ANNUAL REPORT
1993 - 94

ICAR

NATIONAL RESEARCH CENTRE FOR SPICES
(Indian Council of Agricultural Research)
CALICUT - 673 012 KERALA INDIA

MANDATES OF NRC FOR SPICES

- To serve as a centre of excellence for conducting and coordinating research on basic and applied aspects of spices
- To serve as a National Centre for storage and dissemination of information on spices
- To serve as a centre for transfer of technology and imparting training on spices

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Photographs

Front cover : Larva of *Chilocorus circumdatus* - a predator of scale insects infesting black pepper

Back cover : An elite line of cardamom

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DIRECTOR'S REPORT

The year 1993-94 witnessed forward surge in the growth of National Research Centre for Spices, Calicut. The Quinquennial Review Team (QRT) constituted by the ICAR submitted its report on December 3, 1993 recommended to upgrade the Research Centre to a level of full-fledged Institute for effective function. Two projects viz., 'Development of *Phytophthora* resistance in black pepper (*Piper nigrum* L.) through biotechnological approach' and 'Development, production and demonstration of biological pest control agents under integrated pest management' were sanctioned by the Department of Biotechnology, Government of India and two ad-hoc schemes viz., 'The parasitic nematode *Trophotylenchulus piperis n.sp.* Mohandas, Ramana & Raski, 1985 and its interaction with black pepper' and 'Biological control of scale insects infesting black pepper' were sanctioned by the ICAR. There were 14 projects in operation in Mini Mission I - Increasing production of spice crops through management of diseases and pests, 4 projects in Mini Mission II - Developing agro-techniques for increasing production of spice crops, 13 projects under Mini Mission III - Increasing productivity of spice crops through crop improvement and 3 projects under Supportive Research Programmes. The Krishi Vigyan Kendra at Peruvannamuzhi organized several training programmes to farmers. The NRCS is recognized as a centre for post-graduate studies by the Kerala Agricultural University. Disciplines of Entomology and Soil Science at NRCS are recognized for doctoral studies by the Calicut University. The budget allotted to the Centre during 1993-94 was Rs.91 lakhs under Non-Plan and Rs.115.89 lakhs under Plan. During the year 1.25 lakhs single-noded pepper cuttings and 20 tonnes of turmeric seed rhizomes were distributed to the states of Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa, Sikkim and Arunachal Pradesh. In cardamom, about 600 kg of seed capsules of CCS-1 were also distributed from Cardamom Research Centre, Appangala.

An effective and cost-efficient strategy to manage *Phytophthora* foot rot in black pepper was standardized and put into practice in 1000 hectares in Wynad and Idukki districts of Kerala during the year. The management practice is expected to cover one lakh ha in 5 districts of Kerala viz. Wynad, Idukki, Calicut, Cannanore and Kasaragod during 1994-95. This is the first time a technology generated at this Centre is put on a massive scale by an integrated approach through efforts of State Department of Agriculture, State Agricultural University and Directorate of Cocoa, Arecanut & Spices Development. Stunted disease of black pepper caused by virus was observed in Wynad (Kerala) and Gudalur (Tamil Nadu). A folder on stunted disease and Phyllody was distributed to development agencies for implementation. The year also saw strengthening the research capabilities. Equipments costing Rs.37.8 lakhs were imported. They include solar radiation measurement system, refrigerated centrifuge, HPLC accessories, Nikon microscope and accessories. Ten indigenous equipments costing Rs.8.6 lakhs were also purchased. The All India Coordinated Research Project

on Spices was strengthened by addition of two centres during the year. Researches on cumin, coriander, fennel and fenugreek have received special attention during the year. The year witnessed strengthening of research programmes in the following areas viz. establishing a global gene bank of spices and conserving germplasm collections in *in vitro* repository, evolving high-yielding varieties with high-quality and resistance to pests and diseases initiating research on seed spices, spice based cropping systems, pesticide residues and post-harvest technology, intensifying work on biological control of various diseases and pests of spices. India made an all time record export of 1.76 lakh tonnes of spices valued Rs.540.12 crores during 1993-94 against the target of Rs.1.27 lakh tonnes valued Rs.500 crores. India exported 46,650 tonnes of black pepper valued Rs.179.67 crores during the year against the target of 30,000 tonnes valued Rs.105 crores. The Research Centre worked in close collaboration with the development agencies to achieve the above target.

The Scientists and staff are grateful to Dr. K L Chadha, Deputy Director-General (Hot.) and Dr.P Rethinam, Assistant Director General (Plantation Crops) for support and guidance.

(K.V.PETER)
Director

अनुसंधान उपलब्धियाँ

जनेटिक रिसोर्सस्

पैपर की उन्नत (49), पैपर लोंगम (22),वन्य (16) पैपर टाईपस, अदरक की उन्नत (75) परदेश से लाई हुई (1) जमैकन, कॅम्पफेरिया शलनगा (2), हल्दी के अलेपी (62), कुरकुमा स्पेसेस (18), दालचीनी की उन्नत (22), वन्य (4), कॅम्पर टाईपस (5), जायफलउन्नत (42), वन्य (5) और लोंग के (4) ऑक्सेशन को जर्मप्लास्म में जमा कर दिया है।

पैपर क्रोकॅटम में 2 एन = 52 तथा उत्तर पूरब रिजन के वन्य कलेक्शन में 2 एन = 91 क्रोमोझोम पाये गये।

क्रॉप इमप्रुवमेन्ट

पैपर के 8 वर्णसंकरीकरण में "वडाकन" (2 एन = 78) फीमेल पेरेन्ट है।

जायफल (ऑक्सेशन नंबर 150-49) के फल गोल तथा बोल्ड पाये गये।

बायोटेक्नालॉजी

अमोमम सुबूलाटम की सूस्मसां साधित विधि विकसित की गयी।

वॅनिला के 10, पैपर लोंगम तथा पैपर कोलुब्रेनम प्रत्येकी 30 बीज संतान सॅइल में लगाये गये है।

मसालें (कालीमिर्च, इलायची, अदरक, हल्दी और वॅनिला) के 205 जर्म प्लास्मों के ऑक्सेशन इन विट्रो सुरक्षा कोष में रखे हैं।

क्रॉप नूट्रिशन तथा मैनेजमेन्ट

काली मिर्च (करीमुन्डा) में आवश्यक, अमुख्य, तथा अल्पार्थक पालन-पोषण करनेवाले नूट्रियन्टस् के माभा का परीक्षण किया गया है और उसका स्टीटिस्टिकल अनालिसीस किया जा रहा है।

गमला बुरा मिर्च के लिए (10 ग्राम/10 किलों सॅइल) मुंगफल्ली की केक दो मास में एक बार देने से काली मिर्च का उत्पन्न 184 प्रतिशत कन्ट्रोल से जादा मिला है।

हल्दी के अलेपी किस्म ने अल्पार्थक पालन-पोषण करने वाले नूट्रिशन को सर्वाधिक रिस्पॉन्स दिया है। प्रोडक्शन टेक्नालॉजी में छिडकाव सिंचाई देने से इलायची फसल नारियल की 13 साल के गार्डन में लेने से उपज में बढत पाई गई।

वेजिटेटीव प्रोपागेशन

एअर लेअरीगस दो साल के दालचीनी पर पहिली बार किया गई।

ऑल स्पाईस के बेसिन में कुलटार (1 ग्राम ए. आई) देने से फूल और फलों की जादा लागज़ होती हुई पाई गई।

मसालों की गुणकता परीक्षण

काली मिर्च के ऑक्सेशन नंबर 12, 99 तथा 210 में लिमोनीन और माइरसिन की माभा जादा पाई गई है।

हल्दी के ऑक्सेशन नंबर 107, 126, 199, 210 तथा 257 में कुरकुमीन की माभा 6 प्रतिशत से जादा मिली।

अदरक के ऑक्सेशन नंबर 251 में ओलेये रेसिन तथा ऍसेनाथियल ऑयल की माभा जादा मिली।

जादा अलफा टरपीनील एसीटेट, तथा 9 प्रतिशत ऑयल की माभा इलायची सिलेक्शन APG 187, 188, 189 और 194 में पाई गयी।

क्रॉप प्रोटेक्शन

काली मिर्च की (पी. 24) फाइटोफथोरा टॉलरन्ट लाइन सिरसी (कर्नाटका राज्य) में बढीया पाई गयी।

VAM का कॉलनाइसेशन होने से काली मिर्च में फाइटोफयोरा कॉपसिसी से होने वाली जड गलन की लाराण में कम पायी गई।

एन्टोमोफेगस निमाटोडस तथा हाथमेनटेरा पॉरसाइडस् जूलै-सितम्बर/सितम्बर-नवम्बर मास में जादा पाया गये।

ट्राईकोडरमा स्पैसिस तथा पैसिलोमाइसीटस लिलासीनस लगाने से इलायची के रूट नॉट निमा टोडसकी गमले में कम हानी पाई गयी।

इलायची में डंम्पिंग ऑफ बिमारी ट्राइकोडरमा लगाने से 66 से 43 प्रतिशत कम हो गई।

नीम, क्रोमोलिना ओडोराटा, कुचला के पतियाँ का अर्कपोलू बीटिल के विरुद्ध प्रयोगशाला परिक्षण में अच्छे पाये गये।

फाइटोफथोरा कापासिसी के वेजिटेटीव तथा असेक्सुअल पुर्नजन्म पर क्रोमोलिना ओडोराटा तथा नीम के पतियाँ का अर्क का असर पाया गया।

काली मिर्च का फाइटोफथोरा फुट रॉढ अकामिन और नीम केक देने से कम हो गया।

प्रोडक्शन ऑफ न्यूक्लीअस प्लॉन्टिग मीटीरियल

काली मिर्च के उन्नत जाती के 1,25,000 रूटेड कटिंगस, हल्दी के जादा उपज देने वाली प्रजातियों के बीज कन्द 20 टनस, तथा इलायची के 600 किलो बीज कोष को अनेक विस्तार एजेनसिस में बॉटा दिया गया।

टेक्नॉलॉजी का ट्रान्सफर

स्पाईसेस प्रोडक्शन टेकनॉलोजी, मसालों के पौधाघर में लगने वाली बीमारी का प्रबंध करने पर प्रशिक्षण गोष्टीका आयोजन किया गया।

अखिल भारतीय समान्वित अनुसंधान परियोजना (मसाले)

अखिल भारतीय समान्वित अनुसंधान परियोजना (मसाले) के अंर्तगत दो नये केन्द्र, हिसार (हरियाना) और धौली (बिहार) राज्य में शुरु किये गये हैं।

सीड मसालों (सौंफ, धनियाँ) के जर्म प्लास्मों को जगुदन और जोबनेर केन्द्रों में बढाये गये है।

जादा उपज देने वाले लंवग के 13, और जायफल के 15 पेंडों को पहचाना गया।

काली मिर्च की प्रजाती पन्नीयूर-5, इलायची की ICRI-3, धनियाँ की DH-5 किस्मों को बाहर करने की सिफारिस की गई है।

ओरिसा राज्य के लिए सोयाबीन का हल्दी के साथ (Inter-coopping) लेने की सिफारिश की गयी है।

धनियाँ को कारबेन्डाझीम (0.1 प्रतिशत) फूल लगने के 20 दिन बाद फवारा लगाने से सीड मोल्ड बिमारी की कम लागण पायी गयी।

राजस्थान राज्य में जीरा के मुरझाना बिमारी का प्रबंन्ध करने के लिए बॅविस्टिन (0.1 प्रतिशत) बीज प्रक्रिया करने की सिफारिश की गई है।

सौंफ मेथी के ऍण्ट्रिस EC 25, 75, 66 पाउडरी मिलडूस प्रतिरोधक पाई गयी है।

MINI MISSION I: INCREASING PRODUCTION OF SPICE CROPS THROUGH MANAGEMENT OF DISEASES AND PESTS

EPIDEMIOLOGICAL STUDIES ON *PHYTOPHTHORA* FOOT ROT DISEASE OF BLACK PEPPER

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

1.Pathogenic variability: Oospores were produced when *Phytophthora* isolate from black pepper was paired with isolates from coconut and cardamom by using slide culture method. The pathogenic variabilities of the oospore progenies are being studied.

2.Serodiagnosis: *P. capsici* when cultured on protein free liquid medium produced protein in the medium. These are being characterized for possible use as antigen to evolve a serodiagnostic technique for early detection of the pathogen.

3.Effect of sequential inoculation of *Phytophthora* and nematodes : A pot culture experiment to study the effect of sequential inoculation of *P. capsici* and nematodes in causing slow decline was set up in a CRD with 12 treatments and six replications. The experiment is in progress.

4.Isolation of efficient VAM strain for suppression of root rot: Seven isolates of VAM belonging to two genera *Glomus* and *Gigaspora* were found to enhance growth of black pepper cuttings when inoculated in the nursery mixture. These were tested for their efficiency to suppress root rot caused by *P. capsici* on four varieties of black pepper viz., Sreekara, Subhakara, Panniyur-1 and Kottanadan in pot culture studies. There were significant differences in suppression of root rot by all isolates (Table 1.1).

Table 1.1 Effect of VAM isolates on suppression of root rot of black pepper caused by *P. capsici*

Treatment	Root rot index (0-4 scale)*	Shoot wt. (g)	Root wt. (g)
T_1 *Glomus sp*	1.188 d	194.7 a	55.19 ab
T_2 *Gigaspora sp*	1.688 bcd	161.6 ab	46.25 bc
T_3 *Glomus sp*	2.125 b	154.1 abc	45.63 bc
T_4 *Gigaspora sp*	1.250 cd	178.8 a	59.38 a
T_5 *Glomus sp*	2.125 b	120.3 *c*	36.25 c
T_6 *Glomus sp*	1.813 bc	125.0 bc	35.75 c
T_7 *Glomus sp*	1.938 b	130.3 bc	34.69 c
T_8 Control	3.500 a	57.81 d	20.69 c
LSD	**0.574**	**41.23**	**12.18**

Scales. 0 - No rotting. 1 - up to 25% rotting: 2 - up to 50% rotting
3 - up to 75% rotting : 4 - up to 100% rotting

DISEASE MANAGEMENT IN *PHYTOPHTHORA* FOOT ROT AFFECTED BLACK PEPPER PLANTATIONS

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

A field trial consisting of different frequencies of application of systemic fungicides viz., Ridomil MZ 72 WP and Akomin (Potassium phosphonate) and contact fungicide the Bordeaux mixture was continued for the second year. All the treatments were superior to control (Table 1.2). Treatments with neem cake along with fungicide showed better protection.

Table 1.2. Frequency of application of fungicides on foot rot of black pepper (1993 - 94)

Treatment	Percentage of vines		
	Dead	Declining	Healthy
Control	20.8	33.3	45.8
Neem cake (NC)	4.1	62.5	33.3
Phorate	8.3	41.6	50.0
Bordeaux mixture (BE) + Copper oxychloride (COC)+ Neem cake (NC)	8.3	33.3	58.3
BE + COC + NC -3 Rounds	8.3	29.1	62.5
Ridomil MZ 72 WP-3 Rounds + NC	20.8	29.1	50.0
Akomin (AK) + NC - 3 Rounds	4.1	45.8	50.0
AK + NC - 4 Rounds	4.1	45.8	50.0

Table 1.3 Effect of varietal mixtures of black pepper on *Phytophthora* infection in sick plot

Combination	Reaction type	Healthy/ total tested
P. colubrinum (PC)	R	6/6
Subhakara (SU)	S	6/6
P 24	T	3/6
P 1178	T	2/6
P 339	T	5/6
P 1534	T	1/6
PC + SU	R + S	*1/6
PC + P 24	R + T	*4/6
PC + P 1178	R + T	*2/6
P 1178 + P 24	T + T	4/6 (2+2)
P 1534 + P 24	T + T	4/6 (2+2)
P 339 + P 24	T + T	4/6 (2+2)

* All the 6 plants of *PC* remained healthy . Figures indicate black pepper alone
R=Resistant S = Susceptible T=Tolerant

An observational experiment on the effect of varietal mixture of susceptibles and tolerant black pepper lines along with *Piper colubrinum*, (a resistant type) was continued. In the presence of *P. colubrinum* or in a mixture of tolerant types the surviving plants were more compared to susceptible types (Table 1.3).

SCREENING GERMPLASM MATERIAL FOR REACTION TO *PHYTOPHTHORA* FOOT ROT DISEASE OF BLACK PEPPER

(Y.R.Sarma and M. Anandaraj)

Screening of open pollinated (OP) seedlings and varieties were continued (Table 1.4). Among the 20190 seeds sown, germination percentage was 2.9 per cent in *Phytophthora* sick beds and 36.7 per cent in sterile soils. A total of 155 cultivars and 109 hybrids were screened. C - 1052 showed tolerant rating. Field trials at Sirsi were continued. Field evaluation of tolerant lines at Peruvannamuzhi was continued. C - 847 was free from infection. None of the screened material showed resistant reaction. Of the 145 cultivars screened C-1112 and C1052 gave tolerant rating. Of the 109 hybrids screened HP 345, and HP 134 gave tolerant rating. Of the 10 NBPGR selection screened, NBPGR 29 gave tolerant rating. The *Phytophthora* tolerant line P 24 continued to remain healthy. Large scale screening of P - 24 along with other tolerant lines in five plots was taken up at Sirsi. The initial establishment and growth were satisfactory.

