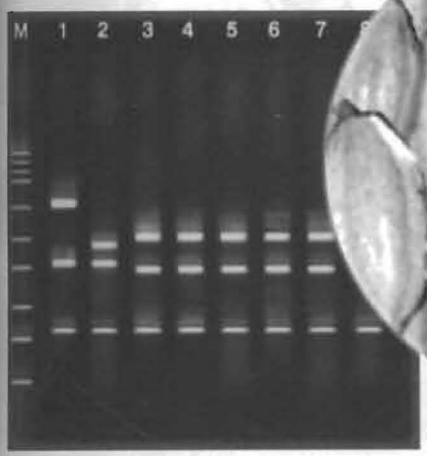
अनुसंधान विशेषताएँ

Research Highlights

2003 - 04



केन्द्रीय रोपण फसल अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद्)
कासरगोड - 671 124, केरल, भारत

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

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RESEARCH HIGHLIGHTS

2003-2004

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(Indian Council of Agricultural Research)
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Front Cover : RAPD profile of *Phytophthora* isolates along with mandate crops
Back Cover : Dr. Pons Batugal, Co-ordinator, COGENT visiting farmer's field at Pallikkara project site

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परिचय

केन्द्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड तथा अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के १४ केन्द्रों की मुख्य फसलें जैसे नारियल, सुपारी एवं कोको पर वर्ष २००३-०४ में हुए अनुसंधान की विशेष उपलब्धियों का सारांश इस प्रकाशन में प्रस्तुत करने का प्रयास किया गया है। संस्थान में जारी ११ बृहत परियोजनाएँ, पाँच मुख्य प्रभाग जैसे फसल सुधार, फसल उत्पादन, फसल संरक्षण, शरीर क्रिया विज्ञान, जैव रसायन तथा कटाई उपरान्त प्रौद्योगिकी एवं सामाजिक विज्ञान के तहत् वितरित हैं।

फसल सुधार परियोजनाओं की मुख्य उपलब्धियाँ हैं - नारियल, सुपारी एवं कोको जननद्रव्यों में बढ़ोतरी, इन फसलों के संकरों का बेहतर उपज और गुणवत्ता के लिए परिष्करण, पुष्पगुच्छ ऊतकों से सुपारी पौध का विकास, माइक्रोसैटेलाइट मार्कर के प्रयोग से नारियल में विविधता का नक्शा बनाना, इत्यादि। फसल उत्पादन प्रभाग में कृषि पद्धतियों में विकास, मृदा एवं जल संरक्षण रीतियाँ, कार्बनिक कृषि प्रौद्योगिकियाँ, रोपण फसल आधारित कृषि प्रणाली में औषधिक एवं बागवानी फसलों का परिचय, इत्यादि को शामिल किया गया है। ताड़ के फाइटोफ्थोरा और गैनोडरमा पर मोलिक्यूलर अध्ययन, कीट एवं रोगों के जैविक नियंत्रण पर अध्ययन फसल संरक्षण प्रभाग द्वारा किया गया है। शरीरक्रिया विज्ञान, जैव रसायन तथा कटाई उपरान्त प्रौद्योगिकी प्रभाग की प्रमुख उपलब्धियाँ जलप्रयोग दक्षता, सूखा सक्षम ताड़ों में स्ट्रेस प्रोटीन पर अध्ययन, काली मिर्च के लिये सौर - एवं - बिजली चालित ड्रायर, नारियल उत्पाद की आशोधित वायुमंडलीय पैकेजिंग, इत्यादि हैं। सामाजिक विज्ञान प्रभाग में सूखे का सुपारी की उपज पर प्रभाव, किसानों के खेतों में प्रौद्योगिकियों का विधिमान्यकरण, विस्तार विभाग के अन्य कार्यक्रम, कृषि विज्ञान केन्द्र, संस्थान ग्राम संपर्क कार्यक्रम और कृषि प्रौद्योगिकी सूचना केन्द्र, आदि के अध्ययन परिणामों को उजागर किया गया है।

वर्ष २००३-०४ के दौरान केन्द्रीय रोपण फसल अनुसंधान संस्थान ने पाँच महत्वपूर्ण बैठक, अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की द्विवार्षिक कार्यशाला एवं कर्नाटक और आंध्र प्रदेश में अभिमुखीकरण बैठक आयोजित की हैं। एक नये जैवसूचना एवं पुस्तकालय भवन का उद्घाटन डा. जी. कल्लू, उपमहानिदेशक (बागवानी एवं फसल विज्ञान) के करकमलों द्वारा संपन्न हुआ। केन्द्रीय रोपण फसल अनुसंधान संस्थान में कीटनाशी अवशेष विश्लेषण एवं गुण परीक्षण प्रयोगशाला और स्पर्श स्क्रीन की स्थापना की गई।

मैं केन्द्रीय रोपण फसल अनुसंधान संस्थान के समस्त स्टाफ को इस वर्ष के दौरान विभिन्न प्रौद्योगिकियों के विकास में दिये गये सराहनीय योगदान के लिए बधाई देता हूँ। मैं इस प्रकाशन के लिये परियोजना अनुवीक्षण एवं तकनीकी विभाग के सहकर्मियों द्वारा दी गई मदद के लिए आभार प्रकट करता हूँ।

वी. राजगोपाल

कासरगोड
७.५.२००४

वी. राजगोपाल
निदेशक

INTRODUCTION

The important research findings on the crops namely, coconut, arecanut and cocoa at CPCRI and those at 14 research centres of AICRP on Palms for the year 2003-04 are summarised in this publication. There are 11 mega projects distributed under 5 major divisions, *viz,* Crop Improvement, Crop Production, Crop Protection, Plant Physiology and Post Harvest Technology and Social Sciences. Additions in coconut, arecanut and cocoa germplasm accessions, evaluation of their hybrids for better yield and quality, development of arecanut plantlets from inflorescence tissue culture, mapping the diversity of coconut using microsatellite markers were the highlights of Crop Improvement Projects. In the Crop Production Division, development in farming systems, soil and water conservation practices, organic manuring technologies, adoption of medicinal and horticultural crops in plantation based cropping system are included. Molecular studies of *Phytophthora* and *Ganoderma* of palms, biological control of pests and diseases were carried out in Crop Protection Division.

