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NATIONAL RESEARCH CENTRE FOR SPICES
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Calicut - 673 012 Kerala India

Front Cover : *Pepper - Coffee Cropping system*
Back Cover : *Bush pepper*
Photographs : *M. Anandaraj*

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DIRECTOR'S REPORT

The National Research Centre for Spices (NRCS) is seven years young by April 1993. The year 1992-93 witnessed emphasis on spices germplasm enrichment, bio-control of pests and diseases, farming system research to realize maximum returns per unit of space and per unit of investment, and transfer of technology. **Biotechnology research** paid rich dividends during the year. Two new research projects, one on "***In vitro*** conservation of black pepper and cardamom" and another on "Rapid multiplication of tree spices" were sanctioned. Regeneration of plantlets from stem and leaf explants of related species of *Piper nigrum*, *Piper betle* was achieved for the first time in the country. Enrichment of germplasm repository of black pepper,ginger, turmeric and tree spices continued with more vigour. This included identification of a variant of *Piper attenuatum* with 2n=104 and three accessions of *Kaempferia galanga*. The black pepper hybrids 732 and 813 performed better at Valparai. Among the open pollinated progenies of turmeric, C-10 was promising for dry recovery and curcumin. Studies on crop management aspects of spices have made significant headway towards characterizing nutrient deficiency symptoms of spices and nutritional requirement of black pepper and turmeric. Eight species of *Piper* were found relatively resistant to `pollu beetle' affecting black pepper. Seven genera of nematodes were found associated with ginger. In **bio-control** studies over 100 isolates of *Trichoderma* were collected and identified. *Pythium aphanidermatum* associated with rhizome rot of ginger was found suppressed by four species of *Trichoderma*. During the year, there was significant increase in the quantum of distribution of nucleus planting materials of black pepper, turmeric and tree spices. A total of Rs.1.567 crores was spent during the year towards research and infrastructure development. **Transfer of technology** in spices received further momentum with the sanctioning of a **Krishi Vigyan Kendra** at Peruvannamuzhi. **The All India Coordinated Research Project on Spices** with 16 coordinating centres made significant contributions during the year. High yielding lines of black pepper (culture numbers 1558, 5128 and 5834), small cardamom (selection No.P-3 and P-5), large cardamom (`Pink Golsey' and `Clone 4') and turmeric (PTS-19 and TC-2) are promising.

The sixth **annual research council** met during 3-5 June, 1993 discussed in detail the projects in progress and suggested new programmes. There were 14 projects in mini mission I, 3 in mini mission II, 12 in mini mission III and 3 supportive research programmes.

Strengthening basic facilities

During 1992-93, equipments costing Rs.38.50 lakhs were procured. The equipments are Electrophoresis Phast System, Kjeltecsystem, Orbital shaker, Cyclotec mill, Millipore water distillation unit, Lab line shaker, Inverted microscope, Wild stereo microscope, Mettler balance, Autoclaves and BOD Incubator. Works initiated during the year are Irrigation projects at Peruvannamuzhi Research Farm (Rs.17.7 lakhs) and at Chelavur Farm (Rs.7.8 lakhs). I express my sincere thanks to the Director General, Indian Council of Agricultural Research, Deputy Director General (Horticulture), Assistant Director General (Plantation Crops), Members of Institute Management Committee and Scientists and Staff of the Research Centre for support and cooperation.

Calicut
17.11.1993

(K.V. Peter)
DIRECTOR

अनुसंधान उपलब्धियाँ

जेनेटिक रिसोर्सस :

- पैपर की वन्य (131), उन्नत (31), अदरक तथा हल्दी के (15), कॅम्पफेरिया गलनगा (1), जायफल वन्य (3), उन्नत (6), लवंग (2) और दालचीनी के (20) किस्मों के जातीयों को मिलाकर जर्मप्लास्म बढ़ाया है ।
- पैपर के (36) सॉयटालाजिकल तथा हल्दी के (81) ऑकसेशन को वर्ण क्रमानुसार सूचीपत्र में तैयार किया है ।

क्रॉप इमप्रूवमेन्ट :

- काली मिर्च के वर्ण संकरण एच.पी. 732 तथा एच.पी. 813 वालपारई (तमिलनाड) में श्रेष्ठ पाये गयै ।
- कोलसीसीन (0.5%) से बीज प्रक्रिया करने से पन्नियूर–1 का (2 एन् = 104) ट्रिपलॉइड बिजाणू पाया गया ।
- अदरक के ओपन पॉलिनेटेड ऑकसेशन नं 64 तथा हल्दी के सी–10 अच्छे पाये गये ।

बायोटेक्नालॉजी :

- पैपर कोलुब्रैनम, पी. लोगम, पी. बारबेरी तथा पी. बीटल को सुक्ष्म – संसाधित विधी से फिर से उत्पन्न किया गया ।
- वॅनिला प्लॅनिफोलिया की सुक्ष्मसंसाधित विधी विकसित की गयी ।
- वृक्ष (ट्री) स्पाईसेस के मल्टीपल तनो के टिपस् को उत्पन्न किया गया ।
- मसालो के जर्मप्लास्म के 100 ऑकसेशन नंबर इन विट्रो सुरक्षा कोष में रखे है ।

क्रॉप मॅनेजमेन्ट :

- काली मिर्च, अदरक तथा हल्दी के एन.पी. के. की मात्रा की कमी के लक्षणों का नामनिर्धारण किया गया ।

मसालो की गुणवत्ता परीक्षण :

- पैपरिन (5.8%) तथा ओलेयेरेसिन (6%) की अधिकतम मात्रा काली मिर्च के जर्मप्लास्म (सी.एल.टी.पी. 55) में पाई गयी ।
- इलायची के सिलेक्शन 188, 221 तथा 223 गुणवत्ता परीक्षण में श्रेष्ठ पाये गये ।
- अदरक के जर्मप्लॉस्म 14, 56 और 122 में ओलेयेरेसिन 9% तथा ऑकसेशन नंबर 14, 97 और 188 में ऍसेनशियल ऑयल 2% की मात्रा पाई गयी ।
- हल्दी की खेती लगाने के तरिके में कुरकुमिन तथा ओलियेरेसिन की मात्रा में बदल पाया गया ।

क्रॉप प्रोटेक्शन :

- पैपर के वन्य (15) स्पेसिज के पोलू बीटल विरूद्ध परीक्षण किया गया । उसमें से ९ स्पेसिज प्रतिरोधक पायी गई है ।
- कामरशल नीम प्रॉडक्ट "रिपेलिन" पोलू बिटल के विरूद्ध संरक्षण देने में अच्छा पाया गया है ।
- पॉट कलचर में निमाटोड इन्फेस्टेशन से अदरक की उपज 11.93–18.19 प्रतिशत कम पाई गयी ।
- इलायची को फोरेट देने से 32.1–37.0 प्रतिशत थ्रिप्स से होने वाली हानी कम हो गयी और 36.5–57.1 प्रतिशत उपज बढ़ गई ।
- मलबार इलायची जड गॉढ वाले निमाटोड को ससेप्टिबल पाये गये ।
- काली मिर्च के लिए VAM का इफिशेण्ड आयसोलेट को पहिचाना गया ।
- ट्राईकोडरमा, बायोकन्ट्रोल एजेन्ट के 100 आयसोलेट को पहिचाना ।

टेकनॅलॉजि का ट्रान्सफर :

- काली मिर्च के 1,35,000 रुटेड कटींगस, हल्दी का जादा उपज देने वाली प्रजातियों के बीज कन्द 26 टनस् तथा इलायची के सी एल 37 बीज कोष को अनेक विस्तार एजेनसिस में बाँटा दिया गया ।
- स्पाईसेस प्रोडक्शन टेक्नॉलोजी में 56 तथा इलायची की खेती के प्राशिक्षण में 55 पार्टिसिपेन्टोने भाग लिया ।
- इलायची के वाइरल रोगों पर ऑफ कॅम्पस प्राशिक्षण का आयोजन किया गया ।
- कृषि विक्षान केन्द्र कार्यरत हो गया ।

अखिल भारतीय समान्वित अनुसंधान परियोजना (स्पाइसेस)

- काली मिर्च के जर्मप्लास्मों को पन्नियूर तथा बढ़ी इलायची के जर्मप्लास्मों को गॅगटोक केन्द्रों में बढाया गया । जोबनेर तथा जगुदन केन्द्रों में सीड मसालों के जर्मप्लॉस्मों को बढाया जा रहा है ।
- चौतिस काली मिर्च, 2 बढ़ी इलायची, 2 छोटी इलायची और 2 हल्दी के जातियों को बढ़ीया पाया गया ।
- सौंफ की 25 किलोग्राम बीज तथा 40:40 किलोग्राम एन.पी., प्रति हेक्टर नवम्बर मास में पहिले सप्ताह में लगाने से अच्छी बीज पैदावर मिली ।
- काली मिर्च को दिसम्बर –अप्रैल मास में आई.डब्लू/सी.पी.ई. 0.25 प्रमाण से सिंचाई करने से उपज में बढ़ोती मिली है ।
- अदरक को 125:100:100 किलोग्राम एन्.पी. के प्रति हेक्टर देने से ज्यादा उपज मिली तथा सोयाबीन का अदरक के साथ (Inter crop) लेना अच्छा पाया गया है ।
- छनियाँ की फसल को बोने के वक्त 60 किलोग्राम एन और 60 किलोग्राम डी.ए.एस. की मात्रा देना कॉफी अच्छा पाया गया ।
- बोरडो मिक्सर 1% और डायफोलॉटेन 0.1% छिडकने से काली मिर्च के पौधा घर में लगने वाले रोगों का नियंभण किया गया ।
- काली मिर्च को एक किलोग्राम चूना (लाइम) 2 किलोग्राम निम केक 'मे' मास में देने से तथा 1% बोरडो मिक्सर छिडकने से फायटोफथोरा द्वारा होने वाले जडों की सड़न कम हो गयी ।
- आंध्र प्रदेश में सुगूना और सुदर्शना कन्द की सडन को प्रतिरोधक पायी गई है ।

MINI MISSION I

INCREASING PRODUCTION OF SPICE CROPS THROUGH MANAGEMENT OF DISEASES AND PESTS

1. PATH.II.1 (813) : EPIDEMIOLOGICAL STUDIES ON *PHYTOPHTHORA* FOOT ROT DISEASE OF BLACK PEPPER

M. Anandaraj, K.V.Ramana and Y.R.Sarma

Etiology of slow decline in black pepper

The experiment on the interaction of *Phytophthora capsici*, *Radopholus similis* and *Meloidogyne incognita* in causing slow decline disease of black pepper was concluded. Results clearly brought out that feeder roots loss caused by *P. capsici*, *R. similis* or their combination resulted in slow decline. The rotting of feeder roots was severe as indicated by root knot, root lesion and root rot indices in plants inoculated with *P. capsici*, *R. similis* and *M. incognita*, and their combinations. (Table 1.1).

Studies on competitive saprophytic ability

The competitive saprophytic ability (CSA) of *P. capsici* was studied adopting plate count method. Foliar and root isolates did not show any significant difference in CSA. The CSA was very low in both isolates.

Studies on VAM

Out of 35 VAM isolates collected from major black pepper growing areas of Kerala, 7 belonging to two genera viz., *Glomus* and *Gigaspora* were identified as efficient. These isolates, when tested on four cultivars of black pepper rooted cuttings showed varying growth responses(Fig. 1.1).

Fig. 1.1 Effect of VAM isolates on growth of black pepper cuttings

Table 1.1 Effect of *P. capsici* and *R. similis*

Treatment	Death of vines after 2 yrs of inoculation(%)	Symptoms on surviving vines		
		RKI*	RLI**	RRI+
P.capsici(PC)	50.0	1.00	1.25	3.0
R.similis(RS)	50.0	1.25	2.00	1.0
M.incognita(MI)	16.3	3.00	2.00	1.8
PC + RS	66.6	1.00	2.50	1.0
PC + MI	16.6	1.75	1.40	2.6
MI + RS	32.2	2.00	3.00	2.0
PC + RS + MI	50.0	2.00	3.30	3.0
Control	0.0	1.50	1.50	1.0
Control + Phorate + Copper oxychloride	0.0	1.10	0.67	0.1

* Root Knot Index 0 - 3 scale

** Root Lesion Index 1 - 5 scale

+ Root Rot Index 0 - 4 scale

Variability of *P. capsici*

P. capsici isolates from black pepper when paired with *P. palmivora* of coconut resulted in the production of oospores. The pathogenic variabilities of these isolates are being studied.

2. PATH.II.3 (813) : DISEASE MANAGEMENT IN *PHYTOPHTHORA* FOOT ROT AFFECTED BLACK PEPPER PLANTATIONS

Y.R. Sarma, M. Anandaraj and K.V. Ramana

Disease management trials against foot rot disease of black pepper were continued for the third consecutive year at Nedumkandam(Idukky district) and Kuppady(Wynad district). Systemic fungicides either alone or in combination with Bordeaux mixture were effective(Table 1.2). A new trial with three rounds of Ridomil MZ 72 WP and four rounds of Akomin along with neem cake was initiated at Peruvannamuzhi. Vines treated with systemic fungicides showed low disease incidence. A new systemic fungicide viz., Dimethomorph was tried against *Phytophthora*

Table 1.2 Foot rot disease management - chemical control trials at Nedumkandam and Kuppady

Treatment	Vine death(%)		
	Nedumkandam	Kuppady	Mean
T1. Control 1.3	10.0	30.0	20.0
T2. Cl. Practices	23.3	13.3	18.3
T3. RMZ - 2r	10.0	3.3	6.7
T4. BM - 2r	16.6	13.3	15.0
T5. RMZ - BM	13.3	0.0	6.7
T6. BM -RMZ	0.0	10.0	5.0
T7. BM - AK	6.6	6.6	6.6
T8. BM - RMZ - AK	20.0	0.0	10.0
T9. AK - BM	13.3	0.0	6.6
T10. AK - 2r	6.6	23.3	14.9
T11. AK - RMZ	10.0	10.0	10.0
T12. RMZ - AK	0.0	3.3	1.6

Cl = Cultural
RMZ = Ridomil MZ 72 WP
AK = Akomin
BM = Bordeaux mixture
2r = Two rounds

capsici in *in vitro* and in pot culture. It was inhibitory to *P. capsici* even at 1 ppm in *in vitro* trials. However in pot culture about 50 per cent mortality was noticed at 200 ppm. This indicates the need to use higher concentration for *in vivo* studies (Table 1.3)

Table 1.3 Effect of Dimethomorph on *Phytophthora* infection in black pepper (Pot culture)

Concentration (ppm)	Plants Inoculated	Plants Infected	Survival (%)
200	20	10	50
100	20	11	45
50	20	15	25
Control	20	20	0

In another study six varietal mixtures involving *Piper colubrinum* a resistant line with one highly susceptible line (Subhakara) and other *Phytophthora* tolerant lines were planted in sick soils to study their disease reaction(Table 1.4).

