# Annual Report of the Central and Regional Arecanut Research Stations

**Ist July, 1965 to 31st December, 1966**

ICAR

**Central Arecanut Research Station, Vittal,**

**Mysore State, India**

**1969**

# CONTENTS

# DIRECTOR'S INTRODUCTION

## A brief historical introduction

The Central Arecanut Research Station, Vittal was started by the erstwhile Indian Central Arecanut Committee in April, 1956. It is located in Vittal Village, Bantwal Taluk of South Kanara Disirict of Mysore State, 45.0 km from Mangalore Railway station on the Mangalore-Vittal-Puttur highway. It lies on 12.25° north latitude and 75.42° east longitude. The altitude of the Station Is about 200 m above mean sea level. The rivulet Vokkethur is the main source of irrigation. The soil at the Station is typically lateritic and is admixed with a mean pH of 5.25. The total area of the Station is 48.37 ha.

Besides the Central Station there are five Regional Research Stations located at Kahikuchi, Mohitnagar, Hirehalli, Peechi and Palode.

The Station at Kahikuchi is located near Gauhati Airport at a distance of 22 km from Gauhati Railway Station in Assam. The altitude of the Station is 48 m above mean sea level, the latitude and longitude being 20.18° north and 91.78° east respectively. The soil is new alluvium with lower strata of laterite and has a pH of 4.4 to 4.8. The total area of the Station is 12.14 ha.

The Station at Mohitnagar is located near the Mohitnagar Farm of West Bengal Government at a distance of 9.66 km northwest of Jalpaiguri Railway Station on the Jalpaiguri-Silguri road. It lies on 26.52° north latitude and 88.72° east longitude. The soil is acidic and has a pH range of 4.5 to 6.0. The total area of the Station is 10.11 ha.

The Station at Hirehalli is located near Hirehalli Railway Station, Tumkur District (Mysore State), on the Bangalore-Poona National Highway, 58 km from Bangalore. It lies on 13.08° north latitude and 77.12° east longitude. It is about 854 m above mean sea level. The soil of the Station is clayey to clayey loam with a mean pH of 6.2. The total area of the Station is 16.24 ha.

The Regional Station, Peechi is at Kannara of Trichur District in Kerala State and is situated about 19.3 km east of Trichur Railway Station. It is located at 10.50° north latitude and 76.17° east longitude. The altitude of the Station ranged from 49 to 55 m above mean sea level. The upper layers of the soil are mainly of the alluvial type with good admixture of sand silt and the lower layers are lateritic. The pH of the soil ranges from 5.6 to 6.8. The total extent of the Station is 14.16 ha.

The Regional Station, Palode is located in Palode Village of Nedumangad Taluk of Trivandrum District of Kerala State and is 36 km from Trivandrum City. It lies at 77.03° east longitude and 8.07° north latitude. The altitude of the Station ranges from 210 to 240 m above mean sea level. The soil is mainly lateritic with a pH ranging from 4.2 to 5 0. The total area of the Station is 11.77 ha.

The Central and Regional Stations were under the control of the Indian Central Arecanut Committee and on the abolition of the Committee the Stations were taken over by the Indian Council of Agricultural Research since April, 1966.

## Objectives

The Central Station is charged with the functions of (i) conducting fundamental and applied research on Botany, Agronomy, Chemistry, Physiology and Pests and Diseases aspects of the arecanut crop, (ii) guiding and co-ordinating the research work carried out at the different Regional Arecanut Research Stations in the country, (iii) solving the regional problems confronting the arecanut crop and (iv) serving as a centre of information on all matters relating to the arecanut crop. The Regional Stations at Kahikuchi, Mohitnagar, Hirehalli and Peechi are to deal with the various agronomic and pests and diseases problems relating to the arecanut crop peculiar to the respective regions as well as serve as testing centres of the reseach findings of Central Station for adoption in the region. The Stations are also to supply quality planting material to the growers. The Research Station at Palode was started mainly to tackle the Yellow leaf disease of arecanut palm which is a serious problem of the tract and also to handle some of the important agronomic problems of the region.

## Organisational structure and changes

Research at the Central Station is being carried out in seven sections viz. Botany, Agronomy, Statistics, Chemistry, Physiology, Pathology, and Entomology. The work of each section is under the immediate charge of the concerned section head, who is assisted by the Research Assistants. The Regional Stations are under the immediate charge of the respective Research Officers who are assisted by Research Assistants. The administration of the Central and Regional Stations is being carried out with the help of a separate Administrative section. The overall control of Central and Regional Stations is with the Arecanut Specialist who is the head of the Central Station.

The Central Station has a library having access to the research workers of Regional Stations also. The Regional Stations also have each a small library for immediate reference.

## Distinguished visitors

The Central and Regional Stations were visited by large number of visitors who consisted of officials of State Departments of Agriculture, Scientists, Parlamentarians, Students from Agricultural and other Colleges and also individual farmers and farmers' organisation in the conntry. The important visitors to the Central Station during the period under report included Shri G. V. B. Naidu, Deputy Director of Agriculture, Mangalore; Prof. T. A. Davis, Crop Science Unit, Indian Statistical Institute, Calcutta; Shri A. R. Ramaswami, M. L. A., Madras; Shri K. P. A. Menon, Secretary, Indian Council of Agricultural Research, New Delhi; Dr. A. Ramadasan, Plant Physiologist, Central Coconut Research Station, Kayamkulam; Shri H. M. Chenna Basappa, Chairman, Study Team on Agricultural Administration, Government of India; Dr. K. C. Naik, Vice Chancellor, University of Agricultural Sciences, Bangalore; Mr. G. A. R. Wood, Cadbury Brothers Ltd, Bournville, England; Mr. G. Finlayson, Dunkeld Estate, Coorg; Shri K R. Ganapathy and Shri S. H Patil, Lecturers, Agricultural College, Hebbal; Shri S N. P. Rebello, Professor of Agricultural Economics, Dharwar; Prof. B. Chandrashekar, University of Agricultural Science, Bangalore; Dr. Swaminathan, Dr. Raychaudhuri and Dr. Pradhan, Head of the Divisions of Botany, Pathology and Entomology respectively of the Indian Agricultural Research Institute, New Delhi; Shri C. M. John, Retired Director of Central Coconut Research Station, Kasaragod; Dr. Kanwar, Director of Research, Punjab Agricultural University, Ludhiana and Shri G. Narayana Gowda, Minister for Agriculture, Mysore State, Bangalore.

## Important events of the year

The Central and Regional Research Stations came under the direct administrative and technical control of the Indian Council of Agricultural Research. The Central Station was recognised as a Centre for carrying out post-graduate research work by the Poona University. An achievement audit committee headed by Dr. Swaminathan, visited the Central Station in June, 1966. The Committee reviewed the work that is being carried out at the Station and suggested future lines of work and development. The technical programme of the Central and Regional Stations was revised so as to make the same totally problem oriented.

## Research collaboration at national level

Training was arranged for two Research Assistants in nematology at the Agricultural College and Research Institute, Coimbatore and for one Research Assistant in Soil Chemistry at the Indian Agricultural Research Institute, New Delhi. The Research Officer, Palode also

attended a course in plant virology at Indian Agricultural Research Institute, New Delhi. The facilities available at the Central Coconut Research Station, Kayamkulam were availed of in the investigations on the Yellow leaf disease of arecanut. The Electron microscope facility available at the Indian Agricultural Research Institute was made use of for examining plant samples affected with Yellow leaf disease. Seed arecanuts were irradiated at the Gamma cell at Indian Agricultural Research Institute. Institute of Agricural Research Statistics was consulted in laying out certain mainfield experiments.

**Research collaboration at international level**

Work on the biological control of mites (a major pest of arecanut) was initiated in collaboration with the Commonwealth Biological Research Institute, Bangalore.

**Fellowships, studentships**

Two of the staff members took their post-graduate degrees in Horticulture and Agricultural Botany. One Research Assistant joined for post-graduate course in Agricultural Botany.

**Research associations**

The Research Council of the Central Station scrutinised the technical programme of the different Stations and reviewed the progress achieved from time to time. The Station has also a Study Circle which meets once in two months. Research papers and review articles are presented and discussed in these meetings. During the period there were six meetings of the Study Circle.

**Advisory service received and provided**

The Central Station gave suggestions in drawing up of the technical programme of the Mysore State Regional Arecanut Research Station, Thirthahalli. The Arecanut Specialist was a member of the Development Council for Arecanut and Spices, Calicut and Arecanut Sub-Committee of the Indian Standards Institution, New Delhi. He attended the meetings and gave suitable advice on various technical matters. The Agronomist was member of the Sub-Committee to review the report on Pilot Sample Survey for correct estimation of area and production of arecanut.

The Station consulted Dr. M. S. Swaminathan and Dr. B. R. Murthy of Indian Agricultural Research Institute, Dr. Jowett of the Iowa State University and Shri T. P. Abraham and Shri V. N. Amble of Institute of Agricultural Research Statistics in connection with the Biometrical studies in progress at the Station. The valuable suggestions received from Dr. B. Weischer and Dr. F. O. Holmes, who were in India on F. A. O.

assignment and from Dr. Raychaudry, Head of the Division of Pathology, Indian Agricultural Research Institute, were availed of in the investigations on the Yellow leaf disease of arecanut.

In addition to normal activities of research, numerous enquiries that were being received by the Central and Regional Stations seeking for advice on various problems connected with the crop such as cultivation practices, spacing and layouts to be adopted, fertilizers and manures to be applied, examination of plant parts affected by various diseases and pests and proper methods of their control, methods of preparation of nuts for the market etc. were suitably answered. Requests for spot inspection, selection of site and layout of gardens received were also attended to wherever feasible. The Central and Regional Stations were also centres of study tour.

Extension

The Central and Regional Stations participated in the extension programmes like Grama Sahayak training camps, compost weeks, Agricultural and Industrial Exhibitions etc. organised by the different State Governments and other organisations. Farmers' week was celebrated in which the extension staff of the State Departments and large number of growers participated. The Stations also continued to raise quality arecanut seedlings and supplied a total of 2 62 476 seedlings and sprouts to the growers during the period.

Finance

The sanctioned annual budget of the Research Station for the financial year 1966-67 was Rs. 7.54 lakhs including a provision of one lakh of rupees for two research schemes on arecanut. The expenditure on the major heads was of the following order.

| | | |
|---|---|---|
| 1. | Pay and allowances of the staff | Rs. 2,46,200 |
| 2. | Working expenses. | Rs. 2,91,600 |
| 3. | Schemes on arecanut | Rs. 88,200 |
| | **Total:** | **Rs. 6,26,000** |

The revenue receipts of the Station touched a figure of Rs. 97.500 against the target of Rs. 75,000 fixed for the year.

# PROGRESS OF RESEARCH

## BOTANY

(In-charge - K. V. Ahamed Bavappa)

### SUMMARY OF SALIENT FINDINGS

The exotic introductions of *Areca catechu* were assessed for their productive potential and the types from China, Saigon, Ceylon and Singapore were found to be promising as compared with the local. Market evaluation of the cured produce of the different types also showed that the rates fetched by most of the exotics compared favourably with the local. Fruits of *A. triandra* were subjected to chewing test and found suitable for the purpose. This species which has not so far been reported to be useful for chewing was also found to produce more than three times the number of female flowers and double the fruit-set as compared to *A. catechu*. Four indigenous types were added to the existing collections. Results of earlier observations on the range of variation in flowering were confirmed. The maximum production of inflorescences during the months of January to March was found to be influenced both by variability in the rate of leaf-fall as well as varibility in the percentage of inflorescences to leaves shed. Floral biology studies revealed that (i) in 90 per cent of the inflorescences the duration of the male phase ranged from 15 to 35 days, (ii) in 87 per cent of the inflorescences the duration of the female phase ranged from 2 to 15 days, (iii) in a tree there is overlapping of male and female phases in 13 per cent of the inflorescences and (iv) in 4 per cent of the inflorescences there is overlapping of male and femals phases within the same spadix. Age at bearing has high heritability and significant negative correlation with yield. It was further observed that palms which came to bearing in the fifth year after transplanting constituted 62 per cent of the population and had a mean yield of 55 nuts more than those which come to bearing in the sixth year. Boric acid at 100 ppm and Gibberellic acid at 500 ppm in a medium consisting of 0.5 per cent sucrose and 0.5 per cent agar gave increased pollen germination and pollen tube growth. A crossing programme for the production of inbred lines, study of inheritance of specific qualitative characters like sweet and red kernel, and combining characters such as semidwarfness, with number of inflorescences, high set and better quality was also initiated. A study of the yield data of all the progenies of the 41 mother palms showed that progeny performance did not have any bearing with the yielding behaviour of their mother palms. It was also observed that some of the mother palms had a high transmitting ability for yield. Such mother palms were found to be distributed in all gardens more or less uniformly. It was also observed that co-efficient of variation is highest in the case of low

yielding families. A trial to compare the effect of mother palm and seednut selection showed that the superiority of selection is not reflected in the seedling vigour. A mass-pedigree system involving screening of families and individuals within a family based on a fixed norm and also superimposing selection for characters of high heritability and correlation with yield was evolved for improving yield. Anatomical studies revealed that the cuticle of *A. triandra* was thicker than that in *A catechu* which factor may be responsible for the higher resistance of mite infection noticed in the former species. The course of meiosis studied in one of type *A. triandra* was normal. The chromosome number was found to be 2n = 32.

(a) RESEARCHES COMPLETED

1. BREEDING AND GENETICS OF ARECA

3. Floral biology of areca

a, b) *Study of range of variation in flowering:* Observations on the month-wise variation in flowering were made on the 3000 palms of 41 families in the main garden of the Central Station. It was observed that the percentage of inflorescences produced to leaves shed was maximum during the months of January, February and March. Maximum percentage of the total production of inflorescences was found to be during the months of February to April. These results are in conformity with those obtained in the previous years.

In order to examine the range of variation in leaf-fall and its bearing on the variability in the inflorescences production, the data were tabulated. The same are given below.

TABLE 1

**Month-wise variation in leaf fall and inflorescence production**

| Month | 1964-65 | | 1965-66 | |
|---|---|---|---|---|
| | Leaf-fall (Mean per tree) | Spadices | Leaf-fall (Mean per tree) | Spadices |
| July | 0.44 | 0.35 | 0.58 | 0.19 |
| August | 3.46 | 0.13 | 0.65 | 0.14 |
| September | 0.45 | 0.16 | 0.51 | 0.14 |
| October | 0.49 | 0.22 | 0.54 | 0.21 |
| November | 0.46 | 0.27 | 0.63 | 0.35 |
| December | 0.66 | 0.49 | 0.58 | 0.49 |
| January | 0.38 | 0 34 | 0.68 | 0,62 |
| February | 0.57 | 0.53 | 0.77 | 0.74 |
| March | 0.65 | 0.62 | 0.86 | 0.82 |
| April | 0.87 | 0.82 | 0.96 | 0.89 |
| May | 1.06 | 0.90 | 0,60 | 0.41 |
| June | 0.49 | 0.32 | 0.38 | 0.24 |

It will be seen from the above table that the rate of leaf-fall is high during the months of January to May. The production of inflorescences is, therefore, influenced both by the variability in the rate of leaf-fall as well as the variability in the percentage of inflorescences to leaves shed.

Floral biology studies relating to the frequency distribution of the duration of male phase, female phase, interval between the closing of male phase and beginning of famale phase and overlapping of male and famale phases of different inflorescences of the same tree were made in respect of 420 inflorescences in 200 plams. The data gathered are given in table 2. It will be seen from the table that (i) in 90 per cent of the inflorescences the duration of the male phase ranges from 15 to 35 days. (ii) in 87 per cent of the inflorescences, the duration of the famale phase ranges from 2 to 5 days, (iii) in a tree there is inter-spadix overlapping of male and female phases in 13 per cent of the inflorescences and (iv) in 4 per cent of the inflorescences there is overlapping of male and famale phases within the same spadix.

Floral biology studies made at the Regional Station, Peechi, revealed that the number of spadices produced per palm ranged from 0 to 10, mean being 4.7. It was also observed that though the production of inflorescences was seen in all the months, the maximum production was between December and April. The maximum percentage of set of flowers was also during December to April.

c) *Studies on early bearing habit and its correlation with fruit production.* Studies taken up in the Statistical Section had shown that age at bearing had a high heritability and significant negative correlation with yield. The yield pattern of palms of different bearing ages was examined. The results are given in the figure 1.

From the figure it is seen that palms which come to bearing early are consistently better yielders. It will also be observed that palms which come to bearing in the fifth year after planting constitute 62 per cent of the population, the mean yield of this group being 55 nuts more than those which come to bearing in the sixth year.

e) *Study of pollen:* Studies on pollen germination and tube growth were made using the medium consisting of 0.5 per cent sucrose and 0.5 per cent agar to which different hormones of various concentrations were added. It was observed that Boric acid at 100 ppm and Giberellic acid at 500 ppm in the above medium give increased germination and pollen tube growth.