Salient achievements in the Plant Physiology and Post Harvest Technology were on water use efficiency, stress proteins studies in drought tolerant palms, solar-cum-electrical dryer for pepper, packaging of coconut products etc. In Social Sciences, results of studies on impact of drought on arecanut yield, validation of technologies in the farmers' fields, and other programmes by extension section, Krishi Vigyan Kendra, Institute Village Linkage Programme and Agricultural Technology Information Centre are highlighted.

During the year 2003-04, CPCRI could organise XVI Biennial Workshop of AICRP on Palms, National Seminar on Coastal Agroecosystem, Interface Meetings at Karnataka and Andhra Pradesh besides five other research meetings/seminars. A new Bioinformatics and Library building was inaugurated by Dr. G. Kalloo, Deputy Director General (Hort. & CS). A pesticide residue and quality testing laboratory and a touch screen information facility was also established at CPCRI, with an aim to improve the research and extension activities.

I wish to congratulate the staff of CPCRI for their contributions to the various technologies developed during the year and acknowledge the help rendered by my colleagues at the PMT Section for bringing out this publication.

V. Rajagopal

Kasaragod
7.5.2004

V. Rajagopal
Director

CROP IMPROVEMENT

Collection, conservation, cataloguing and evaluation of germplasm.

- Under the NATP/PB project, a germplasm collecting trip was undertaken to Port Blair, Bamboo Flat, Rangath, Mayabander and Diglipur areas in the Andaman and Nicobar Islands and 11 coconut accessions were collected. In another trip to Lakshadweep, Amini and Kadamath Islands were surveyed and 10 accessions were collected (Fig.1).

- Principal component analysis of fruit component data revealed that Kurmadera Brown Tall and Panighat Giant were distinct accessions of Andaman and Nicobar Islands.

Fig.1. Coconut diversity in Amini Island

- Seventy one numbers of arecanut accessions were planted for their evaluation in the sub Himalayan terai region of West Bengal in different phases. Maximum numbers of nuts were collected from the accessions Nalbari (989 nuts/palm) followed by K&J Hills (965 nuts/palm).

- Based on the comparatve yield trial on elite cocoa clones, about 2,200 grafts belonging to 4 hybrids *viz.*, II-67xNC-29/66, II-67xNC 42/94, ICS-6xSca 6, I-56xII-67 and one clone, NC-45/53 were produced as breeder s stock.

Biotechnology

In vitro multiplication of coconut and arecanut

- A protocol for arecanut tissue culture from inflorescence tissues was evolved and observed to be repeatable. The protocol was also tested with different arecanut varieties.

- The coconut rachilla explants could be maintained without transfer for over five years in flask with newly developed stopper. Prolonged maintenance of cultures was possible as the evaporative loss from the tube could be controlled. Rachilla explants maintained for one year under slow growth were subcultured to obtain shoots from the floral primordia (Fig.2).

Fig.2. Rachilla explants of coconut in test tube.

Microsatellite analysis of Andaman collections :

- Microsatellite analysis was carried out for 12 Andaman coconut accessions with 10 microsatellite primers and the other 12 accessions with 6 microsatellite primers. A total of 52 alleles were detected by the 10 primers, with an average of 5.2 alleles per primer. The mean gene diversity was 0.362. Heterozygosity was lowest for Nicobar Orange Dwarf and the highest for Dugong Creek Tall. The Nicobar Orange Dwarf and Andaman Yellow Tall clustered as a separate group and the rest of the accessions clustered as another group.

Microsatellite analysis of root (wilt) resistant and susceptible mother palms

- Microsatellite analysis was carried out in the root (wilt) resistant mother palms and susceptible palms with nine microsatellite primers to identify the genotypes conferring resistance and susceptibility to the disease. A total of 30 resistant mother palms and 30 susceptible palms were analysed with nine microsatellite primers. The resistant talls from Haripad and Kayangulam clustered together as separate group and the resistant talls from Kottayam and Thiruvalla clustered as separate group in the dendrogram.

Bioinformatics

Development of coconut database for biologists

- Developed three databases *viz.*, Coconut cultivar identification (Web enabled), Coconut germplasm management system and Database on coconut biotechnology (Literature Database).
- Developed web site with provision to access the databases. Also web enabled access is provided for resource sharing between Central Plantation Crops Research Institute, Kasaragod and Indian Institute of Spice Research, Calicut.

CROP PRODUCTION

Development and evaluation of soil and water conservation measures and land use systems for sustainable crop production in western ghats of coastal region.

