

अनुसंधान विशेचताएँ  
**RESEARCH HIGHLIGHTS**  
**2006-07**



केंद्रीय रोपण फसल अनुसंधान संस्थान  
( भारतीय कृषि अनुसंधान परिषद् )  
कासरगोड़ - 671 124, केरल, भारत

**CENTRAL PLANTATION CROPS RESEARCH INSTITUTE**  
( *INDIAN COUNCIL OF AGRICULTURAL RESEARCH* )  
**KASARAGOD - 671 124, KERALA, INDIA**



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*(Indian Council of Agricultural Research)*

Kasaragod - 671 124, Kerala, India





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## प्रस्तावना

केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़ का अधिदेश नारियल, सुपारी और कोको पर अनुसंधान है। अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना का मुख्यालय भी इसी संस्थान में स्थित है। नौ बृहत् परियोजनाओं, बाह्य निधि परियोजनाओं और अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के अंतर्गत 2006-07 में मुख्य उपलब्धियों का संक्षिप्त ब्यौरा इस प्रकाशन में दिया गया है।

नारियल पराग के शीत परिरक्षण का मानकीकरण किया गया। इन्क्यूबेटर द्वारा सुखाया हुआ या शीत परिरक्षित पराग का अंकुरण संभव पाया गया। रत्नागिरी से मीठी, मृदु और कम रेशे वाली गिरी वाले नारियल का संग्रहण किया गया।

कर्नाटक के उत्तर कन्नड़ा जिले के सुपारी उगाने वाले क्षेत्रों से सुपारी की दो उच्च उपज पर्यावरण प्ररूपों का संग्रहण किया गया। कोको के भिन्न गुणों वाले 36 क्लोन (EC संख्या 595986 से 596021) का आयात यूनाइटेड किंगडम के रीडिंग विश्व विद्यालय से किया गया।

तटीय रेतीली मृदा में, नारियल छिल्का और कयर गूदे का प्रयोग नारियल ताड़ों और अंतर फसल, अनानास की वृद्धि और उपज बढ़ाने में सहायक पाया गया। 3:1 अनुपात में नारियल पत्तों और कयर गूदा एवं रॉक फॉस्फेट का मिश्रण 75 से 80 दिनों में वर्मिकंपोस्ट में परिवर्तित हो गया जबकि नारियल पत्तों और लकड़ी की राख का मिश्रण *यूट्रिलिस* प्रजाति के केंचुओं के लिए हानिकारक पाया गया।

विभिन्न परिस्थितियों में संभाव्य अनुप्रयोग के लिए नारियल साइमुलेशन मॉडल विकसित किया गया। विभिन्न कृषि-जलवायु अंचलों में नारियल एक फसल के शुद्ध प्राथमिक उत्पादन ने दर्शाया कि जमीन स्तर से ऊपर के नारियल जैवभार का वार्षिक कार्बन अलगवाव संभाव्य 8 से 32 सी.ई.आर. (टी CO<sub>2</sub>/ है) तक पाया गया। उपस्थित मॉडल में सुधार करके एक सुवाह्य स्नोबॉल डाब मशीन का विकास किया गया।

मूल रोध रोग पता लगाने के लिए एलिसा जाँच को सरल और द्रुत बनाया गया। चॉकलेट फैक्टरी का अग्रशेष, कोको फली छिल्का, जैव एजेंट के बहुगुणन और प्रश्रेत्र स्तर उत्पादन के लिए अच्छी आधार वस्तु पाए गए। *नियोसेलुस बंराकी* अथियास - हेन्त्रियोट (फाइटोसिडी) की पहचान नारियल के एरियोफिड कीट के विरुद्ध सबसे प्रभावी भक्षक कीट के रूप में की गई। कीट द्वारा तय की गई दूरी को गति विश्लेषण के जरिए पता लगाने की विधि का विकास किया गया।

देश के 17 मुख्य नारियल वर्धित जिलों में किए गए समयपूर्व पूर्वानुमान अध्ययन में नारियल का अखिल भारतीय पूर्वानुमानित उत्पादन 14.37 करोड़ फल पाया गया जो 1996-97 में दर्ज किए गए उच्चतम उत्पादन से 10 प्रतिशत से भी अधिक है। प्रौद्योगिकी हस्तांतरण कार्यक्रमों को और समर्थ बनाया गया और प्रादेशिक केंद्र, मिनिर्काय और विट्टल एवं अनुसंधान केंद्र, काहिकुची, में किसानों के बीच प्रौद्योगिकियों के विस्तार के लिए किसान मेला का आयोजन किया गया।

इस वर्ष की अवधि में संस्थान के योगदान को राष्ट्रीय स्तर पर मान्यता प्राप्त हुई। भा.कृ.अनु.प. के 2003-04 द्विवार्षिक अवधि का उत्कृष्ट टीम अनुसंधान का पुरस्कार 'नारियल की प्रक्षेत्र में अभियांत्रिक और कटाई उपरांत प्रक्रमण के लिए प्रौद्योगिकियों का विकास' परियोजना के लिए कटाई उपरांत प्रौद्योगिकी अनुभाग के वैज्ञानिकों ने प्राप्त किया। उत्तम स्नातकोत्तर शोध प्रबंधक पुरस्कार पादप रोग विज्ञान की विद्या वाचस्पति छात्रा ने प्राप्त किया।

मैं उन सभी का आभारी हूँ, जिन्होंने विज्ञान की उन्नति और कृषक समुदाय के हित के लिए महत्वपूर्ण योगदान दिया।

जॉर्ज वी. थॉमस  
(डॉ. जॉर्ज वी. थॉमस)  
निदेशक

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## PREFACE

The Central Plantation Crops Research Institute, Kasaragod has the mandate to conduct research on coconut, arecanut and cocoa. The headquarters of All India Coordinated Research Project on Palms is also located at this institute. The significant achievements made during 2006-07 under nine mega projects, externally aided projects and AICRP (Palms) are summarised in this publication.

Cryopreservation of coconut pollen was standardized and viability/germinability could be maintained even after the pollen was incubator-dried. A sweet kernalled coconut eco type, having sweet and soft endosperm with low fibre was collected from Ratnagiri. An exploration trip undertaken in areca growing tracts of Uttar Kannada district of Karnataka resulted in collection of two high yielding eco types. Imported 36 cocoa clones (EC No. 595986 to 596021) of distinct characteristics from Reading University, U.K.

