# NRCS

## annual report 1988-89



NATIONAL RESEARCH CENTRE FOR SPICES
CALICUT 673 012, KERALA, INDIA

# NRCS
# ANNUAL REPORT 1988-'89




National Research Centre for Spices
Calicut 673 012, Kerala, India

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# *Director's introduction*

India, the land of spices contributes a major share of world's spice production. Spice crops with high export potential are an important source of foreign exchange earnings. Initially Indian Council of Agricultural Research (ICAR) was supporting several ad-hoc schemes on spices upto 70s. In order to strengthen the research efforts on major spices and grain spices, ICAR established All India Coordinated Spices and Cashewnut Improvement Project during 1971 at Central Plantation Crops Research Institute (CPCRI), Kasaragod. In view of the increased importance of these crops, ICAR established a Regional Station of CPCRI at Calicut during November, 1975 to further intensify research on all major spices *viz.*, black pepper, cardamom, ginger, turmeric, clove, cinnamon and nutmeg. During the VII Five Year Plan period, ICAR elevated the CPCRI Regional Station, Calicut to the National Research Centre for Spices (NRCS) and merged with it the CPCRI Research Centre on Cardamom at Appangala, Kodagu (Karnataka). Thus the establishment of National Research Centre for Spices in April, 1986 can be considered as an important land mark in the history of spices research. During 1985, All India Coordinated Spices and Cashewnut Improvement Project was bifurcated into two Projects *i.e.*, one for spices and another for cashew and the headquarters of the All India Coordinated Research Project on Spices was shifted to NRC for Spices, Calicut. Besides the Coordinating Cell at Calicut, the project has 15 centres located in 9 states representing different agro-climatic zones.

**OBJECTIVES:**

The National Research Centre for Spices was established with the following objectives:

* Evolve high yielding varieties in black pepper having multiple resistance to *Phytophthora*, nematodes and 'pollu' beetle.

* Develop integrated field control measures against wilt diseases of black pepper.

* Characterise drought tolerance in black pepper and cardamom and evolve drought resistant tolerant varieties.
* Standardise input technologies in relation to nutrients, spacing and standards for increasing the productivity of black pepper.
* Evolve high yielding varieties of ginger resistant to rhizome rot and bacterial wilt diseases.
* Monitor pesticide residues in spices wih special reference to black pepper and cardamom.
* Multiply planting materials of clite clones through tissue culture.
* Transfer of spices production technology.

**LOCATION:**

The campus of NRC for Spices at Calicut with an area of 14 ha is located within Calicut Corporation on the the Calicut-Wynad Road, 10 km away from the Centre of the City. The research farm is at Peruvannamuzhi which is 51 km away from Calicut, near Kuttiadi Irrigation Project. The farm has an area of 94.00 ha of which 50 ha has been brought under cultivation for various field experiments. The Cardamom Research Centre is located at Appangala on the Madikeri-Bhagamandala Road of Kodagu district in Karnataka, 8 km away from Madikeri. The area of the farm is 14 ha.

**STAFF:**

The sanctioned staff strength of NRCS is 152, consisting of 39 scientific, 18 administrative, 28 technical, 5 auxiliary and 62 supporting staff members.

**BUDGET:**

The budget allocation for the year 1988-89 was Rs. 77.00 lakhs.

Some of the major research achievements of the NRCS are given in brief as follows:

The major thrust is on *Phytophthora* foot rot and slow decline diseases of black pepper, two important production constraints. In view of the absence of spatial segregation of *Phytophthora* and plant parasitic nematodes under field conditions, an integrated disease management involving cultural, chemical and biological methods along with host resistance is the strategy adopted for controlling these diseases. The germplasm collection of spices maintained at the NRCS is the largest in the world consists of 800 black pepper, 210 ginger, 285 turmeric, 251 cardamom, 152 clove, 305 nutmeg and 170 cinnamon which include other related species also.

Two high yielding selections of c.v. Karimunda viz., Selection 14 which yielded 7650 kg/ha (green) and with an yield potential of 12000 kg/ha and Selection 27 which yielded 6720 kg (green)/ha with an yield potential of 12640 kg (green/ha) during the 5th year after planting, have been recommended for release. These two selections are also of high quality with 5.1 and 3.4% of piperine, 13.0 and 12.4% of oleoresin and 7.0 and 6.0% of essential oil respectively. Two turmeric selections PCT 13 and PCT 14 which yielded 29.3 and 28.8 t/ha with an yield potential of 60 and 55 t/ha and 4.9 and 7.9% of curcumin content respectively have been recommended for release as high yielding and high quality types of turmeric.

Karimunda selection No. 69 of black pepper was found to be relatively drought tolerant.

Initial evaluation of spacing cum varietal trial indicated that the population level of 5000 vines/ha with a spacing of 2 x 1 m yielded 4743 kg of green pepper/ha compared to 1028 kg/ha pepper in traditional method with 1100 vines/ha. Studies with different forms of urea indicated the superiority of neem coated urea as an efficient N fertilizer.

Spraying of monocrotophos or dimethoate at 0.05% was found effective in controlling thrips infestation in black pepper. *Meloidogyne incognita* infestation in cardamom resulted in significant reduction in tiller and leaf production.

Organogenesis and plantlet formation were obtained from both vegetative bud and ovary in ginger. Performance of tissue cultured plants of cardamom in the field was superior to suckers and seedlings.

High production technology of cardamom and black pepper was demonstrated in farmers' field which has become popular among growers. The nucleus material of elite types of black pepper, cardamom and turmeric were supplied to the various developmental agencies for further multiplication and distribution. Nine training programmes were organised on spices production and protection technology.

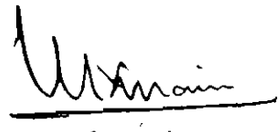
Under All India Coordinated Research Project on Spices, research programmes were carried out on grain spices apart from major spices. The high yielding cultivars of black pepper, ginger, turmeric, fennel, fenugreek, coriander and cumin have been identified for release to the farming community.

An International Pepper Community Workshop on Joint Research for the control of black pepper diseases was organised by NRCS from 27th to 29th October, 1988. The scientists from India, Indonesia and Malaysia participated which enabled interaction to develop strategy for effective disease

control. Dr. P. H. Tsao, Professor of Plant Pathology, University of California, USA and Chairman, *Phytophthora* Committee of ISPP delivered a special lecture on Taxonomy of black pepper *Phytophthora*.

**ABOUT THIS REPORT:**

This is the Third Annual Report of NRCS pertaining to the period from January 1988 to March 1989. The research programmes on priority have been formulated into 10 mega projects consisting of 30 projects. The important highlights of the research programme are presented in the beginning followed by research results of individual projects and concluded projects.



Kasaragod
31-10-1989

(M. K. Nair)
Director

# PROJECTS IN PROGRESS

**Foot rot and slow decline diseases of black pepper**

Feeder root damage caused by *Phytophthora capsici* in black pepper resulted in declining symptoms such as foliar yellowing, defoliation and drying of the part or entire vine.

Death of the vine is proportional to root damage. Affected vines can thrive for more than two seasons until root infection culminates in collar rot or foot rot.

Performance of P 1352 and P 24, two open pollinated lines is promising at Sirsi, Karnataka; a hot spot area for *Phytophthora,* infection.

Black pepper berries collected from Metalaxyl (Ridomil-Ziram) treated (100 ppm) vines four months after second spray did not show detectable levels of metalaxyl residues.

To isolate black pepper *Phytophthora,* a baiting technique using *Albizia falcataria* leaflets as baits has been developed.

**Germplasm in spices**

**Black pepper:** Eighty four collections were added to germplasm of pepper. Two hundred and eighty accessions were planted at NRCS, Appangala.

**Ginger and turmeric:** Ten collections of turmeric and 28 collections of ginger collected from Wynad were added to the germplasm. In the multi-location trial, PCT-13 and PCT-14 gave a mean yield of 25.7 and 24.1 kg per 3 x 1 m bed respectively, compared to local (13.9 kg per 3 x 1 m bed).

**Tree spices:** Clove seeds could be preserved in moist charcoal medium for 2 weeks after collection without any loss of viability.

A wild nutmeg *(Myristica andamanica)* having long and oval seeds, was added to the germplasm.

**Breeding for high yield and resistance to pests and diseases**

**Black pepper:** Karimunda selection Nos. 14 and 27 were the most premising among the first batch of 100 selections based on 4 year yield data.

**Quality analysis**

**Black pepper:** Quality evaluation of 35 germplasm accessions indicated that accessions 10, 12, 22, 23, 30 and 31 contained high piperine (5.6-6.0% w|w), Acc. 12 contained high oleoresin (15.5% w|w) and accession 2 contained high essential oil (6.9% v|w). Among the 48 Karimunda selections, selection 18 contained high piperine (6.7% w|w), Selection 12 contained high oleoresin (14.73% w|w), and Selection 109 contained high essential oil (5.5% v|w).

**Cardamom:** Among the 33 germplasm accessions, Acc. No. 27 had the highest husk to seed ratio, 0.75, accession No. 71 contained high oleoresin 6.9% (w|w), accession No. 69 and 154 contained high essential oil 8.3% v|w. Acc. No. 44 had high flavour ratio of 1.11.

**Nutritional *requirement and crop management***

**Black pepper:** In the spacing cum varietal trial, a population level of 5000 vines|ha (2 x 1 m) gave an average yield of 4743 kg green pepper|ha compared to 1028 kg|ha at the population level of 1100 vines|ha (3 x 3 m). Karimunda out yielded Panniyur I and Aimpiriyan at all population levels.

The effect of slow release nitrogenous fertilizers on the release pattern of urea-N in a laterite soil showed that application of neem coated urea followed by urea form resulted in the highest content of urea-N, ammonical and nitrate nitrogen in the soil. The total N content in the soil and leaf tissues were also high due to application of neem coated urea. The application of neem coated urea resulted in the production of more laterals and more number of spikes per laterals in Panniyur-1.

**Drought tolerance in black pepper**

Based on the high stomatal resistance and low transpiration rate at critical moisture levels Kalluvalli and Kottanadan were selected for further characterisation of drought tolerance.

Ten Karimunda selections were screened for their tolerance to depleting soil moisture content. Based on the visual observation on wilting, Selection No. 69 was found to be relatively tolerant.

**Pest management**

**Black pepper:** Studies on the population dynamics of gall thrips *Liothrips karnyi* indicated that pest population was high during June-August and low during December-March.

The population of the common predators *Montandoniola moraguesi* and *Androthrips flavipes* was high during August-September and July-September,

respectively. Fourth instar nymphs of *M. moraguesi* consumed 5-9 larvae of gall thrips per day. Second stage larvae of *A. flavipes* consumed 4-7 eggs of gall thrips per day.

Field trials conducted with six insecticides for the control of gall thrips indicated that spraying of monocrotophos or dimethoate (0.05%) was effective in controlling the pest infestation.

The predatory thrips recorded on *Lepidosaphes piperis* was identified as *Aleurodothrips fasciapennis*. The predatory mite which was found to attack *Lepidosaphes piperis* and *A. destructor* was identified as *Bdella* sp.

**Disease management**

**Nematodes in cardamom:** The PI suckers inoculated with *Meloidogyne incognita* showed significant reduction in the number of tillers and total number of leaves, six months after inoculation.

**Rhizome rot of cardamom:** Survey conducted in 73 plantations in Kodagu revealed that rhizome rot is a problem in only few pockets. The incidence varied from 0.2 to 47% in various plantations.

**Biotechnology**

***Ginger:*** *Callus was produced using vegetative bud, ovary and pseudostem as* explants on MS modified medium with 2, 4-D.

Organogenesis and plantlet formation were obtained from the calli derived from both vegetative bud and ovary on MS modified medium with low concentration of 2, 4-D and high concentration of BAP.

**Cardamom:** In a CYT trial the tissue cultured plants produced more number of tillers (12.02) than suckers (8.23) and seedlings (9.95). They produced more number of leaves|plant (94.19) compared to plants raised from suckers (65.99).

**Production of parental materials**

**Black pepper:** About 4511 rooted black pepper cuttings of high yielding selections of Karimunda, Kottanadan and Panniyur-1 were supplied to the developmental agencies for multiplication and distribution to the farmers.

**Cardamom:** About 520 kg of Cl-37 seeds, an elite line was supplied to developmental agencies.

**Turmeric:** About 2000 kg of elite seed material of turmeric was supplied to various government agencies and farmers.

**Transfer of technology**

Nine training programmes on various aspects of spice production technology was conducted for the departmental officers and farmers.

A Kisan mela was conducted at NRCS Cardamom Research Centre, Appangala, wherein over 250 farmers participated.

**High production technology in cardamom**

In the pure stand of cardamom plantation an average yield of 778 kg/ha was obtained which is about 13 times more than the national average of 60 kg/ha.

In the mixed cropping trial with Robusta coffee an yield of 950 kg dry cardamom/ha was recorded.

## *I. Foot rot and slow decline diseases of black pepper*

**(General Leader : KV Ramana)**

**Path. II.1(813) Epidemiological studies on *Phytophthora* foot rot disease of black pepper**

*(M Anandaraj, N Ramachandran* and *YR Sarma)*

At NRCS Farm, Peruvannamuzhi, meteorological parameters and disease incidence were monitored. The field simulated pot culture experiment (in 1 x 1 m tubs) to study the effect of age of host on infection to *Phytophthora capsici* showed that all the age groups tested (1-5 years) were equally susceptible (Table 1).

**Table 1.** Effect of age of black pepper vines to infection by *P. capsici*

| Age group | Infection (%) | Vines dead (%) | Surviving vines with reduced canopy (%) |
|---|---|---|---|
| 5 years | 50.0 | 37.5 | 12.5 |
| 4 years | 81.3 | 25.0 | 56.3 |
| 3 years | 81.3 | 43.7 | 37.5 |
| 2 years | 50.0 | 37.5 | 12.5 |
| 1 year | 62.5 | 25.0 | 37.5 |
| Average | 65.0 | 33.7 | 31.3 |

Feeder root infection resulting in root rot showed varying degrees of declining symptoms such as reduced canopy, foliar yellowing, defoliation, wilting and drying of the part or entire vine. These symptoms were proportional to the amount of root damage.

Root regeneration to root loss determined the survival of the vine. Such root rot affected vines survive more than one season and succumbed later leading to collar infection or by root rot alone.

Due to prolonged favourable weather conditions conducive to disease development, the disease incidence was 4% at NRCS Farm, Peruvannamuzhi during 1988.

A baiting technique to isolate black pepper *Phytophthora* from soil using *Albizia falcataria* leaflets as baits was developed and the Disease Potential Index (DPI) of the soil was monitored.

**Path. II.3(813). Disease management in *Phytophthora* foot rot affected black pepper plantations**

*(N Ramachandran, M Anandaraj* and *YR Sarma)*

Disease incidence was not noticed in the experimental plots when the vines were given different levels of phosphorus. Soil samples did not yield *Phytophthora* by baiting technique.

A field control trial out at CPCRI Regional Station, Vittal, Dakshina Kannada District, Karnataka against slow decline with fungicide (Bavistin) and phorate (Thimet) alone and in combination did not alleviate the symptoms. Vine death was more in Bavistin treated plots compared to untreated control plot. This indicated the probable preponderance of *Phytophthora* propagules in the soil and consequent root infection. This also might be due to suppression of natural antagonists of *Phytophthora.*

An observational trial on the effect of metalaxyl and phorate granules alone and in combination were tested on vines showing slow decline symptoms. The recovery of the vines was 42% in metalaxyl-phorate treatment compared to 18% and 30% in phorate and metalaxyl treated vines respectively. This indicated the combined action of metalaxyl-phorate on *Phytophthora* and nematodes which are not spatially separated under field conditions.

Dried black pepper berries from Metalaxyl-Ziram (100 ppm metalaxyl) treated vines (twice treated @ 5 l/vines), four months after the second spray did not show detectable levels of metalaxyl residues.

**Nema. II(813). Role of nematodes in the incidence of slow decline disease of black pepper**

**b) Population dynamics and pathogenicity of root knot and burrowing nematodes**

*(KV Ramana)*

**1. Pathogenicity experiments**

Three experiments initiated during 1983 and 1984 to study the pathogenicity of *Meloidogyne incognita* and *Radopholus similis* individually and in combination on black pepper under simulated field conditions were concluded. Salient results are as follows:

**(i) Pathogenicity of *M. incognita* and *R. similis* individually:** The foliar yellowing and defoliation indices of the vines inoculated with different levels of *M. incognita* and *R. similis* at the time of initiation of the experiments and at termination are given in Table 2.

**Table 2.** Foliar yellowing (F.Y.I.) and defoliation (D.F.I.) indices of black pepper vines inoculated with different levels of *M. incognita* and *R. similis*

| *M. incognita* | | | *R. similis* | | |
|---|---|---|---|---|---|
| Inoculum level | 1983 Oct. | 1987 Oct. | Inoculum level | 1985 Oct. | 1987 Oct. |
| 100 nematodes | | | 10 nematodes | | |
| F.Y.I. | 1.20 | 1.40 | F.Y.I. | 1.00 | 1.57 |
| D.F.I. | 1.00 | 1.20 | D.F.I. | 1.00 | 1.28 |
| 1000 nematodes | | | 100 nematodes | | |
| F.Y.I. | 1.00 | 1.60 | F.Y.I. | 1.42 | 2.71 |
| D.F.I. | 1.00 | 1.40 | D.F.I. | 1.14 | 2.14 |
| 10,000 nematodes | | | 1000 nematodes | | |
| F.Y.I. | 1.00 | 1.75 | F.Y.I. | 2.41 | 3.42 |
| D.F.I. | 1.00 | 1.50 | D.F.I. | 1.28 | 3.14 |
| 100,000 nematodes | | | 10,000 nematodes | | |
| F.Y.I. | 1.60 | 1.60 | F.Y.I. | 2.14 | 3.57 |
| D.F.I. | 1.00 | 1.40 | D.F.I. | 1.42 | 3.28 |
| Control | | | Control | | |
| F.Y.I. | 1.00 | 1.00 | F.Y.I. | 1.00 | 1.00 |
| D.F.I. | 1.00 | 1.00 | D.F.I. | 1.00 | 1.00 |

In general, these indices were high during April and low during July for both the nematodes. In the case of *M. incognita*, the inoculum level of 10,000 nematodes followed by 100,000 nematodes showed maximum indices. With *R. similis* the maximum indices were noticed at the inoculum levels of 1000 and 10,000 nematodes. There was a gradual increase in the intensity of the symptoms with increase in the inoculum level and time.