- Growing of CO 3 grass as intercrop (for dual purpose i.e, soil and water conservation and fodder) in coconut garden with hose irrigation proved to be the best treatment economically with net return of Rs. 87,577/ha with BC ratio of 3.03 closely followed by growing grass as intercrop with drip irrigation with BC ratio of 3.00 (Rs. 84,771/-). However, in terms of soil and water conservation, the best treatment was trench filled with coconut husk with two rows of pineapple border, where the loss of soil, nutrients were minimum compared to other treatments.
- The total harvested water in the storage structure (7.46 million litres) could irrigate 1.5 ha of coconut based cropping

system (banana, pineapple, grass and pepper) for a period of seven months (November to May) conveniently through micro irrigation. The quantity of water available even during peak summer was more than 60 per cent of the total capacity.

- For arecanut grown in an area with 1- 3 per cent slope, one drain between four rows is sufficient to provide better drainage and to keep nutrient loss to the minimum compared to conventional practice of having one drain between two rows of arecanut palms.

High density multi-species cropping system model for coconut root(wilt) affected garden

- The output obtained from HDMSCS model for root (wilt) affected garden in 1 ha area during 2002-2003 from different crops of the system was as follows: coconut —5942 nuts (1.07 tonne of copra) from 98 palms, banana —1752 kg, pepper — 19.6 kg, nutmeg — mace-6.0 kg, nutmeg —18.0 kg, pineapple — 87 kg, amorphophallus —146 kg and cassava -172 kg.
- The variable cost of production involved in maintaining one ha of this system during the year was Rs. 38945/ and the gross return obtained from one ha system was Rs. 86871/(based on nuts sold), Rs.105146/ (based on copra sold). The net return was Rs. 47926/(based on nuts sold), Rs.66201/ (based on copra sold). The gross income obtained from component crops was Rs. 34670 during the year. The average nut yield during the year under the system was 61 nuts/ palm/year.

Initiation of the mixed farming system

- Guinea grass and Hybrid napier grasses have been established as mixed crops in coconut garden. The cropping system is integrated with dairy unit consisting of two cross bred cows, one cross bred HF and another cross bred Jersey (Fig.3). The waste obtained from the system is being recycled into the coconut garden.

Fig.3. Mixed farming model comprising of coconut with fodder grass and cattles in root (wilt) affected garden.

Plantation based integrated farming system under the island conditions (Lakshadweep)

- Locally produced hybrids performed better than their parents and the varieties / hybrids introduced from out side. The hybrid combination Laccadive Ordinary (LO) x Dwarf Green (DG) continued to maintain its high yield potential over the others with 175 nuts/ palm/year.
- Mushroom culture utilizing the waste materials like the banana leaf sheath, coconut bunch waste and seaweeds available in the island has been standardized. Maximum yield of 910 g of mushroom (*Pleurotus florida)* was

obtained from 1 Kg bed of banana leaf sheath followed by 730g on coconut bunch waste.

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

- Different winter season and summer season annual vegetables were planted under arecanut shade. Among the summer vegetables, the performance of basella (poi), and different gourds were satisfactory. Maximum yield/ha (536 quintal) was recorded from pumpkin followed by bottle gourd (268 quintal).

Performance of wilt tolerant pepper lines in areca garden under sub Himalayan Terai region.

- In the experiment laid out in 2001, maximum vine length was recorded in lines Karimunda (220.5 cm) with a maximum leaf of 148 per vine and maximum (13.0) numbers of shoots per vine. The performance of other lines P-339 and P-24 was also similar to Karimunda. During July-August maximum vines of all the lines were affected by the fungus *Phytophthora* but it was minimized during the next period. Only 16.60 and 11.10 % of vines of two lines (C-1090 and Panniyur 1, respectively) were affected by this fungus.

NPK requirement of high yielding varieties of arecanut

- The experiment was laid out in a strip plot design with four replications. Different fertilizer doses were imposed in four released arecanut varieties. Maximum numbers of nuts per inflorescence (74) was recorded in Mohitnagar at F_0 level of fertilizer whereas maximum challi yield was recorded in Mohitnagar at F_4 level of fertilizer. The number of nuts per palm was recorded low in this year due to severe nut fall as there was bad weather condition during January-February.

Vermicompost from palm wastes

- Vermicomposting trials with coconut leaves + banana pseudostem waste and coconut leaves + glyricidia leaves (@3:1 proportions) proved that *Eudrilus sp.*, could successfully convert 60-65% of the substrate to mature vermicompost.

- *Metarhizium anisopliae* was found to be effective in managing the breeding of rhinoceros beetle grubs in vermicomposting sites, where recycling of coconut biomass using native earthworm species - *Eudrilus* sp. is being done. The pathogen was also safe towards the earthworms.

- During this year, about 2.5 lakhs earthworms of the local *Eudrilus* sp. were multiplied and distributed to the farmers and agricultural/horticultural departments of Kerala and neighbouring states as a part of disseminating vermicomposting technology.

Allelopathy studies in coconut based cropping system

- Green house studies on the effect of coconut root and leaf leachates on the growth and rhizosphere microbial

activity of pepper cutting and nutmeg graft indicated that the rhizosphere microorganisms played a critical role in overcoming the possible allelopathic effects of the coconut leachates on the growth of these spice crops. Vermiwash (allelochemical extracted from coconut leaf vermicompost) significantly improved soil microbial activity and growth parameters of nutmeg.

- The effect of coconut leachates at different concentrations was tested *in vitro* against the efficient diazotrophs and PGPRs, which are under field experimental trials in coconut crop. The coconut root and leaf leachates at three concentrations 1:0, 1:1 and 1:10 showed antibacterial allelopathic properties against the diazotrophs tested, particularly the *Herbaspirillum frisingense*.