In coastal sandy soil, husk and coir pith application significantly influenced the growth and yield of coconut and intercrop, pineapple. Conversion of coconut leaves mixed with coir pith and rock phosphate at 3:1 ratio into vermicompost was achieved in 75 to 80 days period while mixing of wood ash was detrimental to the *Eudrilus* worms.

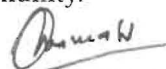
A coconut simulation model was developed with potential application in various conditions. The net primary production (NPP) estimations of coconut monocrop in different agro-climatic zones indicated that annual carbon sequestration potential of coconut above ground biomass ranged from 8 CERs (T CO<sub>2</sub>/ha) to 32 CERs. The standing carbon stocks ranged from 18 CERs to 51 CERs. A portable snowball tendernut machine was developed by making improvement in earlier model.

ELISA test for the detection of root (wilt) disease has been refined further to a simple and very rapid test. Cocoa bean shell, a by-product of chocolate factory, has been found to be a good substrate for the preparation of non-synthetic mycological culture medium as well as for the mass multiplication and farm level production of bioagents. The most efficient predatory mite of coconut eriophyid mite was identified as *Neoseiulus baraki* Athias-Henriot (Phytoseidae). A novel way to find the distance traveled by the insects combined with motion analysis was developed.

An early forecast study conducted in 17 major coconut growing districts in the country indicated an all India forecasted production of 14.37 billion coconuts, which is more than 10% of the highest production recorded during 1996-97. Transfer of technology programmes were strengthened and Kisan melas conducted at Regional Stations, Minicoy and Vittal and Research Center, Kahikuchi to disseminate the technologies to farmers.

The Institute's contributions were also recognised at national level during the year. ICAR Award for outstanding team research for the biennium 2003-04 was bagged by the scientists of Post Harvest Technology for their project "Development of technologies for on farm engineering and post harvest processing of coconut. The best Post Graduate thesis award was bagged by a Ph. D. scholar in the discipline of plant pathology.

I take this opportunity to thank all those involved in making significant contributions for the advancement of science and for the benefit of farming community.



(Dr. George V. Thomas)  
Director

April 2007

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## CROP IMPROVEMENT

### Genetic resources

#### Coconut

A valuable new coconut ecotype having sweet and soft kernel with low fibre content was collected from Ratnagiri district of Maharashtra in collaboration with AICRP (Palms) centre, Bhatya, Ratnagiri.

The bank of Cauvery River in Trichy and Erode districts of Tamil Nadu was explored for coconut germplasm during February 2007. Three collections representative of the area were made, viz. (i) representing the general population of the area with tall habit and elongate fruits; (ii) a sub population from *in situ* drought tolerant palms and (iii) a tall population with large fruits.

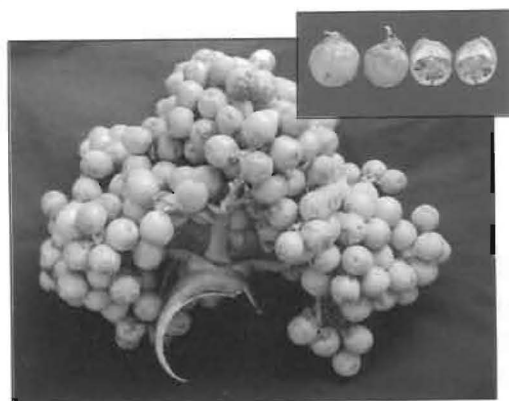
About 180 seedlings representing accessions collected from Karnataka, under NATP-Plant Biodiversity, were planted in RBD in the field gene bank at Kidu.

For developing World Catalogue of conserved germplasm, typical mother palms were identified and *in situ* photo documentation was completed for 41 accessions as per revised COGENT guidelines.

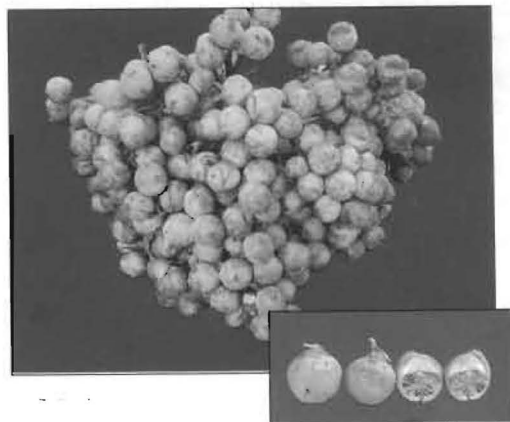
#### Arecanut

An exploration trip was undertaken in areca growing tracts of Uttar Kannada district of Karnataka and collected two high yielding eco types of arecanut making the total holding to 153 at the main field gene bank CPCRI, Vittal. The two collections made were Vajrahalli and

Kannipal. The accession, Vajrahalli has distinct desirable traits such as high chali yield (about 8-10 kgs chali/palm /year), drooping crown and comparatively thick stem. Nuts are yellowish orange in colour, round in shape and medium in size. High kernel weight and more recovery of chali are striking features of this accession. It is also observed that palms are regular bearers giving consistently high yield for the past 15 years. There was no incidence of any diseases, nut splitting and other disorders observed so far.



Vajrahalli bunch and nuts



Kannipal bunch and nuts

**Cocoa**

Imported 36 cocoa clones (EC No. 595986 to 596021) of distinct characteristics from Reading University, UK, which comprised of 7 Amazonian (AMAZ 1/8, 3/9, 5/2, 10/1, 12; 15, 15/15), 4 Brazilian (B 5/3, 5/7, 7/14, 12/2), 4 Jamaican (JA 1/9, 1/19, 5/25, 10/12), 6 Mexican (RIM 2, 6, 21, 39, 41, 189), 14 Pound collections (LP 1/41, 3/40, 4/32, LV 20, 28, LX 6, POUND 4/B, 7/B, 16/A, 16/B, 18, 18/A, 19/A, SJ 1/19) and a related species *Herrania nitida*. With this, the cocoa germplasm holding at CPCRI, RS, Vittal was enhanced to a total of 185.

Based on magnitudes of stability parameters and high yield, the clones V-1, IMC-10, NA-242, IMC-67 were found to be stable performers at Vittal whereas, EET-272, ICS-6, I-14 and SIAL-93 performed better under Kannara conditions. Among the Malaysian clones Amelonado x NA-32, Jarangau Red Axil, Landas-357 and Landas-364 showed high adaptability under Kerala and Karnataka conditions with high pod yields and pod weights over different growth periods.

