NATIONAL WORKSHOP ON ARECANUT PRODUCTION – ASPECTS AND PROSPECTS

11-12 October 2004

SOUVENIR AND PROCEEDINGS

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PREFACE

Arecanut (*Areca catechu* L.) is an important palm species in India, which occupies a prominent place in the social, cultural, religious and economic activities of the society. It is one of the most profitable cash crops in India. India has become self sufficient in arecanut in the early seventies. The ICAR initiated research on arecanut in 1947 and constituted an ad-hoc arecanut committee to study the problems of arecanut industry. The Committee gave a firm foundation for arecanut research by establishing the Central Arecanut Research Station at Vittal in 1956. During the years 1958 to 1959 five Regional Stations at Kahikuchi (Assam), Palode and Kannara (Kerala), Hirehalli (Karnataka) and Mohitnagar (West Bengal) were also established.

Arecanut is cultivated in India over an area of 3.349 lakh ha producing 4.094 lakh tonnes during 2001-02 with the productivity of 1.22 tonnes/ha. The main pockets of production of arecanut in India are distributed in the states of Karnataka (40% of area and 44% of production), Kerala (26% of area and 21% of production), Assam (22% of area and 17% of production). Other states producing significant quantities of Arecanut are Meghalaya, West Bengal, Andaman & Nicobar Islands, Andhra Pradesh, Goa, Maharashtra, Mizoram, Tamil Nadu, Tripura and Pondicherry.

The workshop is intended to take stock of advancements in the research and development in arecanut for last few decades. People from the entire areca growing areas of the country are attending the workshop. Apart from research workers, people from developmental agencies, industry and growers are also participating in the workshop. The workshop is divided into five sessions *viz.,* Advances in Arecanut Research, Farmers' Innovations, Extension and Development, Marketing and Planery Session for better discussion on different topics. In all about 31 papers will be presented in the seminar, which includes lead papers, oral, and poster presentations.

The souvenir articles and extended summaries submitted by authors have been included in the proceedings.

Editors

CONTENTS

Author Index

National Workshop on Arecanut Production – Aspects and Prospects
11-12 October 2004

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ARECANUT RESEARCH IN INDIA

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Introduction

Arecanut (*Areca catechu* L.) is an important palm species in India, which occupies a prominent place in the social, cultural, religious and economic activities of the society. It is one of the most profitable cash crops in India. India has become self sufficient in arecanut in the early seventies. The ICAR initiated research on arecanut in 1947 and constituted an ad-hoc arecanut committee to study the problems of arecanut industry. The Committee gave a firm foundation for arecanut research by establishing the Central Arecanut Research Station at Vittal in 1956. During the years 1958 to 1959 five Regional Stations at Kahikuchi (Assam), Palode and Kannara (Kerala), Hirehalli (Karnataka) and Mohitnagar (West Bengal) were also established.

The Indian Central Arecanut Committee was dissolved on 30th September 1965 and its research activities were taken over by the Indian Council of Agricultural Research since then. Consequent to the establishment of the Central Plantation Crops Research Institute (CPCRI) in 1970, the Central Arecanut Research Station became the Regional Station of the Institute and the five Regional Stations became the Research Centres of CPCRI and these Centres continue to do research mainly on arecanut.

Climate and Soil

In India arecanut grows within a wide range of temperature, ranging from a minimum of 4^{o}C to a maximum of about 40^{o}C. However, the palm flourishes well within a temperature range of 14^{o}C to 36^{o}C. Arecanut flourishes in tracts of very heavy rainfall where annual rainfall go up to 4500 mm as well as in the low rainfall areas where the annual rainfall is about 750 mm. In areas of prolonged dry spell, the palms are irrigated. The largest area under arecanut is found in gravelly laterite soils of red clay type of Southern Kerala and Coastal Karnataka. In the plain region or the *Maidan* Karnataka, it is planted in fertile clay loam soils.

Crop improvement

The CPCRI, Regional Station, Vittal has embarked on the collection and maintenance of world arecanut germplasm since its inception in 1957. At present the germplasm bank consists of total 140 accessions, which include 23 exotic types belonging to six species of *Areca* obtained from important areca growing countries. Based on studies of comparative yield trial, three varieties were released for cultivation. The VTL-3 from China was released in 1972 as Mangala. It was found to have a number of desirable characters in comparison with local South Kanara variety. Average yield of this variety is 3.00 kg chali/palm. The two varieties, VTL-11 and VTL-17 were released for all the areca growing areas in general and Dakshina Karnataka in particular as Sumangala and Sreemangala in 1985. These varieties have shown a yield increase by 62.89 and 47.59% over SK local. Mohitnagar, an indigenous (Mohitnagar, West Bengal) arecanut variety with a high yield potential has been recommended for release during 1991.

Hirehalli dwarf, a dwarf mutant of arecanut has been utilized in hybridization programme for developing dwarf hybrids and the hybrids, Mohitnagar X H. Dwarf and H. Dwarf X Sumangala have shown promising results.

Crop Production

Being a perennial crop, adequate care should be taken in selecting the planting material. High yielding healthy palms that come to bearing early should be considered for mother palms. Bold and heavy nuts should be selected for raising seedlings. Seedlings having healthy dark green leaves and good girth should be preferred.

The crop thrives well in humid areas protected well against hot sunburn and heavy wind. The site selected should have adequate facility of water for irrigation and the soil should have proper drainage facilities. The soil should be deep (preferably not less than two meters) and water table should be sufficiently low for better root development. Aligning the rows in north-south direction with a deviation of 35º towards South-West lowers the incidence of sun-scorch.

The spacing trials conducted at different centres of CPCRI revealed that spacing of 2.7m X 2.7m was optimum. In well-drained soils, planting at a depth of 90 cm and in heavy soils, planting at a depth of 60 cm are recommended. In areas where Southwest monsoon is severe, planting in the month of September-October is recommended. In other areas planting can also be done in the months of May-June.

Annual application of 100 g N, 40 g P_2O_5 and 140 g K_2O in addition to 12 kg each of green leaf and compost per palm per year is recommended. In heavy soils application of 50g N, 40g P_2O_5 amd 70g K_2O with 14kg green leaves appears to be optimum.

Arecanut wastes are efficiently converted into vermicompost with a recovery of 87.75 % in a composting period of 3 months by using African night crawler (*Eudrilus eugeniae).* vermicompost produced from organic wastes of one hectare of arecanut plantation meet 50 % of N, 32.5 % of P and 26 % of K requirement besides supplying considerable organic matter and micronutrients.

Arecanut requires irrigation during prolonged dry spell. Sprinkler and drip irrigations can save 20 and 44% of water. Application of nutrients through irrigation water (fertigation) is found more effective and profitable.

Research efforts at CPCRI revealed that banana, cocoa, pepper, lemon, betelvine, elephant foot yam and tapioca can be grown with arecanut as High Density Multi Species Cropping System, which can increase the net returns by 2 to 2.5 times over arecanut alone.

Crop protection

Fruit rot (*Phytophthora meadii):* It is one of the major diseases seen in heavy rainfall areas of arecanut tract. The disease occurs during South-West monsoon season. The loss due to this disease is reported to vary between 10 – 90%. It is controlled effectively by proper spraying with

Bordeaux mixture (1%) twice. Recent studies have shown that polythene covering of bunches is very effective in checking the disease.

Bud rot *(Phytophthora meadii*): This is a fatal disease seen during South-West monsoon as well as in the subsequent winter months (Oct.- Feb.). As an effective control measure, infected tissues are scooped off by making longitudinal side slit and treated with Bordeaux paste (10 %).

Foot rot (*Ganoderma lucidum):* It is a major problem in the Malnad and Maidan areas of Karnataka, parts of Tamil Nadu, Kerala and Assam. The development of inflorescence and nuts is arrested and nuts already formed are shed. The diseased palms are to be isolated by digging deep trenches around the affected palm. The palm in the early stages of disease are root fed with 125 ml of 1.5 per cent calixin solution at quarterly interval. The basins of affected palms are to be treated with 1.5 per cent calixin by drenching. Bordeaux mixture (2 %) as soil drench at monthly intervals throughout the monsoon season also proved superior in controlling the disease.

Inflorescence die-back and button shedding: The disease is seen throughout the year but becomes severe during summer months. The symptoms are, yellowing and drying of the rachis from the tip towards the base followed by shedding of female flowers or buttons. The disease can be controlled by spraying with Dithane Z 78 @ 4 g/lit. or Dithane M 45 @ 2 g/lit. of water or a mixture of aureofungin-sol and copper sulphate both at 50 ppm.

Yellow leaf disease: This is a fatal disease and is prevalent in parts of Karnataka, Kerala, Maharashtra and Tamil Nadu. Phytoplasma is found to be constantly associated with the disease. The plant hopper, *Proutista moesta* acts as a vector in the spread of the disease. Since the disease in not amenable to control by conventional plant protection measures, proper management of the garden is the only suggested method to prevent the loss due to this malady. Application of NPK fertilizers with additional dose of super phosphate in combination with lime (1 kg/palm) and improvement of drainage will minimise the disease incidence.

Mites: Mainly two species of phytophagous mites viz. White mite (*Oligonychus indicus Hirst*) and Palm or red mite (*Raoiella indica* Hirst) colonise on the lower surface of leaves. Spraying the lower surface of leaves with dicofol 2% or dimethoate 1.5% gives effective check of these mites.

Spindle bug(*Carvalhoia arecae* Miller): It is a chronic problem in arecanut plantations of Kerala, Karnataka and parts of Tamil Nadu. Application of 2g of phorate granules in perforated sachets of 3cm wide is effective. Plantations with initial infestation may be sprayed with dimethoate 0.05% in and around the spindle and inner whorls of leaves.

Root grub (*Leucopholis burmeisteri* Brenske *and L. lepidophora* Blan): Root grub infestation is seen in low lying and clayey soils where the water table is high. Collection and destruction of beetles during the period of their emergence from soil is an effective management practice for reducing the population. Application of Phorate 15 g per palm twice a year in May-June and September-October for a period of minimum three years will reduce the infestation.

Pentatomid bug (*Halymorpha marmorea*): This bug causes tendernut drop in arecanut. The bugs pierce the tendernuts of different maturity and suck the kernel sap. As a result, the kernel dries up and the tendernuts drop. Spraying the bunches with endosulfan at 0.05% twice (March-April and 45 days after) is effective.

Scale insects: (*Aonidiella orientalis*): Scale insects colonise the leaves, spathes, leaf sheaths and bunches and suck sap from the tissues. Continuous feeding on nuts results in pre-mature yellowing of nuts and the kernel may not develop and may turn black and shrivel up in case of severe infestation. Natural enemies like coccinellid beetles (mainly *Chilochorus spp*.), thrips,

and mites keep the scale population in a low level. Spraying of insecticides like malathion 0.1% or fenthion 0.1% is found effective..

Harvesting and Processing

Harvesting of nuts at correct stages is very important for obtaining the produce of better quality. After harvesting, the ripe nuts will have to be sun-dried for about 40-45 days. It is necessary to spread the nuts uniformly in a single layer for drying. Proper drying of nuts is important to prevent fungal infection of the nuts in the drying yard.

Chemical composition of arecanut

The chemical composition of arecanut depends on the maturity of the nut as well as on the variety. The major constituents are polyphenols(20%), fat(14%), polysaccharides (20%), fibre (10%) and protein (8%). Alkaloid is present as a minor constituent, but is an important constituent.

Alternate uses of arecanut

Arecanut alkaloids, particularly arecoline is known to be effective on various helminthes. The areca tannins have been found to have a lower acid/salt ratio and as a consequence, to produce a mellower type of leather when tanned. The nut contains 10–14% fat, which can be extracted by solvent extraction processes. Areca fat has comparable characteristics with hydrogenated coconut. Areca husk is a good source of furfural, as it contains about 18 per cent furfuraldehyde. Quality pulp suitable for making packing paperboards can be obtained from areca leaf sheath. Various useful items like throwaway cups and plates have been made out of the sheath.

The polyphenol fraction and arecoline was found to significantly increase the breaking strength of incision wounds However both the alkaloid and polyphenol fractions of areca were found to decrease the period of epithelization and increase the percentage of wound contraction required to heal excision wounds. In the dead space wound model the areca alkaloids were found to increase the breaking strength. Studies on the polyphenols of arecanut have shown that the marginal antibiotic effect on the bacteria *Escherichia coli, Pseudomonas, Vibrio cholerae, Salmonella typhi* and *Staphylococcus aureus,* compared with the broad-spectrum antibiotic gentamycin.

Studies at CPCRI, RS, Vittal have revealed that mushroom and vermicompost production using arecanut wastes such as leaves, leaf sheaths and husk are the promising technologies in terms of waste recycling and employment generation.

MARKETING AND DEVELOPMENTAL PROGRAMS ON ARECANUT BY CAMPCO

L. N. Kudoor
President, CAMPCO

Arecanut *(Areca catechu Linn)* is an important plantation crop grown mainly in the states of Karnataka, Kerala, Assam, Goa, Maharashtra and West Bengal. It is estimated that

more than 3.5 lakh hectares of land come under this crop, yielding about 4.15 lakh Metric Tones of Arecanut. Nearly 20 Million people are engaged in production, processing and marketing of the crop directly and the number of people involved in the allied occupations would come around 40 million. There has been a constant expansion of the Arecanut cultivation during the last two decades mainly because of the economic viability of this crop. Therefore, naturally, marketing and developmental programs have to play an important role so as to safeguard the interest of the Areca growers of the Nation.

Arecanut is consumed in raw as well as in processed forms. The practice of consuming raw Arecanut both in fresh and processed forms prevails in the entire producing areas of Assam, Kerala and Karnataka. The raw nuts are sold in all the primary markets in the producing areas. For consumption during the off-season preserved nuts *(Buratamul and Neetadaka)* are also sold for local consumption in all the markets. The itinerant merchants play an important role in the collection and grading of the produce and bringing it to the primary markets for sales. As the raw nuts are intended for local consumption no interstate trade exist in the commodity. The dry nuts normally called supary *(chali)* is also brought to the market by the cultivators themselves and sold to the wholesalers. The wholesalers then send it to the agencies of the consuming centers. The major states consuming supari are Maharashtra, Gujarat, Madhya Pradesh, Rajastan, Uttar Pradesh, Bihar, Himachal Pradesh and Delhi. The tender processed nuts are mainly consumed in the southern districts of Tamilnadu and certain parts of Karnataka, Maharashtra and Andra Pradesh. The boiled varieties (Red Supary) are mainly used in the manufacture of Pan Masala and Gutka which are having big markets within and outside our country.

Better marketing of agricultural produce is essential and this can be achieved by proper regulatory measures as well as the adoption of scientific methods of Marketing. The Karnataka Agricultural Produce Marketing (Regulation) Act was first enacted in 1939 and was later revised in 1966. The Act contemplates provision for better regulation of buying and selling of Agricultural produces. The introduction of this Act has gone a long way in regulating the marketing activities on scientific methods, ensuring remunerative and competitive prices to the producers and establishment and administration of markets for such agricultural produce. Arecanut is one of the many agricultural commodities brought under this Act in Karnataka and as far as Arecanut is concerned there are about 22 regulated Markets.

Previous to the regulation of Markets there were many Agencies engaged in assembling of Arecnaut Viz., Growers who bring their own produce for sale to the Market, Growers who collect Arecanut in their own and neighbouring villages, itinerant and village Merchants, Commission Agents, Wholesalers, Cooperatives etc. There was no uniformity in Market Charges. It not only varied from Market to Market but also from Merchant to Merchant within the same Market. There were also many unauthorized deductions in vogue in the market . All this had reduced the share of producers in a Consumer's rupee. There was also no systematic regular and correct weighment.

There were only few Cooperative Marketing Societies dealing in Arecanut in Kerala. These Societies were not functioning satisfactorily due to several impediments. In Karnataka Regulated Markets were functioning well. Anyhow, the price of Arecanut was in proportion to the cost of cultivation till 1970. But from the year 1970, it started to fall sharply from Rs.600/- per quintal (Mangalore Supary) and by 1973 it touched below Rs.300/- per quintal. The Arecanut farmers and their dependents were in panic. Many Arecanut Traders in different parts of the country went bankrupt, many traders withdrew from the market for ever since the situation became bad to worst.

The problem was raised in Karnataka and Kerala Assemblies and also in the Parliament., but no solutions were found.

Shri Varanashi subraya Bhat was at that time the Chairman of the Agricultural Produce Marketing Committee Mangalore, the largest arecanut trading center in the country itself. He felt it was his duty to find out ways and means to revive the Arecanut Market. Shri.B.R. Kamath, his colleague in the market Committee provided him all encouragements and assistance. They organized several Seminars and conferences in the different parts of areca growing areas. The first conference was held at Vittal under the banner of South Kanara and Coorg Areca Planters'

Association which was inaugurated by Dr.D.Veerendra Heggade of Dharmasthala . Consequently a lot of meetings and seminars were convened at various places of Areca growing areas which were attended by eminent personalities like Sri.K.H.Patil, the then Agricultural Minister of Karnataka, who suggested that the farmers should come forward to find a remedy and the Government would provide all assistance required. It was also felt that a study of consuming market should be made and accordingly a team under the able guidance of Shri Varanashi Subraya Bhat visited the major areca markets in Central and North India. They could make out that the price in the markets was not fallen as sharply as in the producing markets and the gap between the producer and consumer was very wide. The team felt that a strong Institution, which can pump in considerable funds to the areca market and to handle 25% of the country's total Arecanut production and supply it directly to the consuming markets, would put a check on the falling market price and even pull up the market. It was also felt that such an Institution should operate both in Karnataka and Kerala states so that it could influence the marketing of nearly 25% of the Indian Arecanut Production. The Govt. of Karnataka constituted an Experts' Committee in September1972, to study the price structure and other allied matters of Arecanut under the Chairmanship of Sri.T.T.Poulose, Director, Directorate of Arecanut and spices, Govt. of India. The Committee after conducting elaborate studies on various aspects could submit its report only in the month of April 1973. By that time a decision had already been taken to promote the CAMPCO, which was finally registered on 11-07-1973. The unique Institution CAMPCO thus came into existence after the continuous struggle and efforts of nearly two years.

The first Board took a very bold decision on its first meeting itself. It decided to enter into the Arecanut market immediately. On 12-11-1973 with the entry to the Arecanut market, CAMPCO offered a higher price than the prevailing market price. For a week the private traders kept away from the market. As the price offered was only 15% more than the prevailing market the private traders were also tempted to enter into the market and offered their prices equivalent to that of CAMPCO. As Mangalore is the largest Areca Market in the country, the trend in the Mangalore Market had its reflections in the other markets like Sirsi, Shimog, Sagar, Kumta, Kozhikode , Kochi etc. Campco was carefully watching the market pulses and went on pulling the market day by day. It succeeded in its strategy to take the private traders also with us. Within three months the prices reached the pre- fall level.

CAMPCO opened seven more branches at Sirsi, Shimoga, Sagar, Kumta, Kasaragod, Thirur and kumaranallur by the end of June 1974. It had also made arrangements to sell the produce directly at Mumbai, Nagpur, Delhi and Lucknow. Within ten months from its inception, CAMPCO could procure more than 60,000 qtls. of Arecanut.

The CAMPCO introduced short-term and long-term Deposits from its members to mobilize funds for its marketing and developmental activities which ultimately benefited CAMPCO by getting funds at a little lower interest rate than that on the Bank borrowals. The members also got a higher interest rate than what they could have got otherwise. Further, the funds mobilized by way of Deposits were fully utilized for Arecanut marketing, indirectly benefiting the growers only.

With active support and influence of the CAMPCO in the Arecanut market, the price of Arecanut continued to move upward in proportion to the production cost. The CAMPCO was able to expand its activities and by the end of 1989-90 it had opened more than 70 branches throughout India. The procurement of Arecanut had crossed beyond 2.5 lakhs quintals. The present Arecanut procurement is around five lakh quintals.

The CAMPCO, keeping in mind that Arecanut has no other use than chewing, arranged for research on alternative uses of Arecanut through 1) *Regional Research Laboratory, Hydrabad,* 2) *Central Drug Research Institute, Lucknow,* 3) *Indian Drugs Research Association, Poona,* 4) *Department of Chemical Technology, Bombay,* 5) *Cancer Research Institute, Tata Memorial Centre, Bombay,* 6) *Central Leather Research Institute, Madras,* and 7) *S.R.K. Menons's Research Laboratory, North Paravur and later Technology Section C.P.C.R.I. Vittal*. The C.P.C.R.I. Vittal coordinated the research works with the different research institutions. The state Agricultural Marketing Board, the Agricultural Market Committees of Mangalore, Sirsi and Shimoga also have contributed funds for research works besides CAMPCO. The findings of the

different research works will be of immense helpful for future research works on industrial basis.

Alternative uses of Arecanut will have to be explored further. These uses will have to be popularized. There should be constant interactions between the producers and consumers. The result of the interactions should be one of the inputs in guiding further research. First of all a Forum for such interaction is to be created. Feeling this as a necessity, a trust called **ARECANUT RESEARCH AND DEVELOPMENT FOUNDATION** has been constituted on 20th May 1998 under the able guidance and advice of Padmabhushan Dr. D. Veerendra Heggade, Dharmadhikari, Shree Kshethra Dharmasthala, who is the founder President of the Trust. The president of CAMPCO will be the permanent Managing Trustee of this Foundation. President TSS Ltd. Sirsi, Vice President MAMCOS Ltd. Shimoga, President All India Areca Growers Association Puttur and Sri.Shankar Badanaje are the Trustees of the Foundation.

The main objects of the Trust are:

1. To initiate and to implement Research activities connected directly or indirectly on the alternative uses of Arecanut and its by-products for the economic benefit of the growers.
2. To promote any activities for increased consumption of Arecanut and its by-products in India and Foreign Countries.
3. To organize periodic seminars/workshops, conferences .to guide and educate the Agriculturists and Consumers.
4. To do all that is necessary to achieve the upliftments and welfare of Areca growers.

Establishment of the Research Foundation is only the initial step in fulfilling the hopes and aspirations of the growers. Since Research is a long term process, the Foundation cannot hold out anything for the present. At present there are folk remedies based on the medicinal properties of various parts of areca plant. And also, there is the possibility of the use of Areca *"chogaru"* as an organic dye and in many other ways. But these, in their present form are not commercially and industrially viable. However, it will be the efforts of the Foundation to find out some alternative uses. This will prevent the prices from nose-diving by creating additional demand. It is sure that the Foundation will achieve the target goal with the unstinted efforts of the scientists involved in the adventure.

Even though Arecanut is available for export, the consumers in the international markets are Indian settlers. At present arecanut is being exported to abroad only for the Indians who are settled outside India. The value added products of Arecanut like Scented Supary, Pan Masala and Gutka are exported to U.S.A., Canada, England and Arab Countries. Further, small quantity of Shimoga varieties and Mangalore *Chali* are exported to Nepal and other European Countries meant for Indian settlers only.

Reaching the consumer directly has been one of the ambitions of CAMPCO for long. **The Small Consumer Packing Unit** has been commissioned on 17-07-1997 and **Mangala Supary** has been launched. A research conducted to explore the market feasibility has painted bright picture for the roasted Arecanut. Since this product could not capture market upto our expectation, recently we have started manufacturing **Kaju Supary** – a mixture of Cashew and Supary on a trial basis, which is expected to be grand success in the market in the years to come.

During the year 1984-85 and 85-86 there was an acute shortage of quality Copper Sulphate in the market. To overcome the scarcity of this fungicide faced by the areca growers the CAMPCO established a Copper Sulphate Plant at Sagar in the state of Karnataka in the year 1985-86 and it is supplying quality Copper Sulphate to the growers at a very nominal price inspite of the abnormal price hike of the raw materials being noticed in the market of late.

The CAMPCO has been advising the areca growers to grow Cocoa also as a mixed crop in their Arecanut gardens since Cocoa is having a very good international market. Many of the Arecanut growers started growing Cocoa. The Cadbury's India Ltd., was the only main Cocoa buyer in India. In the year 1980, during the peak Cocoa season the Cadbury's suddenly withdrew from the procurement market of Cocoa. This situation created an agitation among the growers, especially in the state of Kerala and at the behest of the Governments of Karnataka and Kerala,

Campco was forced to enter in the Cocoa market also. Since the procurement of Cocoa beans was beyond our expectations we could not find international market for the produce so procured and we were forced to explore some other avenues. After careful studies it was found that to establish an assured market for Cocoa, it is necessary to put up a Chocolate Factory. The Factory was completed in a record time by 1986. This Factory, popularly known as the CAMPCO CHOCOLATE FACTORY can stand in line with any of its kind in the world itself in all aspects.

The CAMPCO LTD., a Multi State Cooperative Marketing Society, registered under the Multi state Cooperative Societies Act 1984, formed by the Governments of Karnataka and Kerala with active participation of the Govt. of India, with members of more than 75,000 growers and about 200 branches spread all around the country with an annual turnover of Rs.500 crores, has completed 31 years of yeomen service to its members. It has successfully crossed across the travails and turmoils of the early years with the sincere support of the farming members and their continued support would further help this Institution to scale new heights.

Session – I: Advances in Arecanut Research

Chairman: Dr. V. Rajagopal

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CROP IMPROVEMENT IN ARECANUT (*ARECA CATECHU* L.)

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Arecanut (*Areca catechu* L.) is one of the important plantation crops of India. It is mainly grown for its masticatory nuts popularly known as 'betelnut' or 'supari'. Presently arecanut is commercially grown in India, Bangladesh and Srilanka. In India it is extensively cultivated in the states of Kerala, Karnataka, Assam, Meghalaya, Tamil Nadu, West Bengal, Maharastra, Goa and Andaman & Nicobar group of islands. Crop improvement research in arecanut has been in progress for the last five decades in the country and contributed immensely to the remarkable increase in production and productivity of arecanut. The success has been achieved by adopting a interdisciplinary research approach to develop suitable techniques for selecting seed nuts and seedlings, standardizing agro-techniques for raising nurseries, standardizing input technologies for establishing arecanut planting, evolving control measures against important pests and diseases and evolving high yielding varieties (Nair, 1999). India is the largest producer and consumer of arecanut and it continues to dominate world in area, production and productivity. Hence it has become essential to give priority for crop improvement.

Crop variability

The origin of the arecanut is believed to be the East Indies Groups of Islands. The genus *Areca* includes 76 species. The genus *Areca* belongs to family Palmae under tribe *Arecae.* Arecanut is highly cross-pollinated crop. It is an allotetraploid with chromosome number 2n=32. Even though *A. catechu* is the only cultivated species, it has been observed that there is a wide range of variation existing for different traits especially for nut size and shape under different geographical and economical regions. Nuts from North Malabar and Mysore are big and oblong shape and are less in number in a bunch. In South Malabar, Travancore, Cochin and Maidan areas of Karnataka, the nuts are medium and oblong, while in Mettupalayam the nuts are very small and roundish. In Malnad parts of Shimoga and Chikmagalore districts nuts are small in size where as the regions of North Kanara and Konkan districts showed different size i.e. nuts are broader than long (Murthy and Pillai, 1982). Incidentally all the above regions form three distinct topographic zones isolated by natural barriers. It is thus evident that nut size of cultivars/ecotypes which are under cultivation in this distinct zones for the past many centuries have been maintained (Ananda and Anuradha Sane, 1999). A dwarf arecanut mutant was reported from Hirehalli, Karnataka (Naidu, 1963). It was reported that 40 years old palm attained a height of only 4.57m. Other characteristic features of this palm are suppressed internodal distance which makes annual scars appear superimposed, erect crown shape, dark green colour of the leaves and produces erect bunches with a yield of 4-5kg ripe nuts/palm/year (Ananda, 2000).