5. Preliminary studies on progeny behavior of mother palms.

Observations on 300 palms of ten familes were continued. The data on productive characters, yield and fruit characters were recorded. It was observed that there is considerable variation between progenies of the

TABLE 2

**Male and female phases in arecanut**

| Male phase | | Female phase | | Overlapping of male and female phases | | |
|---|---|---|---|---|---|---|
| Class interval (days) | Percentage frequency | Duration (days) | Percentage frequency | Duration of overlapping (days) | Percentage of frequency | |
| | | | | | Between bunches of same tree | Within the same bunch |
| 5- 9 | 1.19 | 0 | 0.24 | No overlapping | 85.95 | 94.52 |
| 10-14 | 3.10 | 1 | 5.00 | 1 | 2.86 | 2.86 |
| 15-19 | 13.57 | 2 | 19.52 | 2 | 1.67 | 0.71 |
| 20-24 | 30.48 | 3 | 30.48 | 3 | 1.90 | 0.95 |
| 25-29 | 31.66 | 4 | 26.42 | 4 | 2.86 | 0.00 |
| 30-34 | 15.00 | 5 | 10.95 | 5 | 3.33 | 0.00 |
| 35-54 | 5.00 | 6 | 3.09 | 6 | 0.48 | 0.00 |
| | | 7 | 1.19 | 7 | 0.24 | 0.48 |
| | | 8 | 1.67 | 8 | 0.71 | 0.48 |
| | | 9-12 | 1.44 | | | |

different mother palms. The yield data gathered earlier, in respect of progenies of all the 41 mother palms were, therefore, examined with a view to study their distribution in various gardens. The data relating to their frequency distribution in different plantations based on their progeny performance are given below.

TABLE 3

**Plantation-wise distribution of mother palms based on progeny yield**

| Range in mean yield of progeny (g) | 1963-64 | | | | 1964-65 | | | |
|---|---|---|---|---|---|---|---|---|
| | KMJ | SDK | SRJ | KKF | KMJ | SDK | SRJ | KKF |
| 2000- 3000 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| 3000- 4000 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 4000- 5000 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 2 |
| 5000- 6000 | 2 | 4 | 1 | 4 | 2 | 2 | 3 | 4 |
| 6000- 7000 | 1 | 1 | 2 | 3 | 2 | 5 | 1 | 3 |
| 7000- 8000 | 1 | 3 | 1 | 1 | 2 | 1 | 2 | 1 |
| 8000- 9000 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 9000 10000 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **Total:** | **10** | **11** | **8** | **12** | **10** | **11** | **8** | **12** |

KMJ = Kammaje
SDK = Saradka
SRJ = Sheraje
KKF = Kallakatta

It will be seen from the above that mother palms having high progeny performance are distributed in all gardens more or less uniformly. Selection of mother palms, giving stress to the gardens in which they are located, therefore, seems to be not advantageous.

The regular yielding habit of mother palms in relation to mean progeny performance was also examined for 22 palms for which nut count data were available. The yielding behaviour of the mother palms and their mean progeny performance are given in table 4. It will be seen that progeny performance does not have any bearing with the regularity in the yielding behavaiour of their mother palms.

TABLE 4

**Yielding behaviour relationship of progenies and mother palms**

| Range in mean yield of progeny (No. of nuts) | Yielding behaviour of mother palms | |
|---|---|---|
| | Regular yielders. | Irregular yielders |
| > 100 | 2 | 0 |
| 100-125 | 0 | 2 |
| 125-150 | 3 | 1 |
| 150-175 | 1 | 1 |
| 175-200 | 3 | 2 |
| 200-225 | 2 | 2 |
| 225-250 | 0 | 2 |
| 250-275 | 1 | 0 |
| | 12 | 10 |

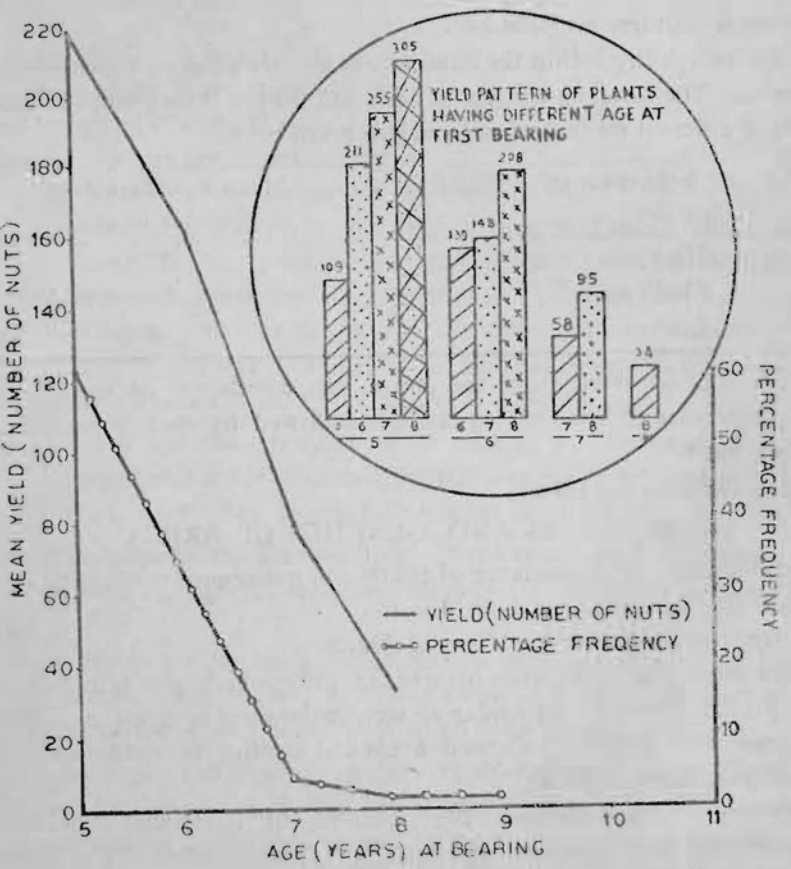



FIG. 1. RELATIONSHIP BETWEEN AGE AT BEARING AND YIELD.

Even though the mean yield of progenies is an index of general comparison, from the point of view of the efficiency of plantation, mean yield may not give a true picture of the population involved. For example progenies from two mother palms having the same mean yield can have highly varying proportions of low or high yielders. A study of the variability of the yield within the progenies so as to throw sufficient light on this aspect was, therefore, taken up. Besides, this approach can also make the selection of mother palms based on prepotency more objective instead of arbitrary classification based on mean alone Mother palms whose families having high, medium and low progeny yields were selected and the percentage frequency of yields of progenies of each of the family plotted. It was observed that the curve for low yield group is L shaped indicating that large proportion of progenies are low yielders, while the curve for medium yield shows a more or less uniform distribution The curve for high yield which should have at least approached a J shape indicating the concentration of high yielding progenies also shows a uniform distribution.

The variability within the families was also tested using the co-efficient of variation. The mean co-efficient of variation for the three groups of families having different mean progeny yields is given below.

| Yielding behaviour of families | Mean co-efficient of variation |
|---|---|
| High | 77 |
| Medium | 86 |
| Low | 108 |

It will be observed from the above that co-efficient of variation is highest in the case of low yielding families followed by medium and high yielding groups.

(b) RESEARCHES IN HAND

1. BREEDING AND GENETICS OF ARECA

1. Introduction and maintenance of exotic and indigenous species and types of *Areca* for selection and hybridisation.

*Exotic types collection at the Central Station:*

*1957 planting:* The four palms planted in 1957 which are introductions from Indonesia, Nicobar and Andaman were maintained in good condition. The former two, however, showed a general decline in yield while the latter showed improvement

*1961 planting:* This collection plot consists of 16 species and types introduced from eight foreign countries viz. Saigon, Indonesia, Fiji, China, Ceylon, Mauritius, Singapore and British Solomon Islands. The comparison

is being done on a randomised block design with single tree plots. Yield characters were recorded for every individual palm for assessing the productive potential of the various introductions as compared with the local. The palms have not yet stabilised for their yield and hence definite conclusions are not drawn at this stage. However, introductions from China, Saigon, British Solomon Islands, Ceylon and Singapore seem to be promising Market evaluation of the cured produce of different types showed that rates fetched by most of the exotics compare favourably with that of the local. *Chali* prepared from the ripe fruits of *A. triandra* were subjected to chewing test. It was found that the nut has a very pleasant aroma similar to that of date fruit, less astringency and deep red colour. This species which throws out 3 to 14 offsets from the base bears on an average 3465 female flowers per palm as against 1015 in *A. catechu*. The fruit-set has also been found to be as high as 57 per cent. Information gathered on turn-over of *Chali* etc. of the two species is given below:

| | *A. catechu* | *A. triandra* |
|---|---|---|
| Mean weight of ripe fruit (gm) | 31.9 | 3.4 |
| Percentage of dry kernel over wet weight | 23.5 | 27.0 |
| Mean weight of dry kernel (gm) | 10.0 | 1.0 |
| Specific gravity of dry kernel | 1.11 | 1.25 |
| No of days required for sun drying the fruits | 40 | 21 |

It will be observed from the above that even though the fruits of *A. triandra* are one-tenth the weight of *A. catechu* fruits, it requires only half the number of days for drying, gives 3.5 per cent more out-turn of *Chali* and has higher specific gravity. Complete varietal description of all the types and species was in progress. Seednuts of different exotic types and species were also distributed to the Regional Stations.

*1964 planting:* All the ten types of *A. catechu* and two apecies of Areca (*A. normanbyii* and another unspecified) planted in 1964 had satisfactory growth in the field. The palms have not yet flowered.

*1964-65 introductions:* Two seedlings of the type from New Guinea (Lae) and nine seedlings of *A. langloisiana* from Nassau (Bahama Is.) were maintained in pots.

*1966 introduction:* Seednuts of *A. bacaba* from Brazil and ten types of *A. catechu*, six from Malaya and four from the Philippines were received during the period. All the seednuts failed to germinate.

*Indigenous types collection:* Thirteen types collected from Thirthahalli, Chickmagalur, Hirehalli, Peechi, Mohitnagar, Assam, South Kanara and Gujarat are being maintained in the collection plot. Four more types from Shreevardhan (Colaba District), Dapoli (Ratnagiri District), Thirthahalli

and Assam were added to the collection plot. Of these the type from Assam (Kamrup District) comes to harvest in May-June as against the others which come to harvest in November-January. Four progenies of the dwarf palm that are under study showed that three are typical dwarfs and one normal tall. The 'sweet areca' (*A. catechu* var. *deliciosa*) from Thirthahalli yielded fruits during the period Astringency of the fruits of the eight palms of the type studied showed that nuts in two are sweet, in another two the astringency is very high and in four the astringency is moderate The ripe nuts when dried gave *Chali* of different quality, those from sweet group giving inferior product due to very bad shrinking as against the normal quality obtained from the highly astringent group.

The performance of different exotic and indigenous types and species is also being tested in the different Regional Stations.

In addition to the earlier plantings taken up at the Fruit Research Station at Chethalli and Athur (915 m) a fresh batch of 126 seedlings of South Kanara variety was planted at Chethalli for studying its performance at the higher altitude.

2 Survey of arecanut gardens to select superior types and assessing genetic variation.

The survey was in progress at Peechi and Hirehalli Regional Stations

3 Floral biology of areca

d) *Floral initiation:* The dates of shedding of leaves from premarked palms were recorded regularly so as to find out the time interval between the emergence of spindle and its fall for correlating the same with initiation and growth of inflorescence.

4 Hybridisation and selection

a) *Production of inbred lines of distinct types:* With a view to produce inbred lines selfing of flowers of mother palms whose progenies are under study had been taken up. A total number of 2855 flowers had been selfed on 12 mother palms standing in different private gardens. The percentage of flower set recorded was 11.5. Nineteen sprouts raised from such selfed nuts of previous year were transplanted to the secondary nursery

With a view to maintain the purity of introduced types, selected palms of the introductions from China, Singapore, Ceylon (1), Saigon (3) and Indonesia (6) were inter-crossed. A total of 9615 flowers were thus pollinated during the year under controlled conditions. Harvesting and sowing of nuts obtained from the above was also in progress. Thirteen seedlings of the introduction from China (selfed) were planted in the field along with six seedlings (open pollinated) for comparison.

b) *Hybridisation between distinct types and selected palms to combine high yield and regular bearing and study of progenies*: Controlled crosses had been made in earlier years between selected mother palms with a view to (1) combine high yield and regular bearing habit, (2) study inheritance of specific qualitative characters like sweet kernel and red kernel, and (3) combine the large size of fruits of South Kanara types with the greater number of fruits per bunch of Thirthahalli type. Seedlings raised subsequently from the above crosses were planted in the main field in August 1966 along with seedlings from open pollinated nuts of the respective parents involved in the crosses. A total of 215 seedlings were planted.

c) *Hybridisation between exotic and indigenous types:* Hybrid seedlings numbering 26 of crosses made during 1965 between the type from China and local from the point of view of hybrid vigour were transplanted to the secondary nursery.

With a view to make the maximum use of the available genetic materials a crossing programme taking into consideration the different gene pools was in progress during 1966 using the following parents on a partial diallel basis.

| *Prepotent local palms* | | *Exotic types from different gene pools* |
|---|---|---|
| KKF — 28 | | Ceylon (1) |
| KKF — 18 | | China |
| KKF — 24 | X | Indonesia (6) |
| SDK — 16 | | Saigon (2) |
| | | Saigon (3) |

A total of 1213 flowers were cross-pollinated. Harvesting and sowing of nuts from the above crosses were in progress. Selfing of parent palms involved in the above crosses was also effected for comparison.

A crossing programme with the type from China as female parent for characters such as semi-dwarfness and number of inflorescences and *A. triandra*, Shrivardhan, local and Thirthahalli species and types as male parents for their characters such as large number of flowers and high set, quality of nut, high yield and large number of nuts respectively was also initiated.

Reciprocal crosses between *A. catechu* and *A. triandra* were continued to be made and a total of 3936 flowers were crossed. Harvesting and sowing of seednuts were in progress. The fruits obtained from the *A. catechu* X *A. triandra* cross were intermediate in size for breadth and longer than either of the two parents.

5. Preliminary studies on progeny behaviour of mother palms.

In order to study the repeatability of prepotency seedlings raised from seednuts collected from nine living mother palms out of the 41 palms whose progenies are under test were planted in the field in September, 1966, on a compact family block design with five replications. A total of 180 progenies are under study.

6. Effect of selection of seednuts on germination and future performance.

This experiment was initiated during 1963-64 with a view to find out how far selection of mother palms and seedunts influences germination and turn-over of quality seedlings in the primary and secondary nurseries as well as their performance in the main field. The experiment was laid out on a 4 x 6 randomised block design with treatments consisting of (1) unselected bulk nuts, (2) selected bulk nuts, (3) unselected nuts from mother palms and (4) selected nuts from mother palms. The seedlings in the secondary nursery were grouped into selected and rejected ones and planted in the mainfield. Planting was done in September-October, 1965 adopting a spacing of 2.4mx2.4m. The annual morphological data of the plants were recorded after one year of planting It was observed that the treatments do not differ significantly for any of the characters examined. During October, 1966, two more treatments viz. (1) selected seednuts from non-prepotent palms and (2) selected nuts from prepotent palms, were added to the trial and the required seedlings were planted contiguous with the earlier plantings.

7 Improvement by mass-pedigree system.

An examination of the yield data of about 3000 palms belonging to 41 families had shown wide variability in their yielding behaviour In view of the limitations such as large area required to raise successive generations, of the large number of crosses and the time lag involved, well established methods such as recurrent selection etc., usually adopted for similar annual crops, cannot be adopted for arecanut. The possibility of evolving an efficient alternative method of selection was, therefore, examined. The following mass-pedigree system involving screening of families and individuals within the family based on a fixed norm and also superimposing selection for characters of high heritability was evolved.

Gardens grown under average conditions were selected and palms whose yield was 60 per cent more than the garden mean selected as mother palms. Progenies numbering 2966 belonging to 41 families (mother palms) were grown under uniform conditions These families were screened using a 'bulk norm' test with a fixed norm of 30 per cent over the garden mean. Only three families satisfied the test. All the 278 progenies of these three families were further screened using a norm of 30 per cent above each family mean and 36 palms which were found to satisfy this 'single plant

norm' test were selected Each of these palms was further screened for characters having high correlation with yield and high heritability such as age at first bearing (yielding fruits in fifth year after transplanting), number of leaves (having five or more) at the time of transplanting, girth at collar (having 20 cm and above) after one year growth in the main field and number of nodes (4 nodes and above) after two years growth in the main field. A total of 20 plants out of the above,36 which passed this test were finally selected. Seednuts were collected from these palms and sown along with two controls, i.e. (1) seednuts collected from phenotypically high yielding mother palms from private gardens and (2) phenotypically high yielding palms (first generation) for growing them in adequately replicated progeny row trial. At planting as well as in the subsequent two years excepting in controls, the seedlings will be subjected to selection as per standards indicated above 'Bulk norm' test will be applied to eliminate all undesirable lines. 'Single plant norm' test will be applied to the plants in the selected lines and nuts gathered from those plants which pass the test directly distributed.

## II. ANATOMICAL STUDIES

(3) Study of anatomy of leaf of different species and types

Anatomical study of leaf and pericarp (fruit husk) was undertaken in *A. catechu* and *A triandra*. The studies revealed that the cuticle was thicker in the case of *A. triandra* The species is also relatively less susceptible to the attack of mites than *A. catechu*.

## III. CYTOLOGICAL STUDIES

(1) Study of meiosis in different species and types

Cytological investigations were taken up in *A. triandra*. The type introduced from Indonesia was analysed It was observed that the course of meiosis was normal and that the chromosome number is 2n = 32.

## IV. PHYSIOLOGICAL STUDIES

(1) Studies on fruit settingand shedding

To find out the economic feasibility of assisted pollination, a large scale trial was in progress. Pollen suspension was sprayed by using an atomiser on a total of 88 trees laid out on a randomised block design with equal number of palms as control. The treatments were not significant.