In the comparative yield trial, the hybrids PII-5, PII-3, PIII-I-23 and PI-IV-478 were grouped as vigorous plants with sturdy stems and well spread canopies during their initial years of growth. The hybrids PI-IV-478, PI-I-38, PIII-I-23, PIII-II-54 and PI-I-18 were identified as precocious bearers and high yielders with 50 pods and > 1 kg dry bean yield per tree per year.

**Breeding for high yield/performance****Coconut**

In the Dwarf x Dwarf experiment planted in 2003, the hybrid combination Malayan Yellow Dwarf x Chowghat Green Dwarf recorded early flowering and yield. Among the 23 hybrid combinations, 14 Dwarf x Dwarf combinations flowered during December 2005 to February 2007.

In an evaluation trial of 15 coconut varieties and 3 hybrids laid out to identify suitable variety for sub Himalayan terai region of West Bengal, three collections from Bangladesh (C-8, C-11, C-1) performed better in terms of seedling vigour and number of leaves.

**Breeding for resistance / tolerance to coconut root (wilt) disease**

A comprehensive breeding programme for the production of quality planting materials for establishing nucleus seed gardens and to develop a resistant/tolerant variety to coconut root (wilt) disease is being implemented. Towards this end, artificial pollination was carried out in farmers' plots of Alappuzha, Kollam and Pathanamthitta districts involving 23 West Coast Tall, 72 Chowghat Green Dwarf and 5 Chowghat Orange Dwarf mother palms. Artificial pollination was carried out involving 470 inflorescences in 17,329 female flowers. Altogether 1,177 artificially pollinated seed nuts belonging to different cross combinations were harvested and sown in the nursery. Besides, a total of 20,886



open pollinated seed nuts belonging to WCT, CGD, COD and MGD were also collected and sown for raising seedlings for distribution among farmers in the root (wilt) disease prevalent tracts.

Studies at CDB Farm-Neriamangalam revealed that Malayan Green Dwarf (MGD) has less root (wilt) disease incidence and is giving the maximum copra out turn among the dwarfs planted there. Besides, a crossing programme involving 15 MGD and MYD and five each of Malayan Orange Dwarf and Chowghat Green Dwarf is progressing at CDB Farm, Neriamangalam for production of planting materials for initiating an evaluation trial involving Malayan Dwarfs.



Malayan Green Dwarf (MGD) palm

A total of 6472 artificially pollinated seedlings have so far been planted for establishing five nucleus seed gardens.

#### **Arecanut**

Among the sixteen tall hybrids under evaluation for economic traits, Shriwardhan x Sumangala combination

showed superiority in yield during the year.

#### **Promising Arecanut variety and hybrids**

##### **Swarnamangala (VTL 12)**

Evaluation of exotic accessions for economic traits resulted in selection of high yielding variety VTL-12 (Saigon). It is a tall variety with homogeneous population. The bunches are well spaced. Nuts are bigger and heavier with high recovery of chali/dry kernel (26.40%). Average yield of this palm is 3.88 kg chali/palm/year.



Swarnamangala palm

Hybrids involving Hirehalli Dwarf (HD) and released tall varieties were developed and evaluated for yield performance and dwarfness. Among the hybrids HD x Sumangala and HD x Mohitnagar were found to be superior for yield with dwarfness.

##### **VTLAH 1 (Hirehalli Dwarf x Sumangala)**

This hybrid is dwarf in nature. Sturdy stem with super imposed nodes, reduced





VTLAH1 palm

canopy size, well spread leaves, partial drooping crown, medium sized oval to round and yellow-orange coloured nuts, early stabilization in yield and high recovery of chali (26.45 %) are the striking features of this hybrid. The average chali yield of this hybrid is 2.54 kg/palm/year.

#### VTLAH 2 (Hirehalli Dwarf x Mohitnagar)

This hybrid is dwarf in nature. Medium thick stem with super imposed nodes, reduced canopy size, well spread leaves, drooping crown, medium sized oval nuts, early stabilization in yield and high recovery of chali (28.53 %) are the striking features of this hybrid. The average chali yield of this hybrid is 2.64 kg/palm/year.

These dwarf hybrids with high yield potential will directly benefit the growers by way of enhanced returns and reduced cost of various cultural operations like harvesting, spraying and also without causing much damages to palms due to sunscorching and heavy wind.

#### Cocoa

Under the cocoa improvement programme, a total of 60 hybrids and 10 clones are being evaluated for high yield and adaptability under mixed cropping systems under arecanut and coconut. Based on the stable performance, high value of heterosis and medium canopy four hybrids II-67 x NC42/94 named as Vittal Cocoa Hybrid 1 (VTLCH1), ICS 6 x SCA 6 (VTLCH 2), II-67 x NC29/66 (VTLCH3), I-56 x II-67 (VTLCH 4) and a clone NC 45/53 (VTLCC1) were developed. These have average yield potential of 1.245 kg, 1.145kg, 1.478kg, 1.481kg and 1.238kg dry beans per plant per year, respectively and would yield approximately 0.8 to 1.1 MT per ha. These hybrids/clone meet the international standard of bean size of more than 1g, which is required by the industry. They also contain internationally acceptable levels of fat content (>50%) in the beans and low shelling percentage (10-12%).



II-67 x NC 42/94 (VTLCH1)



### Seed Production in Coconut, Arecanut and Cocoa

Under the mega seed project, 68044 coconut seed nuts have been produced and around 32218 seed nuts have been sown for seedling production. In addition, approximately 15000 coconut seedlings and around 24632 coconut seed nuts have been sold to farmers/development agencies. In arecanut, 362873 seed nuts were produced and about 240000 seed nuts were sold to farmers. About 66000 cocoa grafts were produced and 43958 grafts and 51 hybrid seed pods were sold to farmers/development agencies. In addition, 21300 cocoa seeds have been sown for raising seedlings for root stocks.

### BIOTECHNOLOGY

Cryopreservation of coconut pollen was standardized and viability/germinability could be maintained even after the pollen was incubator-dried or cryopreserved.



*In vitro* germination of cryostored pollen (75 days) of coconut (WCT) after 90 minutes in pollen germination medium.

Root (wilt) resistant, Malayan Green Dwarf palms were analyzed using molecular markers. Among the MGD palms, an average 80% similarity was detected.

Molecular characterization of typical Chowghat Orange Dwarf and Chowghat Green Dwarf palms revealed 68% of average similarity among COD and 74% among CGD. There is considerable variation among CGD from Chowghat area.

Using the primer pair P1/P6, a phytoplasma specific band at 1.5 kb in the YLD affected areca samples (leaves, inflorescence tissues and petiole) was observed. The same primer P1/P6 amplified 1.5 kb fragment in serologically positive coconut spindle leaf samples. Consistent amplification was obtained at high stringency.