Biofertilizers and PGPRs

- Plant growth promoting rhizobacteria (PGPR) of *Bacillus* spp. were found to significantly increase the plant growth parameters of coconut seedlings (WCT variety) like number of leaves, seedling length, collar girth etc. The establishment of the treated seedlings was better than the untreated ones.

CROP PROTECTION

Bioecology and management of coreid bug *Paradasynus rostratus* Dist. affecting coconut palm

- An egg parasitoid *Chrysochalcisea indica* Narendran (Torymidae) could be obtained from egg mass of coreid bug. This is a new record.

Investigations on biocontrol agents of pests of coconut palm

- In Androth Island of Lakshadweep rhinoceros beetle damage on palms was found to be very mild with an average of 5.64% leaf damage, 0.5% spathe damage and 1% spindle damage and the population of *Oryctes rhinoceros* showed 25 % of OBV incidence. This shows the impact of release of OBV for bio suppression of *O. rhinoceros*.

Studies on nut infesting eriophyid mite in coconut plantations

- Survey on mite incidence in Androth island revealed an average 19.82% nut infestation. Eighty percent of infested nuts exhibited mild level of infestation. Sample nuts collected showed high population of predatory mites especially *Amblyseius sp.*

Rotting and immature nut fall of eriophyid mite infested coconut

- Though immature nut fall is one of the symptoms of eriophyid mite attack, the nut shedding becomes very severe when the nuts are invaded by fungi through the wounds caused by mite. Rotting of nuts is very often noticed even with minor mite attack.

Lasiodiplodia theobromae has been identified as the causal organism of rotting and immature nut fall of eriophyid mite infested nuts.

- Among the fungicides tested, Bavistin (Carbendazim 50% WP) 0.0125 to 0.1% and Indofil M-45 (Mancozeb 75% WP) 0.3% completely inhibited the growth of *L.theobromae* and were fungicidal.
- Among the various plant extracts tested, the extract of *Allium sativum* at 2-4% concentration was superior to all other extracts in inhibiting the growth of *L.theobromae.*

Management of leaf rot disease in root (wilt) affected coconut palms

- Management of leaf rot disease in root (wilt) affected coconut palms could be achieved with talc-based biocontrol agent *Pseudomonas fluorescens, Bacillus subtilis*, with fungicides *viz.*, Contaf, Tilt, Bavistin and acetone extracts of *Adenocalymma alliceae* and *Lawsonia inermis* (Fig.4). *B. subtilis* was found to be highly compatible with the fungicides and plant extracts for possible use in integrated management.

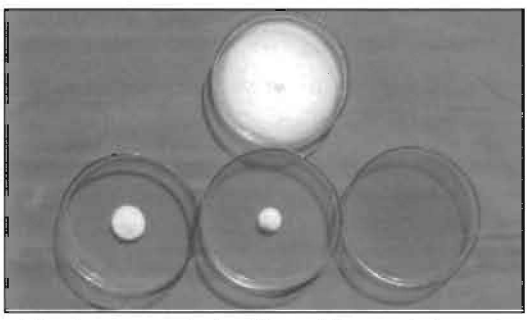

Fig. 4. Antagonistic effect of *Lawsonia inermis* extract on *Colletotrichum gloeosporioides*

Optimization of PCR conditions and RAPD profile for detection of coconut bud rot pathogen:

- PCR procedures were successfully standardized for coconut bud rot pathogen *Phytophthora palmivora* (Pp), with ITS 3 and ITS 4 primers. Optimization of reaction conditions like annealing temperature (55°C) and concentration of various components involved in PCR i.e., template DNA (100ng), Taq polymerase 1U, $MgCl_2$ (1.5mM), dNTP s (200 M) and 50 pM of each primers were carried out to get a reaction product of 650 bp (Fig. 5).

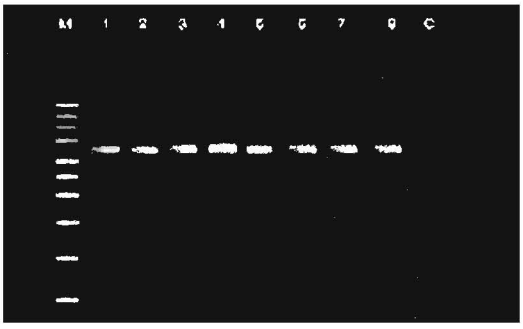

Fig. 5. PCR amplicons of different *P.palmivora* isolates

- Of the 10 random oligoprimers screened against 8 isolates, four were selected as informative ones as they were giving clear and repeatable RAPD profiles. Isolates Pp 1 (Thrissur Dt.) and Pp 5 (Dakshina Kannada Dt.) showed clear polymorphism with all the four primers (OPA - 3, OPA - 11, OPD - 02 and OPF - 1). Isolate Pp8 (Kannur Dt.) showed polymorphism with primer OPF - 11 alone whereas others did not show any difference (Fig. 6).

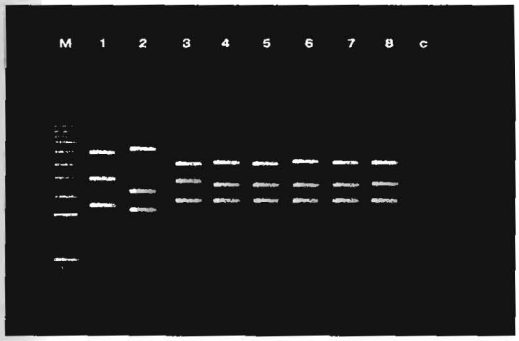

Fig. 6. RAPD profile with oligoprimer OPA 3

M-100 bp marker
1-Pp 1 (Thrissur)
2- Pp 5 (Dakshina Kannada)
3-Pp 8 (Calicut)
4-Pp 21 (Kannur)
5-Pp 25 (Kasaragod)
6-Pp 30 (Wayanad)
7-Pp 33 (Malappuram)
8-Pp 34 (Palakkad)
C-Control

Molecular Studies of *Ganoderma*

- The DNA from 17 isolates of *Ganoderma* had been isolated using isopropanol method to study the molecular variability of the isolates. PCR conditions had been standardized successfully using ITS3 / ITS4 and *Ganoderma* specific primers. Both the primers showed amplification at the expected size.