Genetic Resources

Organized crop improvement programme in arecanut dates back to mid-1950's in the erstwhile Central Arecanut Research Station, Vittal with the mandate to improve the production and productivity. Comprehensive collection of germplasm from within the country and abroad have been made and screening them under uniform conditions were undertaken. A total of 140 accessions representing five species viz., *Areca catechu* L., *Areca triandra* Roxb., *Areca normanbyii*, *Areca concinna, Areca macrocalyx* Zipp. and one related genera *Actinorhytis calapparia* were collected so far and being maintained in the field gene bank at the Station. This comprises 117 indigenous ecotypes collected from Assam, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Meghalaya, Tamil Nadu, West Bengal, Nicobar group of Islands (Ananda, 1999) and 23 exotic accessions introduced from other countries especially South-East Asian countries

such as Fiji, Mauritius, South China, Sri Lanka, Indonesia, Saigon, Singapore, British Soloman Islands and Australia. All the indigenous and exotic collections are sub-sampled and planted in CPCRI Research Centre Mohitnagar as alternative germplasm repository for arecanut. Descriptors for sixty arecanut accessions have been prepared based on plant morphology, reproductive and fruit component traits.

Evaluation of germplasm

Release of varieties through evaluation and selection

Screening of the available arecanut cultivars for their performance under different ecological conditions is a promising method of obtaining ecotypes suited for the different regions of our country. But arecanut palm is more sensitive to moisture stress than coconut and therefore its cultivation is restricted to areas with well distributed rain fall or assured irrigation facilities. At CPCRI, Vittal on the basis of comparative yield trials of indigenous and exotic accessions, promising cultivars were selected and released as varieties (Table 1). Under the evaluation of exotic accessions and selection for high yield and its attributes, the varieties released were Mangala (VTL-3 from China) in 1972, Sumangala (VTL-11 from Indonesia) and Sreemangala (VTL-17 from Singapore) in 1985. The evaluation of indigenous accessions resulted in identifying the variety Mohitnagar (VTL-60 from West Bengal) with high yield potential which was released during 1991. Besides two more varieties namely Calicut-17 (VTL-36 from A & N Islands) and SAS-1 (VTL-52 from Sirsi area) have been released during 1995 for Andaman and Nicobar group of Islands and traditional arecanut growing valleys of Sirsi hill zone of Karnataka, respectively.

Table 1. Yield performance of released Arecanut varieties

Cultivar / Accession	**Variety**	**Chali Yield (Kg / Palm)**	**State for which recommended**
VTL-3	Mangala	3.00	Karnataka and Kerala
VTL-11	Sumangala	3.28	Karnataka and Kerala
VTL-17	Sreemangala	3.18	Karnataka and Kerala
VTL-60	Mohitnagar	3.67	West Bengal Karnataka and Kerala
VTL-36	CAL-17	4.37	Andaman & Nicobar Islands
VTL-52	SAS-1	4.60	Valleys of Sirsi, Karnataka

Identification of donor parents

Evaluation of germplasm has resulted in identifying the probable donors of different desirable traits which are being exploited in improvement of the crop.

Table 2. Distribution of characters in different arecanut accessions

Characters	Probable donors
High yield	*A. catechu* 'Mangala' *A. catechu* 'Sumangala' *A. catechu* 'Sreemangala' *A. catechu* 'Mohitnagar' *A. catechu* 'Cal-17' *A. catechu* 'Kahikuchi' *A. catechu* 'SAS-1'
Early bearing	*A. catechu* ' Mangala'
Greater number of fruits/bunch	*A. catechu* ' Thirthahalli'
Better nut quality	*A. catechu* ' Shriwardhan'
Fruit size- large	*A. catechu* ' South Kanara', 'Sreemangala' ' Kahikuchi'
Regular bearing	*A. catechu* ' South Kanara'
Dwarfness	*A. catechu* ' Dwarf mutant'
Tolerance to yellow leaf disease	*A. catechu* ' Dwarf mutant'

More number of female flowers per bunch	**A. triandra , A. concinna**
High percentage of fruit set	*A. triandra, A. concinna*
Suckering habit	*A. triandra, A. concinna*
Semitall nature	*A. catechu* 'Mangala', Sriwardhana', *A. triandra , A concinna* *A normanbyii*

Breeding

Breeding work in arecanut was initiated with a specified objective taking into consideration the existing variability / donor genes (Bavappa and Nair, 1982). The CPCRI, Regional Station, Vittal has a live herbarium of areca species and cultivars mainly from South-East and South Asian Countries, possessing large number of desirable traits and offer choice of selection of parents depending on the breeding objectives. The breeding programme was directed to evolve varieties with high yield and regular bearing (high yielding released varieties x SK Local), combining large sized fruit with more number of nuts per bunch (Sreemangala/Calicut-17/Kahikuchi x T. halli/ Sagar), combining semi-tall early bearing and high yield with quality (Mangala x Shriwardhan), evolving varieties tolerant to yellow leaf disease (released varieties x H. Dwarf and vice-versa), transferring suckering habits, more number of female flowers and high percentage of nut set (interspecific crosses: High yielding varieties of *A. catechu* x *A. triandra*), studying the genetics of dwarfness, and their exploitation in breeding dwarf varieties (released varieties x H. Dwarf and vice-verse), studying the combining ability for exploitation of hybrid vigour.

Selection

Seedling selection

Studies have shown that considerable yield increase can be obtained by judicious selection of seedlings at the time of planting and in subsequent stages (Bavappa and Ramachandra, 1967a, Bavappa, 1970). Among the various seedling characters correlated with heritability estimates, it was found that the number of leaves at the time of planting, girth at collar after planting and number of nodes two years after planting have positive genotypic and phenotypic correlations with yield and high heritability. All these have negative correlation with age at first bearing indicating that selection of seedlings based on these characters. A standard established for seedling selection is four or more number of leaves, girth of 20 cm or more after one year and minimum height for transplant to the main field.

Mother palm selection

The regularity in yielding behaviour of the mother palms had no relation with the performance of the progenies (Bavappa and Ramachander, 1967c). Further, it is observed that mother palms having high progeny performance were distinct in almost all the gardens and hence giving emphasis for selection of seed nuts from a particular garden as practiced by the farmers has no scientific validity (Bavappa and Ramachander, 1967c). Yield pattern of the palms of different bearing ages indicate that palms come to bearing earlier are always better yielders (Bavappa and Ramachander, 1967c). They also observed that selection of seedlings for number of the leaves girth at collar and number of nodes as per standard fixed totally eliminated late bearing palms in a garden established with such seedlings. Selection based on yield alone may not be worth practicing since heritability values for the number of nuts and weight of nuts are very low.

Mass pedigree selection

Bavappa and Ramachander (1967c, 1968a, 1968b) initiated a modified mass pedigree selection with the primary objective of attainment of increase in yield in a garden established with about 2,966 palms selected from 41 farmers from the farmers garden. Families and palms

within the selected families were selected by applying bulk and individual norm tests (Harland, 1957). The screening of 10 palms belonging to three families and the second generation established from the progenies of these selected palms indicated the expected genetic gains were very low for wet weight of nuts as well as for the number of nuts. It was concluded that such a selection procedure of applying bulk norm and individual testing is ineffective in improving the yield of arecanut (Anon., 1981).

Bavappa and Ramachander (1967b) suggested a refinement of selection procedure superimposing characters of high heritability and correlation with yield, prepotency, selection index and desirable characters such as resistance to pests and diseases in addition to the bulk norm test and single norm test. However, an advantage of such selection procedure is yet to be confirmed.

Correlation, heritability and path analysis

As the heritability for yield in arecanut is very low (0.20), practically no improvement in yield could be achieved by direct selection for this character (Bavappa and Ramachander, 1967a). Among various characters considered, age at first bearing alone was found to have high heritability and correlation with yield followed by percentage of inflorescence to leaves shed. Though the percentage of nut set is highly correlated with yield, heritability was found to be relatively low (Bavappa and Ramachander, 1967c). Bhagavan (1985) studied the direct and indirect effects of seed weight, days taken for germination, seedling girth, seedling weight and number of leaves, time taken for flowering on yield characters of arecanut. Path analysis suggested that the selection of heavy nuts (35g and above) plays a major role for raising better seedlings resulting in higher yield. The seedling that comes to early flowering (less than 4 ½ years) produced better yield. The thinner seedlings must substantiate with early flowering for better yield (Bhagavan, 1985).

Selection index

Selection based on age at first bearing may not lead to a very significant improvement in yield due to limited variation for this trait. An attempt to refine selection method was made by Ramachander and Bavappa (1972) adopting selection index techniques. For this, 17 growth measurements taken at stages of growth measurements giving an efficiency of 47.6 per cent straight selection index based on yield indicating significance of growth measurements over the yield components. They also worked out a simple index using only two characters viz., number of leaves and weight at the time of transplanting, which gave genetic advancement 90 percent and relative improvement of 332% (Bavappa, 1970).

Performance of Inter-varietal crosses

The hybrid Mangala x Shriwardhan was more vigorous than the cross Mangala x SK Local as observed from increased height and girth of stem and number of leaves. Seedlings from inter-varietal crosses among Mangala, Sumangala, Sreemangala, VTL-12, VTL-13, Mohitnagar, Thirthahalli, Shriwardhan and Hirehalli Dwarf mutant were screened for their reaction to Yellow Leaf Disease (YLD) of arecanut and it was found that hybrid seedlings derived from crosses involving dwarf mutant have some degree at tolerance (Anon., 1981).

Performance of Inter-specific crosses

The F1 hybrids of *A. catechu x A. triandra* had only one stem as in *A.catechu* indicating the dominance of single stem. Reciprocal hybrids did not show such genetic effect and failure of *A.catechu* pollen to germinate on stigma of *A.triandra* indicated/confirmed that *A.triandra* x *A.catechu* nuts might not be of sexual origin. Apomixis in *A.triandra* was indicating by the limited degree of meiotic irregularities, reduced pollen fertility, low quality of pollen and low chiasma frequency (Bavappa and Nair, 1982).

The interspecific hybrids between *A. catechu* and *A. triandra* showed high sterility and also hybrid vigour for many characters. This is to be expected in an interspecific cross involving genetically divergent parents. The studies on intercluster divergence showed that the genetic distance between *A. catechu* and *A. triandra* is wide (Bavappa, 1974). Since it has been possible

to backcross the F1 hybrids of *A. catechu* x *A. triandra* to *A. catechu*, the possibilities of transferring high fruit set reported in *A. triandra* (Bavappa, 1966a, 1966b, 1963) to *A. catechu* are bright. As the sterility observed in the hybrids appears to be due to disharmonious interaction between the cytoplasm of *A. catechu* and genotype of *A. triandra*, restoration of fertility through repeated backcross to *A. catechu* may be feasible and it may be possible to evolve better varieties combining qualities of both the species.

Multilocation trials of promising cultivars/varieties

Comparative yield evaluation trial of released varieties of arecanut viz., Mangala, Sumangala, Sreemangala, Mohitnagar and Thirthahalli Local under malnad conditions at Thirthahalli registered lower height with high percentage of flowering and found to be superior in ripenut yield in the initial years of bearing closely followed by Thirthahalli local (Ananda and Anuradha Sane, 1999). Bhadraiah *et al*. (1985) studied the performance of seven areca varieties viz., VTL-3, VTL-11, VTL-12, VTL-13, VTL-17 Mohitnagar and thirthahalli at Sirsi with Sirsi Local as control. Among the cultivars studied VTL-11 and Sirsi Local appeared to be more precocious in bearing.

In order to find out the suitable variety for Konkan region, a varietal trial consisting of eight promising varieties VTL-3, VTL-11, VTL-12, VTL-13, VTL-17, Mohitnagar, SK Local and Shriwardhan Local as check conducted at Dapoli resulted in identifying Shriwardhan Local as high yielder followed by Mohitnagar (Salvi *et al*., 1985) and further observed the earliness in bearing in variety Mangala. A trial on the comparative yield trial of 5 cultivars of the arecanut VTL-3, VTL-11, VTL-12, VTL-13 and VTL-17 and Mettupalayam Local at Coimbatore, Thangaraj *et al.* (1985) reported that the variety Mangala consistently maintained the highest yield over others with 14.81, 17.65 and 16.27 kg of ripenuts for the years 1979, 1980 and 1981; respectively with 43.0, 15.7 and 3.03 per cent increase in yield over the Mettupalayam Local in three years.

Breeding dwarf varieties by incorporating dwarfing genes

"Hirehalli Dwarf" a natural mutant identified earlier (Naidu, 1963), is being utilized in arecanut improvement. Its short stature and relative tolerance to YLD are indicative of its use as a good genetic source for arecanut improvement. The yield of Hirehalli Dwarf is quite low (4-5kg/palm/year ripe nut) (Ananda, 2000). An attempt was made to study the genetics of dwarfism in arecanut using Hirehalli dwarf and released varieties / promising cultivars (Ananda, 2000). Maximum dwarfs and intermediates were recovered in the cross Sumangala x Hirehalli Dwarf followed by Mohitnagar x Hirehalli dwarf and Mangala x Hirehalli dwarf crosses among the twelve hybrid combinations classified based on height, colour intensity and vigour of seedlings to work out segregation pattern and distribution ratios. The absence of pure homozygous materials of released varieties is a handicap in studying the genetics of characters in case of areca nut (Ananda, 2000). Biometrical observations in eight hybrid combinations showed intermediate height as compared to tall parents in general and produced more or less equal number of leaves. However, stem girth was more in Hirehalli Dwarf x Sumangala and Mohitnagar x Hirehalli Dwarf crosses. The earliness in flowering was noticed in parents Mangala and the cross Mangala x Hirehalli Dwarf, since the variety Mangala is an early bearer and might have inherited genes responsible for this character. (Ananda, 2000).

To exploit the dwarfing genes in arecanut improvement a study was undertaken in eight hybrids involving H. Dwarf and released varieties and five parents for yield performance and dwarfness and also to estimate the heterosis in hybrids for yield and fruit component traits in order to identify the hybrids with high yield potential and dwarfness (Ananda, 2002). Among the hybrids, highest mean number of nuts produced/palm (349.25) was observed in the cross Hirehalli Dwarf x Sumangala which also recorded maximum cumulative of 4191 nuts from first year to fourth of bearing followed by the cross Mangala x Hirehalli Dwarf and Hirehalli Dwarf x Mohitnagar with cumulative of 3236 and 3210 nuts/palm, respectively. With regard to the character fresh nut yield/palm, the cross H.D. x Sumangala recorded maximum mean yield of 9.14 kg/palm/year followed by the cross Mohitnagar x H.D. (8.91 kg ripenut/palm) and Sumangala x H.D. (8.81 kg/ripenut/palm) among the crosses (Ananda 2002). Crosses Mohitnagar

x H.Dwarf and H.Dwarf x Mohitnagar exhibited linear trend in recording consistent higher yield per palm over the years. The maximum heterosis of 53.32 per cent and 96.18 percent for the number of nuts/palm/year and fresh nut yield /palm was observed in the cross Mangala x H.Dwarf. The negative/low heterotic effect was measured in the parent H. Dwarf for the number of nuts/palm/year (-08.08%) and fresh nut yield (-20.24%) (Ananda, 2002).

In general, high yielding parents have recorded higher values for fruit traits compared to their hybrids except in H. Dwarf, which maintained its identity of small sized nuts. As expected H. Dwarf recorded low values for all the nut characters studied. However, the dwarf palms showed significantly higher recovery of chali/dry kernel (28.5%) compared to other parents and hybrids. The next highest recovery of 28.2 per cent was noticed in the cross H.D. x Mohitnagar. This may be due to low content of husk in the nut of the parent Hirehalli Dwarf. Hence, nuts with less husk is always desirable and such palms could be used as donor parent for future crop improvement programme. However, the cross H. Dwarf x Mohitnagar showed the maximum heterosis (19.5%) for recovery of chali. This high recovery of chali might have come from the parent H. Dwarf, which had the maximum recovery of dried kernel and probably combined well with the parent Mohitnagar. Overall crosses H. dwarf x Sumangala and Mohitnagar x H. dwarf were found to be promising in the initial years of bearing. The crosses Mohitnagar x H. Dwarf and Mangala x H. D. exhibited higher heterotic effects for most of the nut component traits. Parents, Sumangala, Mangala and Mohitnagar have been the common parents with H. Dwarf for high yielding hybrids suggesting its usefulness as best combiners for exploiting hybrid vigour for economically important yield and nut component traits of Arecanut (Ananda, 2002).

Breeding for varietal purity through *inter se* matings

Although arecanut varieties posses high yielding nature, the subsequent progenies of the varieties showed greater variations among the individuals of the same population due to the cross-pollinating nature of the crop which resulted in heterozygosity in their genetic constitution. An attempt has been made to bring out the varietal purity and improved yield performance if any, through *inter se* /sib- matings of the typical palms of the arecanut variety “Mangala” and exercised secondary selection for desirable morphological, reproductive and yield components among the thirteen *inter se* mated progenies (Ananda *et al*., 2004). Among the progenies, cent percent typical Mangala palms were recovered from three combinations namely 56 x 300, 157 x 71 and 35 x214 compared to other combinations and open pollinated progenies. The inter se combinations 47 x 93, 185 x 42, 35 x 214 and 42 x 300 showed higher values for production of nuts (378.08 350.27, 342.68 and 321.64 nuts/palm/year), and chali yield (3.59, 3.45, 3.34 and 2.94 kg per palm/year) with 46.53, 40.82, 36.33, 20.00 percent increase in chali yield over open pollinated progenies. The highest (24.08%) recovery of chali was noticed in 47 x 93 combination followed by combinations 35 x 214 (23.53%), 154 x 7 (22.64%), 56 x 300 (22.48%), 42 x 300 (21.65%) and 150 x 19 (21.60%), while the *inter se* combination 177 x 95 noticed the lowest recovery of 17.28% and the open pollinated ‘Mangala’ recovered only 21.04% dry kernel from the fresh nut. Overall the combinations 47 x 93, 35 x 214 and 154 x 7 showed their superiority for most of the nut characters. Thus the superiority of *inter se* progenies of different combinations exhibited for recovery of typical Mangala palms as well as for their performance in production of nuts, chali yield and fruit components over the progenies obtained from open pollination (Ananda *et al*., 2004).

Conclusion

It is confirmed that the considerable variability exists in the present germplasm holdings introduced from South-East-Asian regions including India. The collection of germplasm and documentation has been so far significant which resulted in identifying donor parents for various desirable traits and also release of high yielding varieties through direct selection namely Mangala, Sumangala, Sreemangala, Mohitnagar and Cal-17. The varietal purity and improvement in yield and its components can be achieved through *inter se*/sib-mating of typical high yielding mother palms of the cultivar / variety and exercising selection in second generation. Dwarf varieties with high yielding nature will definitely benefit the farmers in the near future.

With the adoption of improved agronomic practices cultivation of high yielding varieties helped the country in achieving self-sufficiency in arecanut production.

There is a need for comprehensive collection of germplasm from within the country and abroad to build up and widen the existing genetic base of arecanut. The screening of germplasm /cultivars/ varieties for abiotic (drought tolerance) and biotic (Yellow Leaf Disease and important pests) stresses is mandatory in order to identify drought/disease tolerant/resistant varieties/ hybrids. For further improvement in arecanut, introduction of all known species and wild relatives of arecanut from different sources to enrich Indian collections and also exploitation of desirable genes of wild species / related genera / natural dwarf mutant in improvement of the crop must be given a top priority.

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RECENT ADVANCES IN ARECA CROP PRODUCTION

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Introduction

Arecanut (*Areca catechu* L.) is the most profitable plantation crop grown in humid tropics of India. The traditional arecanut growing regions in India are southern Karnataka and Kerala, parts of Maharashtra, Assam and West Bengal. The area under this crop has increased from 94,800 ha (1956-57) to 3.13 lakh hectares (2000-01). The production has gone up from 74,700 tonnes to 3.79 lakh tonnes during the same period. However, the productivity has become stagnant because of improper input management. The average productivity in India is 1180 kg/ha (2000-01). Moreover, arecanut is essentially a crop of small and marginal holders with insufficient income to sustain dependent families. So, the emphasis should be on increasing the productivity per unit area. In view of the increased pressure on land, it is imperative to fully exploit the existing cultivated land by growing compatible intercrops to improve and sustain high productivity and income. The long pre-bearing period, high investment and low returns in initial period, the fluctuations in market prices and problem of pest and diseases are the main factors which make it essential to take up inter/mixed cropping in arecanut plantations.

Organic farming is a form of food production system wherein traditional wisdom and ancient knowledge of Indian farming community such as crop rotation, residue recycling etc. are amalgamated with modern practices of crop cultivation and livestock management to enhance profitability without much dependence on off-farm resources.

With the advent of green revolution, the chemical inputs have become the mainstay of Indian agriculture. Nevertheless, this led to a decline in the use of organic manure. Dependence on chemical fertilizers has brought with it many problems facing modern agriculture. Though not so profound, yet soil degradation is one of its outcomes (Acharya *et al.*, 1988). One of the reasons for the reduced organic matter application, which can maintain the soil health is lack of availability of organic matter due to increase in area under crop cultivation. Thus it was felt that recycling of the wastes available from the existing garden would be a better proposition for organic matter application.

The annual rainfall in the arecanut growing belt is around 3900 mm, but most of it occurs with in a short span of 3- 4 months from June to September. During December to May, the rainfall is below half of the Potential Evapotranspiration(PET) which can be considered as a period of moisture stress. Thus the crop experiences a wide spectrum of soil moisture regimes, which affect the productivity of the crop. Arecanut is highly sensitive to moisture stress compared to other palms and shows severe reduction of growth and yield in the absence of proper irrigation. Abdul Khader *et al* (1985) noticed yield reduction to the extent of 75 per cent with palms irrigated once in 20 days compared to palms irrigated once in 5 days. Arecanut, being the most profitable cash crop, irrigation has positive and significant effect on economics (Dinesh kumar and Mukundan, 1996; Latha and Palanisami, 1996).

Cropping systems in Arecaut

Arecanut as a sole crop does not fully utilize the natural resources such as soil, space and light. The compact nature of arecanut crown, raised well above the ground (10 to 15 m), allows more sunlight to pass down to ground and maintain high humidity which, in turn, favour excellent growth of shade loving crops. Studies at CPCRI have revealed that orientation and structure of arecanut canopy permits 32.7 –47.8 per cent of incident radiation to penetrate down depending on the time of the day (Muralidharan, 1980). Normally in an areca garden spaced at 2.7 x 2.7 m, the light energy reaches the ground and wasted. Rooting pattern revealed that arecanut palms planted at 2.7 x 2.7 m spacing could use effectively only 30 per cent of the land area (Bhat and Leela, 1968). The normal cultural operations are also confined within about 75-80 cm radius from the base. Thus, the areca palm exploits only 2.27 sq.m of (r=0.85 m) land area out of 7.29 sq.m (2.7 x 2.7 m) land available to each palm. Arecanut plantations are mostly located in laterite soils in the coastal and Ghat regions in Kerala and Karnataka, and are good in organic matter content. Thus, the arecanut plantations also are more ideal for inter/mixed cropping.

Pepper, banana, cocoa and few other crops were found economical in arecanut gardens (Muralidharan, 1980; Nair, 1982; Shama Bhat, 1988; Khader *et al.*, 1992). Further studies showed that more than one crop can be grown simultaneously which is found economical and the system is called as High Density Multi Species Cropping System (Bavappa *et al.*, 1986 and Bhat *et al.*, 1999). Further many other medicinal and aromatic crops have great potential to be grown as inter crops in arecanut garden. Some of them are vanilla, patchouli, lemon grass, vetiver, basil, long pepper, java long pepper, palmarosa and many others.

Organic farming studies

Field experiments carried out at Vittal and Hirehalli have revealed that *Mimosa* is the highest yielder of green matter. *Stylosanthus* did not thrive at Hirehalli but grew well at Vittal. In *Maidan* part, Mimosa *invisa* and *Centrosema pubescens* produced significantly more green matter, compared with *Pueraria javanica* [*P. phaseoloides*], *Calopogonium mucunoides*, *Crotalaria anagyroides* and *Sesbania speciosa*. However, *M. invisa* and *C. mucunoides* gave the best improvement in soil organic C status (Sannamarappa, 1987).

Crop waste recycling

It is estimated that in one hectare of areca (*Areca catechu L.*) garden about 5 tonnes of recyclable biomass in terms of leaf shreds alone is available every year. Leaves and leaf sheaths of an areca palm can add about 75g N, 8g P and 66g K every year when recycled (Bhat and Mohapatra, 1989). In general recyclable biomass from areca gardens in India can supply 5260, 1337 and 6230 tonnes of N, P and K respectively to the agricultural system annually (Biddappa, *et al.*, 1996). Cocoa (*Theobroma cacao L.*), which is an important mixed crop in arecanut, could contribute 540, 72 and 244 tonnes of N, P and K respectively through recyclable wastes. These wastes could be converted into composts by using earthworms. The wastes from one hectare of arecanut plantation could meet 50% of N, 32% of P and 26% of K requirement of the crop by converting it into vermicompost (Chowdappa *et al.*, 1999). Vermicompost also contains substantial quantity of micronutrients.

A study was conducted to explore the feasibility of recycling wastes from an areca based cropping system. The crops in the system were arecanut as base crop and cocoa, clove, banana, pepper and coffee as mixed crops. All the recyclable wastes including weeds were recycled. The biomass included the areca leaves, bunch waste, arecanut husk, cocoa prunings and leaf fall, clove leaf fall, banana suckers, leaves, and the plants and the weed biomass. About 9 t of recyclable wastes was collected from the system. The same was put for composting using earthworms and 7.2 t of compost was obtained with 80% recovery. The contribution towards the biomass was the maximum in arecanut (40%) followed by cocoa (23%). The least contribution was from clove (5%). The weeds contributed about 14% of biomass. The entire waste biomass was converted into compost using the earthworms *Eudrilus eugeniae*. A recovery percentage of about 80% was obtained. The compost had 1.71, 0.21 and 0.43% N, P and K content respectively. This compost was applied back into the system as organic manure.

More than 1/3rd of the nitrogen requirement is met by the vermicompost. The supply of P and K were negligible through vermicompost. The 2/3rd recommended chemical fertilizer along with the organic matter recycling supplied 95% nitrogen, 73% phosphorus and 72% of potash requirement of the crops. In general the nutrient content (N, P and K) was higher at surface level as compared to lower depth. They are also higher than the initial nutrient level (N: 42 ppm; P: 15.0 ppm; K: 56.8 ppm). The organic carbon content was higher with lower chemical fertilizer application and at lower depths in all the crops.

Improvement in the yield of the crops has been noticed over the year. Though the treatment difference was not seen in arecanut and cocoa, the yields were increased by about 8.0 and 168% over pre-experimental yield. Banana gave significantly higher yield under full dose of chemical fertilizer with organic matter recycling. This may be due to the higher nutrient requirement of the crop.

Microbial activity was higher when more of organic matter was added to the soil. This has helped in better nutrient efficiency. Total microbial biomass, phosphatase activity, dehydrogenase activity and carbon mineralization were better with organic matter recycling.

Thus it can be concluded that organic matter recycling is viable in areca based cropping system.

Water management

Initially the studies conducted were based on flood, furrow and/or basin irrigation methods. At Vittal irrigation intervals of 5 and 10 days were found superior throughout over 15 and 20 days (Abdul Khader *et al*., 1982). When irrigation was scheduled based on IW/CPE ratio, it was found that irrigation of 30 mm of water when the CPE is 30 mm is optimum (Yadukumar *et al.*, 1982). This works out an irrigation frequency of once in 7-8 days during November-December, once in 6 days during January-February and once in 4-5 days during March-April and May. The quantity of water to be applied per irrigation was about 200 L. In all the above cases water was supplied as basin irrigation. The irrigation efficiency in this method was only up to 50-60%. Thus the actual water applied was double the water needed by the crop. Thus under drought conditions the plants will not get sufficient water.