(2) Inducing mutations in arecanut

With a view to increase genetic variability in the existing material so as to isolate mutants with desirable characters like dwarfness, less astringency, resistance to disease etc., the following treatments with mutagenic agents were initiated in 1960-61.

a) *By irradiation of seednuts with Thermal and Pile neutrons:* Seedlings obtained from seednuts irradiated with Thermal neutrons were planted in the main field in June 1963. The palms are under observation.

b) *By irradiation with Gamma rays:* During 1965-66, 200 seednuts were irradiated at the Gamma Cell of the Indian Agricultural Research Institute at intensities of 5000 r. and 10,000 r. The nuts recorded 87.0 and 86.3 per cent germination respectively. The seedlings have been planted in the field at the Central station, as well as at the Regional Station, Palode.

c) *By chemical - colchicine:* Seedlings obtained from sprouts treated with colchicine and planted in the field were under observation.

(3) Effect of plant regulators on growth

A large scale spraying trial using hormones such as gibberellic acid, boric acid etc. alone and in combinations were programmed to be taken based up on the results obtained in the previous years.

(c) RESEARCHES CONTEMPLATED

Experiments to test the efficacy of mass-pedigree selection programme and study of the cytology and anatomy of different types, species and hybrids invoiving different altitudes of their cultivation have been programmed.

**Programme of work for 1967**

| Number and name of the project. | | Venue of work |
|---|---|---|
| B.1 | Introduction and maintenance of indigenous and exotic species and types of Areca for selection and hybridisation. | Vittal, Peechi Hirehalli, Mohitnagar, Kahikuchi and Palode. |
| B.2 | Survey of arecanut gardens to assess the genetic variation and selection of common cultivars. | Vittal, Peechi, Hirehalli, Mohitnagar, Palode and Kahikuchi |
| B.3 | Studies on the performance of progenies of known mother palms and the mother palm progeny relationship. | Peechi and Hirehalli |
| B.4 | Production of inbred lines of distinct types | Vittal |
| B.5 | Hybridisation between exotic and indigenous types and species | Vittal |
| B.6 | Efficiency of phenotypic selection of mother palms, seednuts and seedlings | Vittal and Peechi |
| B.7 | Improvement by mass-pedigree selection | Vittal, Mohitnagar and Peechi |
| B.8 | Floral initiation | Vittal |
| B.9 | Structure and development of fruits in arecanut under high and low altitudes | Vittal and Kahikuchi |

| | |
|---|---|
| B 10 Cytological and anatomical studies of types, species and hybrids of arecanut | Vittal |
| B.11. Studies on fruit setting and shedding | Vittal, Mohitnagar, Peechi, Hirehalli, Kahikuchi, & Palode. |
| B.12 Inducing mutation in arecanut by (i) irradiation of seednuts (Thermal and pile neutrons, X-ray and Gamma rays), (ii) Chemicals and (iii) use of irradiated pollen | Vittal. |

## AGRONOMY

(K. Shama Bhat, K. P. Padmanabhan Nambiar, S. C. Paul and K. Narasimha Murthy)

### SUMMARY OF SALIENT FINDINGS

Partial shade was found to be necessary for arecanut nurseries for preventing sunscorch. This also increased the out-turn of plantable seedlings. In the transplanting experiment it was observed that plants which were set in the main field earlier are more vigorous and precocious than those which had been retained in the nursery for longer duration and then transplanted. Spacing given to the palms in the main field was found to have influence on sunscorch of stems, inflorescence production, flower-set and yield. Palms spaced at 2.7 m X 2.7 m and less had less than 2.0 per cent of palms showing scorching as against a maximum of 70.0 per cent in the wider spacings. The mean number of spadices produced per tree and the percentage of spadices to leaf-fall progressively increased with increase in spacing. The mean percentage of flower-set in trees spaced at 1.8 m X 1.8 m was 6.1 as against 13.9 to 22.6 in the wider spacings. The maximum yield per unit area was from trees spaced at 2.7 m X 2.7 m. Spacing was found not to have any appreciable influence on the quality and out-turn of cured produce. In the study on the root system of arecanut palm it was observed that in general the maximum concentration of roots is within a radius of 100 to 125 cm from the stem and 100 cm from ground level. The spacing given to trees was found to influence the pattern of distribution of roots. The quantity of roots (dry weight) per unit volume of soil in the feeding zone increased with decrease in spacing, whereas the estimated quantity of gross roots per tree decreased with decrease in spacing. Palms irrigated once in three days were more vigorous than those receiving irrigation at wider intervals. Palms planted at 90 cm depth had significantly more height and number of nodes than those planted at 30 and 60 cm depths. Among the cover crops tried in arecanut gardens *Mimosa invisa* was the most promising. For central Kerala elephant-foot-yam *(Amorphophallus campanulatus)* was found to be the most profitable intercrop for arecanut gardens. The intercrop of banana does not have any adverse effect on the growth of arecanut during the initial three year period of the plantation. In the mixed garden of arecanut and cacao, the latter flowered and set pods within two years of its planting. Under the conditions prevailing in southern Kerala arecanut palms planted on terraces formed along the contours of hill slopes and receiving clean cultivation and manuring had

better growth than other systems tried. The palms also flowered earlier. In the N P K manurial experiment the influence of N and green leaf at higher levels (25 and 50 kg of N and 3400 and 6800 kg of leaf per 500 palms) was found to be significant on the vigour of palms as well as on the earliness in the production of spadices. At one centre, potash at 70 kg per 500 palms influenced production of number of nodes and girth. The harvesting trial confirmed the necessity of choosing fully ripe bunches for the preparation of *Chali*. From the uniformity trials it was observed that the minimum number of trees required per plot for field experiments in arecanut is twelve.

(a) RESEARCHES COMPLETED

## VI. A. 2. SOWING EXPERIMENTS

c) Effect of different intensities of shade in seed bed and secondary nursery beds on growth performance of seedlings

This experiment was taken up to find out the optimum intensity of shade that is to be provided for the seedlings in the nurseries to obtain healthy growth. The treatments in the primary nursery consisted of (1) no shade, (2) partial shade and (3) complete shade. In the secondary nursery the seedlings from each of the three treatments were subgrouped into three and the same three treatments as in primary nursery given. The trial was first initiated at the Central Station in 1962-63, and repeated in 1963-64. The last set of observations made during the period also gave results similar to the earlier observations. The mortality of seedlings in the open nurseries was 75.2 per cent as against 16.2 per cent in the partial and 12.9per cent in the completely shaded nurseries. The out-turn of plantable seedlings under partial and complete shades was 77.0 and 82.2 per cent respectively as against 4 9 per cent in the open.

## VI. D. MISCELLANEOUS

2 & 5) Harvesting trials

*Quality of produce as influenced by degree of maturity:* Areca growers are in the habit of harvesting two successive bunches at one and the same time while attending to the harvest of ripe bunches. These two bunches will necessarily be of different maturity, the lower one being of higher maturity than the upper one in the same tree. To find out the difference in the quality and out-put of the cured produce *(Biligotu)* obtained from the fruits of the two bunches harvested as above, a trial was in progress. The results showed that nuts from the lower bunch (higher maturity) give seven per cent higher out-turn of the produce, This is in conformity with the results obtained earlier. The quality of

the produce obtained from the lower bunch was also superior as indicated by the higher price of Rs. 300.00 per 50 kg of *Chali* obtained against Rs. 266.00 per 50 kg of *Chali* from the upper bunch.

6) Simple manurial trials on arecanut in ryots' gardens

Simple manurial trials laid out around the Central and Regional Stations in the growers' gardens in 1960-61 as part of the above scheme of the erstwhile Indian Central Arecanut Committee were continued. Data on yield of palms under the trial recorded during the period showed that the treatment differences are not significant at any of the centres The above results have been included in the final report of the schems prepared by the erstwhile Committee The trials have been discontinued.

7) Weedicidal trial

Trials on the control of weeds in arecanut gardens using proprietary weedicides were taken up at the Regional Arecanut Research Stations, Peechi and Hirehalli. Out of the nine weedicides tried at Peechi, Stam-F. 34 was found to have effect for 2 to 3 months in controlling the grass growth. At Hirehalli Stam-F. 34, Bladex 'O' and Bladex 'C' were found to be effective in controlling many of the grasses. However, there was regeneration of the weeds in the course of 6 to 8 weeks. Due to the high cost of chemical control as compared to manual weeding and unsatisfactory results obtained, the trials were discontinued.

(b) RESEARCHES IN HAND

VI. A. h). Determination of optimum age of transplanting seedlings-cum-sowing *in situ vs.* transplanting of single, double and treble tranplanted seedlings.

Seedlings of different ages are used for the main field planting in different tracts. The practice of directly sowing the nuts *in situ* as well as transplanting seedlings in nurseries themselves prior to the main field planting are also in vogue. An observational trial to study these aspects was laid out at Central Station with the following eight treatments.

1. Directly sowing seednuts in the main field.
2. Transplanting one year old seedlings.
3. Transplanting two year old seedlings.
4. Transplanting three year old seedlings.
5. Transplanting four year old seedlings.
6. Transplanting two year old seedlings which had been transplanted once in the nursery.
7. Transplanting three year old seedlings which had been transplanted twice in the nursery.

8. Transplanting four year old seedlings which had been transplanted thrice in the nursery.

It was observed that the plants which were set in the main field earlier are more vigorous and precocious than those which had been retained in the nursery for longer durations and then transplanted. Observations made during the initial three years after planting have shown that transplanting of seedlings once in the nursery reduces the height.

A similar trial with six treatments was in progress at Kahikuchi since 1963—64.

## VI. B. CULTURAL EXPERIMENTS

a. 1) Determination of optimum spacing in the main field

This experiment having spacings of 1 8 m X 1.8 m, 2.7 m X 1.8 m, 3.6 m X 1.8 m, 2.7 m X 2.7 m, 3.6 m X 2.7 m. and 3.6 m X 3.6 m as treatments laid on a randomised replicated design was in progress since 1958. The trees commenced flowering in 1962-63.

Studies on the following aspects were continued to be made in the experimental garden.

*Spacing and sunscorch:* The wider spacings of 3.6 m X 3.6 m and 3.6m X 2.7 m had 70.0 and 18.6 per cent respectively of the palms affected by sunscorch which was significantly more than the rest of the treatments. The difference between these two treatments was also significant. In all the other spacings the palms affected by sunscorch was less than two per cent.

*Spacing and inflorescence production:* Leaf-fall, production of spadices and percentage of spadices to leaf-fall progressively increased with increase in spacing. The spacing of 1.8 m X 1 8 m had significantly lesser number of leaves shed (6.1) than others. The number of spadices produced per palm was significantly less in 1.8 m X 1.8 m and 1.8 m X 2.7 m spacings than those produced in 2 7 m X 2.7 m, 3 6 m X 2.7 m and 3.6 m X 3 6 m spacings. The minimum of 3.5 inflorescences per palm was produced in 1.8 m X 1.8 m spacing and the maximum of 6.2 in 3.6 m X 3.6 m spacing While there is no significant difference in the number of flowers per spadix in the various treatments the percentage of flower set is significantly less in 1.8 m X 1.8 m spacing (3.4%) than the rest. The maximum set of 22 6 per cent was obtained in 3 6 m X 3.6 m spacing.

*Spacing and yield:* The maximum yield of 10,515.8 kg of ripe fruits per hectare was obtained from 2.7 m X 2.7 m spacing which was significantly

more than the yield from 1.8 m X 1.8 m, 2.7 m X 1.8 m and 3.6 m X 3.6 m plots. The pattern of increase in yield from year to year in different treatments was studied for a period of first three years. The data gathered are given below.

TABLE 1

**Yield variability under different spacings**

| Spacing | Mean yield per tree | | |
|---|---|---|---|
| | 1963-64 | 1964-65 | 1965-66 |
| 1.8 m X 1.8 m | 29 | 53 | 46 |
| 1.8 m X 2.7 m | 54 | 98 | 101 |
| 1.8 m X 3.6 m | 64 | 127 | 155 |
| 2.7 m X 2.7 m | 52 | 154 | 214 |
| 2.7 m X 3.6 m | 91 | 168 | 240 |
| 3.6 m X 3.6 m | 43 | 162 | 248 |

From the above it will be seen that the rate of increase in yield from year to year is very slow in closer spacings whereas it is quite rapid in the wider spacings.

*Spacing and quality of produce:* The turn over of *Chali* (dry kernel) and its quality (market rate and proportion of *biligotu* to *kokka*) were assessed from representative harvests. The results showed that spacings have no effect on the above.

*Spacing and root spread:* Studies on the distribution of roots as influenced by different spacings adopting soil-block or quantitative method gave the following results:-

1. In general heavy matting of 60.9 to 66.9 per cent of total roots and 51.3 to 55.6 per cent of the fine roots are concentrated within 50 cm radius of the palm. More than 80.0 per cent of total roots are within 100 to 125 cm from the stem, though the roots are found to traverse beyond 1.75 m laterally.

2. Vertically, maximum concentrations of 66.3 to 79.0 per cent of total and 72.2 to 76.3 per cent of fine roots, as within the first 50 cm layer. The second layer of 51 to 100 cm contains 18.3 to 23.3 per cent of total roots and 13.6 to 20.0 per cent of fine roots. The maximum vertical penetration of roots was upto 2.8 metres.

3. Trees when planted at closer spacings have a tendency to explore the lower strata more judiciously than palms planted wider apart.

4. The quantity of roots (dry weight) per unit volume of soil within the feeding zone increases with increase in density of planting,

whereas the estimated quantity of gross roots produced per tree decreases with increase in spacing.

The same trial was also running in the Regional Stations at Peechi, Hirehalli and Kahikuchi. At Peechi, where the experiment was laid out in 1960, yield obtained from plots with 2.7 m X 2.7 m and 2.7 m X1.8 m spacings was significantly higher than the yield obtained from 2.7 m X 3.6 m and 3.6 m X 3.6 m spacings. A more or less similar result wherein closer spacings had given higher yield had been obtained at Central Station also during the year 1963-64. The palms of the corresponding experiment at Hirehalli and Kahikuchi have commenced flowering during the period.

2) Effect of interval in irrigation at different depths of planting arecanut seedlings.

The depths at which arecanut seedlings are planted in the main field and the intervals at which they are irrigated vary considerably from tract to tract and with different soil conditions. This experiment was, therefore, initiated to determine the effect of depth of planting areca seedlings in the main field and the intervals at which irrigations are to be given under the conditions prevailing in the different regions. The planting of the experiment was done in 1962 at the Peechi Station adopting a 4 x 3 x 5 split plot design with four intervals of irrigation ( viz. no irrigation, irrigation once in 3, 6 and 9 days ) and three depths ( viz. 30 cm, 60 cm and 90 cm ) of planting. The main treatments ( intervals of irrigation ) were superimposed from the second year after planting. The growth measurements recorded showed that palms under no irrigation had significantly lesser girth at collar, height and number of nodes than those under other irrigation treatments. As regards girth at 75 cm above ground level ( permanent mark ) also palms under no irrigation treatment were significantly poorer than those irrigated once in three days. Palms irrigated once in three days were most vigorous and had significantly more girth at collar, girth at 75 cm and number of nodes than those under other treatments. Deeper planting at 60 cm and 90 cm significantly reduced the girth at collar. Palms planted at 90 cm depth had significantly more height and number of nodes than those planted at 30 cm and 60 cm depths.

Observations similar to those made at Peechi were also made at Hirehalli, Kahikuchi and Mohitnagar. In all these centres the irrigation treatment was superimposed only during the period under report and hence the growth of palms as influenced by depth of planting alone could be studied. At Hirehalli where 30, 45 and 60 cm depths had been adopted, there was no significant effect on the girth and height of palms due to depth However, seedlings planted at 30 cm depth had significantly more number of leaves than those at 60 cm depth. At Kahikuchi where 15, 30 and 45 cm depths

have been adopted seedlings planted at 45 cm depth have recorded significantly less girth at collar and height than those planted at other depths. At Mohitnagar the experiment had to be discontinued due to severe casualities in the experimental plots.

At Central Station the experiment was laid out during June, 1966 on a 4 x 3 x 5 strip plot design with four intervals of irrigation and three depths of planting.

4) Study of intercrops in arecanut gardens.

In order to explore the possibility of growing certain inter and associate crops in arecanut gardens without detriment to the arecanut crop, a trial on a 5 x 5 Latin square design was laid out at the Peechi Station in 1964. The inter crops tried were banana, colocasia, *(Colocasia antiquorum)*, pineapple and elephant foot yam *(Amorphophallus campanulatus)*. A control plot with no inter crop was also maintained. Considering the yield and cost of raising the crops, it was observed that elephant foot yam was most profitable, banana being second in the order. Pineapple and colocasia though they come up fairly well under the shade of arecanut trees,were not economical. Data on the growth measurements and yield of arecanut palms revealed that cultivation of intercrops in arecanut gardens had no significant adverse effect on either growth or yield.

A similar trial as above with inter crops of banana, pineapple, guinea grass, ginger and betelvine was in progress at the Regional Station, Kahikuchi. Raising of inter crops was found not to have any adverse effect on the growth of arecanut palms.

At the Central Station specimen plot of banana, pineapple, ginger, arrow-root, guinea grass and cardamom were maintained. All the crops except ginger were found to grow satisfactorily under the shade of arecanut trees.

5) Comparative study of different green manure and cover crops for arecanut gardens.

A 4 x 5 randomised replicated trial with *Calapogonium muconoides*, *Pueraria phaseoloides* and *Mimosa invisa* was in progress at the Regional Station, Peechi. A control plot (no green manure crop) had also been included. The yield of green matter obtained was 12.7, 12.9 and 16.8 tonnes per hectare during 1965 and 8.2, 9.2 and 8 8 tonnes per hectare during 1966 respectively for *Calapogonium*, *Pueraria* and *Mimosa*. The effect of the cover crops on the performance of arecanut palms at the end of two year period was studied. The growth and yield data of palms collected did not reveal any significant beneficial or adverse effect on arecanut due to growing of cover crops.

