, Ratnagiri)
Aliyarnagar

Incidence and intensity of coconut pests under different treatments in AICRP experiments were studied.

It was found that the rhinoceros beetle was high on coconut palms intercropped with lemongrass and Patchouli. Moderate on coconut palms intercropped with Karisalanganni, but low with Sriyangai and Sitharathai. Similarly in the case of eriophyid mite incidence, coconut palms intercropped with Lemongrass and Patchouli were found to have high followed by moderate level when intercropped with Karisalnganni,. On the other hand, low level of eriophyid mite infestation was noticed on coconut palms intercropped with Sitharathai and Sriyanagai.

Ambajipeta

Data on the incidence and intensity of coconut pests is being collected from three experiments.

Ratnagiri

Mild to medium incidence of mite intensity and leaf damage due to rhinoceros beetle in the range of 2.22 to 6.24% was observed in different treatments of Agr. 3B.

Mild to medium incidence of mite intensity and leaf damage due to rhinoceros beetle was in the range of 1.53 to 3.25% was observed in different treatments of Agr. 5A.

Mite incidence was 60% and intensity was 2.91% while leaf damage due to rhinoceros beetle was 7.25% and incidence was 6% in Agr. 10 experiment.

VI. Experimental Results in Oil Palm

6.1 Crop Improvement

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

Aduthurai

Design : Randomised Block Design
Replications : 3 (Three)
Plot size : 6 trees/plot
Treatments : 10 (Ten)
Date of planting
(Main field) : 11-04-2006
Location : Peraiyur Village, Thiruvarur District.
Soil Type : Red sandy loam
Farmer's Name : Mr S.Pandiyan, S/o. Sivagnanam,
Location : Peraiyur, Mannargudi Tk, Thiruvarur Dt.

Hybrid combinations:

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

The data on plant height varied from 4.7 m to 7.3 m between hybrids evaluated. NRCOP 14 showed significantly taller trees followed by NRCOP 13. NRCOP 16 resulted with shorter trees among the hybrids with 4.7 m. The differences between some of the hybrids were not atatsitically different and the performance in terms of height of trees showed that all hybrids have grown to the optimum height. The leaf production of different hybrids ranged from 33 to 41 leaves per palm. NRCOP 14 registered significantly higher number of leaves over NRCOP 12, NRCOP 16. The hybrids NRCOP 19 and NRCOP 11 have also produced more number of leaves per palm.

The flowering was random and higher number of female flowers were observerd in NRCOP 13 followed by NRCOP 19.

Gen 8 A. Evaluation of oil palm genotypes for drought tolerance (Gangavathi, Mulde)

Gangavathi

Treatment details: The treatments consisted of six Zambian (ZS) and three Tanzanian (TS) selections

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

Design: RBD, Replications: 3, Year of planting: October 1998

FFB yield : The FFB yield during 2009-10 differed significantly among the various genotypes. The genotype ZS-3 recorded significantly higher mean FFB yield of 6.14 t/ha over ZS-6, ZS-8, ZS-5 & TS-7. The genotypes ZS-1 and ZS-9 with FFB yields of 4.85 and 3.94 t/ha respectively were on par with ZS-3 (Table 57)

Cumulative FFB: The cumulative FFB for a period of 8 years from 2002-03 to 2009-10 revealed that there was significant difference between genotypes. The mean cumulative FFB yield was significantly higher in the case of ZS-3 (21.90 t/ha) followed by ZS-5 with FFB yield of 18.0 t/ha & ZS -1 with FFB yield of 17.94 t/ha.

Number of bunches: During 2009-10, significant difference in the number of bunches per palm was observed for oil palm genotypes. Mean number of bunches were significantly higher in the genotypes ZS-3 (4.3 no) followed by ZS-1 (4.0 no). Significantly lower number of bunches per palm was recorded in genotype ZS - 5 (2.78 no.).

Mean bunch weight: Similarly there was significant difference in the mean bunch weight. Mean bunch weight was significantly higher in the genotypeZS-3 (42.9 kg/bunch) followed by ZS-1 (33.90 kg/bunch) and ZS-9 (33.10 kg/bunch).

Data in respect of height, girth and number of leaves/palm of different genotypes under irrigated and rainfed condition were recorded during the period July, 2009 to June, 2010.

Table 57. FFB yield of different drought tolerant oil palm genotypes during 2010 (Gangavathi, 2010)

Genotypes	FFB Yield (t/ha)								
	2003	2004	2005	2006	2007	2008	2009	2010	Mean bunch weight (kg)
ZS-1	0.81	0.66	0.81	1.80	0.95	3.19	4.86	4.85	33.9
ZS-3	1.52	1.04	0.29	1.82	2.55	3.72	4.81	6.14	42.9
ZS-5	0.91	1.26	0.48	1.28	1.71	3.08	5.43	3.85	26.9
ZS-8	1.18	0.58	0.48	0.74	1.08	2.46	4.00	3.53	24.7
ZS-6	1.62	1.29	0.48	1.93	1.69	2.89	3.75	3.41	23.9
ZS-9	1.03	1.10	0.55	1.30	1.23	3.54	3.94	4.73	33.1
TS-4	1.03	1.45	0.57	1.41	0.89	1.68	4.07	4.28	29.9
TS-5	1.37	0.78	0.58	1.25	2.37	2.05	4.94	4.20	29.4
TS-7	0.84	0.73	1.43	1.71	1.18	2.56	3.75	3.81	26.6
SEm+/-	0.28	0.17	0.24	0.19	0.19	0.58	0.88	0.75	5.29
CD (p=0.05)	NS	0.53	NS	0.57	0.59	NS	NS	2.23	15.58

Mulde

Objective **:** To evaluate the Oil Palm Dura accessions for drought tolerance

Treatments **:** Eighteen

Experimental design : Randomized Block Design

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

(G.B. - Guinea Bissau, TS - Tanzania, ZS- Zambia)

Spacing : 9 m x 9 m

Replications : Three

Plant unit per plot : Six

3 palms were maintened under irrigated and another 3 palms under rainfed conditions.

Date of planting : June, 1999

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

It is clear from the data recorded that, different genotypes have shown significant effect on height and girth of the plant while number of leaves were non significant under irrigated as well as rainfed condition. Under irrigated conditions, genotype ZS-9 recorded lesser height (2.8 m)while genotype TS-8 recorded maximum height (5.1 m). Under rainfed condition G.B. 25/314 recorded maximum height (4.4 m) while less height (2.9 m) was recorded in genotype ZS-1. Under rainfed conditions, except ZS-2 and ZS-9, all the genotypes recorded comparatively less height as against under irrigated conditions.

Under both the conditions, girth of the genotypes was almost same with range between 2.9m to 2.5 m.

Number of leaves per palm were more under irrigated conditions and range between 21.2 (ZS-2) to 24.8 (G.B. 25/314) while under rainfed conditions it range between 20.1 (TS-11) to 23.6 (G.B. 25/314).

Data on number of inflorescences produced under irrigated and rainfed condition during the period under report indicated that production of male, productive and total inflorescences differed

significantly among the different genotypes under irrigated condition only. While no significant difference among different genotypes was observed under rainfed condition. Maximum number of male inflorescences (10.8) under irrigated condition was produced in the genotype TS-10 while it was less in TS-7 (5.1). Under rainfed conditions genotype G.B. 22/311 recorded maximum number of male inflorescences (9.1) and ZS-2 recorded less number of male inflorescences (3.8).

Number of productive inflorescences under irrigated condition was maximum (6.4) in genotype ZS- 3 followed by 6.1 in genotype G.B. 25/314 while it was less (1.8) in genotype TS-8. Under rainfed condition, genotype ZS-9 recorded maximum (5.7) number of productive inflorescences and genotype TS- 5 recorded less number of productive inflorescences i.e. 1.8 only. Genotype TS-10 recorded maximum (13.9) number of total inflorescences under irrigated condition while under rainfed condition, genotype G.B. 22/311 recorded maximum number of total inflorescences i.e. 12.9. It is seen from the data that Guinea Bissau genotype produces less number of male inflorescences and more number of productive inflorescences under irrigated conditions.

The data regarding yield attributes under irrigated and rainfed condition were recorded in eighteen genotypes during the period July 2009 to June 2010 and are presented in Table 58.

Data revealed that there was no significant difference among the different genotypes for number of FFB/palm and yield of FFB. However, genotype G.B. 25/314 produced more number of FFB i.e. 10.0 per palm under irrigated condition while under rainfed condition, ZS-9 produced maximum number of bunches per palm i.e. 8.2 bunches. Minimum number of bunches under irrigated condition were recorded in TS- 8 i.e. 4.1 whereas TS-9 recorded minimum (4.4) bunches under rainfed condition.

Average weight of bunch ranged from 2.7 kg per bunch (G.B. 25/314) to 11.3 kg per bunch (ZS-3) under irrigated condition while it range from 2.6 kg (G.B. 21/310) to 11.5 kg (Zs-8) under rainfed condition.

As far as yield of FFB are concerned, ZS-3 recorded highest yield i.e. 74.9 kg per palm (10.7 t/ha) followed by TS-6 (71.6 kg/palm and 10.2 t/ha) while genotype G.B. 25/314 recorded lowest yield i.e. 27.6 kg per palm which is only 4.0 tonnes per hectare under irrigated condition. Highest yield under rainfed condition was recorded by genotype ZS-8 i.e. 69.6 kg per palm per year (9.2 t/ha) followed by genotype ZS-5 (56.4 kg/palm i.e. 8.1 t/ha).

Drought Index: The response of plant to drought is evaluated by drought index (DI %) based on yield under both stress and non- stress conditions.

Out of eighteen genotypes, five genotypes Viz., ZS-8, TS-7, TS-8,TS-9 and TS-10 have shown per cent drought index values above 100 and it was the highest in TS-8 i.e. 153.66 per cent followed by TS-10 (108.93 %) and TS-9 (107.69 %) indicating high tolerance to drought condition. Among the seven Zambian genotypes only ZS- 8 has shown high drought index i.e. 103.13 per cent indicating high tolerance to drought. Other six genotypes could be rated as moderately tolerant to drought as their drought index ranges from 71.03 per cent in ZS-3 to 91.30 per cent in ZS-9.

G.B. 21/310 could be treated as susceptible genotype to drought exhibiting drought index of 44.44 per cent.

. The relative water content (RWC %) recorded for the month of September and November 2009 (Non stress period), April 2010 (Moderate Stress), and in the month of May and June 2010 (Stress period) did not vary significantly for different genotypes under irrigated and rainfed conditions. The mean RWC was higher under irrigated condition over rainfed condition in respective genotypes in non stress period. Under rainfed condition, in the month of November 2009 during non stress period, RWC was in the range of 69.5 (TS -9) to 87.7 (G.B. 25/314). During the month of April (moderate stress), ZS-8 recorded 86.5 RWC under irrigated condition and 78.9 under rainfed condition.