Pathogenicity of *Ganoderma* on areca seedlings and induction of fruiting body in culture

- A pathogenic isolate of *Ganoderma lucidum* (G3) multiplied in saw dust + malt extract + biotin medium was incorporated into the root zone of areca seedlings raised in polybags. Out of 10 seedlings inoculated, three seedlings started showing symptoms of basal stem rot — stem cracking and oozing of reddish brown liquid- 4 months after inoculation (Fig.7). Five seedlings were also inoculated by root split method with *G. lucidum* mycelia multiplied by growing the fungus on Waksman Agar. On one of the seedling stems, water soaked lesion was noticed two months after inoculation.

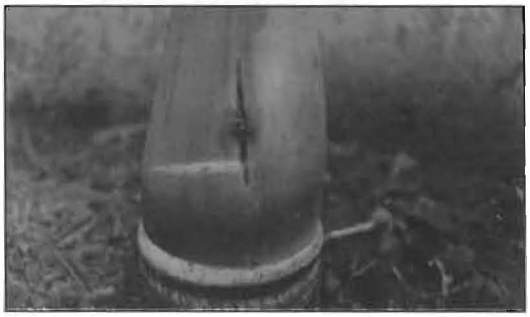

Fig. 7. *Ganoderma* inoculated seedling showing oozing symptom

- To initiate fruiting body production in the culture, *G. lucidum* was grown in wheat straw + rice bran + saw dust medium in polybags and incubated at 27¡C for three weeks. The culture was transferred to a mushroom shed and the mouth of the polybags opened to facilitate fruit body formation. Fruiting body initials were noticed after one week.

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

- Observation on root (wilt) disease incidence in various cross combinations of West Coast Tall variety of coconut revealed the superiority of artificially pollinated seedlings (full sibs) over the open pollinated seedlings (half sibs).
- The CGD X WCT hybrid, planted during 1991, gave an average yield of

78 nuts/palm/year, even though sixty five percent of hybrids recorded the incidence of root (wilt) disease. The disease-free hybrids gave an average yield of 95 nuts/palm/year and the diseased hybrids gave an average yield of 55 nuts/palm/year indicating that the CGD X WCT hybrid is tolerant to root (wilt) disease.

- Artificial pollination was carried out in the farmers plots of Alappuzha, Kollam, Pathanamthitta and Kottayam districts involving 69 West Coast Tall, 85 Chowghat Green Dwarf and 25 Chowghat Orange Dwarf, to develop a resistant/tolerant variety to coconut root (wilt) disease and for the production of quality planting materials for establishing nucleus seed gardens.

- A total of 6344 artificially pollinated seedlings have been planted so far, for establishing the five nucleus seed gardens. These seed gardens when they come to the full bearing stage are expected to produce 2.5 lakh seedlings/ annum, which will substantially meet the heavy demand for quality planting materials in the root (wilt) prevalent tract.

Sero-diagnostic test for the detection of arecanut yellow leaf disease

- A polyclonal antiserum to arecanut yellow leaf disease has been prepared in New Zealand variety rabbits. Membrane fractions of phytoplasma isolated and purified from the spear leaves of diseased areca palms was used as antigen for immunizing rabbits. Double diffusion test has been standardized for the detection of YLD. Spear leaf extracts from diseased and healthy palms were tested in one per cent agar gel against yellow leaf antiserum. A single precipitin line was observed midway between the diseased antigen and antiserum wells. The antiserum can be used for identifying disease free elite areca palms for crossing programmes to evolve YLD tolerant/resistant areca varieties.

Studies on homopterans of areca palm:

- The most abundant diaspidids colonising areca palm are the oriental scale *Aonidiella orientalis,* the mussel scale *Lepidosaphes* sp. and the pandanus scale, *Pinnaspis buxi*. The coconut scale, *Aspidiotus destructor* is not found infesting areca palms. An Aleyrodid closely resembling the citrus black fly is found colonizing the leaves of areca palms causing necrosis and drying of leaves. This is identified as *Aleurocanthus* sp closely resembling *Woglumi* but a different species. Out of the many species of mealy bugs infesting areca palm, except *Dysmicoccus* sp., all are of minor importance.