Expressed Sequence Tags of cocoa was functionally annotated and a database on annotated ESTs was prepared.

PALMDB, a database on palm resources, was created. COCOSAT, a database on coconut microsatellites, was also created.

*WRKY* sequences and Resistant Gene Analogues (RGAs) were cloned and characterized from coconut using degenerate primers.

### CROP PRODUCTION

#### Coastal sandy soil management

In the field experiment on coastal sandy soil management, husk and coir



pith application has significantly influenced the number of leaves, fruit size and fruit weight of pineapple. Higher fruit yield was obtained under husk application (14,673 kg from one hectare of coconut garden) and it was on par with coir pith application and significantly differed from the control treatment.



Pineapple growth in sandy soil

The complementary effect of growing vegetable and pineapple intercrops was observed on coconut productivity. Higher coconut yield was recorded under coconut+vegetable intercropping system compared to monocropping of coconut.

#### Management of coconut based farming system

The number of tillers and plant height of fodder crops was significantly influenced by nutrient treatments. Total green foliage yield of Bajra Napier hybrid - Co 3 was significantly increased with the application of 50 per cent NPK through vermicompost + 50 per cent NPK through chemical fertilizer (110 t/ha/year). Similarly, the fodder maize and sorghum were evaluated as intercrops in coconut garden. Fodder maize variety

African Tall recorded green fodder yield of 11.6 t/ha and dry fodder yield of 2.2 t/ha from one hectare of coconut garden. In case of fodder sorghum varieties, K-tall, CO 27 and CO 26 were tried as intercrops in coconut garden. Among the different varieties, CO 27 recorded higher straw yield.

#### Organic cultivation of coconut

The field experiment on organic cultivation practices on West Coast Tall and D x T coconut palms indicated that all the organic cultivation treatments recorded significantly higher nut and copra yield when compared to control. Among the organic cultivation treatments, vermicomposting in trenches, application of biofertilizers (*Azospirillum* and Phosphate solubilizing bacterium) and raising vanilla and pepper resulted in higher copra and nut yield and it was on par with other organic cultivation treatments and significantly differed from the control treatment.

#### Medicinal plant Nagadanti (*Baliospermum montanum*) as intercrop in coconut garden

Nagadanti, a medicinal herb plant, used for preparation of ayurvedic medicines, performed well as intercrop in coconut garden. The plant is propagated with stem cuttings and planted at 60x60cm spacing on a raised bed. When grown as intercrop in coconut garden, it grows to a height of 1.75 m to 2.00 m producing 3 to 4 branches and 46



to 55 g of fresh roots per plant. By growing this crop, coconut farmer can earn about Rs.8000/ to Rs. 10,000/ per acre of coconut garden in an year.



Nagadanthi as intercrop in coconut garden

### Autotoxicity studies in coconut seedlings

Autotoxicity studies on effect of coconut leachates on coconut seedlings revealed that leaf and root leachates had positive effect on the growth of coconut seedlings, rhizosphere microflora (both general and function specific communities) and soil enzyme activities (dehydrogenase, phosphatase and urease). Vermiwash from coconut leaf vermicompost, at 1:20 concentration, significantly improved the growth of the coconut seedlings and also enhanced the soil microbial population and their activities.



(a)



(b)

Effect of coconut leaf leachate (a) and vermiwash (b) on growth of coconut seedlings

### Nutrient enrichment of coconut leaf vermicompost

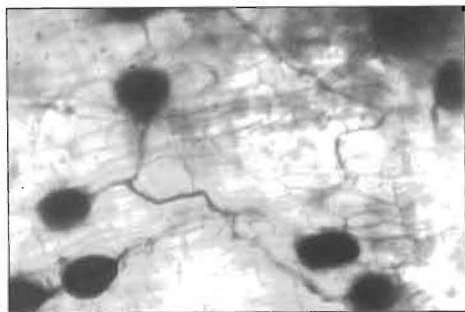
Production of vermicompost from coconut leaves mixed with coir pith, rock phosphate and wood ash at 3:1 ratio was studied. It was observed that the *Eudrilus* sp. converted the first two mixtures into vermicompost in 75 to 80 days period. However, all the worms died in the coconut leaf + wood ash mixture. The conversion of the substrates to vermicompost was at an average of 65 – 70 % and the multiplication of the worms in the order of 40 –50 % above the initial numbers introduced.

### Effect of coconut leachates on mycorrhizal association

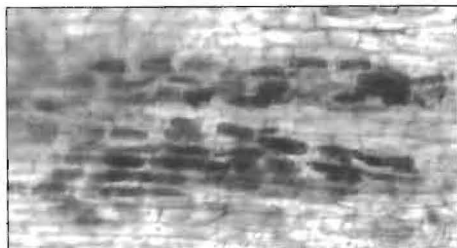
The impact of coconut leachates (root and leaf) was studied on the percentage of AM association in the roots of vanilla and clove plants, which is an important indicator of the involvement of agriculturally important microorganisms in the overall effect of allelochemicals on



the growth of plants. In non-sterile bulk soil, the addition of the coconut leachates significantly increased the AM association in roots of both clove and vanilla whereas in sterilized bulk soil, there was drastic suppression of AM association.



Vesicles of AM fungi in clove roots  
(under 40 x magnification)



Arbuscules of AM fungi in vanilla roots  
(under 10 x magnification)

#### **Flow of allelochemicals from different crop canopies in coconut based cropping system**

In the allelopathic studies, the concentrations of allelochemicals, particularly phenols and sugars flowing from the leaf leachates of coconut, clove, banana and nutmeg were analyzed. It was observed that the total phenols were higher in the leachate collected from the first copious rainfall of the season

(received in May). Among the crops, coconut leachate carried the maximum phenol concentration of 0.73 mg/ml, and banana had the least of 0.07 mg/ml. In the immediate next leachate collection, the phenol concentration decreased by 70% in coconut, 50% in clove and 25% in nutmeg, whereas that of banana leachate did not change. However, the concentrations of total sugar content increased by more than 60% in all samples.

#### **Intercropping of horticultural crops in plantation based cropping system for NE region**

At Mohitnagar (West Bengal) different flower crops like aster, halychrysum, chrysanthemum, calendula, sunflower, cox's comb, antirrhinum, gladiolus, marigold (both French and African types) were evaluated in arecanut garden and open condition. Vegetative growth of all the crops in arecanut garden was more than the growth in open condition.