Table 1.4 Leaf reaction of *Piper* sp. to *P. capsici* (72 hours of incubation)

Piper spp.	Lesion length (mm)	
	PP	PP
P. arboreum	0.0	0
P. colubrinum	0.0	0
P. chaba	5.0	3
P. longum	5.0	3
P. trichostachyon	11.0	6
P. wightii	12.0	5
P. argyrophyllum	12.5	5
P. betle	14.0	5
P. attenuatum	16.0	5
P. longum	25.0	3
P. barberi	25.0	15

PP = Pin Prick : PP- = No pin prick

EVOLVING A DISEASE INDEX FOR *PHYTOPHTHORA* / NEMATODE INDUCED DAMAGE IN BLACK PEPPER

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

The project was initiated during 1990 with an objective of evolving a disease index for *Phytophthora* / nematode induced damage in black pepper to rank the intensity of the disease. Indexing could be done for visual symptoms of foliar yellowing and defoliation by assigning scores from zero to four, depending upon the percentage of foliage affected. Scores of '0' for healthy, '1' for the vines having 1 to 25 per cent of the foliage affected, '2' for the vines with 26 to 50 per cent of the foliage affected and so on. Scoring is to be done for yellowing and defoliation. The incidence of these symptoms in the affected vines were approximately in the ratio of 1:1. Also, the average of the scores for the affected vines over the years was nearly in the ratio of 1:1 suggesting that a weightage of 1:1 can be given to these symptoms. Therefore, a simple index for the severity of the disease can be arrived at by adding these individual scores for the two symptoms of yellowing and defoliation and converting to percentage. In the case of feeder root infection, the vines do not die quickly but continued to remain alive up to 3 years with occasional remission in the expression of symptoms depending on climate, nutrition and the root regenerating capacity of the variety. Though all the varieties were found to be susceptible to the fungus, life span of the affected vines varied depending upon the above factors.

Another salient observation was that the symptoms viz., yellowing and defoliation were expressed only after significant damage caused to the feeder roots, especially during the rainy season, leading to a delay in diagnosing the disease. This could be the reason for the failure in saving the affected vines which are in the advanced stage of disease incidence.

INVESTIGATIONS ON VEIN CLEARING VIRUS OF SMALL CARDAMOM

(M.N.Venugopal)

1.Distribution of disease: New disease affected plantations were located in Coorg, Chickmagalur and North Kanara districts of Karnataka state. The disease incidence in these plantations varied from 0.1 to 78.4 per cent

2.Epidemiology of disease: The pattern of disease outbreak in different plantations suggested the dual pattern of disease spread. Random spread was noticed in newly planted plantations located 1 to 5 km away from the disease affected plantations. Within the infected plantations both centrifugal and random solitary infections were noticed. A steep disease gradient was observed in the plots with higher percentage of disease incidence. The rate of disease spread per unit per year varied from 1.3 to 8.5 per cent in different plantations. Transmission experiments involving banana bunchy top and 'kokke kandu' from cardamom to banana and banana to cardamom through *Pentalonia nigronervosa f. typica.* did not result in positive infection. Repeated experiments conclusively suggested the lack of seed, soil and mechanical transmission.

3.Virus-vector relationships: Studies with Hongadahalla and Sirsi isolates and respective bio-types of aphid vector *Pentalonia nigronervosa f. caladii*, indicated that the virus was acquired within 30 minutes of transmission feeding and persistence of virus in the vector was observed beyond 8 hours of acquisition feeding. In serial transmission also the virus persisted beyond 6 hours with positive transmission in the 3 rd transfer.

4.Yield loss: Growth and yield data collected from infected plants at various stages clearly indicated yield reduction to an extent varying from 62 to 84 per cent in the first year of peak crop due to infection of 'kokke kandu'.

5.Management of the disease: Roguing was found to be effective in eliminating infection in three isolated recently infected test plantations. In the plots with selective rouging the fresh incidence was effectively reduced to 1.5 from 14 per cent initial incidence. In another joint study with ICRI, Saklespur, the feasibility of community approach to contain the disease was initiated with the cooperation of growers at Yadally, Sirsi. So far, the trend indicated that both 'Katte and Kokke kandu' can be effectively minimized by undertaking replanting followed by periodical surveys and roguing of new infections.

RHIZOME ROT OF GINGER AND TURMERIC

(T.G.Nageshwar Rao and G.N.Dake)

Five districts viz.,Calicut, Cannanore, Idukki, Ernakulam and Palghat were surveyed for the incidence of rhizome rot of turmeric. (Table 1.5 and 1.6). The disease incidence ranged from 0 to 10 per cent in the districts surveyed. Pathogenicity test was conducted for *Pythium aphanidermatum, Fusarium* sp, and *Macrophomina phaseolina*.

Table 1.5 Survey for the incidence of rhizome rot of turmeric

District	No. of fields surveyed	Disease incidence(%)
Calicut	12	0-5
Cannanore	14	0-1
Idukki	22	0-5
Ernakulam	08	0-5
Palghat	24	5-10
Total	80	0-10

Table 1.6 Frequency of isolation of organisms associated with rhizome rot of turmeric

Organism	Calicut	Idukki	Palghat	Ernakulam	Cannanore
Pythium sp	21	29	54	15	10
Fusarium sp	35	42	61	18	1
R. bataticola	46	11	22	02	05
R. solani	02	00	00	00	02
Trichoderma sp	08	11	06	06	01
Curvularia sp	00	00	00	00	02
Bacterium	09	12	03	02	06

Positive results were obtained with *Pythium aphanidermatum* and *M. phaseolina. M. phaseolina* took up infection only at low moisture levels. Yellowing and drying were noticed in infected plants. Cross inoculation studies were made with *Pythium* isolates of ginger and turmeric. It was observed that turmeric isolate of *Pythium* could infect ginger also, whereas ginger isolate did not infect turmeric. The taxonomic characters of *Pythium* isolated from turmeric was studied in detail and it has been identified as *Pythium aphanidermatum.*

STUDIES ON BACTERIAL WILT OF GINGER - A GENETIC APPROACH TO *PSEUDOMONAS SOLANACEARUM*

(G. N. Dake and T.G. Nageshwar Rao)

1.Cross inoculation test: Seven isolates of *Pseudomonas solanacearum*, i.e., one isolate each from chilli, ginger, turmeric, tomato, marigold, *Ageratum* and *Chromolaena* spp. were cross inoculated with ginger and turmeric for pathogenicity test. Strains of *P. solanacearum* from ginger, turmeric, tomato and marigold were pathogenic to ginger while strains from chilli, *Ageratum* and *Chromolaena* were non pathogenic to ginger (Table 1.7). In general wilt symptoms varied with host plants and strains of *P. solanacearum*. The symptoms developed on ginger plants 12 days and 17 days after inoculation with isolates from ginger and turmeric respectively. The ginger plants wilted rapidly in response to inoculation with isolates biotypes III and IV, whereas in turmeric the symptoms developed after 45 days.

2.Drug resistant mutants: Drug resistant mutants of *Pseudomonas aeruginosa* to Kanamycin and *P. putida* the prototrophic strain resistant to rifampicin to provide contra - selective marker against the donor were used to generate chromosomal (Tn 5) mutation. On the basis of specific growth requirement, two auxotrophs which required methionine and leucine were identified.

3.Virulence of *P. solanacearum*: The fluidal extracellular-polysaccharides (EPS+) *P. solanacearum* was isolated from naturally infected ginger crop from Pulpally area of Wynad district of Kerala and was identified as *P. solanacearum* biotype III. The log phase cultures of virulent pathogenic strains were stored in sterile distilled water at 40°C for 48 hours in incubator and another set at 4 ° C in refrigerator as control. The cultures exposed to 40°C were restreaked on nutrient sucrose agar (NSA) so as to get discrete single colonies. The well separated afluidal (Eps- colonies of isolates were picked up and stored on yeast glucose carbonate agar (YGCA) slants in sterile distilled water. The fluidal and afluidal strains of *P. solanacearum* were grown in NS broth for toxin extraction keeping one set of NS broth medium without inoculation either with fluidal or afluidal strains of *P. solanacearum.*

The cell free cultures of fluidal, afluidal and uninoculated NS broth were passed through Dowex 50 and I. The elutes were collected and tested for bioassay. The cut shoots of pseudostem immersed in elute collected from fluidal strain showed flaccidity while the pseudostem immersed in the elute collected from afluidal strain and NS broth did not show flaccidity, thereby implying that EPS is virulent factor of *P. solanacearum* (Table 1.8).

Table 1.7 Pathogenicity response of ginger to strains of *Pseudomonas solanacearum* from ginger and other host plants

Bacterial strains	Source plants	Reaction*-
AcPs 1	*Ageratum* sp.	-
CoPs 4	*Chromolaena* sp.	-
CaPs 7	Chilli	-
ClPs 13	Turmeric	+
LePs 16	Tomato	+
TePs 21	Marigold	+
ZoPs 23	Ginger	+
Check	Water	-

* + = With symptom ; - = Without symptom

Table 1.8 Reaction of cut shoots of ginger to crude toxin solution produced by fluidal and afluidal strains of *P. solanacearum*

Elute / toxin collected from	Flaccidity observed after *30 minutes in shoots		
	1	2	3
Fluidal Strain -1 (EPS +)	+	+	+
Fluidal Strain -2 (EPS +)	+	+	+
Afluidal Strain -1 (EPS -)	-	-	-
Afluidal strain -2 (EPS -)	-	-	-
Control (Medium Broth without inoculation	-	-	-

* + = With symptom
- = Without symptom

INVESTIGATIONS ON STUNTED DISEASE OF BLACK PEPPER

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

1.Survey: Survey for the disease incidence in Wynad was continued. In the 12 villages surveyed the disease incidence ranged from 0.6 per cent to 18.6 per cent. In general, incidence was less compared 100 per cent noticed in some gardens in Pulpally area (Table 1.9).

2.Transmission: Infected plant sap showed local lesion in green gram and cowpea. However, sap transmission from pepper to pepper was not successful which needs further testing. Transmission studies with aphids were not successful.

3.ELISA Test: The infected plant sap gave a positive reaction with antisera of cucumber mosaic virus (CMV) strain of banana and groundnut thereby indicating that stunted disease is caused by a strain of CMV.

Table 1.9 Incidence of stunted disease of black pepper in Wynad District

Village	Incidence (%)			Mean (%)
	* a	b	c	
Kalpetta	6	8	6	6.6
Thariyod	6	8	2	5.1
Pozhudana	0	6	0	2.0
Padinjarathara	14	2	4	6.6
Vellamunda	14	0	0	4.6
Nallurnadu	0	0	2	0.6
Pottathara	2	10	6	6.0
Meppadi	12	8	36	18.6
Vaduvanchal	4	10	0	4.6
Ambalavayal	0	4	2	2.0
Nenmeni	30	2	4	12.0
Noolpuzha	6	4	4	4.6

* Clusters surveyed

BIONOMICS OF MAJOR PESTS OF BLACK PEPPER AND EVOLVING INTEGRATED CONTROL MEASURES AGAINST THEM

(S.Devasahayam)

1.Screening of black pepper germplasm Seven wild Piper species were screened for berry damage against 'pollu' beetle in the field and six of them viz., *P. attenuatum, P. barberi, P. chaba, P. colubrinum, P. hymenophyllum* and *P. longum* were resistant (Table 1.10). Laterals of four cultivated accessions (Accession Nos. 816, 841, 1084 and 1114) identified as relatively resistant to 'pollu' beetle in the field were raised and maintained for screening under caged' conditions.

Table 1.10 Screening of wild Piper spp. to berry damage against 'pollu' beetle

Piper species	Percent berries infested
P. attenuatum	Nil
P. barberi	Nil
P. chaba	Nil
P. colubrinum	Nil
P. hymenophyllum	Nil
P. longum	Nil
P. nigrum	19.4
Panniyur-1 *(P. nigrum)*	21.0

2.Studies on antifeedants isolated from wild *Piper* spp:The effect of two promising antifeedant compounds viz., crotepoxide and pipoxide chlorhydrin isolated from *P. attenuatum* (a known resistant species) was tested for their antifeedant activity in various concentrations and combinations against 'pollu' beetle using leaf disc technique and

adopting no choice tests. Antifeedant activity was maximum in crotepoxide (500 ppm) where 44 per cent feeding deterrence was achieved. Various combinations of the compounds did not enhance the antifeedant activity significantly.

3.Evaluation of neem products: Two commercial neem products (Neem Azal and NEM-104), neem leaf extract, neem seed kernel extract and neem oil were evaluated for their antifeedant activity against 'pollu' beetle in laboratory bioassays using leaf disc technique are adopting no choice tests. Among the various products Neem Azal, neem seed kernel extract and neem oil were more effective resulting in 100 per cent feeding deterrence at 3 and 4 per cent concentrations respectively, 24 h after treatment (Table 1.11).

Table 1.11 Effect of neem products on feeding behaviour of 'pollu' beetle (no choice tests)

Product	Percent feeding deterrence	
	90%	100%
Neem Azal	3%	3%
NEM-104	>10%	>10%
Neem leaf extract	4%	5%
Neem seed kernel extract	3%	4%
Neem oil	4%	4%

Values denote concentrations at which 90 and 100 per cent feeding deterrence occurred 24 h after treatment

4.Evaluation of natural products: Leaf extracts of *Piper colubrinum, Chromolaena odoratum* and *Strychnos nux-vomica* were evaluated for their antifeedant activity against 'pollu' beetle in laboratory bioassays using leaf disc technique and adopting no choice tests. Leaf extracts of *C. odoratum* and *S. nuxvomica* were more effective causing 100 per cent feeding deterrence at 3 and 4 per cent concentrations, 24 h after treatment (Table 1.12).

Table 1.12 Effect of plant products on feeding behaviour of 'pollu' beetle (no choice tests)

Product	Percent feeding deterrence	
	90%	100%
Piper colubrinum	>5%	<5%
Chromolaena odoratum	3%	3%
Strychnos nux-vomica	3%	4%

Values denote concentrations at which 90 and 100 per cent feeding deterrence occurred 24 h after treatment.

STUDIES ON COCCIDS INFESTING BLACK PEPPER

(K.M.Abdulla Koya and S.Devasahayam)

1.Distribution of scale insects: Surveys were conducted in 21 locations in Kottayam, Ernakulam and Nilgiris districts to record the incidence of scale insects on black pepper.

The pest infestation was negligible in the former two districts. In Nilgiris district, the percentage of vines infested by *Lepidosaphes piperis* and *Aspidiotus destructor* ranged from 6.7-80.0 and 0.0 - 73.3 respectively, in various location.

2.Mass rearing of scale insects: Several plant materials such as rooted cuttings of black pepper, pumpkin, ashgourd, elephant foot yam, colacasia, potato and orange were evaluated as possible hosts for multiplication of *L. piperis* and *A. destructor.* Development of *L. piperis* was satisfactory on black pepper cuttings alone. *A. destructor* developed satisfactorily on black pepper cuttings and pumpkin.

Table 1.13. Evaluation of insecticides for the control of scale insect on black pepper (combined analysis of two years 1993 & 1994)

Insecticide (0.1%)	Percent mortality		
	15 DAS1	30 DAS1	15 DAS2
Monocrotophos	96.0 (78.4)	99.7 (86.7)	100.0 (90.0)
Phosphamidon	84.3 (66.7)	83.8 (66.2)	91.2 (72.7)
Dimethoate	95.5 (77.8)	99.9 (88.2)	100.0 (90.0)
Dichlorvos	77.5 (61.7)	58.1 (49.7)	66.2 (54.5)
Methyl parathion	84.2 (66.7)	91.9 (73.5)	95.1 (77.3)
Malathion	92.0 (73.6)	99.5 (85.9)	100.0 (90.0)
Control	4.8 (12.7)	2.5 (9.1)	5.7 (4.3)
CD at 5%	7.4	6.1	6.9

DAS_1= Days after first spray
DAS_2= Days after second spray
Figures in parentheses are transformed values

3.Field control: Six insecticides viz., monocrotophos, dimethoate, phosphamidon, malathion, methyl parathion and dichlorvos (0.1% each) were evaluated for their efficacy in controlling *L. piperis* at Kuppadi (Wynad). Two sprays were undertaken at monthly intervals after harvest of the crop. The results indicated that all the insecticides were effective in controlling the pest infestation. At the end of 15 days after second spray, plots treated with monocrotophos, dimethoate and malathion had maximum mortality (100 per cent). Combined analysis of two years (1993 and 1994) data also indicated that spraying of monocrotophos, dimethoate or malathion twice at 30 days interval is more effective in controlling *L. piperis* on black pepper (Table 1.13).

INVESTIGATIONS ON NEMATODES ASSOCIATED WITH GINGER, TURMERIC AND BLACK PEPPER

(K V Ramana)

A survey was conducted in collaboration with Regional Agricultural Research Station, Jagtial (APAU) in major turmeric growing areas of Adilabad, Nizamabad and Karimnagar

districts of Andhra Pradesh. Fifty samples each of soil and rhizomes (Adilabad-10, Nizamabad-20, Karimnagar-20) were collected and processed at Plant Quarantine Regional Station (NBPGR), Hyderabad.

Results indicated that six genera of plant parasitic nematodes viz., *Meloidogyne*, *Rotylenchulus, Hoplolaimus, Criconemoides, Longidorus* and *Pratylenchus* were associated with turmeric crop. The most predominant nematode associated with turmeric was *Meloidogyne* (78%, Population range 2-127/100cc soil) followed by *Rotylenchulus* (64%, Population range 23-215/100 cc soil). Other nematode genera recorded were *Hoplolaimus* (21%), *Criconemoides* (18%), *Longidorus* (16%) and *Pratylenchus* (14%). However, population of these nematodes were low. Survey in ginger growing areas in Kozhikode district indicated association of five genera of plant parasitic nematodes viz., *Meloidogyne, Rotylenchulus, Helicotylenchus, Xiphinema* and *Criconemoides* with the crop.

Meloidogyne sp. was the most predominant species (100%, population range 51-561/ 100 cc soil) found in the rhizosphere of ginger.

A pot culture experiment to assess the damage potential of *M. incognita* in ginger was conducted with five treatments replicated five times in earthen pots of 12" dia filled with sterilized soil mixture @ 10 kg/pot. Seed rhizomes of cultivar 'Maran' @ 20 g/ pot were sown and one month after germination nematodes were inoculated as per the treatments. Four months after inoculation the plants were harvested and observations recorded (Table 1.14).Nematode inoculation caused considerable reduction in the growth parameters in ginger. Plants inoculated with the highest inoculum level i.e., 2.0 nematodes/g soil caused 16.04%, 21.87% and 16.97% reductions in plant height, number of tillers and weight of pseudostems respectively though these reductions were not statistically significant. Root-knot index increased with increase in the inoculum level from 1.2 to 2.8.