With the drawback of the conventional methods of irrigation improved method of irrigation like sprinkler irrigation was invented. It was able to irrigate uneven terrains effectively. However the energy required to pressurize the water can become expensive. There will not be much savings in water when this irrigation method is followed. Water required to be given through sprinkler irrigation is about 40-60 L per day per palm. The irrigation interval is 3-4 days (Mahesha, 1987). The irrigation efficiency in this case also was about 70%. Thus this method also could not help in drought alleviation. The higher wind velocity, and temperature can affect the efficiency of this system.

The interests of man to grow the crop even at low water availability lead to the invention of drip or trickle irrigation. In this system water is applied to the soil at a very slow rate, drop by drop. Drip irrigation supplies plants with the precise amount of water they need. Just enough water is delivered to the root zone of plant to replenish the amount consumed in evapotranspiration, which is far more efficient then wetting the entire field. In conventional irrigation methods, there is relatively short period of infiltration followed by a long period of redistribution, evaporation and extraction of water by plants. That causes large time fluctuations in the soil water contents during the irrigation cycle. In drip irrigation, the plants grow without stress in an environment of favourable moisture. It also maintains the soil moisture tension at an optimum level for crop growth. Thus water required for irrigation is less and the irrigation efficiency is about 90-95%.

The research conducted at CPCRI, RS, Vittal revealed superiority of drip irrigation over conventional method of irrigation. A greater fluctuation in moisture content was observed in the plot irrigated by conventional method while in drip-irrigated plot, uniform moisture content was maintained. The vertical movement of water was more in the drip-irrigated plot as compared to conventional method. A total quantity of 1898 litres of irrigation water per palm was saved by drip irrigation in one season and the quantity of water saved per hectare in one season was 2590 thousand litres (25.9 cm), which amounted to 44% saving as compared to the quantity of water

used for irrigation in conventional method. All the growth and yield parameters were significantly better with drip irrigation as compared to conventional method of irrigation. Yield increase by 44% by drip irrigation has been observed over conventional method of irrigation. It was concluded that 20 litres of water per day per palm is required to irrigate the arecanut palm through drip irrigation.

Fertigation in Arecanut

An experiment to study the feasibility of application of fertilizers through drip irrigation is underway at Vittal. The initial results have shown that for pre-bearing arecanut palms 50 per cent of recommended nutrient is sufficient when it is given through drip irrigation thus saving considerable amount of fertilizer cost (Sujatha *et al.,* 2002). Annual maintenance cost could be reduced considerably through saving in labour and fertilizer input over normal practice of basin application of fertilizers and irrigation. Highest root dry weight and root/shoot ratio were observed in ferti-drip method (Sujatha and Abdul Haris, 2000). A two fold and more than four fold increase in number of feeder roots over drip and basin method respectively was observed. The fertilizers in the form of Urea, DAP and Muriate of potash can be given at 20 day interval during irrigation period.

Water harvesting

Farm ponds and check dams are two of the water harvesting structures, which are useful in areca growing areas. In the valleys small check dams may be constructed which makes water to stop and percolate in the soil. This can enrich the ground water level. The farm pond can store water during rainy season and the water stored can be used for irrigation during the summer.

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APPROACHES AND STRATEGIES IN THE MANAGEMENT OF YELLOW LEAF DISEASE OF ARECANUT (*ARECA CATECHU* Linn.)

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Arecanut palm (*Areca catechu* Linn.) is one of the important cash crops of India, cultivated extensively in Kerala, Karnataka and to some extent in Tamil Nadu, Andhra Pradesh, West Bengal and Assam. The palm is affected by a number of diseases and pests during different stages of its growth and development. Based on the nature and extent of damage, the Koleroga, Anabe, Yellow Leaf Disease and Inflorescence dieback are considered to be the major diseases.

Yellow Leaf disease (YLD) is the most serious malady affecting arecanut cultivation in Kerala and Karnataka, which considerably reduced the production and quality of the product. The exact period when the disease was observed is not known. However, the earliest information is found in the publication 'Diseases of coconut palm' by Varghese in 1934. According to Nambiar (1949), the disease was first reported in 1914 in Moovattupuzha, Meenachil and Chalakkudi area of central Kerala. Now, yellow leaf disease is prevalent in all district of Kerala, five districts of Karnataka and some parts of Tamil Nadu and Maharashtra causing heavy economic loss to the growers. It affects the normal growth and vigour of the palm. Reduction in yield up to 50% within a period of three years after the onset of the disease has been observed (Nair, 1994).

Symptoms

Leaves of arecanut turn yellow colour due to various biotic and abiotic factors. But symptoms of YLD can be differentiated from yellowing of leaves due to various other factors. Characteristic yellowing of leaves is the most important visual symptom of the disease and hence the name yellow leaf disease. Initially yellowing occurs in one or two leaves of outer whorl. Yellowing starts from the tip of the leaflets on either side of the leaf and gradually extends to the base. There is a clear demarcation between the green and yellow region of the leaflet at this stage. When the yellowing extends from tip to the basal portion of leaflets there will be a clear band of green tissue adjacent to the midrib. This characteristic symptom is different from the yellowing caused by other diseases and pests. The tip of the infected leaves become necrotic and eventually dry up. In advanced stage, the leaves become reduced in size, become stiff, closely bunched and abnormally puckered and the crown becomes very much reduced in size. Immature nut fall, kernel discolouration and extensive root rot are the other major symptoms (Rawther, 1976; ChandraMohanan, 1979; Nair, 1994).

Anatomical studies of leaves from diseased palms revealed multinucleated cells, disturbed tissue differentiation, blocking of palisade cells with brown pigments and degeneration of chloroplast (Nayar, 1968).The leaves of diseased palms showed smaller epidermal cells, stomata and midrib parenchyma cells, while xylem tissues in the midrib were larger. Rapid collapse of stomata and occurrence of tyloses in varying degree were recorded. Significant

accumulation of starch grains indicated impaired translocation of food materials and accumulation of products of photosynthesis (Menon, 1960).

Etiology

Extensive and systematic research has been conducted to find out whether the disease was caused by fungi, bacteria, nematodes, viruses or by nutritional disorders. But it has been clearly revealed that none of these can cause YLD.

Electron microscopic (EM) studies showed the presence of Phytoplasma in young sieve elements of YLD affected palms (Nair and Seliskar, 1978). EM examination of root tissue of YLD affected palms invariably showed the presence of Phytoplasma whereas they were totally absent in roots of healthy palms (Anon, 1985 and 1986).

Detailed investigations on possible vectors of the disease have revealed the constant association of a plant hopper *Proutista moesta* (Westwood) with arecanut palms. On EM examinations, Phytoplasmas were observed in the salivary gland tissue of plant hopper collected from the leaves of diseased palms while Phytoplasmas were totally absent in the salivary gland tissues of laboratory reared plant hopper as well as the insects collected from healthy areas. Transmission of the disease and vector role of *P.moesta* were confirmed by observing YLD symptoms on arecanut seedlings inoculated with *P.moesta* which was given five days acquisition access to diseased palm and 25- 36 days inoculation period (Ponnamma *et. al*., 1991 & 1997). These results lend further support to Phytoplasma etiology.

The presence of Phytoplasma and its transmission were established also by dodder transmission (Anonymous, 1991).

Antibiotic therapy against YLD revealed marked reduction in foliar symptoms in neomycin, ledermycin oxytetracycline (OTC), gentamycin and hostacycline treated palms. But, there was no reduction in disease intensity in the penicillin treated palms. On the other hand, the disease intensity of the palm in this treatment increased as usual. Thus it again confirmed the phytoplasmal etiology (Anonymous, 1990 & 1991).

Disease Management

Since YLD is caused by Phytoplasma it is not possible to control the disease by adopting conventional plant protection measures.

The perennial nature of the crop, persistence of the pathogen once it is acquired and possible transmission in brief duration of feeding by vector, rule out the effective prevention of the spread of the disease by control of vector. Diseased palms treated with antibiotics exhibited only temporary remission of symptoms and need to be applied repeatedly. Prohibitive cost of antibiotic and caution against its indiscriminate use for treating any plant disease are the other limitations of its use. Therefore, it became imperative to find out other means of containing the disease so as to obtain the maximum economic return from affected gardens.

One of the significant features of this disease is that it is not lethal but a slow declining malady. Thus YLD affected palms will die only after a long protracted period of illness. In the absence of any control measures, this nature of the disease is advantageous to adopt proper management practices to increase the vigour and yield of palms in the initial stage of disease. In managing the disease two strategies, one for the mildly affected area and other for heavily diseased area, have been formulated.

The strategy for mildly affected area is to contain the disease by removing all the diseased palms. Eradication of disease affected palms to contain the disease can be successful if continuous monitoring for occurrence of the disease and uprooting of diseased palms in the very initial stage of the disease are taken up simultaneously. If the programme is not monitored uninterruptedly the desired goal will not be achieved.

In heavily diseased area, yield of the palms can be sustained or even improved through adoption of integrated management practices - removal of disease advanced and juvenile palms, balanced fertilizer application, addition of organic manures, irrigation during summer months, practicing plant protection measures. The income from a unit area can be further increased by adopting inter and mixed cropping.

By taking into account all the results from earlier trials, a detailed experiment was initiated in 1982 at Palode (Kerala) with four management practices on two varieties of arecanut to evaluate their effect on the incidence of yellow leaf disease. Incidence of the disease was least in palms treated with higher dose of phosphorus application over and above the normal package. Mangala and its segregants were superior to South Kanara local. The effect of phosphorus in reducing the incidence of YLD was evident (Anon, 1991; Nair, 1994). It is apparent that soil and nutrient management had improved the condition of disease affected palms and increased the yield to some extant or maintained the yield level. Thus, it is essential to follow management recommendations in order to reduce the disease incidence and to realize maximum economic return from the affected garden.

Based on the various field trial conducted in different locations the following management practices have been recommended to improve the yield of YLD affected palms in heavily disease affected areas.

- Regular and balanced fertilizer application. Apply 200 g of urea, 200 g mussorie phos and 230 g muriate of potash per palm per year in two splits.
- In addition to the above, apply 800g of mussorie phos in the affected gardens.
- Apply organic manures @ 12 Kg each of compost and green leaves per palm per year.
- Provide irrigation during summer months.
- Avoid water stagnation in the garden by providing drainage facilities.
- Grow cover crops in the garden.
- When only a few palms are affected in a garden, remove them to delay further spread of the disease within the garden.
- Adopt need based plant protection measure against other pests and diseases.

Lose can be reduced to the minimum if the palms could be attended immediately on appearance of symptoms.

Screening of Varieties against YLD

Studies on varietal reaction to YLD were initiated as early as in 1960. In a multi location trial conducted during 1970's, six promising cultivars such as VTL-3 (Mangala), VTL-11 (Sumangala), VTL-17 (Sreemangala), Mohitnagar, VTL-12 and VTL-13 with South Kanara local as check were evaluated and the results indicated that all of them were susceptible. Nampoothiri (1982) reported that 52 arecanut collections derived from both exotic and indigenous sources also succumbed to YLD with varying degrees of intensity. Further, large scale screening of germplasm collection / varietal hybrids, hybrids produced from disease escapes, *inter se* / selfed progenies of different collections involving 88 different cross combinations comprising of 2,328 palms were undertaken in YLD affected belt during 1976-1993. All of them were highly susceptible and 18 genotypes showed less than 25 percent of disease incidence. The 21 diallel cross combinations planted at CPCRI, Palode in 1976 have contracted the disease within a period of three years. The disease incidence varied from 63.9 to 100 percent. Maximum incidence was noticed in VTL-3x VTL-13, VTL-11x VTL-13, VTL-11x Thirthahalli, VTL-13x VTL-17 and VTL-17x Thirthahalli (100%) and minimum in VLT-12x Thirthahalli (63.9%). The hybrid combinations between Hirehalli dwarf mutant and promising cultivars (VTL-3, VTL-11, VTL-13, Mohitnagar and Thirthahalli) planted in 1976 exhibited certain degree of tolerance in the initial years (Anon, 1981). However, all succumbed to YLD within a period of 6-8 years. The disease incidence was the highest in Thirthahalli x Dwarf (62.9%) and least in Dwarf x VTL-11 (18.1%) (Anon, 2000).

A field trial involving nine varietal hybrids and Mangala and South Kanara as control initiated during 1984 at CPCRI Research Centre, Palode indicated that all of them contracted the disease within a period of three years except VTL-12 x South Kanara combination. Later, this combination also succumbed to the disease.

Even after 18 years of field experimentation, none of the hybrids or varieties tested was completely resistant. But in the hot spots of YLD affected areas, in the midst of diseased palms, some high yielding palms are found without any symptoms of the disease. Hence, the investigations were undertaken to identify field tolerant/resistant elite palms in hot spots of YLD affected areas.

Selection criteria of disease free elite palms

- The mother palms should have a minimum age of 20 years.
- More than 90% of the surrounding palms should be affected by YLD.
- Disease free nature of the palm should be confirmed by light microscopic test/ serodiagnostic test.
- They should yield a minimum of 200 nuts per palm per year under neglected conditions (Farmers neglect the garden when YLD incidence is very high).
- Selected palms should be generally free from major pests and diseases.

Breeding for resistance against YLD

Since there are no curative or prophylactic measures available to combat YLD, the long-term option is to breed for disease resistance. Disease free elite mother palms were identified in hot spots of Kerala and Karnataka states (ChandraMohanan and Nampoothiri, 2001). They were further monitored every year for disease incidence and yield. The disease free elite palms were selfed by artificial pollination and F_1 progenies were interplanted in severely (more than 90%) YLD affected gardens in the hot spots of Karnataka for evaluating their susceptibility to the disease (Fig.1). Simultaneously, seedlings raised from open pollinated seed nuts of disease free elite palms were also planted in severely YLD affected gardens. Though research work in this line is in progress, it will take a very long time to evolve a sufficiently large population of tolerant/resistant palms and to replace the diseased palms with tolerant/resistant ones, in a phased manner. Therefore, seedlings produced from disease free elite mother palms identified in hot spots may be used as quality planting material for the replanting programme in disease endemic areas.

Technology Implementation

The yield of palms in heavily YLD affected areas can be sustained or improved by adopting recommended management practices in the initial stage of the disease. To adopt the recommended management practices, arecanut farmers are to be convinced of the advantages of adopting the recommended technologies. For this, economically viable technology developed for increasing the income per unit area by improving the health and yield of palms has to be convincingly demonstrated by implementing it in a contiguous area in each district and thus developing model arecanut farms in each of the district having high incidence of YLD. Simultaneously farmers of the selected plots can be thoroughly trained to develop them as 'Farmer Professors' who will serve as resource persons for other farmers in each district (Fig-2). Such farmers will have regular contact with research organizations to disseminate the newer technologies among other farmers in the district. They are expected to identify disease free elite mother palms in hot spots in the respective district to produce quality planting materials from elite palms by selfing and to supply to the other farmers in the district.

Future Thrust

Satellite survey of the disease affected arecanut tract using Geographic Information system (GIS) would be helpful in identifying the extent of spread and intensity of the disease as well as in understanding the incidence in surrounding areas.

Identification of disease resistant/tolerant palms and screening of these progenies should be a continuous process in research for tolerant genotypes. Assessing resistance to YLD using biotechnological tools can be tried to shorten the breeding cycle. Screening the materials against the disease with dodder and insect vector and early detection of the disease using ELISA would accelerate the identification of resistance. PCR based molecular fingerprints can be exploited for determination of genetic diversity in arecanut germplasm and tagging resistant genes. Pathogen derived resistance mechanisms need to be employed to produce transgenics to resolve this stalemate.

Evolving field tolerant lines coupled with suitable management practices will be final solution in tackling the YLD of arecanut.

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RESEARCH ACTIVITIES ON ARECANUT AT UAS, NAVILE CAMPUS, SHIMOGA

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Though malnad and coastal regions are the traditional arecanut growing belts in Karnataka, the actual area expansion during recent years has taken place in maidan region which constitutes now >50 percent of the total arecanut area in the state. Hidimundige, Crossnode, Anabe roga, Inflorescence dieback, Bacterial leaf stripe, Bud rot and Sucking pests are the major problems faced by the areca growers in this region. Long felt need of the arecanut farmers in this region has come true with the establishment of Arecanut Research Centre at University of Agricultural Sciences, Navile campus, Shimoga. The center is funded initially by the local

organizations like MAMCOS, APMCs, APSCOS, TUMCOS to a tune of Rs. 90 lakhs spread over a period of 5 years starting from 2000-01 to 2004-05. The center is to continue its activities later on, by generating its own income in the arecanut gardens established at the center. The responsibility lies on the team of scientists to generate the funds for continuation of the research work in accordance with the principle of Land Grant System of education in Agricultural Universities.

In order to give immediate attention to the problems of arecanut growers, activities of the research center have been focused around the following two main aspects.

1. 'ON FARM' demonstrations and Farmers' Participatory Research programs.
2. 'ON STATION' experiments, development of value added products and marketing studies.

Mainly four districts viz., Shimoga, Chikkamagalur, Davangere and Chitradurga have been included at present for the activities of the center. Different farming situations covered in these districts are as follows.

1. Channel irrigated maidan region : Shimoga, Bhadravathi, Honnali
2. Malnad situation : Sagar, Hosanagar, Thirthahalli, : Koppa, Shringeri
3. Under ground source dependent maidan belt :Channagiri, Bheemasamudra.

Surveys made on the faulty management practices followed in the above situations are as follows.

Faulty managements practices	Percentage of gardens following wrong practices			Average (%)
	Canal irrigated maidan region (60 gardens)	Malnad situations (190 gardens)	Under ground water source dependent gardens (112 gardens)	
1. Faulty lay out of the gardens	68.33	23.15	63.39	51.62
2. Shallow method of planting	100.00	10.52	91.07	67.20
3. No proper drainage system	91.67	31.58	100.00	74.42
4. Flooding method of irrigation once in 15-20 days	93.33	5.26	24.11	40.90
5. Non application of fertilizers.	71.67	50.00	65.18	62.28
6. Application of tank bed silt every year.	81.67	5.26	72.32	53.08
7. Excessive intercultivation using farm machineries.	88.33	13.15	94.64	65.37

The above basic informations indicated the necessity of extensive strategies to be adopted not only in the dissemination of production technology to areca growers, but also to take up actual field demonstrations and research trials directly in the growers fields.

Further survey revealed that hidimundige, yellow leaf disease and root grub in different arecanut growing belts are the major pest and diseases affecting the economic yield and long life span of the plants.

Survey on incidence of important diseases/physiological disorders.

Places	No.of gardens visited	Yellow leaf disease	Hidimundige	Anabe roga	Cross node
1. Shringeri & Koppa	148	43.92	4.72	6.08	8.11
2. Sagar & Sorab	116	-	13.79	6.03	12.07
3. Channagiri & Shimoga	145	-	18.62	15.17	8.96

4. Bheemasamudra	49	-	20.41	8.16	4.08

Survey on incidence of important pests.

Places	No.of gardens visited	Root grub	Spindle Bug	Pentatomid	Mite
1. Shringeri & Koppa	148	35.14	17.57	12.16	3.38
2. Sagar & Sorab	116	37.07	11.21	16.38	4.31
3. Channagiri & Shimoga	145	-	8.28	4.83	17.93
4. Bheemasamudra	49	-	10.20	6.12	55.10

Extending the areca cultivation in Malnad region on paddy soil has paved the way for increase of root grub infestation whereas raising of crop in the forest cleared soils made the trees to grow very vigorous. This has invited the physiological disorders like corky stem, cracking in the top nodal regions and subsequent incidence of 'Garagasa Roga'. In fact the gardens supplied with excess organic matter also showed similar symptoms.

'ON FARM' TRIALS AND DEMONSTRATIONS

Various management and research trials taken up directly in the farmer's gardens are presented below.

Sl. No	Name of the trials	No. of locations	Year of start
1.	Hidimundige management	7	2002-03
2.	Research trial on hidimundige	4	2003-04
3.	Management of yellow leaf disease	7	2002-03
4.	Research trial on yellow leaf disease	5	2003-04
5.	Management of root grub	4	2002-03
6	Integrated nutrient management	6	2003-04
7.	Cross node problem in arecanut	1	- do -
8.	Management of inflorescence dieback disease	1	- do -
9.	'Anabe Roga' disease management	4	- do -
10.	Bacterial leaf stripe disease management	2	- do -
11.	'Spindle bug' control in arecanut	1	- do -
12.	Arecanut mite control	2	- do -
13.	Soil profile categorization and analysis of areca garden soils	332 samples	- do -

The above trials are in progress. The initial observations and results have been recorded.

Non existence of proper drainage, application of tank bed silt every year, flood method of irrigation, excess inter-cultivation and soil compaction have been observed to be the main reasons for hidimundige disorder. A regular degeneration and regeneration of root system, due to faulty management practices, has resulted in loss of rooting vigour after certain age of the trees. Subsequently the trees showed symptoms of hidimundige. Emphasis has been given on these aspects in the trial demonstrations carried out in the grower's fields. With regards to yellow leaf disease, affected gardens, management practices recommended by CPCRI, Vittal have been adopted while certain micronutrient combinations are being tried in the research plots. For other pest and diseases, newer chemicals and bio-pesticides are being tested.

Areca growers, in the recent years, have started applying more of micronutrient mixtures and formulations as advocated by different firms. It is a dangerous phenomenon wherein excess accumulation of trace elements in the gardens over a period of time may become highly toxic to the plants. An extensive collection of soil samples both from surface and subsurface levels has

been made and analysed for textural class, soil reaction, salt content, organic carbon and nutrient status at different taluks of traditional and non tradition belts of Karnataka.

'ON STATION' EXPERIMENTS

In order to strengthen the research on production technology of Arecanut in maidan region, fresh gardens have been established in the Arecanut Research Center, Navile and Sub Center, Honnavile.

The name of the center	Freshly planted area (ha)		Old gardens transferred (ha)	Total area (ha)	Experiments proposed/ laid out
	2003	2004			
Navile, Shimoga Honnavile Shimoga	1.00 1.20	1.00 1.20	0.50 1.20	2.50 3.60	1. Performance of improved varieties 2. Integrated nutrient management 3. Water management studies 4. Inter/mixed cropping systems 5. Integrated pest & disease management
Total	2.20	2.20	1.70	6.10	

The plants have established well. Drip irrigation system has been adopted. Proper drainages have been provided. Treatments have already been imposed in early-established gardens.

Identification and refinement of traditionally used value added products.

Socio- anthropological studies carried out in the traditional arecanut farming situations such as Sagar, Hosanagar, Siddapur and Thirthahalli taluks have enabled to identify the following value added products.

1. Dia Area – To manage diabeties
2. Areca Mouth Freshener – To manage cough and mouth ulcer.
3. Herbal Gutika – An alternative to tobacco based gutka.

Biochemical and clinical tests for the above products are in progress.

Market studies have been undertaken against the backdrop of socio-economic profiles of arecanut farmers. The following are the important aspects of study.

1. Pricing system and tendencies
2. Price behaviour over periods in different markets
3. Consumption pattern and habits.
4. Current factors affecting arecanut prices
5. Recommendations for stable marketing strategies.

Finally, this newly established Research Center on Arecanut aspires to grow steadily by building up the infrastructure of its own and coordinating with CPCRI and other organizations. A team of scientists at Navile campus has been given a free hand by the University to work on arecanut and win the good will of Arecanut growers.

PHARMACOLOGICAL USES OF ARECANUT

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Introduction

Areca nut chewing is a practice of great antiquity in many parts of Asia, mainly India, Pakistan, Bangladesh, Sri Lanka and in some Pacific islands. It is estimated that currently there are several hundred million users of areca nut in the world. In India this practice is at least 2000 years old; it is an integral part of the religious and cultural rituals and also of everyday life. The

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seed (endosperm) can be used fresh, after sun drying, curing or baking. Curing is done by boiling the seed in water with a little extract from previous years' curing; this results in uniform colour, softens the nut, and reduces the tannin content.

The two most important constituents of areca nut are tannins (11-26%) and alkaloids (0.15-0.67%). Arecoline is the major alkaloid. Some of the minor ones are arecaidine, guacine, guvacoline and arecolidine. Other constituents of areca nut include fats (8-15%), carbohydrates (15-23%), proteins (6-9%), and various other substances.

Methods of use

Areca nut is most commonly chewed as a constituent of betel quid. The betel quid is a mixture of betel leaf, areca nut, and slaked lime (calcium hydroxide). Depending upon individual and local preferences, condiments, sweetening agents, and spices may be added. In India, most habitual chewers of betel quid add tobacco. In some countries, e.g., Papua New Guinea, tobacco is not added.

Areca nut preparations available in the market are: uncured, cured, whole, broken, wafered, shredded, commercially manufactured, etc. In Assam, the use of fermented areca nut (tamol) is common. It contains higher levels of arecoline and is often infected with fungus. Mainpuri tobacco is a mixture of areca nut, tobacco, lime, and condiments. It is popular in parts of northern India and is highly carcinogenic. Mawa is a mixture of about 5 g areca nut pieces and 0.5 g tobacco sprinkled with a few drops of lime (calcium hydroxide) water. It shows a high relative risk for oral submucous fibrosis. Gutka is the mixture that is put in betel-quid except that it is not wrapped in betel leaf. In recent years an increasingly popular form of areca nut chewing is the use of so-called "betel quid spices" (Pan Masala). They are available in tins and foil packets. Their main appeal perhaps lies in the fact that unlike betel quid they are not perishable.

Health effects

It has now been established that areca nut use causes oral submucous fibrosis, which is a serious debilitating, and progressive disease. Stiffening of the oral mucosa and development of fibrous bands resulting in a restricted mouth opening mark this disease. Submucous fibrosis is not reversible nor is there any effective cure and is precancerous in nature. The risk of developing oral cancer among individuals with oral sub-mucous fibrosis has been demonstrated to be very high, especially if they also use tobacco, whether in smokeless or smoking form. Since most individuals who use areca nut also use tobacco either in the form of chewing or smoking, the epidemiological evidence about the carcinogenicity of areca nut alone has not been regarded as sufficient (Gupta *et al*., 1992*)*. There are case reports of oral cancer developing among individuals who use areca nut but do not use tobacco in any form (Gupta *et al*., 1982*)* There is some experimental evidence to show that in the presence of salivary nitrates, areca nut alkaloids can form nitrosamines that are carcinogenic (IARC, 1984).

The mutagenicity of betel quid, arecoline (the main alkaloid in areca nut) (Jeng et al., 1999), arecaidine (a metabolite of arecoline) (Shirname et al., 1984) and N-nitrosoguvacoline (the only N-nitrosamine product of arecoline) (Wang and Peng, 1996) has been reported. Calcium hydroxide in the lime used by betel quid chewers, in the presence of areca nut forms reactive oxygen species, which might cause oxidative damage in the DNA of buccal mucosa cells of betel quid chewers and cytogenetic damage (Nair et al., 1992). Jeng et al. (1994) indicates that the cytotoxic effect of arecoline is due to glutathione depletion and not due to attack of oxygen free radicals.

Pharmacological Uses

From the foregoing account, it is to be understood that although chewing of areca nut may be a practice of great antiquity, it cannot be regarded as a safe habit. As a practice that is often associated with concurrent smokeless tobacco use, it needs to be strongly discouraged. But it has also to be emphatically stated that the areca nut has its uses too – those of pharmacological importance are stated below.

Wound healing activity

CPCRI, in collaboration with the Department of Pharmacology, KMC, Manipal, studies the effect of alkaloid and polyphenolic fractions of areca nut on healing of different wound models. The polyphenol fraction was found to significantly increase the breaking strength of incision wounds However both the alkaloid and polyphenol fractions of areca were found to decrease the period of epithelization and increase the percentage of wound contraction required to heal excision wounds. In the dead space wound model the areca alkaloids were found to increase the breaking strength. The study needs further refinement to identify and apply the wound healing property of areca nut to medical use.