The electrolyte leaching was estimated during the month of September and November 2009 (Non stress period), April 2010 (Moderate Stress) and in the month of May and June 2010 (Stress period) and

Table 58. Yield behaviour of drought tolerant genotypes under different conditions (Mulde, 2010)

Genotypes		No. of FFB / palm		Wt. of bunches (kg/bunch)		Yield of FFB (t/ha)		Drought Index (DI %)
		Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	
V_1	G.B. 25/314	10.0	5.2	2.7	4.3	4.0	3.3	82.50
V_2	G.B. 22/311	6.9	5.2	4.3	4.0	4.2	3.0	71.43
V_3	G.B. 21/310	7.4	5.5	4.4	2.6	4.5	2.0	44.44
V_4	ZS -1	6.7	5.2	8.0	7.8	7.5	5.7	76.00
V_5	ZS-2	6.7	7.7	9.1	7.8	8.6	7.2	83.72
V_6	ZS- 3	6.7	7.2	11.3	7.5	10.7	7.6	71.03
V_7	ZS- 5	6.3	6.7	9.1	8.6	8.2	8.1	98.78
V_8	ZS- 6	8.4	7.0	7.3	8.0	9.1	8.0	87.91
V_9	ZS- 9	7.7	8.2	6.0	6.1	6.9	6.3	91.30
V_{10}	TS- 2	6.6	6.1	9.3	7.6	8.2	6.6	80.49
V_{11}	ZS-8	6.4	5.7	10.7	11.5	9.6	9.9	103.13
V_{12}	TS -4	5.3	5.7	8.8	7.4	6.7	6.0	89.55
V_{13}	TS- 5	7.3	5.2	9.6	7.8	10.2	5.8	56.86
V_{14}	TS-7 (Control)	6.5	5.7	7.8	8.8	7.2	7.3	101.39
V_{15}	TS-8	4.1	4.5	7.2	9.5	4.1	6.3	153.66
V_{16}	TS- 9	4.7	4.4	8.4	8.9	5.2	5.6	107.69
V_{17}	TS- 10	4.7	5.5	8.5	7.6	5.6	6.1	108.93
V_{18}	TS -11	5.1	5.1	10.9	8.2	8.1	6.4	79.01
S. E. ±		1.3	1.2	0.9	1.2	1.6	1.4	
C.D. at 5 %		N.S.	N.S.	2.7	3.4	N.S.	N.S.	

expressed as the percentage of final conductivity. There was no significant difference among the different genotypes in respect of electrolyte leaching. However, it is seen that the values of the percentage of electrolyte leaching are more during September- November (Non stress period) and April i.e. during moderate stress, while values are lower during Stress period (May and June). Similarly, within a different stress period, values were more under irrigated conditions as compared to rainfed conditions.

The lipid peroxidation was estimated in the month of May 2009. Various genotypes did not express significantly for lipid peroxidation under both the conditions. The mean lower peroxidase activity (as indicated by lower OD value) observed in the genotype ZS-3 with an OD value of 0.03 under rainfed condition, while under irrigated condition, values are lower in genotype G.B. 25/314, TS- 2 and ZS-1 i.e. 0.04. (Table 59).

The number of dried leaves did not show significant variation. Average number of drooped leaves was lower in the genotype TS-11 (1.1) under irrigated condition and 0.8 under rainfed condition. Under irrigated condition, ZS-5 did not show bunch failure, while under rainfed condition, it showed only 0.2 dried bunches/ palm.

Table 59. Lipid peroxidation and No. of failure bunches in drought tolerant genotypes (Mulde, 2010)

Genotypes		Lipid peroxidation (OD value) 2009-2010		No. of failure bunches	
		Irrigation	Rainfed	Irrigated	Rainfed
V_1	G.B. 25/314	0.04	0.04	1.3	2.8
V_2	G.B. 22/311	0.07	0.07	1.1	1.2
V_3	G.B. 21/310	0.08	0.08	1.1	3.1
V_4	ZS -1	0.04	0.04	0.6	1.0
V_5	ZS-2	0.08	0.07	0.4	0.3
V_6	ZS- 3	0.04	0.03	0.2	0.2
V_7	ZS- 5	0.05	0.05	0.0	0.2
V_8	ZS- 6	0.05	0.05	0.3	0.6
V_9	ZS- 9	0.08	0.08	0.2	0.8
V_{10}	TS- 2	0.04	0.04	0.1	0.4
V_{11}	ZS-8	0.08	0.07	0.6	0.3
V_{12}	TS -4	0.06	0.06	0.6	0.4
V_{13}	TS- 5	0.06	0.06	0.2	0.4
V_{14}	TS-7 (Control)	0.05	0.05	0.6	0.4
V_{15}	TS-8	0.08	0.08	0.5	0.2
V_{16}	TS- 9	0.05	0.05	0.2	0.3
V_{17}	TS- 10	0.05	0.05	0.2	0.3
V_{18}	TS -11	0.08	0.08	0.3	0.3
S. E. ±		0.01	0.01	0.2	0.4
C.D. at 5 %		N.S.	N.S.	0.6	1.3

Drought tolerant genotype (Mulde, 2010)

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

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

Gangavathi

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

Cross combinations :

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

Design: RBD; Replications : 3; Palms/treatment : 6

Date of planting : 15-2-2007, Spacing : 9m x 9m x 9m equilateral triangle method., Soil type : Black clay

Vegetative growth parameters :

Palm height: There was no significant difference in palm height among different hybrids. Mean palm height was higher with the hybrid NRCOP-5 and NRC OP-2 (4.33 and 4.24 m respectively Table 60).

Palm girth : Similarly, palm girth did not differ significantly. Mean palm girth was more in the case of NRCOP-5 and NRCOP-8 (2.54, 2.41 m, respectively) followed by NRCOP-4 (2.40 m).

Annual leaf production rate: The annual rate of leaf production was significantly were more with the hybrid NRCOP-1 (23.04) over NRCOP 6 &

Table 60. Vegetative growth parameters and inflorescence production of different oil palm hybrids during 2010 (Gangavathi, 2010)

Hybrids	Height (m)	Palm girth(m)	Annual leaf production	Male flowers	Female flowers	Sex ratio
NRCOP-1	3.8	2.2	23.0	10.9	3.9	26.87
NRCOP-2	4.2	2.3	20.1	11.0	7.7	41.75
NRCOP-3	4.1	2.2	20.0	8.9	5.5	37.97
NRCOP-4	4.2	2.4	20.4	11.6	3.5	23.21
NRCOP-5	4.3	2.5	20.0	8.9	5.4	39.63
NRCOP-6	3.7	2.2	16.6	8.2	4.9	35.75
NRCOP-7	4.0	2.3	18.9	9.2	6.2	41.03
NRCOP-8	4.0	2.4	19.2	9.2	3.3	25.76
NRCOP-9	3.8	2.1	20.3	7.7	5.1	38.88
NRCOP-10	3.8	2.2	17.4	6.6	5.1	43.76
S.Em+	0.24	0.26	1.76	1.57	1.2	8.29
CD (p=0.05)	NS	NS	5.18	4.63	3.68	NS
CV(%)	10.30	19.52	15.57	29.59	42.73	40.51

NRCOP 10 (16.6 & 17.39). NRCOP 4, NRC OP 9 & NRCOP 2 were on par with NRCOP -1.

Inflorescence production:

No. of male flowers: The number of male flowers was significantly less in the case of NRC OP-10 and NRC OP-9 (6.63 and 7.7 respectively) followed by NRC OP-6 & 3 (8.17 & 8.9). NRCOP-2 recorded higher number of male flowers (11.0).

No. of female flowers: The number of female flowers was significantly more in the hybrids NRC OP-2 and NRCOP-7 (7.70 and 6.23 respectively) followed by NRCOP-3 and NRCOP-1(5.53 and 5.43, respectively).

Sex ratio: The sex ratio remained non significant for various hybrids. The mean sex ratio was more with NRC OP - 10, NRC OP 2 and NRC OP 7 (43.79, 41.75 & 41.03, respectively).

Mulde

Objective : Multilocation trials on the performance of the Oil Palm hybrids

Experimental Details :

Treatments : 10 Hybrid Combinations

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

Experimental design : Randomized Block Design
Spacing : 9 m X 9 m
Replications : Three
Plant unit per plot : Nine
Date of planting : September, 2007

The growth observations in respect of new cross combinations of oil palm were recorded and data represented in Table 61.

Table 61. Growth performances of Oil Palm hybrids for the year 2009-10 (Mulde, 2010)

Cross combination	Code Number assigned	Mean height (m)	Mean girth (cm.)	No. of leaves/ palm
78 D X 435 P	NRCOP 1	0.81	1.2	17.9
90 D X 557 P	NRCOP 2	1.01	1.3	18.5
158 D X 116 P	NRCOP 3	0.85	1.0	18.5
131D X 435 P	NRCOP 4	0.88	1.2	18.4
5 D X 577 P	NRCOP 5	0.75	0.9	18.0
173 D X 435 P	NRCOP 6	0.91	1.2	17.7
183 D X 577 P	NRCOP 7	0.87	1.2	17.9
70 D X 557 P	NRCOP 8	0.99	1.4	18.6
28 D X 435 P	NRCOP 9	1.15	1.4	18.6
345 D X 577 P	NRCOP10	0.73	1.0	17.7
SE ±		0.13	0.2	0.7
CD at 5%		N.S.	N.S.	N.S.

It is clear from Table 61 that there was no significant difference among the different cross combinations of oil palm in respect of average height, girth and number of leaves. Average height of the new cross combinations of palm ranged between 1.15 m (28 D x 435 P) to 0.75 m (5 D x 577 P). Average girth of the palm ranged between 0.9 m (5 D x 577 P) to 1.4 m (70 D x 557 P) and (28 D x 435 P). Production of average number of leaves was in the range of 17.7 (173 D x 435 P) and (345 D x 577 P) to 18.6 (28 D x 435 P) and (70 D x 557 P).

NRCOP8 (Mulde, 2010)

Vijayarai

Design : R.B.D; Replicatioins: 3; No. of palms / plot: Six; Spacing: 9x9 m; Date of planting : 09-04-2007.

The one year old ten cross combinations of oil palm, growth characters data were recorded. The growth characters i.e., plant height, girth and number of leaves were found non significant. However, the maximum plant height was recorded in NRCOP-9 with 2.9 m and the shortest plant height was recorded in NRCOP-4 with 2.2 m. The maximum number of leaves were recorded in NRCOP-9 with 17.2 and the lowest number of leaves were recorded in NRCOP-1 with 13.1. The plant girth was recorded maximum in NRCOP-9 with 1.3 m. The lowest girth was recorded in NRCOP-1&4 with 0.8 m.

Data on the three year old palnts of ten cross combinations of oil palm revealed that the maximum plant height was recorded in NRC OP-4 with 3.4 m and the shortest plant height was recorded in NRC OP-10 with 2.4 m. The maximum number of leaves was recorded in NRC OP-1 with 26.0 and the lowest number of leaves was recorded in NRC OP-2 with 20.1. The plant girth was recorded maximum in NRC OP-7 with 1.5m followed by NRC OP-4 with 1.5 m. The lowest girth was recorded in NRC OP-3 with 1.2 m.

Aduthurai

Set I: "Studies on the comparative performance of different hybrid combinations of oil palm"

Design	:	Randomised Block
Replications	:	3 (Three)
Plot size	:	6 trees/plot
Treatments	:	10 (Ten)
Date of Planting - Main field	:	September, 2007.
Location	:	Manakarambai, Thittai, Thanjavur Dt
Soil type	:	Clay loam soil
Farmers Name	:	K.Mujibir Rahman, S/oL.Kamal Batcha
Location	:	Manakarambai, Thittai, Thanjavur dt.