Table 1.14 Effect of *M. incognita* on growth of ginger (Means of five replications)

Treatment	Height (cm)	% Reduction	No. of tillers	% Reduction	Weight (g)	% Reduction	Root knot index
Control	62.4		6.4		61.5		0.0
0.5Nematodes/ g soil	61.3	1.79	5.6	12.50	65.9		1.2
1.0 "	56.3	9.83	5.6	12.50	58.9	4.19	2.2
1.5 "	55.7	10.75	4.8	25.00	52.4	14.79	2.8
2.0 "	52.4	16.04	5.0	21.87	51.1	16.97	2.8
CD 0.05%	N.S		N.S		N.S		

Role of M. incognita in rhizome rot complex of ginger

A pot culture experiment to asses the role of *M. incognita* in rhizome rot complex of ginger was conducted. Seed rhizomes of ginger cultivar 'Maran' @ 20 g/pot were sown in pots (12" dia) filled with 10 kg sterilized soil mixture. One month after germination the plants were inoculated with freshly hatched second stage juveniles of *M. incognita* @ 5,000 nematodes/pot as per the treatments. Twenty days after nematode inoculation the plants were inoculated with *Pythium* sp and

Pseudomonas sp as per the treatments. Six replications were maintained per treatment. Incidence of the disease was monitored and the plants were harvested at 2 months after final inoculation. The data are presented in Table 1.15.

Table1.15 Effect of *M. incognita* in the disease incidence (Total of six replications)

Treatment	No. of Tillers (6 plants)				
	Healthy	Diseased	Total	* Onset of the Desease	% of Desease
M.i alone	29	0	29	--	Nil
Py alone	6	21	27	14	77.7
Ps alone	0	26	26	5	100.0
M.i + Ps	10	18	28	14	64.3
M.i + Ps	0	25	25	5	100.0
Py + Ps	0	25	25	6	100.0
M.i + Py + Ps	0	22	22	6	100.0
Control (No pathogens)	37	0	37	--	Nil

* Onset of disease in days from the date of fungal and bacterial inoculations.
M.i = *Meloidogyne incognita*, Py = *Pythium aphanidermatum*, Ps = *Pseudomonas solanacearum*

Results indicated that symptoms of bacterial wilt started appearing from the 5th day after inoculation in plants inoculated with either Pseudomonas alone or in combination with *M incognita* and from 6th day onwards in plants inoculated with bactera in combination with *Pythium* and *Pythium* and nematodes. Symptoms of *Pythium* infestation started appearing from 14th day after inoculation irrespective of nematode presence. Symptoms of bacterial wilt dominated in all the plants where bacteria and fungus were inoculated and in plants inoculated with fungus alone, 77.7% tiller showed infestation of the fungus while in plants inoculated with fungus and nematode 64.3% tillers showed fungal infestation at 2 months after inoculation. Maximum number of tilers (37) were recorded in plants where no pathogens were inoculated followed by in plants inoculated with nematodes alone (29). The results indicate that nematode inoculation prior to fungal/ bacterial inoculation neither enhanced disease incidence nor caused early incidence of the disease caused by *Pseudomonas/Pythium* indicating no positive role of the nematode in the disease complex in ginger. However, the results have to be confirmed further.

INVESTIGATIONS ON PLANT PARASITIC NEMATODES ASSOCIATED WITH CARDAMOM

(Santhosh J. Eapen and M.N. Venugopal)

1.Field evaluation of nematicides and neem oil cake: Field trial using carbofuran, phorate, quinalphos and neem oil cake was continued for the fifth year. As in previous years, phorate,

carbofuran and neem oil cake gave good control of nematodes. Phorate @ 2.5 and 5.0 g a.i./ clump increased the yield of cardamom to 478.4 and 504.8 g/plant (wet weight) respectively, while the untreated control plants yielded only 249.9 g (Table 1.16). Besides, phorate treatment reduced thrips and root grub damage also. Cardamom samples were collected at 2, 4 and 6 weeks after application of the pesticides and were analyzed for pesticide residues. Carbofuran residues were found even at the 4-week interval while no residues could be detected at the same interval, with regard to phorate @ 2.5 g a.i./ plant. *Pythium* population in neem cake amended cardamom soils was found to increase during the post monsoon period. Phorate was applied @ 1 g a.i./m^2 alone and in combination with 0.2% copper oxychloride @ 5 l/m^2, applied thrice, viz., 2-3 leaf stage, rhizome formation stage and tillering stage. Combined application of phorate and copper oxychloride improved the growth of cardamom plants and reduced the incidence of pests and diseases in cardamom nurseries (Table 1.17).

2.Screening of germplasm: Fifteen germplasm accessions were screened for their reaction to root knot nematodes and all were found susceptible.

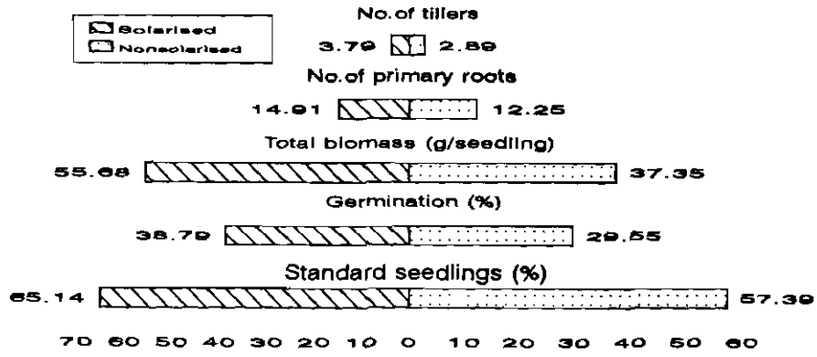
3.Solarization studies: Soil solarization was carried out at two locations (CRC, Appangala and Spices Board, Biligeri) for a period of 45 days, using 400 gauge transparent polyethylene sheets. Observations on germination, growth of plants, incidence of pests and diseases, etc, were recorded and are represented in Fig 1.1 and 1.2. Biocontrol agents and plant protection chemicals were found to perform better in solarized soils.

Table 1.16 Effect of three granular pesticides on growth and yield of cardamom

Treatment	Dosage (g.a.i./plant)	Height (m)	Number of			Yield. wet wt. (g/plant)
			Tillers	Panicles	Capsules	
Carbofuran	2.5	1.92	20.83	14.35	68.4	246.2
	5.0	2.07	24.44	19.35	134.7	409.6
Phorate	2.5	2.29	22.58	17.86	171.6	478.4
	5.0	2.21	22.55	18.50	184.6	504.8
Quinalphos	2.5	1.97	20.58	14.95	100.8	235.6
	5.0	1.85	19.77	13.56	95.8	215.4
Check	-	2.05	20.55	15.11	90.2	249.9
LSD	-	0.18	NS	3.22	41.6	114.9

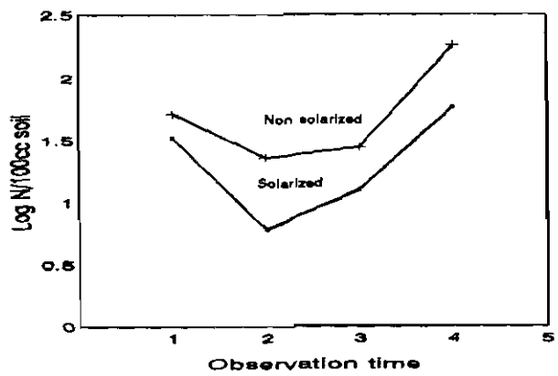
Data are means of four replications combined over three neem oil cake levels

Fig 1.1: Effect of soil solarization on growth and vigour of seedlings



Data are means of 4 replications combined over subplot treatments and 3 trials

Fig 1.2: Effect of soil solarization on plant parasitic nematodes in soil



1- Initial 2- After solarization 3- After germination 4- Final

Table 1.17 Efficacy of phorate and copper oxychloride for management of pests and diseases in cardamom nurseries*.

Treatment	Total biomass (g/plant)	No. of standard seedlings (%)	Incidence of		
			Rhizome rot (%)	Nematodes[a]	Root grubs[b]
Phorate	47.16	60.69 (53.17)	25.53 (30.35)	92.7 (1.967)	0.46
Copper oxychloride	40.66	63.39 (52.77)	25.88 (30.58)	238.9 (2.380)	1.96
Phorate+ copper oxychloride	45.68	62.27 (52.10)	21.31 (27.49)	58.6 (1.768)	0.21
Check	43.29	51.94 (46.11)	45.59 (42.47)	390.7 (2.593)	2.04
LSD	NS	(03.73)	(03.96)	(0.401)	0.77

*Data are means of four replications combined over three trials. Figures in parentheses are transformed values

[a] Final nematode level in one gram of root

[b] Root grub damage based on a 0 - 5 scale

BIOLOGICAL CONTROL OF PESTS AND DISEASES OF SPICES

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

1.Diseases: Field trials using VAM and *Trichoderma* spp and *Gliocladium virens* were taken up against *Phytophthora capsici*, the causal organism of foot rot of black pepper. Two isolates of Trichoderma and one of *Gliocladium* were isolated from cardamom fields mix cropped with arecanut, coffee, cocoa and black pepper. *Gliocladium* was effective in suppressing *Pythium vexans* in dual culture. In a field trial in cardamom, a combination of *Trichoderma* spp and *Paecilomyces lilacinus* effectively reduced rhizome rot incidence by 39 per cent.

2.Insect pests: Three more species of coccinellid beetles were identified to be predaceous on scale insects of black pepper. Mass multiplication of host insects on suitable host materials was being standardized for rearing of natural enemies of scale insects in the laboratory. An unidentified species of nematode and two unidentified species of hymenopterans were recorded as natural enemies of shoot borer. At Peruvannamuzhi, parasitization of larvae by the nematode and hymenopterans was as high as 25.0 and 42 per cent, respectively.

3.Nematodes: ***(a) In vitro* testing:-** Four isolates of *Trichoderma* spp. and an isolate of *Gliocladium* sp. isolated from cardamom fields were tested against root knot nematodes of cardamom in a pot study using sterile soil and native soil. *Trichoderma* sp.(isolate No.4) was

more efficient among all the isolates used in controlling nematodes(54.5 - 59.3 %) as well as improving the growth of seedlings (>30%). All the isolates performed well in native soil than in sterile soil. Generally, all the isolates improved the growth of cardamom seedlings, irrespective of the presence or absence of root knot nematodes.

b) Field testing:- Performance of *Trichoderma* spp. and *Paecilomyces lilacinus* were assessed in cardamom nurseries at Appangala and Biligeri. Incorporation of these biocontrol agents increased the number of quality seedlings and reduced the incidence of nematodes and other diseases like damping off and rhizome rot (Table 1.18).

Table 1.18 Evaluation of *Trichoderma* spp. and *Paecilomyces lilacinus* in cardamom nurseries.

Treatment	Std.seedlings (%)	Rhizome rot (%)	Root knot nematode Final*
Trichoderma spp.	63.16a	29.83a	163.06ab
Paecilomyces lilacinus	60.96a	22.75a	100.62bc
Trichoderma + P.lilacinus	66.43a	21.48a	51.17c
Check	51.94b	42.47b	390.74d

Means followed by the same letter are not significantly different at 5% level
Data are means of four replications combined over three trials.
*Root knot nematode population in one gram root.

ISOLATION AND IDENTIFICATION OF NATURALLYOCCURRING COMPOUNDS AGAINST MAJOR PESTS AND PATHOGENS OF BLACK PEPPER

(N K Leela)

The aqueous leaf extracts of *Azadirachta indica, Lantana camara, Strychnos nuxvomica* and *Chromolaena odorata* were tested in vitro for toxic effect on *Phytophthora capsici.* Extracts from *C. odorata* and *A. indica* showed significant inhibition of mycelial growth at 2 per cent, even after 5 days of incubation. Extracts from *C. odorata, A. indica* and *S. nuxvomica* completely prevented sporulation even at 0.25 per cent. One hundred per cent inhibition of zoospore release and germination were observed with 1 per cent extract of *A. indica,* where as with *C.odorata* corresponding concentrations were 2 per cent and 0.25 per cent respectively. Leaf extracts of *S. nuxvomica, A. indica, L. camara* and Allspice were screened *in vitro* for nematicidal activity against the second stage juveniles of *M. incognita.* Except *L. camara,* all of therm showed significant nematicidal activity at 1 per cent, after 48 hours of incubation. One of the nematicidal principles in Allspice leaf oil was identified as eugenol by G.C. analysis followed by the bioassay of the authentic sample.

For the isolation of fungitoxic principles in *P. colubrinum,* the aqueous extract was partitioned with petroleum ether followed by column chromatography on alumina and subsequent elution with Methanol-water mixture of increasing polarity yielded five fractions. Although inhibition of myceilial growth was observed with all the five fractions, one of them showed max inhibition (86%). These fractions will be further purified to isolate the active principle.

MULTILOCATION PROJECT ON RHIZOME ROT OF GINGER (ICAR CESS FUND PROJECT 1991-94)

(Y.R. Sarma)

Summary

Investigations carried out clearly brought out that *Pythium aphanidermatum* is the predominant pathogen in Kerala causing rhizome rot of ginger. Soil solarization and biocontrol agents were found effective in disease suppression. The survey carried out in Calicut, Cannanore, Ernakulam, Kottayam, Idukki and Wynad districts showed varying degrees of disease incidence in Wynad district, bacterial wilt caused by *P. solanacearum* either alone or in combination with *P. aphanidermatum* was noticed. Dry rot caused by *M. phaseolina* and *B. theobromae* was also noticed. Nematode infection caused by M. incognita did not show any increase in rhizome rot or bacterial wilt. The disease incidence started during July and was maximum by October. Disease management trials conducted in *Pythium* sick soil showed that soil solarization showed enhanced suppression of weed growth and disease incidence and increased yield. Among the biocontrol agents *Trichoderma* spp. and *Gliocladium virens* was isolated and studied for their *in vitro* activities. Their mode of action as hyperparasites or through their production of volatile and non-volatile antibiotics was studied.

Effect of soil application of *T. viride, T. harzianum, T. hamatum* and *G. virens* was found to be effective in suppressing disease and increase yield. Their suppressive effects were more conspicuous when combined with soil solarizatioin conditions. The fungicides Dithane M-45, Ridomil MZ, Captafol application both as seed treatment and as soil application were found superior to control in disease suppression. However, they were not statistically significant.

High degree of host resistance to both rhizome rot and bacterial wilt were not located in any of the germplasm accessions screened so far. However, a low variability for disease resistance was noticed. The studies clearly brought out the potential of soil solarization and biocontrol agents in disease suppression of rhizome rot of ginger. Soil solarization combined with biocontrol agents conspicuously reduced rhizome rot.

MINI MISSION II : DEVELOPING AGROTECHNIQUES FOR INCREASING PRODUCTION OF SPICE CROPS

STUDIES ON THE IMPACT OF INPUT TECHNOLOGY ON THE YIELD PERFORMANCE AND QUALITY ATTRIBUTES OF BLACK PEPPER

(K. Sivaraman, A.K. Sadanandan, C.K. Thankamani and K. Kandiannan)

1.NPK Experiment: Experiment was initiated during 1987 to study the effect of fertilizer on black pepper. Twenty one treatments consisting of 4 levels of N, 4 levels

of K and two levels each of Ca and Mg, along with control (No fertilizer) were laid out in RBD with three replications. Yield recorded from third year onwards and cumulative yield presented in Table 2.1. Application of 200 g N + 280 g K_2O/vine/year in two equal splits (one at June and second at September) recorded maximum cumulative yield of 12.117 kg/vine whereas control gave only 2.680 kg/vine The response to Ca and Mg was not apparent

TABLE 2.1 Cumulative (1990-91 - 1993-94) green pepper yield (kg/vine)

Nutrients					Cumulative yield
N	P_2O_5	K_2O	Ca	Mg	(kg/vine)
50	60	70	0	0	3.308
50	60	140	0	0	3.749
50	60	210	0	0	4.903
50	60	280	0	0	5.339
100	60	70	0	0	5.617
100	60	40	0	0	6.761
100	60	210	0	0	6.489
100	60	280	0	0	6.128
150	60	70	0	0	7.554
150	60	140	0	0	7.681
150	60	210	0	0	8.824
150	60	280	0	0	8.448
200	60	70	0	0	9.495
200	60	140	0	0	1.0186
200	60	210	0	0	10.656
200	60	280	0	0	12.117
0	0	0	0	0	2.680
0	60	0	0	0	2.955
50	60	140	50	0	4.551
50	60	140	50	50	4.336
50	60	140	0	50	4.016
$CD_{(0.05)}$					1.047

2.Critical Nutrient Indexing: Two hundred yielding black pepper vines were selected at Pulpally, Wynad district, Kerala. Leaf and soil samples were collected and analyzed for major and minor nutrients and study is in progress.

3.Irrigation Experiment: Experiment on irrigation requirement of black pepper was initiated during 1988 and modified during 1993 as per staff research council suggestions with following treatments.

Treatments:

A. Irrigation method

Irrigation at IW/CPE ratio

1. 0.9
2. 0.6
3. 0.3
4. Drip irrigation @ 7 lit/day/vine*

5. Unirrigated control

B. Duration

1. October to March
2. October to April
3. October to May

Note: * Drip irrigation depending upon evaporation.

STUDIES ON EFFECT OF ORGANIC NUTRITION AND SECONDARY NUTRIENTS ON ESTABLISHMENT, GROWTH AND YIELD OF BLACK PEPPER

(M. Gopalakrishnan Nair, K.Sivaraman, C.K.Thankamani, M. Anandaraj and K.V. Ramana)

An observation trial was initiated during 1993 with a view to study the effect of organic nutrition and secondary nutrients on black pepper. There are 16 treatments formulated by combining the following factors.