Table 1.4 Reaction of varietal mixtures to *P.capsici*

1. *Piper colubrinum*(R)
2. Subhakara(S)
3. P 24(T)
4. P 1178(T)
5. P 339(T)
6. P 1534(T)
7. 1+2(R-S)
8. 1+3(R-T)
9. 1+4(R-T)
10. 3+4(T-T)
11. 3+6(T-T)
12. 3+5(T-T)

R - Resistant S - Susceptible T - Tolerant

3. PATH.II.2 (813) : SCREENING GERMPLASM MATERIAL FOR REACTION TO *PHYTOPHTHORA* FOOT ROT DISEASE OF BLACK PEPPER

Y.R. Sarma and M. Anandaraj

A rapid screening method using excised leaves was standardized. Medium mature leaves when inoculated with pin prick gave consistent infection. The time required for recording observation varied from 72-90 h. Two hundred and forty two types were screened adopting this technique and all were found susceptible. Open pollinated seeds amounting to 1,16,650 from 143 cultivars were sown in both sterile and sick soils. The germinations were 28.0 and 3.4 per cent respectively. The germinated seedlings were inoculated with zoospores of *P. capsici* and 15 seedlings which survived are being maintained for multiplication and further screening. Field evaluation of *Phytophthora* tolerant lines at Sirsi in Karnataka, Peruvannamuzhi in Kerala and Valparai in Tamil

Table 1.5 Promising *Phytophthora* tolerant lines

Types	Green pepper yield(g/vine)		Name
P 339	1492 *	(5500) **	Cholamundi
P 1178	1324	(2250)	Kalluvally
P 1534	1358	(3500)	Perumkodi
HP 23	1436	(2050)	Hybrid
C 1095	1538	(2250)	UIT+
C 1047	1490	(2600)	Neelamundi

* Mean

** Maximum yield obtained per vine

\+ UIT Unidentified types

Nadu were continued. Six *Phytophthora* tolerant lines evaluated at Peruvannamuzhi were found to be promising based on their yield. *(Table. 1.5)*

Phytophthora tolerant line P-24 has given consistently a mean yield of 3.6 kg of green pepper per vine and the maximum of 5.8 kg per vine was recorded during the year. This line is being tried in 4 gardens in Sirsi in comparison with local varieties. Ten *Piper* spp. viz., *P. attenuatum, P. chaba, P. barberi, P. hymenophyllum, P. longum, P. betle, P. arboreum, P. wightii, P. argyrophyllum, P. trichostachyon* were screened for the reaction to *P.capsici* and their reaction was variable. All were susceptible except *P. arboreum.*

4. STAT. IV(813) : EVOLVING A DISEASE INDEX FOR *PHYTOPHTHORA* / NEMATODES INDUCED DAMAGE IN BLACK PEPPER

Jose Abraham, K.V.Ramana, Y.R.Sarma and M. Anandaraj

Studies carried out on a large sample of vines in the disease affected gardens in Wynad, Idukky and Peruvannamuzhi revealed that foliar yellowing and defoliation are the visual symptoms of the root damage caused by *Phytophthora capsici* and nematodes. The selected vines were monitored for two years. Visual symptoms were scored for individual vines. Scores from 0 to 4 were assigned separately for the symptom expressions of foliar yellowing and defoliation. The frequencies of these scores were worked out for the six rounds of observations taken during the different seasons viz., before, during and after monsoon period in order to assess the variations in these symptoms.

Though there was increase and remission of the above symptoms depending on the season, a gradual decline of the vines having the above symptoms was observed.

Table 1.6 Per cent Distribution of different scores for yellowing (Y) and defoliation (DF)

Score	Y	DF
0	48.2	51.1
1	34.6	20.4
2	10.4	13.6
3	1.7	7.1
4	5.1	7.8

The frequencies of vines having different scores from 0 to 4 were worked out which were of the same pattern regarding yellowing and defoliation. Hence, the mean of frequencies of these scores over 6 rounds were obtained separately for yellowing and defoliation scores and the percentages worked out *(Table 1.6)*.

It is seen that 48 per cent of the vines were having '0' score for yellowing while 51 per cent were having '0' score for defoliation. In other words, 52 and 49 per cent of vines were having mild to severe yellowing and defoliation symptoms respectively, there by indicating that there exist a 1:1 ratio of these symptoms. This indicates that giving equal weightage for these two symptoms is justified and a single index can be obtained by integrating these two scores by adding them and converting to percentage. Thus if a vine has a score of 'Y' for yellowing and 'D' for defoliation, the index can be worked out as

$$\frac{Y + D}{8} \times 100$$

which gives a simple index expressed as percentage.

5. PATH. XII (813) : INVESTIGATIONS ON STUNTED DISEASE OF BLACK PEPPER

Y.R.Sarma, M.Anandaraj and S.Devasahayam

Surveys conducted at seven locations in Wynad district indicated that the mean disease incidence ranged from 1.3 - 46.0 per cent (Table 1.7). However, cent per cent incidence was noticed in some gardens in Pulpally area.

Insect fauna associated with diseased vines

Nine genera/species of insects were collected from stunted disease affected vines. These included tree hoppers, leaf hoppers, mealy bugs, scale insects, aphids and thrips belonging to the families Tropiduchidae, Cicadellidae, Pseudococcidae, Diaspididae, Aphididae and Phlaeothripidae. Except leaf gall thrips, the association of other insects with infected vine was negligible.

Hot water therapy

Studies on hot water therapy indicated that when infected cuttings were treated in hot water at 45°C for 60 minutes and planted, there was 7.5 per cent germination, but disease symptoms were noticed. This needs confirmation.

Transmission studies

Experiments on transmission were also undertaken. Cuttings raised from apparently normal runner shoots from infected vines showed disease symptoms in 80 per cent of plants, thereby indicating the systemic nature of the disease. Infected plant sap prepared in 0.01 M phosphate buffer and inoculated to black pepper, did not give positive results. Out of 50 cleft grafts tried, only 5 successfully established and 2 of them exhibited disease symptoms. This needs further testing.

Table 1.6 Per cent Distribution of different scores for yellowing (Y) and defoliation (DF)

Location	Cluster	Incidence (%)	Mean (%)
Pulpally	A	100	46.0
	B	20	
	C	20	
Adikolly	A	22	15.0
	B	16	
	C	8	
Mullankolly	A	2	2.0
	B	0	
	C	4	
Chiyambu	A	6	4.6
	B	0	
	C	8	
Manalvayal	A	8	9.3
	B	8	
	C	12	
Nadavayal	A	4	1.3
	B	0	
	C	0	
Kamblakad	A	0	3.0
	B	0	
	C	6	

6. PATH.X (813) : INVESTIGATIONS ON THE VEIN CLEARING VIRUS ('KOKKE KANDU') OF SMALL CARDAMOM

M.N. Venugopal

Epidemiology

(i) *Pattern of disease introduction :* Extensive field surveys were made and individual plant observations were recorded periodically from the surveyed plots. The disease incidence pattern within the blocks of different plantations indicate that initially the disease at different places occurs at random suggesting the aerial mode of disease introduction.

(ii) *Sources of disease spread :* Different field models were maintained to record the sources of disease. Similarly nurseries, self sown plants and left out pieces of suckers were also monitored. The observations clearly indicated that nearby infected gardens, voluntary seedlings, nurseries raised in vicinity of virus source and sprouted discards of infected suckers were the potential sources of virus inoculum for disease re-introduction. Live colonies of aphid vector were seen in all these sources of infection.

(iii) *Pattern of disease distribution :* Individual plant observations were recorded periodically from the plantations located at different places from virus source. The trend indicated that there is dual distribution pattern of disease. Initially many independent infections appear in new spots and further cluster of infections are formed by secondary spread which follows a centrifugal pattern.

(iv) *Disease dispersal gradient :* Plotting of disease against distance from inoculum source indicated that the infections are mainly concentrated near the primary inoculum with steep gradients and the infections are less as the distance increases. Independent new infections were recorded up to 168 metres from primary inoculum.

(v) *Rate of spread :* Periodical observations on the disease incidence were recorded in 3 identified plots. The trend indicates that rate of spread in 3 different plots varied from 3.76 to 10.30 per unit per every 6 months.

(vi) *Effect of roguing on disease spread :* To study the effect of phytosanitation practice on disease spread, a large plot of 80 ha was selected which initially had 1.43 to 45 per cent infection in different plots. Systematic inspection of plantation, detection of virus infected plants and prompt elimination of virus infected plants was carried out at monthly interval. The trend indicates that the new infections can be reduced significantly (> 1%).

Transmission of disease

Seed Transmission: Fresh seeds were collected from plants of initial and advanced stages of infection and sown separately. Two batches of seedlings that have already been raised did not

Table 1.8 Transmission through seeds

Batch number	Seed source	Number of seeds Sown	Germinated	Infected (after 14 months)
H.Halla	Initial infection	803	311	Nil
	Advanced infection	83	17	Nil
	Healthy	1000	783	Nil
Sirsi	Initial infection	1034	343	Nil

Table 1.9 Transmission through aphids

Inoculation particulars and symptoms	Stage 5-6 leaf	3-8 leaf	Bearing
Inoculants	131	58	14
Number	101	32	9
Infected	28	9	48
Incubation period (d)	Slender lines on veins, rosetting, mottling on pseudostem	Slender lines on veins, rosetting, mottling on pseudostem	Slender lines on veins, rosetting, mottling on pseudostem, hook-like tiller after 6 months
Symptoms			

Table 1.10 Effect of *Kokke Kandu* on Yield (means of 84 plants)

Vegetative and yield characters	Healthy	Initial infection	Advanced infection
Plant height (m)	1.72	1.43	0.92
Number of tillers	16.80	15.40	8.90
Number of panicles	21.00	16.00	4.00
Number of capsules	486.00	176.00	13.00
Weight of 100 green capsules (g)	68.00	51.00	28.00
% Reduction	—	78.90	99.60

show disease symptoms thereby indicating that virus is not seed transmitted (Table 1.8).

Mechanical transmission : Possibilities of transmission through farm implements during routine farm operations was studied through simulation. None of the 120 test plants contracted infection, indicating the absence of mechanical transmission through farm implements.

Transmission through soil : Fresh soil with root and rhizome bits collected from infected plants of different stages were added to microplots to study the possibility of transmission through soil. None of the 120 test plants contacted infection.

Transmission through aphid : Repeated green house aphid transmission experiments were conducted with different periods of acquisition feeding and transmission feeding. Positive transmission through cardamom aphid *Pentalonia nigronervosa* f.*caladii* was obtained in all the experiments. Preliminary studies indicate that up to 78 per cent transmission can be obtained with viruliferous aphids (Table 1.9). In separate transmission studies with single alate and apterate aphids, positive infections were obtained on 26 per cent of the inoculants within 48 days of inoculation.

Studies on yield loss

To study the effect of '***Kokke Kandu***' on yield, a 3 year old sick plot was selected and 3 groups of plants viz., i) Healthy ii) Initial infection (Symptoms on all new tillers) and iii) Advanced infection (Symptoms on all tillers) were made. Data on important growth and yield characters like Number and height of tillers, Number of panicles and capsules and dry recovery were recorded. The results indicate the yield loss of 78.9 and 99.6 per cent respectively in initial and advanced stages of infection *(Table 1.10)*.

7. PATH. III (813) : RHIZOME ROT OF GINGER AND TURMERIC

T.G.Nageshwar Rao and Y.R.Sarma

Survey for the incidence of rhizome rot of turmeric in Kerala

Three districts of Kerala viz., Ernakulam, Idukky and Kottayam were surveyed

Forty five turmeric gardens were visited. Information on crop condition, soil type, method of cultivation and incidence of disease were recorded in the prescribed proforma. The district wise collection of samples is given in Table 1.11.

The disease incidence ranged from 0 - 25 per cent. The organisms isolated on potato dextrose agar medium from infected turmeric roots and rhizomes are given in Table 1.12. The pathogenicity tests were positive with *Pythium* sp. The role of other associated organisms is being studied.

Table 1.11 District wise areas surveyed and samples collected

District	Number of samples collected
1. Ernakulam	20
2. Kottayam	18
3. Idukky	7
Total	45

Table 1.12 Frequency of isolation of different organisms obtained from rhizome rot affected turmeric samples

	Organism	Root	Rhizome	Total
1.	*Pythium* sp.	10	14	24
2.	*Fusarium* sp.	12	10	22
3.	*Rhizoctonia bataticola*	5	2	7
4.	*Rhizoctonia solani*	2	4	6
5.	Others	2	—	2
	Total	31	30	61

8. PATH.XI (813) : STUDIES ON BACTERIAL WILT OF GINGER - A GENETIC APPROACH TO *PSEUDOMONAS SOLANACEARUM*

G.N. Dake

A total of 25 isolates of *Pseudomonas solanacearum*(Ps) isolated from ginger, turmeric, chillies, tomato, marigold, *Ageratum* and *Chromolaena* spp. were subsequently plated on triphenyltetrazolium salts (TTC) medium. After two days virulent wild type characteristics of *P.solanacearum* (Fluidal, either entirely white or with pale red centre) were subcultured and maintained on yeast dextrose carbonate agar (YDCA) in sterile distilled water at 4°C in refrigerator (Table 1.13).

Table 1.13 Sources of *P.solanacearum*

	Host plants	Date of isolation
1.	Ginger - *Zingiber officinale*(Zo)	October 1992
2.	Turmeric - *Curcuma longa*(Cl)	November 1992
3.	Weed - *Chromolaena odorata*(Co)	October 1992
4.	Goat weed - *Ageratum conyzoides*(Ac)	November 1992
5.	Chillies - *Capsicum annuum*(Ca)	February 1993
6.	Chillies - *Capsicum frutescens*(Cf)	February 1993
7.	Tomato - *Lycopersicon esculentum*(Le)	March 1993
8.	Marigold - *Tagetus erecta*(Te)	March 1993

The bacteria were tested for gram reaction using 3 per cent KOH, levan production, and fluorescence pigmentation on King's medium B.

Further characterization of bacterial strains to biotypes on the basis of utilization/oxidation of disaccharides (lactose, maltose, cellobiose) and hexahydric alcohols (Mannitol, sorbitol Dulcitol) was done and were placed in bio-types III and IV *(Table 1.14)*.

Table 1.14 Characteristics of *P.solanacearum* isolates

Isolate number		Oxidation of Disaccharides			Oxidation of Hexose alcohols			Biotypes
		Lac	Mal	Cel	Man	Sor	Dul	
AcPs	1	—	—	—	—	—	—	?
	2	—	—	—	—	—	—	?
	3	—	—	—	—	—	—	?
CoPs	4	—	—	—	—	—	—	?
	5	—	—	—	—	—	—	?
	6	—	—	—	—	—	—	?
CaPs	7	+	+	+	+	+	+	III
	8	+	+	+	+	+	+	III
	9	+	+	+	+	+	+	III
CfPs	10	—	—	—	—	—	—	?
	11	—	—	—	—	—	—	?
	12	—	—	—	—	—	—	?
ClPs	13	+	+	+	+	+	+	III
	14	+	+	+	+	+	+	III
	15	+	+	+	+	+	+	III
LePs	16	+	+	+	+	+	+	III
	17	—	—	—	—	—	—	?
	18	+	+	+	+	+	+	III
	19	—	—	—	—	—	—	?
TePs	20	—	—	—	+	+	+	IV
	21	—	—	—	+	+	+	IV
	22	—	—	—	+	+	+	IV
ZoPs	23	—	—	—	+	+	+	IV
	24	—	—	—	+	+	+	IV
	25	+	+	+	+	+	+	III

Lac - Lactose
Mal - Maltose
Cel - Cellobiose
Man - Mannitol
Sor - Sorbitol
Dul - Dulcitol

9. ENT.X (813) : BIONOMICS OF MAJOR PESTS OF BLACK PEPPER AND EVOLVING INTEGRATED CONTROL MEASURES AGAINST THEM

S. Devasahayam, K.M. Abdulla Koya and T. John Zachariah

Screening of cultivated germplasm

Seven cultivated accessions maintained in the germplasm at NRCS Experimental Farm, Peruvannamuzhi and identified as relatively 'resistant' to the pest in the field were further screened against infestation by 'pollu' beetle. However, only four of them viz., Accession Nos. 816,841,1084 and 1114 continued to be resistant this year. Laterals of these accessions were raised for screening under insect cage conditions.

Screening of wild germplasm

Fifteen wild species of *Piper* were screened against 'pollu' beetle using leaf disc technique and adopting no choice tests. Among them, *P. colubrinum*, *P. betle*, *P. hymenophyllum*, *P. attenuatum*, *P. barberi*, *P. mullesua*, *P. arboreum*, *P. longum* and *P. chaba* were relatively resistant to the pest (Table 1.15).

Table 1.15 Screening of wild *Piper* spp. against 'pollu' beetle (no choice tests)

Species	Area(mm²) fed per beetle / day
P.colubrinum	0.00
P.betle	0.00
P.hymenophyllum	0.00
P.attenuatum	0.05
P.barberi	0.05
P.mullesua	0.08
P.arboreum	0.13
P.longum	0.20
P.chaba	0.23
P.argyrophyllum	0.48
P.magnificum	1.18
P.trichostachyon	2.05
P.sugandhi	2.65
P.nigrum	2.58
P.galeatum	3.45
P.nigrum(Panniyur - 1)	5.13
CD (0.05)	0.23

Studies with antifeedants from wild *Piper* sp.