Ten hybrid combinations (Aduthurai)

TH1 (14 x 66)	TH 2 (15 x 66)	TH 3 (25 x116)	TH 4 (37x435)	TH 5 (38 x 116)
TH 6 (39 x 214)	TH 7 (58 x 214)	TH 8 (66 x 435)	TH 9 (88 x 435)	TH 10 (351 x 435)

The field was maintained very poorly and the farmer was requested to take care of the field. Because of the continuous rain the field was waterlogged and seedlings suffered for want of drainage. Mortality and death of seedlings were observed.

SET II - "Studies on the comparative performance of different hybrid combinations of oil palm"

Design	:	Randomised block design;
Replications	:	3 (Three)
Plot size	:	6 trees/plot
Treatments	:	10 (Ten)
Date of planting	:	28-09-2007
Farmer's Name	:	Mr S.Pandiyan, S/o. Sivagnanam,
Location	:	Peraiyur, Mannargudi taluk, Thiruvarur Dtt
Soil Type	:	Red sandy loam

Regular biometric observations were recorded and the data was statistically analysed.

The biometric observation on plant height, number of leaves per palm, number of female and male flowers produced were recorded and presented in Table 62.

The plant height showed significant variation between hybrids evaluated. The height varied from 4.00 m to 5.00 m between hybrids. NRCOP 10 produced significantly taller palm over NRCOP 2. NRCOP 8, NRCOP 6 have also resulted in taller palms.

The number of leaves produced varied from 25 to 37 leaves per palm. NRCOP 8 registered significantly more number of leaves over NRCOP 1, NRCOP 2. Higher production of leaves were also observed with NRCOP 10.

The flowering has just started with NRCOP 2, NRCOP 6, NRCOP 3 and NRCOP 8 with more of female flowers. In general, the male flower production was more with all hybrids.

Ten hybrid combinations

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

Table 62. Biometric observations for the hybrids in GEN 8 C Set II trial (Aduthurai, 2010)

Hybrids	Plant height (m)	No. of leaves	No. of female flowers	No. of male flowers
NRCOP1	4.4	29.9	1.2	3.3
NRCOP2	4.0	25.6	1.7	4.3
NRCOP3	4.5	32.9	1.6	4.7
NRCOP4	4.2	31.2	1.7	5.2
NRCOP5	4.3	32.3	1.3	3.7
NRCOP6	4.7	34.4	1.7	4.4
NRCOP7	4.3	31.5	1.4	3.4
NRCOP8	4.9	37.4	1.6	5.0
NRCOP9	4.2	32.1	1.5	5.7
NRCOP10	5.0	36.3	1.3	5.2
Mean	4.4	32.4	1.5	4.5
SEd	0.27	3.10	Statistically not analysed	
CD at 5%	0.55	6.23		

Madhopur

Experimental details ;

A. No. of Cross combinations - (01-10) (Progeny evaluation trial)

Plant Population - 6 palms/plot

Spacing - 9m x 9m

Design - R.B.D.

Date of Planting :- 4th May 2011

Treatment Details :- 100 % of the recommended dose of the fertilizer through drip irrigation. In winter season, nursery plants were affected by cold and resulted in restricted growth. As the temperature increased, growth was gradually recovered.

B. Ten cross combinations (NRCOP 31-NRCOP-40) progency evaluation trial plants in primary nursery were transferred to secondary nursery in the month of March, 2011.

Gen. 8 D : Progeny evaluation trials in oil palm

(Mulde, Pasighat, Aduthurai)

Mulde

Objectives: Multilocation progeny trials on the performance of new oil palm hybrids

Experimental Details :

Replications	:	Three
Spacing	:	9 m x 9 m x 9 m
Treatments	:	10 Hybrid Combinations (NRCOP- 31 to NRCOP- 40)
Design	:	Randomized Block Design
Palms/Plot	:	9 palms/ plot
Area	:	2 ha
Material Procured	:	December,2009
Probable Date of planting	:	June, 2011

Total 500 sprouts of ten hybrid combinations (50 per each combination) were collected from DOPR, Pedavegi on 22/12/2009. These sprouts were transferred from primary nursery to bigger size polybag for further maintenance in the secondary nursery.

Pasighat

Experimental details

No. of hybrid combinations: 10

Replications: 3

Plot size: 6 palms/plot

Design: RBD

Land preparation for the field experiment was carried out during April-July 2010. Pits of (1mx1mx1m) size were dug and filled with top soil and well rotten FYM in 1:1 ratio. Bigger pits had to be dug than the recommended size (60cmx60cmx60cm) due to presence of stones and gravels in the soil. Planting with 9 palms per plot could not be done due to shortage of area, hence only 6 palms per plot could be accommodated. The seedlings were transplanted in August 2010.

Aduthurai

The sprouts of 10 hybrid combinations (NRCOP 31 to NRCOP 40) transported from DOPR, Pedavegi were planted in the secondary nursery and sufficient care was taken to protect the seedlings.

6.2 Crop production

Agr. 6A : Studies on fertigation in oil palm through micro irrigation (Gangavathi, Mulde, Vijayarai).

Gangavathi

Objectives:

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

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

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

No of palms/treatment: 6

No of replications : 3

Fertigation to be given : 6 splits

Fertilizer source : Urea, DAP & Muriate of potash

Treatment details:

Sl.No	Treatments
T1	300:150:300 g NPK through fertigation
T2	600:300:600 g NPK through fertigation
T3	900:450:900 g NPK through fertigation
T4	1200:600:1200 g NPK through fertigation
T5	1200:600:2700 g NPK through fertigation
T6	1200:600:1200 g NPK through soil application
T7	1200:600:2700 g NPKthrough soil application

Results:

FFB yield and yield parameters

Number of bunches per palm: The number of bunches per palm was significantly higher in the treatments T3 & T1 (3.4 & 3.1, respectively) over T2 & T5 treatments (Table 63).

Mean bunch weight: There was no significant difference in the mean bunch weight, however, it was higher in the treatments T1 & T6 (42.8 & 40.7, respectively.

FFB yield: Similarly, there was no significant difference in the FFB yield. Among different treatments, the higher FFB yield was noticed with T1 & T6 (6.12 & 5.82 t/ha, respectively).

Mulde

Fertilizer source: Urea for nitrogen, Diammonium phosphate for nitrogen and phosphorus and Muriate of potash for potassium. Fertigation is to be given in 6 splits.

Date of start of the experiment: July, 2008.

Water requirement was worked out by using the crop factor of 0.7.

Yield data during the year 2009-10 revealed that there was no significant difference among the various treatments for yield characters. However, treatment T5 recorded more number of FFB (5.6), maximum bunch weight (24.0 kg/bunch) and yield of FFB (19.3 t/ha) (Table 64).

Table 63. Effect of fertigation treatments on the FFB yield of oil palm (Gangavathi, 2010)

Treatments	Number of Bunches/palm	Mean bunch weight (kg)	FFB yield (t/ha)
T1 : 300:150:300 g NPK through fertigation	3.1	42.8	6.12
T2 :600:300:600 g NPK through fertigation	2.2	30.4	4.35
T3 :900:450:900 g NPK through fertigation	3.4	35.9	5.13
T4 : 1200:600:1200 g NPK through fertigation	2.4	29.8	4.26
T5 :1200:600:2700 g NPK through fertigation	2.3	28.0	4.00
T6 : 1200:600:1200 g NPK through soil application	2.7	40.7	5.82
T7 :1200:600:2700 g NPK through soil application	2.7	36.5	5.22
SEm	0.39	7.51	1.07
CD(0.05)	1.15	NS	NS
CV(%)	25.09	37.33	37.33

Table 64. Yield parameters of oil palm as influenced by fertigation (Mulde, 2010)

Treatments	Bunch weight (kg/bunch)	No. of FFB/ palm	Yield of FFB (kg/ palm)	Yield of FFB (t/ha)	Pre expt. mean yield (t/ha)
T_1 300:150:300g NPK fertigation	21.7	4.9	105.9	15.1	16.3
T_2 600:300:600g NPK fertigation	23.1	3.4	79.5	11.4	14.0
T_3 900:450:900g NPK fertigation	23.4	5.3	123.1	17.6	15.3
T_4 1200:600:1200g NPK fertigation	22.8	5.1	116.7	16.7	20.4
T_5 1200:600:1800g NPK fertigation	24.0	5.6	135.1	19.3	15.1
T_6 1200;600;2700g NPK through fertigation	21.0	5.4	112.8	16.1	16.9
T_7 1200:600:2700g Soil application	23.9	5.2	123.1	17.6	21.8
SE +	1.4	0.6	18.4	2.6	
CD at 5%	N.S.	N.S.	N.S.	N.S.	

Vijayarai

Fertigation treatments could not be initiated so far.

Aduthurai

The data on number of leaves alone attained statistical significance. Among the seven treatments 1200:600:2700 gm NPK/palm through soil application(T7) has recorded maximum number of leaves, while 1200:600:2700 gm NPK/palm through Fertigation(T5) has registered maximum stem girth. The stem girth varies from 2.05 to 2.37 with different treatments and number of leaves per palm ranged from 27 to 37 functional leaves per palm. Fertilizer application method and doses of fertilizer had marked effect on number of bunches harvested and FFB yield. Significantly higher number of leaves and FFB harvest was obtained in T5 with 1200 : 600 : 2700 g NPK /palm/year through fertigation. 1200:600:2700 gm NPK/palm through Fertigation(T5) has attained more stem girth and produced more number of leaves / palm. The FFB harvested was also more with this treatment.

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

Pasighat

Treatments

T_1: Irrigation management through drip system

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

T_3: T_1+ 100% NPK as chemical fertilizers

T_4: T_1+ 100% NPK as organic manure

T_5: Rain fed + 100% NPK as organic manure

Replications: 4

Nos. of palms per plot: 6

One hundred and fifty, 'Tenera' plants planted in the month of August, 2008 at the college farm are being used as experimental material for conducting this trial.

i. **Post- treatment soil and leaf analysis**: Post-treatment soil and leaf samples were collected in February 2011 and are being analysed.

ii. **Imposition of treatment:** The recommended dose of nutrients (1200:600:1200 g per plant per year) was applied as per the treatment details in the summer, pre-monsoon and post monsoon in the year 2010. Chemical fertlizers were applied in three split doses in T2 and T3 treatments in summer, pre- monsoon and post monsoon months. The organic manure treatment in T2, T4 and T5 treatments were applied in two split doses.

iii. **Recording of morphological parameters**: Morphological parameters such as plant height, girth and number of leaves was recorded in March 2011. The results of the morphological parameters are presented in Table 65. Plant height (2.7 m) and collar girth (117.2 cm) recorded was maximum in T3, whereas number of leaves per plant (22.1) was highest in T1.

The plants in T4 showed maximum increase in growth with respect to plant height (158.03 %) and collar girth (355.32 %) over a period of one year. Increase in plant height (110.99 %) and collar girth (248.85 %) was least in T2 and T3, respectively.