1. P_0 . No plant protection
2. P_1 . Plant protection (30 g phorate/vine + Ridomil 2.5 g/lit)
3. M_1 - Organic Manure - 30 kg Cowdung/vine
4. M_2 - Inorganic fertilizer (100:40:140 g N, P2O5, K2O/Vine/year)
5. Ca_O . No Calcium
6. Ca_1 . 900 g Ca/vine/year
7. Mg_0 . No Magnesium
8. Mg_1 . 300 g Mg/vine/year

The treatment imposed on each two healthy and diseased vines of Karimunda variety trailed on concrete posts. Pre-treatment and post-treatment scoring for yellowing and defoliation were recorded. There was apparent reduction in yellowing and defoliation due to application of organics with calcium and magnesium. This needs to be studied in detail for confirmation.

INVESTIGATIONS ON SPICES BASED CROPPING SYSTEMS

(V S Korikanthimath and K.Sivaraman)

A field experiment was laid out with eight crop combinations (Table-2.2) at NRCS, Cardamom Research Centre, Appangala during September, 1991, with each crop combination in an area of 0.1 ha. The objectives are to study crop compatibility, optimum utilization of natural resources like solar radiation, water and nutrients, organic recycling of crop residues, impact of crop combination on beneficial soil micro organisms, generating conducive micro climate and economic analysis of various crop combinations. During the year recorded observations on solar radiation on land and aerial space and related micro climatic parameters. Microbial load in the root region of component crops and the growth characters of component crops were also recorded.

1.Photosynthetically active radiation (PAR): The PAR recorded in the sole crop of cardamom was the highest (1192.28 μ mol/m2/sec) followed by the component crop viz., Nutmeg (579.5), clove (513.8), cinnamon (282.77), allspice (282.77) and pepper (112.85). The sole crop of coffee recorded the PAR of 407.80 μ mol/m2/sec as against 376.50 in case of coffee mix cropped with cardamom.

2.Temperature: Temperature outside(TA): Amongst the sole crops, coffee recorded the maximum temperature of 33.48 °C followed by Cardamom (31.11°C). Amongst the component crops pepper recorded the lowest temperature of 30.87°C as it is covered both by the canopy of permanent live standard *Erythrina lithosperma* and overhead shade of forest trees. Leaf temperature was highest in case of sole crop of coffee followed by sole crop of cardamom (32.30°C). Amongst the mixed crops, pepper recorded the lowest leaf temperature of 29.51°C.

3.Transpiration: Among the main crops, transpiration was highest in coffee (3.40 µmol $H_2O/m^2/sec$, followed by cardamom (2.24). In case of component crops, cinnamon had the highest transpiration (3.66 µmol $H_2O/m^2/sec$) and it was lowest (1.76) in allspice.

4.Stomatal Conductance: Stomatal conductance was maximum in case of sole crop of coffee (0.098 µmol/m^2/sec) as against 0.058 in cardamom. Among the component crops, cinnamon recorded the highest stomatal conductance (0.131 µmol/m^2/sec).

5.Photosynthesis: Amongst the sole crop, coffee recorded highest net photosynthesis (2.38 µmol $CO_2/m^2/sec$) followed by cardamom (1.90). Among component crops, cinnamon corded the highest net photosynthesis (3.51)

6.Intercellular CO_2 Concentration: Sole crop of coffee recorded the highest values (243.40 µmol/m^2/sec) followed by cardamom (180). Among the component crops, allspice, recorded the lowest value (173.27).

7.Water use efficiency: Among the sole crops, cardamom had highest water use efficiency (0.848) followed by sole coffee (0.700). The component spice crops had the maximum water use efficiency (average 0.743) and the highest value was obtained in case of allspice (1.017).

II.MICROBIAL POPULATION

Soil samples in the root region of both the sole crops and component crops were collected and analyzed for the microbial population of bacteria, fungi, Actinomycetes, N2 fixers and phosphate solubilizers (Table 2.4).

1.Bacteria (X 10^5): Population of bacteria was the highest (18.35) in case of cardamom mix cropped with various component crops followed by sole crop of cardamom (16.0) and control i.e.,, no cultivation (7.0). The root region of pepper recorded the maximum bacteria (16.5) as against average (9.7) of all component crops.

2.Fungi (X 10^3): The population of fungi was the highest (34.88) in case of cardamom mix cropped with various component crops followed by sole crop of cardamom (31.0) and control (7.5). The root region of clove recorded the maximum fungi population (48.0) as against the average of all the component crops (28.10).

3.Actinomycetes (X 10^6): The microbial population of actinomycetes was highest (2.01) in case of root region of cardamom mix cropped with various component crops, followed by sole crop of cardamom (2.00) and control (0.30). Amongst the component crops, root region of nutmeg and allspice, recorded the maximum population of actinomycetes (1.4) as against the average of all the component crops (1.06) put together.

4.N_2 fixers (X 10^4): The microbial population of N2 fixers was highest (14.16) in case of the root region of cardamom mix cropped with various component crops, followed by sole crop of cardamom (10.80) and control (4.30). Amongst the component crops root region of nutmeg recorded the highest population (12.4) of N2 fixers as against the average of all the component crops put together (7.71).

Table 2.2 Cardamom based cropping systems

Crop combination	Spacing		No. of plant/ha	
	Main crop (Cardamom)	Component crop	Main crop (Cardamom)	Component crop
Cardamom + Nutmeg	1.8 x 1.8 m	9.0 x 9.0 m	2963	123
Cardamom + Clove	1.8 x 1.8 m	7.2 x 7.2 m	2893	193
Cardamom + Allspice	1.8 x 1.8 m	7.2 x 7.2 m	2893	193
Cardamom + Cinnamon	1.8 x 1.8 m	3.6 x 3.6 m	2315	771
Cardamom + Pepper	1.8 x 1.8 m	3.6 x 3.6 m	2315	771
Cardamom + Coffee	3.6 x 1.8 m	3.6 x 1.8 m	1543	1543
Cofee alone (Sole crop)	-	1.8 x 1.8 m	-	3086
Cardamom alone (sole crop)	1.8 x 1.8 m	-	3086	-

Table 2.3 Micro climate in the cropping system

Crop combination	Humidity outside	PAR µmol/m²/ sec	Temp. outside °C	Transpn µmol/ H_2O/m²/sec	Leaf temp °C	Stomatal conductance µmol/m²/sec	Photosy nthetic rate
Cardamom + Nutmeg	16.16	579.50	32.38	2.68	32.26	0.076	1.58
Cardamom + Clove	11.00	513.80	31.76	2.36	31.61	0.066	2.21
Cardamom + Allspice	8.40	279.20	31.10	1.76	30.76	0.049	1.790
Cardamom + Cinnamon	17.00	282.77	31.33	3.66	28.96	0.131	3.51
Cardamom + Pepper	16.00	112.85	30.87	3.40	29.51	0.121	1.60
Cardamom + Coffee	11.63	376.50	31.99	2.49	31.55	0.070	1.441
Average of component crops	13.36	357.43	31.57	2.72	30.77	0.085	2.021
Cardamom alone	20.86	1192.28	31.17	2.24	32.30	0.058	1.90
Coffee alone	13.80	407.80	33.48	3.40	32.680	0.098	2.38

5.Phosphate solubilizers: The microbial population of phosphate solubilizing bacteria and fungi in the root region of sole crop of cardamom and component crops were analyzed.

i) Bacteria (X 10^4): The microbial population of P solubilizing bacteria was highest (8.0) in the root region of sole crop of cardamom as against the least population in control (1.70). The average of P solubilizing bacteria population in the root region of component crops was (5.65). Amongst the component crops the root region of clove recorded the maximum P solubilizing bacteria (6.0) as against the average of 5.38 of the component crops.

ii)Fungi (X 10^4): The microbial population of P solubilizing fungi was the highest (2.00) in case of cardamom as against the sole crop of cardamom (0.70) and control (0.00). Amongst the crops, clove recorded the highest microbial population of P solubilizing fungi (1.38) as against the average of 0.87 in case of all the component crops put together. The above study clearly shows that the microbial population in the root region of cardamom mix cropped with component crops can be enhanced as against the sole crop of cardamom and control (no cultivation).

III.LEAF NUTRIENT CONTENTS

The physiologically matured leaves both from the main crop of cardamom and component crops were collected and analyzed for nutrient contents. The leaf nitrogen content of main crop of cardamom was 3.5%. Amongst the component crops pepper recorded the highest nitrogen content (4.3%) and the lowest N content of 2.2% was observed in allspice. In case of leaf phosphorous, sole crop of cardamom recorded 0.53%. Amongst the component crops, coffee recorded the highest leaf P content of 0.53% and the lowest was found in the leaves of clove (0.45%).

1.Growth characters: The growth characters of both the main crop of cardamom and the component crops were recorded and the average was worked out.

i)Cardamom: The average height of cardamom was 224.98 cm. Out of the total number of tillers of 44.76 per clump, 30.53 were bearing tillers and 14.23 were non bearing tillers respectively. The cardamom clumps could record an average of 51.46 panicles/plant. The length of panicles was 56.30 cm. The number of nodes was 17.90 per panicle.

2.Yield of cardamom: A promising maiden average cardamom yield of 0.339 kg dry cardamom yield per clump and 870 kg/ha was recorded during the second year (30 months of planting). The moderate yield of coffee was also recorded. The component crops viz tree spices, (Nutmeg, clove, allspice and cinnamon) and pepper are yet to commence the bearing.

NUTRIENT REQUIREMENT OF IMPROVED VARIETIES OF SPICE CROPS

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

1.Nutritional requirement of pepper cv. Sreekara and Subhakara trailed on living and non-living standards: Experiment was initiated in 1992 with the objective of determining the fertilizer and micro-nutrient requirement of two released pepper cultivars. There were six fertilizer treatment including micro nutrients laid out in a split plot design replicated four times. There were 95 and 90% survival for Sreekara and Subhakara respectively. Studies are in progress.

2.Long term effect of fertilization on

black pepper: The NPK field experiment laid out in 1979 was retained to study the soil and nutrient changes due to fertilization for 15 years. Continuous fertilization decreased soil pH, increased N application increased molybdenum status and decreased Al content in pepper leaf. Increased P application decreased Zn status in leaf. Positive interaction of N x P, and N X K were also observed.

3.Nutrient requirement of bush pepper (Inorganic fertilization): The experiment initiated during 1991, as pot culture experiment, was continued with the objective to determine the nutritional requirement of bush pepper. There were four treatments viz. three levels of NPK and a control replicated four times using two varieties viz. Panniyur-1 and Karimunda. Application of NPK @ 1.0, 0.5, 2.0 g/pot (30 cm diameter with 10 kg soil) at bimonthly intervals gave highest number of spikes laterals, berry volume and yield (365 g). The increased levels of NPK fertilization increased both soil and leaf status of nutrients, in both the varieties

4.Nutrition requirement of bush pepper (Organic farming): The study initiated in 1991 with the objective of finding out the effect of application of organic manures on black pepper production using Panniyur 1 and Karimunda as test varieties was continued. There were seven treatments (viz. Five organic cakes compared with one inorganic fertilizer and a check) replicated three times. Application of organic oil cakes equivalent to the nutrient level of N, P, K. @ 1.0, 0.5, 2.0 g/plot significantly increased leaf nutrient status, spiking intensity and yield of pepper. Among the treatments groundnut cake was superior. This was followed by cotton cakes . The B/C ratio was 1.0, 3.1 and 3.3 respectively for check, fertilizer and ground nut cake.

5.Nutritional requirement of turmeric genotypes (inorganic fertilization): A field experiment was laid out in 1993 to study the nutritional requirement of improved varieties of turmeric. There were four genotypes viz. Suvarna, Suguna, Sudarshana, and Alleppey and seven treatments, comprising NPK fertilizers each at 3 levels and micronutrients (Mn, Zn, B and Mo) each at two levels as soil application and also one treatment as foliar application. Studies showed that among the genotypes, the maximum dry yield (5663 kg/ha/ha) curcumin recovery (401 kg/ha) and nutrient uptake were registered by turmeric cv Alleppey. This was followed by Sudarshana (yield 4945 kg/ha curcumin recovery 282 kg/ha) then Suguna (yield 4503 kg/ha and curcumin recovery 245 kg/ha) and the least by Suvarna (yield 3801 kg/ha) and curcumin recovery 147 kg/ha). Among treatments application of NPK @ 60, 50, 120 kg/ha was economical

6.Turmeric organic farming: A field experiment was laid out with the objectives to study effects of organic farming on the nutrition and quality of improved turmeric genotypes. The genotypes of turmeric tested were Suvarna, Suguna, Sudarshana and Alleppey. Studies showed that application of organic cakes increased the availability of soil available micro nutrients compared to application of fertilizer alone. Among the varieties maximum yield was registered by Alleppey (4925 kg). This was followed by Sudarshana (4708 kg) then Suguna (4565 kg) and Suvarna (3381 kg). Curcumin recovery was maximum for Alleppey (358 kg/ha). This was followed by Sudharshana (266 kg/ha), Suguna (359 kg/ha) and the least was from Suvarna (134 kg/ha). Among the treatments groundnut cakes applied plot continued to register highest B/C ratio (1.57) after fertilizer (1.66).

7.Ginger (organic farming): A field experiment was laid out to study the effect of application of organic cakes on ginger nutrition, yield and quality, There were nine treatments which includes six organic sources one inorganic NPK fertilizer with and without micronutrients and a check. There were five replications. Among the treatments

cotton cake applied plot registered highest fresh yield(20.38 t/ha) followed by Neem cake (19.73 t/ha). Application of organic cakes, fertilizer and FYM had significantly increased the nutrient uptake, yield and oleoresin recovery. The maximum B/C ratio 1.53 was registered by Fertilizer @ 75, 50, 50 Kg NPK/ha .

8. Deficiency symptoms in spice crops: An experiment was initiated to study the nutrient deficiency symptom of pepper, ginger, turmeric, clove and nutmeg using quartz sand and Hoagland solution. It was found that Nitrogen deficiency is characterized by foliar yellowing and stunted growth. Phosphorous deficiency was characterised by dark green to purple yellow leaves with stunted growth and final death of plant. Potash deficiency was characterized by drying of tips and margins of the leaves which finally dried away especially in older leaves. The Ca deficiency was characterized by production of necrotic areas near the tips and margin of upper leaves followed by drying of the whole plants. The Mg deficiency was characterized by interveinal chlorosis of mature leaves at starting which then spread to younger leaves. The S deficiency was indicated by chlorosis of young leaves, shedding of leaves and death of plants.

9.Nutritional diagnosis in black pepper using DRIS: The leaf analysis and yield data of pepper vines from major pepper growing areas of Kerala and Karnataka were used for the above study consisting of a population of 578 vines. Nutritional norms were worked out. It was found that if optimum nutrition maintained the expected yield would be 4400 g/vine/year. The optimum nutrient arrived from this population is 2.2, 0.11, 2.02, 2.67, 0.22 and 0.21% respectively for N, P, K, Ca, Mg and S. Regarding micronutrients the status were 329, 467, 29 and 290 ppm for Fe, Mn, Zn and Cu, respectively.

MINI MISSION III: INCREASING PRODUCTIVITY OF SPICE CROPS THROUGH CROP IMPROVEMENT

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF BLACK PEPPER GERMPLASM

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

Collection survey undertaken in Cannanore district, helped to assemble 39 cultivated black pepper types. Surveys in other regions of Kerala, Karnataka and Tamil Nadu resulted in gathering 10 cultivated types. Sixteen species of Eastern Ghat origin were collected from Kolli and Shevaroy hills of Tamil Nadu. Wild *Piper nigrum, P. sugandhi, P. galeatum, P. trichostachyon* and *P. mullesua* and other unidentified species totalling 27 accessions were collected from the forest areas in Idukki, Wynad and Nilgiris. Twenty two accessions of long pepper types cultivated in the hilly areas of Araku valley, Paderu and Chintappally in Vishakapatnam district in Andhra Pradesh were collected and added to the germplasm. The tribals use them for the stem and roots that marketed locally for medicinal use. Morphological observations including the reproductive characteristics of 25 accessions of black pepper were recorded.

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF CARDAMOM GERMPLASM

(Regy Luckose)

The germplasm maintained in the centre consists of 232 accessions of small cardamom and 10 species of related genera. Growth characters viz., tillers/plant, yielding tillers/plant, height of the tallest tiller, length and breadth of the median leaf, leaves/ plant, panicles/plant and yield were recorded in Wynad collections. No significant difference were found between the treatments in any of the characters.

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF GERMPLASM OF GINGER AND TURMERIC

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

1.Germplasm collection, conservation and cataloguing: Five hundred and sixty six accessions of turmeric and three hundred seventy three accessions of ginger and seven accessions of *Kaempferia galanga* were maintained. Hundred and twenty new accessions of turmeric, 28 accessions of ginger and 2 accessions of *Kaempferia galanga* were collected during the year. Cataloguing of 80 new accessions of turmeric was completed. Yield, dry recovery and rhizome characters of other 100 accessions of turmeric were recorded for cataloguing. Morphological features of about 500 turmeric accessions were also recorded for distinguishing morphotypes / species.

2.High curcumin varieties: Nine cultivars reported to be having high curcumin content viz., Mananthody, Sugandham, CII 328 Sugandham, Wynad Local, Aizwal, Edapalayam, Erattupetta, Palappally and Thodupuzha were evaluated for yield and dry recovery in replicated trials at Peruvannamuzhi. Differences among the cultivars were not significant for fresh rhizome yield / 3 m^2 bed. However, fresh rhizome yield / 3 m^2 bed ranged from 12.5 (Mananthody) to 15.5 kg (Wynad Local). The dry recovery of these cultivars varied from 15.5 (Wynad Local) to 18.2% (Aizwal).

3.North Eastern Collection: Twenty one turmeric accessions collected from North East India during 1990 were evaluated for fresh yield and dry recovery in a replicated trial at Peruvannamuzhi. Differences among these accessions were significant for fresh rhizome yield / 3 m^2 bed. Acc.313 recorded maximum fresh rhizome yield / bed followed by Acc.329. However, highest dry recovery was observed in Acc.295. Table 3.1 gives the fresh rhizome yield /3 m^2 bed and dry recovery of these accessions.