Three compounds with suspected antifeedant properties viz., Crotepoxide, Pipoxide and Pipoxide chlorhydrin were isolated from *P. attenuatum* (a known resistant species) at Regional Research Laboratory, Trivandrum and tested for their antifeedant activity against 'pollu' beetle using leaf disc technique and adopting no choice and paired choice tests. Antifeedant activity was significant in some of the treatments in no choice tests and a maximum of 62 per cent feeding deterrance was observed (Crotepoxide 500 ppm). However, in paired choice tests though up to 65 per cent feeding deterrance was observed, there was no significant difference between treatments (Table 1.16).

Table 1.16 Effect of antifeedants from *Piper attenuatum* on feeding bahaviour of 'pollu' beetle (no choice tests)

Compound			Area(mm²) fed per beetle per day
Crotepoxide			
	100	ppm	9.56
	500	ppm	1.55
	1000	ppm	5.00
	5000	ppm	4.40
	10000	ppm	4.50
Pipoxide			
	100	ppm	6.95
	500	ppm	7.05
	1000	ppm	4.80
	5000	ppm	3.80
	10000	ppm	4.15
Pipoxide chlorhydrin			
	100	ppm	8.85
	500	ppm	4.85
	1000	ppm	5.45
	5000	ppm	4.90
	10000	ppm	2.10
Control			6.70
CD (0.05)			1.68

Table 1. 17 Effect of neem based insecticides on feeding behaviour of 'pollu' beetle (no choice tests)

Insecticide	Per cent feeding deterrance	
	90%	100%
Repelin	2%	3%
Neemgold	4%	3%
Nimbicidin	6%	10%
Achook	8%	> 10%

Values denote concentrations at which 90 and 100 per cent feeding deterrance occurred.

Studies with neem products

Four commercial neem based products viz., Repelin, Neemgold, Nimbicidine and Achook were tested for their antifeedant activity against 'pollu' beetle in the laboratory using leaf disc technique and adopting no choice tests. Among them, Repelin was the most promising causing 90 and 100 per cent feeding deterrance at 2 per cent and 3 per cent concentrations, respectively (Table 1.17).

Reproductive biology

Studies on reproductive biology of 'pollu' beetle were continued. Morphometrics of reproductive structures of male and female beetles were studied. The sex ratio, maturity of ovarioles, dry weight, water and fat contents (which are important indices of the reproductive and physiological status) of field populations of 'pollu' beetles were monitored at bimonthly intervals throughout the year. Sex ratio was fairly constant throughout the year with a preponderance of males, the female : male ratio ranging from 1:1.3 to 1:1.9 except during May when there was an increase in the percentage of males in the field. Dry weight was higher in females throughout the year. In females, fat content declined during the breeding season; water content was higher during the active feeding and breeding seasons.

10. ENT. IX (813) : STUDIES ON COCCIDS INFESTING BLACK PEPPER

K.M. Abdulla Koya and S. Devasahayam

Survey for coccids

Surveys conducted in three taluks in Malappuram and one taluk in Palakkad district of Kerala revealed that scale insects were not present on black pepper vines in these areas. Observations made in Uttara Kannada and Shimoga districts of Karnataka during the survey indicated that infestation by *Lepidosaphes piperis* and *Aspidiotus destructor* occurred in varying degrees in different gardens, the percentage infestation in the case of *L. piperis* ranging between 0 and 11.1 and in the case of *A. destructor* between 0 and 26.7.

Population dynamics

Studies conducted on population dynamics of *A. destructor* at Kalpetta (Wynad district of Kerala) showed an increase in the population from August, though slight reduction was noticed during October, November and December. Peak population occurred during September and March.

Life history

Studies on biology of *L. piperis* were continued in the laboratory. The first and second instars extended up to 9-12 and 9-10 days respectively in females, and 10-12 and 9-10 days respectively in males. The pre pupal and pupal stages in males lasted for 2-3 days each.

Field control

The field control trial using six insecticides viz., monocrotophos, dimethoate, methyl parathion, dichlorvos, phosphamidon, and malathion at 0.1 per cent each was continued at Kuppadi (Wynad district of Kerala). Two sprayings were given at monthly intervals. Samples were collected for assessing the population prior to treatment and 15 days after each spraying. The data collected indicated that all the insecticides tried were superior to control. Maximum suppression of the pest was obtained on black pepper vines treated with monocrotophos, dimethoate, methyl parathion and malathion followed by phosphamidon and dichlorvos.

11. NEMA. III (813) : INVESTIGATIONS ON NEMATODES ASSOCIATED WITH GINGER, TURMERIC AND BLACK PEPPER

K.V. Ramana

Surveys for nematodes associated with ginger

Surveys were conducted in 3 districts in Kerala viz., Ernakulam, Kottayam and Idukki to identify plant parasitic nematodes associated with ginger crop. Soil and rhizome (78 each) samples from 46 fields (Ernakulam - 18, Kottayam - 19, Idukky - 9) selected at random representing major ginger growing areas in each district were collected. Samples were processed and nematode populations recorded.

Seven genera of plant parasitic nematodes viz., *Meloidogyne, Rotylenchulus, Helicotylenchus, Xiphinema, Longidorus, Criconemoides and Tylenchorhynchus* were recorded from the rhizosphere soils of ginger crop. *Meloidogyne* was the only nematode genus isolated from rhizome samples. *Meloidogyne* sp is the most predominant nematode species associated with ginger crop in the districts surveyed followed by *Rotylenchulus reniformis.*

Damage potential of *M. incognita* to improved varieties of turmeric

A pot culture study was conducted to assess the damage potential of *M. incognita* to improved varieties of turmeric viz., Suvarna(P.C.T-8), Suguna(P.C.T-13), Sudarshana (P.C.T-14) and Alleppey. Earthern pots (20 cm dia.) were filled with 7 kg sterilized soil mixture. Seed rhizomes @ 30 g/pot of the test varieties (16 pots for each variety) were sown. One month after sowing 8 plants in each variety were inoculated with freshly hatched second stage juveniles of *M. incognita* @ 3500/pot. Remaining 8 plants in each variety were left as control. All the pots were arranged in net house and maintained. Seven months after sowing all the plants were harvested and observations on weight of leaf and pseudostem(dry), rhizomes(fresh), root (fresh), root-knot index and nematode population build up were recorded and data analyzed statistically.

It was observed that nematode inoculation resulted in significant reduction in all the growth parameters recorded in all the four varieties tested (Table 1.18). Maximum reduction in dry weight of leaf and pseudostem was in Sudarshana(20.5%) followed by Suvarna. The reduction was the least in the variety Alleppey(11.2%). Similarly Alleppey recorded the minimum reduction in fresh weight of rhizome and root(11.9% and 9.6% respectively). Maximum reduction in fresh rhizome weight was in Suvarna(18%) and fresh root weight in Suguna(21.2%). Among the four varieties of turmeric tested the damage caused by *M.incognita* infestation is the least in the variety Alleppey compared to Suvarna, Suguna, and Sudarshana.

Screening black pepper germplasm to root-knot and burrowing nematodes

Cultivated types : Twenty accessions of cultivated types of black pepper were tested for their reaction to *M. incognita* and *R. similis.*

Root knot index in the accessions tested ranged from 2.2 to 5.0. Accession Nos.1364 and 1467 recorded the lowest root knot index of 2.2, indicating some degree of resistance to the nematode in the preliminary screening. These two accessions will be further tested for assessing their reaction to the nematode.

Root lesion index in different accessions tested ranged from 4.2 to 5.0 indicating their high degree of susceptibility to *R. similis.*

Seedling progenies : None of the 12,000 seedling progenies of popular black pepper cultivars tested against *M. incognita* and *R. similis* was found resistant/tolerant to either of the nematode species.

Table 1.18 Effect of *M. incognita* on growth and yield of turmeric varieties

Varieties/Treatments	Dry weight of leaf and pseudostem(g)	Fresh weight of rhizomes(g)	Fresh weight of roots(g)
Suvarna (PCT - 8)			
Control	17.68	235.26	53.08
Inoculated	14.07	192.45	46.30
Per cent reduction	20.40	18.20	12.70
Suguna(PCT - 13)			
Control	15.45	281.43	28.90
Inoculated	13.12	237.57	22.75
Per cent reduction	15.00	15.50	21.20
Sudarshana(PCT - 14)			
Control	15.00	303.36	23.07
Inoculated	11.92	258.90	19.26
Per cent reduction	20.50	15.70	16.50
Alleppey			
Control	37.45	388.51	98.33
Inoculated	33.25	342.16	88.81
Per cent reduction	11.20	11.90	9.60
CD(0.05)	1.41	17.54	3.48

12. NEMA. I (813) : INVESTIGATIONS ON PLANT PARASITIC NEMATODES ASSOCIATED WITH CARDAMOM

Santhosh J. Eapen and M.N.Venugopal

Evaluation of nematicides and neem oil cake

Phorate @ 2.5 and 5.0 g a.i. per clump gave the highest yields for the third year consecutively. Phorate treated cardamom plants produced 645.0 and 742.5 Kg/ha (wet weight), while the untreated control plants yielded only 473.5 Kg/ha. The pooled data for the past three crop years are given in Table 1.19. Besides, phorate treatment improved the size of cardamom capsules and also reduced thrips damage by 32.1-37.6 per cent. Carbofuran @ 5 g a.i. per clump enhanced tillering, but the yield improvement was not satisfactory. Carbofuran and phorate at both levels significantly reduced root knot nematode population. Neem oil cake @ 500 g per clump gave excellent control of plant parasitic nematodes, but failed to improve the yield of the test plants.

Screening of germplasm

The host status of 30 germplasm accessions was tested and were found to be susceptible. It was observed that, in general, 'Malabar' types are more susceptible to root knot nematodes than 'Mysore' or 'Vazhukka' types.

Solarization studies

Two trials were laid out, one at Appangala (old site) and another at Biligeri, with same treatments and design. The soil was mulched for 55 days during September-November with 300 gauge transparent polythene sheets. Germination in solarized beds was enhanced by 3.4 - 9.9 per cent as a result of the increase in soil temperature. Observations on growth of plants, pests and disease incidence were also recorded.

Table 1.19 Growth and yield of cardamom plants treated with various pesticides

Treatment	Dosage (g a.i)	Height (m)	Number of			Yield (Wet) (g)
			Tillers	Panicles	Capsules	
Carbofuran	2.5	1.784 cd	16.7 abc	13.9 bc	165 cd	219 cd
	5.0	1.877 abc	18.2 a	15.8 ab	216 bc	262 bc
Phorate	2.5	1.934 ab	16.0 bc	15.4 ab	244 ab	290 b
	5.0	1.974 a	17.5 ab	17.7 a	297 a	366 a
Quinalphos	2.5	1.808 cd	15.2 c	13.3 bc	144 cd	190 d
	5.0	1.750 d	15.6 c	12.4 c	133 d	180 d
Check	—	1.848 bcd	15.8	14.5bc	156 cd	201 d

Values are for individual plants, which are the means of four replications averaged across neem cake levels and three years. Means within a column with same letter are not significantly different according to DMRT

13. BIOCONTROL. I (813) : BIOLOGICAL CONTROL OF PESTS AND DISEASES OF SPICES

M.Anandaraj, Y.R.Sarma, M.N.Venugopal, S.Devasahayam, K.M.Abdulla Koya and Santhosh J.Eapen

Diseases

The effect of VAM in protecting the root systems against infection by *Phytophthora capsici* in black pepper was studied under field conditions and an observation trial was also laid out in the field to study the effect of biocontrol agents such as *Trichoderma* sp. in combination with VAM.

In cardamom, five isolates of *Trichoderma* were obtained from disease suppressive soils. The compatibility of four isolates with *Paecilomyces lilacinus* was studied *in vitro*. Four isolates of *Trichoderma* effectively inhibited colony growth of *Pythium vexans* and *Rhizoctonia solani* in *in vitro* dual cultures. Four isolates of *Trichoderma* were mass multiplied on neem oil cake and decomposed coffee husk and applied to a sick cardamom nursery. The isolates were effective in reducing damping off of primary seedlings by 71.7 per cent.

Field trials are in progress to test the efficacy of *Paecilomyces lilacinus* against root knot nematode.

Pests

1. *Identification of natural enemies*

An entomophagous mite and a nematode were observed to parasitize adult 'pollu' beetles at Peruvannamuzhi during July to September. A predatory bug on *Aspidiotus destructor* and two species of predatory beetles on *Lepidosaphes piperis* were collected from Peruvannamuzhi and Kuppady.

2. *Seasonal incidence of hymenopterous parasites of top shoot borer*

The seasonal incidence of *Apanteles cypris* (Braconidae) and *Goniozus* sp. (Bethylidae) was studied at Peruvannamuzhi. Both the parasites occurred in the field during September to November. Peak parasitism by *A. cypris* (20.0 per cent) and *Goniozus* sp. (6.7 per cent) occurred during October.

3. *Seasonal incidence of natural enemies of scale insect*

The seasonal incidence of *Encarsia lounsburyi* (Encyrtidae), *Cybocephalus* sp. (Coccinellidae), *Chilocorus* sp. (Nitidulidae) and *Bdella* sp. (Bdellidae) on *Aspidiotus destructor* was studied at Kalpetta *E. lounsburyi* and *Cybocephalus* sp. were observed almost through out the year with higher populations during May-June and September- November, respectively. The populations of *Chilocorus* sp. and *Bdella* sp. were comparatively lower.

14. ORG. CHEM. I (813) : ISOLATION AND IDENTIFICATION OF NATURALLY OCCURRING COMPOUNDS AGAINST MAJOR PESTS AND PATHOGENS OF BLACK PEPPER

N.K.Leela, M. Anandaraj and K.V. Ramana

Crude methanol extract of *Piper colubrinum* leaves when bioassayed showed antifungal activity against *Phytophthora capsici*. *In vitro* bioassays of the above extract also exhibited significant nematicidal activity against *Meloidogyne incognita* larvae after 48 h.

15. AD-HOC SCHEME : MULTILOCATION PROJECT ON RHIZOME ROT OF GINGER

Y.R.Sarma

Survey

Survey was conducted in three major ginger growing districts of Kerala viz., Ernakulam, Kottayam and parts of Idukki. Disease incidence ranged from 0-50 per cent. Out of 20 fields visited in Ernakulam district, 12 were infected, while in Kottayam 7 fields were infected out of 20 fields surveyed. Among 9 fields covered in Idukki district, only one field showed symptoms of rhizome rot.

Etiology

Out of 12 infected samples collected from Ernakulam district 10 yielded *Pythium* spp. and two samples yielded combination of *Pythium* and *Pseudomonas solanacearum*. All seven infected samples from Kottayam district yielded *Pythium* spp. *Fusarium* sp. was also isolated from two samples from Ernakulam along with *Pythium* but was not found to be pathogenic.

Isolation of biocontrol agents

Rhizosphere soil and plant parts collected from the healthy fields were used for isolation of biocontrol agents. One hundred and fifteen isolates of *Trichoderma* spp. belonging to eight species viz., *T. viridae*, *T. harzianum*, *T. hamatum*, *T. polysporum*, *T. longibrachiatum*, *T. koningii*, *T. pseudokoningii* and *T. aureoviride*, isolates of *Gliocladium virens*, 30 isolates of bacteria, 22 isolates of actinomycetes and three genera of VAM viz. *Glomus macrocarpum*, *G. fasciculatum*, *Gigaspora* spp. (2 isolates) and *Acaulospora leavis* were isolated. *In vitro* interaction of the above fungi and bacteria with *P. aphanidermatum* was studied. In dual culture testing, the inhibition percentage ranged from 47.43 to 65.28 with fungal isolates (*Trichoderma* spp./*Gliocladium* spp.) and 20.5 to 100 per cent in the case of antagonistic bacteria.

Screening germplasm accessions for their reaction to pathogens

Sixty-three germplasm types were evaluated separately for their reaction to *P. aphanidermatum* and *P. solanacearum*. All of them were found susceptible. However, the percentage of disease incidence varied. The accessions Uttar Pradesh and Zahirabad showed disease incidence below 10 per cent.

Disease management

The experiments were conducted in solarized and non-solarized plots. The temperature build up during the solarization period was recorded at three different depths viz., 5,15 and 30 cm. In solarized plots, the temperature range was 35.5 to 46.5.

Significant reduction of *Pythium* (Propagules) population was noticed 15 days after solarization (28 colony forming unit(cfu)/g), whereas the population increased in the case of non-solarized fields during this period (122 cfu/g) (Table 1.20).