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

Pasighat

Oil palm seedlings planted in the year 2006 is being taken up as the material for "maximization plot" and all the recommended crop management practices are being adopted to harvest maximum yield. The average plant height, coller girth and number of leaves per plant recorded in month of March 2011was 3.62 m, 1.75 m and 24.17 leaves per palm, respectively. Since April, 2010 to March, 2011, flowering in all the palms have been observed. The average number of male and female flowers per palm is 4.90 and 7.48, respectively. The sex ratio (Female:Male) per palm is 1:1.5. The weight of the first fruit bunch harvested in March 2011 was 6.5 kg.

Table 65. Growth parameters of oil palm plants in INM Trial (Pasighat, 2010)

Treatment	Plant height (m)	No. of leaves/ plant	Collar girth (cm)
T_1	2.6	22.1	109.9
T_2	2.3	20.1	96.8
T_3	2.7	21.7	117.2
T_4	2.6	20.7	107.0
T_5	2.5	22.0	107.4
Mean	2.5	21.3	107.7
Sem±	0.12	0.75	5.83
CD at 5%	0.37	2.31	17.96
CV (%)	9.41	7.02	10.82

• • •

VII. Experimental Results in Palmyrah

7.1 Genetic Resources

Gen. 9. Survey and collection of palmyrah germplasm and evaluation (Killikulam, Pandirimamidi)

Killikulam

A joint survey programme for germplasm collection of palmyrah at Bahalpur and Banka districts of Bihar was made in co ordination with Dr. J.B.Tomar, NBPGR,Ranchi, Er. P C Vengaiah, HRS Pandirimamidi, Dr.Ruby rani and Dr. Aftab, AICRP palms, Sabour from 2.9.2010 to 6.9.2010. A total of 13 accessions were assembled and the details of germplasm were collected. The accessions were sown on 25.9.2010 in 13 lines @ 15 seeds per line and the trial is in progress.

Germplasm evaluation

A minimum of four plants in each accession is being maintained and the germplasm so far assembled (210 nos.) were scored for biometrical characters viz; plant height (cm), number of leaves, leaf length and stalk length during the period under report and the data recorded on the various biometrical characters.

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

Compact planting of promising germplasm

Two types viz; BF-34 and BF 23 are found to be the superior genotypes with respect to nungu and neera yield, based on the data recorded continuously for ten years. Out of these, BF 34 is female and BF 23 is male. Seeds were collected from BF 34 and compact planting of BF-34 which is a promising genotype for both nungu and neera production was done on 30.12.2010, as per the suggestion given in Annual Researchers Meet on Palms (2010). A total of 50 seedlings have been planted in New area of Orchard as a compact block.

Palmyrah collection from Bihar

Pandirimamidi

Of the 13 accessions planted during 1991, mean plant height was maximum in accession 4/91 (7.53 m) followed by Acc 6/91 (7.51m). Maximum Stem girth of 1.96 m. was recorded in Accession- 4/91 followed by accession 13/91 (1.81m). Higher leaf parameters have been recorded with accession 08/91.

Among the 1993 accessions, maximum palm growth and stem girths were recorded with accession 17/93. Accession 17/93 was superior with regards to leaf parameters.

Of the 14 accessions of 1994 collection, maximum plant height was recorded in accession 37/94 and all leaf parameters studied were also found highest. Stem girth and number of leaves however were more in accession 36/94.

Among the 13 accessions of 1995, accession 49/95 has recorded higher value for palm height and leaf number, accession 43/95 highest in stem girth, and accession 48/95 highest in other leaf parameters.

Maximum palm height in 1998 accessions has been recorded with accession 55/98.
Maximum Stem girth has been observed in 57/98, Maximum leaf numbers in 51/98.

Among the 8 accessions of 1999, palm height was highest in accession 60/99 and

62/99. Number of leaves produced were highest with accession 60/99 followed by 64/99.

Among the 18 accessions of 2000, height of the accession was highest with accession 77/00. Number of leaves produced were higher in accession 84/00.

Of the 45 accessions of 2001 collection, plant heights and number of leaves produced and other leaf parameters evaluated were higher in accession 98/01.

Among the 18 accessions collected from Nalgonda district, plant height was highest in accession140/02. Number of leaves produced /palm varied from 7.5 to 10.4 Relatively accession 133/02 has given higher leaf parameter values over the other accessions.

Of the 16 accessions collected from Tamil Nadu palm heights ranged from 0.29 m to 0.80 m. number of leaves produced were higher in accession 157/02.

Among 13 accessions collected locally in 2003, accession 169/03 has shown higher leaf parameter values. Growth rates were highest in accession 164/03 and lowest in accession 172/03 which was a monocious palm.

Number of leaves produced is highest in accession 178/04 among the 2004 accessions. Palm height highest in accession 177/04. All accessions did not show clear differences for leaf parameters.

Growth data has been collected for accessions collected during 2006 and 2007 which are in early juvenile stage.

Gen. 16: Growth and development studies in Palmyrah

Killikulam

The data on plant height so far recorded in all the germplasm lines right from 2005-2010 were utilized for working out the rate of growth of plants and the pooled evaluation of rate of growth of germplasm over a period of five years was arrived and the data analyzed are furnished in Table.66

The results showed that the growth rate of trees ranged from 1.99 cm / year (Acc.208) to 51.33 cm / year (Acc.191) over a period of five years (from 2005-2010).Amoung the years, the rate of growth recorded during 2008, had maximum growth rate (Table 67).

Table 66. Month wise neera yields in male palms (Killikulam, 2010)

Defoliation%	Jan.	Feb.	Mar.	April	Total
30	29.2	51.9	88.9	14.0	184.1
50	0.0	117.2	134.1	0.0	251.4
70	3.8	130.7	105.8	0.0	240.3
90	0.0	20.4	38.5	3.8	62.7
Control	0.0	138.2	235.4	1.9	375.5
	33.0	458.4	602.9	32.6	1126.9

Table 67. Mean rate of growth (cm/year) from 2005-2010 (Killikulam, 2010)

Year of planting	Max. rate of growth		Min. rate of growth	
	Acc.No	Rate of growth (cm / year)	Acc.No	Rate of growth (cm / year)
1995	Acc. 02	25.9	Acc.22	3.9
1997	Acc.41	26.6	Acc.48	3.9
1999	Acc.73	16.5	Acc.83	3.0
2001	Acc.100	35.9	Acc.96	8.2
2001 a	Acc.102	34.9	Acc.108	5.9
2002	Acc.124	22.4	Acc.122	9.6
2002 a	Acc.136	37.9	Acc.137	10.0
2003	Acc. 149	14.8	Acc.153	12.9
2004	Acc.170	42.1	Acc.166	4.4
2005	Acc.174	23.0	Acc.182	4.6
2006	Acc.191	51.3	Acc.187	6.0
2007	Acc.204	17.2	Acc.208	1.9
2008	Acc.213	53.4*	Acc.209	2.9

*one year data only

Studies on age of transplantation of palmyrah seedlings

As per the suggestion of Dean (Hort) ,TNAU, Coimbatore, palmyrah seeds were sown under masonry nursery to study the effect of transplantation of young seedlings. Palmyrah seedlings of age groups viz;25,50,75,100,125 and 150 days, which were sown in masonry nursery,have been transplanted in separate lines of 15 pits each to study the root development that could withstand transplanting of seedlings. A total of 6 lines (for 6 age groups), each with 15 pits have been raised for studying the appropriate stage of transplanting of seedlings. The pits are regularly pot watered and the percent establishment of seedlings in various age of transplanting is being assessed.

Correlation between leaf orientation and sex of palm

Observation on leaf orientation of palmyrah trees in relation to (known) sex of the trees available in the college farm was done as per the suggestion of Project coordinator palms:

From the information collected with 24 nos of trees (10 male and 14 female), it is arrived that the trees with clockwise leaf orientation are found to be male, while the trees with anti clockwise orientation are found to be female. Further, the data on orientation of leaves in known male and female trees, selected out side the farm area was done. The sequence of leaf orientation in relation to sex of palms could not be confirmed, since, the information collected showed no concrete and clear-cut correlation between leaf orientation and sex of the palm. In some cases, male sex forms were seen in anti clockwise and female in clockwise leaf orientation.

Table 68. Abstract of rate of growth (cm/year)

Year of planting	Mean rate of growth (cm/ year)
1995	15.9
1997	11.1
1999	7.1
2001	25.3
2001 a	16.5
2002	15.6
2002 a	24.4
2003	13.9
2004	23.9
2005	13.8
2006	15.8
2007	5.3
2008	23.1
Over all mean	16.29 cm / year

Study on determining age of matured palm

Scars on the trunk in one foot length was counted and after measuring the height in feet, the total number of scars were arrived to estimate the age of the palm based on the scars. Preliminary study on calculating the age of the palm based on scars on the trunk showed that half of the total number of scars counted on the entire length of the tree can be taken as the age of the tree in years.

Pandirimamidi

The project was initiated in the month of October 2007, data on various growth characters was recorded during 2010 and presented below:

1. Early juvenile stage - 4 years age [2006 Block]

Growth rates have been recorded at fortnight intervals in 10 plants of 2006 block. In the early juvenile stage, rate of petiole growth is very slow ranged from 0.42 mm to 1.65 mm among the different leaves in the same plant. Growth rate is slower in the oldest leaf and comparatively faster in youngest leaf. Lamina growth also has exhibited the same pattern and it slower [0.81 cm] in older leaves and faster [4.84 cm] in younger leaves. Time taken for successive leaf emergence varied from 60 to 71 days among the different plants (Table 69).

2. Juvenile phase: 7 years age [2003 Block]

In the juvenile plants of 2003 block, growth parameters have been recorded at fortnightly intervals in 10 plants. Rate of petiole growth ranged from 3.31 cm [oldest leaf] to 12.37 cm in the younger leaves. Rate of lamina growth also ranged from 0.6 cm to12.9 cm among the leaves of different ages. Time taken for successive leaf emergence ranged from 28.5 days to 30.5 days (Table 70).

Table 69. Growth characters of 4 year old palmyrah (Pandirimamidi, 2010)

Leaf Number	Rate of petiole growth [mm]	Rate of lamina growth [cm]	Rate of leaf production	Duration of leaf retention (days)
1	0.9	0.8		
2	1.6	3.4	60 -71	100-115
3	1.5	4.8	days	days
4	0.4	3.4		

Table 70. Growth characters of 7 year old palmyrah (Pandirimamidi, 2010)

Leaf number	Rate of petiole growth [cm]	Rate of lamina length [cm]	Rate of leaf emergence [Days]
1	3.3	0.7	P1 29.50
2	5.1	0.6	P2 30.00
3	6.2	1.6	P3 29.00
4	7.1	3.9	P4 30.40
5	6.6	5.5	P5 28.50
6	7.2	8.3	P6 29.90
7	9.9	10.4	P7 29.70
8	12.4	12.9	P8 29.30
9	11.2	11.4	P9 30.50
10	9.5	10.2	P10 29.00

3. Adult phase: 1991 germplasm

In the adult palms of 1991 block, petiole growth rate in male palms varied from 4.88 to 10.43 cm whereas in female it varied from 4.83 cm to 10.18 cm. Time taken for opening of successive leaf varied from 25.5 days to 28 days in female and 26 to 28 days male palms. Length of the un opened crown leaf at which emergence of petiole takes place ranged from 0.81 to 1.01 among different plants. Inflorescence growth rates varied from 6.45 cm to 10.55 cm among the plants (Table 71).