Root knot nematodes caused significant reduction in all the growth parameters viz., height of the vine, number of primary shoots, dry weights of shoot, leaf and root. More than 60 per cent reduction in these growth parameters

was noticed in the vines inoculated with higher inoculum levels of *R. similis*. Maximum reduction in the yield (47%) was at the inoculum level of 100,000 nematodes in the case of *M. incognita* and in the case of *R. similis* the reduction in the yield was more than 50% at higher inoculum levels (Table 3).

**Table 3.** Effects of *M. incognita* and *R. similis* on the growth and yield of black pepper (Percentage reduction over control)

| Inoculum level | Height of the vine | Number of primary shoots | Dry weight | | | Yield (dry berries) |
|---|---|---|---|---|---|---|
| | | | Shoot | Leaf | Root | |
| *M. incognita* | | | | | | |
| 100 nematodes | 5.44 | 13.43 | 12.21 | 2.48 | — | 12.82 |
| 1000 nematodes | 7.30 | 17.16 | 27.89 | 21.61 | 14.54 | 12.16 |
| 10,000 nematodes | 20.34 | 38.05 | 43.36 | 29.48 | 23.50 | 37.74 |
| 100,000 nematodes | 19.98 | 38.80 | 52.26 | 32.35 | 32.80 | 46.91 |
| *R. similis* | | | | | | |
| 10 nematodes | 0.21 | 13.23 | 24.74 | 25.34 | 34.47 | 0.30 |
| 100 nematodes | 11.61 | 44.30 | 42.88 | 55.76 | 60.50 | 28.98 |
| 1000 nematodes | 19.81 | 48.40 | 55.27 | 80.73 | 69.84 | 50.15 |
| 10,000 nematodes | 19.63 | 56.61 | 60.83 | 77.12 | 81.88 | 59.47 |

**(ii) Pathogenicity of *M. incognita* and *R. similis* in combination:** Foliar yellowing and defoliation indices and reduction in the growth parameters were higher with *R. similis* alone or in combination with *M. incognita* compared to *M. incognita* alone (Table 4). Varying amount of root degeneration and consequent reduction in the uptake of nutrients and water are responsible for the declining symptoms.

## 2. Field control trials

The field control trial against slow decline of black pepper started during 1985 at CPCRI Regional Station, Vittal was concluded during 1988. Populations of both *M. incognita* and *R. similis* increased in the vines treated with Bavistin alone and a significant reduction of both nematodes was noticed in the vines treated with phorate and neem cake. However, neem cake was found to be more effective in reducing the population of *M. incognita* compared to that of *R. similis*.

**Table 4.** Effect of *M. incognita* and *R. similis* in different combinations on foliar yellowing (F.Y.I.) defoliation (D.F.I.), growth parameters and yield of black pepper

| Inoculum level | F.Y.I. | | D.F.I. | | % reduction in the growth parameters and yield over control | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct. 1985 | Oct. 1987 | Oct. 1985 | Oct. 1987 | Height of the vine | No. of primary shoots | Dry weight | | | Yield (dry berries) |
| | | | | | | | Shoot | Leaf | Root | |
| M.I. 500 | 1.16 | 1.16 | 1.00 | 1.00 | 1.87 | 8.25 | 16.05 | 4.43 | 0.29 | 4.08 |
| M.I. 1000 | 1.16 | 1.33 | 1.00 | 1.66 | 11.27 | 22.93 | 25.26 | 23.20 | 19.30 | 7.84 |
| R.S. 500 | 1.50 | 2.00 | 1.50 | 3.33 | 10.69 | 42.04 | 43.66 | 61.38 | 47.23 | 56.35 |
| R.S. 1000 | 2.00 | 3.33 | 1.33 | 3.33 | 22.01 | 50.30 | 65.23 | 81.86 | 70.09 | 61.06 |
| M.I. 500 + R.S. 500 (S) | 1.16 | 2.50 | 1.16 | 2.16 | 7.03 | 43.31 | 30.25 | 57.92 | 51.47 | 44.74 |
| M.I. 500 + R.S. 500 (20DA) | 1.50 | 2.16 | 1.16 | 2.16 | 10.74 | 43.96 | 39.77 | 62.88 | 56.41 | 38.46 |
| R.S. 500 + M.I. 500 (20DA) | 1.33 | 3.00 | 1.16 | 3.16 | 8.52 | 35.66 | 38.36 | 61.89 | 53.76 | 53.37 |
| M.I. 1000 + R.S. 1000 (S) | 1.83 | 3.50 | 1.33 | 3.50 | 17.82 | 53.51 | 72.47 | 75.24 | 70.93 | 64.63 |
| MI 1000 + RS 1000 (20DA) | 2.16 | 3.16 | 1.33 | 3.16 | 14.26 | 49.04 | 62.67 | 78.12 | 75.32 | 55.10 |
| RS 1000 +M1 1000 (20 DA) | 2.00 | 3.16 | 1.66 | 3.33 | 11.99 | 50.30 | 62.73 | 68.08 | 71.98 | 58.39 |

M.I. = *Meloidogyne incognita*
R.S. = *Radopholus similis*
S = Simultaneously
20 DA = Twenty days after 1st inoculation.

## *II. Rhizome rot diseases in spices*

**(General Leader : MN Venugopal)**

**Path. III(813). Rhizome rot of ginger**

*(GN Dake* and *CK Parthasarathy Prasad)*

Semipurified toxin of *Pseudomonas solanacearum* was found to be non-specific since wilting symptoms were noticed in cut shoots of turmeric and tomato kept in toxin solution (1:10). The purification of toxin is being continued.

The disease escapes from bacterial wilt affected plots collected earlier were found susceptible, under conditions of artificial inoculation. Similarly two of the accessions viz., VI2 V2 E5-2 and VI K5-1 reported resistant to rhizome rot from Pottangi were found susceptible when screened at NRCS.

**Path. IX(813). Investigations on the rhizome rot disease of cardamom**

*(MN Venugopal)*

**1. Epidemiology of the disease**

Isolation studies were conducted from two plots during summer, pre-monsoon, monsoon and post-monsoon period. *Pythium* association is relatively predominant in the monsoon period.

In young plantations (1-4 years) in slopy area the disease spread is along the gradient and in flat lands the spread is in centrifugal fashion. In the trench system of planting in the high rainfall tracts (5000 mm|year) disease spread is along the trench.

The disease incidence is high under heavy rainfall. More than 87% of the total infection occurred during monsoon months (June-November).

The stored soil and debris samples collected from the sick plots yielded positive isolations upto 6 months.

A pot culture experiment has been initiated to study the role of root grub *Nodostoma fulvicorne* in rhizome rot.

## 2. Survey for rhizome rot incidence in Kodagu

Seventy three plantations in Kodagu district, Karnataka were surveyed for rhizome rot incidence. Amongst the 14 different zones in Kodagu, the rhizome rot is found to be severe in Madenadu, Tannimani (Bhagamandala) and Hosur. However, the disease is present in all the representative plantations with incidence ranging from 0.2-47%.

## 3. Isolation of pathogens from different zones

Isolation studies with the rhizome rot infected plants from Bettageri, Bhagamandala, Cheyyandanae, Madenadu, (All from Madikeri Taluk), Halery, Shanthalli (Somwarpet Taluk) and Badagarakeri (Virajpet Taluk) yielded both *Pythium* sp. and *Rhizoctonia* sp.

# *III. Evolving/locating resistance/tolerance to diseases and pests*

**(General Leader : YR Sarma)**

**Path. II.2(813). Screening of germplasm materials for their reaction to *Phytophthora capsici*, the pathogen of foot rot of black pepper**
*(YR Sarma, M Anandaraj* and *N Ramachandran)*

**1. Mass screening of $M_2$ seedling progenies**

Of the 1,70,000 $M_2$ seedling progenies of Panniyur-1 and Kottanadan screened, 31 seedlings which remained unaffected were transplanted into poly-bags for further testing.

**2. Screening of cultivars/hybrids/selections**

Twenty Karimunda selections screened were found susceptible. Of the 110 hybrids and 22 cultivars screened, 20 hybrids and 9 cultivars were found tolerant.

**3. Field evaluation**

**(i) Sirsi:** Fifteen lines (10 open pollinated and 5 hybrids) were evaluated for their reaction to *Phytophthora*. Two OP lines P 1352 and P 24 remained healthy indicating their field tolerance.

**(ii) At NRCS Farm, Peruvannamuzhi:** In the sick plot, 50 OP lines, 9 hybrids and 7 cultivars were planted during the year. They will be exposed to natural inoculum to evaluate their field tolerance.

**Nema. II.(813). Role of nematodes in the incidence of slow decline of black pepper**

**a) Survey and screening of black pepper germplasm against root knot and burrowing nematodes**
*(KV Ramana)*

**1. Screening of germplasm**

**(i) Cultivated germplasm:** Twenty collections of cultivated germplasm were inoculated with *Meloidogyne incognita* and *Radopholus similis* and are under observation.

**(ii) Karimunda selections:** One hundred Karimunda selections were tested for their reaction to both the nematodes. None of them showed resistant| tolerant reaction to *M. incognita* and *R. similis*.

**(iii) Intercultivar hybrids:** Eight hybrid lines showed resistant reaction to *M. incognita* in the preliminary test.

**(iv)** *Phytophthora* **tolerant lines:** None of the 20 lines tested was found resistant|tolerant to *R. similis*.

**(v) Open pollinated seedlings:** Fourteen thousand seedlings tested for their reaction were found susceptible to both the nematodes.

**2. Susceptibility of black pepper to** *R. similis* **in relation to its age**

The experiment initiated during 1986 to study the susceptibility of black pepper to *R. similis* in relation to the age of the pepper vines was concluded during 1988. The results showed that pepper vines of all the age groups tested (3, 6, 9 and 12 months old) were found susceptible to the nematode. However, the expression of symptoms such as foliar yellowing and defoliation were delayed with the increase in age.

# *IV. Genetic resources in spices*

**(General Leader : B Krishnamoorthy)**

## Gen. I(813). Collection, conservation, cataloguing and evaluation of black pepper germplasm

*(PN Ravindran, K Nirmal Babu* and *VS Korikanthimath)*

### 1. Collection and evaluation

During 1988, eightyfour new collections were added to the germplasm of pepper. Two hundred and eight accessions were planted at the Cardamom Research Centre at Appangala for conservation.

From germplasm evaluation, four promising accessions have been identified based on yield characters. A set of cultivars and wild taxa were planted at Peruvannamuzhi to establish a live herbarium.

### 2. Characterisation

Fiftyone *Piper nigrum* lines (fortyfour cultivars and seven wild *P. nigrum* lines) and ten related taxa were studied morphologically and chemically. Twenty two characters — including morphological and anatomical were recorded from the cultivated types and 30 characters from the related taxa. This data were used in a cluster and factor analysis study for establishing relationships.

### 3. Anatomical studies

Pepper leaf exhibits the typical structures of a dorsiventral dicot leaf. The characteristic features include a hypodermis made of 2-3 layers of large, rectangular cells; a small palisade region made of a single row of small cells; mucilage canals inside the mesophyll, often close to the vascular supplies and the presence of pearl glands (or wax glands) on both surfaces of leaves. The pearl glands consists of a stalk and a globose head, located inside a depression in the epidermis. The stomata in black pepper is cyclocytic, surrounded by a layer of subsidiary cells. Stomatal development is mesogenous.

The anatomy of *P. nigrum* was studied and compared with *P. attenuatum, P. longum* and *P. hymenophyllum.* The anatomical features were very similar

among these species except for minor variations in the number of vascular bundles, presence of mucilage canals etc.

**4. Spike characters of *Piper* sp.**

The spikes of *Piper* spp. can be erect or pendulous. Erect spikes are seen in three species, *P. mullesua, P. longum* and *P. silentvalleyensis*. Spikes are globose in *P. mullesua,* cylindrical in *P. longum* and filiform in all others. Spikes in *Piper* spp. ranged from 1.0 cm in *P. mullesua* to 18.3 cm in *P. argyrophyllum.*

**5. Chemical studies (Chemotaxonomic studies)**

Fiftyone *P. nigrum* lines were analysed for flavonoids, triterpenoids and steroids. Flavonoids were analysed using methanol extract of dried leaf material by descending paper chromatography using Whatman's 3 mm paper. Variations in flavonoid patterns were noticed among the species and also among the cultivars; while there was considerable uniformity in the profile of triterpenoids.

**Gen. II(813). Collection, conservation, cataloguing and evaluation of germplasm in ginger and turmeric**

*(MJ Ratnambal, K Nirmal Babu* and *PS Ravindran)*

**1. Collection of germplasm**

Wynad and the surrounding areas were surveyed and ten cultivars of turmeric and 28 cultivars of ginger were added to the germplasm.

**2. Maintenance of germplasm**

In turmeric, 195 accessions of cultivars and 8 accessions of wild types and in ginger 65 accessions of cultivars and 4 accessions of wild types were maintained.

**3. Yield**

In turmeric CLS No. 5 B gave the highest yield of 31.3 kg fresh rhizomes in 3 x 1 m bed. In ginger CV. Himachal Pradesh gave the highest yield of 7 kg of fresh ginger per 1 x 1 m bed.

In the multilocation trial (MLT) involving 10 PCT lines and 3 controls PCT 13 yielded 25.7 kg of fresh turmeric followed by PCT 15 and 14 with 24.5 kg and 24.1 kg/bed respectively compared to local with 13.9 kg/bed (Table 1).

**Table 1.** Yield data of multilocation trial of PCT selections at NRCS Farm, Peruvannamuzhi

| Sl. No. | Name of the cultivar | Mean yield of fresh rhizomes per bed(kg) (3 x 1m) | Projected yield of fresh rhizomes per hectare (tonnes) |
|---|---|---|---|
| 1. | PCT-10 | 23.9 | 48.03 |
| 2. | PCT-11 | 16.1 | 32.36 |
| 3. | PCT-12 | 19.3 | 38.79 |
| 4. | PCT-13 | 25.7 | 51.65 |
| 5. | PCT-14 | 24.1 | 48.44 |
| 6. | PCT-15 | 24.5 | 49.24 |
| 7. | PCT-16 | 20.4 | 41.00 |
| 8. | PCT-17 | 18.7 | 37.58 |
| 9. | PCT-18 | 12.8 | 25.72 |
| 10. | PCT-19 | 20.6 | 41.40 |
| | Controls | | |
| 11. | PCT-2 | 13.9 | 27.93 |
| 12. | PCT-5 | 20.6 | 41.40 |
| 13. | Peruvannamuzhi Local | 13.9 | 27.93 |
| | C.D. at 5% | 5.13 | |

In another MLT under All India Coordinated Research Project on Spices involving selections from HARS, Pottangi; KAU, Trichur; TNAU, Coimbatore and NRCS, Calicut, PCT-8 (Suvarna) recorded the highest mean yield of 16.5 kg fresh rhizomes per 3 x 1 m bed, followed by 321, Ethamukula from KAU with 13.1 kg, compared to 7.5 kg in local.

**4. Supply of elite planting material — Suvarna**

About 2000 kg seed rhizomes were supplied to various agencies.

**Gen. VI(813). Collection, conservation, cataloguing and evaluation of germplasm in tree spices**

*(B Krishnamoorthy* and *J Rema)*

A wild nutmeg *(Myristica andamanica)*, with long and oval seeds from Andamans and a wild cinnamon *(Cinnamomum gracile)* from Nagercoil were added to the germplasm. The germplasm collections were conserved and evaluated.

Floral biology observations in nutmeg and cinnamon were carried out. Efforts were made to study the root tip mitosis of nutmeg. Of the pretreatment agents tried 8-HQ gave better results. The vegetative characters of the elite cinnamon lines were recorded.

In clove, seed germination was studied. Higher germination was recorded when seeds were sown horizontally. Seed preservation study indicated that preservation in moist activated charcoal was the best.

Trials on inducing orthotropic shoots in nutmeg is in progress. Preliminary trials on vegetative propagation in clove indicated that grafting of clove on its own root-stock and on *Eugenia cuminii* was successful, but the percentage success was very low.

Planting materials of cinnamon, clove and nutmeg were raised for distribution.

**Gen. IX(813). Collection, conservation, cataloguing and evaluation of cardamom germplasm**

*(Regy Lukose* and *MN Venugopal)*

The germplasm maintained at the Cardamom Research Centre, Appangala consists of 225 accessions which include 14 related species collected from different locations.

Growth parameters viz., number of tillers|plant, number of yielding tillers|plant, number of panicles|plant and yield were recorded in the germplasm assemblage. The highest number of tillers, number of yielding tillers and number of panicles were 27.13, 11.63 and 19.63 respectively in APG 28 (C.29). The highest yield was recorded in APG-28 (C-29) (358.8 g|plant-wet weight) followed by APG 166 (Cl.6|13) (346.9 g|plant).