Chemical control

Field trials were conducted in *Pythium* sick soils which were subjected to soil solarization. Seed treatment and soil drenches were given with the respective fungicides. Experiments with all the test fungicides were also conducted in plots which were not solarized to compare the effects of solarization. Basal application of neem cake was given @ 1 kg/ bed for all the beds.

The fungicides viz., Dithane M-45, Captafol (0.3%), Chlorothalonil (0.3%) and Ridomil MZ 72 WP (500 ppm) were used both for seed treatments and soil drenches. Phorate 30 g/3 m² plot was given as basal application. Soil drenching with respective fungicides were given 30 days after sowing.

The plants were more vigorous and disease incidence was low in solarized plots compared to non-solarized up to two months after sprouting. Germination percentage and disease incidence ranged from 92.08-99.58 and 34.12-57.39 in solarized plots as against 95.2-99.16 and 40.86-51.33 respectively in non-solarized plots. The yield range was 2.2-3.4 kg in solarized plots compared to 1.6-2.7 kg in non-solarized plots. Yields though higher in solarized plots, the values were not statistically significant.

Biocontrol

Field efficacy of biocontrol agents was evaluated with four isolates of *Trichoderma* spp. and one isolate of *Gliocladium virens* in comparison with the fungicide Dithane M-45 under solarized and non-solarized conditions. The seed germination was almost uniform in all the treatments. However, disease incidence was conspicuously less in biocontrol agents treated plots and the yields were comparatively high when compared to control plots. Among the 5 biocontrol agents, *T. harzianum*-1 gave maximum yield in both solarized (3.445 kg) and non-solarized (3.970 kg) plots. In biocontrol agents treated plots, the disease incidence was less and yields were higher compared to Dithane M-45 treated and control plots (Table 1.21).

Population of *Pythium* and *Trichoderma* both in solarized and non-solarized plots were monitored during 30,60,90 and 120 days after germination. *Pythium* population was less in solarized plots. With time, the population level increased in both the conditions. However, the *Pythium* population decreased in all the biocontrol agents treated plots compared to untreated control. In the case of *Trichoderma* the adaptation/survival ability was very high in solarized plots compared to non-solarized.

Detection of seed-borne inoculum

To detect seed-borne inoculum, seed rhizomes collected from infected clumps were planted, 20 replications each, in acid washed sand, sterilized soil, immersed partially in sterilized water and wrapped in cotton swab and kept in humid chamber. Among these cotton swab was found to be the best in expressing maximum rot (80%) in minimum time (3 weeks).

Table 1.20 Survival of *Pythium* propagules* in soil during solarization

Days	Solarized	Non solarized	Mean(1)
15	28.00	122.00	75
30	85.00	183.00	134
Mean (2)	56.49	152.66	

* Average number of *Pythium* propagules as cfu/g of air dried soil

TABLE 1.21 Effect of biocontrol agents on rhizome rot of ginger

Treatments	Solarized			Non solarized		
	*G%	*DI%	Yield (kg/3m²)	G%	DI%	Yield (kg/3m²)
1. *T.viridae*	90.80	13.97	2.844	86.04	15.53	2.198
2. *T.harzianum* 1	96.60	19.02	3.445	89.80	21.72	3.970
3. *T.harzianum* 2	90.60	10.03	2.595	92.90	28.94	2.494
4. *T.hamatum*	91.66	16.51	3.260	94.30	18.06	2.610
5. *G.virens*	88.75	15.15	2.530	94.50	23.87	2.973
6. Dithane M-45	97.90	53.40	2.788	93.96	38.57	1.485
7. Control	97.10	60.22	1.892	98.50	50.07	1.720

*G = Germination
*DI = Disease incidence

MINI MISSION II

DEVELOPING AGRO TECHNIQUES FOR INCREASING PRODUCTION OF SPICE CROPS

1. AGR VI (813) : STUDIES ON THE IMPACT OF INPUT TECHNOLOGY ON THE YIELD PERFORMANCE AND QUALITY ATTRIBUTES OF BLACK PEPPER

K.Sivaraman, A.K.Sadanandan and C.K.Thankamani

NPK experiment

A field experiment with twenty one treatments including different levels of nitrogen, phosphorus, potassium, calcium and magnesium using Karimunda as a test variety was started in 1987 (Table 2.1).

It is seen that the application of 200 g of nitrogen along with 70 g of potassium resulted in the maximum cumulative yield of 6.137 kg/vine. However, this needs further experimentation for the confirmatory results.

Irrigation experiment

A trial on irrigation requirement of black pepper(variety Karimunda) was initiated during 1988 using *Erythrina indica* as standards. A maximum yield of 2.635 kg/vine was recorded with the application of water @ 2 l per vine through drip irrigation from October to March.

Table 2.1 Cumulative green pepper yield(kg/vine)

Nutrient levels (g/vine/year)					Cumulative green pepper yield (1990-91 to 1992-93)	
N50	K70				2.629	b
N50	K140				3.029	c
N50	K210				2.446	a
N50	K280				3.652	h
N100	K70				4.361	l
N100	K140				3.520	f
N100	K210				5.276	s
N100	K280				5.031	p
N150	K70				3.591	g
N150	K140				5.461	t
N150	K210				4.971	o
N150	K280				4.599	m
N200	K70				6.137	u
N200	K140				5.129	r
N200	K210				3.161	d
N200	K280				4.097	k
N0	P0	K0			4.711	n
N0	P60	K0			5.104	q
N50	P60	K140	Ca50	Mg0	3.905	i
N50	P60	K140	Ca50	Mg50	3.952	j
N50	P60	K140	Ca0	Mg50	3.472	e

In a column, means followed by a common letter are not significantly different at 5 per cent level by DMRT.

2. AGR.IX (813) : INVESTIGATIONS ON THE SPICES BASED CROPPING SYSTEMS

V.S.Korikanthimath and K.Sivaraman

This project was initiated during 1991-92. It aims at (i) exploiting the production potential of different cropping systems where spices are planted as component crops, (ii) quantifying and analyzing the sources of availability of plant resources in the above and below ground environments in such systems, (iii) working out the efficiency with which these resources are captured and utilized by the crops in the system, and (iv) build systems depending more on renewable, farm derived resources which lead to economically sustainable and ecologically sound agriculture.

In cardamom based cropping systems trial at Appangala, observations on growth and yield components of cardamom viz., height, number of bearing and non-bearing tillers, and number of panicles per plant were recorded. The height and number of branches produced per plant in nutmeg, clove, allspice, cinnamon and coffee were recorded. Per cent ground cover occupied by the component crops and photosynthetically active radiation(PAR) intercepted by the crops in the system were also recorded(Fig 2.1 and Fig 2.2).

Fig 2.1 Per cent ground cover by crops in cardamom based cropping systems

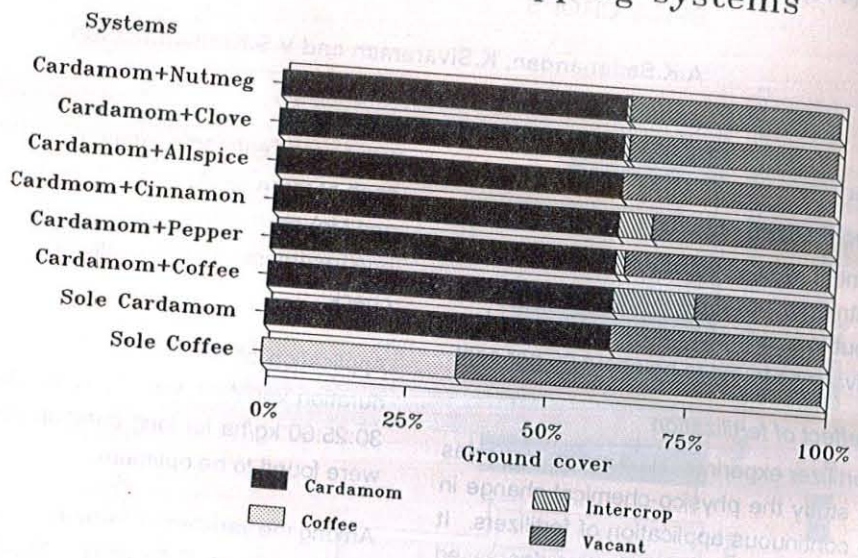
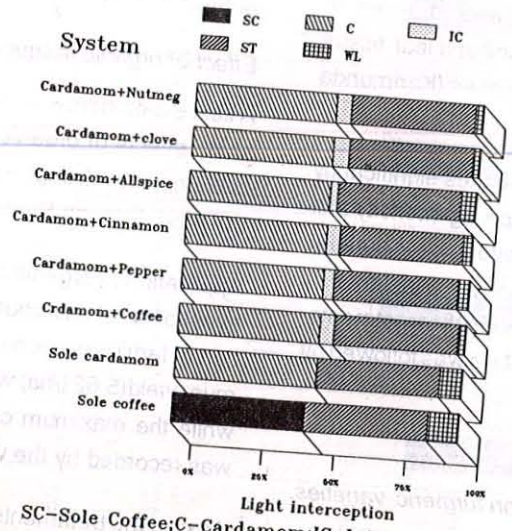


Fig 2.2 Pattern of light interception in cardamom based cropping systems



SC–Sole Coffee;C–Cardamom;IC–Intercrop
ST–Shadetree;WL;Wasted light

3. SSc. II (813) : NUTRIENT REQUIREMENT OF IMPROVED VARIETIES OF SPICE CROPS

A.K.Sadanandan, K.Sivaraman and V.S.Korikanthimath

Black pepper

Nutritional requirement

This experiment was initiated in 1992 with six fertilizer treatments including macro and micronutrients laid out in a split plot design replicated four times. Survival was found to be about 95 per cent.

Long term effect of fertilization

The NPK fertilizer experiment laid out in 1979 was retained to study the physico-chemical change in soil due to continuous application of fertilizers. It was found that continuous fertilization decreased soil pH. Increased N application, increased molybdenum status in pepper leaf and decreased the Aluminum content. Increased P application decreased status of Zn in leaf.

Nutrient requirement of bush pepper

Application of NPK @ 1.0, 0.5, 2.0 g/pot (30 cm, diameter with 10 kg soil) at bimonthly, intervals resulted in the maximum number of spikes, laterals, berry volume and yield . The increased levels of NPK fertilization increased both soil and leaf tissue status of nutrients in both the varieties (Karimunda and Panniyur 1).

In another experiment, organic cakes significantly increased leaf nutrient status, spiking intensity and yield.There was no significant difference in number of spikes and berry volume among the varieties viz., Karimunda and Panniyur 1. Among the treatments, groundnut cake was superior. This was followed by gingelly and cotton cakes.

Turmeric

Effect of Inorganic fertilizers on turmeric varieties.

A field experiment was laid out in 1992 to study the nutritional requirement of four varieties of turmeric viz., Suvarna, suguna, sudarshana, and Alleppey with seven treatments comprising of NPK fertilizers each at three levels and micronutrients(Mn, Zn, B and Mo) each at two levels as soil application and one treatment as foliar application with a common check.

Application of NPK @ 60:50:120 kg/ha for short duration varieties, viz., Suguna, Sudarshana and 30:25:60 kg/ha for long duration variety. Alleppey were found to be optimum.

Among the varieties maximum yield was recorded by Sudarshana (5.63 t/ha). Maximum B/C ratio (2.4) and profit was found to be due to fertilizers. Maximum uptake of N was recorded by Suguna(96 kg/ha) while maximum P_2O_5 (39 kg/ha) and K_2O (256 kg/ha) uptake were recorded by Sudarshana(Fig 2.3) . Maximum yield (5.67 t/ha) and Curcumin recovery (333 kg/ha) were obtained due to application of NPK @ 30:25:60 kg/ha together with micronutrients (20 kg Mn, 5 kg Zn, 0.5 kg Mo and 2 kg B per hectare).

Effect of organic manuring on turmeric varieties

A field experiment was laid out with the objectives to study effects of organic manuring on the nutrition and quality of improved turmeric varieties viz., Suvarna, Suguna Sudarshana and Alleppey.

Application of organic manures increased the soil availability of micronutrients compared to application of fertilizers alone. Among the varieties maximum yield(5.62 t/ha) was recorded by Sudarshana while the maximum curcumin content(361 kg/ha) was recorded by the variety Alleppey.

Among the treatments groundnut cake treated plot registered the highest yield (5.61 t/ha). Regarding the influence of cakes on curcumin, gingelly cakes

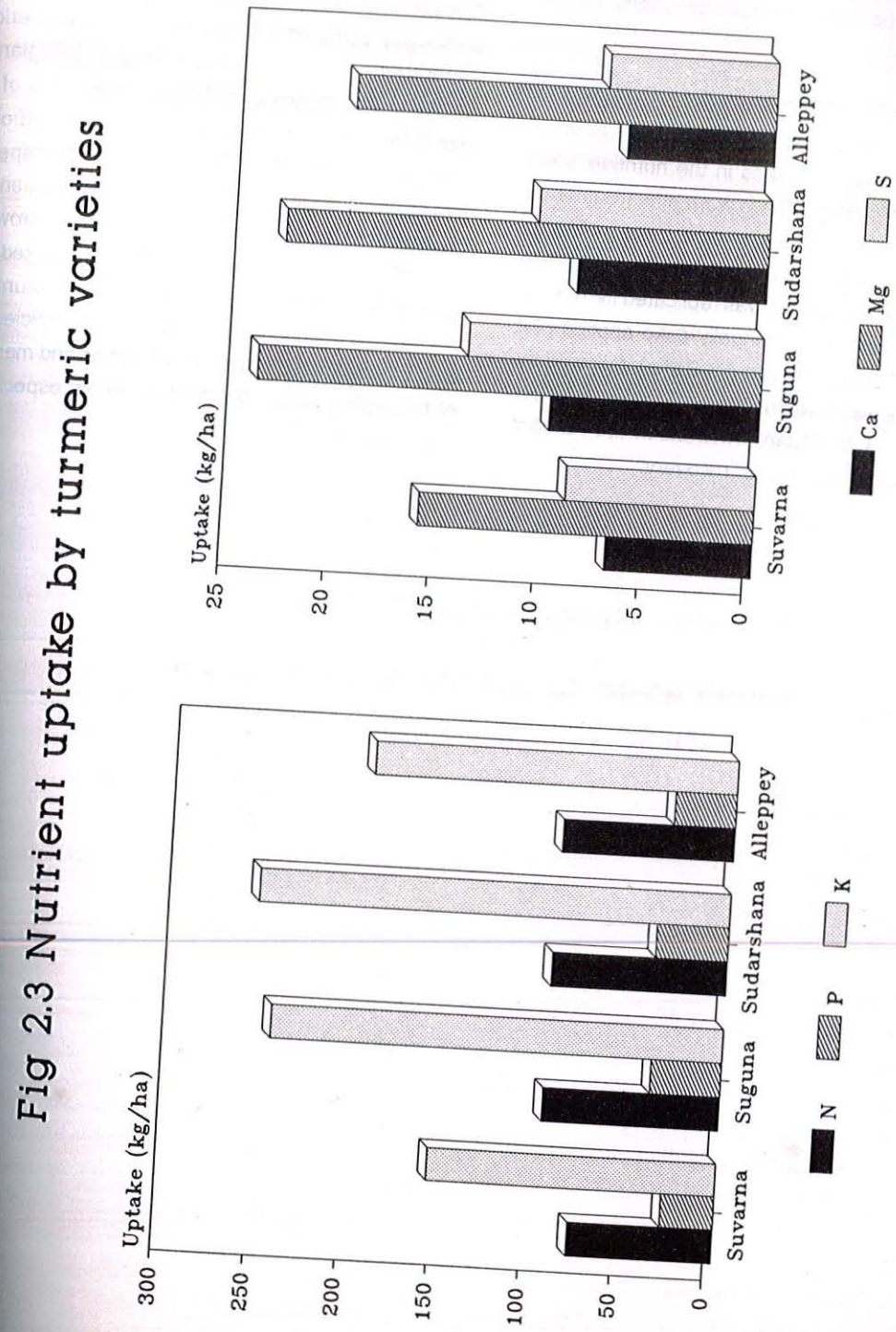


Fig 2.3 Nutrient uptake by turmeric varieties

registered higher curcumin recovery (318 kg/ha) which was on par with cotton and groundnut cakes.