Antimicrobial activity

Studies at CPCRI showed that the polyphenols of areca have marginal antibiotic effect on the bacteria *Escherichia coli, Pseudomonas, Vibrio cholerae, Salmonella typhi* and *Staphylococcus aureus,* compared with the broad-spectrum antibiotic gentamycin. No effect was observed on fungi. The arecoline fraction showed no inhibition on any of the organisms.

Antihelminthic Activity

Arecanut decoction as well as arecoline and its salts have been found to be effective in taenia infections. Arecoline is reported to be useful in infections like fasciolopsian cestode, ascariasis, heterales and Rallietina sp. Areca is used in veterinary practice as a vermifuge for tapeworm and roundworm in dogs (Mujumdar et al., 1982)

Hypoglycemic activity

Studies by Chempakam (1993) at CPCRI have shown that arecoline compares with other oral hypoglycemic drugs. Arecoline at 0.05 – 0.25 mg per kg body weight dose caused hypoglycemia (27 – 42%) and at 0.5 – 1.0 mg per kg dose produced hyperglycemia (23 – 29%).

A myriad other effects of areca nut of medicinal importance have been reported, a few of which are listed below:

Central nervous system

(1) The CNS actions of arecoline are biphasic, as they increase and decrease spontaneous motor activity, water and food consumption at low and high doses respectively.
(2) Arecoline has a depressant action on the CNS, of the parasympathetic type.
(3) Arecoline inhibits conditioned avoidance responses (CAR).
(4) Arecoline administered by intracerebroventricle route in unanaesthetized cat evoked emotional, behavioral and autonomic changes as well as convulsions.
(5) Arecoline was shown to induce aggressive behavior in unanaesthetized cats.
(6) Arecoline penetrates the blood-brain barriers, prevents halothane induced shivering and delays the return to normothermia.
(7) Arecoline produces both the muscarinic and nicotinic actions of acetylcholine - bradycardia, hypotension, increase in intestinal tone, salivation and sweating. At presynaptic sites, arecoline appears to be useful for liberation and maintenance of neurotransmitter.

Cardiovascular Activity

All crude extracts of areca nut in different solvents – water, alcohol, acetic acid and calcium hydroxide – were found to cause capillary constriction .

Urine and electrolyte secretion

Arecoline hydrochloride produced marked natriuresis and chlorouresis in hydrated rats. It has some direct effect on renal haemodynamics, as it affects the effective renal plasma flow. It increased Na, K and osmolity of urine without increasing the urine volume.

Ocular effects

Miotic effect of arecoline has been known for a long time, it accelerate the regeneration of visual purple.

Antifertility activity

In male white rat, arecoline causes morphofunctional changes such as stimulation of hormogenesis and disruption of spermatogenesis.

Other metabolic effects

Direct injection of arecoline into the adrenal gland resulted in increased secretion of adrenaline. Arecoline increases excretion of CO_2 and H_2O and absorption of oxygen in rabbits. Arecoline hydrobromide is used in an antisnoring composition, which was formulated into gargles and tablets.

Conclusion

Though use of areca nut as a masticator may be on the wane as long as it is under the cloud of its carcinogenic property, its other equally important pharmacological uses need to be explored and taken advantage of.

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NATURE OF ACIDITY IN TRADITIONAL ARECA GROWING SOILS OF KARNATAKA

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Soil acidity is a major problem in traditional areca growing soils of Karnataka, leading to severe toxicity of iron, aluminium and Manganese, accompanied by deficiency of phosphorus, and low microbial activity leading poor yield of the crops. The sources of soil acidity include

mainly the exchangeable H^+ and Al^{3+} and Al oxides, clay and organic matter. But the predominant characteristics of acid soils being the presence of Al^{3+} in soluble and exchangeable forms and an index of its concentration is used in lime requirement. Iron can contribute towards the acidity of a soil by hydrolysis but has a little effect on pH until most of the soil-Al^{3+} has reacted. However, there is a wide information gap on the nature of acidity in these soils. The present investigation was undertaken to characterise the nature of acidity in such soils.

Materials and methds

Fifty unlimed surface soil samples (0-20 cm) were collected from different agroclimatic zones of Karnataka viz., Hilly zone (Thirthahally, Koppa, Sringeri and Sagar) and Coastal zone (Kundapura). After collection, the soils were processed, seived (2 mm) and analysed as described in Jackson, (1973) and Page (1991). Total and exchange acidity of the soils were estimated by extracting with 1.0 M sodium acetate (pH 8.2) (Baruah and Barthakur 1997), and 1.0M KCl (McLean, 1965), respectively and subsequently titrated with standard NaOH solution using phenolphthalein as indicator. The difference between total and exchange acidity was considered as hydrolytic acidity. The total potential acidity however, estimated by extracting with $BaCl_2$-TEA (pH 8.2); while the pH-dependent acidity was calculated as the difference between the total potential acidity and exchange acidity. The electrostatically bound aluminium was estimated from KCl extract using aluminium (McLean 1965); while the electrostatically bound hydrogen was estimated by taking difference between exchange acidity and electrostatically bound aluminium. The extractable acidity was estimated by extracting the soil with 1.0M NH_4OAc (pH (4.8) as described byBaruah and Barthakur(1997).

Results and Discussion

All the experimental soils were acidic in nature with mean pH values of 5.47, 5.58, 5.48,5.90 and 5.56 for Thirthahally, Koppa, Sringeri, Sagar and Kundapura taluk soils respectively.

Forms of acidity

The total potential acidity (TPA) of the soils varied from 4.01 to 22.1, 10.0 to 30.1, 10 to 34.2, 4.0 to 21.0 and 6.0 to 30.1 with mean values of 14.54, 20.07,17.87, 15.51 and 17.07cmol (p^+) kg^{-1} for soils of Thirthahally, Koppa, Sringeri, Sagar and Kundapura taluks, respectively. (Table 2). This indicated that Koppa, Sringeri and Kundapur soils contained the highest amount of organic carbon and clay, and lowest pH values. Their total potential acidities were relatively high as compared to soils of Thirthahally and sagar taluks.

The total acidity (TA) of the soils ranged from 1.0 to 5.7, 1.1 to 5.4,1.1 to 3.7,1.1 to 2.2 and 1.0to 4.6 Cmol (P^+) Kg^+ with mean values 2.0, 2.72, 2.55, 1.72 and 2.81 for Thirthahally, Koppa, Sringeri, Sagar and Kundaprua taluks, respectively. The values of total acidites were almost quarter or less of those of TPA. This was related to the chemistry of extraction of acidity from soils by the two soils viz., $BaCl_2$-TEA and NaOAc used for this purpose, as explained later. The magnitude of differences in values between total acidities and TPA's for Koppa, Sringeri and Kundapura were very small.

Acidity owing to variable charge (pH-dependent acidity) as measured by the difference between the total potential acidity and exchange acidity (EA) varied from 3.9 to 21.9, 4.8 to 30.0, 9.5 to 33.7,3.9 to 21.6 and5.9 to 27.9 Cmol (P^+) Kg^+ with mean values of 14.39, 17.9, 17.39, 15.28 and 17.30 Cmol$(P^+)Kg^+$ for soils of Thirthahally, Koppa, Sringeri, Sagar and Kundapura taluks, respectively contributing to the extent of 98.96, 99.1, 97.3, 98.5 and 99.0 percent of total potential acidity of the soils. Similarly soils of Koppa, Sringeri and Kundapur taluk contained the highest amount of pH-dependent acidity followed by Sagar and Thirthahally taluk soils.

The hydrolytic acidity (HA) of the soils calculated as the difference between TA and EA varied from 0.83 to 5.26, 1.0to5.23,0.70 to 3.30, 0.93 to 1.97 and 0.86 to 4.33 with mean values of 1.72, 2.55,2.07,1.51 and 2.65 Cmol$(P^+)Kg^+$ contributing 86.0, 93.8, 80.8,87.8 and 94.30 percent of TA for Thirthahally, Koppa, Sringeri, Sagar and Kundapur respectively. The values of hydrolytic acidites for all the soils were less than those of pH-dependent acidity. The high concentration of Ba^{2+} in $BaCl_2$ -TEA used for estimating TPA and subsequently pH-dependent

acidity by substracting with EA not only serve to replace completely the exchangeable Al^{3+} with H^+ ions but should also increase the extent of hydrolysis of adsorbed aluminium and the degree of dissociation of acidic groups on the clay surface. While the Na^+ in NaOAc used for estimating TA subsequently HA cannot replace the entire quantity of Al^{3+} from soil exchange complex, because of its (Na^+) low charge and high ionic (hydrated) diameter. This explains the high values of pH-dependent acidity than HA.

The extractable acidity as extracted by 1N NH_4OAc (pH 4.8) varied from 0.35 to 0.85, 0.27 to 0.90, 0.17 to 0.77, 0.30 to 0.67 and 0.27 to1.0 with mean values of 0.65, 0.553, 0.534, 0.430 and 0.452 Cmol (p^+) Kg^{-1} for soils of Thirthahally, Koppa, Sringeri, Sagar and Kundapura taluks respectively. This form of acidity, possibly originated from polyhydroxy molecule of Al, was higher in soils of Thirthahally, followed by Koppa, Sringeri, Kundapura and Sagar taluks.

The exchange acidity includes the exchangeable H^+ and Al^{3+} held at the permanent charge sites of the soil exchange complex (McLean 1965). Unlike TPA and TA, the exchange acidity of the all the soils was much less and its values ranged from 0.07 to 1.15, 0.10 to 0.33, 0.20 to 0.75, 0.17 to 0.25, and 0.13 and 0.23 with mean values of 0.275, 0.17, 0.48, 0.213 and 0.16 Cmol(p^+)kg^{-1} for soils of Thirthahally, Koppa, Sringeri, Sagar and Kundapura taluks respectively. The contribution of exchange acidity to total acidities (TA and TPA) was very less. The relatively low contribution of EA towards total acidities had also been observed by Kailashkumar *et al (1995).* The highest contribution of H^+(Table-2) in Thirthahally taluk soils was associated with their lowest pH. The contribution of exchangeable $Al3^+$ towards exchange acidity was more than the exchangeable H^+. Kailashkumar *et al* (1995) also observed that contribution of exchangeable Al^{3+} towards the exchange acidity was more than the exchangeable H^+ in some acid soils of Manipur.

Results thus indicated that $BaCl_2$-TEA method may be a better choice for quantification of acidity in soils containing high organic carbon and different forms of Aluminium and the nature of soil acidity of areca growing soils is pH-dependent and nature of soil acidity should be considered for assessing the lime needs of the soil.

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Table – 1 : Physicochemical properties (ranges) of the soils of areca gardens

Sl. No	Taluks & No. of samples	PH (1:2.5)	EC (ds/m)	OC (g/kg)	CEC cmol (p^+)/kg	B.S. (%)	Fe_2O_3 (%)	Clay (%)
1.	Thirthahally (10)	4.4-6.1 (5.47)*	0.01-0.09 (0.05)*	3.9-15.3 (8.64)*	9.3-29.0 (20.72)*	18.8-56.9 (27.4)*	1.2-2.1 (1.48)*	19.1-28.19 (25.25)*
2.	Koppa (10)	5.0-6.2 (5.38)*	0.05-0.26 (0.094)*	8.7-24.3 (16.08)*	16.8-36.7 (25.67)*	17.8-40.2 (30.5)*	1.7-2.7 (2.19)*	20.2-30.2 (20.32)*

3.	Sringeri (10)	4.8-6.2 (5.48)*	0.02-0.10 (0.04)*	4.8-22.0 (16.0)*	15.5-47.7 (25.7)*	17.4-42.8 (27.93)*	1.2-1.8 (1.5)*	17.2-34.2 (23.5)*
4	Sagar(10)	5.5-6.5 (5.9)*	0.03-0.16 (0.07)*	7.2-26.7 (16.4)*	9.8-31.7 (21.52)*	21.2-58.6 (33.12)*	0.8-1.7 (1.34)*	18.9-30.2 (22.65)*
5	Kundapura (10)	4.9-6.8 (5.56)*	0.02-0.24 (0.07)*	7.2-27.6 (16.4)*	16.0-33.9 (22.91)*	16.8-41.7 (26.58)*	0.8-1.8 (1.23)*	22.9-30.44 (25.33)

*Values in the paranthesis indicates mean values

Table – 2 : Different forms of acidity (cmol(p^+)/kg) of the soils**.**

Sl. No	Location & No. of samples	Total potential acidity	pH dependent acidity	Extractable acidity	Total acidity	Hydrolytic acidity	Exchange acidity	EB.Al^{3+}	Exch. H^+
1.	Thirthahally (10)	4.01-22.1 (14.54)*	8.9-21.9 (14.39)*	0.35-0.85 (0.65)*	1.0-5.7 (2.0)*	0.83-5.26 (1.72)*	0.07-1.15 (0.275)*	0.07-0.31 (0.127)*	Traces-1.06 (0.15)*
2.	Koppa (10)	10.0-30.1 (20.01)*	9.8-30.0 (19.9)*	0.27-0.90 (0.553)*	1.1-5.4 (2.72)	1.05-5.25 (2.55)*	0.10-0.33 (1.7)	0.07-0.17 (0.11)*	Traces-0.19 (0.06)*
3.	Sringeri (10)	10.0-34.2 (17.87)*	9.5-33.7 (17.39)*	0.17-0.77 (0.534)*	1.1-3.7 (2.56)*	0.70-3.30 (2.07)*	0.20-0.75 (0.481)	0.12-0.50 (0.294)*	Traces-0.50 (0.187)*
4	Sagar (10)	4.0-21.8 (15.51)*	3.9-21.6 (15.28)*	0.30-0.67 (0.43)*	1.1-2.2 (1.72)*	0.93-1.97 (1.51)*	0.17-0.25 (0.213)	0.05-0.17 (0.18)*	0.05-0.50 (0.157)*
5	Kundapura (10)	6.0-30.1 (17.47)*	5.9-27.9 (17.30)*	0.27-1.0 (0.452)*	1.0-4.5 (2.81)*	0.86-4.33 (2.65)*	0.13-0.23 (0.16)*	0.06-0.17 (0.11)*	Traces-0.08 (0.05)*

*Values in the paranthesis indicates mean values

ENHANCING MICROBIAL ACTIVITY WITH VERMICOMPOST APPLICATION IN ARECANUT (*ARECA CATECHU* L.) RHIZOSPHERE

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Organic farming is fast catching up and the use of organics is increasing day by day to improve the soil health and sustain the production on long term basis. The application of organics, apart from increasing the organic carbon, improves the biological activity of the soil (Bopaiah and Bhat, 1981). The biological activity in terms of nitrogen fixers, phosphate solubilizers help in increased nutrient availability to plants and thereby improve the productivity. This is most important in perennial crops as they occupy the field for 3-4 decades. Arecanut (*Areca catechu* L.) is one of the important commercial crops in humid tropics of India. It is mainly grown in lateritic and red sandy loam soils, which are generally poor in fertility. Though the organic carbon in the soil is in the medium range, continuous application of organic manure is necessary due to faster decomposition of organic matter in tropical climate and to improve the soil health. Vermicompost is one of the widely used organic fertilizers and contains higher content of both macro and micronutrients (Chowdappa *et al*., 1999) and microbial population (Nowak, 1975; Lee, 1985). The technology for conversion of wastes from the arecanut garden has been standardized. A long term study is being conducted to know the beneficial effects of vermicompost application to arecanut. As a part of this study, the microbial activity in the root zone of arecanut was studied.

Materials and Methods

The experiment was laid out at the Experimental Farm of Central Plantation Crops Research Institute, Regional Station, Vittal in Karnataka, India. The place is located 58 m above MSL with average rainfall of 3800 mm and has 36°C and 21°C mean maximum and mean minimum temperature. The soil of the experimental site is laterite with a pH of 5.6 and available soil nutrient status of 143 ppm N, 10.1 ppm P and 53 ppm K at a surface depth of 25 cm. The experiment is started in 1998 with arecanut as test crop planted at 2.7 m X 2.7 m spacing. The treatments included eight combinations of organic and inorganic combinations with a control. Here organic fertilizer was vermicompost. The treatments were (1) 100% vermicompost (VC) (2) 200% VC (3) 100% chemical fertilizer (CF) (4) 200% CF (5) 50% VC + 50% CF (6) 100% VC + 100% CF (7) 150% VC + 50% CF (8) 50% VC + 150% CF (9) Control (No fertilizer). Here 100% vermicompost means the full nitrogen requirement (100 g) is supplied through vermicompost. Hundred percent chemical fertilizer is 100:40:140 g $N:P_2O_5:K_2O$ /palm/year. The treatments were laid out in RBD with three replications. The soil samples were collected from the basin of arecanut with soil auger to a depth of 25 cm. The soils were stored at 4°C before using for further tests. The microorganisms were isolated from the soil samples by standard methods for enumeration. The cultural characteristics, microscopic appearance and biochemical tests of these isolates were carried out for the identification of the microorganisms.

Results and Discussion

The major microbes observed in arecanut rhizosphere were bacteria, actinomycets, fungi, nitrogen fixers, and phosphate solubilizers (Table1). Application of vermicompost has resulted in significant proliferation of bacteria, actinomycetes and fungi (Table 2). As vermicompost is aggregate of semi-digested organic matter, it meets the energy needs of various beneficial microbes resulting in microbial proliferation. However, chemical fertilizer application has resulted in significant reduction in the microbial population compared to vermicompost application. Even combined application of vermicompost and chemical fertilizer in equal quantities did not improve the microbial activity. The phosphate solubilizers were in higher numbers than nitrogen fixers.

The study revealed that vermicompost application resulted in significant proliferation of beneficial soil microorganisms, while fertilizer application reduced the microbial activity in the arecanut rhizosphere. Thus, regular application of organic manures is essential to improve the soil health and to ensure nutrient availability.

Table 1. Bacteria, nitrogen fixers, phosphate solubilizers, actinomycetes and fungi found in the basin of arecanut

Bacteria	**Nitrogen**	**Phosphate**	Actinomycetes	**Fungi**

	fixers	**solubilizers**		
Pseudomonas	*Bacillus*	*Pseudomonas*	*Streptomyces*	*Penicillium*
Arthrobacter	*Beijerinckia*	*Aspergillus*	*Nocardia*	*Fusarium*
Bacillus		*Penicillium*	*Actinomyces*	*Trichoderma*
Xanthomonas			*Micromonospora*	*Aspergillus*
Micrococcus				

Table 2. Microbial population (CFU/g soil) under arecaut with vermicompost application.

Treatments	Fungi (10^4)	Actinomycetes (10^5)	Bacteria (10^5)	Nitrogen fixers (10^4)	Phosphate solubilizers (10^5)
100% vermicompost (VC)	15.0	19.7	20.7	18.3	9.0
200% VC	18.7	22.0	23.3	20.7	10.7
100% chemical fertilizer (CF)	7.3	9.3	13.0	12.0	4.7
200% CF	4.0	6.7	11.7	11.7	4.0
50% VC + 50% CF	6.0	7.7	18.3	16.7	7.0
100% VC + 100% CF	5.0	6.0	17.0	15.3	6.7
150% VC + 50% CF	14.3	17.0	19.3	17.7	8.3
50% VC + 150% CF	9.0	11.3	13.7	12.3	5.7
Control	9.7	8.7	14.7	13.0	6.3
S.Em.±	0.5483	0.4444	1.2127	1.2203	0.5556
CD (5%)					
CV (%)	9.61	6.40	12.46	13.82	13.89

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EFFECT OF FERTI-DRIP IRRIGATION ON NUTRIENT MOBILITY IN A LATERITE SOIL IN ARECANUT BASIN

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Arecanut (*Areca catechu* L.), which belongs to family Palmae, is predominantly grown commercial crop in humid tropics of India. It is mainly grown in laterite and red sandy loam soils, which are generally poor in fertility. The annual nutrient mining by the arecanut palm is 79 kg N, 28kg P_2O_5 and 79 kg K_2O per hectare (Rethinam, 1990). The nutrient use efficiency of the crop is very low ranging from 10-15% for N, 25-30% for phosphorus and 20-25% for potassium. Further, roots are concentrated in the surface and they do not penetrate deep into the soil. More than 70% of the roots are concentrated within the first 60 cm depth from the ground level and within a radius of 60 cm from the palm (Bhat and Leela, 1969). Several studies indicated that P mobility in soil is very restricted due to its strong reaction by soil oxides and clay minerals. P will not move normally more than 2 to 3 cm with surface irrigation. Shinde and Firake (1998) reported that phosphate moved horizontally up to 25-30 cm from point source because of saturation at reaction sites by P near the point of application and subsequent movement by mass flow of P with soil water. With trickle irrigation, luxury consumption of potassium is avoided by application at low rates and frequent applications (Uriu *et al*., 1980). To get increased nutrient efficiency it is essential to place the nutrient in the root zone in smaller quantities. Fertigation has come in handy for this purpose. It is essential to know the movement of the nutrients vertically and horizontally for better management of the nutrients in laterite soil. This also helps in fixing number of drippers to be used for better utilization of applied nutrients. An experiment was conducted to study the mobility of phosphorus and potassium in soil when applied through drip irrigation.

Materials and Methods

The experiment was laid out at the Experimental Farm of Central Plantation Crops Research Institute, Regional Station, Vittal in Karnataka, India. The place is located 58 m above MSL with average rainfall of 3800 mm and has 36°C and 21°C mean maximum and mean minimum temperature. The soil of the experimental site is laterite with a pH of 5.6 and available soil nutrient status of 143 ppm N, 10.1 ppm P and 53 ppm K at a surface depth of 25 cm. The experiment was started in 1996 with 14 treatment combinations laid out in 4x3+2 factorial RBD with three replications. The treatments included four levels of fertilizers *viz.,* 25, 50, 75 and 100 percent of recommended fertilizer dose (100:40:140 g N: P_2O_5: K_2O/palm/year) applied at three intervals *viz.,* 10, 20 and 30 days. Two controls *viz.,* absolute control (without fertilizer application) and normal fertilizer application were included for better appraisal of the results. The source of fertilizers used were urea, diammonium phosphate and muriate of potash. The arecanut was planted with a spacing of 2.7 m x 2.7 m. The fertilizer was applied from December to May. The crop was given 20 l of water per day per palm through drip irrigation throughout the dry period. The following treatments were considered for the study of phosphorus and potassium mobility.

1) No fertilizer application
2) 50% of recommended dose applied once in 10 days
3) 100% recommended dose applied once in 10 days

The samples were collected at 0, 15, 30, 45 and 60 cm distance from the drip point and at 15, 30, 45 and 60 cm depth. The soil samples were collected after complete application of fertilizers in May, 1999. After collection, the samples were air dried and ground to pass through 2 mm sieve. The particles greater than 2 mm and plant debris were discarded and those below 2

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mm were retained for analysis. Analysis of the samples for available P and K were performed by standard procedures (Jackson, 1973).

Results and Discussion

Phosphorus

The available P content was highest at the dripping point and declined progressively with distance from dripping point (Fig.1). This was true in all the treatments. The P content was highest up to 45 cm depth and declined thereafter showing unimodal distribution. Similar trend has been reported by Keng *et al.* (1979) in Oxisols. The soil of the experimental site being acidic in nature, P is immediately fixed when applied to the soil. Thus availability of the nutrient will be low. In particular, the adsorption site of soil is not fully saturated with P ions, hence, low available P values are obtained in most of the treatments (Haynes, 1985).

Potassium

When 100 % of recommended fertilizer was applied at 10 days interval through drip irrigation, in general it was found that the potassium content was highest at the dripping point and declined thereafter (Fig.2). Since most of the potassium will be in water soluble form, the potassium will move with water. This is because the soil is acid laterite with Kaolinite as dominant clay mineral, which means the fixation of potassium will be less. Further more than 80% of the available K is accumulated within 30cm distance from the dripping point. But the situation was different with respect to the movement of K at different depths. The available K content increased with depth. And the distribution was unimodal. This may be due to less fixation of K in soil and movement of K with the movement of water to deeper level. In soils having very low CEC and K fixation capacity, the potassium as fertilizer might have moved along with the water. Similar reasons were attributed by Keng *et al.,* 1979, while explaining the behaviour and distribution of potassium in Puerto Rican soils.

When 50% of the recommended fertilizer was applied at 10 days the mean available K content was observed at 30 cm away from the dripping point. The mean available K content at different depths had unimodal distribution. The highest K content was recorded at 45 cm away from dripping point (204 ppm) in the treatment. In the treatment absolute control where no fertilizer has been applied, the mean available K content was highest at dripping point (87 ppm) and declined progressively with distance from dripping point. Depth wise, the mean available K distribution in the soil profile followed a unimodal distribution.

In general, the mean distribution of both available phosphorus and potassium at varying depth followed quadratic equation, whereas, it was mainly quadratic/third order polynomial at varying distance away from the dripping point. Further, the accumulation of both available K and P content was mainly at the dripping point within 45 cm depth. Use of fertigation technique places the nutrients in the active root zone, which increases the nutrient use efficiency. This is evident from the available P and K content in the root zone. The horizontal distribution of the nutrients has revealed the necessity of putting 2-3 drippers for each palm.

This study showed that the nutrient movement is much greater when applied through trickle irrigation than other application methods.