Out of 28 elite clonal accessions screened for 'katte' resistance, only 9 accessions remained free from 'katte' symptoms after 45 days of inoculation.

The solitary 'katte' escape from germplasm screening viz., APG 100 expressed mild symptoms after 3rd inoculation. Consequently all the original cardamom accessions assembled at NRCS, Appangala were found to be susceptible to 'katte' virus.

## *V. Selection/breeding for high yield and quality in spices*

**(General Leader : PN Ravindran)**

**Gen. VIII(813). Breeding for high yield and resistance to *Phytophthora* and nematodes in pepper**

*(K Nirmal Babu, PN Ravindran, MJ Ratnambal, B Krishnamoorthy* and *PS Ravindran)*

**1. Production and multiplication of hybrid lines**

About 1000 hybrid seeds from 15 different cross combinations were sown and the resultant 300 hybrid seedlings were planted in polybags for establishment and maintenance.

Five hundred lines of established hybrids were multiplied using rapid multiplication technique and 314 lines of hybrids and 84 cultivars were supplied to Pathology division for screening. Thirty six hybrid lines and 47 cultivars were supplied to Nematology division for screening.

**2. Maintenance and evaluation of preliminary and comparative yield trials**

The vines in preliminary yield trials (PYT 1 & 2) and comparative yield trial (CYT 2) have started flowering.

In CYT 1 with 5 promising cultivars, Cv. Karimunda with a mean yield of 1.59 kg of green berries|vine and Cv. Aimpiriyan with 1.34 kg|vine were the high yielders.

**3. Selection in Cv. Karimunda and Cv. Kottanadan**

Karimunda selections 14 and 27 were found to be the best among the first batch of 100 selections, based on 4 years yield data (Tabe 1). These two selections have been proposed by the Annual Research Council of NRCS for consideration and approval by the Variety Release Committee.

In Kottanadan, selection Nos. 2426 and 2559 gave a mean yield of 2 kg of green berries|vine after 2nd year of harvest.

**Table 1.** Yield data of elite lines of Karimunda

| Cultivars | Mean yield (green weight of berries\|vine in kg) | | | |
|---|---|---|---|---|
| | 1985-86 | 1986-87 | 1987-88 | 1988-89 |
| K.S. 14 | 0.42 | 0.99 | 4.23** | 4.78** |
| K.S. 27 | 1.08* | 1.67** | 4.22** | 4.18* |
| Panniyur-1 | 0.72 | 1.59* | 1.72 | 1.77 |
| Bulk Karimunda | 0.98 | 1.11 | 3.00 | 2.55 |
| Population mean | 0.541 | 0.858 | 2.39 | 2.72 |
| Standard deviation (SD) | 0.253 | 0.334 | 0.85 | 0.94 |

* Above population mean + 1 SD
** Above population mean + 2 SD

**Conclusion:**

K.S. 14 — Above population mean + 2 S.D. in the years 1987-'88 and 1988-'89.

K.S. 27 — Above population mean + 2 S.D. in the years 1987-'88 and 1986-'87 and

Above population mean + 1 S.D. in the years 1988-'89 and 1985-'86.

**4. Planting of new CYT**

A new comparative yield trial with 10 *Phytophthora* tolerant hybrids, 10 *Phytophthora* tolerant cultivars, 5 selections from open pollinated progenies and 3 promising cultivars were planted.

One vine each of 150 hybrids were planted for further yield evaluation.

**Gen. X(813). Breeding cardamom for high yield and resistance to 'katte' disease**

*(Regy Lukose* and *MN Venugopal)*

Growth parameters viz., number of tillers|plant, number of yielding tillers|plant and number of panicles and yield were recorded.

Of the 6200 $M_1$ seedlings raised from 72 high yielding plants screened thrice for resistance to 'katte', 73 plants remained free from disease. These disease escapes are being multiplied for further testing.

Screening of 1987 lot was continued for 'katte' resistance. After 4 repeated inoculations, 318 seedlings remained free from 'katte' symptoms. All the seedlings were reinoculated for the 5th time and shifted to bigger pots to ensure proper growth of test plants.

Eighty two natural 'katte' disease escapes which include 1986 and 1987 collections were subcloned for proposed field screening trial. In addition, 11 natural 'katte' disease escapes were collected from five villages of Kodagu and Hassan districts of Karnataka.

**Phy. III(813). Quality evaluation in black pepper**

*(A Gopalam* and *T John Zachariah)*

Evaluation of 45 accessions of cultivated germplasm was carried out. Piperine, oleoresin and essential oil contents ranged from 2.8-6.0% (w|w), 7.5-15.5% (w|w) and 2.0-6.9% (v|w) respectively. Accessions 10, 12, 22, 23, 30and 31 contained high piperine (5.6-6.0%, w|w), acc. 12 contained high oleoresin (15.5% w|w) and accession 2 contained high essential oil (6.9% v|w).

Among the 48 Karimunda selections, piperine, oleoresin and essential oil contents ranged from 3.8-6.7% (w|w), 5.0-14.7% (w|w) and 3.0-5.5% (v|w) respectively. Selection 18 contained high piperine 6.7%, (w|w), selection 12 contained high oleoresin (14.73%, w|w) and selection 109 contained high essential oil (5.5%, v|w).

Evaluation of 30 Kottanadan selections was carried out. Piperine, oleoresin and essential oil contents ranged from 3.8-6.3% (w|w), 12.9-17.0% (w|w) and 3.2-4.6% (v|w) respectively. Selections 2477 and 2455 contained high piperine, (6.3% w|w), selection 2454 contained high oleoresin (17.0% w|w) and selection 2472 contained high oil (4.6% v|w).

**Phy. VII(813). Quality evaluation in cardamom**

*(T John Zachariah* and *A Gopalam)*

Thirty three cardamom accessions were evaluated for physical, chemical and aroma quality. Acc. No. 85 had the lowest (0.28) and Acc. 27 had the highest husk to seed ratio (0.75). Oleoresin and essential oil contents ranged from 4.0-6.9% (w|w) and 6.0-8.3% (v|w) respectively. Acc. 71 contained high oleoresin (6.9% w|w) and accessions 69 and 154 contained high essential oil (8.3% v|w). The flavour quality ratio of the oil (determined on the levels of $\alpha$ -terpinyl acetate over 1, 8-cineole is high in Acc. 44 (1.11).

Physical, chemical and aroma quality of cardamom grown under different fertilizers at different levels and spacing was carried out. There was no significant effect.

Chemical and aroma quality of cardamom dried by the conventional methods like flue pipe, electrical and sun drying was studied. There was a reduction in volatile oil content in flue pipe and sun drying whereas there was no appreciable reduction in electrical drying. Flavour quality was not affected by the method of drying.

Chemical and aroma quality of cardamom harvested at ripe, mature and immature stages was studied. In the immature stage, husk to seed ratio is very high and essential oil content was low.

## *VI. Developing suitable technology for spices crops*

**(General Leader : A Ramadasan)**

**Agr. VI(813). Studies on the impact of input technology on the yield performance and quality attributes of black pepper**

*(K Sivaraman, BN Reddy* and *AK Sadanandan)*

A new fertilizer experiment with four levels of nitrogen (50, 100, 150 and 200 g per vine per year) and four levels of potassium (70, 140, 220 and 280 g per vine per year) with five additional treatments involving phosphorus, calcium and magnesium started during the year 1987 is being maintained.

The yield of pepper in the varietal cum spacing trial started during 1983 is given in Table 1.

**Table 1.** Yield of black pepper as influenced by varieties and spacing during 1988-89

| Varieties | Spacing (m) | | | | |
|---|---|---|---|---|---|
| | 3.0 x 3.0 | 2.5 x 2.5 | 2.5 x 1.5 | 2.0 x 1.0 | Mean |
| | (1100)* | (1600) | (2600) | (5000) | |
| Panniyur-1 | 616** | 1365 | 1856 | 2350 | 1547 |
| Karimunda | 1438 | 2594 | 4839 | 7470 | 4085 |
| Aimpiriyan | 1030 | 1501 | 2647 | 4410 | 2397 |
| Mean | 1028 | 1820 | 3114 | 4743 | |

* Values in parenthesis are number of vines/ha.
** Values indicate mean yield in kg/ha (green).

It is clear from the data that closer spacing of 2 x 1 m in Cv. Karimunda recorded the highest yield (7470 kg/ha) followed by Aimpiriyan at the same spacing. The results of 1987-88 and 1988-89 consistently showed the superiority of Karimunda over other varieties under closer spacing.

A trial on irrigation requirement of pepper Cv. Karimunda was initiated during 1988 to study the response of pepper to irrigation and to compare the productivity of pepper under drip irrigation system. *Erythrina indica* plants were used as standards. Different irrigation treatments will be imposed during 1989.

**SSc. I(813). Nitrogen management through slow release nitrogenous fertilizers**

*(AK Sadanandān)*

The effect of slow release N fertilizers (neem coated urea, coir dust coated urea, ureaform, urea and a check) on the release pattern of nitrogen in a laterite soil with Panniyur-1 was studied. Data showed that application of neem coated urea for three years followed by ureaform resulted in the highest content of urea-N, ammoniacal nitrite and nitrate nitrogen in the soil.

The total content of nitrogen in the soil and leaf tissues were also high due to application of neem coated urea. The plots in which urea was applied followed by urea pellet registered higher soil pH compared to others.

The application of neem coated urea also resulted in the production of more laterals, more number of spikes per laterals indicating the superiority of neem coated urea over the other slow release nitrogenous fertilizers tested for black pepper.

**Agr. XIII(813). Systems of planting-cum-fertilizer levels in cardamom under rainfed conditions**

*(VS Korikanthimath)*

The experiment was laid out during 1985 with two systems of planting (pit and trench) and five levels of fertilizers viz., 0:0:0 (control), 40:40:40, 80:80:160, 120:120:240 and 160:160:320 kg N, P, K per hectare by using Cl. 37 material and following 2.0 x 1.0 m spacing and a plot size of 12.0 x 8.0 m was continued.

Data on the growth and yield were recorded. Soil moisture was determined by gravimetric method both in the pit and trench systems.

**1. Growth characters**

The trench system of planting recorded the highest value (24.02) for total number of tillers per plant when compared to pit system of planting (18.87). There was a significant difference between the number of tillers per plant under trench system in the treatments applied with fertiliser 40:40:80 (15.62), 80:80:160 (22.80) and 120:120:240 (29.60) kg N, P, K per hectare as compared to control (9.00). The treatment 160:160:320 kg NPK/ha gave the highest number of tillers per plant (32.06) in trench system. Even in case of pit system with higher levels of fertiliser i.e., 120:120:240 and 160:160:320 kg NPK/ha the maximum number of tillers per plant were 28.75 and 24.07 respectively compared to control (9.25).

## 2. Soil moisture

Soil moisture was determined by gravimetric method thrice viz., after dry period of 83 days in summer (March), after receiving premonsoon showers (May) and after the break in North-east monsoon (November), 1988. During summer (March) trench system recorded the highest percentage of moisture (18.50) folowed by pit (14.00). After receiving pre-monsoon showers of 164.4 mm with 15 rainy days, samples collected in May, revealed that trench system retained maximum soil moisture (22%) and the pit (19.0%). The soil moisture determined during the break in North-east monsoon (November) revealed that trenches retained the highest moisture (26.0%) followed by pit (21.0%). Taking the average of all the 3 samplings, trench system of planting recorded 22.16% of moisture followed by pit (18.00%). The trench system was superior to pit system as the latter was found more effective in conserving soil moisture and supplement the plants even during dry spell which is crucial for better crop stand and early initiation of panicles.

## 3. Yield

The yield data is presented in Table 2.

**Table 2.** Yield of dry cardamom under two systems of planting and different fertilizer levels

| Systems of planting | Fertilizer levels (NPK\|ha) | Yield (Kg\|ha) |
|---|---|---|
| Pit | 0:0:0 | 106.20 |
| | 40:40:80 | 230.40 |
| | 80:80:160 | 267.90 |
| | 120:120:240 | 312.93 |
| | 160:160:320 | 368.70 |
| Trench | 0:0:0 | 131.53 |
| | 40:40:80 | 284.42 |
| | 80:80:160 | 330.30 |
| | 120:120:240 | 374.53 |
| | 160:160:320 | 400.33 |
| SE\|PLOT | | 30.88 |
| G. Mean | | 280.72 |
| C.V. (%) | | 11.00 |
| C.D. | | 44.81 |

The trench system of planting recorded the highest yield of dry cardamom (304.22 kg|ha) followed by pit (257.27 kg|ha). The application of 160:160:320 kg NPK|ha, recorded the highest yield of 400.33 kg|ha in trench system as against the 368.70 kg|ha in pits, followed by 120:120:240 kg NPK|ha which recorded 374.53 kg|ha in trench and 312.93 kg|ha in pit systems respectively. The control (no fertiliser) recorded the lowest yield of 131.53 kg|ha in trench and 106.20 kg|ha in pit system respectively.

**Stat. III(813). Optimum size and shape of plots and blocks for experiments in black pepper**

*(Jose Abraham)*

Preliminary analysis of data collected during the first year of the study (1987-'88) revealed that the plot size of single vines showed a coefficient of variation 58.7% which came down to 33.8% for the plot size of 6 vines, while there was no substantial reduction in the CV per cent for further increase in plot size.

**Phy. V(813). Characterisation of drought tolerance in black pepper and cardamom**

*(A Ramadasan* and *S Vasantha)*

The criteria fixed for identification of drought tolerance at critical soil moisture levels were (1) relatively higher stomatal resistance and (2) lower transpiration rate. Based on these characters two cultivars viz., Kulluvally and Kottanadan were selected for further characterisation.

Screening of six months old Karimunda selections (10 Nos.) have indicated Sel. No. 69 to be relatively tolerant over the rest. The stomatal resistance and transpiration rate recorded were 17.5 ($Scm^{-1}$) and 1.8 ($\mu g\ cm^{-2}\ s^{-1}$) respectively. Root mass was also estimated. Sel. No. 69 recorded highest root mass (2.9 g) over the rest (range 0.74-2.2 g).

## *VII. Insect pest management in spices*

**General Leader : T Prem Kumar**

**Ent. XV(813). Bionomics of major pests of pepper and evolving integrated control measures against them**

*(T Prem kumar, S Devasahayam* and *Jose Abraham)*

**Pollu beetle** *Longitarsus nigripennis*

**1. Screening of pepper germplasm against pollu beetle**

Observations were recorded from 250 black pepper accessions for pollu beetle infestation. Ten spikes from each of the vines were randomly selected. Total number of berries and berries infested were recorded and the per cent berry damage worked out. The accessions were classified into 4 groups viz. no infestation, $< 1\%$ infestation, 1.5% infestation and $> 5\%$ infestation. The number of accessions studied were categorised as per the above mentioned scale and are as follows: No berry infestation 8, $< 1\%$ infestation 50, 1-5% infestation 66 and above 5% infestation 32.

**2. Economic threshold of pollu beetle infestation**

The progress in berry infestation was recorded at weekly intervals from 3 plots with 20 vines each to calculate the economic threshold of pollu beetle infestation. Spraying of endosulfan 0.05% was carried out in one plot during July and October and the remaining two plots were left unsprayed. The infestation percentages in the unsprayed plots were 47 and 42 and that of sprayed plot 2.2.

Taking into consideration the input cost, yield loss and beetle population, economic threshold was worked out. It was found that 2 pollu beetles|100 leaves during 4th week of July is capable of causing economic damage.

**Top shoot borer** *Cydia hemidoxa*

**1. Survey for top shoot borer incidence**

A survey for the incidence of top shoot borer was carried out in Cannanore district. The infestation of the new shoots ranged from 21 to 100%. The infestation in 26 localities was more than 50%.

**2. Field control trial against top shoot borer**

Field control trial against top shoot borer was continued. The insecticides were endosulfan, quinalphos, methyl parathion, dimethoate, monocrotophos and phosphamidon at 0.05% concentration.

The pooled analysis of two years data showed that all the insecticides were significantly superior in controlling the shoot borer and are on par with regard to their efficacy (Table 1). However the vines sprayed with monocrotophos recorded minimum shoot borer incidence.

**Table 1.** Effect of insecticides for the control of shoot borer.

| Insecticides | Shoot damage % |
|---|---|
| Endosulfan (0.05%) | * 26.82 (20.36) |
| Quinalphos (0.05%) | 24.05 (16.61) |
| Methylparathion (0.05%) | 23.90 (16.41) |
| Dimethoate (0.05%) | 26.26 (19.53) |
| Monocrotophos (0.05%) | 23.28 (15.62) |
| Phosphamidon (0.05%) | 26.10 (19.35) |
| Control | 54.77 (66.72) |
| C.D. at 5% level | 4.9 |

* Transformed values.

**Ent. VIII(813). Bioecology and control of marginal gall forming thrips** *Liothrips karnyi* **Bagnall infesting black pepper**

*(S Devasahayam)*

**1. Incidence of gall thrips**

A survey was carried out for gall thrips incidence in Nilgiris, Kanyakumari and South Kanara districts. The pest infestation ranged between 8.1-13.2, 1.2-6.6 and 0.0-4.1 per cent, respectively in various locations in these districts.

**2. Ecology of gall thrips**

**(i) Seasonal population:** Studies on the seasonal population were conducted at Kalpetta (Wynad district). The pest population was high during June-August and low during December-March. The population was maximum during August and minimum during February. Studies on the increase in the number of individuals within a leaf in relation to its age indicated that maximum number of adults and juveniles and eggs occurred in galls that were about 2 and 1 month old respectively.