Ginger

Effect of organic manuring

A field experiment was laid out to study the effect of application of organic cakes in the nutrition, yield and quality of ginger. There were nine treatments which included six organic sources, one inorganic NPK fertilizers with and without micronutrients and a check. The experiment was replicated five times. Among the treatments, gingelly cake applied plot registered the highest yield (5.02 t/ha) followed by cotton cakes, Application of organic cakes, fertilizer and FYM had significantly increased the nutrient uptake, yield and oleoresin recovery.

Deficiency symptoms in spice crops

Experiments were initiated to study the nutrient deficiency symptoms in pepper ginger, turmeric, clove and nutmeg, using quarts and Hoagland solution. For inducing deficiency symptoms of a particular nutrient, that nutrient was eliminated from Hoagland solution and watered daily with respective solution. It was found that nitrogen deficiency characterized by foliar yellowing and stunted growth in all. Phosphorus deficiency was characterized by dark green to purple yellow leaves with stunted growth and final death of plant. Potash deficiency was characterized by drying of leaf tips and margin of the leaves which finally dries away, especially older leaves.

MINI MISSION III

INCREASING PRODUCTION OF SPICE CROPS THROUGH CROP IMPROVEMENT

1. GEN I (813) : COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF BLACK PEPPER GERMPLASM

K. Johnson George, R.Ramakrishnan Nair, P.N Ravindran,
B. Sasikumar and V.S Korikanthimath

Collection and conservation

Western Ghats forest ranges were extensively surveyed. Nineteen accessions consisting of five *Piper* species were collected from Muthikkulum, Kerala jointly with NBPGR, Trichur. In a separate trip, ninety one *Piper* accessions were collected from Muzhiyar, Themmala and Kolathupuzha ranges in Quilon district of Kerala, which includes *P. barberi* and fifty six wild *P. nigrum* types. Idukki, Malappuram districts in Kerala and Dakshina Kannada in Karnataka were surveyed and twenty one accessions of different *Piper* species including wild *P. nigrum* and cultivated *P. betle* were collected. Seventy accessions of cultivated black pepper were also collected from the farmers fields in the above districts(Table 3.1).

Cytological studies

Somatic chromosome numbers of 46 *Piper* species / accessions were determined. All the accessions had chromosome number of 2n = 52 except one accession of *P. attenuatum* which had 2n = 104. Two hundred and forty germplasm collections of cardamom and related genera are being maintained at NRCS cardamom research centre, Appangala. Collections from Wynad district of Kerala were evaluated for growth and yield performance.

Fig 3.1 A wild *Piper nigrum* collected from Quilon district

Table 3.1 *Piper* germplasm collected during 1992 - '93

Species	Areas covered
Wild species	
1. *P. attenuatum*	Muthikulam (Palakad Dt.)
2. *P. argyrophyllum*	Kolathupuzha (Quilon Dt.)
3. *P. hymenophyllum*	Themmala (Quilon Dt.)
4. *P. longum/hapnium*	Muzhiyar (Quilon Dt.)
5. *P. mullesua*	Idukki
6. *P. sugandhi*	Dakshina Kannada Dt.
7. *P. nigrum*	"
Cultivated types	
1. *P. nigrum*	Malappuram, Quilon and
2. *P. betle*	Idukki (Kerala) and Dakshina Kannada (Karnataka)

2. GEN IX (813) : COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF CARDAMOM GERMPLASM

Regy Lukose

Growth characters viz., height of the tallest tiller and tillers per plant were not significantly different among the entries, but, the wet capsule yield differed significantly with the highest yield of 991 g recorded in Vazhukka suckers followed by Vazhukka seedlings (959 g) and APG 223 (775 g).

3. GEN. II (813) : COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF GERMPLASM OF GINGER AND TURMERIC

P.N. Ravindran, R.Ramakrishnan Nair,
Johnson K. George and B. Sasikumar

Germplasm collection, conservation and cataloguing

Five hundred and forty three accessions of turmeric and 343 accessions of ginger were maintained in the germplasm conservatory. Fifteen accessions each of ginger and turmeric were added during the year. Three collections of *Kaempferia galanga* were also made. Eighty accessions of turmeric were catalogued.

Turmeric

Multiplication of germplasm

Nine high curcumin cultivars of turmeric viz., Mananthody, Sugandham, CII 328 sugandham, Wynad local, Aizwal, Edapalayam, Erattupetta, Palappally and Thodupuzha were multiplied for yield and quality assessment. These lines were reported to be containing 9 per cent or above of curcumin. Fresh rhizome yield from 3 m² bed of these entries ranged from 9.2 (Aizwal) to 27.02 kg (Thodupuzha). The dry recovery ranged from 16.5 (Palappally) to 21 per cent (CII 328 sugandham).

Eighty turmeric accessions collected from North-Eastern India during 1990 were multiplied for further evaluation.

Yield evaluation

Seven open pollinated progenies of turmeric along with 4 controls were evaluated at NRCS farm, Peruvannamuzhi and farmer's field, Muvattupuzha,Kerala for yield. Significant differences were observed for mean fresh rhizome yield at both the locations. Alleppey ranked first (24.76 kg/3m² bed) at Peruvannamuzhi while Shillong progeny (Acc.no.364) was first at Muvattupuzha (38.0 Kg/3 m² bed). Accession 367 had the highest dry recovery at Muvattupuzha (26.6%) whereas Alleppey had maximum dry recovery at Peruvannamuzhi (24.5%) (Table 3.2).

Ginger

Yield Evaluation

A replicated yield trial with fifteen cultivars of ginger were laid out at NRCS farm,Peruvannamuzhi and

farmer's field, Muvattupuzha. ACC No. 64 ranked first at Muvattupuzha and second at Peruvannamuzhi with 16.1 and 15.25 kg mean fresh rhizome/3m² bed, respectively. Differences among the entries were significant at Peruvannamuzhi only. Dry recovery of ACC No. 64 was 22.9 per cent at Muvattupuzha and 19.10 per cent at Peruvannamuzhi (Table 3.3).

In another replicated yield trial, twenty two germplasm accessions of ginger were selected on the basis of mean yield per plant. There was no significant differences observed for mean fresh rhizome yield per bed. Mean fresh yield from 3m² bed of these accessions ranged from 10.5 (ACC No. 4) to 13.86 kg per bed (ACC No. 293).

Induction of polyploidy

Ginger rhizomes derived from bits treated with colchicine were cytologically analyzed. Two tetraploids with 2n = 44 were recovered from the buds of Maran treated with 0.2 per cent colchicine.

Table 3.2 Yield and dry recovery of selected turmeric progenies at two locations

Accession No.	Mean fresh yield (kg/3 m² bed)		Dry recovery (%)	
	P.muzhi	M.puzha	P.muzhi	M.puzha
366	17.73	29.67	15.75	—
364	23.50	38.00	11.25	12.00
363	24.76	36.00	12.50	18.80
360	19.03	29.60	20.00	19.00
367	11.43	31.57	19.50	26.60
361	18.67	22.55	19.50	15.00
358	22.40	37.60	11.25	—
Controls				
Suvarna	15.40	27.07	20.00	19.80
Suguna	24.37	34.20	12.00	11.00
Sudarshana	23.53	36.10	12.00	12.20
Alleppey	5.70*	26.50*	24.50*	11.00*
CD	5.79	5.17	—	—
CV(%)	17.60	9.40	—	—

* Affected by disease

Table 3.3 Yield and dry recovery of ginger cultivars / accessions in two locations

Entries (Accession No.)	Mean fresh yield (kg/3 m² bed)		Dry recovery (%)	
	P.muzhi	M.puzha	P.muzhi	M.puzha
51	14.80	15.98	20.0	22.4
64	15.25	16.10	19.0	22.9
141	13.23	15.08	17.0	22.8
251	14.87	14.67	17.0	16.6
222	11.97	12.10	21.5	22.3
63	12.81	12.40	18.5	17.1
151	13.02	14.45	16.0	21.3
53	13.42	15.40	17.0	17.9
11	12.67	15.83	18.0	21.2
249	14.69	14.50	20.5	20.8
65	13.45	15.57	15.0	19.9
H.P. local	13.46	15.63	21.0	22.2
Suprabha	15.67	16.00*	14.5	21.6
Maran	—	16.00*	20.5	19.5
M. puzha local	12.79	12.79	20.5	22.6
CD	2.09	N.S.	—	—
CV%	9.10	—	—	—

* Affected by disease

4. GEN. VI (813) : COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF GERMPLASM OF TREE SPICES

B.Krishnamoorthy, J. Rema and V.S. Korikanthimath

Collection and conservation

Twenty wild cinnamon types were collected from the forest ranges of Ponmudi, Kerala. Six high yielding nutmeg trees and three wild types viz., *Myristica malabarica*, *M. gibbosa* and *M. magnifica* from the forest ranges of Calicut and Mannuthy in Kerala and Mahe in Pondicherry and in clove two collections from a survey of Ambanad Estate in Quilon district, Kerala were added to the germplasm.

A live herbarium of tree spices was established. Twenty wild cinnamon and twenty five cassia collections were field planted. Maintenance of germplasm was started at NRCS Chelavur campus by planting 106 nutmeg grafts, 135 clove seedlings and 50 cinnamon rooted cuttings of elite types. Planting materials of elite clove and cinnamon seedlings were supplied for laying out field trials at Yercaud, Pechiparai, Ambalavayal and Thadiyankudisai under the All India Coordinated Research Project on Spices (AICRPS).

Cataloguing and evaluation

CINNAMON : From the yield evaluation trial of elite progenies of cinnamon it was observed that growth, regeneration capacity and fresh weight of

bark per plant of the seedling progenies were better as compared to clonal progenies. A similar trend was observed during 1990-91 and 1991-92 also.

CLOVE: A progeny trial of clove with fourteen elite lines with a local control (bulk) was laid out at NRCS Chelavur campus. Another progeny trial, involving elite lines, Kallar 6, Burliar 57, Burliar 76 and Burliar 95 along with a local control (bulk) was laid out in an established arecanut plantation at NRCS farm, Peruvannamuzhi.

In the clove progeny trial laid out at NRCS, Cardamom Research Centre, Appangala (altitude about 1000 m above MSL), a low coefficient of variability was observed for the mean height, number of branches per plant and girth at 30 cm from the ground level (Table 3.4).

Table 3.4 Growth characters of elite clove progenies

ECT No.	Mean height (cm)		Mean No. of branches / plant		Girth at 30 cm level MAP
	2 MAP	15 MAP	2 MAP	15 MAP	
1 B 95	164.88	174.29	17.50	18.57	3.79
2 B 57	151.13	170.63	15.50	17.63	3.54
3 K 8	157.63	175.00	17.13	19.86	3.44
4 K 4	158.13	179.57	17.50	21.43	3.20
5 K 5	162.00	178.75	14.75	17.00	3.54
6 J 7	149.88	166.25	17.00	18.00	3.30
7 K 1	160.75	172.9	15.75	17.57	3.21
8 K 9	158.13	183.75	15.63	21.25	3.31
9 K 10	152.25	191.25	16.00	19.25	3.95
10 K 3	149.00	165.00	16.63	16.29	3.33
11 K 76	159.88	175.63	15.88	17.38	3.53
12 B 81	153.50	188.75	12.13	16.38	3.10
13 B 74	145.13	160.00	15.88	17.00	3.29
14 B 2	153.38	179.17	17.00	21.50	3.45
Control	110.88	133.13	10.25	12.63	2.84
Mean	152.44	172.94	16.04	18.12	3.39
CV (%)	8.34	8.02	11.16	12.91	7.99

NUTMEG: Seedling and clonal progenies of nutmeg selection 70/A.11 had been planted and the progenies of selected nutmeg accessions are maintained in the nursery.

Inducing flowering/fruit set in allspice

To induce flowering/fruit set in allspice, cultar (suspension concentrate containing 250 g Paclobutrazole/lit) was tried. Four concentrations of Paclobutrazole (1% a.i, 2% a.i, 3% a.i and 4% a.i) along with a control were tried. Drenching with 1% a.i Paclobutrazole gave encouraging results. The trees were also sprayed with ethrel, GA, NAA and 2,4-D, but no positive results were obtained. However, this needs further tests for confirmation.

5. HORT. 1 (813) : VEGETATIVE PROPAGATION OF TREE SPICES

J. Rema and B. Krishnamoorthy

Field evaluation of clove grafts

Growth observations viz., height, number of primary and secondary branches, and girth above the graft union were recorded on clove approach grafts planted during June 1991.

Vegetative propagation of all spice

Vegetative propagation by cuttings, layering, stooling and approach grafting were attempted. Terminal cuttings treated with rooting hormones like IBA (2500 and 5000 ppm), IAA (500 and 1000 ppm) NAA (500 and 1000 ppm) and commercial rooting products like Quicroot and Seradix did not aid in rooting of mature cuttings. However, Quicroot helped in the production of roots in juvenile cuttings. Layering (with out any hormones) was also found to be ineffective for production of roots. Stooling and approach grafting experiments are in progress.

Inducing orthotropic shoots in nutmeg

Continuous supply of auxins (IAA 10,20 and 50 ppm), GA (GA3 10 and 20 ppm), cytokinin (kinetin 10 ppm) and their combination (GA 10 ppm + auxin 10 ppm + cytokinin 10 ppm and GA 10 ppm + auxin 10 ppm) and control did not help in the production of orthotropic shoots from the grafts.

Severe pruning of 3 - 4 years old plagiotropic grafts showed a tendency to produce orthotropic shoots. This needs further testing for confirmatory results.

Top working of nutmeg

Nutmeg is dioecious in nature and the sex of the tree is known after flowering (about 7 years after planting). It was observed that unproductive male trees could be converted to productive trees by top working. Sixteen male trees were detopped and wedge grafted with scions from high yielding female trees on the newly emerged shoots. About 90 per cent success was obtained in this method of top working.

6. GEN.VIII (813) : BREEDING FOR HIGH YIELD, RESISTANCE TO *PHYTOPHTHORA* NEMATODES AND DROUGHT IN BLACK PEPPER

R. Ramakrishnan Nair, P.N.Ravindran, Johnson K.George and B.Sasikumar

Yield trials

Comparative Yield trial II (CYT - II):- The existing CYT-II was modified with twenty two hybrids and two controls. The experiment is laid out in RBD with three replications and trial is in progress.

Evaluation trial of wild *Piper nigrum*:- Six plants each from fifty accessions of wild collections of *Piper nigrum* collected from the forests of Western Ghats were planted on *Glyricidia* standards for evaluation.

Comparative Yield Trial III(CYT-III):- In CYT-III, comprising of 10 hybrids, 8 cultivars and 2 controls, collection 1501 continued to yield higher during the second year with 1.94 kg mean green pepper per vine followed by collection 1500 (1.85 kg/vine).

Bush pepper yield trial

Bush pepper interplanted with perennial pigeon pea as shade crop and trial is in progress.

Other comparative yield trials

Trials on open pollinated progenies and hybrids and trials at Valparai in Tamil Nadu, Chickamagalore, and Bangalore and Pollibeta in Karnataka were gap filled and maintained.

At the high altitude trial at Valparai (1067 m above MSL) hybrids 732 and 813 were continued to be superior during the second year of yielding. The mean yield of these entries were 1.125 kg and 0.95 kg green pepper per vine with a dry recovery of 35.5 and 34.4 per cent respectively.

Polyploidy

An induced tetraploid of black pepper was recovered for the first time. A total of 95 plants derived from colchicine treated seeds of black pepper cultivars 'Karimunda' and 'Panniyur-1' were cytologically analyzed. One of the plants derived from seeds of Panniyur-1 treated with 0.05% colchicine was found to be a tetraploid with 104 chromosomes in somatic cells.

7. GEN.V (813) : BREEDING CARDAMOM FOR HIGH YIELD AND RESISTANCE TO *KATTE* DISEASE

Regy Lukose and M.N. Venugopal

The cardamom selections from various research centres were utilized for multilocation trials(MLT). First trial with 13 Malabar selections and second comparative yield trial with six hybrids were laid out in RBD each with four replications.