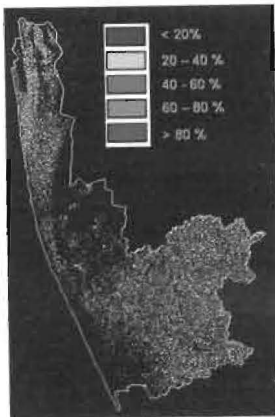
At Kahikuchi, flowering crops like marigold, gerbera and gladiolus and vegetables like brinjal and Knolkhol performed better under young arecanut plantation.

#### **Identification of root (wilt) disease affected coconut palms using Remote Sensing and GIS**

For spectral unmixing Nonnegative Constrained Least Square (NCLS) technique algorithm was tested in the simulated data. In the simulated data subpixel classification accuracy was 98.2%. This NCLS algorithm was



implemented in IRS P-6 satellite digital data in the Alleppey district for sub pixel classification of the coconut root (wilt) affected palm mapping. The ground truth survey revealed that about 98.64% sub pixel classification accuracy was attained for coconut root (wilt) map. The total coconut area in that district is about 47217 ha and root (wilt) affected area is 30264 ha.



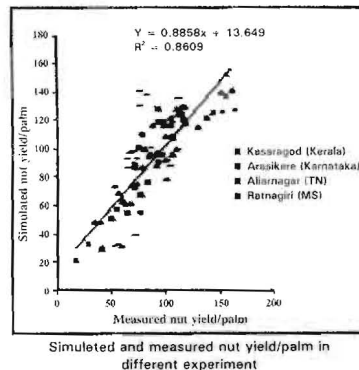
Coconut root (wilt) affected fraction of pixel – Alappuzha district

**PHYSIOLOGY AND BIOCHEMISTRY**

**Coconut simulation model**

Simulation modelling in perennial crops has immense potential use in decision making for plantation management. By adapting a generic crop model INFOCROP, a coconut simulation model was developed with a potential application in various conditions of coconut growing area in tropical and subtropical environments. The model used coefficients for phenology, leaf area development, radiation use efficiency, photosynthetic efficiency, source sink

relationships and dry matter partitioning and weather and management inputs. Simulated trends of phenological development and total dry matter, its partitioning ( $R^2=0.95$ ) and nut yield ( $R^2=0.86$ ) were in close agreement when measured with acceptable error up to  $\pm 15\%$  in few cases. Considering that the field measurements also generally have 10-15% error and wide variation in treatments, it can be concluded that model was adequate to simulate the effect of various management factors and agro-climatic conditions to obtain quick results and recommendations for increasing the efficiency of experimentation in coconut.



**Carbon sequestration potential in coconut plantations**

The net primary production (NPP) estimations of coconut monocrop in different agro-climatic zones indicated annual carbon sequestration potential of coconut above ground biomass ranged from 8 CERs ( $T\ CO_2 /ha$ ) to 32 CERs. The standing carbon stocks were ranged from 18 CERs to 51 CERs. Coconut simulation model was used to simulate the outputs



on the net primary production of coconut in 60 years. The estimates indicate long term (~60 years) carbon stocking in stem is around 150 CERs. Simulations further indicated that the nut yield stored carbon in short to medium duration (~2 to 5 years) and is estimated to be around 1350 CERs during the entire economic life span of coconut. Further, carbon storage in leaf and inflorescence, which again is for short to medium duration (2-3 years), is estimated to be around 1000 CERs in entire span of coconut economic life of 60 years. These estimates indicate coconut as an important candidate for carbon sequestration in clean development mechanism.

## **PRE AND POST HARVEST TECHNOLOGY**

A portable snowball tendernut machine was developed by making improvement in earlier model. Here the circular cutting blade is modified to have 24 teeth so that the cutting operation is smooth and loss of nuts due to breakage is reduced to 1 to 2%. The machine weighs 25 kg and the cost is Rs.16000/-only.



Portable snowball tendernut machine.

## **Automatic pumping system for skimming wells**

Prototype of an automatic pumping system to extract fresh water from skimming wells has been developed. The instrument consists of a salinity sensor to measure the salinity of water directly and continuously. The sensor is designed based on electrical conductivity. It has a detector electrode embedded in a casing, the probe, an amplifier to amplify the input signal and a digital display unit. The probe is provided with 10m long electric cable so that it can be immersed in to any of the surface/ ground water sources to sense the salinity of water. The instrument reads salinity instantaneously and the user can read the salinity of water in the digital display unit. The instrument can terminate pumping and there by stopping irrigation when the salinity level reaches a preset level. The instrument can be fitted to an electric pump drawing water from either a tube well or an open well in salt affected areas to skim fresh water without disturbing saline water. The default setting in the instrument to stop pumping is 800ppm. However, the user can set any salinity level, depending on the tolerance level of the crops grown, in the instrument.

## **CROP PROTECTION**

### **Diseases**

#### **Sero-diagnosis of root (wilt) disease**

ELISA for the detection of root (wilt) has been refined further to a simple and very rapid test. In the modified procedure



leaf bits are being used as test antigen instead of leaf extract, thus reducing the time required from 24 hrs to 7 hrs.

### Mass production and use of biocontrol agents in the integrated management of coconut leaf rot disease

Bacterial (*Bacillus subtilis* and *Pseudomonas fluorescens*) and fungal (*Trichoderma viride*) biocontrol agents of local origin could be mass multiplied using coconut water and processed into formulations utilizing talc powder as carrier material, packing in polythene covers and sealing through standardized procedure. The mass-produced biocontrol agents were distributed to different stakeholders through programmes implementation.

### Fruit rot and immature nut fall of coconut

Studies on the role of fungi in fruit rot and nut fall of coconuts revealed *L. theobromae* as the predominant and major fungus causing rotting of nuts at different stages of maturity and in stored mature nuts throughout the year. The soft and white tissue beneath the perianth where eriophyid mite causes injury was found to be vulnerable to infection by *L. theobromae*.

Bavistin 50% WP (Carbendazim) 0.1% and companion WP (carbendazim 12% + mancozeb 63%) 0.1% were found to be very effective in controlling the disease when sprayed on the bunches. One or two sprays depending upon the intensity of the disease are sufficient to control the disease.



*L. theobromae* infection in tender nuts



*L. theobromae* infection spreading to the kernel

### Studies on stem bleeding of coconut and Ganoderma disease of arecanut

At Kahikuchi, laboratory study on efficacy of botanicals (40nos.) against *Thielaviopsis paradoxa* (stem bleeding of coconut) was carried out and result showed that only *Allium sativum* was effective with 100% inhibition over control after 96 h of incubation.