**(ii) Natural enemies:** The population dynamics of the common predators of gall thrips *Montandoniola moraguesi, Androthrips flavipes, Rhodesiella* sp. and *Lestodiplosis* sp. was studied at Kalpetta. The former two predators were observed in the field throughout the year and their population was high during August-September and July-September, respectively. The population of *Rhodesiella* sp. was high during July-August. *Lestodiplosis* sp. was observed in the field during August-December only.

The life history and predatory potential of *M. moraguesi* and *A. flavipes* was studied in the laboratory. The duration of egg and I-IV nymphal stages of *M. moraguesi* ranged between 3-5, 2-3, 3-4, 3-5 and 4-6 days respectively. During this period the nymphal stages consumed 2, 2-4, 3-6, 5-9 and 9-12 individuals of second stage larvae of gall thrips, respectively. The duration of egg, larva I and II, prepupa and pupa I and II stages of *A. flavipes* ranged between 5-7, 3-5, 3-4, 1, 1-2 and 2 days respectively. First and second stage larvae consumed 2-3 and 4-7 eggs of gall thrips per day.

**(iii) Other fauna in thrip galls:** The sequential occurrence of arthropodan fauna in thrip galls in relation to the age of the leaf and population of gall thrips was recorded at Kalpetta. The interrelationships between the various types of arthropods recorded were studied. The ants, lepidopteran larvae, other thrips and mites occurring in the thrip galls were identified.

### 3. Field trials

Field trials for the control of gall thrips were laid out with six insecticides (endosulfan, quinalphos, dimethoate, monocrotophos, phosphamidon — 0.05% and malathion — 0.1%) at Kuppadi (Wynad district). Spraying of various insecticides was undertaken during July during emergence of new flushes. Obervations on the percentage of leaf galls on the vines were recorded 15 and 30 days after treatment.

All the insecticides were effective in controlling the pest infestation at the end of 15 days after treatment. Plots treated with dimethoate had minimum pest infestation followed by monocrotophos. At the end of 30 days after treatment monocrotophos and dimethoate alone retained their efficacy in controlling the pest infestation.

Combined analysis of three years data indicated that monocrotophos and dimethoate (0.05% each) could be recommended for the control of the pest.

**Ent. IX(813). Studies on the coccids infesting black pepper**

*(KM Abdulla Koya)*

**1. Survey**

Survey for coccids was conducted in 16 locations in Wynad district showed that infestation by *Lepidosaphes piperis* ranged between 11.0 to 63.0% and that of *Aspidiotus destructor* 6.7-20.0%. Infestation by *L. piperis* or *A. destructor* was not noticed in 21 locations surveyed in Cannanore district. However, traces of infestation by the mealy bug *Pseudococcus longispinus* was recorded in Chapparappadavu and Alakkode villages of Cannanore districts.

**2. Seasonal abundance of coccids and their natural enemies**

Studies conducted on the seasonal abundance of *L. piperis* on ten selected vines at Kuppady (Wynad district) showed that many of the heavily infested laterals dried up. A drastic reduction in the population of the pest was noticed after the heavy showers during June-August. Infested laterals remained unhealthy and non-productive.

**3. Natural enemies**

Two predators, on thrips and a mite collected from infested pepper spikes and leaves respectively were identified as *eAlurodothrips fasciapennis* (Franklin) (Phlaeothripidae : Thysanoptera) and *Bdella* sp. (Bdellidae : Acarina). The mite is observed throughout the year and fed on adult males. Two hymenopteran parasites, one each collected from *L. piperis* and *Aspidiotus destructor* are being identified.

**4. Biology**

Attempts were made to establish the crawlers on pumpkin and potato for studying the biology. Few crawlers established on pumpkin, but their growth was poor. They did not establish on potato. The crawlers released on the leaves of rooted pepper cuttings got established. They settled on the leaves after 2-3 days. After getting fixed, they get flattened and secrete silken threads around them. A full grown female found to harbouf 35-50 eggs at a time. The crawler move out from the adult once hatched.

## *VIII. Transfer of technology and production of elite planting materials*

**(General Leader : AK Sadanandan)**

**Extn. I(443).** Training of extension and research workers and farmers
*(KM Abdulla Koya, MN Venugopal* and *VS Korikanthimath)*

National Research Centre organised nine training courses (Table 1) at Calicut and Appangala on different aspects of Spices Production Technology. The training courses were attended by research and extension workers, officials of Agriculture and Horticulture Departments of state governments and progressive farmers. A special training on ginger production was also imparted to one official from Pakistan sponsored by USAID for 3 months at Calicut.

**Table 1.** Training courses conducted at NRCS, Calicut and Appangala

| S. No. | Title of the course | Duration and venue | No. of trainees | State/Union territory |
|---|---|---|---|---|
| 1. | Rapid multiplication and nursery management of black pepper (one each for farmers and departmental officers) | 1 day Calicut | 3 | Kerala |
| 2. | Cultivation and management of spices | 2 days Calicut | 19 | Kerala, Tamil Nadu & Karnataka |
| 3. | Epicotyl grafting of nutmeg | 2 days Calicut | 2 | Karnataka |
| 4. | Nursery techniques in cardamom and nutmeg | 2 days Appangala | 12 | Kerala, Goa & Madhyapradesh |
| 5. | Pest & disease management in spices | 2 days Calicut | 12 | Kerala, Tamil Nadu & Karnataka |
| 6. | Production & processing of cinnamon (for farmers only) | 1 day Calicut | 3 | Kerala |
| 7. | Cardamom production technology | 2 days Appangala | 9 | Kerala & Karnataka |
| 8. | Spices production technology including cardamom | 5 days Calicut & Appangala | 10 | Kerala |

Apart from the regular training programmes, 75 persons including Agricultural Officers and progressive farmers were imparted one day training on different aspects of spices cultivation. At Appangala, 119 persons including farmers were trained in cardamom production technology.

A Kisan Mela was organised at NRCS, Appangala in which more than 250 progressive farmers and officials from Spices Board participated. An exhibition was organised in connection with the Kisan Mela to educate the participants. A field trip was also organised to one of the Research-cum-Demonstration plots to show and convince the farmers the success of high production technology developed by the Research Centre.

**Extn. IV(443). Research-cum-demonstration plots**
*(AK Sadanandan* and *VS Korikanthimath)*

**1. Black pepper**
*(AK Sadanandan)*

Suitability of black pepper as a mixed crop in coconut and arecanut gardens was demonstrated in farmers' fields.

Two hundred numbers of Panniyur-1 vines were grown in the interspaces of coconut using *Erythrina indica* as standard. Fortynine per cent of the vines flowered during the year. Two hundred and forty Karimunda vines were maintained on arecanut palms and fortynine per cent of the vines flowered. There was no incidence of *Phytophthora* foot rot or slow decline.

**2. Cardamom**
*(VS Korikanthimath)*

The high production potential of cardamom was demonstrated in two of the Research-cum-Demonstration plots viz., (i) conventional management followed by intensive cultivation of cardamom, and (ii) pure (mono) crop of cardamom under intensive care and cardamom mix cropped with Robusta coffee.

**i. Conventional management followed by intensive cultivation of cardamom**

The 10 ha cardamom plantation in Kodagu (M|s. Lakshmi Estate, Halery, North Kodagu) planted during 1972, under neglected condition, severely affected with 'katte' disease (75%) was adopted.

This plantation (under rainfed condition), in virgin forest, was brought under cultivation during 1972 with an average level of management (without application of fertilisers and plant protection measures etc.). The plantation yielded 52 kg|ha during the 3rd year, and the highest yield of 300 kg|ha was obtained during fourth year. The 9 years average yield of dry cardamom was 116.58 kg|ha.

After adopting intensive cultivation in 1983, highest maiden crop of 850 kg/ha was recorded during 1985 as against the conventional management during 1972-1982 (52 kg/ha). The average of 5 crop seasons (1985-88) with intensive care was 515 kg/ha dry cardamom. The economic analysis is given in Table 2.

**Table 2.** Economics of cardamom per ha under intensive cultivation (1983-'88)

| Expenditure/Returns | Amount in Rs. |
|---|---|
| Investment during establishment (Pre-bearing period) | 16,115 |
| Compound interest on investments @ 14% | 19,560 |
| Total investment | 35,675 |
| Annuity value @ 14% | 6,300 |
| Annual maintenance cost | 17,350 |
| Total cost per year | 23,650 |
| Gross returns | 71,250 |
| Net returns | 47,600 |
| Cost of production/kg of dry cardamom | 47.30 |
| Benefit cost ratio (BCR) | 3.52 |
| Net present worth (NPW) | 2,04,491 |
| Annual net present worth (ANPW) | 36,100 |
| Internal rate of returns (IRR) | > 20 |

**ii. Pure (mono) crop of cardamom under intensive care and cardamom mix cropped with Robusta coffee**

Studies were carried out on both the pure (mono) and cardamom-Robusta coffee mix cropped system at M/s. Chettoli Estate, Chettalli, North Kodagu.

**(a) Pure crop of cardamom:** Intensive cultivation was adopted from 1982 onwards. A modest dry cardamom yield of 290 kg/ha was obtained in 1984 (2 years after planting), followed by the highest crop of 1625 kg/ha in 1985 (3 years after planting). During the following year i.e., 1986 (fourth year after planting) the yield came down to 400 kg/ha and subsequently increased to 775 and 800 kg/ha during 1987 and 1988, 5th and 6th year after planting respectively.

Because of the adoption of scientific cultivation practices, it was possible to produce an average dry cardamom yield of 778 kg/ha.

**(b) Mixed cropping of cardamom with Robusta coffee:** In the Robusta coffee garden (Ferdinia) planted at 2.7 x 2.7 m during 1947, alternate row was removed during 1985, to accommodate Malabar type of cardamom Cl.37 (between two rows of coffee spaced at 5.4 x 2.7 m) at a spacing of 1.8 x 1.2 m.

An average yield of 1970 kg|ha dry coffee (mean of 4 years) and 950 kg|ha cardamom (mean of 2 years) were obtained.

**Extn. I(813). Increasing productivity of black pepper and cardamom through large scale demonstration of improved technology in farmers' fields**

*(AK Sadanandan, Jose Abraham, M Anandaraj, VS Korikanthimath* and *MN Venugopal)*

## 1. Black pepper

*(AK Sadanandan, Jose Abraham* and *M Anandaraj)*

The high production technology (HPT) developed at the Institute for augmenting the productivity of black pepper was demonstrated in 50 farmers' fields in three villages.

Analysis of the soils revcaled that there is substantial build up of soil nutrients particularly P and K due to the addition of inputs like organic and inorganic fertilizers.

There was 238% increase in yield of pepper due to the adoption of HPT programme (Table 3). There was marked reduction in the incidence of foot rot and slow decline (Table 4).

**Table 3.** Effect of HPT of pepper in farmers' field on yield (kg|vine-dry)

| Year | Peruvannamuzhi | | | Puthupadi | | |
|---|---|---|---|---|---|---|
| | Farmers' practice | HPT | Increase (%) | Farmers' practice | HPT | Increase (%) |
| 1986-87 | 0.356 | 1.100 | 209 | 0.375 | 1.510 | 303 |
| 1987-88 | 0.413 | 1.178 | 185 | 0.576 | 1.895 | 229 |
| 1988-89 | 0.336 | 0.836 | 149 | 0.415 | 1.402 | 238 |

**Table 4.** Impact of HPT programme on pepper disease incidence (%)

| | 1985-86 | Years | | |
|---|---|---|---|---|
| | (Pre-expt.) | 1986 | 1987 | 1988 |
| Foot rot disease | 6.1 | 2.2 | 0.5 | 2.5 |
| Slow decline | 6.4 | 2.0 | 1.0 | 3.2 |

## 2. Cardamom

*(VS Korikanthimath* and *MN Venugopal)*

High production technology (HPT) programme was initiated during 1986 in all the key cardamom growing zones of Kodagu and Hassan districts to motivate growers to increase the yield per unit area and bring down the cost of cultivation.

Forty two farmers were selected under HPT programme covering an area of 94 ha by using 4,70,500, Cl.37 seedlings in five agroecological conditions and rainfall pattern in 5 distinct zones viz., Virajpet (13 Nos.), Bhagamandala (7 Nos.), Madikeri (12 Nos.), Somwarpet (2 Nos.) and Yeslur (8 Nos.).

The data collected on the pre-planting bench mark survey of HPT cardamom plantations revealed that the average size of the holding was 6.54 ha and the average family size was 6.55. The average age of the plantations was 16.98 years. The mean rainfall in all the units was found to be 3150 mm per annum. Bhagamandala unit recorded highest rainfall of 4197 mm.

The performance of cardamom is quite satisfactory in almost all the HPT demonstration plots and the maiden crop obtained during 1988 just 2 year after planting was promising. The highest yield recorded was 530 kg. dry cardamom per hectare. However, the average yield was 494.5 kg|ha. (Table 5)

**Table 5.** Yield data in HPT plots

| Name of the Unit | Average yield in kg|ha before adoption of HPT | Average yield kg|ha, 2 years after adoption of HPT |
|---|---|---|
| Bhagamandala | 32.50 | 455 |
| Madikeri | 73.55 | 475 |
| Somwarpet | 80.00 | 530 |
| Virajpet | 41.81 | — |
| Yeslur | 66.16 | 518 |
| Mean | 58.80 | 494.5 |

The timely inspection, detection and elimination of 'katte' virus infected plants has resulted in containing the disease (below 1%) in the plots which are in contiguous with the 'katte' infected plantations.

The interested growers, officials of Extension Agencies were trained on High Productivity Technology in Cardamom.

**Gen. I(443). Production of parental materials and breeders's stock of black pepper and cardamom**

*(K Sivaraman, BN Reddy* and *VS Korikanthimath)*

**1. Black pepper**

*(K Sivaraman* and *BN Reddy)*

Elite lines of 21 Karimunda and 24 Kottanadan selections were multiplied for distribution to the various developmental agencies. A total of 4511 single noded cuttings of Karimunda, Kottanadan and Panniyur 1 were distributed to the following agencies: Andhra Pradesh Forest Development Corporation, Department of Horticulture, Government of Karnataka and Department of Agriculture Government of Kerala and farmers.

In addition rooted cuttings of 92 Kottanadan, 349 Panniyur-1, 388 Aimpiriyan and 1104 Karimunda were supplied to Scientists of NRCS and CPCRI for research purpose.

**2. Cardamom**

*(VS Korikanthimath)*

Three promising Cl.37 accessions viz., 262, 561 and 800 were multiplied clonally and supplied to coordinating centres of All India Coordinated Research Project on Spices.

A separate clonal multiplication plot (0.2 ha) was established for generating sufficient elite material of Cl.37 hybrids and other promising lines to cater to the requirement of various experiments and supplying to various growers and Development Departments.

Totally 520 kg of Cl.37 seed capsules were supplied to Spices Board, Horticultural Department, Karnataka and farmers.

In addition to these, a rapid mutiplication nursery of black pepper was established for the production of planting materials of Panniyur-1, Kottanadan, Karimunda and Aimpiriyan.

# *IX. Nematode management in spices*

**General Leader : Santhosh J. Eapen**

**Nema. I(813). Investigations on plant parasitic nematodes associated with cardamom**

*(Santhosh J Eapen)*

**1. Pathogenicity trial**

The $P_1$ suckers planted in cement pots containing nematode-free soil were inoculated during February-March with active *Meloidogyne incognita* nematodes collected from cardamom and multiplied on tomato. The nematode levels used are 0, 100, 1000, 10000 and 100000 eggs and juveniles/plant with ten replications. The growth characters viz., height of the plant, number of tillers, total number of leaves, leaf length and width, number of panicles were recorded at quarterly intervals. The plants inoculation with different levels of *M. incognita* showed significant reduction in the number of tillers and total number of leaves from the sixth month after inoculation (Table 1).

**Table 1.** Growth characters of plants inoculated with different levels of *M. incognita* — 6th month after inoculation (Mean of 10 replications)

| No. of nematodes | Height of plant (m) | No. of tillers | No. of total leaves | Leaf length (cm) | Leaf width (cm) |
|---|---|---|---|---|---|
| 0 | 2.05 | 21.7 | 133.7 | 58.2 | 8.5 |
| 100 | 1.94 | 13.7 | 87.2 | 55.5 | 8.1 |
| 1000 | 1.93 | 12.9 | 87.4 | 56.7 | 7.9 |
| 10000 | 1.91 | 13.9 | 83.8 | 57.5 | 8.3 |
| 100000 | 1.96 | 12.5 | 83.5 | 57.7 | 8.4 |
| C.D. (P=0.01) | NS | 5.2 | 39.3 | NS | NS |

**2. Screening of germplasm**

A trial to standardise the screening techniques was conducted in June-July under green house conditions at inoculum level of 0, 100, 500 1000 and 5000 juveniles/plant with 25 replications. Five replications each were drawn at one month intervals since the second month after inoculation. They were rated for root galling and nematode development. An inoculum of 500 second

stage root-knot nematode larvae per plant and an exposure time of three months are optimum levels for screening cardamom plants with *M. incognita* (Table 2).