In the sick plot, as in earlier years the same 19 entries continued to show field resistance against natural infection of *Katte* virus. These entries have not taken infection for the last 3 years. Three parallel observation trials in three situations, one each in high rainfall, low rainfall and arecanut based crop mix with clones(10-12 clones/accession) of promising entries (field resistant plants) were initiated with corresponding local susceptible clones.

A Comparative Yield Trial(CYT) with 16 promising clonal entries of *Katte* resistant lines, one each of multibranch type and rhizome rot resistant line, two pre-release selections (CCS-1 & M-1) with local malabar type was planted in a completely randomized design(CRD) to study their yield potential. Each plot is replicated thrice with 12 plants per plot. The recommended cultural practices, gap filling and plant protection measures were carried out. The trial is in progress.

8. PHY.V (813) : CHARACTERIZATION OF DROUGHT TOLERANCE IN BLACK PEPPER AND CARDAMOM

A. Ramadasan and S. Vasantha

In the field evaluation of promising drought tolerant lines Karimunda selection 69 continued to show better tolerance for the third consecutive year. Physiological and yield data are being analyzed. Karimunda selections 14 and 27 were screened for drought tolerance.

9. PHY.III (813) : QUALITY EVALUATION IN SPICES

T. John Zachariah and N.K.Leela

Black pepper

Among the 54 germplasm accessions evaluated for essential oil, oleoresin and piperine contents CLTP 55 contained high piperine(5.8%), oleoresin(16%) and essential oil(6%). Accessions with more than 5 per cent piperine are CLTP 2, 55, 192, 201 and 234. Accessions with more than 4.5 per cent (v/w) essential oil are CLTP 55, 61, 185 and 187. Accessions with more than 13 per cent oleoresin are 55, 185 and 192.

Cardamom

Thirty seven Wynad collections and eight controls were evaluated for the essential oil content and chemical quality. Accessions 188, 195, 217, 221 and 223 and 224 contained more than 8 per cent essential oil. Selections 188, 221 and 223 were superior in quality as indicated by the high alpha terpinyl acetate in these selections.

Ginger

Among 66 accessions evaluated for chemical quality, Accessions 14, 54, 82, 86, 92, 94, 103, and 118 contained above 2 per cent essential oil and accessions 14, 56 and 122 contained above 9 per cent oleoresin.

Turmeric

A study was conducted to find out the effect of planting dates (like late April, early May, late May, early June and Late June) and harvesting dates (late November, early January and February) on dry recovery and curcumin content in the newly released turmeric varieties viz. Suvarna, Suguna and Sudarshana in comparison with Alleppey as control. The dry recovery was maximum at 250-270 days of maturity.

Curcumin content decreased as the maturity increased in all the four varieties. Planting in May and harvesting in November recorded the highest curcumin. As the harvesting is delayed there was a decline in curcumin content. This can be attributed to the relative accumulation in starch and fibre.

Allspice

Leaf samples from twelve trees were analyzed for oil content. It ranged from 1.8 to 3.3 per cent (v/w). Four trees had more than 60 per cent eugenol.

10. BIOTECH.III (813) : MICROPROPAGATION OF BLACK PEPPER

J.Rema, K. Nirmal Babu, Johnson K.George
and B.Sasikumar

Micropropagation of *Piper betle* L.

Piper betle L. cv Lakkuvalli was successfully micropropagated on WPM. Different explants *viz.* shoot, leaf and root tissues developed multiple shoots and regenerated into plantlets either directly or through intervening callus phase on WPM supplemented with 3 mgl^{-1} BA and 1 mgl^{-1} kinetin. The excised shoots developed good root system on growth regulator free medium of the same composition. The plantlets were transferred to the soil with 80 percent success.

Micropropagation of *Piper barberi* Gamble

Protocol for *in vitro* multiplication of *Piper barberi*, an endangered species of *Piper* was standardized. Multiple shoots could be induced and plantlets regenerated from shoot and leaf explants when cultured on half strength WPM supplemented with BA and kinetin. The shoots were rooted *in vitro* on growth regulator free WPM at half strength. The plantlets were transferred to soil with 90 percent success.

Micropropagation of *Piper chaba* Hunt

P. chaba a major source of long pepper could be micropropagated on WPM supplemented with BA and kinetin. This medium was found to be ideal for shoot regeneration and their subsequent growth from both leaf and stem explants either with or without intervening callus phase. These shoots developed good root system when growth regulators were completely removed from the culture medium. The micropropagated plantlets could be easily established in soil with over 75 percent success.

Conversion of root meristem to shoot meristem

When rooted plantlets of *P. colubrinum* and *P. longum* were grown in WPM supplemented with BA and kinetin conversion of root tips to shoot meristem was noticed and they subsequently developed in to plantlets.

11. BIOTECH. I (813) : TISSUE CULTURE FOR RAPID MULTIPLICATION OF ELITE CLONES OF CARDAMOM

Regy Lukose

About 2000 plantlets were produced from the callus of Cl 37 x PV 1. The plantlets are being transferred to White's medium + 0.5 mg NAA/l for rooting.

In CYT-I, tissue cultured plants, seedling and suckers of Cl 37 were compared for it's growth and yield performances. Significant differences were found in the height of the tallest tiller, tillers/plant, panicles/plant and yield/plant and cumulative yield (Table 3.5). Tillers/plant and leaves/plant did not show significant differences between the treatments.

In CYT-II, similar type of comparison was made with Mudigere-1. Significant differences were observed between the treatments for yielding tillers/plant, panicles/plant, yield and cumulative yield(Table 3.6). However, tillers/plant, height of the tallest tiller and leaves/plant did not show significant differences between the treatments.

Callus was induced from the rhizome of Cl.37 selection 893. The callus is subcultured for multiplication.

Table 3. 5 Growth parameters of cardamom in CYT I(Cl.37)

Growth characters	Tissue cultured plants	Suckers	Seedlings	CD (0.05)
Tillers/plant	24.6	22.4	21.7	
Yielding tillers/plant	15.9	11.1	12.3	NS
Height of the tallest tiller(cm)	167.0	150.0	170.0	2.8
Leaves/plant	134.0	114.0	135.0	13.8
Panicles/plant	21.1	15.2	18.0	NS
Green yield(g/plant)	434.0	194.0	305.0	2.5
Cumulative yield (1990 to '92) (g/plant)	774.0	476.0	628.0	112.0
				226.0

NS *Non significant*

Table 3.6 Growth characters of cardamom in CYT II (Mudigere - 1)

Growth characters	Tissue cultured plants	Suckers	Seedlings	CD (0.05)
Tillers/plant	20.9	19.8	17.1	
Yielding tillers/plant	14.1	12.3	9.5	NS
Height of the tallest tiller(cm)	162.0	141.0	166.0	3.5
Leaves/plant	130.0	119.0	109.0	NS
Panicles/plant	17.1	14.6	11.9	NS
Green yield(g/plant)	267.0	165.0	162.0	3.8
Cumulative yield (1990 to '92) (g/plant)	506.0	385.0	329.0	51.3
				113.0

NS *Non significant*

12. BIOTECH II (813) : *IN VITRO* SELECTION FOR RESISTANCE TO SOFT ROT AND BACTERIAL WILT OF GINGER

K. Nirmal Babu, T.G.Nageshwar Rao and N.K.Leela

Characterization of tissue cultured plants

Over two hundred micropropagated plants and somaclones were evaluated in pot culture for various morphological characters and yield. One promising line OCP 1222 (Fig.3.2) was identified from the somaclones and is being multiplied for further evaluation.

Fig 3.2 A promising Somaclone of ginger, OCP 1222

Multiplication of somaclones and polyploid culture

Over 500 cultures of somaclones and polyploid cultures treated with colchicine and embryoid cultures treated with EMS were maintained. This is for increasing the spectrum of variation.

Biochemical Characterization

Preliminary studies on stored protein in ginger rhizomes were carried out electrophoretically. Samples in varying concentrations of buffer and different gel gradients were analyzed. Based on the studies proteins of molecular weight ranging from 10 - 90 KD are present and 9 of them could be separated electrophoretically.

Suspension cultures

Suspension cultures of ginger were initiated and maintained.

Field screening of somaclones for disease resistance

Fifty six somaclones raised in polybags were screened for their reaction to soft rot caused by *Pythium aphanidermatum*. Symptoms developed in all the lines and none of the lines were found to be tolerant.

Extraction of culture filtrate

Pythium aphanidermatum was grown on corn meal agar in petri dishes. Culture filtrate was extracted by the standard procedure and used for bioassay.

In vitro selection for resistance to soft rot

The culture filtrate extracted from *P. aphanidermatum* were concentrated to 50 per cent by dialysis. The concentrated culture filtrate was added to the MS medium in conical flasks on which ginger embryoids and callus were grown. Controls were maintained with MS medium and the MS + CZ medium. Callus and embryoids were found to grow luxuriously in the controls but the MS medium incorporated in the concentrated culture filterate 80 per cent of the callus and the embryoids were dead within 20 days of inoculation. The surviving calli will be subcultured and regenerated into plants which will further be tested by inoculating with *P. aphanidermatum*.

13. DBT PROJECT : *IN VITRO* CONSERVATION OF SPICES (BLACK PEPPER AND CARDAMOM GERMPLASM)

K.V.Peter, P.N.Ravindran and K.Nirmal Babu

Selection of suitable basal medium

Of the three different basal media(MS, B5 and WPM) tried, WPM was found suitable for micropropagation of black pepper, while in cardamom and related genera MS medium was found to be better.

In vitro responses

Black pepper and related genera

Micropropagation protocols were standardized using stem and leaf explants in *P. chaba, P. barberi, P. nigrum* and stem, leaf and root explants in *P. longum, P. colubrinum* and *P. betle*. Plant regeneration was both direct as well as *via* intervening callus phase. Shoot tip cultures of 61 accessions of black pepper and related taxa were established in *in vitro* gene bank. Studies to induce slow growth in black pepper were initiated.

Cardamom and related genera

Micropropagation protocols for cardamom and its related genera like *Zingiber*, and *Curcuma* were already standardized in this centre. Protocols for other related genera like *Kaempferia*,(Fig.3.3), *C. amada, Alpinia* were also standardized.

An experiment was initiated to study the effect of mannitol (10 mg l^{-1} and 15 g l^{-1}) in closed culture vessels and low temperatures (22°C, 10°C and 4°C) in reducing the growth rate and increasing the subcultural intervals in cardamom.

Half strength MS medium (devoid of growth regulators) supplemented with (10 mg l^{-1}) mannitol and (10 mg l^{-1}) sucrose in closed (screw capped tubes) culture vessels at laboratory temperature (22 ± 2°C) was found to be better to induce slow growth and increase subcultural interval substantially, to about 200 days.

Over 65 accessions of cardamom and related taxa including 16 accessions of cultivated cardamom were established in *in vitro* repository.

Fig 3.3 Micropropagation of *Kaempferia galanga*

14. DBT PROJECT : RAPID MULTIPLICATION OF TREE SPICES (NUTMEG, CLOVE AND CINNAMON)

P.N.Ravindran, K.Nirmal Babu and J.Rema

Cinnamon

Axillary buds of cinnamon (*Cinnamomum verum*) shoot explants were cultured on WPM supplemented with BA and kinetin. Multiple shoots up to 5 could be induced in 30 % of the cultures.

In vitro rooting could be induced in shoot tips cultured on WPM supplemented with IBA in 40 days of culture.

Shoot tip cultures of an economically important species of *Cinnamomum*, *C. camphora* (Campher tree) were established and multiple shoots up to 4 were induced in 10 % of the cultures. Callus cultures of cinnamon and camphor were established on MS medium supplemented with 2, 4-D.

Leaf fall, delay in shoot elongation and shoot tip burning were the problems encountered in cinnamon cultures.

Clove

Lateral buds were activated and up to 8 - 10 multiple shoots were obtained in 10% of clove shoot tip cultures on WPM supplemented with BA and kinetin.

Callus could be induced from leaf segments of clove in MS supplemented with 2, 4-D.

Phenolic exudate was major problem in shoot tip cultures and was overcome by frequent transfers to fresh culture media.

Leaf fall and lack of elongation of shoots were observed in clove cultures. Initial attempts to overcome these by the addition of glutamine (up to 20 mg l^{-1}) to the culture medium did not help in solving the problem.

Nutmeg

Among the tree spices, Nutmeg tissue cultures are relatively slower in responding to the culture media, except for the aril tissues.

Axillary buds could be activated to grow in cultures, however the growth was very slow and at a later stage the media were found insufficient to sustain its further growth.

SUPPORTIVE RESEARCH PROGRAMMES

1. EXT.I (813) : INCREASING PRODUCTION OF BLACK PEPPER AND CARDAMOM THROUGH LARGE SCALE DEMONSTRATION OF IMPROVED TECHNOLOGIES IN FARMERS' FIELDS

A.K. Sadanandan, Jose Abraham, V.S. Korikanthimath and M. Anandaraj

1. Demonstration of High Production Technology - Pepper

Five demonstration plots were selected one each representing (i) pepper as mixed crop in coconut garden (ii) in arecanut garden (iii) in coffee plantation and (iv) pepper as a monocrop. The improved technology package was translated in farmer's fields with the objective of suppressing the disease and pest incidence, increasing the nutrient availability in the soil by the adoption of integrated nutrient management, inclusion of cultural practices to augment pepper productivity. The pepper yield ranged from 1.2-2 kg/vine. The foot-rot incidence was reduced to 2.3% due to the adoption of technology package. The management technologies created mass awareness of research results among the farmers ensuring rapid dissemination of information among the end users.

2. Demonstration of HPT - Cardamom

2.1 Conventional management followed by HPT (Area 10 ha)

A mean yield of 438 kg dry capsules per ha was obtained over a period of 8 years (1985-86 to 1992-93) by adopting HPT, whereas, an yield of 117 kg of dry capsules was recorded under conventional management. A net return of Rs.72,185 was obtained through HPT as against Rs.21,849 under conventional management.

2.2 Introduction of cardamon as a sole crop in place of Arabica Coffee by adopting HPT (2 ha).

An yield of 684 kg/ha was recorded during the year. A maximum yield of 1625 kg/ha was obtained during 1985-86. This is the highest recorded yield recorded anywhere in the world so far.

The mean annual maintenance cost and the net recovery over a period of 9 years(1984-85 to 1992-93) were Rs.35,148 and Rs.1,12,843 per ha per year respectively.

2.3 Comparative performance and economic returns from cardamom, coffee and black pepper (10 ha each)

It was observed that based on the availability of assured water source, cardamom could be cultivated most profitably by adjusting existing shade pattern and establishment of additional shade if required in partially shaded or vacant area.

2.4 Large scale onfarm demonstration of adoption of HPT in cardamom(30 ha).

This large scale onfarm demonstration trial was laid out during 1991 in an area of 30 ha. In this trial entire HPT on cardamom has been adopted and implemented. This plot is attracting a number of cardamom growers to emulate this lab to land programme in their plantations.

2.5 Conversion of marshy areas for profitable cultivation of cardamom (0.4 ha)

This onfarm trial, aims at bringing the low lying marshy areas under profitable cultivation of cardamom. An yield of 1350 dry capsules/ha was recorded dry 1992-93.

2.6 Homestead cultivation of cardamom under controlled shade

This system involves raising cardamom in trenches by resorting to high density planting (1.8 x 0.6 m - 9250 plants/ha) under over head pandal. This system has been implemented in 0.5 acre. It has

become popular in Sirsi and surrounding areas of Uttara Kannada district of Karnataka. Six onfarm trials on this system of homestead cultivation are being monitored. Besides providing gainful employment to small and marginal farmers, the quick and early yield (18-20 months) could be obtained apart from the multiplication of high yielding clones.

2. GEN I (443) : PRODUCTION OF PARENTAL MATERIALS AND BREEDERS STOCK OF SPICES

K.Sivaraman and V.S.Korikanthimath

At Peruvannamuzhi, multiplication and distribution of high yielding black pepper varieties of Sreekara, Subhakara, Panchami, and Pournami were taken up. One lakh eighty five thousand rooted cuttings were distributed to various departmental agencies and progressive farmers for further multiplication. Twenty six tonnes of seed rhizomes of turmeric varieties viz., Suvarna, Suguna, Sudarshana, and Alleppey were also distributed against the target of 10 tonnes.