Soil drenching with aqueous extract of *Allium sativum* and *Azadirachta indica* @ 10% (5l/palm) was effective in managing the Ganoderma disease.

### Crown rot of areca palms

Crown rot affected areca farms could be saved by drenching the root zone with five litres of fungicide solution containing either phosphorous acid or tridemorph at a conc. of 0.3%. Palms in the advanced stage of disease did not respond to the treatment and such palms had to be destroyed.

### Mycological culture medium from cocoa bean shell

Cocoa bean shell (CBS), a by-product of chocolate factory, has been found to





be a good substrate for the preparation of non-synthetic mycological culture medium as well as a cheap substrate for the mass multiplication and farm level production of bioagents like *Trichoderma harzianum* and *Metarhizium anisopliae*.

#### **Mass multiplication and formulation of biocontrol agents in cocoa 'sweating' wasted from cocoa fermentaries**

Cocoa sweating diluted with water (1:4) when used for moistening cocoa bean shell, the growth and sporulation of both the bioagents were much better than that moistened with water.

Bio-formulations of *T. harzianum* and *M. anisopliae* were also prepared using talc powder as carrier material. Studies of CFU revealed that these formulations are better than those prepared using conventional media. CFUs of *T. harzianum* were  $6.5 \times 10^6$ /g and that of *M. anisopliae* were  $4.2 \times 10^8$ /g of bioformulation after 3 months of storage at room temperature.

### **PESTS**

#### **Olfactory learning in *Goniozus nephantidis* Muesbek, the parasitoid of coconut black headed caterpillar, *Opisina arenosella* Walk.**

A novel way to find the distance traveled by the insects combined with motion analysis was developed. Optical flow technique was used to understand the patterns of motion and calculation of path length of insects.

A five port odour delivery system was fabricated with solenoid valves so as to automate the odor delivery in electro antennogram. This would facilitate for rapid stimulus delivery on the test object.

Electrophysiological recordings of the female antennae of the *G. nephantidis* showed maximum response to honey, acetate and alcohols.

#### **Electrophysiology of *Leucopholis coneophora***

The electrophysiological response of male and female *Leucopholis coneophora* generated during 2005 was confirmed with the response from the insects collected during 2006. Similar trend of increased response of antennae to dodecane, tridecane and ethyl acetate of *L. coneophora* was observed. The response of female to all the volatiles tested was low as compared to males. The beetles exhibited dose dependant response to ethyl acetate, dodecane, tridecane and linalool.

Among the micro wave assisted extraction of host volatiles *viz.*, coconut, mango and banana leaf gave a maximum response followed by mango and banana.

#### **Eriophyid mite management**

The efficient predatory mite of coconut eriophyid mite was identified as *Neoseiulus baraki* Athias- Henriot (Phytoseidae). 70-80% of sampled nuts from mite infested tracts harboured the predatory mite during 2006.



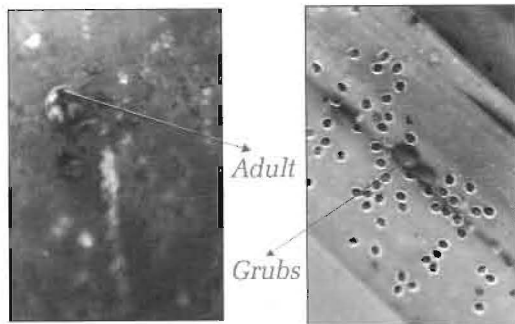
Predatory mite (*Neoseiulus baraki*)

Among the 38 isolates of *Hirsutella thompsonii*, eight isolates were found to be highly virulent. Standardized mass multiplication techniques of the fungus *Hirsutella thompsonii* in the laboratory using rice media.

Developed a PVC pipe trap for catching floating population of rhinoceros beetle in the field using pheromone. This trap is giving 3-4 times more catch than the conventional bucket trap.

#### Arecanut

A coccinellid and a land planarian was recorded as predators of areca pests. The coccinellid was found predaceous on the palm aphid, *Cerataphis brasiliensis*. This



Adult & Grubs of *Cryptogonus kapuri* on palm aphid colony

is identified as *Cryptogonus kapuri* Ghorpade (Coleoptera: Coccinellidae). This is a specific predator of the palm aphid.

The land planarian was found predaceous on the slug *Mariella dussumieri*, which damages the spadices of areca palm. This flat worm commonly known as the Shovel-headed garden worm is identified as species of *Bipalium*. This belongs to the Phylum: Platyhelminthes, Class: Turbellaria and Family: Bipaliidae. These flat worms devour the slug completely, and are seen during the wet and cool months of the year.

A trial was carried out for management of the stem weevil of arecanut at Kahikuchi with five treatments and the initial results showed that application of chlorpyrifos 20 EC @ 0.05%, along with mud slurry was found effective against the pest.

#### Cocoa wilt

The occurrence of cocoa wilt was severe in Mysore and Mandya areas of Karnataka. The cocoa wilt is associated with a secondary pest *Xylosandrus compactus*. Application of propiconazole (0.2%) and imidacloprid (0.2%) after the removal of the infected parts in the diseased tree helps to prevent the spread of the disease.

### SOCIAL SCIENCES

#### Forecasting coconut production

To provide an early forecast of coconut



production in India for the year 2006-07, a study was conducted in 17 major coconut growing districts in the country. Ratio estimate using average production for the years 2002-03 and 2003-04 was used for production forecasting. The forecasted production in million nuts for Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh are 5406.6, 2214.0, 4187.0, and 918.9 respectively. And the all India forecasted production of coconut for the year 2006-07 was worked out to be 14.37 billion nuts, which is more than 10% of the highest production recorded during 1996-97.

Correlation analysis between production with total rainfall and production with season wise rainfall going up to 4 years previous was worked out for four districts of Karnataka. In Chitradurga District, Sept.-Dec. rainfall up to 4 years previous gave significant positive correlation with production. No significant correlations were obtained for the districts Hassan and Chickmagalur. In Tumkur district rainfall during the period May to August up to 4 years previous was found to have significant positive correlation.

#### **Price trend**

Domestic price of copra showed considerable variation: It was Rs.3750/- per quintal during December 2006 but fallen sharply to Rs.3100/- by March 2007. The price of copra was below the MSP (Rs.3590/-) in most of the months and even below the cost of production in certain months. Compared to

international price, the domestic price was nearly 90% higher. The weekly forecasting of the coconut price in three markets using ARIMA models was continued and posted in the website.