**Table 2.** Standardisation of screening techniques (Mean of five replications)

| Treatments | Observation intervals (months after inoculation) | | | | |
|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 |
| a) Gall index* | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 100 | 2.2 | 3.6 | 2.6 | 3.2 | 3.8 |
| 500 | 3.4 | 3.8 | 1.8 | 4.5 | 3.5 |
| 1000 | 3.5 | 3.2 | 3.6 | 2.5 | 3.4 |
| 5000 | 2.0 | 1.8 | 2.0 | 4.4 | 4.0 |
| b) Reproductive factors** | | | | | |
| 0 | 0 | 0 | 0 | 0 | — |
| 100 | 5.6 | 18.0 | 19.3 | 65.2 | — |
| 500 | 1.6 | 3.9 | 3.3 | 24.4 | — |
| 1000 | 0.6 | 0.9 | 4.8 | 6.0 | — |
| 5000 | 0.1 | 0.4 | 0.4 | 1.9 | — |
| c) Per gram root population | | | | | |
| 0 | 0 | 0 | 0 | 0 | — |
| 100 | 294.2 | 148.9 | 163.3 | 264.8 | — |
| 500 | 407.5 | 221.7 | 254.1 | 880.0 | — |
| 1000 | 645.9 | 125.0 | 623.1 | 731.8 | — |
| 5000 | 90.9 | 85.8 | 234.7 | 562.3 | — |

* Gall index scale: 0 = 0 galls; 1 = 1-2 galls;
2 = 3-10 galls; 3 = 11-30 galls;
4 = 31-100 galls; 5 = 100 + galls.

** The reproduction factor $R = \frac{\text{Final nematode count}}{\text{Initial inoculum level}}$

### 3. Nematode field control trial

The trial against *M. incognita* has been initiated.

### 4. Studies on population dynamics

The temporal distribution of root-knot nematodes in infected plantations were monitored at monthly intervals showed that the nematode population attains two peaks during April-May and September-October.

# X. *Biotechnology*

**(General Leader : MJ Ratnambal)**

**Biotech. I(813). Tissue culture for rapid clonal multiplication of elite plants of cardamom**

*(Regy Lukose)*

About 1145 plantlets with roots raised from callus were transferred to soil vermiculite medium for hardening and to the cage house subsequently for further acclimatization.

The comparative yield trial (CYT.1) which was laid out during 1987 with Cl.37 bulk tissue cultured plants, Cl.37 suckers and Cl.37 seedlings, showed significant differences for total number of tillers|plant and total number of leaves after one year of planting. The tissue cultured plants produced more number of tillers (12.02) than the suckers (8.23) and seedlings (9.95). They produced more number of leaves|plant (94.19) than the suckers (65.99).

The CYT.2 which was laid out during 1987 with monoclonal $P_1$ Mudigere tissue cultured plants, $P_1$ monoclonal suckers and $P_1$ seedlings was maintained.

A new trial CYT.3 with tissue cultured plants of 6 high yielding selections has been laid out during January 1989.

**Biotech. II(813).** ***In vitro*** **selection for resistance to soft rot and bacterial wilt in ginger**

*(MJ Ratnambal, GN Dake* and *K Nirmal Babu)*

Callus was produced from 3 different explants viz., vegetative bud, ovary and pseudostem (leaf sheath). MS basal medium with relatively high concentration of 2, 4-D gave good callus formation in all the 3 explants. The calli were multiplied and maintained in media with very low concentration of 2, 4-D and high concentration of kinetin or BAP.

Organogenesis and plantlet formation with calli derived from vegetative bud and ovary explants were achieved, when the calli were subcultured at low concentration of 2, 4-D (0.2 mg|l) and high concentration of BAP (10 mg|l).

# *All India Coordinated Research Project on Spices (Summary Report)*

**(Project Coordinator : S Edison)**

The All India Coordinated Research Project on Spices (AICRPS) has 15 coordinating centres located in 9 states and about 45 research experiments are being conducted on crops such as black pepper, cardamom, ginger, turmeric, coriander, cumin, fenugreek, fennel and large cardamom.

The major objectives of the project are:

* Evolving high yielding varieties resistant/tolerant to diseases and pests
* Standardisation of agro-techniques for the crops under different agro-climatic conditions
* Evolving control measures for major diseases and pests
* Working as an inter-face and feed-back between the Agricultural Universities, NRCS and ICAR.

An account of research work carried out by the different coordinating centres during 1988 is summarised below:

## BLACK PEPPER

### 1. Panniyur

During the year 3 more black pepper cultivars and 10 wild types were added to the germplasm thus making a total of 73 cultivars and 127 wild types. Based on the maturity of berries the cultivars were tentatively classified into:

i) eary maturing; ii) late maturing, and iii) intermediate types.

A total number of 171 hybrids involving 14 parental combinations and open pollinated seedlings were transplanted to the main field. An open pollinated seedling No. 5128 of the cultivar 'Cheriyakaniakadan' gave maximum yield. Three cultures viz., 141, 239 and 331 have been identified as high yielders and are under pre-release testing.

For the management of *Phytophthora* foot rot, spraying and drenching of Bordeaux mixture 1% and foliar application and soil drenching of Ridomil-Mancozeb (0.2%) were found effective in reducing disease incidence. An observational trial for the control of *Phytophthora* foot rot showed that application of Bordeaux paste, spraying and drenching Bordeaux mixture 1% along with soil application of neem cake and lime increased vine yield.

The fungal pollu disease can be controlled by two rounds of spraying with 1% Bordeaux mixture during the last week of June and last week of August. The nursery disease associated with *Colletotrichum* sp., *Pythium* sp. and *Rhizoctonia* sp. could be controlled by fortnightly spraying and drenching the cuttings with 1% Bordeaux mixture or 0.1% Difolatan.

Pesticide residue analysis of pepper berries collected from the vines treated with Bordeaux mixture 1%, Copper oxychloride 0.3%, Ridomil-Mancozeb 0.2% and Captafol 0.2% showed 0.470 ppm Cu, 0.525 ppm Cu, 0.954 ppm metalaxyl and 0.247 ppm Captafol respectively.

**2. Sirsi**

Seventy accessions were maintained in the germplasm including five wild types.

Black pepper vines treated with Aliette were free from foot rot disease.

Pesticide residue analysis of pepper berries showed 0.422 ppm Cu, 0.450 ppm Cu, 0.681 ppm of metalaxyl and 0.695 ppm of Captafol respectively in Bordeaux mixture 1%, Copper oxychloride 0.3%, Ridomil-Mancozeb 0.2% and Captafol 0.2% treated vines.

**3. Chintapalli**

Germplasm collection at this centre consists of 17 cultivated and 12 wild accessions. The vines in the comparative yield trial (CYT) with 9 selected cultivars established well except Kurielmundi which has not survived.

## CARDAMOM

**1. Mudigere**

The existing germplasm at this centre consists of 197 cultivated types and 8 wild related genera. Out of the 38 entries in one germplasm block, P-1 recorded maximum yield of 211.7 to 255.0 g|clump. In the CYT of clonal progenies of 27 accessions, K-4 gave the highest yield (2021 g|clump) followed by NPK-469 (1937.5 g|clump). The high yielding elite clones viz., CL-679, CL-683 and CL-726 are on onfarm trials. High density planting with 1.8 x 0.9 m and 1.8 x 0.6 m were found beneficial.

Of the twelve cardamom clones subjected to moisture stress, clone P-6 and Cl-757 registered high LAI and dry matter indicating their drought tolerance.

Three pathogenic fungi were isolated from clump rot affected plants viz., *Fusarium* sp., *Pythium* sp., and *Phytophthora* sp.

Dithane M-45, 0.25% and Foltaf 0.25% were found significantly superior to control for reducing the leaf spot disease in cardamom nurseries caused by *Phyllosticta elettariae.*

**2. Yercaud**

Of the 35 accessions in germplasm the green capsule yield was maximum in the local Mysore type.

Surveys were conducted for the micronutrient status and the samples are being analysed.

**3. Pampadumpara**

At present 54 cultivated types and 18 wild relatives are maintained in the germplasm.

The cultures PV-1 and P-1 have been recommended for release as varieties in Kerala and Karnataka respectively. Hybridisation studies were carried out to evolve high yielding varieties with desirable characters and to improve the capsule character of the variety PV-1. Studies were conducted to formulate suitable nutritional schedule for cardamom under shade.

Involvement of *Phytophthora meadii* in Azhukal disease of cardamom has been confirmed. Spraying foliage and capsules and soil drenching with 1% Bordeaux mixture was found effective in checking the disease.

Seeds of PV-1 were irradiated to induce variability for 'katte' resistance and seedling progenies were transplanted to main field.

## LARGE CARDAMOM

**1. Gangtok**

A CYT with 13 popular cultivars has been laid out. Apart from the 'Chirkey' and 'Foorkey' diseases, the leaf spot caused by *Pestalotiopsis* as well as the panicle rot are the other serious diseases.

## GINGER

**1. Pottangi**

At Pottangi the germplasm consists of 120 accessions. PGS-22 gave highest yield (4.5 kg|sq.m.). A new multilocation trial (MLT) was laid out during 1988 with 6 entries. Selections $V_2E_5$ - 2 gave highest rhizome yield (8.7 kg|3 sq.m.) and the incidence of soft rot was least in PGS-35 and has been released as a variety 'SUPRABHA'. The yield potential of the variety PGS-35 is 16.6 tons green rhizomes|ha, and contains 4.4% crude fibre and 1.9% essential oil.

**2. Solan**

The germplasm collections at Solan consists of 52 types including the 11 accessions received from the NBPGR, New Delhi.

Mulching with grass + FYM significantly increased the yield of ginger followed by pine needle mulching + FYM.

Field application of Dithane M-45 (0.3%) and Captaf (0.25%) were found to reduce the soft rot incidence. Seed treatment with Dithane M-45 (0.3%) and Apron SD-35 (700 ppm) resulted in maximum germination and was found effective in minimizing the incidence of rhizome rot. The cultivars, B-1, Awacho, Jamaica, Ausu, Nadia, Maran and SG-666 were found to be moderately resistant to rhizome rot. The seed treatment with combination of Dithane M-45 (0.25%) and Bavistin (0.05%) for 60 min. before storage in pits was found effective in reducing storage rot.

**3. Vellanikkara**

Out of the 32 collections of ginger available at Vellanikkara, 7 promising types evaluated for yield. The preliminary studies revealed that types ZO-12 and ZO-2 were found to be high yielders and are suitable for dry ginger production. A new MLT was laid out with 6 entries and the type Maran showed maximum vegetative growth followed by SG-666. Highest yield of 7.4 kg|3 sq.m. was obtained in Maran followed by SG-666 (5.5 kg|3 sq.m.).

Application of Ridomil-Ziram 0.25% was the most effective for the control of soft rot and recorded maximum germination percentage and maximum yield of green ginger.

Seed treatments with Captaf 0.2% and Dithane M-45 (0.3%) gave significantly higher germination percentage.

**TURMERIC**

**1. Pottangi**

Of the 150 germplasm collections of turmeric evaluated, the highest yield was recorded by CLS-7 (7.6 kg|1.2 sq.m.). There was no significant difference in yield under pure crop and intercrop conditions.

The selection PTS-10 from Pottangi with yield potential of 20.7 tonnes|ha, 9.3% curcumin and 4.2% essential oil has been released as a variety 'Roma'.

**2. Solan**

Fifty seven accessions were evaluated for yield and growth parameters. Selection ST-415 gave the highest yield of 24.50 kg|3 sq.m. plot.

**3. Vellanikkara**

In the CYT, VK 76 was found promising considering the dry rhizome yield and curcumin content. In the MLT, PCT-8 (Suvarna) gave maximum yield (10.6 kg 2 sq.m.) PCT-8, PCT-5, PTS-38, 321-Ethamukula are promising types considering dry yield of turmeric|ha and curcumin content.

Spacing of 25 x 25 cm and 20 x 25 cm were found to be optimum for yield.

**4. Jagtial**

In the MLT consisting of 13 cultivars, the long duration local Armoor gave significantly higher yield. PCT 13 and 14 performed better than Suvarna.

**CORIANDER**

**1. Coimbatore**

Wide variations in biometrical characters were observed in 105 germplasm lines evaluated during Rabi 1987-88 and 90 lines and 75 mutants during kharif 1988. In the initial evaluation trial (IET) with 18 lines, none of the varieties were found significantly superior.

CS-287 was found to be field tolerant to grain mould. Spraying with Carbendazim at 0.1%, 20 days after grain set was very effective in reducing the grain mould incidence.

**2. Guntur**

Of the 108 entries of germplasm evaluated, CS 45 gave the highest grain yield of 13.3 q|ha. In the CYT with 19 entries, CS-4 gave significantly higher grain yield of 11.7 q|ha.

In the trial to determine the response of coriander to applied phosphorus in the black clayey soil with low available 'P' showed that significantly increased yield with increased levels of 'P' upto 60 kg.

Of the 10 treatments tried to control grain mould of coriander, Potassium Nitrate 2% treatment gave significantly superior yield (8.53 q|ha).

**3. Jagudan**

Three hundred and one germplasm entries were maintained and evaluated for the growth and yield characters. The short duration variety Co-2 gave the highest yield (15.9 q|ha).

**4. Jobner**

Thirty six germplasm accessions were maintained. The seeds of UD-21, UD-354, UD-374 and UD-41 were multiplied in isolation plots.

The CYT was conducted at two locations viz., Jobner and Diggi. At Jobner, 18 entries were evaluated and the entries showed variation for yield/plot, days to 50% flowering, plant height, number of umbels/plant and number of grains/umbel. The mean performance of entries over the previous years revealed the superior performance of UD-41. The variety UD-41 has since been released under the name "RC-41".

At Diggi among the 5 entries UD-21 recorded maximum yield (9.2 q/ha) followed by UD-41 (7.9 q/ha).

The response of coriander to time of nitrogen application showed that 60 kg N/ha in 3 equal splits i.e., at sowing, at 30 and 75 days after sowing gave maximum yield.

The effect of different stages of harvesting of 3 coriander varieties (long, medium and short duration) showed that variety GAU-1 (medium) and RCr-41 (long) gave significantly higher yields than the short duration variety Co-2. The seed yield was affected by the stage of harvesting and early harvesting reduces the grain yield. Highest yield was obtained at 100% grains turning yellow (6.1 q/ha) followed by 50% grains turning yellow (5.9 q/ha).

Out of the 63 entries screened against stem gall disease, variety UD-41 was found to be completely free from stem gall under field conditions. In the case of root knot nematode, out of 21 varieties screened, only Co-1 and Co-2 showed resistance.

**CUMIN**

**1. Jagudan**

One hundred and fifty seven germplasm entries were maintained at this centre.

Soil amendments with different oil cakes viz., neem, cotton, castor and mustard, @ 20 q/ha in combination with seed treatment with Bavistin and Captan each @ 2 g/kg seed did not control wilt.

Of the 34 selected entries tested for their reaction to wilt disease under natural and wilt sick plot conditions, the entry EC-109635 continued to be moderately resistant.

**2. Jobner**

Seventy nine germplasm entries were maintained. In the MLT with seven entries maximum yield of 9.3 q/ha was obtained in UC-208 followed by UC-89 (8.3 q/ha). The performance of entries evaluated in the CYT for yield for three years (1984-87) indicated superior performance of UC-19.

UC-19 with an average yield of 7 q|ha, 2.6% volatile oil, better grain quality and tolerance to wilt has been released as variety RZ-19.

In the adaptive trial at Diggi, variety UC-208 recorded the highest yield (9.3 q|ha) followed by UC-89 (8.3 q|ha) and RZ-1 (8.1 q|ha). The accessions UC-198 and UC-19 recorded maximum yield at Ajmer and Rampura respectively.

Two single plant $M_3$ progenies derived from UC-19 were identified for resistance to wilt under the hybridization programme. In a chance cross between wilt resistant varieties UC-19 and UC-198, four $F_4$ progenies (SPS-3, SPS-55, SPS-56 and SPS-94) were identified as superior. In the selection of natural population, single plant progenies of 211 plants were evaluated and 10 progenies were identified as 'Superior' based on their wilt tolerance and general performance.

## FENNEL

### 1. Jagudan

One hundred and eighty two lines were maintained and the growth and yield characters were recorded.

In the MLT, seven cultures were tested and the highest grain yield was obtained from Guj. Fennel-1 (28.5 q|ha) followed by UF-112 (25.9 q|ha). Application of nitrogen @ 90 kg|ha and picking of umbel when seed was about to turn yellow colour gave the highest yield (37.8 q|ha), which was 18.4% higher than the control.

The selection UC-14-3-3 with an average yield 7 q|ha, 2.6% volatile oil was released as new variety Gujarat Fennel-1.

### 2. Jobner

One hundred and twelve lines were maintained and observed for growth and yield characters. Twelve cultures were maintained by sibmating under muslin cloth bag. In the adaption trial of improved varieties, 5 varieties were evaluated and UF-101 gave 28.20% higher grain yield (12.9 q|ha) compared to 10.1 q|ha in the local type.

In the MLT, the maximum significant grain yield of 12.9 q|ha was found in UF-101 followed by UF(M)-1 (12.2 q|ha) and GF-1 (11.3 q|ha) and lowest in UF-112 (9.5 q|ha).

The study of the effect of nitrogen levels on stage of picking umbels on yield and quality of fennel indicated that nitrogen at 90 kg|ha gave significantly highest seed yield compared to 0, 30 and 60 kg N|ha.

## FENUGREEK

### 1. Coimbatore

A dual purpose variety viz., Co.1 has been released in Tamil Nadu gave 40.09 q of greens|ha and 5-6 q grains|ha. A total of 84 and 66 accessions were evaluated during rabi 1987 and kharif 1988 respectively and there was wide variability for biometrical characters and yield components.

In the MLT with 14 entries, the pooled data for 1987-88 revealed the superior yield potential of Co-1 over other cultures.

Control of root rot disease involving application of soil amendments, treatments with antagonistic fungi and drenching of fungicides revealed that drenching with 0.1% carbendazim recorded minimum root rot incidence followed by neem cake at 10 q|ha in both seasons.