PLANT PHYSIOLOGY & BIOCHEMISTRY

- Variations in ABA and cytokinin in coconut cultivars and hybrids in relation to drought tolerance have been observed with changes in the water status of the soil as well as leaf. ABA concentration increased with reduction in leaf water potential whereas cytokinin concentration decreased. The low ABA with high cytokinin concentration in the xylem sap in COD, MYD and COD x WCT during stress period showed negative impact on stomatal closure thus making the cultivars/hybrids susceptible to moisture stress. On the other hand, WCT, LCT, Benaulim, WCT x GBGD, LCT x GBGD and LCT x COD with medium to high ABA/CK adapted to stress conditions by stomatal closure thus maintaining the water balance. The present observations thus further confirmed the drought tolerant/ susceptible nature of the coconut cultivars/hybrids.
- The aqueous polyphenol fraction of arecanut at 0.5 mg kg^{-1} body weight of Albino Wistar rats had significant incision-wound healing properties, both alone and in combination with the alkaloid fractions of same concentration. The alkaloid fraction of areca, separately, had little wound healing effect.
- The fatty acid profile of developing nut indicated progressive increase in the concentration of Lauric and Myristic acid. The concentrations of C 8:0 and C 10:0 fatty acids also increased during the nut development. However, the concentrations of other fatty acids (C: 16:0; 18:1; 18:0; 18:2; 6:0; 20:0; 16:1; 22:0; 24:0) either decreased or remained constant during nut development. Results indicated that the 6^{th} and 7^{th} month old nut had proportionately higher concentrations of long chain fatty acids.

PRE AND POST HARVEST TECHNOLOGY

Development of the packaging technique for mature fresh coconut kernel, coconut paste and ball copra

- Passive MAP packaging of fresh kernel facilitated the shelf-life of fresh kernel to six months. Care should be taken that the temperature should not go below 10^0 C to avoid chilling injury.
- Bottling (canning) of the kernel enhanced the shelf life of the fresh kernel to three months at storage temperature of 25^0C. This storage period can be extended to more than three months by canning the kernel in the cans.
- Mature fresh coconut kernel paste can be bottled for a storage period of two months.
- The storage period of ball copra and cup copra could be extended to four months

by vacuum packing in PVC film of thickness 0.0952 mm.

Solar dryer

- A solar tunnel dryer of semi cylindrical shape with base area of 3 meter x 3 meter and maximum height of 1.5 meter was developed. The metallic frame structure was covered with UV stabilized transparent polyethylene film of 200-micron thickness. Black polyethylene sheet of 250-micron thickness was spread on the ground inside the dryer for better absorption of solar radiation. In order to prevent condensation of moist air during night hours, an exhaust fan of 1000-m^3 air flow rate capacity and 0.7 KW power rating was provided. A Humidity sensor was developed to control the operation of the exhaust fan to maintain relative humidity inside below 50%. The capacity of the dryer is 2000 nuts and the cost of the dryer is calculated as Rs.10000/ only. The dryer can be used to dry other plantation crops such as pepper, cardamom etc.

Shell fired copra dryer

- A copra dryer was designed to dry 1000 nuts/batch from the heat generated by firing coconut shell. The heating chamber was designed such that smoke does not come into contact with copra. The drying air temperature in the drying chamber was 80¡C. It took 22, 21, 26 and 25 h to dry coconut from the average initial moisture content of 90.14, 88.34, 92.12 and 86.23 to 6.25% db., respectively in the four replicate tests conducted at full load. The thermal efficiency of the dryer at full load was in the range of 25.25 to 16.48%. The cost of 1 unit of this dryer was approximately Rs.15,000/- The average cost of drying 1kg of copra was worked out to be Rs.5.33.

SOCIAL SCIENCES DIVISION

The major highlights of the transfer of technology programmes conducted by the Institute during the year for the benefit of extension personnel and farming community from different regions of the country are:

- Three package programmes on Entrepreneurship Development Programme on Value Addition in Coconut were or ganized at Pallikkara (Kasaragod district), Perla (Kasaragod District) and Pathiyur (Alappuzha District). The programme was sponsored by the National Agricultural Technology Project. Each programme, of ten days duration, aimed at providing skill oriented training to 30 - 75 farm women on the following six coconut based value addition technologies: 1) Snowball tendernut; 2)Chips production; 3) Quality coconut oil production; 4) Preparation of coconut candies; 5) Mushroom production; 6) Vermicompost preparation.
- A total of 22 training programmes were organized on various aspects of coconut, arecanut and cocoa crop management as

well as post harvest technologies for officials and progressive farmers from Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, Bihar, Maharashtra and Assam States.

- **An Interactive meeting of farm journalists and scientists** was organised at CPCRI, Kasaragod on January 14, 2004. 24 journalists representing 12 news papers, 2 farm journals and 2 television channels participated in the programme.

- A **Dialogue session on the impact of participatory demonstration of root (wilt) disease management** was conducted on August 9, 2003 at CPCRI (RS) Kayangulam. The 82 participants included extension officials, participant farmers/family members of demonstration programmes and scientists. The participants opined that the integrated management practices are very effective in improving the health and yield of root (wilt) affected palms.

- Five Video Films on selected technologies were prepared for use by extension personnel, farmers and students: 1) Coconut cultivars and hybrids; 2) Coconut production technology; 3)Management of root(wilt) affected coconut garden; 4) Management of eriophyid mite in coconut and 5) Arecanut production technology.

- The IPGRI Project on Developing sustainable coconut based income generating technologies in poor rural communities in India was implemented among the coconut growing communities in Pallikkara (West-Coast region) and Ariyankuppam (East-Coast region). In each site, a Community Based Organisation of coconut farmers was formed and registered. Training programmes on micro credit management, CBO Management, inter/ mixed cropping in coconut, livestock rearing and value addition technology were organized. Specific interventions aiming at improving the returns from coconut cultivation in terms of inter/ mixed cropping, mixed farming and value addition technologies were introduced and their impact were analysed with reference to improvement in income, cost benefit ratio and other economic and technical parameters.