A trial similar to the above was initiated at the Hirehalli Station and seeds of six cover crops were sown.

At the Central Station green manure and cover crops viz., *Crotalaria anagyroides*, *Sesbania speciosa*, *Calapogonium muconoides*, *Pueraria javanica*, *Centrosema pubescens*, *Stylosanthes gracilis*, and *Mimosa invisa* were tried in observation plots. The green matter obtained from the crops were 8.0, 32.2, 10.7, 13.4, 5.3, 13.4 and 17.0 tonnes per hectare respectively. *Mimosa invisa* seems to be the most promising cover crop

7) Effect of growing banana in arecanut gardens for different durations

Banana is the most common food crop intercropped in arecanut gardens of all the arecanut growing tracts. In order to assess the effect of growing banana as an intercrop in arecanut gardens as well as to find out the optimum number of plants and the stages at which the former can be raised with the latter, an experiment on an 8 x 4 randomised block design with the following treatments was laid out at the Central Station in 1963.

1. No banana throughout the period of experiment (i. e. pure plantation of arecanut crop.)
2. Banana as intercrop throughout the period of experiment at full level.
3. Banana up to the end of third year at full level and no banana thereafter.
4. Banana up to the end of 3rd year at full level and at reduced level for the rest of the period of the experiment.
5. Banana up to the end of 3rd year at full level and at reduced level till the end of sixth year and no banana thereafter.
6. Banana up to the end of 6th year at full level and no banana thereafter.
7. Banana up to the end of 6th year at full level and at reduced level thereafter for the rest of the period.
8. Banana up to the end of 6th year at full level and at reduced level till the end of the 10th year and thereafter no banana.

*Note*:— The third year corresponds to the period when majority of the palms would have formed distinct nodes. Sixth year corresponds to the period when more than 50 per cent of the palms would have flowered. Tenth year corresponds to the attainment of the full bearing capacity.

Both the crops were given the cultural and manurial operations as per the normal schedule for each crop. The data recorded on growth features showed that the difference in the vigour of palms grown under the two conditions i. e., with the intercrop of banana and without banana is not significant. Growing an intercrop of banana during the initial three years of plantation has no adverse effect on the growth of arecanut

palms. Banana suckers were replanted at full level under treatment 2, 6, 7 and 8, at reduced level under treatments 4 and 5 and completely uprooted from treatment number 3.

A similar experiment as above with only five treatments superimposed in a three year old garden was running at the Regional Station, Kahikuchi since 1963-64. The growth measurements of the arecanut palms recorded during the year showed that growing banana did not have any adverse effect on the growth of the arecanut.

9) Mixed garden of (a) arecanut and coconut (b) arecanut and cacao.

*(a) Arecanut and coconut:* Arecanut and coconut are found grown as mixed plantations in certain areas. To assess the desirability of such a practice as against raising them as pure crops, an observational trial with two treatments viz. (1) arecanut and coconut as mixed crops and (2) arecanut as pure crop, repeated twice was laid out at the Central Station during 1964. The coconut seedlings were planted in 1964 at a spacing of 8.1 m X 8.1 m and arecanut in 1965 at 2.7 m X 2.7 m. The growth of both arecanut and coconut seedlings was satisfactory.

Similar trials were also in progress at the Regional Stations, Kahikuchi and Palode.

*(b) Arecanut and cacao:* A mixed garden of arecanut and cacao (Criollo variety) was planted at the Central Station in 1964 as an observational trial with (1) arecanut and cacao at 50: 50, (2) areca as pure crop and (3) cacao as border to areca garden. The growth of both arecanut and cacao trees was satisfactory. The cacao plants commenced flowering and a few pods have set. The flowering of cacao during the second year of planting is quite early for this crop as compared to its performance reported from outside India.

11) Studies on the performance of nuts gathered at different stages of maturity.

Fifteen seednuts in each raised from seednuts of different maturity (viz., 19, 9½, 10 and 10½ months) were planted at the Central Station as an observational trial in 1962-63 to study their performance. The growth measurements showed that on an overall consideration, palms raised from seednuts of 10 and 10½ months maturity are more vigorous than others.

12) Effect of different spacings and methods of layout on the incidence of sunscorch of arecanut palm.

Arecanut palms are highly susceptible to sunscorch, particularly in situations where the palms are exposed to the southern and south western sun. In order to find out whether method of aligning the garden and spacing have any bearing with scorching, an observational trial was planted in 1960 with three spacings of 2.4 m X 2.4 m square, 2:7 m X 2.7 m

square and 3.6 m X 3.6 m quincunx, each aligned in north-south direction and at an angle of 20° to north-south. A count of the palms showing sun-scorch symptoms was made in December, 1966. The indications from the observations were that aligning rows in north-south direction reduces the incidence of scorching.

13) Mulching trial—a comparison of different mulches in arecanut gardens.

A trial to compare the utility of different mulching materials for arecanut gardens was laid out at the Central Station adopting a completely randomised design with four plots per treatment. The mulches tried were (1) chopped arecanut leaves, (2) guatemala grass *(Tripsacum laxum)*, (3) arecanut husk and (4) dry leaves collected from forest. The control plot did not receive any mulching. The mulching was done in February, 1966 with the advent of summer. Observations on soil moisture status made at intervals after an irrigation showed that the loss of moisture from the mulched plots was very slow compared to the plots with no mulch. The percentage of moisture in the 'no mulch' plot was 10 at the end of 10 days after irrigation which moisture level was seen in the mulched plots even 18 days after irrigation. The mulched plots were also comparatively free of weeds unlike the 'no mulch' plots. Between the different mulches there was no appreciable difference.

14) Study of different methods of raising arecanut gardens on hill slopes.

This experiment laid out in 1961-62 at the Regional Station Palode has three main treatments consisting of (1) planting on terraces made along the contour, (2) planting on terraces made at the site of planting and (3) planting on slopes not taking into account the contour and three sub-treatments, viz., (1) no cultivation no manuring, (2) clean cultivation and manuring and (3) permanent cover cropping and manuring.

Observations made on growth and flowering behaviour of the palms showed that plants planted on terraces along the contour were significantly more vigorous than those planted in the other methods. Palms which were under clean cultivation and manuring were also significantly more vigorous than palms underthe other two treatments. The percentage of palms flowered as well as the average number of spadices produced per tree were highest in plots under clean cultivation and manuring.

Observations on moisture status and organic carbon content of soil in the various plots were also being made in collaboration with the Chemistry Section.

## VI. C. MANURIAL EXPERIMENTS

2) N. P. K. manurial experiment.

This experiment was laid out both at Central and Regional Stations to find out the N P K requirements of arecanut palm under varied soil and climatic conditions, It was laid out in 1961 at Vittal on a $3^4$ confounded factorial design as a single replicate. The treatments consisted of 0, 25 and 50 kg of nitrogen, 0, 20 and 40 kg of phosphoric acid, 0, 35 and 70 kg of potash and 0, 3400 and 6800 kg of green leaf, all per 500 palms.

The results of quinquennial observations (1965) on growth of the palms showed that nitrogen and green leaf (G) alone had significant effect on characters such as girth at last exposed node, length of oldest leaf, number of leaves and number of trees which had not attained 75 cm height from the base. There was no significant difference between $N_1$ and $N_2$ and $G_1$ and $G_2$ levels. $N_0$ and $G_0$ treatments had significantly more number of plants which have not attained a stem height of 75 cm. Plants in these treatments also had significantly lesser girth at the last exposed node, length of oldest leaf and number of leaves than at higher levels of N and G. Data on leaf-fall, production of spadices and number of palms flowered in different plots were recorded. The results showed that nitrogen at both levels ($N_2$ and $N_1$) has given rise to significantly more leaf fall, more spadices, greater percentage of spadices to leaves shed and higher percentage of palms flowered than at $N_0$. There was no significant difference between $N_1$ and $N_2$. Significantly higher leaf fall had been obtained at higher levels of phosphoric acid. Green leaf at $G_2$ and $G_1$ levels had also significant influence on leaf-fall. The main effect of $G_2$ on the number of spadices, percentage of spadices to leaf-fall and percentage of palms flowered was significantly higher than $G_0$. There was no significant difference between $G_2$ and $G_1$ on any of the characters studied The influence of potash was also not significant.

Observations on the above lines were also made on a similar trial being conducted at Peechi since 1961. Unlike at Vittal the influence of K was significant, $K_2$ recording more number of nodes and girth at last exposed node than $K_0$. Phosphoric acid at $P_2$ level recorded significantly lesser number of nodes than $P_0$.

The above experiment planted in later years was running at Hirehalli and Kahikuchi Stations also. Annual growth measurements of the palms were recorded.

4) Effect of N P K in organic and inorganic forms on palm performance.

The experiment was programmed to determine whether palms receiving chemical fertilizers will have any adverse effect if changed over

to organic manures and *vice versa*. The treatments were superimposed in a six year old garden at Central Station which was receiving only cattle manure and green leaf throughout uniformly. The first dose of fertilizers as per treatment was applied in 1963-64. The treatments consist of (1) N, P and K (25, 25 and 40 kg respectively per 500 palms per year) in organic form from 6th to 15th year, (2) N, P and K in inorganic form from 6th to 15th year, (3) N, P and K in organic form from 6th to 10th year and then in inorganic form till 15th year and (4) N, P and K in inorganic form from 6th to 10th year and then in organic form till 15th year.

The yield difference between the two treatments under comparison was not significant.

## VI. D. MISCELLANEOUS

### 1) Uniformity trials - collection of yield data of palms.

This study was in progress since 1958-59 in a private garden (progenies of unknown mother palms) for determining the optimum number of palms to be planted in experimental plots and to determine the shape of such plots. Yield data collected from 1958-59 to 1964-65 indicated that increasing the plot size beyond 12 tress per plot does not result in any appreciable reduction in coefficient of variation. The data collected during the period also gave more or less similar results.

With a view to find out whether the variability will get reduced if selected progenies of known mother palms are planted as done for field experiments, the above study was extended to the progeny garden of the station during 1964-65. Yield data of 144 palms were scrutinised. The results showed that in this case also a plot size of 12 trees is required. It was, however, seen that long narrow plots are more efficient than compact plots.

### 2 & 5) Harvesting trials.

*Quality of produce as influenced by degree of maturity:*

In practice, when ripe bunches are harvested stray fruits are observed to be still green. Information about the quality of the *Chali* obtained from these nuts is not available. The above study was further extended to gather information on this aspect. The nuts from routine harvest were grouped as (1) fully ripe and (2) partially ripe (as indicated by the yellowish green colour of the fruit). The former gave 8.6 per cent increase in out-turn of *Chali* of superior quality (Rs. 347/- per 50 kg) as compared to the latter which fetched only Rs. 201/- per 50 kg.

A similar study was in progress at the Regional Arecanut Research Station, Peechi in respect of tendernut harvest which is the practice at that region.

TABLE 2

**Rainfall data - 1966**

| Months | Vittal | | Peechi | | Hirehalli | | Kahikuchi | | Mohitnagar | | Palode | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rain fall in mm | Mean rain fall for previous years | Rain fall in mm | Mean rain fall for previous years | Rain fall in mm | Mean rain fall for previous years | Rain fall in mm | Mean rain fall for previous years | Rain fall in mm | Mean rain fall for previous years | Rain fall in mm | Mean rain fall for previous years |
| January | 0.30 | 0.03 | — | — | — | 1.26 | 23.90 | 3.40 | 25.10 | — | — | 51.93 |
| February | — | — | — | 15.60 | — | 3.50 | 7.50 | 7.75 | 4.20 | 7.90 | 4.00 | 65.10 |
| March | — | 2.46 | 39.60 | 31.00 | 9.80 | 3.66 | 31.60 | 55.13 | — | 22.75 | 78.80 | 170.45 |
| April | 35.70 | 35.06 | 36.00 | 26.00 | 13.00 | 81.66 | 99.60 | 167.05 | 16.20 | 144.25 | 295.90 | 382.50 |
| May | 188.70 | 250.08 | 97.00 | 97.70 | 176.00 | 91.92 | 203.60 | 271.60 | 227.50 | 309.62 | 16.60 | 243.08 |
| June | 516.80 | 860.93 | 540.90 | 535.97 | 149.30 | 90.16 | 458.30 | 324.05 | 263.50 | 599.12 | 433.00 | 202.73 |
| July | 1067.80 | 1173.81 | 778.90 | 687.53 | 130.90 | 116.22 | 235.80 | 368.23 | 931.40 | 771.70 | 289.60 | 455.78 |
| August | 283.90 | 795.92 | 228.00 | 443.27 | 183.20 | 210.04 | 342.70 | 249.53 | 1356.80 | 787.95 | 135.60 | 230.73 |
| September | 201.00 | 363 99 | 131.50 | 272.47 | 313.90 | 207.28 | 173.10 | 154.75 | 559.60 | 477.50 | 423.00 | 280.55 |
| October | 205.00 | 215.61 | 544.20 | 293.40 | 328.10 | 167.12 | 32.90 | 65.33 | 27.60 | 51.07 | 388.80 | 432.50 |
| November | 110.30 | 81.98 | 243.60 | 85.20 | 316.20 | 78.48 | 46.20 | 9.03 | 1.60 | 5.75 | 293.10 | 209.40 |
| December | 33 90 | 35.80 | 32.70 | 45.33 | 16.40 | 23.30 | 5.60 | 7.37 | 12.00 | — | 306.00 | 98.65 |
| **Total:** | 2643.40 | 3815.67 | 2672.40 | 2533.47 | 1636.80 | 1073.60 | 1660.80 | 1683.22 | 3425.50 | 3177.61 | 2657.60 | 2823.40 |

## VI. E. CROP WEATHER STUDY

Weather data in respect of rain fall, temperature, humidity, etc., were recorded at the Central and Regional Stations. The rain fall data are given in table 2.

### (c) RESEARCHES CONTEMPLATED

Experiments to find out suitable methods of intercultivating arecanut gardens as well as for determining the best method and time of application of fertilizers have been proposed to be taken up. Assessment of different types of areca for evolving a suitable type for rainfed cultivation has also been programmed.

Experiments contemplated on drainage and different sources of nitrogen have been postponed due to their low priority.

**Programme of work for 1967**

| Number and name of the project | Venue of work |
|---|---|
| A. 1. Determination of optimum age of transplanting seedlings-cum-sowing *in situ vs* transplanting of single, double and treble transplanted seedlings | Vittal and Kahikuchi |
| A. 2. Determination of optimum spacing in the main field | Vittal, Peechi, Hirehalli and Kahikuchi |
| A 3. Effect of different methods of layout on the incidence of sunscorch on arecanut palms | Vittal |
| A. 4. Effect of different intervals of irrigation at different depths of planting arecanut | Hirehalli, Vittal, Peechi, Mohitnagar and Kahikuchi. |
| A. 5. Investigations on different types of areca under rainfed and irrigated conditions | Mohitnagar and Vittal |
| A. 6. Intercropping experiments-<br>a) banana<br>b) other crops | Vittal, Kahikuchi, Peechi, Hirehalli and Mohitnagar |
| A. 7. Mixed cropping experiments-<br>a) coconut<br>b) cacao | Kahikuchi, Vittal and Palode |

| | | |
|---|---|---|
| A. 8. | Effect of different methods of inter-cultivation on the productivity of palms | Hirehalli, Vittal, Peechi and Mohitnager |
| A. 9. | N P K manurial experiment | Peechi, Vittal, Hirehalli, Mohitnagar and Kahikuch |
| A. 10. | Effect of applying fertilizers to supply N P K in organic and inorganic forms on palm performance | Vittal |
| A. 11. | Studies on placement and fractional application of fertilizers | Vittal |
| A. 12. | Harvesting trials (i) season-wise variation in quality of produce and (ii) quality of produce as influenced by degree of maturity | Peechi and Vittal |
| A. 13. | Root studies of arecanut palm of different ages and under different soil conditions | Vittal and Palode |
| A. 14. | Crop weather study | Vittal, Peechi, Hirehalli, Palode, Mohitnagar and Kahikuchi |

## STATISTICS

(P. R. Ramachander)

### SUMMARY OF SALIENT FINDING

A technique for forecasting the crop yield in arecanut has been worked out Two samples of 12 kg each of ripe nuts drawn from a given lot at random were found to be sufficient for determining percentage of kernel weight to wet weight. Rejection of seedlings which do not have a minimum of five leaves at the time of planting (18 months old) and subsequent replacement of such of those which do not attain at least 20 cm girth at collar after one year growth and those which do not develop at least four nodes after two years growth is estimated to give 20 per cent increase in yield. Progenies of palms which come to bearing in the fifth year of transplanting itself could be expected to give eight to fifteen per cent increase in yield Application of the selection standards to the seedlings was found to substantially eliminate the late bearers in the garden and also other uneconomic palms Length of longest leaf of sprouts was found to be positively and significantly correlated with height, number of roots and length of roots and negatively with girth at collar Number of leaves at the time of planting has negative correlation with seedling height. Number of nuts has negative significant correlation with size of nut and positive significant correlation with total weight but there is no threshold value for these characters in the local type. The correlation between number of bunches and yield is high and significant. Number of female flowers does not have any correlation with nut set. The number of nuts borne by adjacent bunches of the same tree is positively and significantly correlated.

### (a) RESEARCHES COMPLETED

#### VII b. REFINEMENT OF EXPERIMENTAL TECHNIQUE

*(1) Determination of sample size for estimating percentage of dry kernel weight to wet weight:* Since *Chali* (dried kernel) is the final produce in arecanut, comparison of treatments in different experiments has to be done for the final out-turn of *Chali* from each treatment. Considerable difficulty exists for drying the large quantity of produce from an experiment, treatment-wise in each replication for each of the harvests to find the weight of final produce. To circumvent this, a sampling technique for determining the conversion rate of ripe nuts to final produce was worked out. It was observed that two samples of 12 kg each of ripe nuts drawn from a given lot at random, will be sufficient for determining the percentage

of kernel weight to wet weight of the lot. These results were in conformity with those obtained earlier.