4.Open pollinated progenies: Seven selections from open pollinated progenies of turmeric along with 4 controls were evaluated at NRCS farm Peruvannamuzhi and farmer s plot at Muvattupuzha for yield and driage for the 3rd consecutive year. The same set of progenies and control along with the local control (PTS-10) was also evaluated at Coimbatore (Farmer s plot). Significant differences were observed for mean fresh rhizome yield both at Peruvannamuzhi and Muvattupuzha. At Coimbatore the yield varied from 10.83 (Suguna) to 26 kg(Acc.366). The control PCT-14 ranked first in both the locations followed by Acc.358 at Muvattupuzha and Acc.364 at Peruvannamuzhi. However, Acc. 367 had highest dry recovery at Peruvannamuzhi while PCT-8 registered maximum dry recovery at Muvattupuzha (Table 3.3). At Coimbatore Acc.366 out yielded the local ruling variety (PTS-10) Highest dry recovery was recorded in Suvarna(22.4%) followed by Acc. 360 (Table 3.2).

Table 3.1 Mean yield/bed and dry recovery of N.E. collections of turmeric germplasm

Acc. No.	Fresh yield Kg 3m² / bed	Dry recovery (%)
305	17.50	18.5
297	16.33	16.0
316	15.33	17.5
325	13.67	20.0
329	21.00	16.0
322	18.00	18.8
303	13.50	20.0
319	17.33	17.0
318	15.00	21.0
327	17.00	20.0
313	25.67	12.0
330	13.84	19.5
312	14.67	16.5
290	18.67	17.5
335	14.33	19.5
295	12.00	22.0
289	14.67	19.8
308	15.00	19.8
311	17.67	15.5
321	8.67	12.5
326	12.67	18.5
CD (P=0.05)	1.77	
CV%	17.93	

Table 3.2 Yield and dry recovery of selected turmeric progenies and contorl at three locations.

Acc. No.	Mean fresh yield (kg / 3m² bed)			Dry recovery (%)		
	P.muzhi	M.puzha	Coimbatore	P.muzhi	M.puzha	Coimbatore
366	18.50	16.05	26.00	12.5	10.0	17.5
364	18.67	22.9	20.00	10.0	10.1	17.0
363	16.30	22.3	16.00	10.0	10.0	19.0
360	11.90	11.43	22.33	17.5	16.2	22.2
367	10.50	14.77	19.83	21.5	17.0	24.0
361	15.88	14.30	24.50	15.0	13.2	18.0
358	18.50	25.63	16.83	10.0	10.0	15.7
Suguna	11.70	15.65	19.50	20.0	18.0	17.0
Suvarana	17.47	23.27	10.83	10.0	10.0	22.7
Sudarshana	22.00	26.17	13.50	9.8	10.0	14.0
352(Aleppy)	--	26.5	22.17	--	--	20.5
Roma	--	--	24.83	--	--	20.5
			--	--	--	--
CD (P=0.05)	2.57	3.21	--	--	--	--
CV%	18.4	19.8				

5.Ginger - New yield trial: Twenty three selected accessions of ginger were evaluated for fresh yield and dry recovery for the 2nd consecutive year in a replicated trial at Peruvannamuzhi. The entries differed significantly for fresh rhizome yield / 3m² bed. Maximum fresh rhizome yield/bed was obtained from the accession 71(11.5 kg). However, accession No.238 had maximum dry recovery of 22 %). Mean yield data and dry recovery of the entries are presented in Table 3.3.

6. Yield evaluation of 11 selected accessions and 4 controls (15 entries): A replicated yield trial with 15 entries of ginger was laid out at NRCS farm Peruvannamuzhi and Muvattupuzha for the 3rd consecutive year(Table 3.5). Differences among the entries were significant at both the locations. Acc. 64 ranked first at Peruvannamuzhi and second at Muvattupuzha. Dry recovery of Acc. 64 was 20 per cent at Muvattupuzha and 17.5 per cent at Peruvannamuzhi (Table 3.3).

7. Multiplication and evaluation of primitive land race from forests. (Sabarimala Ginger):This Collection was multiplied and compared its performance with cultivar Maran (Table 3.4) Sabarimala Ginger is characterized by unusually small rhizome, small leaves, more tillers and small plant type.

Based on the cumulative yield data for the last 3 years the ginger accession 64 is being proposed for release. This will be the first ginger variety bred in Kerala and also the first ginger variety of NRCS, Calicut. The salient features of this accessions are given in Table 3.6.

Based on the cumulative yield of curcumin/ ha the O.P progeny accession of turmeric viz. Acc.360 is also being proposed for release. This will be the first turmeric variety developed through recombination breeding. The Acc.366, another O.P progeny which has out yielded the local ruling variety PTS-10 at Coimbatore may also be considered for releasing for Tamil Nadu. Salient feature of Acc.360 are given in Table 3.7.

Table 3.3 Mean yield data and dry recovery of ginger accessions

Accession No	Fresh Yield (kg / 3m² bed)	Dry recovery (%)
238	8.83	22.0
233	8.17	16.5
193	8.00	18.5
295	9.67	18.0
61	10.50	17.5
231	9.33	20.0
71	11.50	11.0
98	9.83	9.8
78	10.67	16.5
110	10.17	15.0
2	9.84	2.0
226	9.17	19.8
49	11.17	16.0
117	11.17	20.0
215	10.17	19.0
179	10.67	18.0
74	9.67	19.0
210	10.33	17.0
73	10.33	16.0
50	8.00	19.0
293	8.83	21.0
101	10.17	21.5
106		17.0
$CD_{(P=0.05)}$	0.62	
CV%	10.56	

Table 3.4 Salient features of Sabarimala ginger and control

Characters	Sabarimala Ginger	Maran (Control)
Plant height (cm)	45.58	67.70
Tiller No.	11.20	8.20
Leaf No.	19.60	22.52
Leaf length (cm)	24.68	26.62
Leaf width (")	2.58	2.96
Days to maturity	198.00	210.00
Fresh yield (kg/3m^2 bed)	5.00	9.70
Dry recovery (%)	19.00	20.00

Table 3.5 Yield and dry recovery and quality of ginger cultivars/accessions at two locations

Entries	Mean fresh yield/bed (3m^2)		Dry recovery (%)		Quality (Peruvannamuzhi)		
	P.muzhi	M. Puzha	P. muzhi	M. puzha	E.Oil(%)	Oleoresin (%)	Crude fibre (%)
51	11.00	9.40	17.0	19.8	2.1	6.8	5.7
64	14.67	11.23	17.5	20.0	1.9	6.0	5.4
141	10.83	10.77	20.0	17.5	1.9	6.5	4.0
251	10.00	10.33	15.5	14.5	2.4	9.0	6.6
222	9.17	9.28	22.0	21.0	2.0	7.0	3.9
63	10.67	9.89	16.0	14.5	2.3	7.0	4.9
151	10.33	9.50	15.0	16.0	2.0	7.0	6.0
53	12.33	10.27	17.0	15.0	2.5	9.9	5.1
11	10.67	9.53	17.5	15.5	2.0	7.0	4.0
249	12.00	10.33	20.0	19.0	2.4	9.0	3.5
65	10.33	8.63	18.0	15.5	2.7	8.0	5.3
H.P.local	11.17	9.50	17.5	21.0	1.2	5.8	8.5
Suprabha	9.17	9.15	16.0	15.9	1.9	6.3	4.4
Maran M.puzha local	9.67	12.15	20.0	19.0	2.0	7.5	6.1
	10.80	9.60	18.0	17.0	1.9	5.9	--
CD(P= 0.05)	0.97	0.68	--	--	--	--	--
CV%	11.90	9.17	--	--	--	--	--

Table 3.6 Salient features of Acc.64 (New ginger variety in pipeline) (Mean of three yeras and two locations)

Identity	Pedigree	Releasing from	Fresh yield (kg/ha)	Dry recovery (%)	E. Oil(%)	Oleo resin (%)	Crude fibre(%)
Acc.64 Germplasm collected from North-East India)	Germplasm selection	NRCS, Calicut	27080	19.9	1.9	6	**4.0**

Table 3.7 Salient features of new turmeric variety being released (Acc.360)

Identity	Pedigree	Releasing from	Fresh yield (kg/ha) *	Curcumin (%)	Curcumin kg/ha	(%)increase to curcumin/ha over the best control
Acc.360	O.P. Progeny selection	NRCS Calicut	37452.0	7.0	587.7	53.29

Computed from 3 m^2 /bed @ 2000 beds/ha.

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF GERMPLASM IN TREE SPICES

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

1.Collection and conservation: A total of 22 *Cinnamomum verum* types, 4 wild cinnamon types, 5 *C. camphora* types, 42 *Myristica fragrans* types, 5 wild nutmeg types and 4 *Syzygium aromaticum* types were collected and added to the germplasm after surveying Shevroy and Kolli hills of the Eastern Ghats and Ratnagiri, Kodagu, Wynad, Calicut, Ernakulam and Kottayam districts of the Western Ghats. Among the 42 nutmeg collections, the most important ones are as follows:

i) Three types of 150 years old from Palai region of Kottayam district, ii) One "Intersex" type from Shevroy hills (Yercaud), producing around 5000 fruits/year; the tree is of 30 years old; it had a lot of male and female flowers in the same inflorescence and iii) Twenty one elite types and four double nut types. The genetic resources of tree spices being conserved in the germplasm conservatory are given in Table 3.8.

2.Conservation of Cassia cinnamon: Air layering was found to be successful in Cassia Cinnamon. (*Cinnamomum aromaticum*). Hence conservation and multiplication of this important type are easy.

3.Field planting of germplasm: Twenty five elite nutmeg lines were field planted with arecanut as the intercrop. Close leaved clove types along with normal clove types were field planted at the NRCS Cardamom Research Centre, Appangala.

Table 3.8 Genetic Resources of tree spices

Sl. No	Crop	No. of accessions			
		Exotic	Cultivated	Wild and related	Total
1.	Cinnamon and Cassia	14	188	44	246
2.	Nutmeg	Nil	398	17	415
3.	Clove	2	202	1	205
4.	Allspice	Nil	135	--	135

4.Germplasm maintenance: Tree spices germplasm materials in Peruvannamuzhi, Chelavoor and Appangala were properly maintained. The live herbarium of tree spices was extended to the cement tubs.

5.Multilocation trials: The multilocation trials on elite tree spices, at Pechiparai ,Yercaud and Ambalavayal under the All India Coordinated Research Project on Spices (AICRPS) were observed. Growth of the entries in all the three centres was found to be satisfactory.

6.Establishment of Spices Orchard and On farm trails on tree spices: A model Spices Garden was established at the Calicut University campus, in order to educate students and extension personnel. Potted plants of allspice, elite lines of clove, cinnamon and nutmeg were provided. Also two elite clove lines and two nutmeg selections are field evaluated at St.Michaels' Church, West Hill, Calicut. The planting was done during 1993 in a coconut garden, to serve as a spices demonstration cum on farm research trial. The growth of the plants is satisfactory.

7.Progeny evaluation of clove at Appangala: Growth parameters were recorded in the progeny evaluation trial of clove with elite lines (6 Burliar; 8 Kallar and 1 control), laid out at Appangala during 1991. (Table 3.14). Analysis of data revealed that the progenies of lines B-98, B-57, K-8, K-5, K-9, B-76 and B-81 had significantly higher plant height than the rest. Within a line, K-4 exhibited the maximum coefficient of variation (32.62%), while K-8, the minimum (8.22%) for the plant height. There was no significant difference between the lines for plant spread. Within a line, K-10 exhibited the maximum variation (37.91%), while K-3 the least (13.03%). With regard to plant girth at 30 cm. above ground level, the progenies of lines B-98, B-57, K-8, K-5, K-7, K-9, B-76 and B-81 had significantly higher girth than the rest. Within a line, K-3 exhibited the maximum variation (26.46%), and B-57 and K-8 the least (7.41%).

8.Clove germplasm evaluation: Clove accession numbers 45, 46, 178 and 82 recorded fresh clove yield of 1140 g; 490 g; 370 g. and 350 g., respectively and the yield of other accessions was comparatively low.

9.Variability in nutmeg: In a progeny population of 16 elite mother trees from Kallar, Burliar, Balamore (TN), Kalady, Moovattupuzha and Kottayam (Kerala), significant variation was observed only for plant height, number of main shoots, number of years taken for flowering, fruit weight and ratio of mace to seed weight (Table 3.13), in their 14th year. There was no statistically significant variation for number of erect shoots, mean girth at 1.4 m. above ground level, canopy size, yield of fruits and weight of seed and mace among the progenies. Estimates of genetic parameters for the significant attributes revealed high magnitude of phenotypic coefficient of variation (PCV) estimates, as compared to the corresponding genotypic coefficient of variation (GCV) estimates, indicating the predominant role

of environment in the expression of these characters. The estimates of heritability and genetic advance were low for all the characters, barring the ratio of mace to seed weight, thereby implying that nonadditive genetic variances are more important here. Lack of significant variation for yield and certain other attributes as well as low estimates of heritability for most of the significant attributes may be attributed to the narrow gene pool of the original mother trees from which the present day nutmeg population evolved.

Out of the total 90 progenies studied for sex segregation, 40 were male, 45 female and 5 bisexual types (Table 3.15). Basically 3 different canopy shapes, namely erect, spreading and conical were observed with variations of few intermediate types. Similarly leaf shape also varied among the population such as elliptic, oblong, ovate, obovate etc. Identification of high yielding nutmeg accessions from germplasm conservatory: Ten accessions viz; A9/20, 22,25,79,86; A4/12, 22,52, and A11/29,70, had been identified as high yielders. A nutmeg type with a very big, bold and round fruit (Accession No.150-A9 progeny of Tree No.47, Kannampally, Chalakkudy) had been identified.

10.Polyembryony in nutmeg: In nursery, out of 4000 nutmeg seedlings, polyembryony was observed in 8 (Two seedlings with separate root and shoot system from a single seed).

11.Immature fruit drop in nutmeg: Effects of Agrimor, a sea weed based plant stimulant on control of fruit fall in nutmeg were tried and results are encouraging.

12.Production of nucleus planting materials: About 5000 cinnamon seedlings, 8000 nutmeg seedlings, 3000 clove seedlings and 500 nutmeg grafts of elite trees ere produced as nucleus planting materials. Breeders' material of elite lines were supplied to APAU, KAU and ICRI for laying out field trials.

13.Inducing flowering/fruit set in allspice: To induce flowering/fruit set in allspice, cultar (suspension concentrate containing 250 g paclobutrazol/lit) was drenched. Four concentrations of paclobutrazol 1g. a.i., 1.5 g. a.i, 2 g a.i, 2.5 g a.i were tried along with control (Water) As during 1992-93, season, 1 g.a.i of paclobutrazol gave profuse flowering.

Table 3.13 Genetic variability for vegetative and yield characters in nutmeg

Characters	Mean	Range	GCV ***	PCV ***	Heritability (%)	Gen.Adv. %of mean
Height (Meters)*	6.075	3-11	12.35	26.39	21.90	11.90
No. of main shoots *	2.818	1-7	22.11	46.88	22.24	21.48
No. of erect shoots (NS)	2.855	0-11	--	--	--	--
Mean girth at 140 cm(NS)	25.60	8-49.5	--	--	--	--
No. of years for flowering**	7.98	6-14	14.58	26.75	29.71	39.64
Canopy size (cubic meters) (NS)	66.14	5.66-376.5	--	--	--	--
Yield of fruits (NS)	204.88	28-843	--	--	--	--
Weight of fruit * (g)	69.25	58.2-114	9.33	16.58	31.66	3.84
Weight of seed and mace (g)(NS)	13.88	10-17.5	--	--	--	--
Ratio of mace weight to seed weight **	0.362	0.24-0.49	17.47	23.11	57.14	1563.14

GCV,PCV=Genotypic & Phenotypic Coefficient of variation, NS : Non Significant

Table 3.14 Growth characters of elite clove progenies at Appangala (25 months after planting)

Elite line	Plant height (cm)			Maximum spread (cm)			Girth at 30cm above ground Level		
	Mean	CV(%)	Range	Mean	CV(%)	Range	Mean	CV(%)	Range
B-98	a201.25	17.15	134-245	83.13	34.02	40-125	6.38	11.67	5-7
B-57	a208.13	10.74	170.250	92.50	17.58	65-110	6.25	7.41	6-7
K-8	a195.00	8.22	170-210	87.50	21.16	60-120	6.25	7.41	6-7
K-4	169.38	32.62	85-230	85.63	36.99	50-135	5.75	18.00	4-7
K-5	a187.50	27.93	110-255	91.25	37.71	50-145	6.75	17.26	5-8
K-7	171.88	21.49	100-210	83.75	31.39	50-130	5.88	23.08	4-8
K-1	176.85	23.55	100-240	76.25	36.04	45-135	5.38	17.04	4-6
K-9	200.00	10.26	170-225	87.50	25.56	60-130	6.50	8.22	6-7
K-10	169.38	28.16	100-210	78.75	37.91	35-120	5.50	19.44	4-7
K-3	170.63	18.89	120-210	69.38	13.03	60-80	5.13	26.46	2-6
B-76	199.38	12.13	170-250	94.38	33.92	50-140	6.25	14.18	5-8
B-81	185.00	11.19	145-205	79.38	29.63	35-100	5.88	16.87	4-7
B-74	172.50	13.15	140-205	71.88	21.03	50-90	5.50	9.72	5-6
B-2	170.63	27.60	100-240	75.63	34.16	30-110	5.38	22.10	4-7
Control	145.63	18.58	110-200	63.75	25.07	35-90	5.00	10.69	4-6
CD at 5%	34.95				NS		0.92		
Over the Population	181.54	20.54		81.38	30.55		5.85	17.40	

Table: 3.15 Sex ratio in progenies of parent trees of nutmeg at different locations

Sl No	Location of mother tree	Sex proportion in progenies		
		Male	Female	Bisexual
1	Kallar	3	6	--
2	Burliar	3	5	--
3	Kozha	7	8	--
4	Kalady	9	10	1
5	Chalakkudy	6	9	1
6	Moovattupuzha	7	5	--
7	Balamore	2	--	2
8	Kottayam	3	2	1
	TOTAL	40	45	5

VEGETATIVE PROPAGATION OF TREE SPICES

(J. Rema and B. Krishnamoorthy)

1.Vegetative propagation of allspice Cuttings: Terminal cuttings from juvenile and mature trees were subjected to various hormonal treatments for studying their rooting performance. Three rooting hormones viz. IBA, NAA and IAA were tested singly as well as in combination. IBA 2000 ppm and IBA 1000 ppm + NAA 1000 ppm aided in adventitious root production. Quick root (commercial rooting hormone) has also proved effective for production of adventitious roots in an earlier studies.