- A project on Farmer participatory characterization of coconut varieties in two poverty reduction project sites in India was implemented in Pallikkara and Ariyankuppam coconut communities. Farmer participatory methods were employed for analysing the coconut diversity in farmers gardens. Altogether, 13 diverse coconut types, 6 in Pallikkara and 7 in Ariyankuppam coconut communities were identified and their significant characteristics were documented. The study revealed that genetic diversity occurs in farmers coconut gardens in the selected communities which could be effectively used for sustainable development of coconut.

During the year, 19 interventions were introduced for Technology Assessment under the Institution Village Linkage Programme. Salient observations made in the project were as follows:

- On assessing the efficiency of telescopic arecanut sprayer, farmers opined that the sprayer was ideal and could be conveniently used in the arecanut gardens of uniform canopy. According to farmers, one of the main drawbacks in telescopic arecanut sprayer is that the quantity of spray solution required was higher due to more wastage while spraying.
- In the verification trial on assessing the performance of CO -3 hybrid fodder grass as intercrop in coconut, it was recorded that the yield in the first cutting was about 12,000 kg/ha. The subsequent harvesting was expected at every 45 days.
- Consumer preference studies were conducted at Ernakulam and Kasaragod districts for coconut jam and coconut water concentrate. The consumers preferred to use coconut jam as a substitute for other jams and they ranked the same as a good match along with bread and butter for the breakfast.
- Nearly 73% of the consumers in Ernakulam were of the view that the taste of coconut water concentrate was fair, while 16% of the consumers opined that the taste was good. Similarly, 83% of the consumers in Kasaragod felt that the taste of coconut water concentrate was fair and 6% of the respondents felt that the taste was good. Most of the consumers felt that the diluted form of coconut water concentrate cannot be considered as a close substitute for other soft drinks.
- Survey conducted among the cocoa growers in Dakshina Kannada District for analyzing economics of cocoa cultivation revealed that the farmers spent Rs. 43,000/- per ha. during the initial three years for the establishment of cocoa gardens. In a well developed cocoa garden, the total cost of cultivation worked out to be Rs. 33695/ha while the total returns was Rs. 78000/ha, thus resulting in a net return of Rs. 44,305 with a benefit cost ratio of 1.91.

Transfer of Technology

- A Touch Screen Monitor was installed at the Agricultural Technology Information Centre of CPCRI (Fig.8). Programmes on coconut cultivation, arecanut cultivation, cocoa cultivation, CPCRI — at a glance andATIC services

Fig. 8. Dr. M.V. Rao, Former Spl. D.G., ICAR inaugurating the Touch Screen Monitor

were installed by modifying the applications to suit the Touch Screen environment and developed an application to integrate the above software packages.

- **Website facilities** : Approximately 15000 clients are visiting the CPCRI

website (http://cpcri.nic.in) every year. Information is available at this website under the following titles:- About CPCRI; Achievements; Technology; ATIC (i. Newsletter, ii. Services, iii. Price list, iv. Registration for planting materials, v. Ask the expert); AICRP on palms; Frequently asked questions; Future thrust; Publications; Personnel; Events; Feed back; Contact us.

- **Utilization of mass media for transfer of technology:** A study on assessing the extent of utilization of mass media for transfer of technology in palms and cocoa by the Institute revealed that there is a substantial increase in the publication of popular articles from 1998-99 onwards. The distribution pattern of popular articles published in different languages showed that a major share of articles was published in English (34.44 per cent) and Malayalam (33.33 per cent), 65 popular articles (18.06 per cent) were published in Kannada, while 37 (10.28 per cent) were published in Hindi. Only few articles were published in Tamil (9 nos.) and Telugu (5 nos.). Crop-wise details of radio programmes present a highly uneven distribution. About two-third (61.4 per cent) of the radio programmes were on topics related to coconut, 25.5 per cent programmes dealt with arecanut and only 4.12 per cent of the radio programmes covered the topics related to cocoa. Hence, efforts to present more programmes on cocoa cultivation are to be strengthened. Further, the results pointed to the fact that palm based farming systems and post harvest processing technologies need to be given more coverage considering the importance of these subject matter areas in increasing the income of farmers especially in the current scenario of globalization.

Impact of drought on areacanut production

- A survey was conducted in four major arecanut growing districts of Karnataka namely Chikmagalur, Tumkur, Shimoga and Dakshina Kannada to estimate the impact of drought on areacanut production. The estimated average yield loss due to drought in the four districts was 14.5%. The drought mainly affected the farmers with small holdings who lacked proper irrigation facilities.

KRISHI VIGYAN KENDRAS

KVK at Kasaragod

- The Krishi Vigyan Kendra organized 114 training programmes for the benefit of 3,798 personnel comprising 1,650 males and 2,148 females. Out of this, 36 are on campus and 78 are off campus . Training programmes were conducted in different disciplines *viz.* agronomy, horticulture, entomology, plant pathology, home science, agricultural engineering, animal science

and agricultural extension for the benefit of practising farmers, rural youth, farm women, self help groups, kudumbashree units and extension functionaries.

- On-Farm Trials were conducted on the management of inflorescence die back (*Colletotrichum gleosporioides*) in arecanut and *in-situ* rainwater harvesting.
- Three Frontline Demonstrations were organized during the year on introduction of high yielding variety of ginger Varada in homesteads; high yielding variety of paddy-Karuna and high yielding variety of cucumber — Arunima, for cultivation by the farmers.
- A total of 26 training programmes (13 on-campus and 13 off-campus) were conducted under Women s Cell of KVK with the participation of 526 farm women and members of SHGs/Kudumbashree units (228 trainees for on-campus and 298 trainees for off-campus).