At Appangala, seed capsules of Cl - 37 cardamom were supplied to developmental agencies and farmers. Multiplication of elite clonal material of CCS - 1, 800, 893 was also undertaken. Ten thousand rooted cuttings of black pepper varieties viz., Sreekara, Subhakara, Aimpiriyan, Kottanadan, Pournami and Panchami were also distributed.

3. EXTN. I (443) TRAINING OF EXTENSION, RESEARCH WORKERS AND FARMERS

T. John Zachariah and M.N. Venugopal

Training programmes on the various aspects of spices production technologies conducted at Calicut and cardamom research centre Appangala are given in the Tables 4.1 and 4.2.

Table 4.1 Training programmes conducted during 1992-93 at Calicut

	Name of the programme	Date	No. of participants
1.	Nursery techniques in black pepper and tree spices	Aug 3-4	15
2.	Nursery management and production technology	Aug 17 - 24	12
3.	Spices production technology	Nov 17 - 24	25
4.	Horticulture training	Nov 17 - 24	5
5.	Nursery management in spices	Feb 17 - 18	7

Table 4.2 Training programmes conducted during 1992-93 at Appangala

Name of the programme	Date	No. of participants
1. Management of 'Kokke Kandu' and other viral diseases of cardamom *(In collaboration with Spices Board)*	May 27 - 29	Officials of spices board
2. Mini field day on coffee + cardamom cropping systems at Chettoli and Banjigere	May 30	93
3. Nursery techniques of cardamom and 'Katte' disease management	Sep 2 - 3	16
4. Management of cardamom nursery and 'Katte' disease	Sep 16	36
5. Students of Horticultural college, Napoklu	Sep 24	23
6. Nursery management in cardamom	Oct 2	3
7. IFS probationers, Forest College, Dehradun	Jan 2	36
8. Exhibition on HPT on cardamom		
9. Seminar and exhibition on cultivation of cardamom, black pepper and tree spices at Honnavar	Jan 24	150

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

There are 16 centres under AICRPS. During 1992-93 ICAR has sanctioned two new centres at Dholi (Bihar) and Hisar(Haryana) to work on coriander, fenugreek, turmeric and cumin, coriander, fennel and fenugreek respectively. The tree spices (clove, nutmeg and cinnamon) were also included under the project. The total budget of the project for the 8th plan period is Rs.300 lakhs.

GENETIC RESOURCES

Germplasm accessions including wild types collected and maintained in the coordinating centres are given in the Table 5.1

One hundred and seventeen wild pepper germplasm from Panniyur (KAU) centre were shifted to RARS, Ambalavayal as the existing environmental conditions are not ideal at Panniyur. The Yercaud centre which initiated work on pepper has added 102 accessions. At Pottangi, a total of 186 turmeric accessions included *Curcuma longa*, *C. aromatica* and *C. amada* and at Solan besides the 146 existing turmeric germplasm, 42 collections from NBPGR, Trichur and ICAR Research Complex, Shillong were added. Eighty collections of turmeric lines were also collected from Anatharajpet and Kovvur areas of Andhra Pradesh by Jagtial centre. Solan centre received 16 more ginger collections from NBPGR and ICAR Research Complex, Shillong. Thirty seven exotic germplasm accessions in seed spices viz., coriander, cumin and fenugreek were obtained from NBPGR were multiplied and maintained for evaluation at Jobner and Jagudan centres. Guntur centre in collaboration with NBPGR collected 110 selective samples of coriander from the predominant coriander growing areas of Andhra Pradesh.

CROP IMPROVEMENT

Black Pepper

The new MLT (1991) on black pepper with 14 accessions was laid out at Panniyur, Ambalavayal and Pampadumpara (KAU), Mudigere (UAS) and Yercaud (TNAU) centres. Hybridization/selection programme at Panniyur centre resulted in the release of Panniyur-2, Panniyur-3 and Panniyur-4 varieties. Based on the performance of the past three years, 34 numbers of cultivars were identified as promising out of the 1134 (hybrid progenies). The culture Nos. 1558 (OP of Kalluvally), 5128 (OP of Cheriyakaniadan) and 5834 (OP of Irumanian) and 239 (OP of Perumkodi) are consistent high yielders and are in the process of release from Panniyur centre.

Cardamom

The Cardamon MLT (1991) with 13 Malabar entries were laid out at Mudigere, Appangala, Sakleshpur and Thadiyankudissai centres. Another MLT with five Mysore types were laid out at Myladumpara and Sakleshpur, Indian Cardamom Research Institute(ICRI) Mudigere (UAS) and Appangala (NRCS) centres. High yielding selections in Cardamom viz. P-3 and PC-5 are under pre-release multiplication. Other cardamom clones CL-692, P-20, CL-683, CL-802, CL-679, CL-726, at Mudigere(UAS); APG-7, YC-1 at Yercaud(TNAU); PTS-10, PV-4, PV-12, PV-3 at Pampadumpara (KAU) appeared promising.

Large Cardamom

Improved large cardamom cultures are 'Pink Golsey' and 'Clone-4' (identified by ICAR Gangtok centre). The cytological investigations in large cardamom at Gangtok centre revealed that somatic chromosome number of *Amomum subulatum* as 2n = 4x =

Table 5.1 Spices germplasm collections at coordinating centres

Particulars	Germplasm accessions
BLACK PEPPER	
Panniyur	193
Sirsi	50
Chintapalli	29
Yercaud	102
CUMIN	
Jobner	220
Jagudan	272
CARDAMOM	
Pampadumpara	87
Mudigere	245
Yercaud	35
LARGE CARDAMOM	
Gangtok	34
GINGER	
Pottangi	146
Solan	152
TURMERIC	
Pottangi	186
Solan	146
Jagtial	147
CORIANDER	
Jobner	445
Jagudan	445
Guntur	120
Coimbatore	189
FENNEL	
Jobner	134
Jagudan	287

48 and *A. dealbutum* as 2n = 2x = 24. The interspecific F1 obtained between two sp. showed triploid level i.e. 2n = 3x = 36. Dzong-Golsey continue to be free from Chirkey disease.

Ginger and Turmeric

High-yielding turmeric mutants PTS-19 (QUAT) and TC-2 (TNAU) are at different stages of testing and release. The V_1E_4-4 a vegetative mutant in ginger is quite promising at Pottangi. Ginger collections viz., SG-674, SG-547 and SG-666 at Pottangi, SG-547, V_1S_1-2 (Solan) were found promising.

Seed Spices

The MLTs in coriander and fenugreek running at Jobner, Jagudan, Guntur and Coimbatore, and in cumin and fennel at Jobner and Jagudan are in progress.

The mutation breeding programmes at Jobner and Coimbatore to evolve coriander varieties with earliness and resistance to diseases and in programmes on developing fenugreek varieties resistant to powdery mildew at jobner are progressing.

Tree Spices

Two MLTs were initiated under this programme. The MLT (1992) in clove with 5 elite lines was laid out at Yercaud (TNAU) Ambalavayal (KAU) and Thadiyankudissai (TNAU), the latter two are participating centres. In cinnamon, MLT with 5 lines was initiated in all the above centres and also at Pechiparai (TNAU).

CROP PRODUCTION

Black Pepper

Pepper varieties Panniyur-1, Kottanadan, Narayakodi and Uddagare were recommended for growing as mixed crop in coffee plantations in Andhra Pradesh. Irrigation cum fertilizer studies at Sirsi in arecanut-pepper mixed cropping system, showed significant yield increase due to the application of 100:40:140 g of NPK each to arecanut and pepper. At Panniyur centre irrigating pepper vines from December to April at IW/CPE ratio of 0.25 gave significantly higher yield of 90 per cent over unirrigated control. In higher altitudes of Andhra Pradesh, application of 75:30:130 g NPK/vine in two splits in July and September under rainfed conditions would be optimum for augmenting productivity in black pepper.

Cardamom

Studies at Yercaud revealed that cardamom cv Malabar local is the best for cultivation under

Shevroy hill conditions followed by selections 112 and SKP-51. The released cardamom variety Mudigere-1 under optimal conditions yielded more than 675 kg/ha with the recommended spacing of 1.8 m x 1.8 m and fertilizer does of 75:75:150 kg NPK/ha at Mudigere condition. In drought tolerance studies, with 12 selected cardamom accessions, significant differences were observed with respect to plant height, number of suckers at different levels of irrigation, though these variations were not significant between clones under full irrigation and irrigation at 50 per cent field capacity. The plant height recorded was more than two metre and number of suckers was more than 20 per clump. Studies were also initiated on the role of bees in pollination in cardamom. The minimum number of bee visits required for a successful pollination in cardamom has been found to be five which resulted in 90 per cent fruit set.

Ginger

The optimum date of planting ginger is the last week of April. The rhizomes are best planted in raised beds (15 cm height) with one metre width and of a convenient length. A compatible crop combination of ginger and soybean has been recommended for Orissa. At Pottangi, fertilizer application @ 125:100:100 g of NPK kg/ha gave maximum benefit.

Turmeric

Turmeric rhizomes are best planted for optimizing yields in 3 x 1 m raised bed. Application of higher dose of N at 140 kg/ha along with P @ 60 kg and K @ 180 kg/ha gave highest turmeric yields. At Pottangi, highest yield of 14.4 t/ha was obtained by the application of N_{125} P_{100} and K_{100} Kg/ha followed by N_{75} P_{50} K_{50} Kg/ha (12.78 t/ha). The cost benefit analysis also showed maximum benefit from the above treatments.

Coriander

Maximum seed yield was obtained at Hisar (HAU) when N was applied @ 60 kg ha^{-1} in two equal doses, one half at sowing and other half at 60 days after sowing(DAS) (17.4 q/ha). Split application of N @ 60 kg/ha, 1/3 at sowing, 1/3 at 30 DAS and remaining 1/3 at 75 DAS was also effective.

Cumin

For cumin, sowing at a spacing of 22.5 cm in rows with a seed rate of 12 kg ha^{-1} was found to be the best. Weed control in cumin could be achieved by use of Terbutryn @ 2.5 kg a.i/ha.

Fennel

Higher yield in fennel was obtained by application of 90 kg N/ha i.e., 36 kg N as basal, 27 kg N after 30 days and 27 kg after 60 days of transplanting with 40 kg P_2O_5/ha applied as basal.

Fenugreek

Fenugreek sown in the first week of November with a seed rate of 25 kg ha^{-1} with 40 kg each of N and P_2 O_5 ha^{-1} gave maximum seed yield at Jobner. Highest seed yield in fenugreek (21.31 c/ha) was obtained by irrigating at IW/CPE ratio of 1.0 (21.26 q/ha) followed by 0.8 (18.4 q/ha) at Hisar. Application of neem cake @ 150 kg/ha/seed pelleting with *Trichoderma viridae* reduced root rot incidence and increased yield. Weed management studies were initiated in coriander and fenugreek using four herbicides viz., oxyflurofen, metalachlor and pendimethalin and flurochloralin at two concentrations together with hand weeding.

EVALUATION OF SPICES FOR QUALITY

Studies on the quality evaluation of ginger, showed that maximum ginger oil and oleoresin was recorded by SG-681. The ginger variety Jamaica gave high dry recovery. The ginger selection SG-666 recorded high essential oil content (2.5%). High volatile oil content was recorded in coriander accession Nos. JCO-125, and UD-435 (0.4%) and in fennel, accession Nos. UF-90 and UF-131 gave higher volatile compounds compared to others.

CROP PROTECTION

Black Pepper

A survey for incidence of insect pests of pepper in high altitudes showed that leaf gall thrips (*Liothrips Karnyi*) scale insects (*Marsipococcs marsupiale*) and top shoot borer(*Cydia temidoxa*) were causing damage in pepper.

The wild pepper germplasm, Madem Acc. No.9 at Chintapalli Centre with high yielding ability coupled with tolerance to *Phytophthora* foot rot may be used for the breeding programme against disease.

The management of *Phytophthora* foot-rot disease was made effective by application of lime @ 1 kg/ vine in May followed by neem cake @ 2 kg/vine and spraying of 1% Bordeaux mixture and drenching with 0.2 per cent copper oxychloride which reduce the *Phytophthora* foot rot in pepper at Panniyur. At Sirsi, adoption of cultural practices and application of neem cake @ 1 kg, phorate 3 g a.i., Bordeaux mixture (1%) spraying and drenching together with pasting (10% Bordeaux paste up to one metre height in the collar region) of each vine during June and August as most effective. Akomin (0.4%) and Ridomil MZ-72 WP (100 ppm) given as spray @ 3 1/vine and drench @ 51/vine respectively were effective. Application of either 1 per cent Bordeaux mixture or Ridomil MZ-72 (200 ppm) in soil @ 5 1/ vine as soil drench around the basins and two rounds of foliar application during July/August gave 86% recovery from pepper foot-rot at Chintapalli.

Studies on integrated management of foot rot showed that with a combination of antagonistic organism (*Trichoderma harzianum*) organic amendments (neem cake @ 200 g/vine) and systemic fungicides (Ridomil MZ 78 WP) 100 ppm foot rot can be checked effectively.

Nursery diseases of black pepper can be effectively controlled by spraying with Bordeaux mixture (1%) followed by Difolatan (0.2%) drenching at fortnightly intervals.

Cardamom

Thrips and borer incidence were minimum (less than 10%) in elite cardamom clones viz. D-163, D-547, D-446, D-514.

Spraying with a combination of Dithane M-45 (0.25%) + Ridomil MZ 72 WP (0.1%) or Bavistin (0.2%) + Ridomil MZ-72 WP (0.1%) controlled damping off and leaf spot diseases in the cardamom nursery.

Application of carbofuran @ 8-10 g/clump controlled root grub. Spraying endosulfan (0.15%) and carbaryl (0.15%) were effective in controlling thrips. The studies indicated that time of spraying insecticides is more important than the number of sprays in bringing down thrips damage. Three sprays given in April (Monocrotophos) June and August (Phosalone) significantly reduced the damage to 11.85% from 25% in control.

Large Cardamom

The leaf streak can be controlled by spraying with either Blitox-50 or Fytolan @ 0.3 per cent concentration.

Ginger

Germplasm screening for rhizome rot showed minimum incidence in SG-227, SG-678, SG-686, SKP, SG-687, Awacho, SG-666, Maran, Jamaica and SG-503.

Application of Phorate (10 kg/ha) at time of bed preparation and seed treatment with combination of Dithane M-45 (0.25%) and Bavistin (0.1%) reduced the rhizome rot and increased ginger yield. The seed treatment alone with Dithane M-45 and Bavistin was however, on par with the above treatments. These treatments could not decrease post emergence rot of ginger.

Turmeric

Trials at Jagtial (AP) showed that Suguna (PCT-13) and Sudarshana (PCT-14) were relatively tolerant

to rhizome rot and are becoming more popular among the farmers.

Coriander

An early maturing coriander accession CS-287, suitable for rainfed tracts of Tamil Nadu, recorded less incidence of wilt and grain mould. The red leaf disease, a new record in coriander had been reported from Coimbatore. Fungi like *Fusarium* sp., *Alternaria* sp., *Curvularia* sp., and *Helminthosporium* sp., were reported to be associated with grain mould disease of coriander. Spraying of carbendazim 0.1% given 20 days after grain set is recommended for control of coriander grain mould. Seed pelleting with *Trichoderma viridae* had registered the lowest wilt incidence and highest yield (356 kg/ha) at Coimbatore.

Cumin

The cumin cultures UC-198, UC-199 recorded less degree of wilt disease in screening studies. Cumin exotic cultivars EC-279053, EC-244375, EC-242684 seem to be tolerant/resistant against wilt and are therefore to be used in future breeding programmes.

The cumin wilt can be checked by seed dressing with 1:1 mixture of Bavistin and Captan @ 4 g/kg of seeds, followed by spraying the crop with Mancozeb (0.2%) at 15 days" intervals and by adopting three year crop rotation cycle.

PRODUCTION OF PLANTING MATERIALS

One of the important activities taken up by the AICRPS centres has been the production and distribution of elit planting materials to various agencies. The centres implemented in the integrated programme for development of spices (IPDS) for production and distribution of elite planting materials under the centrally sponsored scheme of the Government of India, Dept. of Agriculture and Co- operation. A brief account of the performance during 1992 - 93 in different centres are:

Panniyur This centre distributed 102401 of rooted pepper cuttings of varieties Panniyur-1, 2, and 4 and culture-239 and Karimunda.