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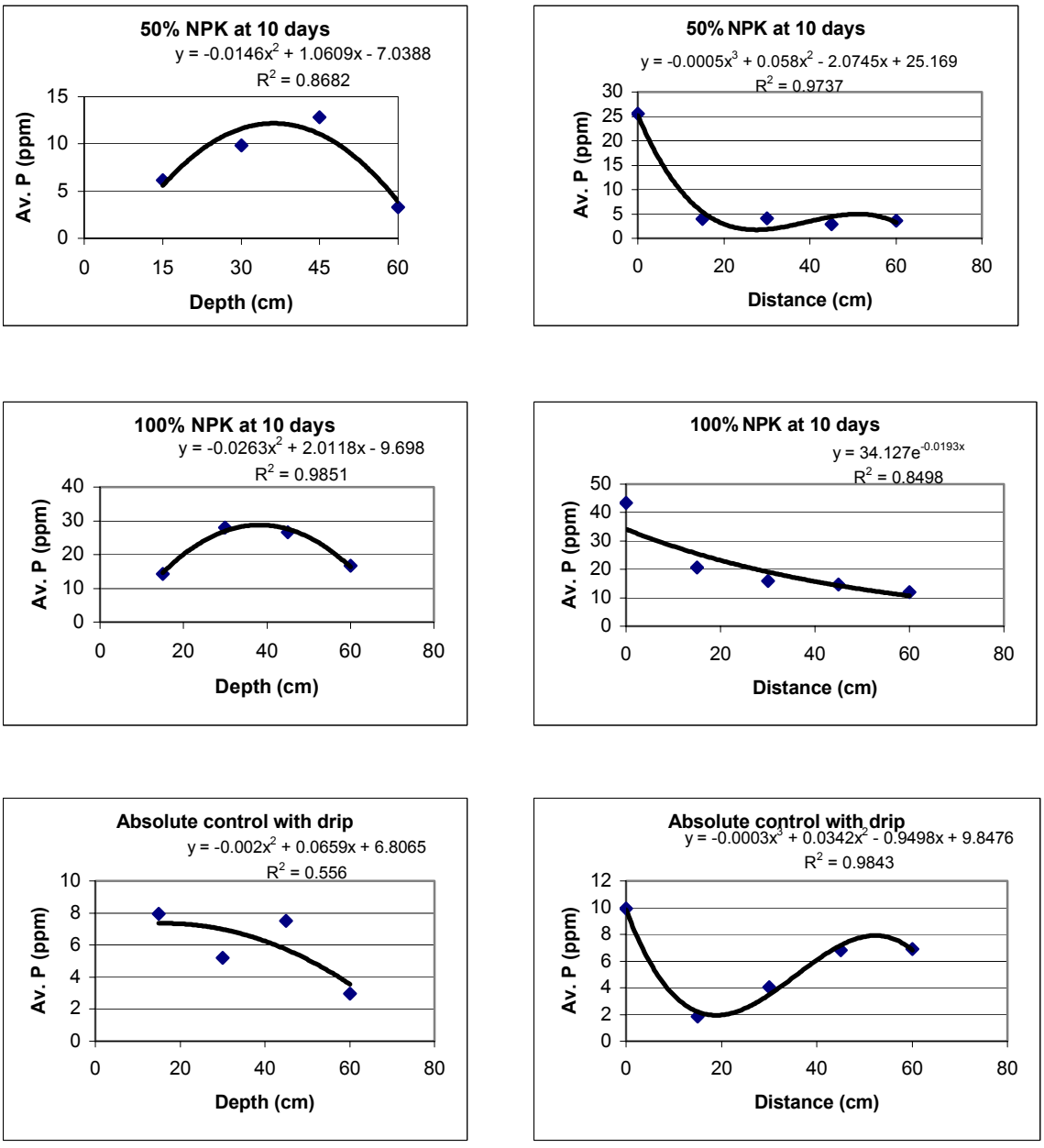

Fig. 1 Effect of ferti-drip irrigation on mobility of phosphorus in arecanut basin

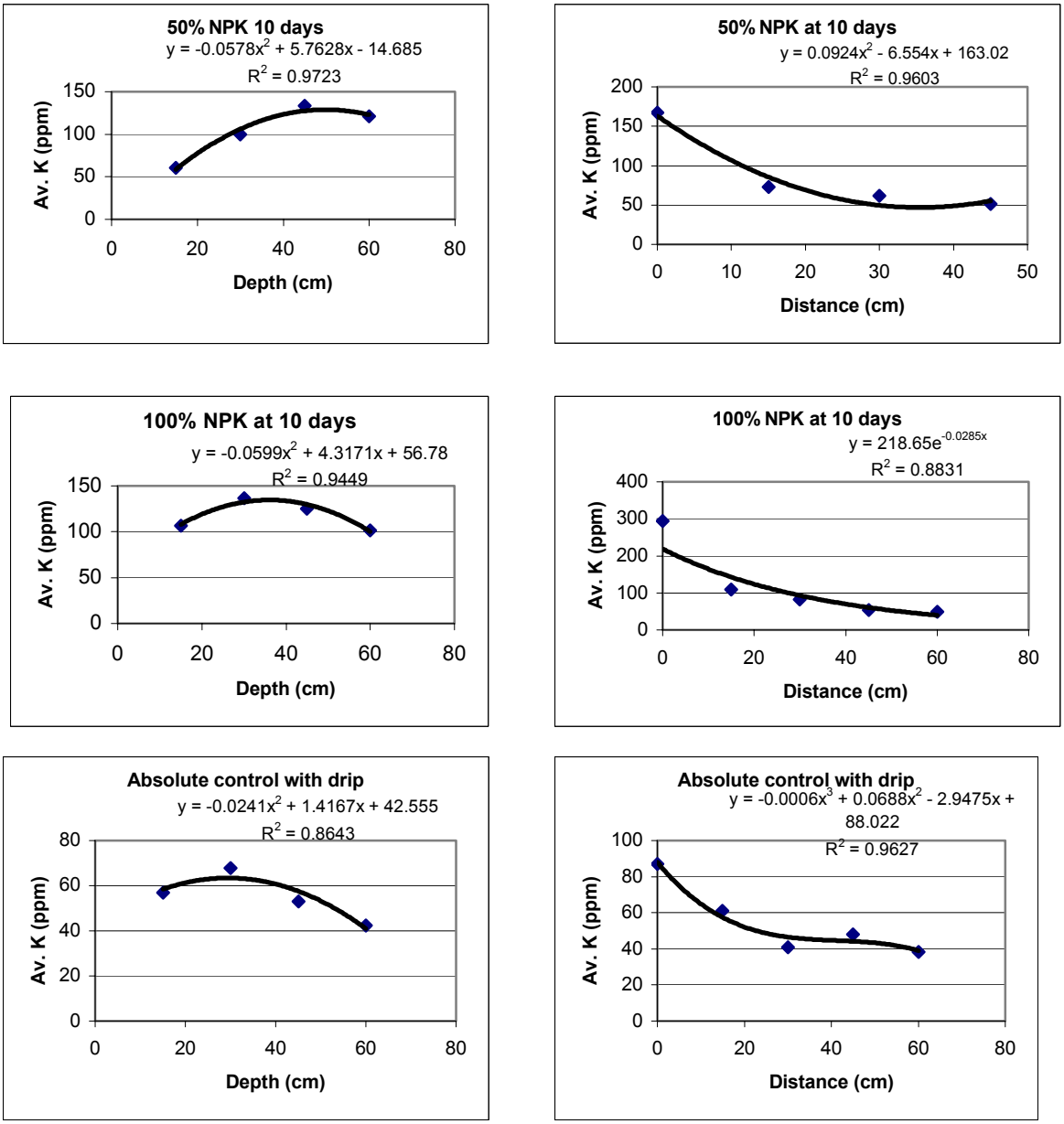

Fig. 2 Effect of ferti-drip irrigation on mobility of potassium in arecanut basin

LIME REQUIREMENT METHODS FOR TRADITIONAL ARECA GROWING AREAS OF KARNATAKA

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Liming is important for management of acid soils for it has considerable influence on soil environment besides nuetralising soil acidity. Several methods have been proposed to determine lime requirement of acid soils to raise pH around 6.5. Soil pH value alone, however is not a good criterion for lime recommendation because of variation in soil acidity. The purpose of this investigation was to evaluate some methods for determining lime requirement of an acid soil distributed widely in traditional areca growing areas of Karnataka.

Materials and Methods

The lime requirement by different methods was calculated for fifty surface soil samples of traditional areca growing areas collecctd from different agroclimatic zones viz.,hilly (Thithahally,Koppa,Sringeri and Sagar) and Coastal zone(Kundapura) by following standard procedures given by Adam Evans method of lime requirement (Adams –Evans,1962), SMP-SB (McLean *et al*, 1978), SMP-DB) (McLean *et al,* 1978),Improved woodruff's method (Brown and Cisco, 1984), Exchangeable Aluminium method (Kamprath,1970) and 45% Ca-saturation method of lime requirement by using CEC and calcium saturation of the soil. The laboratory incubation study was conducted by selecting five surface soil samples differ in soil acidity parameters, coming under different agroclimatic zones. One kg of soil was subjected to incubation with the known quantity of lime applied as estimated by SMP-SB, Improved woodruff's and exchangeable aluminium methods. The lime requirement methods were chosen based on highest regression co efficient values (R^2) obtained with the properties related to soil acidity. At the end of incubation soil samples are drawn and analysed for pH, per cent base saturation and acidity parameters.

Results and Discussion

The lime requirement in terms $CaCO_3$ was recorded highest in Improved woodruff's method for all soils fallowed by 45% Ca-saturation, Adams Evans method, SMP-DB, SMP-SB and least by exchangeable Aluminium method (Table-1). This is in agreement with Dolvi and Dutta (2001).

Laboratory incubation study (Table – 2) reveals that the drastic increase in pH was recorded in Improved woodruff's (72.7%), followed by SMP-SB and exchangeable aluminium method. This may be due to the quantity of lime applied. Similarly increase in percent base saturation was maximum in Improved woodruff's method and least increase was observed in exchangeable Al^{3+} method.

Effect of liming on exchange acidity parameters (Table-2) revealed that the decrease in exchange acidity was recorded maximum in SMP-SB, followed by Improved woodruff's and least decrease was observed in exchangeable Al^{3+} method. Similar trend was observed on change in total acidity and total potential acidity.

The change was observed maximum in Improved woodruff's as well as SMP-SB method. Compared to exchangeable Al^{3+} method. Therefore first two methods are recommended for managing the areca growing soils of Karnataka.

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Table 1 : Lime requirement by different methods (mean values).

Sl. No.	Location and No. of Sample	Depth (cm)	Adams & Evans	SMP-SB	SMP-DB	Imp-Woodruffs	Exch-Al^{3+}	45% Ca-Saturation
			----------CO_3 t ha^{-1}----------					
1	Thirthahally (10)	0-20	4.8 (1.8-10.1)	4.6 (3.1-8.3)	4.8 (4.4-5.6)	11.5 (5.0-26.5)	0.13 (0.07-0.31)	7.2 . (4.6-10.8)
		20-40	3.80 (1.1-7.1)	4.6 (3.1-8.9)	4.9 (4.4-6.5)	10.0 (3.8-21.0)	0.22 (0.07-0.66)	8.5 (5.7-13.3)
2	Koppa (10)	0-20	5.0 (2.7-8.4)	4.4 (3.1-5.7)	4.6 (3.4-5.3)	13.1 (6.6-23.0)	0.10 (0.07-0.15)	7.5 (4.4-14.2)
		20-40	4.70 (1.8-8.6)	4.7 (3.1-7.0)	4.5 (3.3-6.4)	13.2 (7.8-22.5)	0.15 (0.09-0.37)	9.0 (3.7-11.9)
3	Sringeri (10)	0-20	6.0 (2.9-9.8)	3.6 (1.7-5.0)	3.5 (1.6-4.9)	14.5 (9.0-21.5)	0.30 (0.13-0.50)	9.4 (4.7-22.9)
		20-40	5.9 (2.8-9.2)	3.4 (1.8-4.3)	3.5 (2.2-4.3)	11.5 (8.5-17.0)	0.28 (0.25-0.37)	7.6 (2.9-14.6)
4	Sagar (10)	0-20	3.6 (1.6-5.1)	3.5 (2.0-4.3)	3.1 (0.8-4.3)	11.4 (8.0-14.0)	0.12 (0.05-0.18)	6.6 (3.7-10.0)
		20-40	3.0 (0.9-5.7)	3.6 (2.0-5.0)	3.2 (0.5-4.4)	11.5 (7.8-15.3)	0.11 (0.05-0.18)	6.1 (4.8-8.6)
5	Kundapura (10)	0-20	8.2 (3.8-10.1)	3.8 (0.0-6.4)	3.8 (1.0-5.7)	13.4 (6.0-21.5)	0.14 (0.06-0.19)	8.5 (1.7-13.9)
		20-40	8.2 (4.8-10.1)	3.9 (0.0-5.8)	4.0 (0.0-5.3)	13.6 (5.3-21.8)	0.11 (0.08-0.28)	11.1 (6.1-19.3)

* Figures in the parenthesis indicates range values

Table 2 : Effect of liming by different methods on soil chemical properties

Soils	PH			Exch-Acidity			Total acidity			Total potential acidity			Base saturation (%)		
				cmol(P^+)kg^{-1}											
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Thudur	7.6 (+72.7)	7.6 (+72.7)	5.6 (+27.3)	0.13 (-88.6)	0.16 (-85.4)	0.23 (-79.3)	0.21 (-91.6)	0.25 (-90.0)	0.92 (-63.2)	4.6 (-71.4)	5.6 (-65.1)	9.6 (-40.2)	70.30 (+44.5)	77.10 (+51.2)	39.14 (+13.4)
Bayasegadde	6.7 (+34.0)	7.6 (+52.0)	5.9 (+18.0)	0.12 (-29.4)	0.13 (-23.6)	0.14 (-16.4)	1.0 (-81.5)	0.23 (-95.8)	2.83 (-56.8)	5.6 (-65.4)	2.4 (-85.1)	8.8 (-45.2)	56.2 (+22.6)	88.5 (+54.9)	47.67 (+14.0)
Addagadde	7.4 (+54.1)	7.7 (+60.4)	5.9 (+22.9)	0.12 (-76.0)	0.12 (-76.0)	0.18 (-64.0)	0.31 (-90.6)	0.25 (-92.4)	1.28 (-61.2)	4.2 (-87.7)	6.6 (-80.7)	10.4 (-69.5)	67.7 (+50.3)	70.1 (+52.7)	32.30 (+14.9)
Malwe	7.4 (+34.5)	7.7 (+40.0)	6.1 (+10.9)	0.11 (-57.6)	0.12 (-52.0)	0.14 (-44.0)	0.26 (-88.2)	0.23 (-89.4)	1.01 (-54.1)	4.8 (-66.9)	6.4 (-55.9)	8.5 (-41.4)	72.4 (46.1)	73.2 (46.9)	59.24 (+33.0)
Balve	7.0 (+42.8)	7.6 (+55.1)	5.8 (+18.4)	0.13 (-45.7)	0.13 (-43.5)	0.21 (-8.6)	0.46 (-86.5)	0.23 (-93.2)	1.83 (-46.2)	7.7 (-45.2)	7.4 (-47.2)	11.70 (-16.6)	56.8 (+34.0)	67.7 (+44.9)	32.89 (+10.1)

* Values in the parenthesis indicate percentage increase (+) / (-) decrease over initial acidity parameters

L_1 = SMP-SB method of liming
L_2 = Improved Woodruffs method of liming
L_2 = Exchangeable-Al^{3+} of liming

DEVELOPMENT OF SUITABLE SOIL AND WATER CONSERVATION MEASURES FOR BETTER GROWTH AND YIELD OF ARECANUT

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Introduction

Arecanut (*Areca catechu* L) is one of the major cash crops of Assam. Most of the farmers of Assam grow arecanut in their homestead garden. Though Assam contributes a major share in the total arecanut production in the country, its productivity is low. The growth and yield of arecanut in sloppy areas of Assam is even worse due to soil and water loss by run off water during rainy period. The growth and yield of arecanut could be improved if proper soil and water conservation measures are adopted in those sloppy areas (Ghosh, 1999). Practically, there is no such information regarding soil and water conservation in arecanut under Assam condition. Keeping these points in view, an experiment was undertaken to study the effect of different soil and water conservation measures on the performance of arecanut

Materials and Methods

The experiment was conducted in farmer's field in the village Lalmati under Rani Development Block of Kamrup District of Assam. The experimental site is sloppy, red sandy loam in texture, medium in available N, P and K with slightly acidic soil reaction. The treatments comprise of six soil and water conservation measures *viz*., T_1= control, T_2=opening of catch pit and placing of one layer of coconut husk in the catch pit, T_3=catch pit and planting of pineapple in the lower side of the catch pit, T_4= bunding with pineapple, T_5=staggered bunding with soil and coconut husk and T_6= half moon trench. The arecanut seedlings were transplanted in the month of March 2003 and the different soil and water conservation structures were made during April 2003.

The treatments were laid out in randomized block design with three replications. The morphological data of the experimental seedlings were recorded at the time of transplanting and after one year of treatment imposition.

Results and Discusstion

It is evident from the Table.1 that the soil and water conservation measures have positive influence on growth character of arecanut seedlings with respect to plant height, girth at base and number of leaves compared to control. Among the different soil and water conservation measures catch pit with planting of pineapple in the lower side of the catch pit (T3) and catch pit with placing of one layer of coconut husk (T2) was found most effective. The treatment T3 showed highest increment in plant height per year (65cm) and girth at base (5.84cm), which is 140.74% and 440.74% more over control respectively (Table.2). The other soil and water conservation measures had also graded improvement over control. The increase in growth parameters might be due to reduction in runoff and more available soil moisture content. Dhanapal *et al*. (2002) found that the coconut yield has increased three times after the implementation of soil and water conservation measures.

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Table.1 Mean plant height (m), girth at base (cm) and number of leaves as influenced by different soil and water conservation measures.

Treatment	Plant height(m)		Girth at base(cm)		Number of leaves	
	At the time of planting	After one year	At the time of planting	After one year	At the time of planting	After one year
T1	1.16	1.43	12.24	13.92	4.86	5.55
T2	1.18	1.80	11.97	16.97	4.89	6.84
T3	1.02	1.67	10.83	16.67	4.83	6.50
T4	1.19	1.65	12.45	17.05	4.91	6.55
T5	1.23	1.75	12.00	17.50	5.0	6.75
T6	1.23	1.67	12.07	16.72	5.0	6.64

Table.2. Mean increment of plant height (cm) and girth at base (cm) as influenced by different soil and water conservation measures.

Treatment	Increment in plant height(cm/year)	Increment in girth at base(cm/year)
T1	27	1.08
T2	62	5.00
T3	65	5.84
T4	46	4.60
T5	52	5.50
T6	44	4.65

VARIABILITY STUDIES ON *GANODERMA LUCIDUM*- CAUSAL AGENT OF BASAL STEM ROT DISEASE OF ARECANUT

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Introduction

Basal stem rot (BSR) disease of arecanut caused by *Ganoderma lucidum* (Curtis ex.Fr.) Karst is one of the dreaded diseases of arecanut, causing loss in yield. It has wiped out many arecanut plantations in certain localities in India. This disease has been reported from Tamil Nadu, Kerala, Assam (Anonymous, 1960) Bengal (Sharples, 1928) and Nicobar Islands (Sangal *et al.,* 1961). The fungus was also found to attack coconut palms (Butler, 1906) and oil palms (Sharples, 1929) and many tree species including *Dalbergia sisso* and pears (Khara et al, 1987).

The growth requirements and morphology of the fungus was found to vary even within the species. The isolates collected from major disease endemic areas including Kerala, Karnataka, Assam, west Bengal and Tamil Nadu showed variation in their morphological characters with respect to colony morphology and fruiting body characters, molecular characters including RAPD and also cultural characters (pH, temperature and growth rate). All the isolates collected from these areas showed remarkable variation.

Materials and Methods

The isolates were collected from disease endemic areas including Tamil nadu, West Bengal, Karnataka, Kerala and Assam (Rohini Iyer *et.al*, 2003). For studying the growth rate of the isolates, the fungus was grown on Waksman's agar. The radial growth of the colony was recorded for all the 8 isolates after 8 days of incubation at 27$\pm$1°C. Three plates each were maintained for each treatment which made three replications.

For cultural studies the fungus was grown on potato dextrose agar (PDA) for 10 days in petridish. Inoculum discs of 5-7mm diameter were cut out from actively growing region and inoculated into 250ml conical flask containing 50ml Waksman's media. The isolates were maintained at 20°C, 25°C, 30°C and 35°C for temperature requirement study and at pH of 4.0, 5.0, 6.0 and 7.0 for pH requirement study of all the isolates. Contents of the flasks were filtered at the end of an incubation period of 20 days. The mycelial mat was washed with distilled water and dried at 50°C. Dry weight of the mycelium was recorded until a constant weight was observed. For studying the variability in morphology with regard to fruiting body the pathogen was mass multiplied on sawdust medium supplemented with 10%malt extract and 5ppm biotin and incubated at 27$\pm$1°C. When the mycelium fully covered the substrate it was transferred to wheat straw (wheat straw supplemented with 10%saw dust) and arecanut stem pieces (supplemented with 10%wheat straw) substrate. This was incubated in a mushroom shed (with restricted light and high humidity) to facilitate the production of fruiting body. When the mycelium fully covered the substrate the mouth of the polythene cover was opened and pealed off gradually on subsequent days. The time required for the full growth of the mycelium and initiation of fruiting body was recorded. Variation in number, shape, colour, and size of the fruiting bodies was also noted.

For studies on variability with regard to molecular characters, DNA was isolated from all the 8 isolates using isopropanol method. The fungus was multiplied in potato dextrose broth and the mycelium was harvested 12 days after incubation. The mycelium was washed twice in sterilized distilled water and dried. The dried mycelium was ground in a pestle and mortar in liquid nitrogen to a fine powder. The powder was then transferred to 2ml eppendorf tubes and DNA was extracted following the method of Lee and Taylor (1990) except for an additional

RNase digestion followed by phenol extraction and isopropanol precipitation to remove contaminating RNA. The final DNA pellet was washed twice with 75% ethanol, dried properly and resuspended in TE, (Tris 1M, EDTA 0.2M) (pH 8.0) buffer. The quantity of DNA was estimated using spectrophotometer. For RAPD, PCR conditions were standardized using OPA1, OPA3, OPA11, OPA 18, OPD-03, OPD-04, OPF 1, OPF 3, OPF 8 and OPG 15 primers. The reaction mixture included 50ng of template DNA, 0.25mM primer, 200µM dNTP's, 1.5 mM $MgCl_2$, and 1U Taq DNA polymerase. The standardized PCR condition for RAPD were initial heating at 94°C for 1 minute, followed by 46 cycles of denaturation at 95°C for 1 minute, annealing at 32°C for 1 minute, extension at 72°C for 1 minute and final extension of 72°C for 8 minutes. The PCR product was elctrophoresed in 1.5 % agarose gel pre stained with ethidium bromide and examined under UV transilluminator.

Results and Discussion

All the 8 isolates showed variation in their growth rate and pH requirement. However, the temperature requirement was similar for all the isolates, with minimum growth rate at 20°C and maximum at 35°C the optimum being 27$\pm$1°C.

Fruiting bodies produced by these isolates showed wide variation. The time required for the initiation of fruiting body, shape, size and colour and number were also different for different isolates (Table 1).

With regard to molecular characterization, among the RAPD primers tested OPA3, OPA11, OPD03, OPD 04 and OPG 15 showed remarkable variation (Fig. 1). This gives additional information on the variability exhibited by these isolates by morphological and cultural characters.

From the present study it could be seen that the isolates of *Ganoderma* which cause basal stem rot of arecanut, show a wide range of variability with regard to morphological, cultural and molecular characters, probably aiding the fungus to adapt to a wide variety of agroclimatic conditions and thus accounting for the wide geographic spread of the disease.

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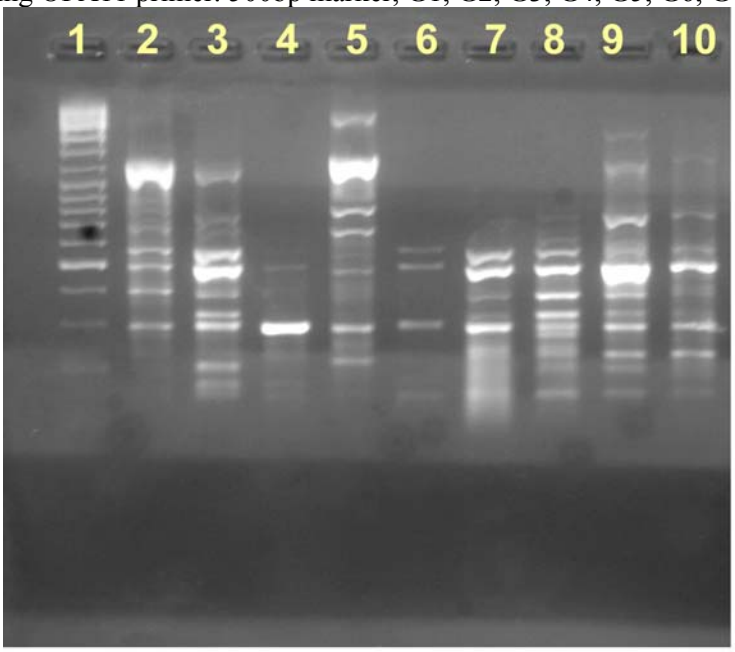
Table 1. Cultural and morphological variability observed in isolates of *Ganoderma lucidum*

Isolate No.	Colony morphology				Optimum pH	Fruiting body characters			
	Growth rate (mm/d)	Colour of the colony	Colour of the reverse pattern	Mycelial pattern	pH	No.	Colour	Shape	Size (l x b) cm
G1	6.3	White	Light brown	Smooth, aerial	5.0	5	Light brown, with white margin	Typical kidney shaped, concentric zones on the surface of pileus. Smooth margins.	1.0 x 1.5
G2	5.9	White	Light yellow	Smooth, aerial	5.0	2	Light brown, with white margin	Antler shaped, No concentric zones on the pileus, smooth	1.3 x 1.8
G3	6.4	White	Light brown	Smooth, aerial	7.0	3	Dark brown brown, white margin	Typical kidney shaped, well developed concentric zones on the surface of pileus. Smooth margins	1.8 x 2.0
G4	3.6	White	Light brown	Smooth, aerial	6.0	4	Light brown, pale yallow margin	Kidney shaped, concentric zones on the surface of pileus. Smooth margins	1.6 x 2.0
G5	5.9	White	Light brown	Smooth, aerial	5.0	20	Light brown, white margin	Typical kidney shaped, concentric zones on the surface of pileus. Smooth margins	1.4 x 2.0
G6	5.0	White	Light brown	Smooth, aerial	5.0	3	Light brown, white margin	Kidney shaped, concentric zones on the surface of pileus. Waved margins	1.2 x 2.5
G7	5.6	White	Light yellow	Smooth, aerial	5.0	6	Light brown, white margin	Antler shaped, no concentric rings on the pileus. Smooth margins	1.0 x 2.5

G8	6.1	White	Light yellow	Smooth, aerial	6.0	7	Dark brown, light brown margin	Typical kidney shaped, well developed concentric zones on the surface of pileus. Smooth margins	2.0 x 3.0

Fig. 1. RAPD using OPA11 primer. 500bp marker, G1, G2, G3, G4, G5, G6, G7, G8 and G9



LABORATORY EVALUATION OF SOME PLANT EXTRACTS AGAINST BASAL STEM ROT DISEASE OF ARECANUT CAUSED BY *GANODERMA LUCIDUM* (CURTIS EX. FR.) KARST

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Introduction

The arecanut palm, *Areca catechu* L. is the only cultivated species in the genera *Areca.* It is the source of common masticatory nut popularly known as "Supari" or "betel nut" which is used in many parts of the world. It is an essential requisite for several religious and social ceremonies. Arecanut palm is affected by a number of diseases during different stages of its growth and development. Basal stem rot of arecanut caused by *Ganoderma lucidum* (Curtis Ex.Fr.) Karst is one of the dreaded diseases of arecanut. It has not only affected the productivity but has also wiped out areca plantations in certain localities. Occurrence of this disease was reported from Tamilnadu, Kerala and Assam (Anonymous, 1960), Bengal (Sharples, 1928) and Nicobar islands (Somgal *et al.,* 1961). Although control measures using fungicides are reported to be effective, with the increased awareness on hazardous effect of toxic crop protection chemicals on crops, environmental problem, residual and pollution effect, exploration of some innovative techniques for the management of disease has become an imperative need. Keeping this in view, the present investigation was undertaken to conduct *in vitro* screening of botanicals against the pathogen.

Materials and Methods

Isolation of *G. lucidum* was made from the fruiting body of basal stem rot affected arecanut palm on potato dextrose agar (PDA) media. The samples were cut into small convenient pieces, sterilized in 0.1% $HgCl_2$ for one minute, washed thrice in sterile distilled water and plated on PDA medium. The plates were incubated at 28 ± 2^0C.

In vitro assay of plant extracts

Twenty locally available plants were tested for their antifungal property against *G. lucidum* by poisoned food technique (Bhaskaran *et al.* 1988) under *in vitro* condition. Fresh leaves of test plants were taken for preparing crude extracts. The leaves were thoroughly washed with water and fine slurry was prepared by taking 100 gram leaves with 100 ml of distilled water. The resultant slurry was filtered through muslin cloth and then through Whatman No.1 filter paper and the extract was used as stock solution.

Results and Discussion

Effect of plant extracts on radial mycelial growth of *Ganoderma lucidum* in presented in Table 1. The data revealed that among the twenty plant extracts tested, *Azadirachta indica* extracts completely inhibited the growth of the pathogen. *Allium sativum* showed 68.90% inhibition over control, followed by *Clerodendron infortunatum* (58.35%), *Carthamus oxycantha* (54.59%), *Datura stramonium*(53.12%) and *Solanum nigrum* (52.49%). Bhaskaran *et al.* (1988) reported that neem cake extract completely inhibited the growth of *G. lucidum*, isolate of coconut. From the present study it can be concluded that the aqueous plant extract of *Azadirachta*

[9] Research Associate

indica, *Clerodendron infortunatum*, *Carthamus oxycantha*, *Datura stramonium* and *Solanum nigrum* can be used for managing basal stem rot disease of arecanut in endemic areas.