The purchasing power of coconut in terms of consumer goods is analyzed for the period 1980-2005: As a whole the increase in prices of inputs were almost at par compared with market price of coconut up to 2000. However, the gap between cost and return narrowed down since 2001. Among the input items, hired labour has shown the highest increase (an eight fold increase). The relatively lower rate of increase in coconut price compared to other agricultural commodities and increase in price of inputs affected the purchasing power of the coconut farmers in the recent past.

#### **Modelling techniques**

The input response relationship in arecanut was studied using generalized additive modeling technique. The estimated values of the component functions provided the mean response of input variables on the yield of arecanut. The optimum value of the input variables was obtained from the graphical representation of the component functions. The analysis of data from the two districts shows that input response relationship vary depending on the agro-climatic conditions of the locations.

#### **Computer applications**

The database updated in MSACCESS was migrated to Oracle server using



Oracle Migration Work Bench (OMWB) tool. Oracle Management Server was configured and clients were added.

The website of the Institute was registered under *gov.in* domain and the site is now available at *www.cpcri.gov.in*. Virtual Private Network connectivity with NIC server for web updation was established.



Website of CPCRI

Augmenting the tables of the INARIS database, a database for pest and disease surveillance at different regions was created. Internet enabled data entry forms were made available for data feeding from different regions.

### Transfer of Technology

During the year, five Institutional training programmes were organised for the benefit of extension personnel. Besides, several one-day training-cum-visit programs for farmers and students were organized at headquarters, regional stations and research centers: Large number of farmers from neighboring states visited the Institute. Institute had

participated in 7 exhibitions held at various places in the country: Two at New Delhi (NAS Centre; KrishiExpo 2007); two places in Alappuzha, Thodupuzaha, Neyyatinkara, and Panniyur. Technology inputs and products including planting materials, farm products, farm literature and CD ROMs were sold through ATIC. A revenue of Rs.5,06,897 generated from ATIC.



Participation in Exhibition at Panniyur

Formal launching of cyber extension programme was done at Malappuram on 2nd September 2006. A seminar on “Cyber extension for technology transfer in coconut, arecanut and cocoa” was organized.

### Vermicomposting of coconut leaves in Lakshadweep

With a view to increase the fertility of the soil of Lakshadweep, which has very poor organic content, vermicomposting was standardized in Minicoy. The technology was demonstrated in Kalpeni Island of Lakshadweep and was adopted by many farmers.



## KISAN MELA

### Vittal

Kisan Mela was conducted at CPCRI, RS, Vittal on 29.11.06 in commemoration with Golden Jubilee celebrations. 500 farmers, department officials and persons from private agencies participated. It was inaugurated by Mrs. Mamata S. Gatty, President, Dakshina Kannada Zilla Panchayat. Mr. K. Padmanabha Kottary, MLA, Vittal constituency presided over the function. Dr. George V. Thomas, Director, CPCRI gave the keynote address.



Inauguration of Kisan mela at Vittal

### Minicoy

A Kisan Mela was organized at CPCRI Regional Station, Minicoy, Lakshadweep on 10.01.2007. A total of 300 progressive farmers of Minicoy participated in the Mela which was inaugurated by Dr. K.V. Ramana, Assistant Director General (PC), ICAR, New Delhi and Dr. George V. Thomas, Director, CPCRI presided over the function. The main topic of discussion during the Kisan Mela was the

relevance of organic farming under the island conditions. An exhibition on CPCRI products including the farm produces and the bunches of high yielding coconut hybrids evolved at Minicoy, was also organized during the Kisan Mela.



Dr. K.V. Ramana, ADG (H-II) addressing Kisan mela at Minicoy

### Kahikuchi

Kisan mela programme was organized at CPCRI, RC, Kahikuchi on 9.1.2007, in which 600 farmers of Kamrup district and a group of agricultural scientists, agricultural officers/managers, agricultural entre-preneurs from different organizations like HRS (AAU), NHB, SBI, RRLRRS (CRRI), CDB, NEDFi, SFAC, Rubber Board, Spices Board, Dhriti (NGO) and others participated. On this occasion an Agri-Exhibition was also organized in which different agricultural research institute and allied organization, NGOs participated. The mela was inaugurated by Dr.S.S.Baghel, Hon'ble Vice-Chancellor of Assam Agriculture University, Jorhat.

**KRISHI VIGYAN KENDRA (KVK)****KVK - KASARAGOD****Training programmes**

Organized a total of 127 training programmes with the participation of 2866 trainees including practicing farmers, farm women, women self help groups, rural youth and extension functionaries on various topics in the disciplines of Agricultural Extension, Agricultural Engineering, Crop Production, Plant Protection, Home Science, Horticulture and allied enterprises. Out of these training programmes 50 were on-campus and 77 were off-campus wherein 1035 (437 men and 598 women) and 1831 (551 men and 1280 women) trainees participated, respectively.

**Front line demonstrations**

Carried out various field demonstrations on cereals, horticultural crops, pulses and allied enterprises to show the performance of varieties as well as technologies. Organized a total of 195 demonstrations in the farmers fields and successfully introduced the high yielding varieties of various crops as well as production technologies viz., PKM-2 (Annual Moringa), Konkan Amruta (Kokum), Surya (Papaya), Kanaka (Sweet potato), TAU-1 (Black gram), Pusa baisaki (Green gram), Nutrition garden, Stem bleeding and drought management practices in coconut, and SRI in paddy.

**Womens' Cell activities**

Organized a total of 18 on-campus and 22 off-campus training programmes exclusively for the benefit of 985 farm women. The topics covered under these training courses are food processing, product diversification in coconut, nutrimix supplements, pine apple preservation, annual moringa cultivation, vegetable cultivation, and beekeeping.

**Extension activities/Services**

Carried out a total of 398 activities comprising of field days, kisan gosthi, kisan melas, exhibitions, film show/Video CD, advisory services, agricultural seminars, farmers visit to KVK, awareness campaigns, field visits, demonstrations etc where in 6116 farmers were benefited. Further, faculty participated in 14 radio TV talks, published 11 extension literature and a total of 31 activities covered in news papers.

**KVK- Alappuzha****Training programmes**

The Krishi Vigyan Kendra organised various training programmes on a variety of topics, out of which 58.3 per cent was on campus and 41.7 per cent as off campus programmes. A total of 145 training programmes were conducted on various topics in which total of 4005 participants attended. Out of these trainings, 74 were on-campus which was attended by 1315 participants and 53 were off-campus programmes which were attended by 1307 participants.