4. Inflorescense growth rates

Male palms started giving out the inflorescences early in the months of November and December compared to female palms emergence of inflorescences as taken place in the month of January. Mean length of inflorescences was 1.21 in male palms and 0.69 in female palms. Growth rate of inflorescence varies 5.18 to 10.9 in male and 8.33 to 11.77 in female palms.

Table 71. Growth characters of adult phase palmyrah (Pandirimamidi, 2010)

Leaf Number	Rate of petiole growth [cm]		Rate of leaf opening [days]		Length of crown leaf at petiole formation [m]	
	Male	Female	Male	Female	Male	Female
1	10.2	7.4	27.0	27.2	1.0	1.0
2	10.4	10.2	27.0	25.5	1.0	0.9
3	8.9	9.3	26.5	28.5	1.0	0.9
4	8.9	9.4	27.5	25.0	0.9	0.9
5	9.8	9.3	26.0	25.2	0.9	0.9
6	7.5	6.0	26.7	25.5	0.9	0.9
7	4.9	4.8	27.2	28.2	1.0	1.0
8	4.9	4.8	28.0	27.0	0.9	1.0
9	4.7	4.2	27.2	26.0	0.9	1.0

7.2 Crop Production

Agr. 9. Studies on influence of levels of defoliation on neera and nungu yield in Palmyrah (*Borassus flabellifer* L.)

(Killikulam, Pandirimamidi)

Killikulam

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

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

The trial is being continued for the fourth year and during the reporting period, recording the yield of neera in both male and female trees were done right from March-April to August -September and the total neera obtained in individual treatments are given below:

From the data recorded, it is inferred that the trees defoliated to 30% level had the maximum neera yield in both male and female, followed by 70% level in male and 50% in female trees. Control recorded the least neera yield in both male and female trees. Similar trend has been recorded in the previous years also. The treatment differences were also found to be highly significant (Table 72).

During the period under report, observations on no.of leaves, leaf & stalk length, % increase of leaves over initial, in the defoliated palms, after completion of the season, were recorded and the data are presented below separately for female and male trees (Table 73).

Table 72 . Influence of defoliation treatments on yield of neera in male and female trees (Killikulam, 2010)

Treatments	Mean Neera yield (l / tree)	
	Male	Female
90 % defoliation	35.8	7.0
70 % defoliation	50.3	28.0
50 % defoliation	41.2	35.4
30 % defoliation	72.1	50.8
Control	36.4	12.6
S.E	4.46	2.87
CD@5%	9.660**	6.265**

The above data revealed that control had least values for leaf length and stalk length,while,90 % defoliation treatment recorded the highest percent increase of leaves over initial in both male and female palms.

Physiological parameters

Observations on physiological parameters viz; 'total chlorophyll content' and 'relative water content (per cent)' were worked out for male and female trees separately and the results are furnished below:

The results showed that there was no definite influence of defoliation treatments on chlorophyll content and relative water content of the samples. The drought tolerance mechanism of the trees is no way affected by defoliation and hence the defoliated trees may not suffer during periods of drought.

Table 73. Biometrical observation on leaf and stalk characters of female trees (Killikulam, 2010)

Treatment	Leaf length (cm)	Stalk length (cm)	No. of leaves at end of season / year	No. of leaves at imposing treatment	% increase of leaves over initial
90 % defoliation	107.5	126.5	19.0	4.0	375.0
70 % defoliation	114.3	140.8	22.3	11.2	98.2
50 % defoliation	112.0	137.5	28.8	21.0	37.2
30 % defoliation	107.3	128.5	36.3	31.2	16.2
Control	105.8	125.5	51.8	42.7	21.2
S.E	7.0	10.71	4.35	4.10	15.74
CD@5%	15.26	23.34	9.48**	8.94**	34.30**
	NS	NS			

Pandirimamidi

The trial was initiated during the month of October in the year 2007 with male and female palms available in the farm. Existing HRS campus palms have been divided in to five blocks and are labeled. Each block contained 5 palms and 5 palms were used per each treatment with in the block. Defoliation was carried out in the month of October in all the blocks as per the treatments. Emergence of inflorescences began in the month of January and tapping was resorted to and continued up to the end of April 2010.

defoliation(251.3). Relative water content of leaves did not vary among the treatments. When yields of neera was verified month wise, highest neera yields have been recorded in March followed by February month (Table 74).

Mean no of bunch/palms was highest in 30% followed by 70% defoliation (Table 76). Least no of bunch/palm was recorded in 90% defoliation. Mean no of fruits per bunch was highest in 70% followed by 50, 30 and control.

Table 74. Total chlorophyll content (mg/g) and relative water content (%) (Killikulam, 2010)

Treatment	Total chlorophyll content (mg/ g)		Relative water content (%)	
	Male	Female	Male	Female
90% Defoliation	0.81	0.79	85.00	87.60
70% Defoliation	0.69	0.74	86.20	88.80
50% Defoliation	0.91	0.88	89.00	86.40
30% Defoliation	0.80	0.79	87.00	87.50
Control	0.89	0.80	89.50	88.30
S.E	0.0869	0.0369	4.2443	4.3029
CD@5%	0.1894 NS	0.0804*	9.248 NS	9.375 NS

Days taken for initiation of flowering ranged from 29.2 to 57.7 days among the treatments. (Table 75). The highest neera yields have been recorded with control (375.5) followed by 50%

Average weight of bunch highest in control followed by 70%. Average weight of fruit was highest in control followed by 70%. Mean nungu yield was highest in 70% followed by 30% (Table 76)

Table 75. Effect of different levels of defoliation on the neera yields in palmyrah (Killikulam, 2010)

Treatment	Days for initiation of flowering after defoliation	No.of days tapped [Duration]	Mean No. of inflorescences Tapped	Total Neera yields [lit]	Relative water content (%)	Length of matured leaf stalk [m]
MALE PALMS						
30% Defoliation	32.0	32.0	6.5	184.1	83.95	1.0
50% Defoliation	29.2	29.3	8.8	251.4	80.02	1.1
70% Defoliation	55.7	55.8	5.8	240.3	82.95	1.2
90% Defoliation	57.7	57.8	4.8	62.7	83.43	1.3
Control	50.5	50.5	6.5	375.5	84.21	1.1
SEM	10.54	8.94		20.52	2.10	0.094
CD @ 0.05 %	0.00	0.00		0.00	0.00	0.00
CV	46.81	50.67		73.701	5.10	16.54
	NS	NS		NS	NS	NS

Table 76. Nungu yields in female palms (Killikulam, 2010)

TREATMENT	Mean No. of bunches per plant	Mean No. of fruits per bunch	Average weight of bunch (kg)	Average weight of fruits in bunch (kg)	Mean yield of Nungu/bunch (kg)
30% defoliation	10.5	13.2	7.9	8.7	1.8
50% defoliation	7.5	13.2	9.4	9.1	1.2
70% defoliation	9.7	15.2	9.9	9.9	2.1
90% defoliation	6.2	10.3	7.0	5.3	1.2
No defoliation	9.2	13.2	12.2	10.7	1.9

7.3 Post Harvest Technology

Pht.1: Standardization and commercialization of inflorescence sap extraction and inflorescence sap based products (Jaggery, Palm Sugar And Candy)

Pandirimamidi

1. Standardization of tapping techniques of inflorescence sap

Yield of neera from the palms mainly depends on skill of the Tapper and the neera flow from the cut end of spathe. The tapper binds the spathes tightly with strips of plamyrah stalk to prevent them from further expansion and descends after having thoroughly bruised the embryo flowers within to facilitate the exit of the juice. For several morning, this operation of crushing repeated and each time a slice is taken off the end of spathe to facilitate the flow of the sap. In about a week the sap begins to flow easily. When this occur, an earthen pot is inserted at the tip end of the spathe and this pot is tied to the spathe to collect the juice that flows from the spathe. Every morning and evening these pots are emptied and for a period of six months sap has to be collected.

Experiments were conducted for increasing the flow of neera by different type of cut for spathe i.e control, cross, V channel and central hole in various spathe of same palm. Replications were conducted for 6 palms with RBD. Slicing of spathe was initiated as control on first day and second day onwards treatments were given. Results shows that V type cut yields more as compared to others and there is significant difference among the. Mostly these are depend on tapper and hence it is to be standardized after so many experiments and replications.

Experiments were conducted to increase neera yield by applying chemicals to the cut portion of spathe. The chemical i.e Ethereal, EDTA, CaOH, BHT and Citric acid was applied for spathe of palm and replicated for 5 palms with RBD design. Tapping initiated with traditional practice and second day of flow of Neera, chemical was applied to the sliced portion of the spathe. The results showed that the ethereal applied spathe gives more yield (almost double) followed by citric acid. Also there observed that there is significant difference among the treatments. More number of experiments with various applying anti oxidants are to be carried out for improving the yield.

Experiments were conducted for studying the effect of time interval between slicing of spathe and yield. It was observed that yield of neera can be improved by slicing of the spathe more number of times and it is also observed that optimum time between successive cutting of spathe is three hours, it affects duration of yielding also. It observed that, time gap between two cuts not more than 24 hours, if so the spathe will not yield neera as it dries completely. Experiment is going on for modeling of neera flow with time and temperature.

Experiments were also tried for collecting devices i.e plastic covers, plastic bowl, tubes bamboo and pots. It was observed that by covering entire spathe with plastic cover the spathe was compressed and became brownish and flow was stopped, so it seems that air should pass to the cut portion for flow of neera. Experiments are going on for further standardization.–

2. Improving the shelf life of inflorescence sap

Experiments were conducted to improve the shelf life of the inflorosence sap (neera) by treating with heat for various temperatures and time with 4 replications as follows ;

T1 = Control at 0^{O}C for 10 minutes

T2 = Heating at 70^{O}C for 10 minutes

T3 = Heating at 80^{O}C for 10 minutes

T4 = Heating at 90^{O}C for 10 minutes

T5 = Heating at 100^{O}C for 10 minutes

Results indicated that the physical appearance of neera stored in glass bottles was good in all treatments up to 24 hours, maintaining its original flavour, colour and turbidity except control. The control showed cloudy colour and off flavour. It may due to microbial infestation and it was spoiled. Physico-chemical parameters showed that the total soluble solid of fresh Neera was 12%, after 10 hours, it came down 4.0% in T1. TSS changed in other treatments was very negligible up to 24 hours at room temperature and the initial acidity of neera was

0.19% and was slightly decreased during storage period in all treatments but the change was higher in control because no heat treatment and no preservative was added. The pH of fresh neera was 5.10, but after one day of storage the change was very negligible in all treatments. T4 and T5 was good up to 2 days of storage. The process may be standardized with more treatments along with preservatives.

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

3. Standardization of diversified inflorescence sap products i.e., palm jaggary, palm sugar etc.

Trials were conducted for preparation of jaggery and standardization of process is in progress. Design of crystallizer and centrifuge was done and fabrication is in progress.

Pht.2: Standardization of tuber flour based food products (Like Pizza, Bakery Items, Confectionery, Health Mix Etc.)