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Table1: Effect of plant extracts on mycelial growth of *Ganoderma lucidum*

Plant extracts	% inhibition over control			
	48hr	72hr	96hr	Mean
Allium sativum	68.47	74.07	64.16	68.9
Ageratum houstonianum	36.94	29.13	29.69	31.92
Azadirachta indica	100	100	100	100
Bougainvillea spectabilis	39.9	44.69	46.76	43.78
Bryophyllum pinnatum	44.83	45.68	48.46	46.32
Carthamus oxycantha	49.26	57.53	56.99	54.59
Centella asiatica	46.3	64.2	57.68	56.06
Clerodendron infortunatum	45.81	65.43	63.82	58.35
Datura stramonium	44.83	55.31	59.21	53.12
Eupatorium odoratum	36.94	36.05	32.59	35.19
Leucas aspera	49.26	55.06	51.11	51.81
Murraya kaeningii	44.83	52.54	52.05	49.81
Musa sp.	35.47	47.65	44.37	42.5
Ocimum sanctum	8.86	32.1	47.95	29.64
Oxalis sp.	40.89	57.04	54.61	50.85
Polyaltha longifolia	45.32	48.15	45.39	46.29
Psidium guajava	38.42	55.55	49.83	47.93
Solanum nigrum	48.77	56.3	52.39	52.49
Tagetes erecta	42.36	52.84	55.97	50.39
Vitex negundo	41.87	48.15	47.61	45.88

SERO-DIAGNOSTIC TECHNIQUE AS A TOOL FOR DETECTION OF YELLOW LEAF DISEASE OF ARECANUT

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Introduction

Yellow leaf disease, a phytoplasmal disease of arecanut (Rajeev, 2003) prevalent in almost all the districts of Kerala and in certain parts of Karnataka, Tamil Nadu and Maharashtra is characterized by foliar yellowing, necrosis of the leaves and reduction in crown size of palms. Immature nut fall, kernel discoloration and extensive root rot are the other associated symptoms of the disease. Reduction in yield up to 50% and leaf fall up to 4% were recorded over a period of three years following disease incidence. The disease is mainly identified based on foliar symptoms. In certain cases the symptoms get masked during dry season (December to May) and hence the identification of diseased palms in the field becomes difficult. Yellowing of leaves induced by other abiotic factors such as sun scorching, water logging, stress conditions, toxicity symptoms and biotic factors like root grub infestation also mislead in confidently identifying palms infected with yellow leaf disease. In this context, the need for a diagnostic technique for detection of yellow leaf disease of arecanut even when symptoms are masked gains significance. An antiserum was prepared against the membrane fractions of phytoplasma isolated from yellow leaf disease infected areca palms. This antiserum is disease specific and being employed in determining the disease status through double diffusion test and immuno-osmophoretic technique. This is the first report of its kind wherein arecanut palms infected with yellow leaf disease was identified by using a disease specific antiserum.

Materials and Methods

Spear leaf samples from yellow leaf disease affected areca palms with clear-cut symptoms were collected and purified by polyethylene glycol (PEG) precipitation and differential centrifugation method (Solomon *et al*., 1983). Purification was carried out by utilizing various buffer systems like M/15 Sorensen's phosphate buffer containing 0.005 M EDTA and 0.5 M Borate buffer having 0.5% thioglycolic acid. Another method for purifying membrane fraction of phytoplasma adopted by Da Rocha *et al*. (1986) and modified by Sinha (1988) was also attempted. Polyclonal antiserum to arecanut yellow leaf disease was prepared by immunizing New Zealand variety rabbits. The common antibodies from the antiserum were eliminated by employing intra-gel cross absorption technique (Solomon *et al*., 1983). Agar gel double diffusion and immuno-osmophoretic tests were performed on microscopic slides, pre-coated with 0.2% formvar in chloroform. Crude sap of tender leaves from unopened spindle (spear leaf) extracted in PBS buffer (1:1 w/v) were used as test antigens. Crude sap from tissues suffering from Inflorescence die back and Mahali were tested against the antiserum. Samples were also collected from symptom-masked phase of disease infected palms for testing the antiserum.

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Results and Discussion

Preparation of a disease-specific antiserum is a pre-requisite for developing an effective sero-diagnostic test. The different methods adopted for the isolation and purification of antigen are presented in Table 1. In all the attempts, the purity and concentration of the suspension were ascertained by spectrophotometry. Using PEG precipitation and differential centrifugation method, samples from both symptom-masked and diseased palms showed similar UV spectral characters and no qualitative differences were discernible. The samples fractionated by an alternate purification method using Borate buffer and thioglycolic acid also on evaluation recorded a very low titre. However, when IgG was fractionated from the antiserum using ammonium sulphate precipitation, which yielded disease specific antibodies, a faint precipitin reaction was observed against tissue extracts from diseased palms. When the methodology for purifying membrane fraction of phytoplasma was adopted, the disease-specific antiserum produced was found to have good titre and on testing, clear-cut precipitin reaction was recorded against tissue extracts from diseased palms in both double diffusion and immuno-osmophoretic tests. The antiserum thus produced was found to be 'yellow leaf disease specific' and does not react with healthy (Table 2) as well as samples from other arecanut diseases like inflorescence die back and Mahali. The present study clearly establishes the disease-specificity of the antiserum prepared. The antiserum can be used for identifying diseased palms during symptom-masked periods and also for screening disease-free elite parental palms for crossing programmes to evolve YLD tolerant/resistant arecanut population.

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Table 1: Details of antigen purification procedures adopted for production of antiserum

Methodology	Result
PEG precipitation & differential centrifugation method	Not promising
Modified method using Borate buffer & thioglycolic acid	Very low titre (-)
IgG fractionation method	Low titre and faint reaction (+)
Method for purifying membrane fraction of phytoplasma	Good titre and good reaction (++)

Table 2: Disease specificity of yellow leaf disease antiserum

Nature of samples	No. of samples tested	Result
Healthy	11	11/11 negative
Diseased	102	90/102 positive

VARIETAL SUSCEPTIBILITY OF ARECANUT TO STEM WEEVIL *DIOCALANDRA STIGMATICOLLIS* GYLL. (COLEOPTERA: CURCULIONIDAE)

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Introduction

Arecanut (*Areca catechu* L.) is the most important plantation crop in Assam. Farmers of this region grow arecanut in their homestead garden. Arecanut palms were infested by many insect pests. Stem weevil (*Diocalandra stigmaticollis*) considered as a minor pest may cause unrecoverable damage if it is unnoticed. The stem weevil was first reported as a minor pest of arecanut by Daniel & Kumar (1979). The adult weevils are small brown cylindrical with creamy patches on both elytra. Grubs are creamy white with reddish brown mouthparts. Both grubs and adults cause damage to the arecanut palm. The stem weevil bore through the leaf sheath and lay eggs in the boreholes; sometimes also in cracks and crevices on areca palm. When the leaf drops off the damage can be seen on the successive internodes. The feeding of stem weevil produces characteristic scars or dent on the stem. Damage can be seen on the successive internodes, as a result the girth of the internodes gets reduced and the plant becomes weak. In severe infestation the plant may even die due to break off. This type of stem weevil attack on areca palm was also reported by Skaria *et al*. (2002). In CPCRI, Research Centre, Kahikuchi, the infestation of stem weevil was observed and it varied among the varieties viz. Mangala, Sumangala, Sreemangala and Kahikuchi selection where package of practices were followed uniformly in the garden. Keeping this in mind, a study was conducted to find out the degree of attack of stem weevil on arecanut varieties.

Materials and Methods

The study was conducted at CPCRI Research Centre, Kahikuchi farm, in a five year areca garden, where varieties viz. Mangala, Sumangala, Sreemangala and Kahikuchi selection are grown. The package of practices was followed uniformly to all the palms as per CPCRI recommendation. The garden had 77 palms of each variety making the total population of 308 palms. The entire population was monitored regularly for weevil infestation. The observations were recorded during the month of July to August, 2004 and the infestation percentage was calculated as follows:

$$\text{Percentage of infested palms} = \frac{\text{Number of palms affected by stem weevil}}{\text{Total number of palms in each variety}}$$

The stem girth of different varieties was also recorded during the study period.

Results and Discussion

The stem weevil infestation on different arecanut varieties is presented in Table 1. The data clearly revealed that the highest infestation was Mangala and the lowest in Kahikuchi selection. The percentage of infestation in Mangala was 25.97, followed by Sumangala (22.07), Sreemangala (18.18) and Kahikuchi selection (5.19). It was pertinent to note that the varieties

[11] Research Associates

viz. Mangala, Sumangala and Sreemangala had greater stem girth and tissues were softer than Kahikuchi selection. Among the varieties Mangala had the highest stem girth. These might be the reason of more susceptibility of these varieties towards stem weevil as because it is easier for stem weevil to bore into the soft tissues of these varieties. More over, these three varieties were introduced to Assam from other areas and Kahikuchi selection was indigenous one, which might have somewhat tolerant capacity to stem weevil. Rana *et al* (1998) reported in case of Sorghum that introduction of high yield hybrids and varieties distinct changes have been witnessed in the composition of insect complex. Several species considered to be occasional pests in the past have attained a major status. These changes are due to the influence of one or a combination of high yielding cultivars, agronomic practices, a biotic factor and impact on the use of pesticide on pest and their natural enemies. However, further scientific studies in this regard are necessary to arrive at a valid conclusion.

The pest damage can be reduced by applying mud slurry containing 10 g lindane 50WP/kg of soil after scrapping the infested portion.

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Table 1: Percentage of infestation by stem weevil in different variety of arecanut.

Variety	Total no. of palms	No. of infested palms	Percentage of infested palms	Stem girth(cm)
Mangala	77	20	25.97	50.13
Sumangala	77	17	22.07	47.03
Sreemangala	77	14	18.18	45.26
Kahikuchi selection	77	04	5.19	42.39

MANAGEMENT OF KOLEROGA OF ARECANUT IN UTTARA KANNADA DIST. OF KARNATAKA IN WESTERN GHATS

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Abstract

Among the diseases of arecanut, Koleroga (*Phytophthora meadii*) appears in severe form during monsoon and leads to huge losses by dropping of immature nuts and death of trees due to rotting of crown region in Western Ghats of Uttara Kannada dist. of Karnataka. Application of metalaxyl mancozeb 72 WP @ 1.5 gm/ liter to the bunch in the form of spray immediately after notice of the symptoms of nut drop gave effective reduction of the incidence of the disease as compared to application of Bordeaux mixture @ 1 per cent.

HALICTOPHAGUS PALMAE SP.NOV. (HALICTOPHAGIDAE: STREPSIPTERA) AN ENDOPARASITOID OF THE PLANT HOPPER, *PROUTISTA MOESTA* WESTWOOD (HEMIPTERA: DERBIDAE) A VECTOR OF YELLOW LEAF DISEASES OF ARECAUT PALM

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Introduction

The plant hopper, *Proutista moesta* Westwood (Heteroptera: Derbidae) is associated with arecanut, oil palm and coconut (Nair and Menon, 1963 Wood, 1968, Rajan and Mathen, 1985). *P.moesta* was proved as a vector of Yellow Leaf Disease of areca palm (Ponnamma, 1994). Ponnamma and Karnavar, (1996) reported that the population density of *P.moesta* is governed by both biotic and abiotic factors. The biotic agents play a vital role in the biological suppression of *P. moesta* (Ponnamma and Karnavar, 1996). These include the strepsipteran parasitoid, *Halictophagus palmae* sp.nov., fifty six species of spiders including *Marpissa tigrina* and the earwig, *Chelisoches moris*. The life history, nature and extent of parasitism, seasonal incidence and effect of parasitism on the host are furnished in this paper.

Materials and Methods

Survey on the occurrence of the biotic agents, in the natural population of *P.moesta* was carried out in the oil palm and areca plantations of National Research Centre for Oil palm, Palode at weekly intervals and at monthly intervals in the oil palm plantations of Oil palm India Ltd., Chithara, and also during the roving survey in oil palm plantations of Kerala and Tamil Nadu. The extent of parasitism, seasonal incidence and sex ratio of the parasitoid was studied by collecting a total of 3,428 plant hoppers (1537 males and 1891 females) from the field within a period of 31 months. Sexes of the parasitoid were assessed externally by examining the difference in the hernia like projections in the abdomen of the plant hoppers. Being an endoparasitoid, parasitism could not be detected in the early stages. Hence life history was studied under laboratory conditions by dissecting the plant hoppers and collecting the various immature stages of the endoparasitoid.

Results and Discussion

Male and female *H.palmae* occur in the same individual host. The parasitoid spends a long time as a larva within the host, giving no external evidence of its existence. The external symptoms noticed in parasitized plant hoppers are hernia-like projections on the abdominal segments. A maximum of five projections were noticed. Projection having yellowish brown colour is the flattened disc-like sclerotised cephalothorax of the female parasitoid, which is extruded out of the abdominal wall. The dark brown projections seen in the abdomen of the plant hoppers are the cephalotheca(cap of the puparium) from which the male parasitoids emerge.

The neotenic female, with none of the true adult body characters required for a free-living life, has often been called ”larviform”. It remains endoparasitic throughout its life. Free-living adult male parasitoids emerge from the puparium pushing open the cephalotheca. The first instar larvae, which hatch out from the eggs inside the female are known as “triungulins”(triungulinids). They are very minute with a group of ocelli and well developed legs and a pair of long caudal setae. Inside the host, the triungulin moults to a maggot-like apodous larva. The apodus larvae consequently develop into male and female parasitoids.

Both sexes of plant hoppers were amenable to parasitization and percentage parasitism is more in females. Out of 3,428 *P.moesta* collected, 313 male and 424 female plant hoppers were parasitized. From the parasitized plant hoppers, 940 parasitoids were obtained out of which 478 (50.25%) were males and 462 (49.15%) were female parasitoids. Build up of population of *H.palmi* was noticed during June, reaching the peak during January. Medium level of parasitization was noticed from September to December. June is the peak period of the population of *P.moesta*. Population of *P.moesta* was at a low level during January to April and also during October to December. The high population of *P.moesta* during June favours the build

up of parasitoid population with a peak during January. Moderately high rate of the parasitization from September to March with a peak during January may be one of the reasons with other biotic factors for the low population of *P.moesta* from January to April. *H.palmi* is highly host specific.

The parasitoid occupies the whole internal abdominal region of the plant hopper. Hence reduced genital organs are seen in parasitised male and female plant hoppers. In males reduction in size of the testis is noticed. In females the ovaries are under-developed and follicles are reduced in size without the production of eggs. The fecundity of *P.moesta* is on average 44 eggs. Hence underdeveloped ovaries without production of eggs retards the progeny emergence.

Studies on the extent and effect of parasitism on *P.moesta* revealed that the strepsipteran parasitoid, *H.palmi* plays a vital role in the biological suppression of *P.moesta* under field conditions.

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VARIABILITY AND CHARACTERS ASSOCIATION AMONG THE NUT TRAITS IN ACCESSIONS OF ARECANUT (*ARECA CATECHU* L.)

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Introduction

The Arecanut (*Areca catechu* L.) is one of the major cash crops of India. It is cultivated in an area of 3.13 lakh hectares with the production is about 3.79 lakh MT of dried kernels with the productivity of dry kernels 1121kgs per hectare. Arecanut is one of the few examples wherein crop improvement work combined with improved input technologies have contributed to revolutionize the production and productivity within the last 40 years (Nair, 1999). Genetic manipulation for higher yield and quality through varietal evaluation and selection is one of the earliest and known methods of crop improvement. Evaluation and selection of exotic and indigenous germplasm have resulted in releasing of high yielding varieties such as Mangala, Sumangala, Sreemangala and Mohitnagar. Though the varieties identified and released on the basis of only yield, further critical evaluation is essential by considering some more desirable traits for different environmental conditions. Therefore, it is not only important to study the yield *per se* but also fruit component traits in accessions under evaluation. Hence an attempt was made to study the variability among the accessions for fruit components and yield along with the nature and magnitude of association among the traits.

Materials and Methods

The present investigation was carried out at CPCRI Regional Station Vittal. A set of 17 exotic accessions introduced mainly from South East Asian countries along with check S. K. Local were planted in 1978 in order to evaluate for economic traits. The recording of dry kernel (chali) yield (Kgs) was done for six consecutive years from 1986-1992. Twenty nuts each from respective accessions have been sampled for nut component studies. Nut characters *viz.,* fresh nut weight-whole fruit weighed in g; length of fruit – measured in polar zone of the nut in cm; breadth of fruit – measured in equatorial zone of the nut in cm; dry nut weight – weighed in g after drying the whole nut; dry kernel weight- weighed in g after dehusking the dry fruit; kernel length and breadth measured in cm in polar and equatorial zone of the kernel, respectively. Besides, recovery of chali (dried kernel) from fresh nut yield was also worked out and expressed in terms of percentage in all the accessions. Yield data and nut component traits were subjected to statistical analyses. To establish the relationships between the chali yield and its component traits, correlation coefficients were worked out.

Results and Discussion

The chali yield (mean of six years) and nut components characters of the 17 exotic accessions along with check 'South Kanara Local' are presented in the Table1. The mean chali yield and nut component traits varied significantly among the accessions. Among the accessions the chali yield ranged from 2.20 to 4.30 Kgs with a mean of 3.00Kg. The highest mean chali yield of 4.30 kg per palm per year was recorded in VTl-11 followed by VTL-12 (3.90kg/palm/year) and VTL-17 (3.80kg/palm/year). The accessions VTL-18I, VTL-18III, VTL-28I, VTL-28III were also found to superior for dry kernel weight. The accessions VTL-11, VTL-

12 and VTL-17 have registered 79.17, 62.50 and 58.33 percent increase in yield over the check South Kanara Local, respectively. The similar results were exhibited for fresh nut yield in Mohitnagar and Sumangala varieties (Ananda, 1999) and in Mangala (Rekha *et al.,* 1991). In the present study, besides high yielding accessions VTL-11 and VTL-17, the performance of accessions VTL-12, VTL-28III, VTL-28I, VTL-18III were found to be promising among the exotic accessions evaluated for their dry kernel (chali) yield.

With regard to the nut component traits there were significant variations observed among the accessions (Table 2). Among the accessions VTL-28III was measured maximum fruit length of 6.31cm while minimum of 4.79cm noticed in accession VTL-9 with mean length being 5.5cm. The fresh fruit breadth ranged between 3.15 in VTL-9 and 4.64 in VTL-15 with mean of 3.98. The maximum fresh fruit weight of 41.1gm was noticed in VTL-15 followed by VTL-18I (41.01gm) and VTL-26 (39.01gm). The husk thickness was significantly lower in VTL-11 (0.37 cm) and the highest thickness was observed in VTL-18I (0.95) with a mean being the 0.66 cm. The accession VTL-13 had maximum kernel (2.9cm) and kernel breadth (3.22cm) while lowest was 1.80cm measured in VTL-18II and kernel breadth 1.89 cm in VTL-28II was recorded. The maximum dry fruit weight was observed in VTL-12 (19.40gm) while it was minimum in VTL-9 (8.99gm). The individual kernel weight ranged between 5.11gm in VTL-5 and 10.40gm in VTL-12 with a mean of 9.88g. The highest recovery (27.30%) was recorded in the accession VTL-11 (Table 1.) followed by VTL-12 (25.30%). The higher recovery of chali from the fresh nut may be due to low content of the husk in the accessions VTL-11 and VTL-12. The accessions VTL-12 and VTL-11 showed superiority for most of the nut characters. The similar trend was noticed for fruit component traits in dwarf hybrids of arecanut and its parents (Ananda, 2002). Hence accessions, which produce low content of husk, are desirable and such palms could be used as parents for further improvement of the crop.

In order to establish the relationship between chali yield and fruit component traits, the correlation coefficients were worked out in seventeen accessions (Table 2.). The association of the yield with ten fruit component traits showed that the kernel weight (0.795), dry fruit weight (0.683), dry kernel length (0.537), dry husk weight (0.538) and fresh fruit weight (0.483) had highly significant positive correlations with chali yield while negative correlation was established between the husk thickness with chali yield. The fresh fruit length and fresh fruit breadth had non-significant positive correlation with chali yield. Similar results were obtained by Bavappa and Ramachandran (1967) while studying the correlation of different characters *viz.,* number of bunches produced, number of nuts per bunch and percent of nut set with nut yield. The recovery of chali from the fresh nut showed significantly positive association with chali yield (0.737) per palm, kernel weight (0.645), dry fruit weight (0.584), dry kernel length (0.628) and dry husk weight (0.484). Thus highlighting the favourable impact of these traits on the yield performance of the accessions and making indirect selection to yield through these component traits.

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Table 1. Mean performance of Arecanut accessions for chali yield and fruit component traits

Accessions/ characters	Fresh fruit length (cm)	Fresh fruit breadth (cm)	Fresh fruit wt. (g)	Husk thickness (cm)	Kernel length (cm)	Kernel breadth (cm)	Dry fruit wt. (g)	Kernel wt. (g)	Dry husk wt. (g)	Dry chali yield (Kg)	Recovery (%)	**% Increase or decrease over Check** (S. K. Local)
VTL-1	4.66	3.06	32.78	0.60	2.17	2.01	11.58	6.16	5.42	2.60	24.30	**8.33**
VTL-3	5.29	4.02	36.07	0.44	2.56	2.75	16.00	8.60	7.40	3.00	24.32	**25.00**
VTL-5	5.54	3.44	28.01	0.69	2.30	2.03	9.56	5.11	4.45	2.30	21.40	**-4.17**
VTL-9	4.79	3.15	23.47	0.45	2.24	2.20	8.99	5.50	3.49	2.36	24.01	**-1.67**
VTL-11	5.08	3.54	36.60	0.37	2.50	2.61	14.60	9.80	4.80	4.30	27.30	**79.17**
VTL-12	4.94	3.78	37.14	0.39	2.51	2.70	19.40	10.40	9.00	3.90	25.30	**62.50**
VTL-13	5.49	4.37	38.63	0.42	2.90	3.22	14.60	8.80	5.80	2.81	22.78	**17.08**
VTL-14	5.31	3.85	36.07	0.64	2.03	2.55	12.40	7.69	4.55	2.44	21.00	**1.67**
VTL-15	6.13	4.64	41.19	0.92	2.33	2.77	16.61	9.46	7.15	2.95	23.15	**22.92**
VTL-17	5.07	3.90	39.06	0.44	2.56	2.86	14.40	8.40	6.40	3.80	24.96	**58.33**
VTL-18I	5.79	4.22	41.07	0.95	2.38	2.28	15.46	9.88	6.83	3.42	24.05	**42.50**
VTL-18II	5.13	3.82	32.83	0.65	1.80	2.35	11.27	6.47	4.80	2.20	18.61	**-8.33**
VTL-18III	5.98	4.20	33.01	0.82	2.17	2.55	13.57	7.99	5.58	3.29	24.21	**37.08**
VTL-26	5.87	4.18	39.11	0.87	2.45	2.40	13.40	8.40	5.00	2.65	23.84	**10.42**
VTL-28I	5.85	4.28	38.00	0.70	2.64	2.65	15.06	9.08	6.98	3.58	23.89	**49.17**
VTL-28II	5.49	3.41	32.69	0.75	2.06	1.89	11.21	6.40	4.00	2.22	18.91	**-7.50**
VTL-28III	6.31	4.32	36.11	0.81	2.45	2.65	16.68	9.81	6.87	3.69	25.26	**53.75**
S.K.Local	6.08	4.31	37.40	0.54	2.29	2.27	15.40	8.05	7.35	2.40	24.52	**-**
GM	**5.49**	**3.91**	**35.51**	**0.64**	**2.35**	**2.49**	**13.90**	**8.11**	**5.88**	**3.00**	**23.42**	**-**
SD	**0.49**	**0.44**	**4.49**	**0.19**	**0.26**	**0.34**	**2.68**	**1.59**	**1.45**	**0.66**	**2.20**	**-**

Table 2. Correlation between the different fruit component traits with dry kernel (Chali) yield

Correlation	F. F. length	F. F. breadth	F. F. wt.	F. F. husk thickness	Dry kernel length	Dry Kernel breadth	Dry fruit wt.	Kernel wt.	Dry Husk wt.	Chali yield	Recovery (%)
Fresh fruit length		0.754**	0.429*	0.728**	0.061	-0.023	0.307	0.304	0.299	0.009	0.077
F. F. breadth			0.778**	0.448	0.339	0.518*	0.651**	0.637**	0.629**	0.233	0.225
F. F. wt.				0.294	0.397	0.477-	0.761**	0.831**	0.646**	0.483*	0.306
Husk thickness					-0.335	-0.370	0.004	0.114	0.008	-0.124	-0.240
Dry kernel length						0.673**	0.508**	0.521*	0.453	0.537*	0.628**
Kernel breadth							0.569*	0.560*	0.454*	0.486*	0.415
Dry Fruit wt.								0.923**	0.824	0.683**	0.584*
Kernel wt.									0.757**	0.795**	0.645**
Dry husk wt.										0.538*	0.484*
Chali yield											0.737**
Recovery (%)											

* Significant at 5% level ** Significant at 1% level

VARIATIONS IN TOTAL PHENOLIC CONTENTS IN WILD RELATIVES OF ARECANUT

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Introduction

The genus *Areca* contains 76 species and the important species known are *A. catechu* L., *A. triandra* Roxb*., A. concinna* Thaw*., A. macrocalyx and A. normanbyii* F. Muel and also one related genera *Actinorhytis calapparia* Wendl. & Drude. (Murthy and Pillai, 1982). Among these, *A. catechu* is the only cultivated species, the nuts of which are chewed as mild stimulant and only the major use of the crop. The other species *triandra* and *concinna* are also used as masticatory (Murthy and Pillai, 1982). Arecanut being the major cash crop of South and North Eastern parts of India, the recent low market price and yield reducing biotic and abiotic factors have affected the areca growers. Among the chemical constituents of arecanut, polyphenols constitute about 20 per cent of the dried kernel (Jayalakshmi and Mathew, 1982). The plant phenolics play a major role against the biotic stresses. Also arecanut polyphenols may be utilized as the natural colouring agent and pharmacaeticals (Amudhan and Bhat, V. R., 2002). It has been reported that the plant polyphenols have been associated with their antioxidant, antimicrobial, anti-inflammatory and antiallergenic properties (Billot *et al.,* 1990). With this perspective, an attempt has been made to quantify the polyphenols in available *Areca species* and relatives of arecanut at different stages of maturity of fruit.

Materials and Methods

The study was undertaken at CPCRI, Regional Station, Vittal during 2001-02 to 2002 – 03 with following *Areca species viz., A. catechu ., A. triandra, A. concinna***,** *A. macrocalyx*, *A. normanbyii* and related *genera Actinorhyts calapparia* were utilized in the present study.

Sampling of 25 nuts from each species (4 palms) collected and mixed properly and made it nice powder with two replications. 50mg of dry kernel powder is utilized for the estimation of polyphenol and estimation was done based on Folin-Ciocalteu reagent method (Bray *et al.,* 1954).

Results and Discussions

Significant differences were observed during maturity of fruits for the total phenolic contents among the *Areca species* and wild related genera. The phenolic contents were more in very tender (three months old) fruit and ranged from 435.50 to 564.80mg/g, as compared to mature nuts. The maximum total phenolic contents recorded in *Actinorhytis calapparia* (56.48%) and lowest (43.55%) in Areca *catechu* in very tender nut. In mature green (six months old) fruit the maximum total phenolics recorded in *Actinorhytis calapparia*. The polyphenols content in ripe (nine months old) fruit is ranged from 171.20 to 270.60 mg/g. Among these related genera *Actinorhytis calapparia* recorded maximum of 270.60mg/g (27.06 %) while minimum of 171.20mg/g (17.12%) of phenolics estimated in *Areca catechu* L. All the other species of *Areca* showed higher content of phenolics as shown in Table 1. The polyphenol content is decreasing as the nuts attaining maturity (Fig. 1). Decreasing trend in polyphenol content with maturity have been reported and during the maturation of the fruit the rapid formation of polysaccharides, fat and fibre, increases the bulk of the nut diluting the total polyphenolic content in *Areca catechu* (Mathew *et al.,* 1964). The desirable higher content of polyphenol trait can be transferred to high yielding varieties by conventional breeding or biotechnological tools so that the yield and quality

improvement can be achieved together and such varieties/cultivar will become more valued in pharmaceutical and industrial use.