Mudigere This centre supplied 188 kg of cardamom seed capsules, 4640 suckers and 245 seedlings of cardamom.

Solan The centre produced two quintals of rhizome of SG-666 and 50 kg rhizome was distributed to farmers for evaluation.

Pottangi Pottangi centre distributed 8 tonnes of seed rhizomes of turmeric varieties viz. Roma, Ranga and Rasmi and one tonne seed rhizomes of ginger variety Suprabha.

Guntur Under IPDS programme 2000 kg coriander seed was produced and distributed by the Centre.

Monitoring the production and distribution of improved planting materials would go a long way in augmenting spices production.

KRISHI VIGYAN KENDRA

A Krishi Vigyan Kendra (KVK) was established by the Indian Council of Agricultural Research at NRCS Experimental Farm, Peruvannamuzhi with effect from 16th November 1992, with the following mandate.

Mandates of KVK

1. Collaborate with the subject matter specialists of the State Agricultural Universities / Scientists of the Regional Research Stations (NARP) and the State Extension Personnel in 'On farm testing', refining and documenting technologies for developing region specific sustainable land use systems.
2. Organize training to update the extension personnel within the area of operation with emerging advances in agricultural research on regular basis.
3. Organize long term vocational training courses in Agriculture and allied vocations for the rural youths with emphasis on "learning by doing" for generating self-employment through institutional financing.
4. Organizing front - line demonstrations in various crops to generate production data and feed back information.

Sri. Jose Abraham, Scientist (SG) has taken charge as the Chief Training Organizer and work has already been initiated for the construction of the buildings and other infrastructural facilities. Regarding the recruitment of the staff, Shri, V.L.Jacob was appointed as the Superintendent and Kum. C.K.Beena and Shri. R.N Subramanian as Jr. Stenographer and Jr. Clerk respectively by 31 of March 1993.

During the short span of 3 months, a three day training was imparted to spice growers for various aspects of spices cultivation and practical training was given in nursery management. An exhibition on spices was also organized at Mokkam in connection with the "Gramasree" celebrations of Mokkam Panchayat to educate the farmers on various aspects of spice crops. The Officer-in-Charge (KVK) has attended the Farm Advisory Committee meetings of the All India Radio. He has also attended a training programme on 'Integrated Krishi Vigyan Kendra' from 8-11 March 1993 conducted by the Zonal Coordinator (KVK) at Central Plantation Crops Research Institute, Kasaragod.

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PARTICIPATION IN SYMPOSIA / SEMINARS / CONFERENCES / GROUP MEETINGS

1. National seminar on pepper and cardamom
   All the scientists of NRCS
2. Group meeting on tree spices research May 15 1992 Coimbatore
   K.V.Peter, S.Edison
3. National seminar on black pepper and cardamom May 17 and 18 1992 Calicut
   All the scientists of NRCS attended the seminar
4. Gregor Mendel foundation seminar July 20-23 1992 Calicut
   K.V.Peter
5. National seminar on tropical essential oils September 18 and 19 1992 Cochin
   K.V.Peter, John T. Zachariah
6. Workshop on Management of agricultural research stations. 22 - 25 September 1992 NAARM Hyderabad
   V.S. Korikanthimath
7. Workshop on DNA techniques October 16 to 22 1992 Madurai
   Johnson K.George
8. Group meeting on seed spices research November 23 and 24 1992 Coimbatore
   K.V.Peter, S.Edison
9. PLACROSYM X December 2 to 4 1992 Kasaragod
   K.V.Peter, Y.R.Sarma, A.K.Sadanandan, M.Anandaraj,
10. Group meeting on establishment of bio-pesticide pilot plants February 16 1993 New Delhi 1993
    Y.R.Sarma, S.Devasahayam
11. Seminar on Water Management for plantation crops. 3 March 1993. CWRDM Thycaud Trivandrum.
    V.S. Korikanthimath
12. National workshop on radiochemistry and applications of radioisotopes March 9 to 19 1993 Calicut
    N.K.Leela
13. National seminar on soil resources vis a vis sustainable land use March 12 to 14 1993 Calcutta
    A.K. Sadanandan

Participation in Training Programmes

1. Training on processing and quality control in spices March 30 to April 10 1992 CFTRI Mysore
   T. John Zachariah
2. DBT National Associate, 1991-92 (April 92 - Jan 93) Dept. of Biotechnology, MKU, Madurai - 625 021
   B. Sasikumar
3. Summer institute on disease management through host plant resistance June 1 to 20 1992 HPKVV Palampur
   T.G.Nageshwar Rao
4. Training course on computer applications in agricultural research 14 to 24 July 1992 NAARM Hyderabad
   Jose Abraham
5. Seventeenth short term course on the use computer in agricultural research 17 to 30 September 1992 IASRI New Delhi
   G.N.Dake
6. Application of laboratory techniques in biotechnology 8 to 16 March 1993 MKU Madurai
   Johnson K.George

Membership in Committees

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Editor, Journal of Spices and Aromatic Crops.
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Member, General Council of Kerala Agricultural University.
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Member, Spices Board, Cochin.
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Member, NRCS Institute Management Committee.
Member, Executive Council, Indian Society for Spices.

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Member, Editorial Committee, Indian Phytopathological Society.
Member, Board of Studies of Life Science, Calicut University.
Member, NRCS Institute Management Committee.
Executive Councillor, Indian Society for Plantation Crops.

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Member, NRCS Institute Joint Council.
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Secretary, Indian society for Spices.

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Member, Technical advisory committee of Sughandhagiri project.Wynad, District, Kerala

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S. HAREENDRAKUMAR
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R.N. SUBRAMANIAN
Junior Clerk

K. PADMINIKUTTY
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Driver (T-I-3)

K. BALAN NAIR
Driver (T-I-3)

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SS.Gr.IV (Peon)

K.M. KUNHIKANARAN
SS.Gr.I (Peon)

K. KEERAN
SS.Gr.III (Lab Attender)

I. UNNI NAIR
SS.Gr.I (Lab Attender)

V.V. SAYED MOHAMMED
SS.Gr.I (Lab Attender)

T. AMMED KOYA
SS.Gr.I (Watchman)

M. KORU
SS.Gr.I (Watchman)

K.P. VIJAYAN NAIR
SS.Gr.II (Mazdoor)

N. RAVINDRAN
SS.Gr.II (Mazdoor)

V. BALAKRISHNAN
SS.Gr.I (Mazdoor)

T. BALAKRISHNAN
SS.Gr.I (Mazdoor)

K. BALAKRISHNAN NAIR
SS.Gr.I (Mazdoor)

P. PRABHAKARAN NAIR
SS.Gr.I (Mazdoor)

V.P. RAMACHANDRAN
SS.Gr.I (Mazdoor)

K.P. DEVAKI
SS.Gr.I (Mazdoor)

C.M. KAMALAM
SS.Gr.I (Safaiwala)

STAFF - EXPERIMENTAL FARM PERUVANNAMUZHI

TECHNICAL

V.K. ABUBACKER KOYA
Farm Superintendent (T6)

K.A. SOMANNA
Farm Assistant (T-II-3)

M.M. AUGUSTY
Technical Assistant (T4)

K.T. MUHAMMED
Jr. Technical Assistant (T-I-3)

V.P. SANKARAN
Jr. Technical Assistant (T2)

N.A. MADHAVAN
Jr. Technical Assistant (T2)

N.P.PADMANABHAN
Jr. Technical Assistant (T2)

K. KUMARAN
Jr. Technical Assistant (T2)

K.K. SASIDHARAN
Jr. Technical Assistant (T1)

S. NATARAJAN
Jr. Technical Assistant (T1)

K. CHANDRAN
Jr. Technical Assistant (T1)

K. KRISHNA DAS
Mechanic-cum-Pump Operator (T1)

P. BHASKARAN
Jr. Technical Assistant (T1)

AUXILIARY

RAMANNA GOWDA
Tractor Driver (A)

SUPPORTING

E. KUNHAYYAPPAN
SS.Gr.III(Watchman)

E.K. NANU
SS.Gr.III(Watchman)

B.T. VELAYUDHAN
SS.Gr.II (Watchman)

P. SADANAHNDAN
SS.Gr.I (Watchman)

N. AYYAPPAN
SS.Gr.III (Mazdoor)

C. BHASKARAN
SS.Gr.II (Mazdoor)

P.K. BALAN
SS.Gr.II (Mazdoor)

M. BALAKRISHNAN
SS.Gr.I (Mazdoor)

K. CHANDRAN
SS.Gr.II (Mazdoor)

M. CHOYIKUTTY
SS.Gr.I (Mazdoor)

P. DAMODARAN
SS.Gr.II (Mazdoor)

K. GANGADHARAN NAIR
SS.Gr.I (Mazdoor)

P. KUNHIKRISHNAN
SS.Gr.I (Mazdoor)

P.T. MADHAVAN
SS.Gr.I (Mazdoor)

K. RAGHAVAN
SS.Gr.II (Mazdoor)

N.K. RAGHAVAN
SS.Gr.I (Mazdoor)

V.K. SANKARAN
SS.Gr.I (Mazdoor)

P. SOMAN
SS.Gr.I, (Mazdoor)

P. SREEDHARAN
SS.Gr.I (Mazdoor)

V.P. VIJAYAN NAIR
SS.Gr.I (Mazdoor)

V.P. SARADA
SS.Gr.I (Mazdoor)

K.P. PREMACHANDRAN
SS.Gr.I (Mazdoor)

STAFF - CARDAMOM RESEARCH CENTRE APPANGALA

SCIENTIFIC

V.S. KORIKANTHIMATH M.Sc.(Ag.)
Scientist-in-Charge, and Scientist SG(Agronomy)

M.N. VENUGOPAL Ph.D
Sr. Scientist(Pathology)

REGY LUKOSE
Scientist(Genetics)

SANTHOSH J.EAPAN
Scientist(Nematology)

ADMINISTRATION

ENID SAVITHA
Superintendent

K. VASUDEVAN
Assistant

TECHNICAL

M.K. APPAIAH
Technical officer(Farm T5)

L. BALAKRISHNA
Jr. Technical Assistant (T1)

G.ARUMUGHAM
Jr. Technical Assistant (T1)

K.ANANDA
Jr. Technical Assistant (T1)

K.B. PRASANNAKUMAR
Jr. Technical Assistant (T1)

AUXILIARY

H.G. NANAMAIAH
Driver (T-I-3)

SUPPORTING

B.J. LAKKAIAH
SS Gr.IV (Mali)

H.Y. ERAPPA
SS Gr.IV (Watchman)

SH. K M THIMMAIAH
SS Gr.II (Watchman)

P.K. BELLIAPPA
SS Gr.I (Watchman)

B.R. JANAKI
SS Gr.I (Mazdoor)

M.G. MARINANJAMMA
SS Gr.I (Mazdoor)

B.L. SEETHU
SS Gr.I (Mazdoor)

N.K. GIRIJA
SS Gr.I (Mazdoor)

H.B. GANGU
SS Gr.I (Mazdoor)

H.B. LAKSHMI
SS Gr.III (Mazdoor)

GOWDIGERE SHETTY
SS Gr.I (Mazdoor)

B.M. SESHAPPA
SS Gr.I (Mazdoor)

P.K. MANIKKA
SS Gr.I (Mazdoor)

K.M. MADA SHETTY
SS Gr.III (Mazdoor)

K.M. CHIKKASAKAMMA
SS Gr.I (Mazdoor)

B.M. CHENNIAPPA
SS Gr.I (Mazdoor)

B.K. POOVAPPA
SS Gr.I (Mazdoor)

S. MAHADEVA
SS Gr.I (Mazdoor)

K.M. PUTTASIDDAMMA
SS Gr.I (Mazdoor)

B.M. LALITHA
SS Gr.I (Mazdoor)

B.K. CHENNAMMA
SS Gr.I (Mazdoor)

D.K. ESWARA
SS Gr.I (Mazdoor)

H.B. NAGAMMA
SS Gr.I (Mazdoor)

BUDGET - 1992-93 *(Rs. in Lakhs)*

Item	Non-Plan BE 92-93	Non-Plan RE 92-93	Plan BE 92-93	Plan RE 92-93
Establishment charges including LSP and PF	56.00	61.00	10.10	2.00
O.T.A.	—	—	—	—
Travelling expenses	2.00	2.00	0.40	0.40
Other charges including equipments	17.00	25.00	20.50	30.60
Works	—	—	32.00	30.00
Other items	—	—	—	—
Total	75.00	88.00	63.00	63.00

LIBRARY

Library acquired 40 scientific books and 83 reprints apart from subscribing 88 Indian and 56 foreign journals. Literature and information on spices were periodically collected and published in Journal of spices and aromatic crops and Agri Sci.Tit Bits, respectively.

IMPORTANT VISITORS

Sri.T. Nandakumar IAS
Chairman, Spices Board
Cochin

Ms. Anila Krime IAS
Secretary, Agriculture
Govt. of Arunachal Pradesh

Dr. P. Rethinam
ADG (PC), ICAR
New Delhi

Dr.M.K. Nair
Director, CPCRI
Kasaragod

Dr.M. Aravindakshan
Director of Research, KAU
Vellanikara

Dr.R. Naidu
Director (Research), Spices Board
Myladumpara, Kerala

Swami Sidhananda
Ramakrishana Mission
Calicut

Dr.D.B. Masih
Director of Horticulture
Govt. of Arunachal Pradesh

Sri.V.V. Dakshinamoorthy
Syndicate member
University of Calicut

Dr. T. Thangaraja
Head, Dept. of Chemistry
University of Calicut

Prof. (Dr.) Suchorska,
Agrl.Research Institute
Poland

Dr. Bakowski
Agrl.Research Institute
Poland

Air Marshal S. Kulkarni
National Defence College
New Delhi

Dr. Hari Eswaran
World Soil Resources
USDA Soil Conservation Service

Mr.K. Viswanathan,
Deputy General Manager,
SBI, Cochin

RAINFALL DATA

Months		Peruvannamuzhi Rainy days	Peruvannamuzhi Rainfall (mm)	Appangala Rainy days	Appangala Rainfall (mm)
1992	April	4	81.00	7	62.8
	May	10	287.20	12	251.6
	June	24	1497.00	20	931.0
	July	29	1117.30	30	863.7
	August	29	1080.70	27	647.8
	September	22	557.90	15	220.2
	October	15	278.20	11	208.0
	November	14	251.40	8	196.7
1993	January	—	—	—	—
	February	—	—	—	—
	March	—	—	—	—

SYMPOSIUM ANNOUCEMENT

INTERNATIONAL SYMPOSIUM ON PLANTATION CROPS

30 November - 3 December 1994 — Calicut, Kerala, India

Plantation crops are of great importance in the economy of several countries. The Indian Society for Plantation Crops has organised a series of symposia on plantation crops (PLACROSYM) in India from 1978 onwards in collaboration with other agencies. The importance of such a symposium at the global level has been realised and hence the present efforts to organise an **International Symposium on Plantation Crops (PLACROSYM - XI)** at Calicut, Kerala, India during 30 November - 3 December 1994. The theme of the Symposium would be **PLANTECH - Plantation Technology for Producitivity and Quality.**

The symposium aims to bring together all concerned with production, research, marketing and development of plantation crops, to a common forum to discuss, exchange ideas and plan strategies for the future.

CROPS

Rubber	Tea	Coffee	Coconut
Arecanut	Oil Palm	Cocoa	Cashew
Black pepper	Cardamom	Clove	Nutmeg
Cinnamon	Allspice	Ginger	Turmeric

SESSIONS

1. Crop Management
   - Agronomy, Cropping systems, Soils and Nutrition, Microbiology and Agrometeorology
2. Disease Management
3. Pest Management
4. Crop Improvement
   - Genetics, Cytogenetics, Plant breeding and Horticulture
5. Biotechnology, Physiology and Biochemistry
6. Harvest, Post-harvest Technology and Quality improvement
7. Marketing, Economics, statistics and Developmental strategies

REGISTRATION FEE

Indian delegates	-	ISPC Members	Rs. 400
		Non Members	Rs. 500
Foreign delegates	-		US $ 100

For further information write to

General Convenor
International Symposium on Plantation Crops
National Research Centre for Spices
Post Box No. 1701, Marikunnu P.O.
Calicut - 673 012, Kerala, India