The above sampling technique will also be useful in the area and production survey in which the expected out-turn of cured produce can be worked out for gardens where crop cutting trials are in progress.

(2) *Crop forecasting:* Unlike annual crops, where crop forecasts are issued about the coming season's harvest no attempt has been made till now to work out the method of predicting the country's production in perennial crops like arecanut. Such forecasts will be useful in planning developmental activities as well as in marketing of the crop. With this end in view the following study was taken up.

It had been observed that the number of nuts in a tree and final produce have a highly significant correlation. As such from an estimate of number of nuts which will be available for harvest, the final produce could be worked out, by finding out suitable conversion factors for each individual tract. The number of nuts was estimated by counting the nuts in all bunches in a random sample of trees of a random sample of gardens during September-October when all fruits would have set. The sample size was determined using the yield data (number of nuts) for 1964-65 of 3207 palms which were grown under uniform conditions. It was observed that the mean number of nuts yielded per tree could be estimated with an estimate falling within 10 per cent of actual value and with 90 per cent precision only if more than 1247 trees (approximately 30 per cent) are taken from the above garden and nut-set counted Random samples of population of sizes varying from 5 to 120 were then taken and estimates of mean yield per tree and its co-efficient of variation worked out by using the usual simple random sample estimate as well as the ratio estimate, the number of nuts yielded during 1963-64 being the auxiliary variable. From the results obtained it was seen that for a sample size of 90 trees (i. e. approximately 3 per cent) the co-efficient of variation is less than 10 per cent but very few estimates fall within the 10 per cent limit of actual value. However, owing to the fact that large number of such samples are required to be taken for forecasting production in a tract, this difference will get adjusted and a sufficiently precise estimate of the production of the tract can be expected. Thus depending upon the most frequently occurring holding size of a particular tract the sample size must be fixed at 3 per cent of the number of trees in such holdings.

## VII C. CORRELATION, HERITABILITY AND CAUSATION STUDIES

### (a) Correlation between morphological characters of sprouts and seedlings.

*(i) Sprouts (six months old):* All possible correlations between (a) height, (b) number of leaves, (c) length of longest leaf, (d) girth at collar, (e) number of roots and (f) length of longest root of sprouts were worked out using the measurements recorded in respect of 100 sprouts. It was seen that (1) number of leaves is not correlated with any of the characters examined and (2) length of longest leaf is positively and significantly correlated with height, number of roots and length of longest root and negatively with girth at collar.

(ii) *Seedling (eighteen months old) :* Correlations were worked out between (a) height, (b) girth at collar, (c) number of leaves and (d) length of longest leaf of seedlings for two sets of plants. The values are given below:-

TABLE 1

*Correlation between different growth characters of seedlings*

| Correlation between. | Set I | Set II |
|---|---|---|
| a and b | 0.42** | 0.44** |
| a and c | -0 11* | -0 21* |
| a and d | 0.40** | 0.55** |
| b and c | 0.01 | 0.01 |
| b and d | 0.21* | 0.49** |
| c and d | -0.57** | -0 27** |

*Significant at 5% level

**Significant at 1% level

It can be seen from the above table that (1) there is no correlation between girth at collar and number of leaves, (2) with increase in height or length of leaves, girth at collar increases, (3) with increase in number of leaves both the height and length of longest leaf decrease. The above go to show that selection exercised for number of leaves at the time of planting will reduce the height, which has a negative genotypic correlation with yield.

(b) correlation between growth and other characters of palm with yield

*(i) Standardisation of nursery selection:* Seednuts for raising seedlings are being gathered from phenotypically high yielding palms and the seedlings transplanted to the main field when they are about one and half years old. Even though some selection is being practised at this stage, the same is not based on any correlation studies. Studies were, therefore, taken up to make the existing method of selection of seedlings much more objective and to investigate whether any further improvement in selection of seedlings can be achieved.

Out of 3207 seedlings that are being grown under uniform conditions at the Central Station 324 randomly selected palms belonging to 41 mother palms were used for the study. Phenotypic and genotypic correlations of different growth characters of seedlings recorded at the time of planting and one and two years growth after planting in main field were worked out with yield (number of nuts) during first, second, third and fourth years of bearing as well as cumulative yield for the first four years. The results are presented in table 2. From the phenotypic correlations given in the table it is observed that the growth characters recorded at the time of planting is significantly correlated with yield in the first year of bearing only, whereas characters recorded one and two years after planting have significant correlations with yield in most of the cases examined. It is also observed that number of leaves at the time of planting, girth at collar after one year growth and number of nodes after two years growth alone have positive significant phenotypic and genotypic correlations with yield. These results indicate that selection based on the above three characters will be advantageous in improving the yield From the point of view of practical considerations it was found necessary to reject out of the one and half years old seedlings those which do not have a minimum of five leaves at the time of planting and subsequently replace such of those seedlings which do not attain at least 20 cm girth at collar after one year growth and also those which do not develop at least four nodes after two years growth. Rejection based on the above standards of selection was estimated to increase the yield by about 20 per cent.

*(ii) Correlation between number of nuts yielded by a tree and size of nuts:* The correlation between the above two characters was worked out using three sets of data when it was seen that they were always negative and significant. However, since the correlation between number of nuts and total weight was positive and significant a search for threshold value between these characters was made. It was observed that threshold value does not exist for the Vittal type, the ultimate weight increasing considerably with the increase in number of nuts borne in spite of the reduction in nut size.

*(iii) Correlation between number of bunches of a tree and yield:* Positive significant correlation was found to exist between the number of bunches harvested and (1) total number of nuts, (2) total wet weight of nuts, (3) number of nuts per bunch and (4) weight of nuts per bunch of a given tree in the two sets of data examined It, therefore, appears that selection of bearing palms for high yield can be based on the number of bunches.

*(iv) Correlation between number of female flowers and percentage of fruit set:* Correlations were worked out between the number of female

TABLE 2

**Phenotypic and genotypic correlations between growth characters of seedlings and their subsequent yield**

| Growth characters | Phenotypic correlation with yield during | | | | Genotypic correlation with yield during | | | | Herita-biiity |
|---|---|---|---|---|---|---|---|---|---|
| | First year | Second year | Third year | Cumulative yield | First year | Second year | Third year | Cumulative yield | |
| I. year (at the time of planting) | | | | | | | | | |
| Number of leaves | 0.21** | 0.04 | 0.04 | 0.06 | 0.32* | 0.12 | 0.21 | 0.26 | 0.92 |
| Girth at collar | 0.12* | 0.04 | 0.03 | 0.07 | 0.12 | –0.35* | –0.04 | –0.34* | 0.96 |
| Height | 0.19* | 0.06 | 0.06 | 0.09 | 0.36* | –0.18 | –0.18 | –0.16 | 0.80 |
| II. year (one year after planting) | | | | | | | | | |
| Number of leaves | 0.26** | 0.17* | 0.12* | 0.19* | 0.98** | –0.32* | –0.03 | 0.08 | 0.32 |
| Girth at collar | 0.21** | 0.27** | 0.16* | 0.28** | 0.46** | 0.10 | 0.16 | 0.16 | 0,80 |
| Height | 0.22** | 0.27** | 0.22** | 0.29** | 0.31* | –0.25 | –0.41** | –0.33* | 0.32 |
| III year (two years after planting) | | | | | | | | | |
| Number of leaves | 0.24** | 0.13* | 0.15* | 0.21** | 0.19 | –0.08 | –0.09 | 0.01 | 0.32 |
| Girth at permanent mark | 0.16* | 0.17* | 0.14* | 0.23** | 0.34* | –0.15 | 0.68** | 0.26 | 0.36 |
| Girth at last exposed node | 0.19* | 0.09 | 0.23** | 0.20** | 0.33* | –0.03 | –0.21 | 0.12 | 0.64 |
| Number of nodes | 0.20** | 0.26** | 0.13* | 0.24** | 0.39** | 0.28* | 0.03 | 0.19 | 0.96 |

* Above P 0.05 level of significance 0.10
** Above P 0.01 level of significance 0.20

* Above P 0.05 level of significance 0.28
** Above P 0.01 level of significance 0.38

flowers in a bunch and corresponding percentage of fruit set for three sets of 100 bunches each. It was observed that none of the correlation co-efficients which ranged from 0.04 to 0.06 was significant showing thereby that fruit set in arecanut is not influenced by number of female flowers produced.

*(v) Studies in yield pattern of arecanut palms and the effect of seedling rejection on them:* With a view to determine the percentage of regularly poor yielding plants, the yield pattern of 324 plants for four years was studied. Plants which yielded less than 20 per cent of the mean for a particular year was grouped as low yielding. The percentage frequency of the different groups and their yield contribution to the total were worked out. Results are given below:-

TABLE 3

**Pattern of variation of yield in arecanut**

| Yielding behaviour over a period of four years | Percentage of occurrence | Percentage contribution to total yield |
|---|---|---|
| Never low | 16 | 30 |
| Low once | 28 | 39 |
| Low twice | 16 | 16 |
| Low thrice | 16 | 9 |
| Low always | 24 | 6 |

It will be seen from the above that 40 per cent plants which are either regularly low yielding or low yielders for three years out of the four contribute only 15 per cent to total yield. By applying the selection standards formulated above (VII C. b. i) the stand of these 40 per cent uneconomic plants will be brought down by about 50 per cent thus making the plantation much more efficient.

*(vi) Correlation between number of nuts borne by different bunches of the same tree:* It was seen that while correlations between number of nuts produced by adjacent bunches were all positive and significant those between non-adjacent bunches were not significant.

(c) Heritability studies

*Standardisation of criteria of selection of mother palms:* Only phenotypic selection of mother palms for yield was being exercised till now. Since the heritability of yield (both number of nuts and total weight of fruits) was found to be as low as 0.20, a search was made to find out yield components and other related characters which have a high heritability and significant correlation with yield. None of the characters examined except age at first bearing had a high heritability (0.72). This character had also

negative significant phenotypic and genotypic correlations with cumulative yield for the first four years as well as the three criteria formulated for the selection of seedlings. Selection for earliness in bearing (fifth year after planting) was estimated to give eight to fifteen per cent increase in yield.

The effect of seedling selection based on the criteria standardised above on age at bearing was studied when the following results were obtained

| Age at bearing (In years) | Percentage of palms in different age groups | |
|---|---|---|
| | Present stand | After exercising selection |
| 5 | 62 | 74 |
| 6 | 32 | 25 |
| 7 | 4 | 1 |
| 8 | 1 | 0 |
| 9 | 1 | 0 |

It can be seen from the above that plants which commence bearing late are totally eliminated when selection standards are applied

(b) RESEARCHES IN HAND

VII (a). PLANNING, ANALYSIS AND INTERPRETATION OF EXPERIMENTS

Statistical analysis and interpretation of results in respect of all the experiments conducted at the Central as well as Regional Research Stations were taken up during the period under report. Designs for new experiments to be initiated in all the Research Stations were suggested.

VII (c). CORRELATION, CAUSATION AND HERITABILITY STUDIES

A further search for the different components of yield and other related characters which have a high heritability and significant correlation with yield is under progress. Data are being gathered from the different Regional Stations with a view to repeat the biometrical investigations reported above, which were done using South Kanara type under Vittal conditions.

(c) RESEARCHES CONTEMPLATED

Since almost all characters so far examined have a low or medium heritability, a direct phenotypic selection for any particular character will not be very effective. Hence it is proposed to work out a selection index for yield using as many measurable characters as possible and data are being gathered with this end in view. Analysis of dispersion of the world collection maintained at the Central Station using the Mahalanobis $D^2$, has also been of programmed. When the final grouping is done a hybridisation programme with a view to exploit hybrid vigour will be drawn up.

**Programme of work for 1967**

| Number and name of the project. | Venue of work |
|---|---|
| S 1. Refinement of experimental technique | Vittal |
| S. 2. Correlation, heritability and causation studies | |
| a) Correlation between growth characters of seedlings | Vittal |
| b) Correlation between growth and other characters of the palm with yield | Vittal, Peechi and Hirehalli |
| c) Heritability studies | Vittal |
| S. 3. Discriminant functions and selection index | Vittal |

## SOIL CHEMISTRY
(Dr. A. R. Kalbande)

### SUMMARY OF SALIENT FINDINGS

Physico-chemical analysis of the soils collected prior to the commencement of the experiment from the N P K trial laid out at Vittal showed that the soils are strongly acidic, medium to high in total nitrogen, medium in available nitrogen and low to medium in available $P_2O_5$ content. Water holding capacity was seen to vary from 39.6 to 46.3 per cent for the surface 15 cm layer. Manuring with organics and inorganics done during the first two years was found to have not increased the total as well as available nitrogen contents of the plots. The decrease in available nitrogen with depth was prominent in all the blocks. Based on the analysis data of the soil samples from the same N P K trial laid out at other four centres, the soil in each centre was classified on the basis of percentage organic carbon content as very high for Peechi, low to medium for Hirehalli, low to high for Kahikuchi and very high for Mohitnagar. The treatment consisting of permanent cover cropping with manuring maintained its superiority over clean cultivation and manuring. Of the different cover crops tried *Stylosanthes gracilis* was found to be the best from the point of view of organic carbon status of the soil. An experiment to study the composition changes in soil and plants brought about by continuous application of manures and fertilizers (N P K) with and without cultivation practices was finalised. Work on the standardisation of a sampling technique for plant samples was initiated. The analysis of different parts of one and half year old seedling showed that as a whole the plant has 75 to 80 per cent moisture and 3.05 to 5.48 per cent ash on oven-dry basis.

### (b) RESEARCHES IN HAND

#### VIII. 1. ANALYSIS OF SOIL SAMPLES FROM N P K MANURIAL TRIAL

Experiment to determine the optimum manurial requirement of areca palm had been laid out in the year 1961 and subsequent years at Vittal, Peechi, Hirehalli, Mohitnagar and Kahikuchi. Soil samples were collected from the experimental plots from three depths (0– 15, 15—45 and 45—90cm) before laying out the experiment to study the initial nutritional status of the soil. Second sampling was done at Vittal in 1964.

Physico-chemical analysis of the soils from Vittal showed that the soils are strongly acidic in reaction (pH 4.5 to 5.6), medium to high in total nitrogen, medium in available nitrogen and low to medium in available $P_2O_5$ content as per the limits of classification used by soil

testing laboratories. Water holding capacity of the surface soil was observed to vary from 39.6 to 46.3 per cent. Application of organic manures and fertilizers during the initial two years was found to have increased the available nitrogen content of the plots only to a negligible extent. The available nitrogen content showed a decreasing trend with depth indicating thereby a restricted activity of soil micro-organisms in the sub-surfce layer. No effect was seen on total nitrogen content due to the application of green leaves or ammonium sulphate.

Soil samples collected from Regional Stations were analysed for percentage organic carbon content and classified into different soil fertility groups. The classifiction along with limits used are given below:—

| Station | Organic carbon status (range between blocks) | Limit of classification. |
|---|---|---|
| Peechi | Very high (1.06 to 1.50 per cent) | Low $<$ 0.5 per cent |
| Hirehalli | Low to medium (0.40 to 0.58 per cent) | Medium 0.5 to 0.75 per cent. |
| Kahikuchi | Low to high (0.38 to 1.06 per cent) | High $>$ 0.75 per cent. |
| Mohitnagar | Very high (1.69 to 2.13 per cent) | |

From the above it can be seen that there is no wide variation in between the blocks at Peechi, Hirehalli and Mohitnagar while at Kahikuchi the variability is high.

## VIII. 3. TISSUE TESTING AND MINERAL NUTRITION OF PALMS.

### Standardisation of technique for leaf sampling:

To standardise the leaf sampling technique for the purpose of analysis ninety palms of uniform age and under uniform treatment were marked out. From each leaf on the crown of these palms ten middle leaflets five, on either side were sampled, washed with distilled water and oven-dried.

## VIII. 4. (a) NUTRIENT EXHAUSTION STUDY.

In order to gather information on the total removal of plant nutrients from the soil by arecanut palm at different stages of its growth, different plant parts (leaf, midrib, stem and roots) of one and half year old seedlings were analysed The results showed that the seedlings as a whole contained 75 to 80 per cent of moisture and 3.05 to 5.48 per cent of ash on oven-dry basis.

## VIII. 8. PERMANENT OBSERVATIONAL PLOT TO STUDY THE COMPOSITION CHANGES IN SOIL AND PLANT BY CONTINUOUS USE OF FERTILIZERS, MANURES AND CULTURAL PRACTICES.

In order to study the compositional and nutritional changes brought about in the soil and plants by the continuous application of manures, fertilizers and adoption of cultural practices an experiment was designed with the following six treatments.

1. Untouched.
2. Clean cultivation alone.
3. Clean cultivation + Inorganic fertilizers.
4. Clean cultivation + Organic manures.
5. Clean cultivation + Organic manures + Inorganic fertilizers.
6. Fertilizers + Organic manures.

## MISCELLANEOUS

(i) Soil fertility studies under different methods of raising arecanut on hill slopes.

An experiment laid out at Regional Arecanut Research Station, Palode to study the effect of different methods of raising arecanut garden on hill slopes on the incidence of yellow leaf disease was made use of for this study. The treatments consisted of (1) no cultivation and no manuring, (2) clean cultivation and manuring and (3) permanent cover cropping and manuring. The results of analysis showed that the treatment, permanent cover cropping with manuring, maintained higher nutritional status than the rest.

(ii) Cover cropping in arecanut and its effect on nutrient content in the soil.