Scientist-Farmer Interaction Programme

- Under Scientists-Farmers Interaction Programme, 10 field visits were conducted, wherein 18 farmers fields located in 17 villages belonging to 11 grama panchayats such as Pullur-Periye, Kallar, Kinanoor-Karindalam, Badiadka, Chemnad, Bedadka, Mangalpady, Madikai, Kodom-belur, Madhur and Mogral Puttur were covered.

KVK, Kayangulam

- A total number of 132 training programmes were conducted on various topics relevant to the District, in which 3112 (2258 females and 854 males) participants attended. Out of these trainings, 72 were on-campus and 60 were off-campus programmes.
- Frontline Demonstrations were organized during the year on 1) *Trichoderma* against quick wilt of pepper; 2) Making coconut homestead self sufficient in organic matter requirement and 3) Prevention and control of anaemia among pre-school children.
- Three On Farm Trials on the following topics were organized: Evaluation of different substrates for the production of oyster mushroom; Comparison of effect of organic and chemical fertilizers in amaranthus and control of rhinoceros beetle in vermicompost pits.
- Farmers help line services through telephone was highly utilized by various clients. A total of 723 help line calls were received and appropriate response was provided on various topics, field problems, collaborative functions and networking of farmers. The average number of persons availing help line services per month comes to 60.2.
- Success stories on the following enterprises based on the training programmes were documented : Chaithanya Kudumbasree unit (pickles, squash, jam); Leenarani (spawn production); Divakaran Pillai (bush jasmine); Jayesh and Marykutty Pappachan (bee keeping) and Meghanath Guptha (*Azolla*).

ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

Coconut

- At Ratnagiri centre in Maharashtra state, coconut is grown with companion crops like cinnamon, nutmeg, clove, black pepper, garcinia and allspice. The results showed that coconut yield gradually increased over a period after planting the intercrops irrespective of the companion crops. Maximum increase was recorded in clove plot (93.4%) followed by allspice (83.0%), cinnamon (71.6%) and nutmeg (69.7%), Coconut + nutmeg was found to be the most profitable combination Rs.70,050/- followed by coconut + pepper with a net profit of Rs.54,455/-. Encouraged by the profit accrued due to mixed cropping with tree spices, the University has proposed Lakhibaugh concept to be followed in coconut grove of Konkan region.

- In the trials on integrated management for coconut through organics being conducted at Agricultural Research Station, Arsikere, Karnataka state, significantly higher nut yield/palm/year was recorded with the application of 100 per cent composted coir pith (95 nuts/palm/year) followed by neem cake + bone meal + ash (87 nuts/ palm/year) as compared to control treatment (51 nuts/palm/year).

- At Aliyarnagar centre in Tamil Nadu state, studies on nutritional requirement of COD x WCT indicated response to application of nitrogen increasing the number of functional leaves, number of bunches, female flowers and yield. Among the 27 treatment combinations, 500:250:200 N, P_2O_5 and K_2O/palm/year recorded a mean yield of 155 nuts/palm which also gave a net income of Rs.35,500/ha and B C ratio of 1.91.

- In the irrigation trials for coconut crop conducted at the Agricultural Research Station, (Arsikere), significantly more number of nuts/palm/year were harvested in the treatment receiving drip irrigation at 100% Eo (117 nuts) which was on par with basin irrigation at IW/CPE ratio 1:00 (107 nuts/palm/ year).

- At Ambajipeta centre in Andhra Pradesh, the field experiment with talc formulation of *Trichoderma viride, T. harzianum* and *T. hamatum* have given encouraging results of effective control and spread of BSR, when applied in combination with 5 kg of neem cake than when used in combination with FYM.

- At Aliyarnagar in Coimbatore District of Tamil Nadu state, the IPM practice involving spraying of Dichlorvos (Nuvan) @ 2 ml + Sandowit 1 ml/litre

and release of pupal parasitoids (1:8) three times at 21 days interval brought substantial reduction in the infestation of *Opisina*.

- Prophylactic control measures for rhinoceros beetle in Ratnagiri involving placement of phorate in sachets in leaf axils followed by endosulfan 4% dust @ 50 g/palm, methyl parathion 2% dust @ 50 g/palm, Lindane 1.3% dust @ 50 g/palm were equally effective as prophylactic measures. Breeding material trap has also given encouraging results to the extent of getting a maximum of 75 grubs per pit during September.

Oil palm

- At Gangavathy centre in Karnataka state, irrigation treatments had significant effect on FFB yield in oil palm. Basin irrigation recorded 10.48 tonnes of FFB/ha. The higher doses of NPK 1200: 600: 2700 g resulted in significantly higher FFB yields (13.14 t/ha). The highest mean yield was recorded with drip irrigation and 1200: 600 : 2700 g of NPK treatments (11.73 t/ha).

Palmyrah

- A joint survey was conducted by the scientists of AICRP-Palms centres, Killikulam and Pandirimamidi in palmyrah growing areas of West Godavari and East Godavari districts of Andhra Pradesh for the collection of local germplasm in palmyrah; 13 types were collected during the survey and the types are being maintained both at Horticultural Research Station, Pandirimamidi (Andhra Pradesh) and Agricultural Research Station, Killikulam (Tamil Nadu).

Workshop on AICRP on Palms

- The XVI Biennial Workshop of All India Coordinated Research Project on Palms was held during October 27-29, 2003 at Central Plantation Crops Research Institute, Kasaragod, attended by 62 delegates. The deliberations of the Workshop were conducted in six technical sessions. The scientists operating the projects at different centres presented the biennial progress reports covering the period 2001-03.