**On Farm Trials**

Under Comparative analysis of fodder grass (Killikulam-1, Para grass and CO-3) in coconut gardens, the average yield recorded was 6 t/ha for para grass, 50 t/ha for killikulam-1 and 98 t/ha for CO - 3.

**ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS**

AICRP on Palms, initiated in 1972 with CPCRI, Kasaragod as the Headquarters, is functioning in 16 Centres located in 9 States. At present, 10 Centres are conducting research on coconut, while 4 Centres are meant for oilpalm research and two Centres are conducting palmyrah research.

**COCONUT**

Based on the Crop Improvement trials in coconut conducted over a period of more than 15 years, the following types are identified as the promising cultivars at the respective locations. The AICRP Centres are taking action to propose the same in the appropriate Varietal Release Committees for their release.

**Tamil Nadu – East Coast:** WCT, Andaman Ordinary, WCT x COD;  
WCT x MYD; Laccadive Ordinary x Cochin China (TxT)

**Maharashtra Coast :** Laccadive Ordinary, Tiptur Tall  
WCT x COD, GBGD x ECT; ECT x GBGD

**Andhra Pradesh:** Philippines Ordinary, Sakhigopal, Laccadive Ordinary

**West Bengal:** Jamaican Tall Laccadive Ordinary, COD x WCT

**Assam :** Assam Green Tall; MYD x WCT

**Chattisgarh :** Fiji Tall

As a thrust area in the Xth Five Year Plan, emphasis was given on the collection, conservation and evaluation of local germplasm at seven centres. A total number of 81 local germplasm types could be collected at different regions during the last two years for further evaluation.

Promising cross combinations of coconut were under evaluation at seven centres. At Ambajipeta in coastal Andhra Pradesh, GBGD x PHOT (134.65 nuts/palm) and GBGD x LCT (126.02 nuts/pam) recorded significantly higher nut yields compared to the control ECT x GBGD (88.78).

Among the proven/recommended varieties and hybrids of coconut under evaluation at Jagadapur in Chattisgarh State since 1988, the nut yield was the highest in COD x WCT (70) followed by WCT x GBGD (65).

Realising the importance of utilizing the local germplasm types or genotypes that have performed well at a particular location as one of the parents in the coconut hybrids, a new project on the "Evaluation of new coconut hybrids" was initiated during the year as per the recommendations of QRT. Seven centres initiated the crossing programme as per the above suggested norms. About 40



new cross combinations would be evaluated at different centres under this trial.

In the coconut based high density multispecies cropping system studies conducted at Arsikere centre in Karnataka State, the mean data over the last four years indicated that the coconut yield was higher with banana as an intercrop as compared to other intercrops. Gross returns were higher when banana was intercropped with coconut followed by drumstick, french bean – ladies finger and redgram. Gross returns were the least in pure crop of coconut.

As a thrust area of research during the Xth Five Year Plan, nine centres initiated studies on the performance of medicinal and aromatic plants as intercrops in coconut gardens. At each centre, a survey on the cultivation of medicinal and aromatic plants was conducted and about 15-20 medicinal and aromatic plants were selected for evaluation under an observational trial. Based on the performance in the observation trials at each centre as well as their market potential, five species were selected at each centre for further detailed studies.

Based on the recommendations of the Biennial Workshop, a new project on "Substrate dynamics for nutrient management in coconut" was initiated at Veppankulam Centre in East-Coast region to study the interaction of biological and chemical substrates to enhance nutrient use efficiency and to find out the suitable

substrate for optimum growth, yield and quality of coconut.

Garden to garden survey on the occurrence of root (wilt) disease of coconut was conducted in Theni, Kanyakumari, Tirunelveli, Dindigul and Coimbatore Districts of Tamil Nadu. Per cent incidence of root (wilt) disease in different villages ranged from 0.8 to 4.0.

A field experiment on the biocontrol of stem bleeding disease indicated the effectiveness of *Trichoderma* spp. against the disease. Of the different treatments, maximum decrease in bleeding (exudation) patch (perimeter) was obtained when *T.viride* / *T.harzianum* / *Thamatum* was applied as a paste on the bleeding patch alone or/and coupled with basal application of the same bioagent (50 g) in combination with 5 kg neem cake per palm.

Studies on the efficacy of pheromones on red weevil in coconut at Ambajipeta Centre indicated that even though CPCRI lure trapped less number of weevils (CPCRI – 1398 nos. & Chem Tica 1865 nos) when compared to that of the Chem Tica lure in a common period of 230 days, it was seen that CPCRI lure caught a total number of 2003 weevils in a working period of 438 days and the lure continued to function afterwards also. Chem Tica lure worked for only 230 days.

#### OIL PALM

Trials on the comparative performance of different cross combinations of oil palm





were continued at all the four oil palm centres. At Mulde Centre in Maharashtra State, the hybrid combination of 115 D X 291 P recorded the highest yield of FFB i.e. 121.75 kg per palm per year (17.4 tonnes per hectare), whereas 109 D X 291 P recorded the highest bunch weight (24.38 kg).

In the studies on the irrigation and nutrient requirements for oil palm crop at Aduthurai Centre, the palms applied with a fertilizer dose of 1200:600:2700 g NPK/palm/year (F3) produced superior FFB yields (14.1 t/ha/year) followed by F2-800:400:1800 g NPK/palm/year (11.9 t/ha/year) and F1-400:200:900g NPK/palm/year (9.5 t/ha/year) and the lowest FFB yield was in palms raised without any fertilizer (F0) (7.7 t/ha/year).

### **PALMYRAH**

Palmyrah research is conducted at Killikulam (Tamil Nadu) and Pandirimamidi (Andhra Pradesh) Centres. The primary task of these two centres is to survey and collect palmyrah

germplasm from different parts of the country and evaluate the same for further utilization. 173 accessions are maintained at Killikulam centre while 176 accessions have been collected and maintained at Pandirimamidi centre since the inception of the project. During the year 2006, survey was continued in Tamil Nadu. Fourteen accessions were collected and the passport data were recorded as per the approved proforma.

At Pandirimamidi centre, tapping was initiated in the 1991 block of palmyrah germplasm as a few palms in some of the accessions have reached the flowering stage. Maximum neera yield of 79.9 litres/palm was obtained in the accession 12/91 over a period of 45 days, which was followed by accession 5/91 that has yielded 37.5 litres/palm in a tapping duration of 35 days.

Seven isolates of pathogen causing tuber rot disease were collected. Among the seven isolates, Killikulam isolate showed maximum growth.