Layering: Air layering was carried out on 12 years old allspice trees using the commercial rooting hormone seradix. Rooting was observed in 20% of the layers in a period of 4-5 months and the rest of the layers are under observation to study their performance.

Stooling: All spice trees were detopped at a height of one foot above the ground level. A one cm. band of bark was removed from the newly emerged shoots and was smeared with IBA 500 ppm. The shoots were covered with sand to facilitate rooting. However, rooting was not observed in any of the shoots up to a period of 8 months.

Approach grafting: Approach grafting of allspice on 3 years old root stocks of *syzygium aromaticum* and *Eugenia jambolana* was carried out. No signs of union was noticed. Grafting was also carried out on 8 month old root stocks of *Eugenia jambolana* and allspice seedlings and is under observation.

2.Vegetative propagation of cinnamon: *Cinnamum aromaticum: Cinnamum aromaticum* (cassia) is a closely related species of *C. verum*, the true cinnamon. Air layering in 2 year old cassia plants was achieved for the first time. A success of 87.5 and 50% rooting was obtained when carried out during July and November, respectively with 100% field establishment.

3.Field evaluation of clove approach grafts: *Growth observation* viz., height, number of primary and secondary branches and girth above the graft union were recorded on 2 year old clove approach grafts.

4.Performance of top-worked nutmeg trees: Growth parameters of the top worked trees has been recorded. One 2 year old top worked nutmeg has flowered during this year; however there was no fruit set.

5.Inducing orthotropic shoots in nutmeg grafts: 50-60% of the epicotyl grafts (plagiotropic grafts) planted in the field showed natural production of orthotropic shoots.

BREEDING FOR HIGH YIELD, RESISTANCE TO *PHYTOPHTHORA*, NEMATODE AND DROUGHT IN BLACK PEPPER

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

1.Yield trials : Yield recording was done for the first time in CYT.IV. 183, 69, K.S.51, K.S.114 and the hybrids HP.1256, HP 1269. and H.P.1513 along with the controls K.S.27 and Panniyur-1 started yielding for the first time. Other yield trials viz., Evaluation of wild *Piper nigrum*, evaluation of O.P progenies of 'Vadakkan', bush pepper yield trial etc were gap filled and maintained.

2.Yield trial at Valparai: Among the hybrid lines being evaluated at Valparai (1067m above MSL) the following hybrid lines have performed well (Table 3.15).

Table 3.15 Performance of hybrid lines at Valparai

Line	Yield(Kg)/vine (fresh)
HP 34	2.268
HP 105	2.210
HP 728	2,710
HP 813	1,500
Control (Panniyur-1)	0.637

3.New trial on black pepper: A new yield trial comprising selected O.P progenies of 'Vadakkan' (Progeny No.3,5,45) mother 'Vadakkan', Kottanadan selection 1495, 2559 and 2563. Kalluvally 880, HP 732, HP 813, Panniyur-1 ( ) HP 833, HP 846 and control (KS 27 and Panniyur-1) was laid out at Peruvannamuzhi. The trial was set to an RBD having 3 replications with 5 plants/ plot. An exhibition plot of all released black pepper varieties was also laid out at Peruvannamuzhi.

4.Studies on direct DNA uptake: Pollen grains of cv.Karimunda were collected, soaked in DNA extracted from *P. colubrinum* seedlings and used for pollinating 'Karimunda' spikes. A total of 10 spikes were pollinated. Out of these, 5 spikes with low to moderate berry setting are retaining upon maturity, the berries will be collected and sown and will be screened for transgenic plants if any.

5.Hybridization: A total of 20 cross combinations were made during the year 1993-94. Seeds collected are being sown. In 8 of the crosses 'Vadakkan' (2n=78) is used either as female or male parent.

6.Observational trial on black pepper grafts: Using *P. colubrinum* seedlings and

stem cuttings as stocks and runners, orthotropic and lateral shoots of Panniyur-1 and Karimunda as scion material 20 grafts each were prepared for evaluating the performance of black pepper grafts. This will be planted in the field during the coming season.

7.Varieties on the pipeline: Two black pepper F1(hybrids, viz., HP 732 and HP 813 for high altitude regions of the country are in pipeline. Drought tolerant Kottanadan and Karimunda selections are under field evaluation. A few other superior F1s (Hybrids) and selections, O.P progenies are at advanced stages of testing.

BREEDING CARDAMOM FOR HIGH YIELD AND RESISTANCE TO 'KATTE' DISEASE

(Regy lukose and M. N. Venugopal)

1.Evaluation of selections in MLTs: Vegetative characters viz., height of the tallest tiller, tillers/plant, leaves/plant, length and breadth of the median leaf were recorded in MLT I and MLT II . In MLT I, 6 Mysore type selections, and in MLT II, 13 Malabar type selections from various centres, are being evaluated. In MLT I, height of the tallest tiller, length of the median leaf, and in MLT II, height of the tallest tiller, length and breadth of the median leaf showed significant differences between the treatments, while the other characters didn't show differences (Table 3.16 and 3.17I).

2.Evaluation of hybrids: Six combinations of hybrids and their parents are being evaluated in a RBD trial. None of the vegetative characters showed significant differences between the treatments.

3.Collection of natural katte escapes: Twenty plantations distributed in Kodagu,Hassan and North Kanara were surveyed and four collections were made. The duplicates of these four collections were screened in the green house. Three collections remained free from infection after Ist round of inoculation with viruliferous aphids.

Table 3.I6 MLT-1 Vegetative characters

Selections	Ht of the tallest tiller(cm)	Length of median leaf (cm)	Breadth of the median leaf (cm)	Tillers/plant	Leaves/plant
SKP-51	148.7	48.5	8.7	7.0	54.7
MCC-12	139.0	50.2	8.8	7.5	59.4
MCC-21	125.3	46.7	8.3	7.4	45.3
MCC-61	109.1	41.7	7.2	6.0	38.6
MCC-25	136.1	50.7	8.7	6.9	58.4
CCS-1	134.1	47.8	8.2	6.8	50.4
CI-3 (Seedling)	123.0	44.7	7.9	6.7	46.5
LSD	19.7	5.0	NS	NS	NS

NS: Non Significance

Table 3.17 MLT-II - Vegetative characters

Selections	Ht. of the tallest tiller (cm)	Length of the median leaf (cm)	Breadth of the median leaf (cm)	Tillers/plant	Leaves/plant
800	99.8	41.9	6.8	5.3	34.9
872	114.5	44.7	6.9	4.9	33.2
893	99.0	38.3	6.3	12.5	57.9
cl.	90.0	38.5	4.9	3.9	21.9
679	119.5	42.8	6.4	7.7	46.6
cl.	61.9	32.4	6.0	3.1	16.1
689	107.2	43.4	4.5	9.5	52.5
cl-729	125.9	44.9	7.2	9.9	64.9
PI	111.5	43.5	7.0	6.8	58.1
OVI	117.6	46.2	8.2	10.2	62.2
SKP-14	158.9	45.4	8.2	11.3	65.7
SKP-72	87.6	39.0	6.6	6.3	35.9
SKP-21	73.0	33.5	6.3	4.4	25.2
MCC-100	142.2	45.9	7.4	10.8	99.4
MCC-34					
CI-37 (seedling)	146.6	44.1	6.6	6.6	50.0
Malabar (Seedling)	33.0	6.1	2.6	NS	NS
LSD					

Table 3.18 Growth characters of hybrids

Hybrids	Height of the tallest tiller (cm)	Length of the median leaf(cm)	Breadth of the median leaf (cm)	Tillers/ plant	Leaves/ plant
800 x E.B	121	46	8	8	45
872 x E.B	108	42	8	10	51
893 x E.B	98	39	8	5	30
EB x 800	122	46	8	11	54
EB x 872	124	44	7	9	45
EB x 893	104	41	8	7	37
800	129	47	8	12	61
872	118	47	8	9	44
893	110	43	8	8	41
EB	123	44	8	10	53
CI.37 (seedling)	136	49	-	11	58
L.S.D 5%	NS	NS	NS	NS	NS

NS : Non significance

4.Evaluation of natural katte escapes in hot spot areas: Testing 16 promising lines in 3 hot spot areas continued. The test entries, which have been planted in single rows of 12 clones each, have been exposed for chances of natural infection amidst severely infected plants. The test entries remained free from infection so far (after 20 months). These results further confirm the resistant nature of these collections against natural infection of cardamom mosaic virus.

CYTOGENETIC INVESTIGATIONS IN BLACK PEPPER AND RELATED TAXA

(R. Ramakrishnan Nair)

Ninety eight accessions of cultivated *Piper nigrum* and nine wild species of *Piper* were cytologically analyzed for chromosome number indexing. Mitotic metaphase chromosome count confirmed p 773 x the cultivars and six wild species analyzed have 2n=52. Chromosome number in *Piper magnificum* was confirmed as 2n=26. *Piper crocatum* has 2n=52 in its somatic cells. A wild species of Piper collected from North-Eastern Region found to have 2n=91. Karyotype analysis of the cultivar 'Karimunda' (Acc.No.917) revealed that chromosome length ranges from 0.66 to 1.33 μ and most of the chromosomes have median and submedian centromeres. *Piper magnificum* found to possess seven pairs of metacentric and six pairs of submetacentric chromosomes and chromosome size ranged from 1.41 to 3.34μ. One hundred and thirty two progenies derived from Colchicine treated seeds of different cultivars such as Narayakodi, Perumkodi, Thommankodi, Kaniakkadan and Valiyakaniakkadan were cytologically examined. All of them were found to be normal having 2n=52.

QUALITY EVALUATION IN SPICES

(T. John Zachariah and N.K. Leela)

1.Black pepper: Among the 22 germplasm accessions evaluated CLTP, 12, 99, 185 and 210 contained high essential oil ; 2 and 41 had high piperine and CLTP 185 had high oleoresin.

2.Cardamom: Among the 54 Wynad selections, APG-187, 188 and 189 contained high oil with high alpha - terpinyl acetate.

3.Turmeric: Among the 225 germplasm accessions evaluated for oleoresin and curcumin, the high curcumin (above 6%) accessions are 109, 126, 199, 210 and 257. Accessions 126, 199 and 361 contained more than 15% oleoresin.

4.Ginger: 15 accessions evaluated at Moovattupuzha and Calicut Acc..251 had high oil and oleoresin at both places. Accns. 51, 53, 65 and 151 expressed high quality at Calicut only.

MICROPROPAGATION OF BLACK PEPPER

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

1.Regeneration of black pepper callus: Callus was induced from leaf, stem and petiole of mature and juvenile explants of *P. nigrum*. Plant regeneration was achieved in woody plant material (WPM) supplemented with BAP and Kinetin. The regeneration

frequency was low (20-30%) and needs further manipulation of the media for increasing the frequency of regeneration.

2.Field planting of *Piper sp.*: The tissue cultured plantlets of *P. nigrum, P. longum* and *P. colubrinum* has been planted in the field. Nine months old tissue cultured *P. longum* has flowered profusely after putting forth a good vegetative growth. The tissue cultured plantlets are under evaluation for various vegetative and reproductive characters.

3.Inflorescence culture of *P. nigrum*: Immature inflorescence of *P. nigrum* has been cultured in white s medium supplemented with hormone after cold treatment for 24-48 hours at 7°C. The responses were different in different media. Berry development was noticed in white s media supplemented with BAP, where as anther development alone was observed when the media was supplemented with BAP and Kinetin. Basal media supplemented with BAP and IAA favoured callus growth from the inflorescence. The various cultures have been transferred to different regeneration media to study their regeneration and further development.

TISSUE CULTURE FOR RAPID MULTIPLICATION AND EVALUATION OF ELITE CLONES OF CARDAMOM

(Regy Lukose)

1.Rapid clonal multiplication of elite clones: 1595 plantlets were transferred to soil + vermiculite mixture for hardening after rooting in White's basal medium + NAA 0.5 µg/l. These plantlets were used for laying out three comparative yield trials(CYTs)

2.Evaluation of tissue cultured plants in the field: Two CYTs were laid out during 1987 using tissue cultured plants, suckers and seedlings of cl.37 and P1-Mudigere. A third CYT was also laid out during 1989 using tissue cultured plants of the selections. In CYT-I significant difference between the treatments about yield were found only during 1991 & 1992 & cumulative yield of 3 years. In CYT-III, no significant difference were found between the treatments about yield during 1989, 1990 and 1991. But significant differences were found about yield of 1992 and cumulative yield of 3 years. Even though significant differences were not found between the treatments about some of the vegetative characters during initial years it was noticed in the later years.

3.Regeneration of plantlets from callus: A protocol for the regeneration of plantlets from callus, which was induced from the rhizome of cl-37xPVI was standardised. 32200 somaclonal plantlets were regenerated from rhizomatic callus of cl-37x PV1. 250 somaclonal plantlets were rooted in Whites medium + NAA 0.5mg/l and transferred to soil + vermiculite (1:1 v/v) medium. 120 hardened plants were planted in the field for evaluation. Vegetative characters viz., tillers/ plant, yielding tillers/plant, height of the tallest tiller, panicles/plant and leaves / plant and yield/plant were recorded in CYT-III, which was planted during 1989 using 6 selections and a control. Significant differences were found between the treatments about tillers/plant, panicles/plant, height of the tallest tiller and leaves/plant except yield/plant (Table 3.19)

200 somaclonal plantlets were regenerated from callus of cl.37 x PVI of these 200 plantlets were transferred to soil + vermiculite mixture after rooting. Out of these, 120 somaclonal plants were planted in the field for its evaluation.

Table 3.19 CYT III Growth characters

Selections	Tillers/ plant	Yielding tillers/ plant	Panicles / plant	Height of the tallest tiller (Cm)	Leaves/ plant	Yield/ plant 9m wet wt.
1271/2-6	17.2	54.7	8.3	253.0	110.5	400
Hy-668	18.3	59.6	8.3	243.0	100.5	416
cl.37xpvi	15.0	49.8	6.7	255.0	79.5	380
cl.671	12.5	52.1	5.7	205.0	57.5	435
Hy-43	15.5	51.4	7.4	283.0	117.8	538
1271/2-10	18.9	66.0	8.9	239.8	101.0	443
cl.37	14.6	46.7	6.8	227.5	94.3	495
LSD (P=0.05)	3.5	NS	1.9	34.8	32.1	NS

NS : Non significance

IN VITRO SELECTION FOR RESISTANCE FOR SOFT ROT AND BACTERIAL WILT IN GINGER

(K. Nirmal Babu, TGN Rao, GN Dake, N K Leela)

1.Characterization of somaclones: Over one hundred and fifty somaclones were evaluated in pot culture for yield and eight lines were identified as promising. Field screening of somaclones for resistance against *Pythium aphanidermatum* and *Pseudomonas solanacearum*. Over 100 somaclones were screened against *P. aphanidermatum* and *P. solanacearum* and 20 lines were identified as tolerant to *P. aphanidermatum* and three lines tolerant to *P. solanacearum*. They are being multiplied for further testing. Two of the lines found tolerant to *P. aphanidermatum* also gave an yield of 300 g of fresh rhizome.

2.Multiplication and maintenance of embryoid cultures: Over 1000 cultures of embryoids in ginger were maintained as stock cultures.

2.Encapsulation of ginger embryoids and production of artificial seeds: Ginger embryoids were encapsulated in sodium alginate. The encapsulated buds were germinated on MS basal medium with 1 mg/l NAA with 100% success.

DBT PROJECT: *IN VITRO* CONSERVATION OF SPICES GERMPLASM BLACK PEPPER AND CARDAMOM

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

1.Standardization of slow growth methods

Cardamom: Slow growth method in cardamom were standardized. By this method the culture could be stored without subculturing up to one year, in 1/2 MS

strength. MS medium devoid of growth regulators, supplemented with 10 g/l each of sucrose and mannitol in closed culture vessels at 21+/-2°C. In this method, cardamom culture could be stored up to 10 year with yearly subculturing.

Retrieval of conserved material: After one year storage 80% of Cardamom cultures could be reverted to their normal growth within 30 days after subculturing to MS medium supplemented with 1mg/l BAP and 0.5 mg/l NAA. Slow growth method standardized in cardamom is found to be suitable for conserving other related genera of cardamom like ginger, turmeric and *Kaempferia.*

Black pepper: In case of black pepper and three of its related species viz., *P. longum, P. colubrinum* and *P. barberi* an experiment for standardization of slow growth methods were started. After 8 months, of observation WPM medium supplemented with 20 g / l sucrose and 10 g/l mannitol in closed culture vessel showed favorable results.

Multiplication protocol: During this year, multiplication protocols were standardized in large cardamom *(Ammomum subulatum)* in MS medium supplemented with 1µg/l BAP and 0.5 mg.l NAA.

Field planting of tissue cultured plants for genetic evaluation: Eighty per cent of tissue cultured plants of *P. colubrinum* and *P. longum* flowered in the field.

***IN VITRO* Gene bank**: Added 140 new accessions of spices (including black pepper and related species and cardamom and related genera) were kept in *in vitro* gene bank to make a total of 240 accessions of spices in *in vitro* repository.