An observational plot to study the efficacy of different cover crops to change the nutritional status of the soil was laid out with (1) *Crotalaria anagyroides*, (2) *Mimosa invisa* var. *inermis*, (3) *Calopogonium muconoides*, (4) *Stylosanthes gracilis*. and (5) *Centrosema pubescens*. A control (fallow) plot had also been included. Of the different green manures *Stylosanthes gracilis* gave promising results as judged from the analytical data obtained for organic carbon and available nitrogen content in the soil

(iii) Standardisation of technique for feeding nutrient solution through stem of areca palm.

Since the application of plant nutrients through soil does not give a correct picture of the quantity of nutrient absorbed an easy technique

for feeding nutrient solution through the stem was tried. The one method tested failed to make the plants absorb sufficiently large quantities of the nutrient solution. The work is being continued.

(iv) Root feeding with ferrous sulphate solution

Chemical analysis of the leaf tissues done earlier had shown that tissues from yellow leaf disease affected palms contain more iron than the healthy one. The iron content of the healthy tissues was, therefore, proposed to be raised by root feeding of ferrous sulphate solution so as to see whether the palmsdevelop the symptoms of the disease as observed in the field Nine healthy palms were fed continuously with 1.0, 0.5 and 0.1 per cent ferrous sulphate solution through roots At the end of the experiment no toxic symptoms were seen on the palms although they had absorbed on an average 2913, 2874 and 2374 ml of solution containing 29.1, 14.4 and 2.4 g of ferrous sulphate respectively. It had been reported by earlier workers that a dose of 12 g ferrous sulphate per palm was lethal. It now appears that the palm can withstand higher doses of ferrous sulphate without any adverse effect if administered over a longer period and in dilute solution. The leaf samples from the experimental palms have been collected for chemical analysis.

(c) RESEARCHES CONTEMPLATED

Studies on the release of N from different organic manures under the soil conditions existing in arecanut gardens are proposed to be taken up for adjusting the inorganic fertilizer application to the crop. Mobility and availabilty of applied phosphorus in the soil profile will also be studied for adjusting the quantity and mode of its application. Studies on soil from important arecanut growing areas were postponed due to its low priority. Proposed work on analysis of cured products will be taken up when the unit on biochemistry is established. The pot culture studies envisaged will be taken up under the project on yellow leaf disease.

**Programme of work for 1967**

| | Number and name of project | Venue of work |
|---|---|---|
| C. 1. | Release of nitrogen to arecanut from different organic manures | Vittal |
| C. 2 | Mobility and availability of applied phosphorus in soil profile | Vittal |
| C. 3. | Comparative study of different green manure and cover crops and their organic matter adding capacity. | Vittal, Mohitnagar, Peechi, Hirehalli and Kahikuchi |

| | | |
|---|---|---|
| C. 4. | Standardisation of sampling technique for plant sample | Vittal |
| C. 5. | Studies on nutrient exhaustion by arecanut palm | Vittal |
| C. 6. | Studies on composition changes in soil and plant by continuous use of fertilizers, manures and cultural practices | Vittal |

## PLANT PHYSIOLOGY

(In-charge Dr. A. R Kalbande)

### SUMMARY OF SALIENT FINDINGS

Field survey of the diseased gardens showed that they are highly neglected from the point of soil conservation, intercultivation, manuring, plant protection etc. The disease was found to affect plants of three years age and above only. Older leaves of the crown, first show the symptoms of the disease. In the field experiments application of macro and micro nutrients was taken up. Quarterly and annual observations were also recorded for assessing the pre and post treatment effect of the application of nutrients on the palms. Chemical analysis of soils showed that the soils from Jayapura centre are strongly acidic and are high in organic carbon content. Punalur soils were seen to have low available nitrogen content.

### (b) RESEARCHES IN HAND

#### IX COMPREHENSIVE PACKAGE PLAN SCHEME

Work on this scheme intended to investigate the role of macro and micro (Fe, B, Zn, Mn and Mg) nutrients in different combinations on the incidence and control of yellow leaf disease of arecanut and initiated towards the close of 1965 at four centres in disease affected areas of Kerala and Mysore states was continued.

1) Field survey of the package plan unit areas

Field survey was taken up in about 50 per cent of the gardens proposed for this purpose in all the four centres to observe the visual symptoms, spread of the disease and the influence of factors such as rainfall, soil, topography, water table, cultural practices etc., on the occurrence of the disease. The following preliminary observations have been made:

i. The disease was found to affect only plants of three years age and above.

ii. In southern Kerala cultivation of arecanut was seen to be mostly on hill slopes giving no attention to soil conservation practices. At Annamanada centre most of the infected gardens were found to be submerged under flood water during rainy season.

iii. In general the cultivation practices adopted were found to be highly inadequate.

iv. Intercropping with coconut, pepper, tapioca, jack, banana, coffee etc., was observed in majority of the gardens.

v. Adequate drainage facilities had not been provided in most of the gardens.

vi. Pests such as spindle bug. mites, root grubs, etc. and diseases such as *koleroga* and *band* were very common in most of the gardens and no control measures were being followed.

(2) Field layouts

The field experiments consist of application of different macro and micro nutrients alone and in combinations as per the following treatments laid out on a randomised block design.

A. N P K (Ammonium sulphate 140 g, Super phosphate 225 g and Muriate of potash 115 g or wood ash 2 kg) plus 11 kg cattle manure per palm

B. As in treatment A + lime at 1 kg/palm

C. As in treatment B + Ferrous sulphate (57 g/palm)

D. As in treatment B + Sodium borate (23 g/palm)

E. As in treatment B + Zinc sulphate (23 g/palm)

F. As in treatment B + Manganese sulphate (68 g/palm)

G. As in treatment B + Magnesium sulphate (68 g/palm)

H. Control—healthy palms receiving garden owner's usual treatment

I. As in treatment B + Manganese sulphate (68 g/palm) + Magnesium sulphate (68 g/palm)

J. As in treatment I + Zinc sulphate (23 g/palm)

K. As in treatment I + Sodium borate (23 g/palm)

L. As in treatment I + Zinc sulphate (23 g/palm) + Sodium borate (23 g/palm).

M. Control—Diseased palms receiving garden owner's usual treatment.

Out of the large number of gardens surveyed 23 gardens were finally selected at four centres to lay out 27 replications. Quarterly and annual observations were being regularly taken for assessing the pre and post treatment performance of the experimental palms. First dose of nutrients as per treatment specifications was applied once in 1966 in 24 replications while three replications at Punalur centre received two doses, first in 1965 and second in 1966.

(3) Chemical analysis of soil and plant tissues

Before the application of nutrients, soil samples from all the treatments were collected to study the pretreatment nutritional status of the soils. Plant samples were also collected from each treatment simultaneously. It was seen from the analytical data of the soils from Jayapura that it is strongly acidic

with high organic carbon content. Soil samples from Punalur centre were observed to have low available nitrogen content.

(c) RESEARCHES CONTEMPLATED

Pot culture studies have been proposed to be taken up for studying the symptoms due to nutritional imbalance.

**Programme of work for 1967**

| Number and name of the project | Venue of work |
|---|---|
| PP. 1. Scheme on comprehensive package plan trials on yellow leaf disease of arecanut<br>a) Survey for assessing the area affected by yellow leaf disease<br>b) Field experiments (with macro and micro nutrients) in growers fields<br>c) Chemical analysis of soil and plant tissues and nuts | Vittal, Koothattukulam, Annamanada, Jayapura and Punalur. |

## ENTOMOLOGY

(S. N. Seshadri)

### SUMMARY OF SALIENT FINDINGS

Laboratory trials conducted with different acaricides against red mite have shown that Kelthane at 1.86 cc per litre of water has the maximum ovicidal effect. Field trials laid out at Peechi and Hirehalli have shown that Kelthane E.C., Kelthane W. P., Trithion and Akar-338 are effective against mites. Biological control of mites taken up in collaboration with Common-Wealth Institute of Biological Control, Bangalore showed that *Phytoseilus persimilis* is predatory on both red and white mites. The inflorescence caterpillar was found to damage 3.5 per cent of the inflorescences. The sporadic occurrence of slug caterpillar could be controlled by spraying DDT 50 per cent W. P. Two insects *Mcrismus carinatus* and *Acanthopsyche plagiophelphs* were recorded as new pests on arecanut.

### (a) RESEARCHES COMPLETED

#### X. 1. CONTROL OF MITES

Field trials conducted in the earlier years at the Central Station had shown that Kelthane and Trithion are effective in checking reinfestation of mite colonies. Laboratory tests were conducted during the year to assess the ovicidal efficacy of five acaricides viz., (1) Akar-338 (1 cc), (2) Kelthane (0.93 cc), (3) Kelthane (1.86 cc), (4) Trithion (1.26 cc) and (5) Mitex (1.2 cc) all per litre of water against red mite *(Raoiella indica)*. The control consisted of spraying with water alone. The results of laboratory experiment done on a randomised block design in respect of red mite is given below:

TABLE 1

**Mean percentage of hatching**

| Treatments | Observation made after | | | | |
|---|---|---|---|---|---|
| | 24 hours | 48 hours | 72 hours | 96 hours | 120 hours |
| Kelthane 0.93 cc per litre | 14.13 | 15.45 | 17.10 | 18.75 | 18.75 |
| Kelthane 1.86 cc per litre | 2.91 | 2.91 | 3.31 | 3.75 | 3.75 |
| Trithion | 5.00 | 6.23 | 8.85 | 8.75 | 8.75 |
| Akar-338 | 7.93 | 10.43 | 10.85 | 11.65 | 11.65 |
| Mitex | 9.18 | 12.25 | 12.96 | 12.41 | 12.91 |
| Control | 27.50 | 44.58 | 54.18 | 79.57 | 95.40 |
| S. E. Treatment mean | 5.21 | 6.86 | 6.77 | 5.18 | 4.01 |
| C. D. (P. 0.05) | 10.58 | 13.93 | 13.74 | 10.51 | 8.14 |

From the above it can be seen that Kelthane at 1.86 cc per litre of water has the maximum ovicidal effect. Field trials laid out at Peechi and Hirehalli with seven acaricides showed that Kelthane E. C., Kelthane W. P., Trithion and Akar-338 are effective against mites.

MISCELLANEOUS

The caterpillar of the pest *Spatulifimbira gresia* Herring was found in a sporadic form during the year in the bulk and experimental plots of the Central Station. The larval stage of the pest which appeared in the months of January to April was found to feed voraciously on the under surfaces of arecanut leaves. In severe cases the plant is almost defoliated. Large scale field trials taken up in the control of the pest showed that DDT 50 per cent W. P. is effective in controlling the same.

At the Regional Station, Hirehalli, an Orthopterous pest *Morismus carinatus* Wlk. was found to damage the leaf blades of young arecanut palms. A psychid pest, *Acathopsyche plagiophelps* Hampson was also found to do similar damage at the same station. The former pest has been found to be effectively controlled by spraying or dusting the seedlings with DDT 50 per cent W. P. or BHC 10 per cent dust at 4 kg per hectare twice at an interval of 15 days.

(b) RESEARCHES IN HAND

X 1. CONTROL OF MITES

A laboratory trial against white mite *(Paratetranychus indicus)* with different acaricides was in progress. Biological control of the pest was initiated in collaboration with the Common Wealth Institute of Biological Control, Bangalore. An imported predaceous mite, *Phytoseilus persimilis* has been found to feed both on the red and white mites of arecanut. Further work is in progress.

X. 2. CONTROL OF WHITE GRUB

The grubs of a cockchafer beetle *(Leucophelis bermeisteri)* feeds on the tender roots of arecanut and cause considerable reduction in the yield and vigour of palms. In severe cases of infection the trees will succumb to the attack. Of late, the pest has gained serious proportions. The life history of the pest was being studied during the period by rearing the grubs in pots planted with arecanut seedlings. Attempts made to rear the grubs under laboratory conditions on tubers of yam, sweet potato and potato did not succeed.

X. 3. STUDIES ON THE BIOLOGY AND CONTROL OF INFLORESCENCE CATERPILLAR

A survey was taken up towards the close of the year to assess the incidence of the pest. Observations made on 750 palms of the Research

Station showed that inflorescences to the extent of 3.5 per cent are damaged by the pest. Damage due to snail which is supposed to be a predisposing factor for the attack of the inflorescence by this pest was found to be 1.5 per cent.

## X. 5. STUDY OF STEM BORER PEST *(XYLEBORUS PERFORANS)* OF ARECANUT PALM AND MODES OF CONTROL

During 1963 64 occurrence of a powder post beetle was reported from Puttur Taluk both on arecanut and coconut palm. The incidence of this pest was again noticed during the year in the farm of the Central Station. The grub of the pest bores into the wood and forms innumerable and irreguiarly running gallaries inside the stem. An attacked stem can easily be recognised by the presence of small circular holes through which frass will be thrown out. In the case of coconut a reddish sap was also found oozing with the frass. The affected palms will succumb easily to the pest. The leaves turn yellow and droop down accompanied with severe nut shedding. The pest was found to be effectively controlled by painting stems with BHC 50 per cent W. P. or Dieldrex at the rate of 2 kg and 631 cc in 100 litres of water respectively.

## (c) RESEARCHES CONTEMPLATED

Methods of control of red ants and scales and study of symbiotic relationship between these are to be taken up. The insect which causes severe tender nut fall is to be trapped and identified.

**Programme of work for 1967**

| Number and name of the project | Venue of work |
|---|---|
| E. 1. Biological control of mites | Vittal |
| E. 2. Studies on the control of the inflorescence caterpillar *(Tirathaba mundela)* | Vittal |
| E. 3. Study on the biology and control of white grub *(Leucopholis bermeisteri)* | Vittal and Hirehalli |
| E 4. Study of the stem borer pest *Xyleborus perforans* of arecanut palms and mode of control | Vittal |
| E. 5. Bionomics and control of spindle bug | Palode, Peechi and Vittal |
| E. 6. Survey for assessing crop losses due to pest<br>a) Mites (b) two indle bug<br>c) Inflorescence caterpillar<br>d) Rootgrub borer | Vittal, Palode, Peechi, Hirehalli and Mohitnagar |

## PATHOLOGY

(T. S. S. Rawther)

### SUMMARY OF SALIENT FINDINGS

Laboratory screening trials with different fungicides against *Phytophthora arecae* showed that Mercurised copper oxychloride, Blitane and Bordeaux mixture effectively checked the fungal growth. In the spraying trials for the control of *Koleroga* using low volume equipment it was observed that the chemicals could reach 12 to 15 meters height when sprayed from the ground. Fycol 8E was observed to produce phytotoxic effects on the leaves of the sprayed palms. Large scale spraying trials against button shedding and tender-nut fall have shown that summer sprayings (April, May) with Bordeaux mixture alone or in combination with B H C reduced the shedding.

### (a) RESEARCHES COMPLETED

### XI. 1. TRIALS IN THE CONTROL OF *KOLEROGA* OR *MAHALI* (FRUIT-ROT) USING FUNGICIDES WITH AND WITHOUT ADHESIVES

A laboratory assay with certain of the fungicides initiated in the previous year was continued using the "poison media technique". Results obtained are given below.

TABLE 1

**Growth of Phytophthora arecae**

| Name of the fungicide | Mean diameter of colony in cm | | | |
|---|---|---|---|---|
| | 2nd day | 3rd day | 4th day | 5th day |
| Fytolan | 1.1 | 1.3 | 1.5 | 1.7 |
| Microcop | 0.8 | 1.1 | 1.5 | 1.7 |
| Coppesan | 1.0 | 1.5 | 1.5 | 1.8 |
| Blitane | nil | nil | nil | nil |
| Mercurised copper oxychloride | nil | nil | nil | nil |
| Bordeaux mixture | nil | nil | nil | nil |
| Control | 1.7 | 2.3 | 2.8 | 3.3 |

It can be seen from the above table that Mercurised copper oxychloride, Blitane and Bordeaux mixture have totally checked the growth of the fungus.

### XI. 5. STUDIES ON THE CONTROL OF TRUNSCORCHING

Damage to the stems of arecanut palms c[Sp]y sunscorch on South western side of the palms accounts for huge lo[nce] f threes annually. It has been observed from previous years' trials that [ ]pahe affords protection

equal to that afforded by leaf sheath and that the film could be used for more than one season. The trial was continued and the economics of using polythene film in comparison with that of leaf sheath worked out. It was observed that polythene, though costlier, can be repeatedly used for two to three seasons and hence is economical in the long run. At Hirehalli also, it was observed that polythene can afford good protection against sunscorching of stem.

(c) RESEARCHES IN HAND

XI. 1. TRIALS IN THE CONTROL OF *KOLEROGA* OR *MAHALI* (FRUIT-ROT) USING FUNGICIDES WITH AND WITHOUT ADHESIVES

*Koleroga* or *Mahali* caused by the fungus *Phytophthora arecae* is one of the major diseases of arecanut palm and accounts for enormous losses of crop in most of the arecanut growing tracts. The fungus can be effectively controlled by spraying one per cent Bordeaux mixture, but preparation and spraying of the same in the monsoon months of June-July are confronted with various problems. The efficacy of copper oxychlorides such as Blitox, Fytolan, Coppesan, Microcop (each @ one kg in 200 litres of water) and Fycol 8E (578 gm in 100 litres of water) as wel as certain other formulations like Du-Ter, Brestan (1 kg in 800 litres of water) and Blitane (578 gm in 100 litres of water) which can easily be prepared in comparison with Bordeaux mixture was compared. Since there was only mild incidence of the disease the fungicide could not be evaluated critically. There was very stray incidence of infection in the plot sprayed with Fycol 8E.