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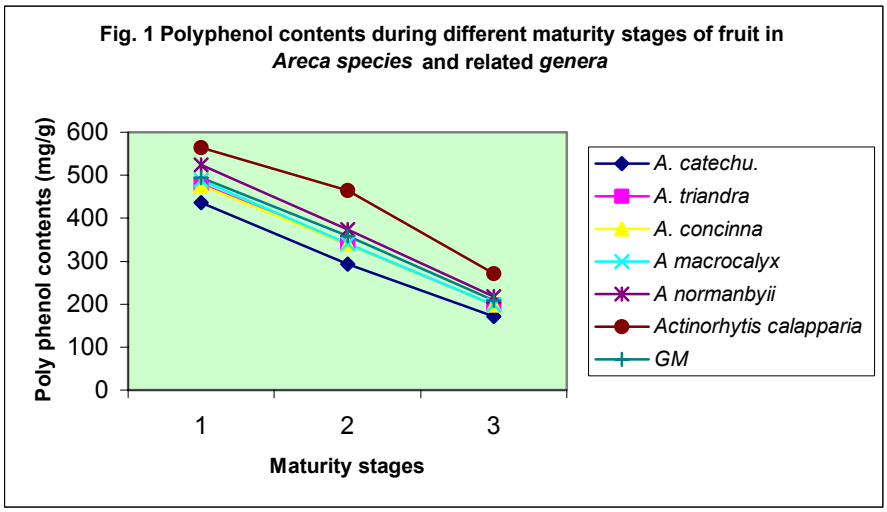
Table 1. Total phenolic contents during different maturity stages of fruit in *Areca species* and related genera of arecanut

Areca species and related genera	Total phenolics (mg/g)					
	3 Months	%	6 Months	%	9 Months	%
A. catechu L.	435.50	43.55	293.20	29.32	171.20	17.12
A. triandra	480.00	48.00	340.00	34.00	197.28	19.73
A. concinna	476.00	47.60	339.00	33.90	198.01	19.81
A macrocalyx	488.00	48.80	340.83	34.08	198.15	19.82
A normanbyii	524.67	52.47	373.50	37.35	216.70	21.67
Actinorhytis calapparia	564.80	56.48	464.30	46.43	270.60	27.06
GM	494.83	49.48	358.47	35.85	208.54	-
SD	40.67	-	52.78	-	33.68	-



MANAGEMENT OF INFLORESCENCE DIEBACK (*COLLETOTRICHUM GLEOSPORIODES*) OF ARECANUT THROUGH FUNGICIDES

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Introduction

Inflorescence die back of Arecanut incited by *Colletotrichum gleosporiodes* Peng. (Stonem) is a serious fungal disease in the semi-malnad tract of Karnataka. About 80 % of the gardens are found infected by this disease. The arecanut inflorescence is succumbed to this problem through out the year, but found serious during summer months (Feb-May).

The infections are seen at three stages. At first instance, the complete death of young inflorescence is found before opening of the spathe. The pathogen produces grayish white growth of the fungus with pinkish spore mass. Secondly, after bursting of spathe the inflorescence though looks healthy later wind borne conidia infects and few rachialle show yellowish brown discoloration from tip downwards. In severe cases, it spreads to entire inflorescence and subsequently dries up. Further, infection causes shedding of male and female flowers (Rao, 1965) and shedding of immature nuts is common phenomenon. The mycelial growth could also be seen on stigmatic ends of fallen nuts. Saraswathi *et al*., (1977) isolated the fungus *Colletotrichum gleosporiodes* from shed buttons and infected inflorescence of arecanut. The fungus is also isolated from coconuts (Anon.2001).

The button shedding could also be attributed to environmental factors such as non-fertilization, nutritional imbalance, excess irrigation, moisture stress and high temperature during summer months (Anon. 2002).

Literature on in-vivo evaluation of fungicides against this disease is found to be very scarce. Hence, a study was taken up at Arecanut Research Centre, Agril College, Navile, Shimoga Karnataka during 2003-04 to find out suitable effective chemical for the management of the disease.

Material and Methods

A field experiment was conducted during 2003-04 in a twelve year old garden at Hosalli, Shimoga taluk to study the efficacy of different fungicides against inflorescence die back along with recommended check (Mancozeb) and untreated check. Six fungicides viz., Propineb @0.25%, Zineb @ 0.3%, Copper Oxy Chloride @0.3%, Mancozeb + Carbendazim (63:12 ratio) @0.2%, Carbendazim @ 0.1 % and Mancozeb @ 0.3% were tried in RCBD design with three replications. Eight trees were maintained in each treatment. Three fungicidal sprays were done at 30 days interval from March to May. The observations were recorded with respect to fresh weight of nuts/bunch, dry weight of nuts / bunch, dry weight of nuts /plant, yield /acre (processed nuts) and disease severity. The disease incidence was recorded by adopting numerical rating method in 5 point scale i.e. 0 = no infection, 1= 1-25% infection, 2=25-50% infection, 3=50-75% infection and 4= 75-100% infection based on area of the inflorescence affected (Chandramohanan and Kaveriappa, 1985).

Results and Discussion

The results presented in Table-1 showed that, differences in dry weight of nuts/plant and disease score were found significant. Where as, fresh weight of nuts/ bunch, dry weight of nuts/bunch and yield of processed nuts/acre were found to be non significant. However, they are

numerically higher over untreated check. The fungicidal treatment Mancozeb + Carbendazim has significantly increased yield (10.2 Q/acre) and with reduction disease severity (1.33) followed by COC @ 0.3% (10.25Q/acre) with disease score of 1.66. The percent increase yield over check is 12.14 as against 6.20% in recommended check.

Saraswathi *et al.* (1975) obtained similar results by using Mancozeb @0.3percent alone against inflorescence die back in arecanut. The Dithiocarbamates are known to inhibit multitude enzymes at several sites, compounds are broad-spectrum systemic fungicides including cytokinin effects (Chaube and Ramji singh, 2002). Hence the application of mixture of Mancozeb and Carbendazim (63:12 ratio) tend to control the disease effectively, besides increase in yields.

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Table-1: Effect of fungicides against inflorescence die-back of arecanut

Treatments	**Fresh wt. of nuts Per bunch (gms)**	**Dry wt. of nuts Per bunch (gms)**	**Dry wt. of nuts Per plant (gms)**	**Yield Kg/ac (Processed)**	**Disease score (0-5)**	**% Increase over check**
1. Propineb @0.25%	2532.66	459.50	1838.00	10109.00	1.66	10.38
2. Zineb @ 0.3%	2036.66	425.73	1702.93	9366.12	2.00	2.26
3. COC @ 0.3 %	2330.00	466.08	1864.33	10253.81	1.66	11.96
4. Mancozeb + Carbendazium (63:12 ratio)@0.2%	**2430.33**	**466.83**	**1867.33**	**10270.31**	**1.33**	**12.14**
5. Carbendazim @ 0.1 %	2023.00	445.41	1781.66	9799.13	2.33	6.99

6. D.M-45 @ 0.3%(Rec.check)	2271.66	412.20	1762.50	9726.75	2.00	6.20
7. Control	1826.66	414.58	1658.33	9158.33	3.66	-
SEm±	357.26	34.18	13.87	334.65	0.403	-
CD @ 5%	NS	NS	42.75	NS	1.32	-
C.V.%	29.52	13.50	1.35	5.91	35.57	-

VARIATIONS IN BIOCHEMICAL COMPONENTS IN ARECANUT GROWN AT DIFFERENT PLACES

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Introdution

Arecanut (*Areca catechu L)* is traditionally cultivated as a one of major plantations crop in India. Arecanut is mainly used for chewing purpose as alone or along with other ingredients like tobacco, lime, and spices. The taste and flavor of arecanut is said to have some differences in arecanut that are grown at different places. Earlier studies conducted at different arecanut growing regions showed variation in physical and chemical constituents (Mathew *et al.,* 1964). This study was conducted to know any variation in arecanut biochemical component at different growing places.

Material And Methods

Mangala variety of arecanut at tender (6-7 months) and ripe (9-10 months) growth stages were collected form five different arecanut growing areas in Mangalore and Kerala for two years. Dried arecanut kernels were ground and used for estimating the four major biochemical components. The study was conducted using RCB design with six replications. Fat was extracted in soxhlet extractor using chloroform as solvent and total fat content estimated gravimetrically. Aliquots of aqueous alcohol (80%) extracts were used for estimation of total phenols by using Folin-ciocalteau reagent (Bray *et. al.,* 1954). Starch was extracted by perchloric acid digestion and estimated by phenol-sulfuric acid method (Dubois *et. al*., 1956). Arecoline, the major alkaloid present in arecanut, was estimated by the method described by Nambudiri (1968).

Results And Discussion

The results are present in the table 1. Polyphenol content showed slight variation among different places of cultivation. In case of tender nut, Sampaje samples had high polyphenol content (26.70%) whereas Badiadka samples showed least content (23.62%). But in fully ripen nut, Sampaje sample recorded high value (21.20%) of polyphenol, whereas Kasaragod sample recorded low value (18.81 %). Fat content observed in this experiment was in accordance to earlier studies (Jayalakshmi, *et al.,* 1982). Moderate variations of fat content are also noticed between samples. Tender nut samples from Perla contain higher content 10.79% followed by low content in case of Kasaragod samples (9.52%). But fully-ripen arecanut, the Perla samples recorded higher value (12.58 %), as that of Badiadka samples showed lower value (10.68 %).

Arecoline content showed variation among samples. Badiadka and Perla samples have higher content in tender nut (0.291%) and mature nut (0.366%) respectively. But samples of Sampaje and Perla samples have low value at tender (0.221%) and mature (0.309%) stages. Perla

samples showed high starch content in tender nut (17.11%) as well as and mature nut (19.89%). In case of ripe nut, Badiadka samples recorded low value in both tender nut (17.11%)and mature nut (19.89%). But these biochemical components of arecanut samples from different five growing places did not show significant variation.

Conclusion

Arecanut, cultivated in and around Mangalore and Kasaragod has shown slight variations in the biochemical components. Further studies should be conducted in the different geographical areas to know the biochemical component variation due to various areas of cultivation.

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Table1: biochemical content of samples of different arecanut growing places

Places	Polyphenol (%)		Total fat (%)		Arecoline (%)		Total carbohydrate (%)	
	Tender*	Ripe#	Tender*	Ripe#	Tender *	Ripe#	Tender *	Ripe #
Badiadka	20.12	20.45	9.71	10.68	0.279	0.322	17.11	19.89
Perla	23.62	20.89	10.79	12.58	0.261	0.366	19.72	22. 65
Kasaragod	26.01	18.81	9.52	11.56	0.254	0.309	19.65	22. 47
Kanhankad	26.12	19.70	10.64	12.54	0.248	0.345	18.45	20.25
Sampaje	26.70	21.20	10.24	12.24	0.221	0.356	18.94	20.43
CD (P= 0.05)	NS							

* 6-7 months arecanut #-9-10 months arecanut NS –Non significant

Session – II: Farmers' Innovations

Chairman: Sri. Srinivas Achar

Rapporteur: Dr. Ravi Bhat

AYURVEDIC SYSTEM OF TREATMENT FOR YELLOW LEAF DISEASE OF ARECANUT

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Introduction

Yellow leaf disease is one of the serious diseases of arecanut both in Kerala and parts of Karnataka. Major crop loss is reported due to this disease. Yellowing starts from the tip of the leaflets downwards in two or three leaves of the outermost whorl. The yellowing due to this disease is distinct from other types of yellowing in arecanut. There is a clear cut demarcation of yellow and green regions. There will be a clear band of green tissue adjacent to the midrib areas of the leaf as well as the leaflets. In the advanced stages the leaves become short, stiff, pointed, closely bunched and abnormally puckered. The leaf tips become necrotic and dry up during summer. There will be heavy shedding of both mature and immature nuts. Blackish brown discolouration of endosperm, which is soft to touch, may occur in some cases. Root system also exhibits varying degrees of rotting and also reduction in lateral root production. Plant becomes weak and prone to attack by other insects and diseases. Hindarance to normal transpiration process adds to the misery.

Since the first report of the disease in 1949 from Central Kerala, it has spread to different regions in Kerala and Karnataka especially in forest and semi ghat regions. The studies conducted by the Institutions have helped in diagnosing the disease, spread of the disease. The cure for the disease is yet to be standardized.

Methodology

Six disease affected gardens were selected from Sullya, Sampaje and Thirthahalli areas. The study is in progress for last four years.

Yellow leaf disease is a nutritional disorder enhanced by the environmental factor and by mineral antagonism. Micro and macro nutrients are necessary for both the plants and animals to grow and propagate. Accordingly their individual digestive systems need carbon and oxygen in the process.

In plants, magnesium is the key component of chlorophyll and photosynthesis. But unless it is made available to the plant, any amount of application will not be useful. Toxicity of manganese, iron, aluminium etc. is all due to malnutrition and indigestion caused by mineral antagonism. Adverse soil conditions leads to magnesium deficiency as well as mal absorption of other elements like nitrogen, phosphorus, potassium and other macro and micro nutrients. Due to this mal-function, the plant digestive system will be impaired and the leaves are affected. This sends wrong signals to roots and the roots start sending toxic substances through Xylem and Phloem. Cells degenerate due to lack of transpiration and water will be stored in the stem. Then the process of putrification starts. This process takes 2-3 years and thus curing of the disease also needs three years. The impairment in the plant digestive system leads to the appearance of symptoms and all the other insect and pests are aftermath of this phenomenon. At this stage plants cannot absorb any nutrients from the soil. Thus to make the plant absorb the nutrients, curative treatment is required. An ayurvedic medicine was used for the disease which is also used in human beings. Purified 'Gowripashanam' (oxide of arsenic) was used as a soil rectifier to remove the mineral antagonism. Purified and medicated (according to Ayurvedic methods) 'Gowripashanam' was administered to the plant as root application in in Homeopathic dosage (ppm levels). A verse in "Shaligrama Nighantu" (1953 edition) was the inspiration for this treatment. The verse is

DRÄ ¥ÁµÁtPÀB ¹ßUÀÞB ¥ÁgÀzÀ¸Àå¤AiÀiÁªÀÄPÀB |
¯ÉÆÃºÀ¨sÉÃzÀPÀgÀ±ÉÑöÊªÀ «ÃAiÀÄðPÀÈvÁÌAwªÀzsÀð£ÀB ||

This “Akhu pashana” (arsenic) has a special quality of breaking metals. It is also used in iron industry for its processing and purification. Since it is highly poisnous, it has to be purified before administering to animals or plants.

In two gardens, ten trees were given the following treatments. Purified Gowripashanam + Lime powder + Turmeric powder + finely sieved sand and earth in specified dosages once in three months during wet and dry season for two years. The very next year of treatment application fruit set increased and quality nuts were produced. The crown began to spread and stunted growth started disappearing. For another 10 trees to test the arsenic in its organic form, human hair (human hair contains highest percentage of arsenic than any other exudations of the body like sweat, tears and nail) along with other medicines. This treatment also produced good results.

For other set of gardens as control, neem cake, magnesium, phosphorus, nitrogen manures were applied in various dosages. But there was no change in the yellow leaf disease symptoms.

The treatment was continued for three years in two gardens in Chembu (Sampaje) and Thirthahalli. The treated trees are now healthy and giving good yield. Since one year the treatment is withdrawn and still the trees are healthy. The farmer is advised to maintain proper drainage, mulching, digging to remove the excess carbon dioxide from the soil after wet season. Proper farm management is the essential factor for the earlier recovery. Proper soil respiration is a conducive factor in eliminating the disease. This avoids formation and absorption of toxins degenerating the normal cell growth.

Conclusion

It is natural that all the pests attack the plant when the plants become weak. The variations of the leaves in wet and dry season shows that this is a localized nutritional disorder which is induced physiologically.

Before conclusion it is worth remembering quotes from the book ‘ Mineral deficiency in plants’.

“Magnesium, iron and zinc deficiency symptoms may be less severe under conditions of low light intensity, whilst boron deficiency effects are less severe and magnesium deficiency effects are more pronounced in wet seasons than in dryness. The outstanding fact about magnesium is that it is a constituent of chlorophyll and is essential to the formation of this pigment. As a result when magnesium is deficient, one of the symptoms commonly shown by plants is chlorosis. Magnesium is also regarded as a carrier of phosphorus in the plant, particularly in connection with formation of seeds of high oil content, which contains the compound lecithin. The element seems to be mobile within the plant, and when deficient it is apparently transferred from older to younger tissues where it can be reutilized in growth process. This agrees with observation that signs of magnesium deficiency make their appearance first on the older leaves and systematically from them towards youngest ones”.

That is what it exactly happens in the culminative of the yellow leaf disease.

R&D ON BETTER USES OF ARECANUT-VARANASHI EFFORT

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Introduction

The recent fall of arecanut price is of concern to every arecanut grower. The price reduction will not only affect the grower but also others in the entire arecanut growing belt. Over production and the propaganda about the health hazardous nature of the arecanut are the main reasons for price crash.

Today, the traditionally used "pan" has been replaced and swept over by the pan masala and gutka, which have reached the mass consumption level. This has resulted in major shift for the demand of the arecanut from individual "Panwala" to pan masala/gutka industries. A welcome development! But unfortunately, due to additives in the panmasala/gutka (tobacco and other items?), the product is supposed to be a health hazard and so certain states have banned it's sales and consumption. Under such circumstances, promotion of better uses of arecanut is the only way.

Statutory problem to promote better uses of arecanut

In 1993, the government of India under food adulteration rules, 1955, brought a blanket rule, which states every package of supari, and advertisement relating thereto shall carry following warning:

"Chewing of supari is injurious to health"

This statutory rule is based on adverse study reports on consumption of panmasala/gutka as well as only arecanut. In fact, there is enough evidence to say that arecanut consumption as pan along with betel leaves and other spices after every meal is health promoting. These texts also say arecanut should not be used alone. Further, one should not continuously chew it. When the rule was made these points were over looked. So, efforts are to be made to delete the rule so that health promoting arecanut products could be popularised.

"Taambula" in Indian diet

The practice of chewing arecanut and betel leaves is very ancient and its mention has been made even in Mahabharatha. Arecanut is used in many religious occasions. Probably, its medicinal properties might have contributed to its time-immemorial use for masticatory purpose.

Information from Ayurvedic Sources

- Regular use of arecanut chewing keeps away bad breath and foul odour of the mouth. The practice also strengthens the gums.
- Arecanut is a digestion-stimulant, which discourages gas accumulation in the stomach.
- Because of the improvement in digestion, it increases alertness.
- Arecanut chewing prevents fat deposition in the body thus helping to maintain the body weight.
- It favours blood circulation due to which it helps to impart glow to the skin.
- It is reported that being a nervine tonic, areca is a good aphrodisiac.

Today to safeguard arecanut growers one need to sustain the demand for arecanut. There may be so many short-term plans to overcome the crises. However, the long-term plans would be of finding better universal use. The ancient texts could give the lead. Accordingly, our research needs to be prioritized.

Varanashis and arecanut

Varanashi Research Foundation (VRF) is collecting information on the better uses of arecanut since last twenty years. Four years ago, VRF got actively involved in developing non-tobacco product based on ayurvedic principles using arecanut as the main ingredient. Two products namely (1) spiced sweet arecanut and (2) sweet arecanut with dry betel leaf (dry pan) were developed. Even though they fall under sweet supari category, they differ vastly from the general scented supari because only natural ingredients are used in these products. Trial production on a pilot unit and consumer acceptance test was also done to the first product named as "Varanashi Herbal Supari." The following opinion has emerged from the consumers.

- It is a stimulant and improves the alertness.
- Wards off bad breath and foul odour of the mouth.
- Improves taste and digestion.
- Keeps away gas trouble and constipation.
- Is a good substitute for beedi, cigarette and other nicotine products.

The products are ready for large-scale production and market penetration awaiting appropriate partners for the venture.

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PREPARATION OF A *LEHA /AVALEHA* FROM *KALIPAK* – A FARMER'S PRESCRIPTION

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Introduction

The practice of chewing arecanut either alone or in combination with betel leaves, tobacco or spices has been in existence from time immemorial. Chewing increases the production of saliva and gastric juices and thus aids digestion. It is believed to strengthen the gums and the teeth and cleanses and deodorizes the mouth. It is an appetizer and stimulant. Arecanut has also been mentioned as a purgative. In our ancient books the utilities of arecanut are mentioned.

कषायमधुरं फोदिरोचनं मोहकृत्गुरु।
पूगंतु मुखवैरस्य मलदौर्गन्ध्य नाशनम्।।

- मदनपाल निघण्टु।

फोदिसाम्मोहदुत् पूगं कषायंस्वादुरोचनम्।
कफपित्तहरं रुक्षं वक्रक्लेदमलापहम्।।

-धन्वन्तरि निघण्टु।

त्रयोदश गुणापेतं संसेव्य सकलैरपि।
ताम्बूलमहमत्रैव स्वीकुर्वेमोदयसंयुत।।

- वाग्भट 4th Century B.C.

Astringency is the characteristic taste of arecanut. Polyphenols present abundantly in arecanut are responsible for this. Astringency decreases with maturity.The quality factors of processed arecanut are extremely important. N*eetadaka, kottapak* and *kalipak* are the common processed products from arecanut. A few experiments in preparing diversified products from arecanut were conducted with some success. Procedure to prepare an ayurvedic preparation which could be used for stomach ailments is presented here.

Methodology

Kalipak is mainly used for making scented supari. Kerala and Karnataka are the main processing centers of kalipak. The nuts of 6 - 7 months maturity, which is soft, and of' 'finger nail press' stage are used to prepare kalipak. Outer skin is dark green in colour at this stage. The processing consists of dehusking, cutting the soft nuts in to pieces, boiling the cut pieces in water or a dilute extract from previous boiling, kalicoating and drying.

A process has been developed for preparation of a *leha* / *avaleha* wherein certain ayurvedic ingredients are included along with immature arecanuts.

[12] Central Plantation Crops Research Institute, Kasaragod

Preparation

Immature nuts of fingernail press stage are dehusked and cut transversely to make thin round pieces. These are boiled in water (600 gram areca pieces in 1 litre water ratio) for 30 minutes by which time the colour of water changes to black or light black. Remove the areca pieces from water and add jaggary into this water and boil it and make the solution thick. (500 gram jaggary for 1 litre water). *Ajamojam, Abhaya, Amla and Yahsti,* cardamom, cinnamon and jeera (all in powder form) are added in a stipulated proportion in to this solution and mixed thoroughly. Add the areca pieces taken out from the boiled water in to it and keep overnight. It is to be taken out next day and dry in the sun. The dried nut is kept again in the solution for overnight. Next day it is dried again in the sun. While drying, each piece should be kept separately, to avoid formation of block and spoiling by fungi and bacteria. This is repeated for at least 10 days by which time the entire quantity of jaggary and other ingredients are absorbed into areca pieces. It is packed in aluminium foil and can be stored for at least 6 months.

This *oushadham* was tested for indigestion and abdominal pain and found that consumption of this *oushadham* 5 gram a day two times after food prevents abdominal disorders. This can also be used as a tonic.

Conclusion

Value addition through product diversification is the need of the hour to maintain the market value of arecanut. So more and more edible and non-edible items should be developed from arecanut and its byproducts for which the scientists, farmers and entrepreneurs should work hand in hand.

Session – III: Extension and Development

Chairman: Dr. M. Tamil Selvan

Rapporteur: Shri. S. Jayasekhar

EXTENSION PROGRAMMES OF CPCRI REGIONAL STATION, VITTAL

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The process of technology generation will be complete and fruitful only when it is utilized by the ultimate user. The process of technology transfer is still more complicated and time consuming than generation of technology, as it has to be accepted by varied users under varying conditions. To attain the sustained adoption of generated technologies, research institutions should have a strong TOT network for disseminating their technologies both directly and indirectly through extension and development agencies to the end users. CPCRI could establish a firm footing in the dissemination of technologies through the following extension methods and programmes.

Training Programmes

I. Orientation training to foreign Nationals.

II. National level training programmes for Government officials and Private entrepreneurs

a) Strategies for enhancing productivity in arecanut gardens by crop diversification.

b) Advances in cocoa production technology.

c) Any other specific training on request.

Duration : 3 days **Number of seats : 20**

Course Fee : For Govt. officials : Rs.3,000. **For private agencies : Rs.4,000.**

III. Training for women SHGs and unemployed youth, students and farmers on softwood grafting, vermicomposting and on various aspects of areca and cocoa cultivation.

IV. Training for beneficiaries under cocoa demonstration programme on production techniques of cocoa with special emphasis on pruning techniques.

V. One day orientation training for farmers and students groups on the activities and achievements of the station.

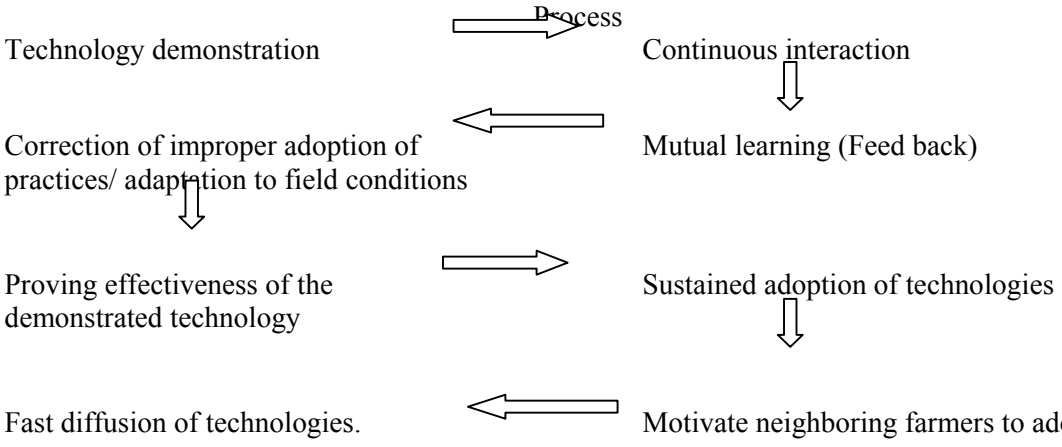
Front Line Demonstrations

Front Line Demonstration is one of the most important activities of any research institute as it can directly convince the ultimate user through the visual impact generated through the experience of self or other users of the technology.

Basic principle

"Seeing is Believing and Learning by Doing".

Process



Technology becomes 'farmer friendly' through Participatory Demonstration.

Performance of cocoa grafts in arecanut and coconut based cropping systems

This station is at present undertaking demonstration in 85 farmers plots of 1Ha. each with the financial assistance of Directorate of Cashew and Cocoa Development.

General observations

- **The cocoa grafts are showing superior performance in more than 80% of the gardens.**
- **The mortality rate was found to be less than 3%.**
- **About 24% of the plants started flowering during second year and 47% of the plants started bearing during third year.**
- **More shade during the initial years was found to be conducive for growth of grafts.**
- **Field problems monitored by the farmers so that timely correction measures could be adopted.**
- **Farmers felt demonstration as useful not only in learning about the particular technology, but on the cropping system as a whole.**

Improper Practices Noticed In Field

1. **Growth habit being different from seedlings, training and pruning during the initial years were done in different ways by the farmers.**
2. **The branches from rootstocks were retained and some of the graft branches removed by many of the farmers.**
3. **Grafting tapes not removed while planting by one or two farmers.**
4. **Stem borer attack was noticed to the grafts from some of the dead stakes used for support in few fields. But it was confused as mortality due to disease by most of them.**

If not corrected in proper time, the technological impact can be negative even with few failure cases during the initial years of introduction of the technology.