DBT PROJECT:RAPID CLONAL PROPAGATION OF TREE SPICES

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

Cinnamon: Bud break was achieved in *Cinnamomum* and *Cassia* on MS medium supplemented with Kinetin. Shoot tips and nodal segments of cassia were induced to *in vitro* rooting in WPM medium supplemented with IBA and NAA. In *Cinnamomum camphora in vitro* rooting could be achieved in growth regulator free WPM medium.

Clove: In clove in vitro rooting could be induced when shoots were cultured on WPM medium supplemented with IBA.

Nutmeg: Nutmeg was slower in response to culture media than cinnamon and clove and the various media tried viz., MS, WPM, B5 etc. did not help in nutmeg. A broad spectrum experiment (De Fassard et. al 1974) was initiated with macronutrients, micronutrients, auxins, cytokinins, growth factors and aminoacids at three levels viz., low, medium and high. Shoot tips and axillary buds were activated to grow and maintain in a medium with low level of nutrients, medium level of growth factors and aminoacids and activated charcoal. Aril tissue callus cultures could be established from immature aril tissue of nutmeg on WPM supplemented with IBA.

SUPPORTIVE RESEARCH PROGRAMMES

INCREASING PRODUCTIVITY OF BLACK PEPPER AND CARDAMOM THROUGH LARGE SCALE DEMONSTRATION OF IMPROVED TECHNOLOGIES IN FARMER'S FIELDS

(V.S.Korikanthimath and M.N.Venugopal)

1.Conventional management followed by intensive cultivation of cardamom by adopting HPT (10ha): The mean yield over a period from 1985-94 was 438.3 kg dry cardamom / ha / year. The net return was Rs.77350.93 / ha / year. The cost per kg of dry cardamom production was Rs.62.11. The study revealed that high yield could bring down the cost of production.

2.Introducing cardamom as a sole crop in place of Arabica (KENT) Coffee by adopting HPT (1982-1994): A mean yield of of 662.7 kg of dry cardamom over a period of 10 years (1984-85 to 1993-94) was recorded.

3.Economics (Average of 5 years 1989-90 to 1993-94): The cost of cultivation works out to Rs.34240, 18171 and 14541 / ha / year towards raising of cardamom, coffee and pepper. The gross income amounted to Rs.193027, 11810 and 529 for cardamom, coffee and pepper respectively.

4.Multistoreyed cropping systems: Cardamom + Robusta Coffee + Pepper + Coorg Mandarin (Orange),system established.

5.Cardamom + Arecanut: Recorded yield of 3800 kg arecanut and 650 kg of cardamom per ha. popularized triangular high density planting of cardamom in Areca.

6.Cardamom + Coconut: Cardamom was successfully cultivated as a mix crop under 13 year old coconut palms following high production technology with sprinkler irrigation. A record first year yield of 509 kg dry cardamom, and 6900 coconuts were harvested per acre of this plantation. It amounted to Rs.2,29,207 from cardamom and Rs.24,150 from coconut indicating the possibility of growing cardamom under the shade of coconut palms in upghat region.

7.Conversion of Marshy areas for profitable cultivation of cardamom: The cardamom yield of 700 kg (dry)/ha was obtained during the crop season (1993-94) as against 1350 kg/ha during the highest maiden crop (1992-93) just 30 months after planting. Amply demonstrated in locations that the low lying area could be suitably brought under profitable cultivation of cardamom by providing adequate drainage, and planting fast growing shade tree species like *Acrocarpus fraxinifollius* and *Cideella toona* etc. Locally available shade tree species like Neeranekki (water drinking plant) is also found to be quite useful in building up of adequate shade in marshy areas which are devoid of proper shade.

8.Homestead cultivation of cardamom: Demonstrated the easy and profitable cultivation of cardamom in the homesteads particularly for small and marginal farmers and the agricultural laborers in their back yard. Monitored 6 plots under homesteads under controlled over head shade, two each covered on top with scrapings of shade regulating material like silveroak twigs, coirmat and agro shade nets.

PRODUCTION OF PARENTAL MATERIALS AND BREEDERS STOCK OF SPICES

(K. Sivaraman, V.S.Korikanthimath and K. Kandiannan)

One lakh twenty five thousand rooted cuttings of popular high yielding varieties viz., Sreekara, Subhakara, Panchami and Pournami were distributed as nucleus planting materials to various development agencies. Twenty tones of seed rhizomes of high yielding turmeric varieties viz. Suvarna, Suguna, Sudharshana and Alleppey were also distributed for further multiplication. Developed and popularized the rapid method for proliferation of suckers in cardamom to generate large number of planting materials in short time from high yielding and elite clones with better quality and yield attributes.

Trained several farmers in the selection of elite cardamom accessions in their fields. Generated planting material of elite lines viz. CCS-1 (872) , 800 and 983 top ranking ones selected from the yield evaluation trial, by resorting to 'Rapid clonal multiplication'. Supplied 654 kg cardamom seed capsules of Cl-37 from NRCS Cardamom Research Centre Appangala besides, over 2000 kg from the Research -cum- Demonstration onfarm trials being conducted at farmers plantations.

TRAINING OF EXTENSION AND RESEARCH WORKERS

(Johnson K George, M.N.Venugopal & C.K.Thankamani)

Training Programme Schedule prepared and distributed all over the country for various research and extension agents and following trainings were conducted.

1. Spices Production technology 22 - 27 Nov. 1993, 7 Participants
2. Nursery management in spices 14 & 15 Feb. 1994. 11 Participants

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

The AICRP on Spices is vested with the mandate to research on 12 Spice Crops at 16 Centres based in 11 Agroclimatic regions of India. The AICRP Centres are attached to the 11 Agricultural Universities and one ICAR Research Complex at Gangtok. Research Achievements made by 41 Scientists from 61 research projects during 1993-94 with reference to genetic resources, crop improvement, production, protection, quality upgradation, planting material production are summarized below.

1.GENETIC RESOURCES

Black Pepper: The Panniyur centre shifted 117 wild accessions in black pepper to Ambalavayal (KAU) for want of ideal climatic conditions. Out of the 76 cultivated types evaluated at Panniyur, Karimunda-I (PRS-20), Karimunda-III (PRS-22) and Sullia (PRS-49) have shown high yield potential. The Yercaud and Mudigere centres also assembled black pepper germplasm as per the decision - that all cardamom centres to initiate work on black pepper. Three wild types from Shevroy and Kolli hills were collected during this year by Yercaud centre.

Cardamom: The germplasm evaluation at Pampadumpara identified cardamom types PS-21, PS-22 and clone-57 for the bold

capsules. The CI-692 (638 kg/ha) and P-20 (556 kg/ha) were promising collections with regard to yield. The entries CL-802 and CL-683 recorded higher values for most of the yield attributes in the germplasm collection at Mudigere.

Ginger: One new accession was added making the progressive total to 147 at Pottangi and out of the 140 accessions of ginger, ZO-17 was the top yielder. Out of the 132 collections maintained at Solan, Collections BDTR-1267, PGS-10, Kerala Local and SG-603 recorded maximum yield.

Turmeric: Jagtial centre made 46 new collections and increased the accessions to 188 while Pottangi centre added one new collection making to 147. Among these cv. Roma gave highest yield in the evaluation of 143 curcuma longa types; Haridaguda and CAM-3 among *C. aromatica* and *C. amada* respectively at Pottangi. In the valuation at Jagtial, Ethamukkula gave highest yield in long duration type. At Solan maximum yield per plot was obtained in CLS-9, ST-41, BDJR-1156 and BDJR-1276.

Tree Spices: The exploratory survey conducted for tree spices (clove, nutmeg and cinnamon) germplasm by the Yercaud centre identified 13 elite mother trees of clove from Courtallam, Nagercoil and Kallar areas and 15 high yielding nutmeg types from Kallar, Burliar and Courtallam. In cinnamon 10 accessions, along with one cassia cinnamon, are also maintained.

Coriander: The existing 578 (468 indigenous and 50 exotic) collections available at Jagudan centre were critically examined and based on the genetic diversity, 143 accessions having variability were retained. Extensive survey work also carried out by Jagudan centre during 93-94 in the state of Gujarat and collected 37 new coriander accessions. Jobner centre made 60 new collections and also received 175 (137 indigenous and 38 exotic) collections from other centres makes the total collection to 683. Hundred and ten germplasm accessions were collected in collaboration with NBPGR and increased the collection to 230 in Guntur centre. Coimbatore centre made 243 new collections making the total to 372. The new centre Hisar, made a collection of 30 lines in coriander.

Thirty seven exotic germplasm in *Coriandrum sativum* received through NBPGR (1990-91) have been distributed to Jobner and Jagudan centres. Another seven Coriandrum sativum (six from Germany and one from Japan) and medicinal plants Carum carvi (4), Anethum graveleus (3), A. beishei, A. anoonals, A. decursevia, Ammi visnga (one each), Anethum graveleous (2), Apium sp. (39) received from NBPGR also forwarded to Jobner.

Jobner centre tested 45 entries against root knot nematode (M. incognita). Out of the 45 entries tested UP-20 and UD-21 were resistant.

Cumin: The existing collections 285 (278 indigenous and 7 exotic) maintained at Jagudan were critically examined and screened from morphological and yield diversity. Based on diversity 106 entries having variability were retained. Others were discarded. With a view to collect diverse genotype of cumin, the whole growing area was surveyed and 460 new entries collected on the basis of diversity by Jagudan during 1993-94 makes the total collection to 566 accessions. A total of 224 (214 indigenous and 10 exotic) are maintained at Jobner. In the screening of 9 germplasm entries E.C 243373, EC 243375 and EC 232684 accessions found to be resistant against *Fusarium* wilt disease in wilt sick plot at Jagudan.

Fennel: At Jagudan the available 283 entries (262 indigenous and 21 exotic) were critically

examined and screened diversity. Based on the genetic diversity 98 entries having variability were retained. Jobner centre maintained 139 collections in fennel. Two fennel germplasm (Germany and Japan) received from NBPGR (93-94) also forwarded to Jobner.

Fenugreek: The germplasm collection was increased to 270 (258 indigenous and 12 exotic) at Jobner centre as a result of 113 indigenous collections received from other centres during 1993-94. The germplasm collection rose to 179 at Coimbatore Centre as a result of enrichment of 53 new accessions during 1993-94. Out of the 53 accessions (received from the Coimbatore), evaluated, none was better than RMt-1 with respect to yield, however, 19 accessions showed lower incidence of powdery mildew and 7 accessions showed lower incidence of root rot. The Hisar made 80 new collections. Seventy accessions were valuated at Guntur. Among the accessions *UM-117 (1100 kg/ha) followed* by *Lam Sel.1* (1092 g/ha) gave highest yields. Jagudan centre holds 185 accessions including two exotic accessions. During the year, the entries were evaluated for morphological and yield diversity. None was found superior in yield over control. Based on genetic diversity, 40 entries having variability retained and other discarded. In the screening of three exotic entries at Jagudan under natural condition EC-257566 (Bulgaria) was found resistant against powdery mildew disease.

2.CROP IMPROVEMENT

Varieties released: In black pepper variety Panniyur-5 from Panniyur (KAU), Cardamom ICRI-3 (SKP-14) from Indian Cardamom Research Institute, Sakleshpur (Spices Board) and Coriander DH-5 from Hisar (HAU) were recommended for release. Important characteristics of the varieties are given below:

Black pepper: Panniyur-5 (Culture 239) was evolved from the Pepper Research Station (KAU) Panniyur, Kerala. It is a selection from the OP progeny of the local cultivar Perumkodi, recommended for growing in Kerala. The most distinguishing feature is the protandrous nature of flowers. The morphological characters are ovate leaf with acuminate tip, shorter internodes. Stipules are faint and violet. Spikes are long, length varies from 12 cm to 26 cm. It gives and average green yield of 3.196 kg/ vine with a projected dry yield of 1255 kg/ha (@ 1100 vines/ha). It contained 12.3 per cent oleoresin, 3.8 per cent essential oil and 5.3 per cent piperine, driage is 35.7 per cent. It comes up well both under monocropping and companion cropping especially with arecanut. It is suitable for growing in all pepper growing tracts of Kerala and has better ability to survive under drought conditions.

Cardamom: ICRI-3 (SKP-14) from Indian Cardamom Research Institute, Regional Station, Sakleshpur, Karnataka is a Malabar type with long and bold capsules, more than 73% of the capsules are above 7.5 mm dia. It is an early maturing type recommended for growing in hills zones of Karnataka state which gives and yield of 439 kg/ha (814% more than the local check) under rainfed and 599 kg/ha under irrigated condition (118% more than the local check) and is capable of giving potential yield of 790 kg/ha. It contains 6.6% essential oil and 54 per cent 1,8 per cent Cineole content.

Coriander: DH-5 was proposed by Department of Vegetable Crops, HAU, Haryana. A selection from the indigenous material collection from Karnal district (Haryana). It is a dual purpose and high yielding variety (135 days duration) with wider adaptability, gives and average yield of 1400=1600 kg/ha. Recommended from Haryana and Andhra Pradesh where long duration varieties are grown.

Fenugreek: HM-57 was proposed by Department of Vegetable Crops, HAU, Haryana, selected from the germplasm collected from Kurukshetra district of Haryana. It is a quick growing dual purpose and high yielding variety. Average yield under normal condition ranges from 1600-1800 kg/ha.

3.CROP PRODUCTION

Black pepper: In black pepper highest yield was obtained at Panniyur by irrigation at IW/CPE of 0.25. Studies at Sirsi confirmed that in companion cropping system the yield of black pepper and arecanut could be increased with the application of 100:40:140 g NPK/year each to arecanut and pepper.

Cardamom: At Mudigeri, studies indicated that in cardamom, the number of suckers per panicles and yield could be significantly increased with increase in N and P levels under uniform shaded conditions. Similarly cardamom yield under irrigated situation was 75 per cent higher compared to yield in rainfed situation at Mudigeri. The average yield from suckers was 48% higher (500 kg/ha) as compared to that from seedlings (337 kg/ha) in case of variety Mudigeri-1.

Ginger: In ginger application of N125 P100 K100 kg/ha recorded the highest yield of 14.35 t/ha with a maximum benefit at Pottangi.

Tree spices: Research on Tree spices (Clove, nutmeg and cinnamon) was initiated at Yercaud centre. Standardisation of vegetative propagation in nutmeg by different gratting methods is under progress. A considerable increase in the population dynamics of Azospirillum and Phosphobacteria in the root zone was observed in cloves and nutmeg plantations by the application of these organisms to the soils.

Seed spices: For cumin the Jobner centre recommended a three years crop rotation i.e., cluster bean - cumin - cluster bean - wheat - cluster bean - mustard crop sequence to be the best for adoption in Rajasthan. A seed rate of 25kg/ha in fenugreek standardised at Jobner gave the maximum yield of 11.12 q/ha; At Coimbatore, coriander sown in first week of November by adopting a spacing of 15 x 15 cm gave high yield.

4.QUALITY EVALUATION

The promising clones of cardamom viz., CL-683, CL-679 and CL-729 were superior to Mudigeri=1 with respect to essential oil and Aloha terpenyl acetate and 1,8 Cineole content. In ginger SG-673 recorded maximum essential oil and SG-675 maximum oleoresin. AN in turmeric PCT-14 followed by PCT-13 recorded maximum curcumin and oleoresin contents.

In seed spices quality is judged by the presence of aroma which is due to volatile oil content in coriander JCo-126 (0.4%0 followed by JCo-81 (0.32%), cumin UC-198 (4.9%) and in fennel by HM-39 (1.5%).

5.CROP PROTECTION

Black pepper: In the studies on the Phytophthora foot rot and nematode disease management in black pepper at Panniyur minimum defoliation was noticed in the treatment receiving all cultural practices + 1kg neem cake/vine + 3g a.i. Phorate/vine + 1% Bordeaux mixture + two drenching with 0.2% Copper oxychloride. At Sirsi Phytophthora foot rot incidence was lowest by adopting cultural practices, combined with application of one kg neem cake/vine, 3g a.i. Phorate/vine, Bordeaux mixture spraying @ 3 l/vine, and drenching copper oxychloride (0.2%), 5 l/vine, before the onset ot monsoon. This was followed by spraying and drenching of Akomin (0.4%)

during second week of July and spraying and drenching Ridomil MZ-72 WP (100 ppm) in second week of September. Bordeaux mixture spraying + pasting or pasting Bordeaux mixture + liotx (2%) drenching recorded only 14% disease incidence compared to 35% in control at Chintapalli.

On farm trial in farmers' plot by Panniyur centre on Phytophthora disease management revealed that combined treatment of Bordeaux mixture spray, pasting and drenching combined with application of neem cake (2kg/vine) and lime on kg/vine was effective. Studies at Panniyur centre showed application of neem cake @ 2kg/vine, Phorate 3g ai/vine and Copper Oxychloride (0.3%) drenching was effective in checking slow wilt of pepper.

Biological control studies of *Phytophthora* foot rot of black pepper at Sirsi using four antagonistic organisms showed that Trichoderma harzianum minimised the foot-rot incidence. Studies at Chintapalli revealed that percentage of Phytophthora disease incidence was less with application of *T. harzianum* and *T. viride*.

Nursery diseases: In the trial on control of nursery disease of pepper, at Panniyur centre minimum infection was noticed in vines treated with Validacin 0.2% under medium shade condition. Spraying and drenching of Difolatan (0.1%) reduced the mortality of peper cutting in the nursery as compared to check under medium light intensity at Sirsi.

Cardamom: At Mudigeri no shoot borer damager was noticed in 10 cardamom germplasm entries viz., CI-1228, C-57, C-154, C-10, P-9, PV-2, C-126, C-2, Ang, cap. and Nel.12. Studies on the effect of shoot borer at Mudigeri in the three types of cardamom on yield, sucker and panicle production showed a significant yield reduction in damaged shoots. But no difference between healthy and damaged shoots in the production of new suckers and panicles. The thrips control studies at Pampadumpara showed that six spraying of monocrotophos (0.05%) combined with thrashing was effective in checking shoot borer.