To explore the possibility of controlling *Koleroga* by low volume sprays, a feeler trial using Oleocop 50 per cent and P. L. copper 40 (copper oxychlorides) in oil was taken up. A shoulder carrying Mini-micron 77 unit was used for spraying the chemicals. It was observed that the chemical could reach 12-15 meters height when sprayed from the ground. A large scale trial was, therefore, taken up with Fycol 8E and Oleocop (2.5 litres of each chemical in 17.5 litres of sovaspray) and Fycol 8E (2.5 litres in 30 litres of water). The control plot was sprayed with one per cent Bordeaux mixture using a normal high volume rocker sprayer. Due to lack of incidence of the disease the treatments could not be evaluated. A similar field trial was laid out at Peechi with Fycol 8, Fycol 8E (both in oil), Captan and Bordeaux mixture. The latter two were sprayed with a rocker sprayer. Fungicides could not be evaluated due to non-occurrence of the disease. Phytotoxic effect was, however, observed on leaves of palms sprayed with Fycol 8E.

## XI. 2. TRIALS TO INVESTIGATE THE CAUSES AND METHOD OF CONTROL OF BUTTON SHEDDING AND TENDER NUT FALL

It had been observed that large scale shedding of buttons and tender nuts is associated with fungus and insect attack. The large scale spraying trials with different fungicides and insecticides in combination which had been initiated in earlier years to control the fungus and insect were continued. The results showed that spraying the bunches twice, once in April and once in May with one per cent Bordeaux mixture alone gives an increase in yield of 21 per cent over the unsprayed control. Addition of any of the insecticides did not improve the yield. However, during the previous trial Bordeaux mixture plus Endrex had given the maximum reduction in shedding. The reduction in the efficacy of the insecticides during the year may be due to the lesser incidenee of insect pest.

In a similar trial laid at Peechi, a combination of Bordeaux mixture and BHC gave 13 per cent more of nut-set than control. This result is in conformity with previous result obtained at this station. The trial repeated during 1966 at the Central Station showed that the treatment differences are not significant.

## XI. 11. INVESTIGATIONS ON THE YELLOW LEAF DISEASE

### a. Pathological aspects

*a) Symptomatology:* Symptomatological studies commenced earlier were continued. The first visible symptom of the disease was found to be yellowing at the tip of leaflets in two or three leaves of the outermost whorl. Rotting of the root system of palms in the advanced stage of infection to a greater extent was also observed. The difference in the condition of roots between healthy and diseased palms in the initial stages of infection was not appreciable. Majority of the palms showing foliar yellowing was also showing discolouration of kernel.

*b) Mycological studies:* Fungi associated with the roots of diseased palms consisted of *Trichoderma* sp., *Pestalotia* sp., *Aspergillus* sp., *Penicillium* sp. and *Fusarium* sp. Pathogenicity tests conducted with *Trichoderma* and *Fusarium* have not shown any appreciable adverse effect of the organisms on the roots.

*c) Study of virus association and transmission of disease:* In order to determine if any virus or viruses are associated with the disease, transmission studies adopting different methods commenced during the earlier years were continued. The following results were obtained

*(i) Sap transmission study:* Sap transmission studies on 125 arecanut palms with leaf sap from diseased arecanut trees initiated in 1964 were continued. None of the palms under observations has developed the disease symptom. Another set of 36 arecanut seedlings raised in pots and kept in the insect proof house at the Central Coconut Research Station,

Kayamkulam and similarly transmitted with diseased arecanut leaf sap at monthly intervals also did not develop any disease symptom. Transmission studies with leaf sap from diseased palms were also made on other host plants such as *Datura stramonium, D fastuosa, D. tatula, Vicia faba, Lycopersicon pimpinellifolium, L. esculentum, Vigna* sp., *Canavalia ensiformis, Jatropha curcas, Stachytarpheta* sp., *Gomphrena* sp , *Manihot utilissima, Physalis minima, Naragamia* sp., *Ageratum conizoides* and *Vinca* sp. None of the plants developed any symptom of virus infection.

*ii) Soil transmission:* Seedlings of cowpea and *Canavalia ensiformis* raised under three different media viz , 1) soils collected from the base of diseased palms, 2) soils rendered sterile and 3) soils collected from the base of healthy palms failed to show any disease symptom.

*iii) Insect transmission studies:* Spindle bug *(Carvalhoia arecae)* which is a common pest of arecanut was collected and released on healthy arecanut seedlings after starvation and acquisition feeding on diseased leaves. The plants did not develop any disease symptom

*iv) Examination of plant material for the presence of virus:* Grids prepared with extract of the diseased arecanut leaf and examined in the electron microscope also did not show the presence of any virus-like particles

*d) Study of insects, mites, nematodes etc., in relation to the incidence of disease:* Soil and root samples collected from the base of healthy and diseased arecanut palms were examined for the presence of nematode population. Seven forms viz., 1) *Rotylenchus* sp., 2) *Meloidogyne* sp., 3) *Hoplolaimus* sp., 4) *Pratylenchus* sp., 5) *Helicotylenchus* sp., 6) *Tylenchorhynchus* sp., and 7) *Xiphinema* sp., were obtained. Further studies on the pathogenicity of the above nematodes on arecanut palms are in progress.

*e) Physiological studies - Study of the effect of administering micronutrients into the plant tissue through roots and leaves:* Leaflets of palms showing yellow leaf disease symptoms were dipped in aqueous solutions of manganese sulphate (0.005, 0.01 and 0.02 per cent), magnesium sulphate (0.5, 1.0 and 2.0 per cent) manganese sulphate + magnesium sulphate (1.0, 2.0 and 5.0 per cent), and ferrous sulphate (0.005, 0.01 and 0.02 per cent). No perceptible change in foliar symptom was noticed. Similarly spraying the leaves of trees showing yellow leaf disease symptoms with aqueous solution of manganese sulphate and magnesium sulphate also did not bring about any appreciable change in the colour of leaves. In another set of trial, micronutrients (manganese sulphate 0.02 per cent, magnesium sulphate 2.5 per cent and ferrous sulphate 0.3 per cent) were fed into the foliage by cutting the distal end of the rachis and dipping the ends so cut into solutions contained in test tubes The trees are under observation.

b. Botanical aspects

*i and ii) Collection of indigenous and exotic species and types of arecanut for studying their performance with special reference to the incidence of the disease*: In the collection plot indigenous types collected from Assam, West Bengal, Mysore, Kerala and Madras and exotic types introduced from Indonesia, Andaman, Nicobar, Australia, Fiji and Saigon were raised and kept under observation. All the palms remained healthy during the period.

*iv) Trials of seed materials irradiated with X-ray, ultraviolet rays etc. to isolate strains resistant to yellow leaf disease:* Eight seedlings raised from seednuts irradiated with Gamma rays (10,000 rads) during 1963-64 and planted in the field remained healthy during the period. Another set of 36 seedlings raised from seednuts irradiated with 10,000 rads and 41 seedlings raised from seednuts irradiated with 5,000 rads were planted.

*v) Histopathological studies*: Samples of stem and leaves of healthy and diseased plants were collected and fixed for further studies.

c. Agronomical aspects

*i) Influence of macro and micronutrients and irrigation on the incidence of yellow leaf disease*: An experiment with five treatments viz, 1) no manure and no cultivation, 2) N P K fertilizers with irrigation, 3) N P K fertilizers without irrigation, 4) N P K fertilizers and micronutrients with irrigation and 5) N P K fertilizers and micronutrients without irrigation and replicated five times is in progress since 1961-62. Nitrogen at 23 kg, P at 34 kg and K at 34 kg per 500 palms were applied over a basal application of 11.5 kg of green leaf or compost per palm. The micronutrients applied consisted of ferrous sulphate 23 kg, sodium borate 9 kg, manganese sulphate 27 kg, calcium oxide 68 kg, copper sulphate 9 kg zinc sulphate 9 kg, magnesium oxide 18 kg and sulphur 2.3 kg, each per 500 palms. The palms in all the treatments remained healthy during the period. Growth measurements made in connection with the quinquennial observations of the palms revealed that seedlings under 'no cultivation and no manuring' have significantly lesser girth and number of leaves than seedlings in other treatments. Ancillary observations recorded have also shown that palms receiving irrigation have recorded significantly more girth at permanent

mark (75 cm above ground level) and at last exposed node, than plants under no irrigation. Similarly, irrigation was found to influence leaf-fall, flowering and percentage of spadices to leaf fall, palms under irrigation being superior to no irrigation. The effect of addition of micronutrients was not apparent.

*ii) Effect of application of N P K with and without lime on disease incidence*: This experiment with six treatments viz., 1) N P K at 46, 36 and 68 kg respectively for 500 palms in the form of fertilizers alone, 2) treatment 1 plus lime at 2 kg per plant, 3) N P K at 23, 18 and 34 kg respectively for 500 palms in the form of fertilizers and the rest 23, 18 and 34 kg in the form of organic manures, 4) treatment 3 plus lime at 2 kg per plant, 5) lime alone at 2 kg per plant and 6) no lime and no manure replicated four times was superimposed in 1964 in a garden planted in 1961. Observations made showed that the palms in all the plots are healthy. Growth measurements of palms made in connection with the quinquennial observations also did not reveal any significant difference in the vigour of the palms.

## (c) RESEARCHES CONTEMPLATED

Investigations programmed for the control of button shedding and tendernut fall is being taken up as a project under the Botany section. Studies on yellow leaf spot and collar rot were kept in abeyance because of low priority. A new disease reported from Assam has been included for the study. For estimating the crop loss due to major diseases a survey has been programmed.

**Programme of work for 1967**

| Number and name of the project | Venue of work |
|---|---|
| P. 1. Investigations on 'Koleroga *(Phytophthora arecae)* | Vittal and Peechi |
| a) Trials on the control of 'Koleroga' using low volume spray. | |
| b) Studies on the retention of copper compounds sprayed on the fruits in the field. | |
| c) Studies on the forecasting of the incidence of 'Koleroga'. | |
| P. 2. Investigations on Band disease | Vittal and Mohitnagar |
| P. 3. Investigations on Anabe | Vittal, Hirehalli and Kahikuchi |

| | |
|---|---|
| P. 4. Investigations on yellow leaf disease of arecanut in Kerala, pathological, virus, physiological entomological, agronomic and botanical aspects | Palode |
| P. 5. Survey for assessing crop losses due to disease (a) Koleroga, (b) Anabe | Peechi, Vittal, Hirehalli and Kahikuchi. |
| P. 6. Study of the crown rot disease in Assam | Kahikuchi and Vittal |

## PAPERS PUBLISHED

During the period under report the following technical papers were written up and sent for publication.

1. Bavappa, K. V. A. Morphological and anatomical studies in *Areca triandra* and *Areca catechu*

2. Bavappa, K. V. A. Supari has a substitute

3. Bavappa, K. V. A. and Raman, V. S. Cytological studies in *Areca catechu* Linn. and *Areca triandra* Roxb.

4. Bavappa, K. V. A. and Ramachander, P. R. Improvement of arecanut palm by selection and breeding

5 Kumar, S.N.S. *Acanthopsyche plagiophelphs* Hampson, A new psychid pest on arecanut

6. Kumar, S. N. S., Sannamarappa, M. and Khan, T. A. Occurrence of Rhinoceros beetle on arecanut crop

7. Kumar, S. N. S. and Naidu, G. V. B. *Morismus carinatus* Walk. as a pest on arecanut

8. Naidu, G.V.B., Kumar, S.N.S and Sannamarappa, M. *Ganoderma lucidum* (Leys.) Karst. – A review and further observations

9. Nair, R. B. and Rawther, T. S. S. *Tirathaba mundella* Walk. – A major pest of arecanut palm *(Areca catechu L.)*

10. Nambiar, K. P. P. and Antony, K. J. A plea for raising cover crops in arecanut gardens in Kerala State

11. Seshadri, S. N. A note on the occurrence of *Xyleborus perforans* Woll. on arecanut and coconut

12. Shama Bhat, K. Plantation efficiency in arecanut

13 Thirumaleshwara Bhat, N. Effect of presowing treatments of seed arecanuts on their germination and vigour of seedlings.

14. Thirumaleshwara Bhat, N. Influence of shade in arecanut nursery

# EXTENSION

(a) Results of immediate practical application

(1) *Areca triandra*, a suckering species introduced from outside the country has been found to be suitable for chewing. With its large number of female flowers, high fruit-set, relative resistance to mite, a major pest and good marketable quality it can form a good substitute for *Supari* (*Areca catechu*).

(2) In selecting mother palms for seednut collection such of those palms which commence bearing early alone should be selected. In the Vittal variety, if selection is confined to palms which come to harvest in the fifth year after transplanting, an increase in yield of 8 to 15 per cent can be expected in the progenies.

(3) Some of the seedling characters have been observed to be highly related with their yield performance. Rejection of seedlings which do not have a minimum of five leaves at the time of transplanting ( 18 months old ) and subsequent replacement of such of those which do not attain at least 20 cm girth at collar after one year growth and those which do not develop at least four nodes after two year growth is estimated to give 20 per cent increase in yield. Application of these standards was found to eliminate late bearers in the garden and also uneconomic plants.

(4) In the nursery, it has been confirmed that arecanut seedlings require partial shade for optimum growth.

(5) Of the different inter crops that were tried, elephant-foot-yam (*Amorphophallus campanulatus*)was found to be the most profitable crop for the central Kerala. This crop was found not to affect the main crop of arecanut.

(6) The harvesting trials conducted have confirmed the necessity of choosing only fully ripe bunches for the preparation of good quality *Chali* from ripe fruits.

(b) Results likely to be useful to the farmers but needing further trials

(1) Introductions made from China, Saigon, Ceylon, Indonesia and Singapore appear to be promising as compared to the local. Heavier yield, earliness in bearing, reduced height of the stem and better quality of nut are some of the points in their favour. Further studies to select the best out of the above are underway.

(2) From the spacing trial that is in progress at different centres it has been observed that a spacing of about 2.7 m X 2.7 m is optimum for

obtaining the maximum yield. Palms planted under this spacing had also relatively less sunscorching.

(3) Of the different cover-cum-green manure crops thornless mimosa *(Mimosa invisa var. inermis)* has been found to be promising for arecanut gardens.

(4) Growing banana as an intercrop has been observed to have no adverse effect on the growth of arecanut palms during the initial three-year period of the plantation. If further observations show that the yield of arecanut palms is also not affected by this crop, intercropping with banana will be a very useful proposition.

(5) Chemical as well as biological control of a serious pest of arecanut (mite) have shown that the pest can be controlled by chemicals like Kelthane and Tedion. An imported mite has been found to be predatory on the above pest. Further field studies are under progress.

(6) Investigations on the yellow leaf disease of arecanut which is a major problem of this crop have given very strong evidence in favour of nutritional imbalance as the cause of the disease. Large scale field trials with macro and micro nutrients that are in progress when concluded are expected to provide control measures for the above disease.

(c) Publicity activities

The station celebrated its annual Farmers' Week, which was presided over and inaugurated by Shri G. Narayana Gowda, Minister for Agriculture, Mysore State. It attracted a very large number of cultivators from the adjoining Districts of Mysore and Kerala States. They were taken round the fields and laboratory for giving them an idea about the latest trends in arecanut research. Different departments of the State as well as firms dealing in agricultural implements, chemicals, etc. also participated in the exhibition organised on this occasion which was inaugurated by Shri K. K. Shetty, M. L. C. Agricultural production seminar organised in collaboration with the Vittal National Extension Block development authorities was also held during the week. The Station also participated in the following exhibitions and seminars.

(1) National Agricultural and Industrial Exhibition at Kottayam, (2) District Horticultural Show at Mangalore, (3) Vittal High School Education Exhibition at Vittal, (4) Arts, Industrial and Agricultural Exhibition at Coondapur, (5) Industrial and Agricultural Exhibition at Siddaganga, (6) The Grama Sahayak Training Camp at Muliyar and Adur and (7) Taluk level Seminar on Pachayat Agricultural Production Plan at Vittal.

Growers from many parts of the country were in constant touch with the Central and Regional Stations by visits as well as by correspondence.

Large number of enquiries regarding seednut selection, manurial requirements of the palm, growing of green manure and cover crops, cost of cultivation, methods of processing, identification and control measures of pests and diseases, use of spraying equipments, etc. were attended to. Undergraduate students from University of Agricultural Sciences, Hebbal and Dharwar; Agricultural College, Vellayani; Agricultural College. Bapatla; Gram Sevaks; Inservice Trainees of State Agricultural Department, etc. visited the Research Stations and were imparted training on the different aspects of arecanut cultivation. Besides, the Arecanut Specialist and staff visited different areas of Mysore, Kerala, Madras, Andhra, Assam and West Bengal and gave on the spot advice to growers on suitability of sites for arecanut cultivation and control of pests and diseases. Pamphlets on various aspects of arecanut crop were prepared and passed on to the Development Council, Calicut, for publication. Results of practical utility achieved were sent to Indian Council of Agricultural Research for giving publicity.

## CONFERENCES AND SYMPOSIA

The station sent representatives to the seminar on the use of radio isotopes and radiations in agriculture and animal husbandry organised by the Indian Council of Agricultural Research, the twelfth Annual Scientific Conference of the UPASI Scientific Department, International Symposium on the Impact of Mendelism on Agriculture, Biology and Medicine and the International Symposium on Plant Pathology.