Pandirimamidi

Experiments were conducted for identifying the maturity stage of tubers for higher nutritive values. Total 8 samples of 8 weeks age to 15 weeks after planting were analyzed and results showed that, 12 weeks and 13 weeks samples having higher nutritive value than other samples. But lot of variations among the samples may be due to genetic variability. So there is a need to study from single palm for different age of tubers.

Experiments were conducted for preparation of flour and suji from palmyrah tuber by various methods i.e autoclave cooked and dried, open fired, fired in iron tin and directly dried. Results showed that autoclave cooked followed by dried in tray drier gives good quality of flour as compared to other methods. Process of standardization is in progress.

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

Pandirimamidi

Physical properities of tender fruit was measured and average weight of tender fruit of after flower initiation up to 75 days, varies from 0.62 kg to 1.25 kg, diameter of the tender fruit varies from 33cm to 45 cm, height of the tender fruit various from 13 cm to 15 cm and average weight of nungu is 75 g to 80 g and about 25 % in tender fruit and tender fruits mostly 3 seeded with equal distribution and rarely two seeded and single seeded. Design of tools for nungu extraction is in progress.

Experiments were conducted for preparation of jam, jelly, squash and health drink from Plamyrah nungu and process of standardization is in progress.

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

Killikulam

Documentation on "Value addition and processing of edible and non edible Palmyrah products and their commercial exploitation" was completed. Purchase of Palmyrah fibre extractor machine from Krishi Vigyan Kendra, CTRI, Rajanagaram Mandal, Andra Pradesh has been completed.

Standardization and commercialization of inflorescence sap extraction and inflorescence sap based products

Killikulam

Following four processing equipments were purchased.

1. Vacuum Packaging and Gas Flushing with Compressor
2. Form fill sealing machine
3. Steam jacketed kettle with compressor
4. Hand operated crown corking machine

Standardization of preservation techniques for palmyrah tender fruit endosperm

Killikulam

Purchase of canning equipments was completed. The work to renovate the existing horticultural lab is initiated.

Oil extraction from fruits

Killikulam

Efforts were taken to explore the possibility of extraction of oil from seed kernels (endosperm) as well as mesocarp of the matured fruits, as suggested by the Project coordinator, AICRP-Palms, Kasaragod. As a preliminary step, the dried seed kernels and mesocarp of the palmyrah fruits were used for the oil extraction at the locally available coconut oil milling unit and it was noticed that no oil recovery could be done by employing the conventional oil extraction practices, as done for coconut oil extraction.

Hence, Indian Institute of Crop Processing Technology, Thanjavur was approached for the oil extraction and as such three samples viz., sample-1 (completely dried endosperm),sample-2 (dried mesocarp) and sample-3 (ground powder of dried endosperm) were sent for the analysis. The results on the samples sent were provided by the Director, Indian Institute of Crop Processing Technology, Thanjavur are presented below:

Name of sample	Fat (%)
Completely dried endosperm	0.18
Dried mesocarp	0.20
Ground powder of dried endosperm	0.10

It was observed that the fat content was very low and not significant in any of the samples.

• • •

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

8.1 Genetic Resources and Crop Production

Jagadalpur

Sulphi palms are the most beneficial to people and has unique place in livelihood of tribal farmers is considered to be an indigenous to India, Ceylon and Malaya and is found large number in forest regions of western and eastern coasts and in the cool and shady valleys of Chhota Nagpur, Orissa, North Bengal and Assam. Sulphi (*Caryota urens L.*) belongs to the family Palmaceae. At village level, it is of economic importance, especially for communities living along forest fringes, providing a significant source of income to the people.

The sugar sap from inflorescence which yields jaggery is converted to toddy, a weak alcoholic beverages on fermentation. Sap locally known as "Bastar beer" is refreshing and energy drink of tribal people.

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

Objectives

1. To collect, conserve and evaluate the sulphi germplasm
2. To document the variability in sulphi palms
3. To establish and assemble the diversity among sulphi population
4. To identify the contributing traits for diversity in sulphi population

Survey for identification of germplasm (Table 77)was conducted in Darbha, Bastanar, Sukma, Tokapal, and Bakawand blocks and few palms were marked for further observations and simultaneously seeds of selected palms were collected for germination study. Survey work will continue in coming year for identification of germplasm.

Table 77. Accession data for Sulphi germplasm (Jagadalpur, 2010)

S. No.	Name of Farmer	Village	Plant type	Plant height (m)	Number of leaves	Girth (cm)	Length of petiole (m)	Total leaf length (m)	Quantity of sap/day/ tree (l)
1	Bhadru	Kilepal	Tall	12.0	19	155	1.6	4.1	20-22
2	Bomda	Bastanar	Tall	11.6	18	148	1.4	3.9	20-24
3	Jogen	Jamgaon	Semi Dwarf	7.5	15	110	1.1	3.1	18-20
4	Jagru	Kodenar	Dwarf	7.4	16	105	1.1	3.2	14-16
5	Budhra	Chindgarh	Dwarf	7.2	20	120	1.2	3.5	15-17
6	Bandi	Chindgarh	Semi Dwarf	7.6	20	125	1.5	3.1	15-18
7	Praveen Salam	Badedongar	Tall	10.5	19	153	1.5	4.1	25-28
8	Tulsi Ram Netam	Tongpal	Semi Dwarf	7.5	19	143	1.1	3.9	20-22

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

Objective :

1. To study the botany of sulphi palm.
2. To study the floral biology in sulphi palm.
3. To study the germination and growth of seedlings.
4. To study the growth and leaf production in juvenile palms.
5. To study the growth, leaf and inflorescence production in adult palms.
6. To study the rate of sap production over seasons.
7. To study the nutritional and medicinal qualities of sap over seasons.

Seed Morphology:

Fruit (Seed with Pulp) -	5.2 g
Seed:	2.8 g
Peel:	1.0 g
Pulp:	1.4 g
Girth of seed:	7.0 cm
Diameter of seed:	5.5 cm

Sulphi seeds (Jagadalpur, 2010)

Seed Treatment

Seeds were collected from different block of Bastar for germination test. Collected seeds were treated with Cow dung slurry for seven days, Hot water treatment and Acid treatments. The seeds were germinated earlier in cow dung slurry, acid treatment and hot water treatments within 75-90 days as compared to control (no treatment).

Growth observation of juvenile and five year old sulphi palms are presented in Tables 78 and 79.

Table 78 . Observation on six months and one year of old sulphi palm (Jagadalpur, 2010)

S.No	Six month old plant			One year old plant		
	Length (cm)	Thickness (cm)	No. of leaves	Length (cm)	Thickness (cm)	No. of leaves
1	8.0	1.0	2	14.0	3.8	6
2	8.0	1.2	2	15.0	3.8	5
3	9.0	1.5	3	17.0	4.0	7
4	8.5	1.0	3	15.5	3.9	5
5	8.0	0.95	2	15.0	3.6	5

Table 79. Observation on five year old sulphi palms (Jagadalpur, 2010)

S. No.	Plant height (m)	Girth (m)	No. of leaves	Petiole length (m)	Leaf length (m)	No. of rings
1	3.60	1.25	6	1.40	3.50	5
2	3.40	1.40	6	1.30	3.40	4
3	3.20	1.30	6	1.30	3.10	3
4	2.0	1.05	6	1.05	1.50	2
5	1.5	0.85	5	0.90	1.20	2

Gen. 19: Documentation of ethno-botanical information on Sulphi palm (*Caryota urens*) in Bastar region of Chhattisgarh

Objectives

1. Area and distribution of sulphi palm.
2. Socio economic factors associated with sulphi palm owners.
3. Values and beliefs related to sulphi palm.
4. Present system of planting materials production, planting and maintenance of sulphi palm.
5. Uses of wood and methods used for its utilization- current status and potentials.
6. Uses of leaves and extraction of fibre- current status and potentials.
7. Extraction of starch from the stem- current status and potentials.
8. Methods of sap extraction and sap utilization.
9. Implements used for sap extraction and its utilization.
10. Fermentation and other methods used for processing sap for toddy and sugar.
11. Indigenous knowledge on production aspects of the palm

Distribution

Jagdalpur- Jagdalpur, Bastar, Kondagaon, Parasgaon, Keskal, Bakawand, Londiguda, Darbha, Bastanar

Dantewada- Chindgarh, Sukma, Katekalyan, Dantewada, Konta, Geedam

Bijapur (Minimum)- Bhairamgarh, Ussuar, Bhopalpatnam, Bijapur

Narayanpur- Narayanpur, Chotedonger, Orcha

Uses: The apical region of the stem of young plant is used as a food source. The mature wood is strong, heavy and durable. Caryota stem yields an inferior timber sometimes used for construction purposes such as planking, rafters, roofing, partitioning and fencing. The stem, cut lengthways in 2 with its centre scooped out, is used for gutters and drains, or to convey water over long distances. As the only palm having bipinnate leaves with fishtail-like leaflets, both young and semi-adult plants are increasingly used as indoor as well as outdoor plants in households. The leaves are also used to enhance floral decorations. Nutritious sap is offered in meetings, all social and ritual functions. People of Bastar used as soft drink before sunrise it act as medicine while it kept for some times it is fermented and locally called as Bastar Beer. Sap is used as medicinal for stonic person.

• • •

IX. Centre wise budget during 2010-11 (ICAR Share)

(Rs. in lakhs)

Sl. No.	Centre	Pay	T.A	R.C	Works	Equip.	Furnit.	Total
1.	Aliyarnagar	28.88	0.80	4.00	0.00	3.46	0.20	37.34
2.	Ambajipeta	31.20	1.00	6.13	0.75	4.40	0.25	43.73
3.	Arsikere	8.42	0.40	2.26	0.62	2.53	0.10	14.33
4	Jagadalpur	3.20	0.59	4.83	1.07	0.05	0.10	9.84
5	Kahikuchi	11.82	0.40	2.00	0.00	0.00	0.00	14.22
6	Bhubaneshwar	6.27	0.20	1.00	1.78	0.00	0.10	9.35
7	Mondouri	13.12	0.60	5.00	0.25	0.81	0.10	19.88
8	Ratnagiri	23.85	0.60	3.00	0.00	2.02	0.15	29.62
9	Veppankulam	34.84	0.84	4.50	0.81	2.69	0.15	43.83
10	Navsari	5.90	0.20	2.68	0.00	0.00	0.00	8.78
11	Sabour	4.20	0.37	2.45	0.00	0.00	0.00	7.02
12	Killikulam	11.52	0.40	2.75	0.00	0.00	0.00	14.67
13	Pandirimamidi	3.77	0.40	3.65	1.51	2.38	0.10	11.81
14	Aduthurai	12.93	0.20	1.00	2.40	0.58	0.05	17.16
15	Gangavathi	8.86	0.20	1.18	1.00	0.87	0.05	12.16
16	Mulde	11.39	0.20	1.00	0.00	0.00	0.00	12.59
17	Vijayarai	2.55	0.20	1.00	1.00	0.40	0.05	5.20
18	Pasighat	0.00	0.40	12.00	0.50	0.30	0.15	13.35
19	Madhopur	0.00	0.40	17.00	0.50	0.30	0.15	18.35
20	Pilicode	0.00	0.08	1.69	0.00	0.00	0.00	1.77
	Total	**222.72**	**8.48**	**79.12**	**12.19**	**20.79**	**1.70**	**345.00**