In the MLT with six lines the variety Co-1 and the accession 1084 were found tolerant to phyllody and root-rot under field conditions. In the screening of 99 lines of germplasm the incidence of phyllody ranged from 2.1 to 23.8% and few lines viz., UM 113, 272, 2335, 197, Lam Sel. 1 etc. were found to be field tolerant to root rot.

### 2. Guntur

In the evaluation of 67 entries obtained from the different regions of the country for yield and yield attributes, maximum seed yield was in Lam Sel. 1 (6.5 q|ha) followed by Methi-3 (6.3 q|ha) and Co-I (6.2 q|ha). In the MLT with 9 entries, Lam Sel. 1 gave the highest grain yield (5.3 q|ha).

### 3. Jagudan

One hundred and seventy germplasm collections maintained were observed for their growth and yield characters. In the MLT, the maximum yield was obtained in Co-1 (7.8 q|ha) followed by Co-2 and Lam Sel. 1.

### 4. Jobner

In the MLT with 11 entries, NLM (Prabha) gave maximum grain yield (22.2 q|ha) which is 19.6% higher than the local; the other potential varieties are UM-34, UM-116, UM-117 and UM-118 (21.0 - 21.9 q|ha). Application of N upto 50 kg|ha and $P_2O_5$ @ 40 kg|ha and irrigation increased the fenugreek yield significantly. Irrigation levels IW|CPE ratio of 1.0 gave the highest grain yield (15.5 q|ha).

# PROJECTS CONCLUDED

## *Selection/breeding for high yield and quality in spices*

### Phy. IV(813). Quality evaluation of tree spices

*(A Gopalam)*

#### OBJECTIVES

Quality evaluation of cinnamon and nutmeg germplasm to select high quality types.

#### TECHNICAL PROGRAMME

1. Evaluation of cinnamon germplasm for quality parameters viz., leaf oil, bark oil and bark oleoresin.
2. Selection of cinnamon elite lines for quality.
3. Evaluation of nutmeg germplasm for fat, oleoresin and essential oils.
4. Separation and identification of lipophilic profiles of nutmeg fat.

#### MATERIALS AND METHODS

**1. Cinnamon**

Seven year old Indian and Sri Lankan accessions from NRCS Experimental Farm, Peruvannamuzhi, Calicut were selected for analysis.

**i) Leaf oil:** Leaf samples are drawn from all the stalk positions and are shade dried for 3 days and powdered just before extraction of leaf oil. Oil is distilled in an essential oil distillation unit, meant for oil lighter than water type. Since oil tends to separate into light and heavy oils, as per the ASTA procedure (1970) 2 ml of toluene is added to oil collection tube and subsequently deducted from the net oil volume.

**ii) Bark oil:** Bark is extracted first after the monsoon showers in the conventional manner and powdered first before oleoresin and essential oil distillation.

**iii) Bark oleoresin:** Preweighed quantity of powdered bark was filled in a column and acetone is percolated for 12 hours. From this acetone extract, the solvent is removed by flash evaporation. Oleoresin is quantified by gravimetry.

**iv) Bark oil:** Essential oil from the powdered bark is also extracted as per the method used for leaf oil extraction.

**2. Nutmeg**

From the experimental farm of CPCRI Research Centre, Peechi, 20 nutmeg accessions were selected for evaluating the quality. The nut and aril were separately dried and powdered first before estimation. Following are the details of experimental methods.

**i) Extractable fat from nut:** Fat is extracted as per the flow sheet from freshly powdered nut (Fig. 1). Total fat is quantified by gravimetry.

**ii) Nut and aril oleoresin:** Oleoresin is extracted from fat depleted nut and aril as per the method described for oleoresin extraction from cinnamon bark.

**iii) Nut and aril essential oil:** Both nut and aril are powdered prior to essential oil distillation and essential oil collected in a lighter than water type trap, quantified and expressed as % v|w.

**iv) Lipophilic profile of nutmeg:** Nutmeg fat was extracted as per the flow sheet method given in Fig. 1 and quantified by gravivetry. TLC profile of lipids and fatty acids and GLC of fatty acids is carried out as per the analytical procedures described below:

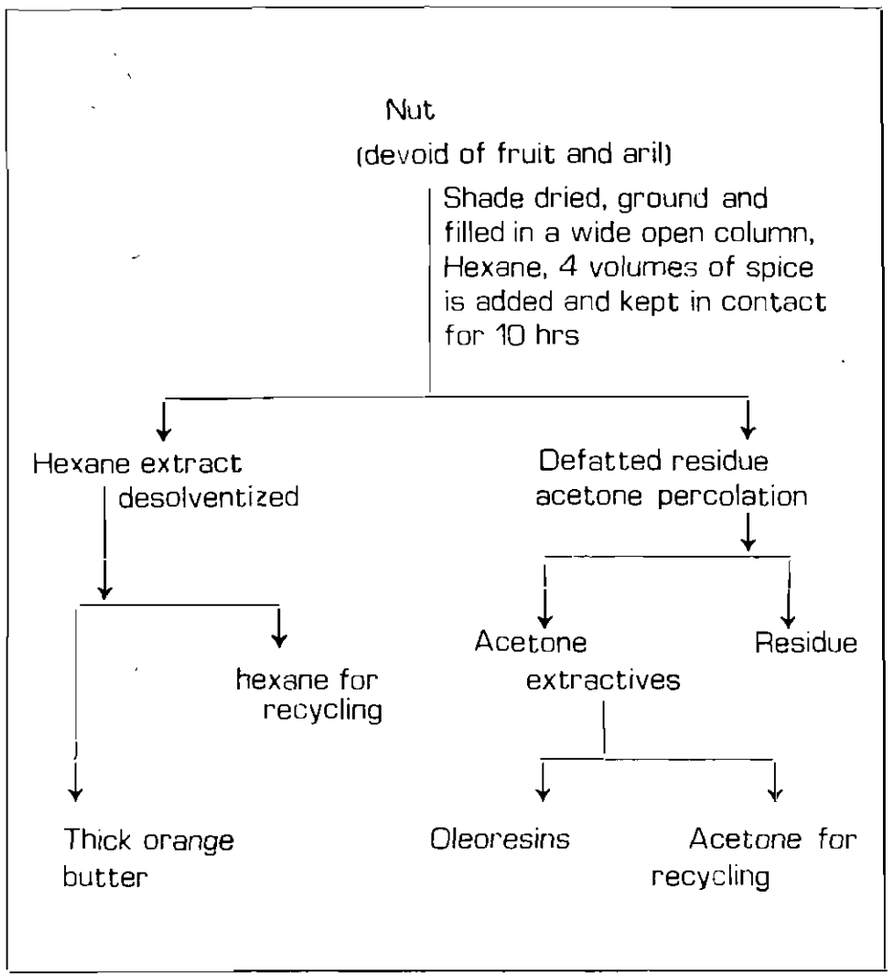
**a. Lipid separation:** The chloroform solubles were resolved by step wise elution into neutral, glyco and phospholipids as per the method of Prakash chandra and Chandrasekharappa (1984) and respective fractions are quantified by gravimetry.

**b. TLC of lipids:** Known quantities of nutmeg fat is dissolved in chloroform along with lipid standards containing mono, di and tripalmitin in equiproportions (Sigma Chemical Co., USA) on a preactivated silica gel G (0.25 mm thickness plates) and developed, in a solvent system containing petroleum ether (60-80°C) diethyl ether and acetic acid (50:10:1 v|v). The developed plates were exposed to iodine vapours for visualisation. Another plate is developed and sprayed with 0.5% Bromothymol blue in aqueous ethanol and exposed to ammonia vapour to confirm the above results.

**c. TLC of fatty acids:** Fatty acids in nutmeg fat are separated by TLC with linoleic acid as a marker standard as per the method of Morrison et al., (1980).

**d. Gas liquid chromatography of fatty acids:** GLC of representative sample of the methylated extractable fat is analysed using Hewlett Packard

Fig 1 Flowsheet for the extraction of nutmeg butter and oleoresins



5730 A interfaced with Varian Techtron Recorder as per the method of Marta I-Aveldano and Lloyd A Horrecks (1983). Individual fatty acids were quantified and presented as the % total of the fatty acids.

## RESULTS AND DISCUSSION

### 1. Cinnamon

One hundred and eighty nine Indian and 102 Ceylon cinnamon lines were evaluated for leaf oil, bark oleoresin and bark oil and are grouped into high, medium and low quality lines on the basis of mean and standard deviation. Average leaf oil of Indian cinnamon ranges from 0.72 to 2.73% (v|w) as against 0.82-3.85% in Sri Lankan types. Bark oil of Indian accessions ranged from 1.14-2.67% (v|w) compared to 0.45-3.85% in Sri Lankan types. The bark oleoresin of Indian cinnamon ranges from 1.2-20.06% (w|w) compared to 2.62-12.45% in Sri Lankan Types. Bark oleoresin and bark oil were more in Indian accessions than in Sri Lankan accessions. Thin layer chromatography of bark oleoresins indicated that Sri Lankan cinnamon accessions followed a uniform pattern of cinnamaldehyde, cinnamyl acetate, eugenol and ∝-terpineol. However, in Indian accession abundant quantities of cinnamaldehyde appears to be present. Based on leaf oil, bark oleoresin and bark oil contents, five Indian accessions (Acc. No. 189, 203, 312, 310 and 313) and five Sri Lankan accessions (Acc. No. 5, 44, 53, 63 and 65) have been identified as high quality lines (Table 1). Among the lines estimated Plant No. 65 appears to be of superior qualitatively.

**Table 1.** Selected cinnamon accessions with high quality

| Acc. No. | Leaf oil % | Bark oleoresin % | Bark oil % |
|---|---|---|---|
| **Indian** | | | |
| 189 | 1.60 | 15.81 | 2.57 |
| 203 | 2.16 | 14.70 | 2.85 |
| 312 | 2.73 | 19.14 | 2.00 |
| 310 | 2.35 | 11.89 | 1.67 |
| 313 | 2.04 | 16.79 | — |
| **Sri Lankan** | | | |
| 5 | 2.62 | 6.03 | 3.85 |
| 44 | 3.41 | 12.45 | 1.58 |
| 53 | 2.54 | 9.88 | 2.56 |
| 63 | 2.35 | 6.58 | 2.56 |
| 65 | 2.75 | 8.58 | 0.95 |

## 2. Nutmeg

Seed fat, oleoresin and essential oil were determined on moisture free basis. The fat ranged from 10.52 to 48.65%. Oleoresin ranged from 2.70 to 14.21% and the essential oil from 1.4 to 3.4%. For demarcating a high quality accession, a single constituent either extractable fat or oleoresin does not appear to be suitable. However, the sum of seed fat and oleoresin considered together appear to be indicator of aroma quality. Considering this, Acc. No. 18, 62 and 66 appear to be superior to other lines (Table 2). Incidentally essential oil levels are also moderate in these accessions. Absolute values of the aroma constituents in any spice crop mislead the commercial potential of the latter. To overcome this, yields of spice are presented either per hectare or per plant to assess the superiority of either accessions (Kaliannan Raju et al. 1985). Extrapolated values per plant basis indicated that range of variation in extractable fat is observed to be 0.109 kg to 1.856 kg. Oleoresin ranged from 0.024 kg to 1.147 kg and in aril the essential oil content varied from 16 to 155 ml. Acc. No. 66 and 78 appear to be superior to all other accessions.

**Table 2.** Fat, oleoresin and essential oil contents of nutmeg accessions

| Sl. No. | Accession No. | Nut-fat % | Oleoresin % | Essential oil % |
|---|---|---|---|---|
| 1 | 18 | 48.63 | 2.70 | 2.4 |
| 2. | 20 | 17.68 | 8.65 | 3.4 |
| 3. | 30 | 11.98 | 6.81 | 1.6 |
| 4. | 31 | 12.92 | 13.22 | 1.8 |
| 5. | 32 | 15.72 | 9.85 | 3.2 |
| 6. | 38 | 26.20 | 5.04 | 1.8 |
| 7. | 40 | 15.13 | 10.19 | 1.4 |
| 8. | 43 | 16.75 | 10.61 | 1.6 |
| 9. | 44 | 15.98 | 8.23 | 1.6 |
| 10. | 48 | 16.18 | 6.31 | 2.6 |
| 11. | 51 | 17.29 | 4.68 | 1.6 |
| 12. | 53 | 15.23 | 4.15 | 1.6 |
| 13. | 54 | 10.52 | 9.34 | 2.8 |
| 14. | 56 | 21.16 | 4.23 | 2.8 |
| 15. | 62 | 19.17 | 14.21 | 1.8 |
| 16. | 64 | 14.91 | 8.83 | 1.4 |
| 17. | 66 | 33.23 | 4.88 | 2.2 |
| 18. | 71 | 15.73 | 6.19 | 1.4 |
| 19. | 78 | 16.85 | 12.05 | 1.4 |
| 20. | 80 | 14.82 | 7.95 | 1.6 |

The aroma quality of aril which covers the seed is important to assess the overall performance of the accessions. Oleoresin generally varies from 10.54 to 38.68% and essential oil from 2.2 to 5.8%. Some of the accessions which contained high aril oleoresin are Acc. No. 38, 56, 64 and 66 and those which contained high oil are Acc. No. 31, 32, 40, 51 and 53. On the whole, Acc. No. 66 followed by 78 appear to be superior and are suitable for large scale multiplication. In Table 3 high quality lines are presented whose tri palmitin content in seed fat is more than 86%.

**Table 3.** Tri-palmitin content in high quality lines of nutmeg

| Accession No. | % Nut-fat | % Tri Palmitin | % Aril Oleoresin | % Aril Essential oil | % Nut oil | % Nut Oleoresin |
|---|---|---|---|---|---|---|
| 66 | 33.23 | 86 | 34.40 | 4.6 | 2.2 | 4.9 |
| 18 | 48:69 | 92 | 38.68 | 4.8 | 2.4 | 2.7 |
| 38 | 26.20 | 92 | 36.37 | 5.6 | 1.8 | 5.0 |
| 61 | 22.08 | 96 | — | 4.4 | 2.4 | 9.0 |
| 32 | 15.32 | 88 | 10.95 | 4.5 | 3.2 | 9.8 |
| 20 | 17.65 | 92 | 18.76 | 4.2 | 3.4 | 8.7 |
| 64 | 14.91 | 94 | 33.52 | 5.2 | 1.4 | 8.8 |

**i) Lipophilic profile of extractable fat from nutmeg:** It is necessary to use wide open column (30 mm x 600 mm) in place of ordinary glass columns since the hexane extract during elution blocks the column by the formation of semi solid fat. Two hundred grams of nut flour yields about 60 g of nutmeg fat. Analysis for the residual solvents in the extractable fat indicated the presence of spice fat only. Wide variation in the total extractable fat was observed in different accessions. A preliminary TLC showed that besides fatty acids, it contains saturated and unsaturated lipids. Mono, di and tri-glyceride content in different accessions indicated that triglycerides varied from 86.2 to 97.4% whereas mono and diglycerides vary from 0.6 to 6.8% and 1.9 to 6.8% respectively. Among the three triacylglycerols i.e., triolein, tripalmitin and trimyristicin, the triglyceride present in nutmeg is found to correlate well with trimyristicin which can serve as a useful quality index.

Fractionation of nutmeg fat to neutral, glyco and phospholipid resulted in 33% of glycolipids, followed by neutral lipids (28%) and phospholipids (10%).

For TLC profile of fatty acids, linoleic acid standard was co-chromatographed and the unknown were identified on the basis of Rf values of Morrison et al. (1980). Gas liquid chromatography of the fatty acids with trimethylsilyl derivatives confirm the results of TLC. The acid value and the saponification

value of the hexane extractable fat was found to be 8.98 and 196 respectively. High saponification value and low acid value indicate its suitability in perfumary. Inspite of its easy extractability and desirable physical and chemical characteristics, reports on the usability of this fat either in perfumary or in confectionary are scanty. High glycolipid content (Finlay Macrutchic, 1977) make the fat desirable for confectionary and low lipolysis of triglycerides (Ahuja et al., 1979) confirm the suitability of this fat for bread making.

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**Collection, conservation and cataloguing of genetic resources of black pepper *Piper nigrum* L. and related species**

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Co-principal investigator : *P. N. Ravindran*
Research fellows :

*R. Asokan Nair* (9.12.85–29.9.1986) *Mercy Mathew* (7.12.85–14.5.1986) *Mohana Kurup* (28.5.86–18.11.1986) *A. Chandran* (17.2.87–21.8.87) *Romeo Alex* (4.3.1987–31.1.1989) *V. V. Radhakrishnan* (28.9.87–6.1.1989)

## OBJECTIVES

1. To collect the genetic resources of *Piper* from the Western Ghat forests and adjoining areas of Peninsular India.
2. Conservation of the genetic resources in the nursery and in the field at the NRCS Farm, Peruvannamuzhi.
3. Description and classification of the germplasm collections.
4. Cataloguing and documentation of the germplasm collections.

## TECHNICAL PROGRAMME

1. Survey of the Western Ghats and adjoining areas for the collection of *Piper nigrum* and its wild relatives.
2. Survey of tribal settlements and old traditional areas not covered so far for the collection of old traditional cultivars.
3. Establishment of conservatories for the long term conservation of the genetic resources.
4. Characterisation of the germplasm collections, cataloguing including preparation of descriptors.
5. Documentation and cataloguing of the germplasm collections — storage of the data and their retrieval for future uses.
6. Anatomical and embryological studies on *Piper nigrum* and related spp. to fill up the existing gaps in our knowledge on these aspects.

## MATERIALS AND METHODS

The pepper growing areas were surveyed for the collection of materials hitherto uncollected. Forest areas were surveyed for collection of wild *P. nigrum* and related taxa. Runner shoots were collected and planted in the NRCS Farm at Peruvannamuzhi for conservation. Herbariums were prepared for taxonomic study.