## SUMMARY OF THE REPORT

Collection of foreign varieties and testing their performance under the conditions prevailing at the Central Station, Vittal and at different Regional Centres viz. Peechi and Palode of Kerala, Hirehalli of Mysore, Kahikuchi of Assam and Mohitnagar of West Bengal were continued. Among the introductions made in the earlier years, types introduced from China, Saigon, Ceylon and Singapore are promising as comapred to the local. The produce obtained from these types was put in the market to test their demand and evaluate the produce. All of them fetched price comparable with that of the local. Another species viz. *Areca triandra* which has not so far been reported to be useful for chewing was subjected to chewing test and found suitable for the purpose. This variety produces suckers and a much larger number of fruits per tree unlike other varieties that are commonly cultivated and is relatively resistant to the attack of mites. Studies on the flowering habit of the various introductions as well as those in the progeny garden of the Station were made. The studies revealed that the maximum production of inflorescences during the months

of January to March is influenced by the variability in the rate of leaf fall as well as by the variability in the percentages of inflorescences to leaves shed. It also confirmed the earlier finding that arecanut is mostly cross-pollinated. Crossing programmes with the object of combining characters like semi-dwarfness, number of inflorescences, high set and better quality of kernel were initiated. Studies on the yield data of progenies of known mother palms indicated that the performance of these progenies did not have any bearing with the yielding behaviour of their mother palms. Palms which come to first bearing early were found to be high yielders. Age at bearing was also found to be transmitted to the progenies to a great extent. A programme for improving the quality of planting material based on screening of families and individuals within the family was evolved.

Trials for standardising nursery practices which were in progress for the last few years were concluded. In the final set of observations made, it was confirmed that partial shade is required for optimum growth and maximum out-turn of plantable seedlings. In a transplanting trial it was observed that plants which are planted in the mainfield earlier are more vigorous and early bearing than those which had been retained in the nursery for longer durations and then transplanted. A trial for determining the optimum spacing to be given for arecanut palms was in progress since 1958. Among the various spacings tried the yield obtained from the plots with trees spaced at 2.7 m X 2.7 m was maximum. It was also observed that planting trees at wider spacings of more than 2.7m X 2.7 m subjects the trees to sunscorch to very great extent. Study on the root system of arecanut palm revealed that in general the maximum concentration of root spread is within a radius of 100 to 125 cm from the stem and a depth of 100 cm from ground level. An experiment to determine the optimum depth of planting arecanut seedlings and optimum intervals of irrigation to be given to them was in progress at Regional Arecanut Research Station, Peechi, since 1962. The observations so far made revealed that palms irrigated once in three days and those planted at 90 cm depth are more vigorous than those irrigated at wider intervals and planted at lesser depths. Among the different cover cum green manure crops tried the thornless Mimosa *(Mimosa invisa)* was most promising for arecanut gardens. Of the various intercrops tried at Peechi, elephant foot yam *(Amorphophallus campanulatus)* was found to be the most profitable and suitable crop for the central Kerala area. A trial at Vittal with banana as intercrop revealed that the same has no adverse effect on the growth of arecanut palms during the initial three years of the plantation. Trials were also in progress to find out the possibility of raising mixed gardens of arecanut and cacao and arecanut and coconut. A study in progress

at Palode on the different methods of raising arecanut gardens on hill slopes indicated that seedlings planted on terraces formed along the contour and receiving clean cultivation and manuring have better growth than those planted under other systems. Trials on N P K manurial requirements of arecanut in progress at Central and Regional Stations revealed that application of nitrogen at 25 and 50 kg and green leaf at 3400 and 6800 kg for 500 palms induced early production of spadices and greater vigour in the palms. Application of potash was found to increase number of nodes and girth at Peechi. A harvesting trial conducted at Vittal confirmed the necessity of choosing only fully ripe bunches for the preparation of good quality *Chali* (whole dry kernel).

A technique for forecasting the crop yield in arecanut, four to five months prior to the harvest season has been worked out. Two samples of 12 kg each of ripe nuts drawn from a given lot at random was found to be sufficient for determining the percentage of kernel weight to wet weight. A selection programme for the South Kanara variety involving rejection of seedlings which do not have a minimum of five leaves at the time of planting 18 month old seedlings and subsequent replacement of such of those which do not attain at least 20 cm girth at collar after one year growth and those which do not develop at least four nodes after two years of growth is estimated to give 20 per cent increase in yield. Since age at bearing was found to be transmitted to the progenies to a great extent choosing seednuts from palms which come to bearing in the fifth year of transplanting is expected to give an yield increase of 8 to 15 per cent. Seedling selection as detailed above was also found to eliminate the uneconomic palms as well as late bearers in the gardens. Studies to determine the relationship between yield and yield attributes as well as morphological characters were also in progress.

From the analytical data of the soils from N P K manurial trial at Vittal it was seen that the application of organic and inorganic manures for the first two years has not affected the total as well as available nitrogen content of the soil. Different parts of one and half year old areca seedlings when analysed were seen to contain on an average 75 to 80 per cent moisture and 3.05 to 5.48 per cent ash on oven-dry basis. In order to study the composition and nutritional changes brought about in the soil and plants by the continuous application of manures and fertilizers and adoption of cultural practices an experiment was designed. Of the different green manure crops that were tried in the arecanut garden *Stylosanthes gracilis* was seen to raise the organic carbon content of the soil. The iron content of the healthy plant tissues was being raised by feeding ferrous sulphate solution of different concentrations through roots. No toxic symptoms were noticed even after the plants had absorbed a maximum of 29.1 gm of ferrous sulphate

as against the reported lethal dose of 12 gm. This might be due to the feeding of the dilute solution spread over a long period.

Field survey of 50 per cent of the yellow leaf diseased gardens proposed to be surveyed showed that no attention was being paid towards cultivation practices in most of the gardens. Intercropping of coconut, banana, tapioca, coffee, pepper, etc. was very common with highly inadequate manuring for both arecanut and other crops. In low lying areas drainage was inadequate while no soil conservation practices were being followed in the gardens planted on hill slopes. Infestation with pests like spindle bug and mites and diseases like bud rot and koleroga which were very common went unchecked.

Among the different insecticides tried for the control of mite, a major pest which feeds on the areca leaves, Kelthane at 1.86 cc per litre of water was found to be most effective in killing the eggs as well as adults. Trials to control the mites by use of predatory mites were also initiated. Spraying with DDT 50 per cent W.P.D. was found to control the slug caterpillar. Two new pests were recorded on arecanut.

Laboratory trials with different fungicides against *Phytophthora arecae*, which causes Koleroga showed that chemicals like mercurised copper oxychloride, Blitane and Bordeaux mixture effectively checked the fungal growth. Trial on the control of *Koleroga* in the field using low volume equipment showed that the chemicals could reach 12 to 15 meters height when sprayed from the ground. Spraying the bunches with Bordeaux mixture (either alone or in combination with BHC) during summer (April and May) was found to reduce the shedding of tendernuts. Investigations conducted at Palode on the possible causes of yellow leaf disease revealed that virus is not the likely cause of the disease. Collections of exotic and indigenous types of areca were maintained at this centre to study their performance in relation to the disease.

# PERSONNEL

## Retirements, promotions, transfers

Sarvashree K. K. Uthappa, Nursery Assistant, Vittal; S. N. Seshadri Research Assistant (Entomology), Vittal; C. K. Mathai, K. Vellaichamy and B. Nagaraj, Research Assistants (Agronomy) Vittal,; C. Devaraju, Research Assistant (Chemistry), Vittal; Tufail Ahamed Khan, Farm Assistant, Hirehalli; V. N. Dambal, Junior Accounts Officer, Vittal and V. L. Kurian, A. V. Bhaskaran and K. Raghava Rao, Administrative Assistants, Vittal, joined duty during the period. Shri K. N. Murthy, Research Officer, Kahikuchi and Shri P. Muddappa Gowda, Senior Research Assistant (Agronomy), Vittal, also joined their respective posts after completing their post graduate courses. Shri K. P. Padmanabhan Nambiar, Research Officer, Peechi, consequent on his reversion to his parent department in Kerala State was relieved of his duties as Research Officer.

**Staff Section wise:**

**Central Arecanut Research Station, Vittal**

| | |
|---|---|
| Arecanut Specialist | Shri K. V. Ahamed Bavappa, M. Sc. (Ag.) |
| **Botany:** | |
| Botanist | Vacant |
| Senior Research Assistant | Vacant |
| Research Assistant | Vacant |
| **Agronomy:** | |
| Agronomist | Shri K. Shama Bhat, M. Sc. (Ag.) |
| Senior Research Assistant | Shri P. Muddappa Gowda, M. Sc. (Ag.) D. H. |
| —do— | Kumari M. Leela, B. Sc. (Ag.) |
| Research Assistant | Shri K. B. Abdul Khader, B.Sc. (Ag.) |
| —do— | Vacant |
| **Farm:** | |
| Farm Superintendent | Shri K. J. Abraham, B.Sc. (Ag.) |
| Farm Assistant | Vacant |
| Nursery Assistant | Vacant |
| **Statistics:** | |
| Statistical Officer | Shri P. R. Ramachander, M. A., Diploma in Statistics (I. C. A. R.) |
| **Chemistry:** | |
| Soil Chemist | Dr. A. R. Kalbande, Ph. D., Assoc I. A. R. I. |

| | |
|---|---|
| Senior Research Assitant | Shri N. Tirumaleshwar Bhat, B.Sc. (Ag.) |
| **Pathology:** | |
| Pathologist | Vacant |
| Senior Research Assistant | Vacant |
| **Entomology:** | |
| Entomologist | Vacant |
| Research Assistant | Shri S. N. Seshadri, B.Sc. (Ag.) |
| **Administration:** | |
| Assistant Administrative Officer | Shri N. K. Srinivasa Murthy, B.Com. |
| Junior Accounts Officer | Shri V. N. Dambal, B. A. (Hons.) |
| Assistant | Shri V. L. Kurian |
| —do— | Shri A. V. Bhaskaran |
| —do— | Shri K. Raghava Rao |
| —do— | Vacant |
| —do— | Vacant |

**Comprehensive Package Plan Scheme:**

| | |
|---|---|
| Research Officer (Plant Physiology) | Vacant |
| Research Assistant (Agronomy) | Shri B. Nagaraja, B.Sc. (Ag.) |
| —do— | Shri C. K. Mathai, B Sc. (Ag.) |
| —do— | Shri K. Vellaichamy, B.Sc. (Ag.) |
| —do— | Vacant |
| Research Assistant (Chemistry) | Shri C. Devaraju, B Sc. (Ag.) |

**Regional Arecanut Research Station, Peechi**

| | |
|---|---|
| Research Officer | Vacant |
| Research Assistant (Pathology) | Shri C. S. Abraham, M.Sc. (Ag.) |
| Research Assistant (Agronomy) | Shri K. J. Antony, M.Sc. (Ag.) |
| Farm Assistant | Shri M. Vijayarajan, B.Sc. (Ag.) |

**Regional Arecanut Research Station, Palode**

| | |
|---|---|
| Research Officar | Shri T. S. S. Rawther, M.Sc. |
| Senior Research Assistant (Botany) | Shri R. Balakrishnan Nair, B.Sc. |
| Research Assistant (Agronomy) | Shri E. Velappan, B.Sc. (Ag.) |
| Farm Assistant | Vacant |

**Regional Arecanut Research Station, Hirehalli**

| | |
|---|---|
| Research Officer | Vacant |
| Research Assistant (Agronomy) | Shri M. Sannamarappa, B.Sc. (Ag.) |

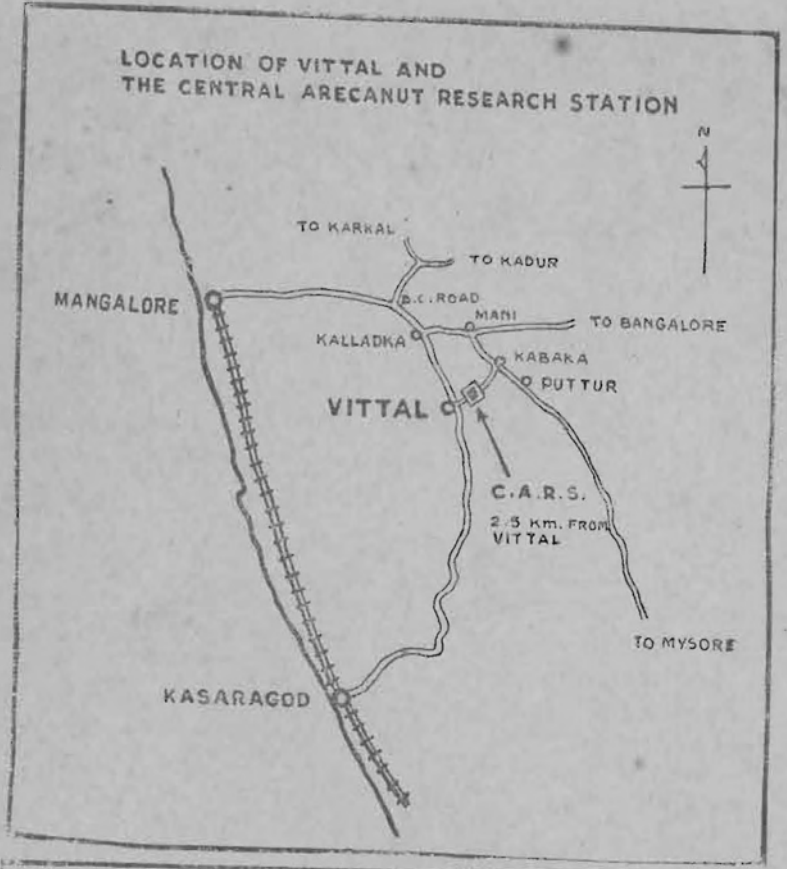
| | |
|---|---|
| Research Assistant (Pathology) | Shri S. N. Sampath Kumar, B.Sc. (Ag.) |
| Farm Assistant | Shri Tufail Ahamed Khan, B.Sc. (Ag.) |

**Regional Arecanut Research Station, Mohitnagar**

| | |
|---|---|
| Research Officer | Shri S. C. Paul, B Sc., B.Ag., Assoc. I. A. R. I. |
| Research Assistant (Agronomy) | Vacant |
| Research Assistant (Pathology) | Vacant |
| Farm Assistant | Vacant |

**Regional Arecanut Research Station, Kahikuchi**

| | |
|---|---|
| Research Officer | Shri K. Narasimha Murthy, B.Sc. (Ag.) |
| Research Assistant (Agronomy) | Shri R. K. Bhattacharya, B.Sc. (Ag.) |
| Research Assistant (Pathology) | Vacant |
| Farm Assistant | Vacant |


LOCATION OF VITTAL AND
THE CENTRAL ARECANUT RESEARCH STATION
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TO KADUR
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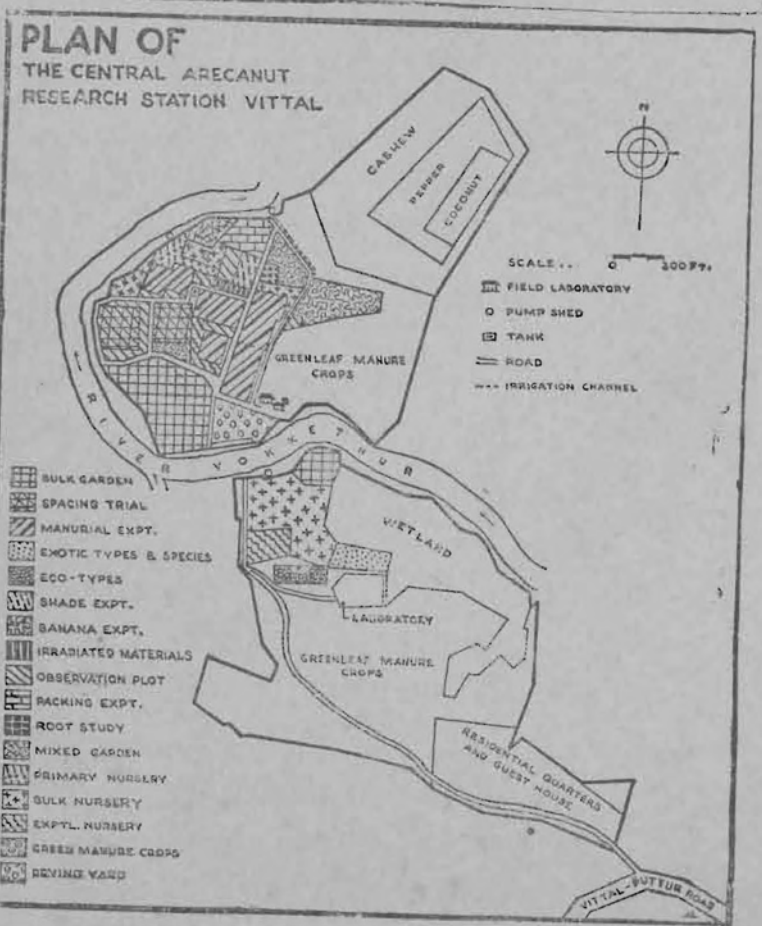
TO MYSORE
KASARAGOD


PLAN OF
THE CENTRAL ARECANUT
RESEARCH STATION VITTAL
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CASHEW
PEPPER
COCONUT
SCALE :
FIELD LABORATORY
PUMP SHED
TANK
ROAD
IRRIGATION CHANNEL
GREENLEAF MANURE CROPS
RIVER YOKKETHUR
WETLAND
LABORATORY
GREENLEAF MANURE CROPS
RESIDENTIAL QUARTERS AND GUEST HOUSE
VITTAL-PUTTUR ROAD
BULK GARDEN
SPACING TRIAL
MANURIAL EXPT.
EXOTIC TYPES & SPECIES
ECO-TYPES
SHADE EXPT.
BANANA EXPT.
IRRADIATED MATERIALS
OBSERVATION PLOT
PACKING EXPT.
ROOT STUDY
MIXED GARDEN
PRIMARY NURSERY
BULK NURSERY
EXPTL. NURSERY
GREEN MANURE CROPS
REVINE YARD