X. Staff Position

HEAD QUARTERS

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

(Phone & Fax: 04994-232733; E-mail: aicrppalms@yahoo.com)

Project Coordinator	:	Dr. S. Arulraj
Scientist	:	Dr. C. Jayabose (Upto Jan., 2011)
		Dr. H.P. Maheswarappa (From Feb., 2011)
Personal Assistant	:	Mrs. K. Narayani
UDC	:	Mr. P. Narayana Naik

Coordinator Centres

ANDHRA PRADESH

Horticultural Research Station, Ambajipeta -533 214, East Godavari Dist. (Phone: 08856-243847)

Principal Scientist (Horticulture)	:	Dr. B. Gautam
Scientist (Horticulture)	:	Dr. A.V.D. Dorajee Rao
Senior Scientist (Entomology)	:	Dr. N.B.V. Chalapathi Rao
Senior Scientist (Pathology)	:	Vacant
Scientist (Pathology)	:	Dr. A. Snehalatha Rani
Technical Assistant	:	Sri. Ch. Mallikharjuna Rao
AEO	:	1. Sri. S. Rambabu
		2. Smt. N. Maheswari

Horticultural Research Station, Vijayarai - 534 475, West Godavari Dist. (Phone: 08812-225826)

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

Horticultural Research Station, Pandirimamidi, Ramapachodavaram P.O. 533 288, East Godavari Dist. (Phone: 08864-243577)

Assoc. Professor (Horticulture)	:	Vacant
Scientist (Food Sci. &Tech.)	:	P.C. Vengaiah
Technical Assistant	:	A.S.R.Anjaneyulu

ARUNACHAL PRADESH

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

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

Assistant Professor (Horticulture)	:	Dr. Barun Singh
Technical Assistant	:	Mrs. Sushma Sharma

ASSAM

Horticultural Research Station, Kahikuchi, Guwahati -781 017, Kamrup Dist. (Phone: 0361-2842513)

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

BIHAR

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

Scientist (Hort)	:	Mr. Parma Nand Mandal

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

Asst. Professor (Horticulture)	:	Dr. Ruby Rani

GUJARAT

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

Asst. Professor (Horticulture)	:	Dr. M.M.Patel

KARNATAKA

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

Agronomist	:	Dr. T.B. Basavaraju
Asst. Professor (Plant Pathology)	:	Vacant
Senior Technical Assistant	:	Vacant
Field Assistant	:	Vacant

Agricultural Research Station, Gangavathi -584 227, Koppal Dist.

(Phone: 08533 271443/08533 271034/08533 271030)

Assistant Professor	:	Dr. D.R. Patil (Upto 4-3-2011)
		Dr. Sanjeevraddi. G. Reddi (From 5-3-2011)
Research Assistant (Technical)	:	Vacant
Field Assistant	:	Vacant

KERALA

Central Plantation Crops Research Institute, Kasaragod- 671 124 (Phone: 04994-232893)

Principal Scientist	:	Dr. R. Dhanapal

Regional Agricultural Research Station, Pilicode, Kasaragod District- 670 533

(Ph.: 0467-2260632/2282737: Mob.: 09447692563.

Associate Director of Research	:	Dr. Jayaprakash Naik

MAHARASHTRA

Regional Coconut Research Station, Bhatye -4215 612, Ratnagiri Dist.

(Phone: 02352 - 235077/02352 - 235331 (Fax))

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

Agricultural Research Station, Mulde, Kudal Taluk, Sindhudurg Dist. PIN- 416520

(Phone: 02362 244231- 244232/02362- 244231 (Fax)

Assistant Professor (Agronomy)	:	Dr. M. S. Gawankar
Senior Technical Assistant	:	Vacant
Field Assistant	:	Shri. D. B. Patil

CHHATISGARH

Saheed Gundadhoor College of Agriculture & Research Institute, Kumharawand Farm, Jagadalpur-494 005, Bastar Dist.

(Phone: 07782-229150/07782-229360(Fax)

Assistant Professor (Horticulture)	:	Dr. L.S. Verma
Assistant Professor (Horticulture)	:	Dr. S. Agrawal

ORISSA

Department of Horticulture, OUAT, Bhubaneshwar- 751 003

(Phone: 0674-2390463)

Professor (Horticulture)	:	Dr. T. K. Das
Tech. Assistant	:	Mr. P. K. Jena

TAMIL NADU

Coconut Research Station, Aliyarnagar- 642 101, Coimbatore Dist.

(Phone: 04253-288722)

Professor & Head (Entomology)	:	Dr. K. Rajamanickam
Asst. Professor (Agronomy)	:	Dr. D. Rajakumar
Assistant Professor (Plant Breeding)	:	Dr. S. Geethanjali
Assistant Professor (Plant Pathology)	:	Dr. I. Johnson
Technical Assistant	:	Mr. Panchalingam

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

(Phone: 0435-2472881)

Professor (Agronomy)	:	Dr. P. Devasenapathy
Senior Technical Assistant	:	Mrs. B.Sundari
Agricultural Assistant	:	Mrs. P.Kalaiselvi,

Coconut Research Station, Veppankulam- 614 906, Thanjavur Dist.

(Phone: 04373-260205)

Professor (PB&G)& Head	:	Dr. C. Natarajan,
Professor (Agronomy)	:	Dr. P.S. Subramaniam
Associate Professor (Plant Pathology)	:	Dr. K. Rajappan
Superintendent	:	Smt. P. Saraswathy
AAO	:	Th. R. Venkatesan
Junior Assistant	:	Mr. R. Saravanan
Office Assistant	:	Mr. P. Chelladurai

Agricultural College & Research Institute, Killikulam -628 252, Vallanad, Tuticorin Dist.

(Phone: 04630-261226/04630 - 261268 (Fax)

Professor (Horticulture)	:	Dr. P. Nainar
Associate Professor (Food Processing Engineering)	:	Dr.N.Anandharaj
Technical Assistant	:	Mr. M. Ananth

WEST BENGAL

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

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

XI. Publications

Basavaraju, T.B. and Hanumanthappa, M. 2010. Integrated nutrient management in coconut. Mysore J. Agric. Sci., 44 (2): 289-294.

Basavaraju, T.B., Hanumanthappa, M. and Lavanya, T.N. 2010. Effect of graded levels of NPK on the productivity of hybrid coconut in *maidan* tract of Karnataka. Journal of Plantation Crops, 38 (3): 228-230.

Chavan, S. A. and Gawankar, M. S. 2010. Prospects of on farm processing in Cashew. The Cashew and Cocoa Journal. Vol. II. No.2 pp 6-10.

Desai, V. S., Gawankar, M. S. and Nagvekar, D. D. 2010. Evaluation of Different Pheromone Lures for Trapping the Red Palm Weevil of Coconut in Konkan Region of Maharashtra. J. Plant Protection and Environment 7(1): 81-84.

Emmanuel, N., Sujatha, A. and Gautam, B. 2010. Occurrence of Bag Worms *Pteroma plagiophelps* Hamps and *Clania sp*. on Cocoa Crop. Insect Environment, Vol.16 (2) pp: 60-61.

Emmanuel. N, Sujatha. A. and Gautham, B. 2010. Record of Leaf Chafer Beetles *Adoretus versutus* Harold and *Apogonia blanchardi* Ritsema on Cocoa (*Theobroma cacao* L.) in Andhra Pradesh. Insect Environment, Vol 16 (1), p. 23.

Gawankar, M. S., Gajbhiye, R.C. and Arulraj, S. 2010. Nutritional requirement of oil palm in Konkan region. Journal of Plantation Crops 38: 183-187.

Natarajan. C, Ganesamurthy, K. and. Kavitha, M. 2010. Genetic variability in coconut (*Cocos nucifera*). Journal of Plant Breeding 1 (5): 1367-1370.

Pawar, S.N., Gawankar, M. S., Pawar, D. R. and Sawale, R. D. 2010. Physiological studies of Oyster mushroom *Pleurotus sapidus* (Schulzer) Kalch. Pestology XXXIV (4):52-56.

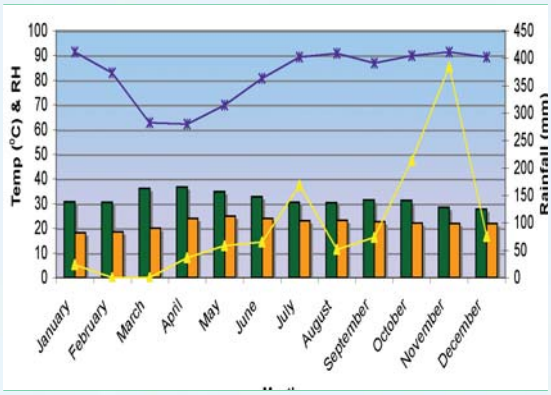
Pawar, S.N., Gawankar, M. S., Pawar, D. R. and Sawale, R. D. 2010. Effect of supplementation of paddy straw on yield of *Pleurotus sapidus*(Schulzer) Kalch. Pestology XXXIV (5):27-29.

Pawar, S.N., Gawankar, M. S., Pawar, D. R. and Sawale, R. D. 2010. Effect of spawn storage conditions on the sporophore production of *Pleurotus sapidus* (Schulzer) Kalch. Pestology XXXIV (9): 42-44.

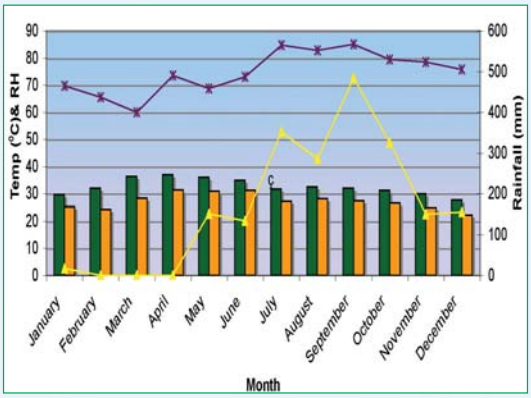
XII. WEATHER DATA OF CO-ORDINATED CENTRES (January - December 2010)