Anatomical studies were carried out from permanent preparations prepared in the conventional ways. Hand sections of fresh materials were also used wherever necessary. Stomatal studies were done from epidermal peelings stained in haematoxylin as well as in safranine. Chemical studies were carried out by paper and thin layer chromatography as described by Markham (1982).

## RESULTS AND DISCUSSION

### Germplasm collection

During 1986-88 many pepper growing areas were surveyed and 255 collections of black pepper germplasm were added to the already existing germplasm. The total of wild *Piper* collections made during the period were 347, out of which 92 distinct ones were assembled for conservation. The taxa collected included *P. argyrophyllum, P. attenuatum, P. hymenophyllum, P. longum P. trichostachyon, P. galeatum, P. mullesua, P. schmidtii, P. wightii, P. silentvalleyensis, P. nigrum* var. *hirtellosum* and many collections of *P. nigrum.*

These collections are being maintained in herbaria and the distinct ones are maintained in the nursery. Certain species like *P. schmidtii, P. wightii,* and *P. mullesua* could not be maintained as they do dot survive in plains. An alternate site for maintenance is being identified at Appangala in Kodagu District.

### Morphological studies

#### Leaf anatomical features

Among the pepper cvs. the leaf thickness varies from 0.313 mm in Karimunda to 0.412 mm in Poonjaranmunda; the majority of the cultivars have leaf thickness between 0.340 and 0.380 mm. The upper epidermal thickness ranges from 0.08 mm in Thevanmundi to 0.144 mm in Cheppukulamundi. The lower epidermal thickness ranges between 0.106 mm in Kaniakkadan to 0.165 mm in Uthirancotta. The mesophyll thickness varies from 0.105 mm in a wild collection (No. 2009) to 0.152 mm in Nedumchola. The stomatal frequency varies from 61.2|mm$^2$ in Karimunda to 130.4|mm$^2$ in Vadakkan.

Among the related taxa, the lowest stomatal density is in *P. attenuatum* (68.4|mm$^2$), followed by *P. trichostachyon* (80.0|mm$^2$). The highest stomatal frequencies are in *P. longum* (113.3) and *P. schmidtii* (103.7).

The length of guard cells varies from 0.022 mm (in Kottanadan, Kuriyalmundi and Kuthiravally) to 0.028 mm (in Thulamundi and Acc. No. 2059); and the breadth of guard cell from 0.015 mm (in Velliyaranmunda) to 0.025 mm (Vadakkan). In the related taxa the guard cell length varies from 0.023 mm in *P. longum* to 0.033 in *P. hymenophyllum* and guard cell breadth from 0.016 mm in *P. schmidtii* and *P. trichostachyon* to 0.002 in *P. hymenophyllum*.

The leaf epidermis is made of small rectangular cells, beneath which there is a hypodermis on both sides, composed of 2-3 layers of large, more or less rectangular cells. The palisade is relatively narrow, composed of just one row of cells in most of the area. The spongy tissue is composed of 3-4 layers of round to irregularly shaped cells. Mucilage canals are seen inside the mesophyll, often close to the vascular supplies. The T.S. through a midrib shows the vascular cylinder, consisting of an indistinct bundle sheath and 5-7 groups of xylem elements. Below the xylem 1-2 layers of cambial cells and below it a small group of phloem cells are present.

**The petiole**

The petiole is groved on the upper surface. The epidermis is made up of hexagonal cells, the cuticle is thick and corrugated in appearance (in T.S). Below the epidermis there is a sclerenchymatous outer cortex, which forms a band all around. Below this there are 10-12 rows of parenchymatous cells. There is a mucilage cavity which occupies a central position. The vascular bundles are distributed in a semi circle, the number varies from 14-16.

**The orthotropic stem**

The structure of the orthotropic shoot is typical of that of Piperaceae. The epidermis is made of rectangular cells over which there is a corrugated layer of cuticle. Below the epidermis there are 2-3 rows of collenchymatous cells with many sclerides distributed in it. Below this there is a discontinuous band of sclerenchyma consisting of 4-6 rows of cells. Inner to this band there are 7-8 rows of parenchyma cells. The peripheral ring of vascular bundles is situated below the parenchymatous region. This ring is composed of 30-40 vascular bundles, consisting of both small and large which often alternate. Each bundle is characterised by a sclerenchymatous cap towards the outside below which lies phloem, cambium and xylem. Just below the ring of peripheral bundles there is a continuous wavy band of sclerenchyma. The inner parenchymatous region lies inside this band, and is made of closely arranged parenchyma cells. The central bundles (or medullary bundles) are arranged inside this parenchyma region. There are 8-10 central bundles, which are larger than the peripheral bundles. Each bundle has a sclerenchymatous cap towards the outerside, below which lies phloem, cambium and xylem. The

medullary rays consist of hexagonal cells. The pith is small and at the centre of the pith there is a mucilage canal which infact forms a continuous canal traversing the entire plant body.

Secondary thickness is initiated by the formation of a cambial ring in the area of peripheral bundles.

**Lateral shoot**

The anatomy of the lateral branch differs from that of the orthotropic shoot in the following details:

1. Continuous band of sclerenchyma in the outer region of the cortex in the lateral branch whereas in the orthotropic shoot this band is discontinuous.
2. There are no sclerenchymatous caps over the peripheral vascular bundles.
3. Less number of peripheral sclerenchymatous bundles (18-24) as compared to 30-40 in the orthotropic shoot.
4. Lesser number of central bundles 4-6 compared to 8-10 in orthotropic shoot.
5. Fewer number of xylem elements both in the peripheral and central bundles than that of the orthotropic shoot.

**Aerial root and the normal root**

The normal underground root is more or less similar to a typical dicot root. There are 5-8 groups of xylem and phloem and a relatively large pith which is not very common in dicot roots. There is no central mucilage canal in the root. The metaxylem elements vary from 1-3 and the protoxylem 5-8.

The aerial root differs from the normal root in having a much larger number of xylem and phloem groups (12-15). The cortex is made of irregularly shaped closely packed cells. Sclerides are distributed towards the periphery of the cortex. The xylem elements are arranged as flattened discs. The number of xylem elements are more but are smaller than the elements of the normal root.

**Spike, flower and fruit characters of *Piper* spp.**

The spikes of *Piper* spp. can be either pendulous or erect. Erect spikes are seen only in three species studied namely, *P. longum P. mullesua* and *P. silentvalleyensis*. Based on shape, the spikes can be either filiform, cylindrical or globose. Globose spike is found only in *P. mullesua,* cylindrical spike only in *P. longum*. In all the other species the spikes are filiform. *P. longum* is also exceptional because the flowers are laterally fused while in all the other species, the flowers are independent.

Spike length in various *Piper* spp. range from about 1 cm in *P. mullesua* (mean 9.00 mm) to 18.0 cm in *P. attenuatum* and *P. galeatum*. Within *P. nigrum* (wild) the seven collections studied range in spike length from 5.7 cm to 13.5 cm. Length of the spike stalk (peduncle) also vary among the species from 0.2 cm in *P. mullesua* to 2.5 cm in *P. argyrophyllum*.

Spikes are glabrous in most of the species studied except in *P. trichostachyon* and in a collection of *P. nigrum (P. nigrum* var. *hirtellosum)*

Bract type is important in species delimitation of *Piper*. In *P. attenuatum, P. argyrophyllum* and *P. hymenophyllum* the bracts are sessile and adnate to the rachis. In *P. longum, P. mullesua* and *P. silentvalleyensis* bracts are peltate, stalked and orbicular. In *P. galeatum* and *P. trichostachyon* the bracts are connate fleshy cup like structures. In *P. nigrum* the bracts are cupular with decurrent base. In *P. schmidttii* the bracts are oblong, narrowed towards the base and adnate with free margins. Stamens are two in *P. nigrum, P. mullesua, P. trichostachyon, P. galeatum, P. schmidtii* and *P. silentvalleyensis*, 2 or rarely 3 in *P. wightii;* 3 in *P. attenuatum* and *P. hymenophyllum*, 3–4 in *P. argyrophyllum* and *P. longum*.

**Spike variations among cultivars**

The smallest spike (3-4 cm) is found in the cv. Vokkalu, a collection from the Sagar taluk of Karnataka State. The longest spike is in the cv. Kuthiravally (17.0 cm) a central Kerala cultivar. The other long spiked cultivars are Poonjaranmunda (16.4 cm), Karimkotta (15.6 cm) and Panniyur-I (14.0 cm). The peduncle length ranged from 0.5 cm in Vokkalu to 2.1 cm in Karimkotta. The fruits of *Piper* spp. can be either free as in most species, or fused laterally as in *P. longum*. Fruit shape is obovate|oblong in *P. attenuatum, P. argyrophyllum, P. hymenophyllum, P. galeatum, P. wightii* and *P. schmidtii*, elliptical in *P. longum* and *P. mullesua*, obovate in *P. silentvalleyensis*. bold in *P. galeatum*. *P. trichostachyon* and in certain *P. nigrum* collections; and medium in other species.

**Herbarium study**

Two new taxa were described during the study. These were named *P. silentvalleyensis* and *P. nigrum* var. *hirtellosum*

**Chemical studies**

Flavonoid analysis showed variation among the species. The chemical evidence in general supported the taxonomic division of the genus arrived at by conventional taxonomy. In the study, close relationships were observed

between (1) *P. trichostachyon* and *P. galeatum* (2) *P. attenuatum* and *P. argyrophyllum* (3) *P. nigrum* and *P. sugandhi* (4) *P. mullesua* and *P. silentvalleyensis.* The pattern of triterpenoids and steroid were very similar among the various species.

The study conducted showed that considerable variability exist in the genus *Piper,* especially in *P. nigrum.* Certain amount of confusion still prevail over the species *P. hapnium* and *P. hookeri.* Further studies are required to solve their taxonomic affinities.

**PUBLICATIONS**

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RAVINDRAN, P. N., NAIR, M. K., ASOKAN NAIR, R., NIRMAL BABU, K. and CHANDRAN, K. 1989. Morphological and ecological notes on *Piper* spp. from Silent Valley Forests, Kerala, India. *J. Bombay Natural Hist. Soc.* (in Press).

# GENERAL INFORMATION

## *Budget for 1988-89 (Calicut and Appangala)*

**Budget allocation**

| | |
|---|---|
| Non-Plan | Rs. 42,00,000 |
| Plan | Rs. 35,00,000 |
| Total | Rs. 77,00,000 |

**Actual expenditure**

| | |
|---|---|
| Non-Plan | Rs. 42,63,329* |
| Plan | Rs. 34,99,674 |
| Total | Rs. 77,63,003 |
| **Receipts** | Rs. 2,71,336 |

* Excess expenditure of Rs. 63,000|- was met out of the revenue receipts vide ICAR letter No. F.12-6|88-EE.V dated, 14-6-1989.

## *Library and documentation service*

Library continued to provide documentation and information services to scientists and other research workers of the research centre as well as research scholars and students of the universities. Library started to publish "Agri Sci Tit Bits", a bimonthly information service, containing news items and notes pertaining to general agriculture and science.

Five doctoral thesis on spices and condiments were obtained on loan and photocopies of the same were added to the library. Reprographic services were provided to research workers and 1,06,186 copies of various such documents have been taken either for distribution or for preservation. Publications of the Research Centre such as annual report, extension pamphlets, research highlights etc. were regularly supplied to various organizations and individuals.

At Calicut, 137 books, 66 bound volumes and 162 reprints were added to the library; 54 foreign and 76 Indian journals were subscribed during the year. Forty books, 5 technical reports and 13 reprints were added to the Appangala library. During this year 9 foreign and 17 Indian journals were subscribed at the Appangala Library.

**RESEARCH|REVIEW ARTICLES**

ABDULLA KOYA, K. M., PREMKUMAR, T. and GAUTAM, S. S. S. 1988. Chemical control of shoot borer *Dichocrocis punctiferalis* Guen. on ginger *(Zingiber officinale* Rosc.). *J. Plant. Crops* **16:** 58-59.

ABDULLA KOYA, K. M. 1988. Distribution of dipteran maggots associated with ginger *(Zingiber officinale* Rosc.) in Kerala. *J. Plant. Crops* **16:** 137-140.

DEVASAHAYAM, S. 1988. Mating and oviposition behaviour of *Helopeltis antonii* Signoret (Heteroptera: Miridae). *Journal of the Bombay Natural History Society* **85:** 212-215.

DEVASAHAYAM, S., PREMKUMAR, T. and ABDULLA KOYA, K. M. 1988. Insect pests of black pepper *(Piper nigrum* L.) in India — A Review. *J. Plant. Crops* **16:** 1-11.

GOPALAM, A. and SAYED, A. A. M. 1988. Evaluating aroma quality of nutmeg accessions. *Indian Spices* **25:** 9-11.

GOPALAM, A. and JOHN ZACHARIAH, T. 1988. Black pepper oil-chemical and aroma quality. *Indian Cocoa, Arecanut and Spices Journal* **XII:** 44-46.

KORIKANTHIMATH, V. S. 1988. Influence of rainfall in the yield of cardamom under different levels of management. *Spices India* **1:** 15-16.

KORIKANTHIMATH, V. S., VENUGOPAL, M. N., NAIDU, R. and SADANANDAN, A. K. 1989. Intensive cultivation of cardamom — a case study. *Spices India* **2:** 5-8.

KRISHNAMOORTHY, B., GOPALAM, A. and JOSE ABRAHAM. 1988. Quality parameters of cinnamon *(Cinnamomum verum)* in relation to flush colour. *Indian Cocoa, Arecanut and Spices Journal* **XII:** 38.

MOHANDAS, C. and RAMANA, K. V. 1988. Population behaviour of *Radopholus similis* in roots of black pepper (*Piper nigrum* L.) in Kerala, India. *Indian Journal of Nematology* **18:** 18-20.

RAJAGOPAL, V., RAMADASAN, A., KASTURIBHAI, K. V. and BALASIMHA, D. 1989. Influence of irrigation on leaf water relations on dry matter production in coconut palms. *Irrigation Science* **10:** 73-81.

RAMANA, K. V. and MOHANDAS, C. 1988. Occurrence of potato cyst nematode *Globodera pallida* (Stone, 1973) in Kerala. *Indian Journal of Nematology* **18:** 18-21

RAMACHANDRAN, N., SARMA, Y. R., ANANDARAJ, M. and JOSE ABRAHAM. 1988. Effect of climatic factors on *Phytophthora* leaf infections in black pepper grown in arecanut-black pepper based cropping system. *J. Plant. Crops* **16:** 110-118.

RAMACHANDRAN, N. and SARMA, Y. R. 1988. Fungitoxic effect of endosulfan and quinalphos on *Phytophthora palmivora* the foot rot pathogen of black pepper. Tests of Agrochemicals and Cultivars No. 9. *Annals of Applied Biology* **112:** 26-27 (Suppl.)

RAMACHANDRAN, N., SARMA, Y. R. and ANANDARAJ, M. 1988. Sensitivity of metalaxyl to *Phytophthora* spp. affecting different plantation crops. *Indian Phytopathology* **41:** 438-442.

SADANANDAN, A. K. and RAJAGOPAL, C. K. 1989. Interrelation of phosphorus content of leaf and yield of pepper in an Alfisol. *Journal of Indian Society of Soil Science* 37: 197-199.

SARMA, Y. R., SOLOMON, J. J., RAMACHANDRAN, N. and ANANDARAJ, M. 1988. Phyllody disease of black pepper *(Piper nigrum* L.) *J. Plant. Crops* **16:** 69-72.

SARMA, Y. R., RAMACHANDRAN, N. and ANANDARAJ, M. 1988. Integrated disease management of quick wilt (foot rot) of black pepper *(Piper nigrum* L.) caused by *Phytophthora palmivora'* 'MF4.' *Journal of Coffee Research* **18:** 68-72 (Suppl.).

SATHEESAN, K. V., and RAMADASAN, A. 1988. Change in carbohydrate level and starch|sugar ratio in three turmeric *(Curcuma domestica)* cultivars grown in mono-culture and as inter-crop in coconut gardens. *J. Plant. Crops* **16:** 45-51.

SATHEESAN, K. V. and RAMADASAN, A. 1988. Effect of growth retardant CCC on growth and productivity of turmeric under mono-culture and in association with coconut. *J. Plant. Crops* **16:** 140-143.

VARGHESE THOMAS, T., GOPALAM, A. and RAMADASAN, A. 1988. A low cost green house. *Indian Cocoa, Arecanut and Spices Journal* **XII**: 94-95.

VIDYASAGAR, P. S. P. V., DEVASAHAYAM, S. and ABDULLA KOYA, K. M. 1988. Sexing live adults of the 'pollu' beetle *Longitarsus nigripennis* Mots. (Chrysomelidae : Coleoptera). *Current Science* **57**: 869.

**POPULAR ARTICLES**

GOPALAM, A. and VASANTHA, S. 1988. Choti elaychi ki krishi. *Spices India* **1(1):** 12-15 (Hindi).

GOPALAM, A. and VASANTHA, S. 1988. Golmirch ki kheti. *Spices India* **1(2):** 12-13 (Hindi).

GOPALAM, A. and VASANTHA, S. 1988. Vriksh sugandho ki krishi. *Spices India* **(14) 1(4):** 9-12 (Hindi).

KRISHNAMOORTHY, B. and REMA, J. 1988. Nursery technique in tree spices. *Indian Cocoa, Arecanut & Spices Journal.* **XI:** 83-84.

KRISHNAMOORTHY, B. and REMA, J. 1988. Clove 'Kirambu'. *Spices India* **I:** 5-6 (Tamil).