Farm Clinic Services

Multidisciplinary team of scientists visit farmers' field with the following objectives:

- **To acquaint with field problems and farmers practices.**
- **To Diagnose field problems and to suggest remedial measures.**
- **To receive feed back from farmers for refinement of technologies.**

30 groups visited 85 farmers' fields during 2003-04.

What could scientists learn?

- **Practical difficulties in adopting certain practices under field conditions.**
- **Farmers' innovations and ways of doing things, which help in developing user friendly technologies.**
- **Identification of priority field problems in various places related to arecanut and cocoa.**
- **New information through sharing of experience.**
- **Cropping patterns followed in different areas.**

Common field problems noticed

- Pests and Disease problems.

2002	2003
Immature nut fall (Due to sudden flush of water after drought)	Immature nut fall (Due to Pentatomid bug and early rains)
Inflorescence Die-back	Inflorescence Die-back
Nut splitting	Crown bending and slantedscars

	(Suspected to be Boron deficiency)
Leaf spot (in some pockets)	Root grub (in some pockets)
Root grub (in some pockets)	

- **Control measures ineffective due to faulty spraying methods, untimely spraying and incorrect dose of PP chemicals.**
- **Application of manures and fertilizers inadequate or imbalanced.**
- **Cultivating intercrops which are not compatible with main crop.**
- **Inadequate drainage and irrigation facilities.**
- **Huge investments for cultivating crops, where land is unfit for cultivation (with hard pan in soil, without terracing in sloppy lands, without proper management in reclaimed soils etc.)**

What the farmers could learn?

- **Suitability of land and soil for growing a particular crop.**
- **Identification of compatible intercrops in any cropping system.**
- **Importance of proper method of planting and spacing for better performance of crop.**
- **Importance of organics and balanced fertilizer application in maintaining soil health.**
- **More on pest and disease management.**
- **Importance of proper and timely spraying.**
- **Identification of nutrient deficiency symptoms preferably that of Boron.**
- **Judicious use of chemicals for environmental safety.**

Agricultural Information Centre

Aimed at providing information, technologies, knowledge, planting materials, seed, consultancy etc. to the farmers, students and other end users through a single window system.

Advantages

- **Any farmer or student can utilize the technological information provided in the centre even in the absence of the concerned specialist.**
- **Plant clinic services made easily accessible for the farmers.**
- **Quick and easy guidance on the services rendered by the institute and sale of planting materials and other products.**
- **Helped in strengthening farmer interactions and feed back mechanisms**.

OTHER EXTENSION ACTIVITIES

KISAN MELAS AND KISAN DIVAS

Organized two kisan melas during 1999 and 2001 with more than 300 farmers and officials.

EXHIBITIONS

Participated in a three day exhibition-cum-krishimela organized by Sri Kshetra Dharmasthala Gramabhivridhi Yojana in collaboration with local bodies at Savanoor and supplied exhibits for many other exhibitions.

REGIONAL NURSERIES

14 Regional nurseries have been established in 4 states for supply of grafts.

AGRICULTURAL SEMINARS AND MEETINGS
RADIO TALKS
POPULAR ARTICLES
PRODUCTION AND SALE OF VIDEO FILMS, CD-ROMS AND AUDIO CASSETTES ON ARECANUT AND COCOA PRODUCTION TECHNOLOGY.
ADVISORY SERVICES : REPLY TO ON-LINE AND POSTAL QUERIES.
PUBLICATION OF EXTENSION LITERATURE

ARECANUT DEVELOPMENT IN INDIA

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Arecanut Development in India was passing through a crisis during mid-Forties due to heavy crop loss caused by fruit rot (*Koleroga* or Mahali) on one side and loss of a sizable area to Pakistan due to partition. The Indian Central Arecanut Committee which was constituted in 1949 to look into the problems of the commodity initiated several research and development programmes in the important arecanut growing regions either by setting up research stations directly under its control or supporting research schemes sponsored by State Agricultural Department, Universities or Institutions. One of the important programmes was setting up of the Central Arecanut Research Station at Vittal (now the Regional Station of CPCRI, Kasaragod) in 1956 and a network of Regional Stations at different arecanut growing regions of the country during the Second Five Year Plan period (1956-57 to 1960-61).

Consequent to the abolition of Indian Central Arecanut Committee on 30th September, 1965, its research activities were taken over by the Indian Council of Agricultural Research with effect from 1st October, 1965. The Department of Agriculture, Government of India took over the development and marketing aspects looked after by the Committee till then by setting up the Directorate of Arecanut and Spices Development as a subordinate office for continuing the development work of arecanut and spices.

In order to continue the association of various officials and non-officials with the development of arecanut and have the benefit of their advice, the Government of India constituted the Indian Arecanut Development Council in February, 1966.

Production scenario

Arecanut is cultivated in India over an area of 3.349 lakh ha producing 4.094 lakh tonnes during 2001-02 with the productivity of 1.22 tonnes/ha. The main pockets of production of arecanut in India are distributed in the states of Karnataka (40% of area and 44% of production), Kerala (26% of area and 21% of production), Assam (22% of area and 17% of production). Other states producing significant quantities of Arecanut are Meghalaya, West Bengal, Andaman & Nicobar Islands, Andhra Pradesh, Goa, Maharashtra, Mizoram, Tamil Nadu, Tripura and Pondicherry.

In the case of productivity Mizoram ranks first with 4.31 tonnes/ha followed by Tamil Nadu (2.96 tonnes/ha). Though Assam contributes significantly to the arecanut sector its productivity is very low (0.95 tonnes/ha). The productivity of arecanut in Karnataka is 1.34tonnes/ha, which is above the national average (1.22 tonnes/ha). Kerala has the productivity of 0.99 tonnes/ha that is below the national average. State wise area and production of arecanut in the country during 1998-99 is given in Table 1.

Export and Import of Arecanut

Arecanut is a commodity, which has a very limited export potential. The bulk of the production is consumed within the country. However a small quantity of arecanut is exported mainly meant for the Indian settlers abroad. Quantity of export was at a range of 330 to 823 tonnes during the period 1994-95 to 2000-01. But the export increased substantially during the last couple of years as seen in Table 2. During 2002-03 India exported 1,555 tonnes valued Rs 741 lakhs. The main countries to which arecanut is exported are UAE, Maldives, Bangladesh etc.

During fifties, arecanut production in the country was not sufficient to meet the internal requirement. This is reflected in the huge quantities that were imported during fifties. The quantity imported during those periods ranged from 18,364 tonnes to 50,600 tonnes. The imported arecanuts were in the form of betel nut whole, betel nut split etc. Thereafter the import gradually began to decline year after year due to the decision of the Government of India to restrict the import with a view to give incentive to the arecanut farmers. From 1974-75 to 1993-94 there was no import of arecanut into the country. Since 1994-95 India started importing arecanut due to the increase in domestic consumption to fill the gap in demand. The quantity of import varied from 545 tonnes to 10,823 tonnes during the years from 1994-95 to 1998-99. From 1999-00 onwards import of arecanut in to the country registered a significant increase. During 2002-03, India imported 21,452 tonnes of arecanut valued Rs 3603.74 lakhs mainly from Bangladesh, Indonesia, Mayanmar, Thailand, Sri Lanka etc. Details of export and import of arecanut in India is given in Table 2.

Development Programmes

The ICAC could not do much for the development of the crop during the I Five Year Plan Period. Establishment of arecanut nursery for distribution of quality seedlings in the potential region of Assam, West Bengal and Kerala was the only activity carried over by the Directorate then.

During the Second Five Year Plan period arecanut development was initiated by allocating Rs. 14.11 lakhs. The actual measures contemplated for achieving the increase in target of area and production were 1) Establishment of new nursery; 2) Demonstration plots; 3) Pump set etc. for irrigation; 4) Supply of fertilizer and credit; 5) Subsidy and plant protection measures; 6) Publicity propaganda.

During the Third Five Year Plan the total provision made for the developmental schemes was Rs. 5.424 million. The principal development measures adapted to the different states were production and distribution of seedlings, organization of demonstration plots, agricultural practices, manuring, plant protection etc. During the periods 1966-67, 1967-68 only annual programmes were initiated. During the IV Plan Period no extension of area under arecanut was contemplated. The scheme-wise outlay of development work on arecanut during the IV Plan was as under.

1. Arecanut demonstration schemes	Rs.	87,000
2. Package of programme of arecanut	Rs.	10,00,000

During the V, VI and VII Five Year Plan Periods only limited developmental measures had been implemented. As the production of arecanut has reached the level of self-sufficiency there was no scheme during the VII Plan. However during 1991-92 and 1993-94 an amount of Rs. 111 lakhs were released for the development of arecanut in the states of Kerala, Karnataka and Assam.

In order to overcome the constraints like wide gap in yield due to non-adoption of recommended package of practices, incidence of diseases, lack of irrigation etc., Central Sector Schemes with an outlay of Rs. 5 crores was implemented during the VIII Five Year Plan period with the measures 1) Control of foot rot disease, 2) Distribution of sprayers, 3) Control of *Ganoderma* disease in Assam through rejuvenation and pre-planting demonstration, 4) Eradication of yellow leaf disease, 5) Installation of irrigation unit under arecanut garden, 6) Production and distribution of arecanut seedlings for replanting and gap filling.

Considering the trend in demand for arecanut and the sophisticated ways in which it is used for chewing, an annual growth rate of 4% was envisaged during the VIII Plan period. Accordingly the production target of 3.4 lakh tonnes has been made for 2000 AD. The additional production is to be achieved mainly through productivity increase in the existing gardens.

Conclusion

Till recently, arecanut was one of the most profitable plantation crops in the country. Because of the higher prices, people started expanding area indiscriminately irrespective of the suitability of the crop to a particular region both in non-traditional and traditional areas converting the paddy fields into areca gardens. This has led to increased problems in arecanut cultivation leading to possible excess production resulting in the steep price fall. This led to the traditional arecanut farmers in Karnataka to approach State and Central Governments for taking appropriate action so that the farmers could be saved from penury.

There is an urgent need to increase not only the productivity of arecanut but also the profitability for unit area of land on a sustainable basis. This necessitates diversification based on the concept of cropping / farming systems. In the present context of removal of quantitative restrictions and the WTO regime, unless we are competitive in terms of price and quality, it is going to be very difficult to sustain arecanut cultivation over a period of time. As far as the productivity is concerned, the Indian productivity is 1222 kg / ha of dry arecanut whereas the yield in China is 3752 kg / ha. If arecanut farmers have to be competitive there is an urgent need to improve the productivity of the crop. This also needs motivation of the farmers and educating them on the need for improving productivity and providing them appropriate technical support in terms of viable technologies and education to achieve the target.

Location specific technologies including cropping / farming system recommendations are available for increasing not only the productivity of unit land area but also profitability. Government of India through its schemes implemented through state department of agriculture/ horticulture may spread the message through mass media about need for being competitive in terms of price and quality to withstand the competition from the neighbouring countries.

The Expert Committee constituted by the Government of India under the Chairmanship of Dr P. Rethinam, Former Chairman, Coconut Development Board examined the various issues related to arecanut, has opined that further area expansion of arecanut is to be reduced, since arecanut has no alternative use other than masticatory purposes. To increase income from unit area of land in the existing arecanut plantations, crop diversification with inter and mixed cropping is to be encouraged.

Though alternative uses and medicinal values of arecanut have been reported, viable technologies are yet to be developed for exploiting it economically. Studies for the uses of arecanut in pharmaceutical, industrial and cosmetic sectors are to be intensified. Available alternative uses of arecanut for medicinal and industrial purposes have to be promoted in a wide manner to increase the domestic consumption of the produce, through institutional funding.

Table 1. State wise area and production of Arecanut in India

State	2000-01			2001-02*		
	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	0.3	0.7	2333	0.3	0.4	1333
Assam	73.2	68.3	933	73.2	69.7	952
Goa	1.6	2.5	1563	1.6	2.5	1563
Karnataka	119.1	162.7	1366	135.1	181.5	1343
Kerala	87.4	87.9	1006	88	86.8	986
Maharashtra	2.2	4.4	2000	2.2	5.6	2545
Meghalaya	11.2	13.7	1223	11.2	13.9	1241
Mizoram	1.0	1.8	1800	1.3	5.6	4308

Tamil Nadu	3.7	4.8	1297	4.8	14.2	2958
Tripura	3.2	6.8	2125	3.4	6.9	2029
West Bengal	7.8	12.2	1564	9.3	14.9	1602
Andaman & Nicobar Islands	4.4	7.2	1636	4.4	7.3	1659
Pondichery	0.1	0.1	1000	0.1	0.1	1000
All India	315.2	373.1	1184	334.9	409.4	1222

Source: Directorate of Economics and Statistics, New Delhi

Table 2. Export and import statistics of arecanut in India

Year	EXPORT		IMPORT	
	Quantity (tonnes)	Value (Rs in lakhs)	Quantity (tonnes)	Value (Rs in lakhs)
1995-96	406	360.76	5091	946.75
1996-97	513	419.08	9565	2122.32
1997-98	664	365.50	10823	3396.48
1998-99	533	468.92	6707	1875.57
1999-00	734	691.78	11695	3480.96
2000-01	712	669.11	29350	8554.64
2001-02	1483	728.90	14788	2600.66
2002-03	1555	741.28	21452	3603.74

Source: Directorate General of Commercial Intelligence & Statistics (DGCI&S), Kolkata

COCOA IN INDIA

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Cocoa is one of the important commercial plantation crops in India and it is mainly cultivated in four major southern States of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh where the agro climatic conditions are suitable for cocoa. The North East states like Assam, Meghalaya and Arunachal Pradesh are also having congenial climatic conditions for cocoa.

At present in India, Cocoa is mainly grown as intercrop either with Coconut or Areca nut. Its adoption to adjust itself to other tall growing species like Coconut and Arecnut and its combining ability with such micro climatic conditions becoming available in such perennial gardens helps its cultivation in utilizing such areas without exacting for an independent growing situation of its own. In the Coconut and Arecanut gardens with 40- 50% sunlight penetration, Cocoa is the most favorable crop to absorb, amicably accommodating and remaining symbiotic to the main crop. The tropical regions of India at present exerting high competition for several crops, the benefit of Cocoa to get along with Coconut and Arecanut garden is an admirable and explorative set up to encourage its cultivation in our country. Its integration with such crop is an added advantage to derive as good an income as possible within the limited resources of land and

water besides helping in the enriching the soil condition, making it beneficial for both crops in improving the soil conditions and nutrients availability.

Indian Cocoa scenario:

At present the area under Cocoa is 23628 ha. With a production of 8409 MT in the following States:

State	Area (ha)	Production (MT)
Kerala	9275	5109
Karnataka	6000	2500
Andhra Pradesh	7953	600
Tamil Nadu	400	200
Total	23628	8409

Even though area under Cocoa is 23628ha, the production is hardly 8400 MT and the productivity is only around 500 Kg per ha or nearly a Kg. of dry beans per tree per annum. This productivity is quite low when compared to the productivity in other countries of its cultivation.

World Cocoa scenario:

Cocoa production takes place in the following countries and according to latest statistics the total production is 31 lakh MT.

Country	Production('000 MT)
Coted'Ivoire	1360
Ghana	595
Indonesia	435
Brazil	185
Nigeria	153
Cameroon	135
Equador	105
India	8
Others	275
Total	3191

Commerce

India has gained a foreign exchange of more than Rs. 10 crores during the last 3 years by way of export of cocoa products* as shown below.

Year	Amount (Rs. In crores)
2000-01	13.670
2001-02	13.770
2002-03	11.420

Source : Cocoa Market Report (ED & F MAN)

* Cocoa products include cocoa powder, chocolate confectionaries, cocoa butter and other food products.

Import of cocoa beans:

As the current domestic production of cocoa beans is not sufficient to meet the demand the industry had to import the shortfall.

Year	Quantity (MT)	Value (Rs. Crores)
2000-01	2027	11.470
2001-02	2149	11.550
2002-03	12141	10.744

Developmental measures in India:

The developmental measures were being initiated in order to increase area, production and productivity with the following components.

i. Area expansion with improved varieties
ii. Rejuvenation of uneconomical plantations
iii. Infrastructure support for planting material generation, processing and marketing development
iv. Effective transfer of technology measures

The promotion of cocoa for increasing the area in the first was initiated during 8th Plan started with a modest approach with the establishment of demonstration plots in the farmers field providing quality inputs like good seedlings and grafts and necessary agronomic practices. These demonstrations in the 9th Plan got oriented towards larger area coverage by way of distribution of good quality planting materials and support of other vital inputs required for scientific management of the plantation. Considering the scope and the interest shown by the farmers in the southern States mentioned above, supportive programmes for generation of quality planting materials by way of Establishment of clonal gardens and regional nurseries came into existence. An allocation of Rs. 6 crores for 9th Plan was made for these programmes and further ongoing schemes as on 2003-2004 considerable areas to the extent of 6000 ha could be freshly brought under cocoa.

Future potential for cocoa development in India:

Potential:

As cocoa is mainly cultivated under irrigated coconut and arecanut gardens, availability of such areas especially coconut gardens in the states like Kerala, Karnataka, some parts of Maharashtra, Pondicherry, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal will offer considerable scope for its development as these areas are coastal belts where coconut is grown under irrigated conditions. Of the 15 lakh ha of coconut gardens in India, the coconut areas in Karnataka, Pondicherry, Tamil Nadu and Andra Pradesh are mostly irrigated in nature. In respect of other states, nearly 30-40% are under irrigation. Therefore not less than 3 lakh ha will definitely be suitable for cocoa as an intercrop, beside the vast land potential available in North East region.

Industrial Demand

At present more than 15 industrial entrepreneurs and companies existing in the field demanding nearly 30,000 M.T. of cocoa beans of which the present production is hardly 30%. The cocoa growers were quite apprehensive about the price trends prevailed during the later part of 20th Century. This was almost a deterring factor for them to adopt cocoa cultivation. In the light of the increasing competition exerted by several companies the domestic price of cocoa beans is now around Rs.70 to 100 per kg. of dry beans depending upon the area of production, quality and quantity. This has evinced an encouraging incentive to the farmers. Considering the international price of Rs.45 to 60 per kg. the domestic price is more than the international price.

Development strategies for 10th Five year plan.

The programmes implemented during 8th and 9th plan and coupled with prevailing remunerative price for cocoa have created enthusiasm among the farming community for adoption of High yielding varieties and better management practices. The global production and consumption of cocoa have been estimated approximately 31 laks MT. Indian Cocoa, due to its high quality, has a vast potential for export. Therefore there is a need to concentrate to bring the new area expansion in the irrigated arecanut and coconut gardens whereas potentiality will be around 3 lakh ha. Even though Cocoa development, especially new planting and replanting, has comes under the purview of State Govt. departments, the development of the crop in all aspect need to be given high priority by state Governments and Directorate of Cashewnut and Cocoa Development. The success of Cocoa development programmes depends on effective communication in order to disseminate latest productive technologies by the State Govt

departments, DCCD and Cocoa Industry. Hence a sustained integrated approach of implementing the Cocoa promotional programmes are addressed in the Plan period.

Conclusion

In view of the potentiality available in the country and the economic liberalization policies of Govt of India and rapid rate of consumption in India Cocoa has a great potential to develop in future years. By way of redefining the technologies and making use of available resources and effective Transfer of Technology measures, the potential areas if converted to better opportunities in the most prevailing tempting trend of prices, the promotion of cocoa in India can be successfully achieved to improve the economic condition of farmers, to meet the needs of the industry and above all to catch a well placed situation for India in the global cocoa production scenario.

Session – IV: Marketing

Chairman: Sri. L. N. Kudoor

Rapporteur: Dr. C. T. Jose

PRICE ANALYSIS AND MARKETING ASPECTS OF ARECANUT

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Introduction

India is the largest producer of the arecanut in the world with an area of 0.313 million hectares, producing 0.379 million tonnes of arecanut (CMIE, 2002). Arecanut prices, which showed a steady increase in almost all markets of India from 1948-49, had an unprecedented fall in 1972-73. However with improvement in the marketing system, the prices showed continuous increase since 1974 till 1985-86. From 1986 onwards the price fluctuations were very much prevalent and the year 1999-00 experienced a drastic fall in areca prices (Rethinam and Sivaraman, 2001). Arecanut marketing is a complicated system where large number of intermediaries are involved. In India arecanut is used only for masticatory purpose and outside India it has almost no demand. Even within India the habit of chewing is slowly declining (Das, 1985). The price variations have become almost a regular feature in the market, which widely affect the poor growers who entirely depend upon the areca income for their livelihood.

Price Analysis

From 1956-57 to 1970-71 the arecanut domestic prices exhibited a stable and steady trend with no fluctuation. In 1972-73 the prices registered a marked fall owing to various reasons like surplus production, market speculation and fall in consumption (Velappan and Paulose, 1974). Central Arecanut and Cocoa Marketing and Processing Co-operative Ltd (CAMPCO) which came into existence in 1973, succeeded in reviving the market within a short period. From 1987-88 onwards the processed arecanut products like 'pan masala' and 'ghutka' captured a good market share and the demand and prices of arecanut improved further. Thus the remunerative prices and demand for the product induced further area expansion even to the non-traditional areas. The scope and demand for the processed areca products attracted a number of traders into arecanut marketing. Despite the wide spread consumption of the produce all over India, the production was localized in few states which left the field open for market speculators and middle men. This coupled with lack of proper market information and the absence of an organized marketing network caused the arecanut price fall in 1999-2000.

The estimated acreage response function, $LnA_t=3.48+0.243LnP_{t(4)}$ revealed that weighed average of lagged arecanut prices had significant impact on area allocation with supply elasticity 0.243. Analysis of trend component in annual series of prices involves ascertaining the general direction of the price movements over years. Cyclical and irregular components were isolated from annual series of arecanut prices using least square method. There were ups and downs in the cyclical component but it cannot be described as regular oscillation. From 1957 to 1987 the irregular component is totally absent in arecanut price data. Later years the irregular component was very much prevalent. These irregularities in arecanut prices can be very well related with the commercialization of areca produce and market imperfections.

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Marketing Aspects

A. Disposal pattern

The study in Dakshina Karnataka showed that 80 percent of the farmers, who dispose the produce immediately after harvest, were small cultivators. Remaining 20 per cent who disposed the produce when the prices in the market are favorable, were large farmers. It was observed that indebtedness and lack of proper infrastructure facilities for storage compel the small farmer to dispose the produce at the earliest. The majority of the farmers (63%) sold *chali supari* to traders, who reportedly paid two rupees extra of the market rate per kg of *chali* sold.

B. Marketing channels

Marketing channels are various agencies/intermediaries involved in movement of arecanut from producer to consumer. Four different marketing channels were observed in the study,

1. Producer - co-operative society - sales representative- trader (consuming center) - retailer - panwalah – consumer.
2. Producer - trader - broker - trader (consuming center) - retailer -panwalah – consumer.
3. Producer - commission agent - trader - broker - trader (consuming center) - retailer - panwalah –consumer.
4. Producer- co-operative society - co-operative society's sales depot (consuming center) - retailer - panwalah – consumer.

It is interesting to observe that once the produce reaches the consuming center the market functionaries are common for all the channels.

C. Marketing efficiency in the channels

Regarding the consumer's share in the final price, channel-4 was the most efficient; it could provide the farmer with 68.1 per cent of the final price. Regarding the marketing cost, channel-2 was found to be most efficient. With respect to marketing margin, channel-4 was observed to be the most efficient; only 9.57 per cent of the final price was spent on this. Rate of return was also lowest for channel-4. Channel-4 was found to be most efficient with lowest composite index. It is obvious that if we can avoid the intermediaries the marketing can be more effective and efficient. But unfortunately the basic structure of the arecanut trade is such that the market intermediaries are inevitable.

Summing Up

Arecanut area expansion was the need of the time during 1950's but area expansion continued even after attaining self-sufficiency in the crop. The compound growth rate of arecanut acreage during last 15 years showed still the area is expanding. Declining growth rates of arecanut production and productivity indicates area expansion has taken place in non-traditional areas. The supply response analysis revealed the arecanut area response to the prices is significant. In the WTO regime arecanut has already moved to the OGL (open general license) list from the restricted list. The market is highly sensitive and the ban campaign on arecanut-processed product is strong. Thus the arecanut market is becoming highly unpredictable.

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MARKETING OF ARECANUT – NEED FOR A PLANNED STRATEGY

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Arecanut or Betel nut, described as Tamboola in Vedic literature, has several medicinal properties. It is cultivated on a large scale in India. The other producers include China, Indonesia, Mynamar, Thailand, Malaysia, Bangladesh and Srilanka. According to FAO estimation, the total area under this crop in the world is 5,59,846 hectares and the production is 6,68,680 tonnes. Of this India's share in production is around 50 percent and that of China around 25 percent followed by Mynamar, Bangladesh and Indonesia respectively[1].

Marketing of Arecanut

The chali and the red are the two main varieties of arecanut consumed by the people mostly as a habit. Chali or the white supari is used mainly in the pan or beedas and the red variety is used both in the preparation of pan and value added products like pan masala, ghutka, sweet supari etc.,

From production to consumption level both private traders and the co-operatives play an important role in India. Here, the share of the cooperative is around 15 per cent and remaining is under the control of the private traders. Among the cooperatives The CAMPCO, a nodal agency has its own purchasing and sales centres throughout the country.

Price Behaviour

The price of arecanut varies from market to market according the variety offered for sale and time of sale. The wholesale price of chali during the 1950's was Rs. 2,600 per tonne, which went upto Rs. 6,600 per tonne in 1970. However, it went down from 1971 onwards and reached to Rs. 4,500 per tonne in 1973.

The CAMPCO was started in 1973 to stabilise the price. Since then the price of arecanut started picking up and reached the peak of Rs. 160,000 per tonne by 1999-2000. However, from then onwards it declined sharply and at percent it ranges in between Rs. 50,000 to Rs. 62,000 per tonne.

Reasons for the fluctuations

Several reasons were pointed out by the traders as well as cooperatives for this ups and downs such as surplus production, declining pattern of consumption, impact of W.T.O. and frequent change in the policy of government on ghutka. However, as per the Market Survey conducted by the AIAGA in Jan. 2001[2], this fluctuation is mainly because of trade manipulations.

It is observed that, since 1970, the fluctuations were there because of the prevalence of the Speculative Traders in the market and non-availability of correct information on supply pattern, demand conditions and about policy implications for both the producers and traders.

Suggestions to Improve the market

As arecanut is consumed by the people as a habit and the volume of its consumption has been increasing over these years, there is every scope to expect a bright future for this. However, so as to encash this there is the need for a planned strategy in this sector. In this regard the following suggestions will be useful.

These are:

- Need to strengthen the Cooperative Marketing Institutions.
- Coordination among the Areca Marketing Cooperatives in the need of hour.
- The cooperative agencies should train the farmers on aspects like grading.
- The farmers should have a strong organisation of their own and there should not be the involvement of political parties.
- There is an urgent need to establish a Research and Development centre on various aspects of areca, especially on marketing aspects.
- The cooperative should spent at least 10 percent of their turnover for market oriented studies.
- Immediate steps are needed for value addition of arecanut.
- There is the need to identify the alternative markets both domestically and externally. Future value addition should be on the basis of taste and preference, age-wise, sex-wise etc.,
- Need to popularise the medicinal values of arecanut through the medias.
- The Government should fix the minimum and maximum price on arecanut yearly and once in a year that too during the time of harvest it has to enter into the market under MIS.
- The Government can make arrangements for coordination among the production and consumption centres cooperatives to overcome the middlemen in marketing.

As arecanut is the main crop in Karnataka and Kerala and several lakhs of farmers, labourers and people are depending upon this for their livelihood over centuries, there is an urgent need to work out a planned strategy. This strategy should be a market oriented one and has to be implemented properly. As the planners and policy makers have been giving importance for production oriented technology over these years, now they have to look towards market oriented activities. Otherwise the whole areca sector may vanish within a short period. So it is the right time to prepare and adopt a planned market strategy for the welfare of this sector.

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