COCONT CENTRES

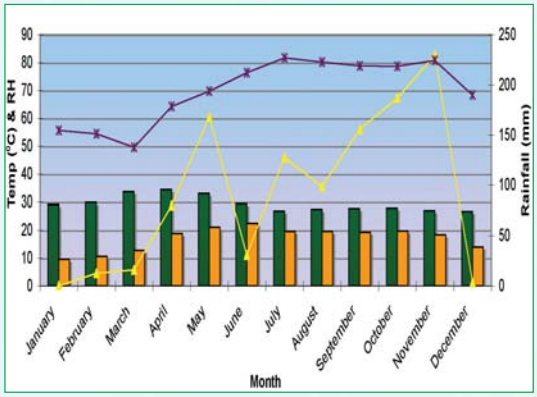
ALIYARNAGAR



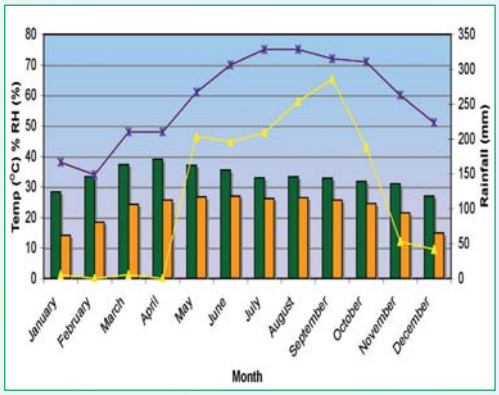
AMBAJIPETA



ARSIKERE

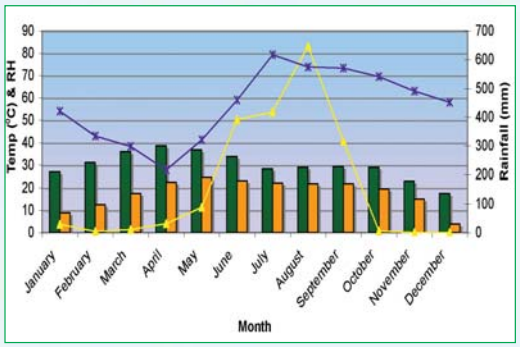


BHUBANESHWAR

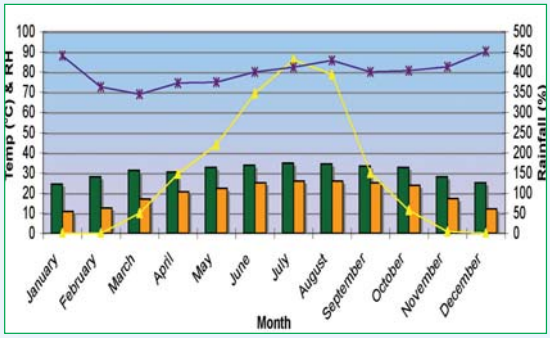


COCONT CENTRES

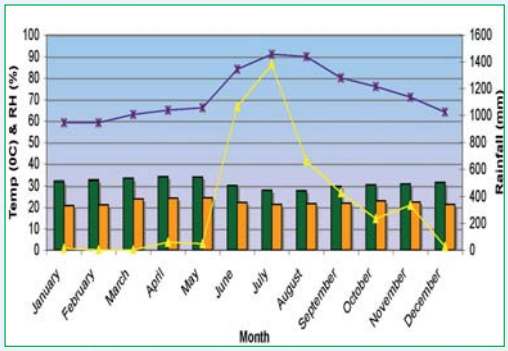
JAGADALPUR



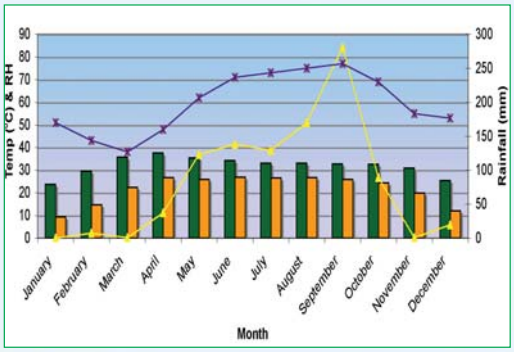
KAHIKUCHI



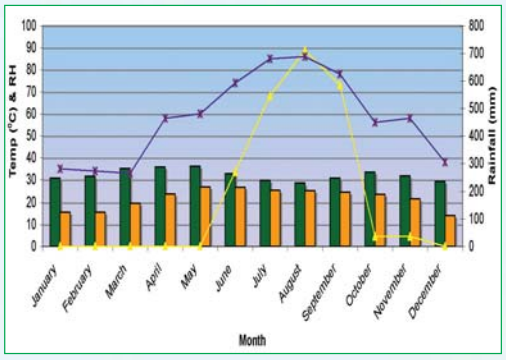
KASARAGOD



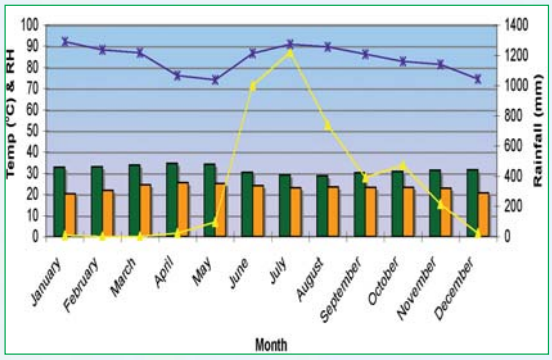
MONDOURI



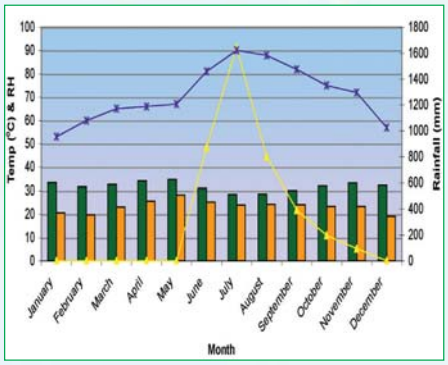
NAVSARI



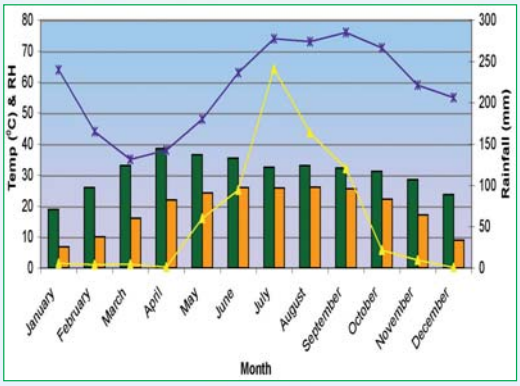
PILICODE



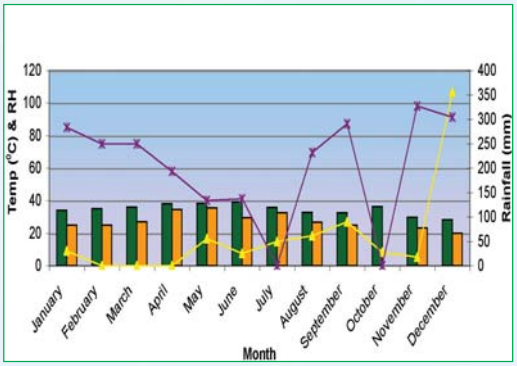
RATNAGIRI



SABOUR

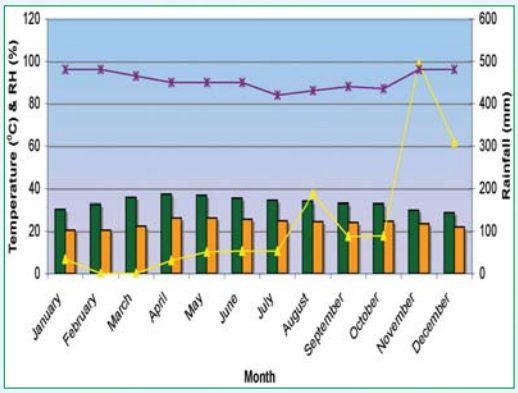


VEPPANKULAM

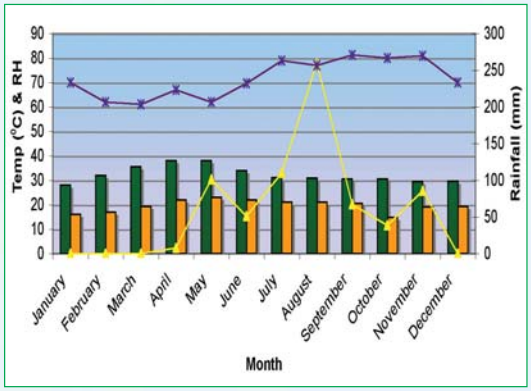


OIL PALM CENTRES

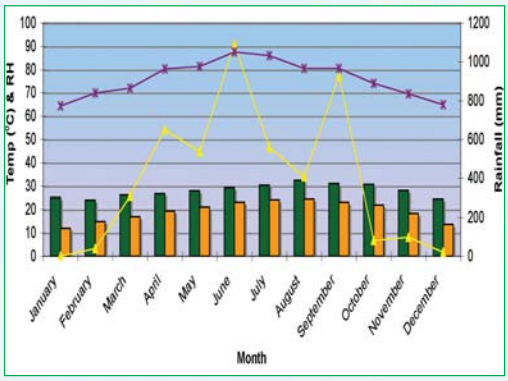
ADUTHURAI



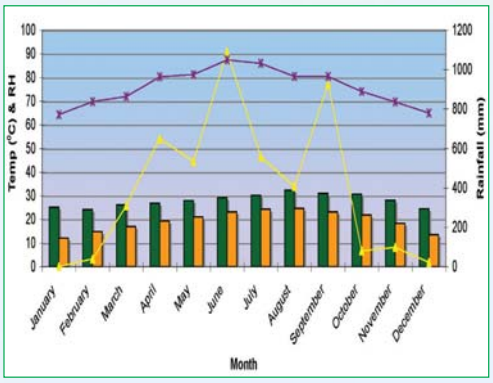
GANGAVATHI



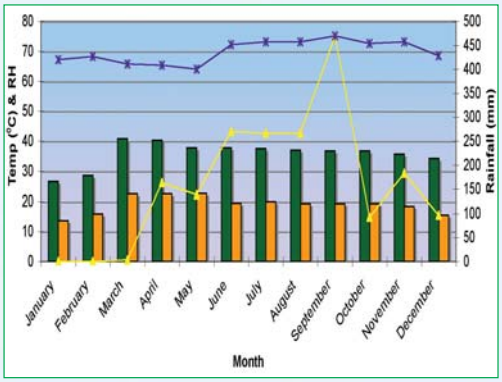
MULDE



PASIGHAT

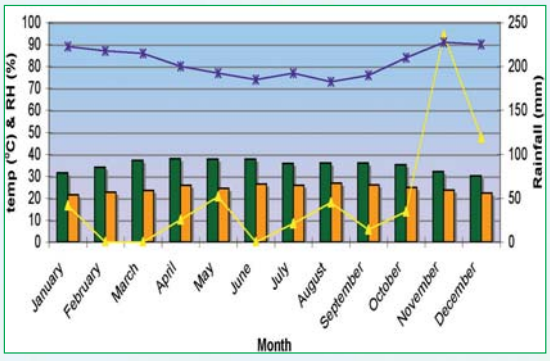


VIJAYARAI

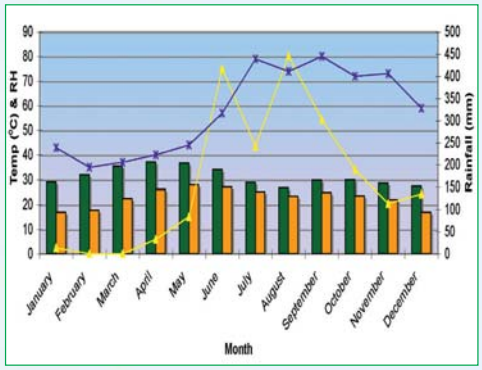


PALMYRAH CENTRES

KILLIKULAM



PANDIRIMAMIDI



NOTE

NOTE

NOTE