KRISHNAMOORTHY, B. 1988. Clove. *The Planter's Chronicle* June 1988. 200.

KRISHNAMOORTHY, B. and REMA, J. 1989. Nutmeg by grafting. *Spices India* **II:** 13-14 (Tamil).

MOHANDAS, C. and RAMANA, K. V. 1988. Slow wilt disease of black pepper. *Cardamom* **XXI:** 19-21.

PREMKUMAR, T. and DEVASAHAYAM, S. 1988. Management of insect pests for higher yields in black pepper. *Indian Cocoa, Arecanut and Spices Journal* **XI:** 121-122.

RAMACHANDRAN, N., SARMA, Y. R. and ANANDARAJ, M. 1988. Strategies to manage *Phytophthora* infection in black pepper. *Cardamom* **21: 15-16.**

RAVINDRAN, P. N. and NIRMAL BABU, K. 1988. Black pepper cultivars suitable for various regions. *Indian Cocoa, Arecanut and Spices Journal* **XI:** 110-113.

SARMA, Y. R., RAMACHANDRAN, N., ANANDARAJ, M. and RAMANA, K. V. 1988. Disease management in black pepper. *Indian Cocoa, Arecanut and Spices Journal* **11:** 123-124.

SARMA, Y. R., PREMKUMAR, T., RAMANA, K. V., RAMACHANDRAN, N. and ANANDARAJ, M. 1988. Disease and pest management in black pepper nurseries. *Indian Cocoa, Arecanut and Spices Journal* **11:** 45-49.

**PAPERS PRESENTED IN SYMPOSIA/WORKSHOP**


ANANDARAJ, M., RAMACHANDRAN, N. and SARMA, Y. R. 1988. Epidemiology of foot rot disease of black pepper *(Piper nigrum* L.) in India. Presented at the International workshop on joint research for the control of black pepper diseases. 27-29 Oct., 1988, Panaji, Goa.

EDISON, S. 1988. Processing of black pepper and technological aspects of various quality parameters. Presented at the Workshop on quality improvement of black pepper. 20 August 1988, Spices Board, Cochin.

EDISON, S. 1988. Strategy for increasing tree spices in Goa. Presented at the workshop on evolving strategies to improve agriculture, animal husbandry and fisheries in Goa. 15 Feb. 1989, Dona Paulo, Goa.

KORIKANTHIMATH, V. S. 1988. Efficient cropping system zones in cardamom. Presented at the National Symposium on efficient cropping system zones of India. 7-10 Jan. 1988, Bangalore.

KORIKANTHIMATH, V. S., VENUGOPAL, M. N., NAIDU, R. and SADANANDAN, A. K. 1988. Prospects of increasing productivity of cardamom through large scale demonstration of improved technology in farmer's fields in Coorg district of Karnataka. Presented at the Plantation Crops Symposium (PLACROSYM-VIII), 28-30, Dec. 1988, Cochin.

NAIR, M. K. and RAVINDRAN, P. N. 1988. Tissue culture of pepper and yield potential, priorities and applications. Proc. Natl. Seminar on plant tissue culture, 2-4 March 1988. CPCRI, ICAR Publ. pp. 163-169.

NAIR, M. K., RAJU, C. R. and SYLA, R. 1988. Collection and observation of recalcitrant seed spices. Basic problem and new options. National workshop on *in vitro* conservation and cryopreservation of plant genetic resources. NBPGR 21-23, July 1988, New Delhi.

RAMACHANDRAN, N., SARMA, Y. R. and ANANDARAJ, M. 1988. Management of *Phytophthora* infection in black pepper *(Piper nigrum* L.) Presented at the International symposium on joint research for the control of black pepper diseases. 27-29 Oct., 1988, Panaji, Goa.

RAMANA, K. V. 1988. Slow wilt disease of black pepper *Piper nigrum* L. in India. Presented at the International symposium on joint research for the control of black pepper diseases. 27-29 Oct., 1988, Panaji, Goa.

SADANANDAN, A. K. 1988. Spices productivity in relation to agroforestry and soil productivity. Presented at the agroforestry workshop. 8 Sept., 1988, Calicut.

SADANANDAN, A. K., MENON, K. S., ANANDARAJ, M., MOHANDAS, C and ABDULLA KOYA, K. M. 1988. Spices production technology in a lab to land programme (Abstracts). Presented at the PLACROSYM-VIII, 28-30 Dec. 1988, Cochin.

SADANANDAN, A. K., RAJU, C. A. and ANANDARAJ, M. 1988. Effect of cultural practices and organic amendments on nutrient availability in soil, germination, yield response and incidence of rhizome rot of ginger (Abstract). Presented at the National seminar on chillies, ginger and turmeric. 11-12 Jan. 1989, Hyderabad.

SARMA, Y. R., RAMACHANDRAN, N. and ANANDARAJ, M. 1988. Status of black pepper diseases in India. Presented at the National workshop on joint research for the control of black pepper diseases. 27-29 Oct. 1988, Panaji, Goa.

SARMA, Y. R. 1988. Major diseases of ginger and the need for integrated disease management. Presented at the National seminar on ginger. 2 March, Nahan, Himachal Pradesh.

SARMA, Y. R., ANANDARAJ, M. and RAMACHANDRAN, N., 1988. Epidemiology of *Phytophthora* diseases of plantation crops, with special reference to *Phytophthora* foot rot of black pepper *(Piper nigrum* L.) caused by *Phytophthora caprici ('P. palmivora'* MF4) presented at the National Symposium on Epidemiology and Forecasting of Plant Diseases, 28th Feb–March 2 1989 Indian Phytopathological Society, IARI New Delhi.

SUBRAMANYAN, S., SADANANDAN, A. K. and VIRAKTAMATH. 1988. Potentials of coconut-cum-fish culture in 'Ghazni' lands of Uttara Kannada (Abstract). Presented at the the workshop on the development of minor forests and ghazni lands in Uttara Kannanda, 20-22 Nov. 1988.

VASANTHA, S., GOPALAM, A. and RAMADASAN, A. 1988. Amino acids in black pepper *(Piper nigrum* L.) cultivars with special emphasis on endogenous proline. Paper presented at the PLACROSYM-VIII. 28-30 Dec. 1988, Cochin.

## *Participation in workshops, seminars and symposia*

National symposium on efficient cropping system zone of India, 7-10 January 1988, Bangalore

Korikanthimath V.S.

Workshop on strategies for the management of root disease incidence in plantation crops, 18-19 January 1988, Chickmagalur

Sarma, Y.R., Ramachandran, N. and Dake, G.N.

State level workshop on package of practices organised by Kerala Agricultural University, 24 April 1988, Trichur

Anandaraj, M.

Workshop on quality improvement in black pepper, 20 August, 1988, Cochin

Edison, S.

Nineth workshop of All India Coordinated Research Project on Spices, September 21-23 1988, Solan

Venugopal, M.N., Edison, S., Ramadasan, A., Sadanandan, A.K. Premkumar, T., and Sarma, Y.R.

International workshop on wilt diseases of black pepper, 27-29 October 1988, Panaji, Goa

Anandaraj, M., Edison, S., Ravindran, P.N., Premkumar, T., Ramadasan, A., Ramachandran, N., Ramana, K.V., Sadanandan, A.K. and Sarma, Y.R.

Workshop on All India Coordinated Project on Betelvine, 14-15 November 1988, Lucknow

Sarma, Y.R.

VIII Symposium on Plantation Crops (PLACROSYM-VIII), December 28-30 1988, Cochin

Korikanthimath, V.S., Edison, S., Sarma, Y.R.
Sadanandan, A.K., Ramadasan, A. and Premkumar, T.

Seminar on molecular biology and biotechnology, 11-13 January 1989, C.M.S. College, Kottayam

Nirmal Babu, K.

National group meeting on production of planting material in plantation crops, 23 January 1989, Kasaragod

Edison, S.

Workshop on evolving strategies to improve agriculture, animal husbandry and fisheries in Goa, 15 February 1989, Goa

Edison, S., Premkumar, T.

Fourteenth meeting of the Indian Spices Development Council, 17 February 1989, Bangalore

Edison, S.

National symposium on epidemiology and forecasting of plant diseases, 28 February to 3 March 1989, IARI, New Delhi.

Sarma, Y.R. and Anandaraj, M.

National seminar on ginger, 2-3 March 1989, Nahan, H.P.

Sarma, Y.R. and Anandaraj, M.

Thirteenth meeting of the Indian Spices Development Council, 4 March 1989, Cochin

Edison, S.

Meeting of the National Committee on spices, March 17 1989, New Delhi

Edison, S.

**TRAINING**

Summer Institute on cytoplasm in crop improvement, 28 June-12 July 1988, TNAU, Coimbatore

Nirmal Babu, K.

## *Membership in committees*

**M.K. Nair**

Chairman: Sub group on spices and cashew for formulating strategy for the development of spices and cashew during VIII plan

Member: Research and Development Board for Cardamom, Spices Board

Special Committee on Personal Matters, Spices Board

Marketing and Development Committee for Spices, Spices Board

ICAR Panel of Fruits, Plantation Crops and Medicinal and Aromatic Plants

ICAR Representative, Spices and Condiment Sectional Committee AFDC 21, 137

National Centre on Bioinformatics

National Council for Tea Research

Academic Council, Kerala Agricultural University

Senate member: Calicut University

Editor: Journal of Plantation Crops

Councillor: South Indian Horticultural Association

**S. Edison**

Convener: Govt. of India Committee on Spices — Working group II spices research

Member: Indian Spices Development Council

Planning Commission Working Group on Horticulture and Plantation Crops (Spices and Cashew)

Experts Group on tree spices, Ministry of Agriculture

Steering Committee of Indian Spices Development Council

Govt of India Sub-group on plantation crops — planting material production, distribution and delivery systems

Executive Councillor: Indian Society of Plantation Crops

**Y.R. Sarma**

*Phytophthora* Committee, International Society for Plant Pathology (ISPP)

**T. Premkumar**

Assistant Editor, Journal of Plantation Crops

**CALICUT**

Dr BC Dutta Roy, Director of Agriculture, Andaman & Nicobar Islands, Port Blair

Mr KM Chandrasekhar, Chairman, Spices Board, Cochin

Dr KP Prabhakaran Nair, Professor, Centre Universities, Camaroon, Paris

Dr Peter H Tsao, Professor of Plant Pathology, California University, U.S.A.

Dr Kuh Tong Khey, P.B. 977, Agriculture Research Centre, Kuching, Malaysia

Dr Sim Soon Liang, 93720 Kuching, Malaysia

Mr R Hali, Director of Agriculture, Government of Kerala, Trivandrum

Mr P Swaminathan, Assistant Director, UPASI Tea Research Institute, Coonoor

**APPANGALA**

Air Comm SD Bhise, Director-General, NCC, Karnataka & Goa

Dr Misra, Project Coordinator (Bee-keeping) Hissar

Dr RM Pandey, Director, IIHR, Bangalore

Dr KM Safeeulla, Vice-Chancellor, Mangalore University, Mangalore

Dr PK Ramachandran, Head of Agricultural Banking, NABARD, Bangalore

Mr N Gopalaswami, IAS, Managing Director, Gujarat Communication & Electronics Ltd., Baroda

Mr Hasmukh Adhia, IAS, Additional Commissioner, Rural Development, Gujarat

Mr NG Kulkarni, Field Manager, Regional Training Centre, NABARD, Mangalore

Dr V Bhaskar, Head, Department of Farm Forestry, UAS, Bangalore

Col K Mohandas, Commander NCC, Group HQ, Mangalore

## CALICUT

### MANAGERIAL

| | |
|---|---|
| A Ramadasan, MA, MSc, PhD | Joint Director I/c<br>Principal Scientist |
| S Edison, PhD | Project Coordinator (Spices)<br>Principal Scientist |

### SCIENTIFIC

**Genetics and Plant Breeding**

| | |
|---|---|
| PN Ravindran Nair, MSc (Ag) | Scientist (SG) |
| B Krishnamoorthy, MSc (Ag) | Scientist (SG) |
| MJ Ratnambal, PhD | Scientist (upto 21-5-1988) |
| K Nirmal Babu, MPhil | Scientist |

**Horticulture**

| | |
|---|---|
| J Rema, PhD | Scientist |

**Agronomy**

| | |
|---|---|
| K Sivaraman, MSc (Ag) | Scientist (SG) (on study leave) |
| BN Reddy, PhD | Scientist (SG) (Joined on 3-5-1988) |

**Soil Science**

| | |
|---|---|
| AK Sadanandan, PhD | Scientist (SG) |

**Plant Pathology**

| | |
|---|---|
| YR Sarma, PhD | Scientist (SG) |
| GN Dake, MSc (Ag) | Scientist (SG) (on study leave) |
| M Anandaraj MSc | Scientist (SG) |
| N Ramachandran, MSc | Scientist (SG)<br>(upto 3-11-1988) |
| CK Parthasarathy Prasad, PhD | Scientist |

**Entomology**

| | |
|---|---|
| T Premkumar, PhD | Scientist (SG) |
| S Devasahayam, MSc | Scientist (SG) |
| KM Abdulla Koya, MSc (Ag) | Scientist |

**Nematology**

| | |
|---|---|
| KV Ramana, PhD | Scientist (SG) |

**Plant Physiology**

| | |
|---|---|
| S Vasantha, MPhil | Scientist (joined on 14-3-1988) |

**Biochemistry**

| | |
|---|---|
| A Gopalam, PhD | Scientist (SG) |
| T John Zachariah, PhD | Scientist |

**Agricultural Statistics**

| | |
|---|---|
| Jose Abraham, MA, MSc | Scientist (SG) |

**Technical**

| | |
|---|---|
| AK Johny, PhD | Technical Officer (joined on 2-11-1988) |
| NR Aditya Varma | Sr. Farm Asst. (T-4) |
| P Azgar Sherif | Sr. Library Asst. (T-4) |

**Administration & Accounts**

| | |
|---|---|
| U Sukumaran | Asst. Adm. Officer |
| NS Sekaran | Asst. Finance & Accounts Officer |
| K Usha | Superintendent |

## APPANGALA

**SCIENTIFIC**

**Agronomy**

| | |
|---|---|
| VS Korikanthimath, MSc (Ag) | Scientist-in-charge (Scientist (SG) |

**Genetics and Plant Breeding**

| | |
|---|---|
| Regy Lukose, MSc | Scientist |

**Plant Pathology**

| | |
|---|---|
| MN Venugopal, PhD | Scientist (SG) |

**Nematology**

| | |
|---|---|
| Santhosh J Eapen, MSc | Scientist |

**Technical**

| | |
|---|---|
| MK Appaiah | Sr. Farm Asst. (T-4) |

**NRCS FARM, PERUVANNAMUZHI**

| Month | Rainfall | | Mean temperature (°C) | | Mean relative humidity (%) |
|---|---|---|---|---|---|
| | No. of rainy days | Rainfall (mm) | Maximum | Minimum | |
| January | — | — | 30.5 | 17.1 | 48.3 |
| February | — | — | 31.7 | 18.1 | 40.0 |
| March | 1 | 4.4 | 33.8 | 20.8 | 48.9 |
| April | 9 | 196.0 | 33.5 | 22.9 | 62.1 |
| May | 7 | 300.0 | 31.9 | 23.4 | 71.2 |
| June | 25 | 936.4 | 25.5 | 25.5 | 72.9 |
| July | 23 | 1237.0 | 27.9 | 25.7 | 78.0 |
| August | 20 | 838.7 | 24.3 | 21.6 | 73.8 |
| September | 16 | 552.0 | 29.4 | 26.5 | 62.3 |
| October | 9 | 232.0 | 29.9 | 26.5 | 62.7 |
| November | 4 | 68.4 | 28.5 | 23.0 | 62.9 |
| December | 2 | 12.0 | 28.1 | 21.0 | 50.0 |

**NRCS CARDAMOM RESEARCH CENTRE, APPANGALA**

| Month | Rainfall | | Mean relative humidity | | Mean temperature | |
|---|---|---|---|---|---|---|
| | No. of rainy days | Rainfall (mm) | Maximum | Minimum | Maximum | Minimum |
| January | – | – | 79 | 51 | 26.8 | 12.4 |
| February | 1 | 8.0 | 81 | 44 | 28.4 | 14.2 |
| March | 2 | 22.0 | 84 | 40 | 31.0 | 16.5 |
| April | 12 | 118.9 | 90 | 59 | 30.6 | 19.2 |
| May | 5 | 49.6 | 89 | 63 | 29.6 | 20.3 |
| June | 26 | 307.7 | 94 | 82 | 25.1 | 18.8 |
| July | 30 | 837.7 | 94 | 83 | 21.5 | 17.5 |
| August | 25 | 427.7 | 95 | 85 | 23.9 | 18.9 |
| September | 25 | 272.8 | 94 | 81 | 27.1 | 18.9 |
| October | 11 | 52.0 | 93 | 67 | 26.9 | 17.9 |
| November | 1 | 8.4 | 85 | 51 | 27.2 | 15.1 |
| December | 2 | 59.6 | 84 | 46 | 26.6 | 13.8 |

Statement showing the total staff strength as on 31-3-1989 and number of SC|ST among them.

| Category | No. of sanctioned posts | No. of employees in position | No. of SC employees | No. of ST employees |
|---|---|---|---|---|
| Scientific | 39 | 25 | 2 | – |
| Technical | 28 | 26 | 3 | 1 |
| Administrative | 18 | 18 | 1 | – |
| Auxiliary | 5 | 5 | – | – |
| Supporting | 62 | 62 | 17 | 1 |
| Total | 152 | 136 | 23 | 2 |