Ginger: In ginger, pre-sowing seed treatment in combination of Indofil M-45 (0.25%) + Bavistin (0.1%) plus soil application of Phorate (10 kg/ha) was effective in managing rhizomerot.

Seed spices: For control of grain mould of coriander spraying of Carbendazim 0.1% after 20 days of flowering was effective. Application of neem cake @ 150 kg/ha was most effective for the management of wilt (4.8% disease incidence) in coriander followed by seed treatment and soil drenching with 0.1% Bavistin gave 5.2% wilt incidence at Coimbatore during Khraif. The incidence of wilt disease has brought down to .1% from 32.3% by the use of Trichoderma viride as a means of biological management and this has been recommended for wilt management in coriander by the Coimbatore centre. The yield was also high in plots applied with Trichoderma (515 kg/ha) compared to control (260 kg/ha). The effect of T. viride either alone or with neem cake in the management of root rot disease of fenugreek was assessed by Coimbatore. The centre recommended application of T. viride along with 150 kg neem cake per hectare which reduced the incidence of root rot of fenugreek. Seed dressing with Bavistin (0.1%) consistently reduced the cumin wilt incidence and is recommended for adoption in Rajasthan.

6.PLANTING MATERIAL PRODUCTION

Small scale production of elite nucleus planting material/foundation seeds of improved varieties are taken up by the AICRP centres under University sponsored programme. In addition to that few AICRP

centres are participating in the integrated programme for development of spices (IPDS) under centrally sponsored programme of Govt. of India, Dept. of Agriculture & Cooperation and programmes sponsored by Spices Board for the production of foundation seeds of improved varieties.

Pampadumpara: The centre produced planting material of cardamom viz., 10,000 primary seedlings, 12,000 secondary seedlings, 40 kg seed capsules and 200 Nos. of rooted pepper cuttings.

Panniyur: The centre distributed 58,468 rooted cutting of black pepper of varieties Panniyur-1 to Panniyur-5 and Karimunda.

Pottangi: Under the University sponsored programme the centre distributed 25 quintals of ginger and 65 quintals of turmeric and under IPDS 35 quintals of turmeric rhizomes were produced.

Yercaud: The centre supplied 410 kg of coriander (Swathi, Sadhana, Sindhu) and 25 Kg of Lam Sel. fenugreek.

Coimbatore: The Centre produced 21 kg of seeds of coriander variety Co-3 and distributed.

Jobner: The centre supplied 645 kg coriander (RCr-41), 1665 kg fenugreek (RMt-1), 1408 kg cumin (RZ-190 under the Central Sector Scheme.

Jagudan: Under the Spices Board Scheme 430 kg Cumin (Guj. Cumin-1), 210 kg fennel (Guj. Fennel-1)m 45 kg fenugreek and under IPDS scheme 60 kg cumin (Guj. Cumin-1) and 200 kg fenugreek (Local) were produced by Jagudan centre.

KRISHI VIGYAN KENDRA

The Krishi Vigyan Kendra (KVK), Peruvannamuzhi, Calicut District, funded by the Indian Council of Agricultural Research, New Delhi was established on 16th November 1992 has started functioning during the year. As a humble beginning, with the available facilities and staff, the KVK has made rapid strides in transfer of technology by way of front line demonstrations, exhibitions, oncampus and off campus training, radio talks and farm advisory services.

During the year 1993-94, a total of 16 training programmes were conducted for the practicing farmers, rural youth and agricultural students and extension workers. To assess the training needs of the farming community of the district, a bench mark survey was initiated and is in progress. A front line demonstration in black gram was also conducted in three farmers fields in Mukkom panchayat with the assistance of the Karasserry Krishi Bhavan.

Five radio talks were also organised on the various aspects of spices production technology including nutrition, control of pests and diseases, quality control and marketing of spices.

Four demonstration plots, two at Peruvannamuzhi, one at the Calicut University campus and one at West Hill, Calicut were established to enlighten the farmers, students and other sections of the society regarding spices cultivation and the potential for intercropping of spices in coconut based cropping system.

Regarding construction of infrastructure facilities and recruitment of staff, the plans and estimates of the main building - Administrative cum farmers' Training block - were got prepared and approval and expenditure sanction obtained from the Council. The plans and estimates of the other buildings viz.,

Farmers' hostel, Home science block, cattle poultry, goat and piggery sheds are being taken up in a phased manner depending upon the budgetory provisions provided by the Council. As regards to the recruitment of staff, 2 posts of Training Associates (T6), one post of Training Assistant (T4), one post of Office Superintendent, one Junior Stenographer, one Junior Clerk and three posts of Supporting staff including a Driver, Watchman and Peon-cum-Messenger were already filled up. The remaining posts are also being filled in a phased manner.

During the short span of one year, KVK has estblished linkages with various organisations like Directorate of Cocoa Arecanut and Spices Department of Agriculture, Kerala Agricultural University, Spices Board, Centre for Water Resources Development and Management, University of Calicut and other extension and developmental agencies.

The location of KVK, being in a remote place, about 55 km from Calicut city, the lack of accommodation for the trainees, especially for the farmers and rural youth, is a major constraint for conducting long term vocational training programs, essential for enabling them for self employment. Once this is overcome, there are ample scope for such programs with the collaboration of various agencies like District Rural Development Agency, Science and Technology Entrepreneurship Development Project, and other research and developmental organisations.

STATUS REPORT: CHARACTERIZATION OF DROUGHT TOLERANCE IN BLACK PEPPER

(A. Ramadasan and S. Vasantha)

With the scope of improving productivity of black pepper under rainfed conditions, a study on characterization of drought tolerance was initiated during 1986 at National Research Centre for Spices, Calicut with the following objectives.

1. To identify characters related to drought tolerance and
2. To evaluate germplasm to locate drought tolerant genotype(s).

Technical programme

1. Characterization of drought tolerance
2. Screening of germplasm lines
3. Field evaluation of selected genotypes.

Materials and Methods

i) Plant materials: Three node pepper cuttings were planted in 12" earthern pots and allowed to establish. When plants were six months old, they were used for screening work. One and half year old vines planted in cement tub were used for characterization work.

ii) Characterization work: Cultivars used were Karimunda, Kalluvally, Kottanadan, Kuthiravally, Neelamundi, Aimpiriyan, Arakulammunda and Panniyur-1. For screening work, Karimunda selections 84, 195, 69, 95, 140, 81, 73, 141, 112, 125, 158, 63, 183, 117, 114, 159, 60, 83, 94, 154, 25, 51, 62, 70, 80, 85, 98, 163 and 176 were used.

iii) Methodology: Moisture stress was imposed by withholding irrigation during summer (January - April). Popular cultivars were planted in cement tubs (50 x 70 cm), trained on teak poles. When the vines were one and half year old, moisture stress treatment was imposed.

Control plants (five number for each cultivars) were watered regularly to maintain soil moisture at field capacity.

iv) Observations recorded:

1.Soil moisture content

2.Agro climatic parameters such as relative humidity (%), leaf temperature and radiation interception.

3.Physiological parameters such as Transpiration rate (TR), stomatal resistance (rs) and water potential (Y) on youngest fully matured leaf.

4.Growth parameters like leaf expansion rate (length and width wise for just opened leaves and leaf area development. Leaf area was calculated using the mathematical formula suggested by Shivashankar and Rohini Iyer (1986).

5.Biomass partitioning and root/shoot ratio were studied in one and half year old vine in three popular cultivar, Karimunda, Kalluvally and Panniyur-1.

6.Biochemical characteristics studied include total chlorophyll and carotenoid pigments free proline and enzyme activities viz., Nitrate reductase, peroxidase and acid phosphate. Activity maxima. for the enzymes was worked out for black pepper.

v) Indexing for drought tolerance:

Indexing was done based on the response of different parameters to soil moisture deficit (at critical soil moisture content. Critical soil moisture content was determined from stomatal response to depleting soil moisture. Stomatal resistance was taken on Y axis and soil moisture content on X axis; half max for stomatal resistance was drawn. This facilitated fixing of soil moisture content. Stomatal resistance was taken in X axis and transpiration rate in Y axis. Half max line of both parameters divided the graph into four blocks. cultivars were placed in different blocks based on their data for stomatal resistance and transpiration rate at critical moisture content and cultivars belonging to I block (ie. higher Y_S and low TR) were considered relatively tolerant.

vI) Laboratory tests:

1.Chlorophyll stability index (CSI): Leaf discs from different cultivars were suspended in 10 ml of distilled water,heated in a thermistatic water bath at 60°C for one hour or kept in distilled water at room temperature (Control) and absorbance read at 663mm./ The difference in absorbance between control and treatment was represented as CSI.

2.Membrane stability: Cell membrane stability was estimated by per cent injury to leaf discs of popular black pepper cultivars subjected to desiccation and heat treatments.

Results and Discussions:

I).Characterization of drought tolerance:

Developmental, physiological and biochemical responses to moisture stress apart from laboratory tests were conducted to study their utility in screening large germplasm lines.

1. Developmental responses: Leaf expansion rate showed a decline both in control and stress treatments, However, the expansion ceased in the stress treatment on the 26th day (much before leaf water potential (ψ_L.) SMC reached critical levels) while in control the leaf expansion continued at a decreased rate. Therefore based on leaf expansion rates, screening cultivars for drought tolerance may not be useful. The leaf area development was also affected by moisture stress.

ii)Studies on biomass partitioning and root : shoot ratio for three popular cultivars indicated that, biomass allocation for stem was maximum followed by leaves and roots in all the cultivars. Root: Shoot ratio was higher in Cv. kalluvally compared to the rest.

iii) Physiological response: In general stomatal resistance increased in all the cultivars studied and transpiration rate decreased. Leaf water potential became more negative in all the cultivars under moisture stress. Two cultivars viz., Kottanadan 14 and Kalluvallay 880 with moderately high stomatal resistance and lower transpiration rate are considered tolerant.

iv) Biochemical responses: Activity maxima of Nitrate reductase was obtained at the following conditions:

Incubation time	5 hour
pH	7.0
Phosphate conc.	0.1M
Nitrate conc.	0.1M

Activity of Nitrate reductase declined, where as activity of peroxidase and acid phosphatase increased due to moisture stress. Cultivars response varied with respect to these enzyme activities. Proline content increased in all the cultivars significantly over the control. Total chlorophyll ranged from 1.2 to 4.9 mg 1g fresh weight and carotenoids ranged from 0.3 to 1.3 mg/ g. Cultivars varied significantly for the pigment reduction due to heat treatment.

v)Laboratory test: i) Chlorophyll stability Index (CSI): Kalluvally and Arakulammunda showed lower CSI compared to other cultivars studied. Lower values indicate less effect on photosynthetic machinery.

ii).Membrane stability: Membrane stability test indicated that cultivars difference in response to desiccation is highly significant and hence the usefulness of the test for screening large germplasm for drought tolerance.

2.Screening Karimunda selections and germplasm lines:

Tolerant cultivars are Kottanadan (1495) and Kalluvally (931). Among high yielding Karimunda selections, selection 69, 114, and 51 were more promising.

3.Field evaluation

Promising lines identified from the screening work were planted in the field to test their field tolerance. During June 1989, Karimunda selection 69 along with Kottanadan (1495) were planted in the field and all cultural practices were carried out including irrigation during summer for better establishment in the first year. From the second year of planting these were maintained as rainfed crop and various physiological observations were recorded in the field. In 1990, Karimunda selection 51, 114, 92 and Kalluvally and Panniyur-1 were planted for field evaluation.

Monthly observations on soil moisture indicated that soil moisture depletion started from October and reached a level of 10% during April. Stomatal resistance reached a peak in the month of March to April. However, a small peak was observed in December in cv. Kottanadan. TR showed a reverse trend to $r_s\psi_L$ decreased with stress intensity.

It is justifiable from the above information that soil moisture has a profound effect on the physiological parameters. As the soil moisture depletes, the plants adapt to the stress situation through stomatal regulation by cuttings down transpiration.

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PARTICIPATION IN SYMPOSIA / SEMINARS / GROUP MEETINGS / CONFERENCES / TRAINING PROGRAMMES

1. Staff Research Council Meeting, Indian Caradamom Research Institute , Myladumpara, 19 - 20 April, 1993.

   K.V.Peter, A.K.Sadanandan, B.Sasikumar

2. National Seminar Post Harvest Technology of Spices, Regional Research Laboratory, Thiruvanandapuram, 13 - 14 May 1993.

   K.V.Peter, A.Ramadasan, P.N.Ravindran, K.V.Ramana, Jose Abraham, K.Sivaraman, S.Devasahayam, G.N.Dake, M.Anandaraj, T.John Zacharia, B.Sasikumar, K.Nirmal Babu and R.Ramakrishnan Nair.

3. Golden Jubilee Symposium of Horticultural Society of India, Bangalore, 24-28 May 1993.

   K.V.Peter and J.Rema

4. Computer Application in Agricultural Research Management, NAARM, Hyderabad, 15-25 June, 1993.

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5. Group meeting on Virus diseases of Cardamom with special emphasis on 'Kokke kandu' a new viral disease. S.V.University, Tirupathi, 13 April, 1993.

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6. National group meeting (XII Workshop) of research workers of AICRPS, Kerala Agricultural University, Thrissur, 26 -29 July 1993.

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7. National Symposium on Recent approaches in integrated nematodes management of agricultural crops, HAU, Hissar, August 6 - 7 1993.

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8. Short term training course on Techniques in isolation and bioimmunological characterization of proteins, Institute for research in reproduction, Bombay, 13 - 30 August 1994.

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9. Symposium on Impact of Biotechnology on Agriculture and Health care in India, Centre for Biotechnology, Anna University, Madras, September 9 1993.

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10. Seminar on conservation of endangered fauna of Malabar, Calicut September 11 1993.

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11. Short term training course on techniques for protoplast based plant regeneration, Indian Institute of Science, Bangalore, 1 -6 November 1993.

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12. National seminar on changing scenario of bird ecology and conservation, Bangalore, 12-14 November 1993.

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13. Pepper Seminar, Nagercoil, December 2 1993.

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14. Group meeting to discuss the implementation of central sector schemes for development of plantation crops, spices, medicinal and aromatic plants during VIII plan, Hyderabad, 9 - 10 November 1993.

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15. International Symposium on "A decade of potassium research" New Delhi, 18 - 20 November 1993.

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16. Research advisory committee meeting of National Horticultural Research and Development Foundation, 31 August and 28 December 1993.

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17. International Seminar on managing red and laterite soils for sustainable agriculture, Banglore, 24 -29 September 1993.

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18. National group meeting of scientists working under AICRP on medicinal and aromatic plants, Kerala Agricultural University, Vellanikkara, Thrissur, 17 - 18 January 1994.

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19. National Symposium on integrated input management for efficient crop production, TNAU, Coimbatore, 22-25 February 1994.

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20. Workshop on Bioinformatics and CD-ROM information retrieval, TNAU, Coimbatore, March 16 - 18 1994.

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21. Second Asia Pacific Conference on Agricultural Biotechnology, Madras, 6-10 March 1994.

    Y.R.Sarma, P.N.Ravindran, M.Anandaraj and K.Nirmal Babu

22. Regional Committee meeting (VIII) of ICAR, Bangalore, January 20 - 21 1994.

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Tech. Officer(T5)- Farm

L. BALAKRISHNA
Jr. Technical Assistant (T1)

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

K. ANANDA
Jr. Technical Assistant (T2)

G. ARUMUGHAM
Jr. Technical Assistant (T1)

Auxiliary

H.G. NANAMAIAH
Driver (T-1-3)

Supporting

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

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

K.M. THIMMAIAH
SS. Gr. III(Watchman)

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

B.R. JANAK
SS.Gr.II(Mazdoor)

M.G.MARINANJAMMAI
SS. Gr.II (Mazdoor)

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

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

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

GOWDIGERE SHETTY
SS. Gr.II (Mazdoor)

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

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

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

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

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

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

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

S. MAHADEVA
SS. Gr.I (Mazdoor)

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

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

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

BUDGET - 1993 - 1994

1. Plan-75 Lakhs
2. Non-plan-78 lakhs
3. AP cess scheme-1.85 lakhs
4. Krishi Vigyan Kendra-27-18 lakhs

STAFF POSITION AS ON 31.3.1994

	Sanctioned	Filled	Vacant
Scietific	41	30	11
Administrative	18	18	--
Technical	28	28	--
Spportn	62	61	1
Auxilliary	5	5	--
Total	154	142	12

LIBRARY

Twenty six books, 113 bound volumes and 63 reprints apart from subscribing 90 Indian and 56 foreign journals. Twenty seven foreign and Indian journals were also received on gratis in addition to Annual reports, technical reports and newsletters from ICAR institutes and Agricultural Universities.

"Bibiliography on Spices" is published regularly in "Jounal of Spices and Aromatic Crops published by the Indian Society for Spices. Four issues of "Agri Science tit bits" were compiled and distributed to various agencies involved in spices research and development. Reprographic services of up to 80,00 pages were made availble to scientists of the research centre. One hundred and twenty six research workers from different Institutes / Universities / Colleges utilized the library facilities availble in the research centre. Interlibrary loan facilities were introduced in the library. Annual reports and other publications of the research centre were mailed to various organisations / institutes.

IMPORTANT VISITORS

Dr.A.M.Michael
Vice- Chancellor
Kerala Agricultural University
Vellanikkara, Thrissur

Dr.G.L.Kaul
Horticultural Commossioner
Government of India

Dr. N.M.Nayer
Officer on Special Duty
Indian Agricultural Research Istitute
New Delhi

Dr.P.C.Sivaraman Nair
Chairman, Quinquennial Review Team

Dr.R.Vikraman Nair
Member
Quinquennial review Team

Dr.K.R.Maurya
Member
Quinquennial Review Team

Dr. K.I.Wilson
Member
Quinquennial Review Team

Dr.P.C.Sundarababu
Member
Quinquennial Review Team

Dr.A.V.Rai
Zonal Coordinator(KVK)

Dr(Mrs).Suseela Thirumaran
Member QRT(KVK)

Dr.A.Kadaswamy
Member QRT(KVK)

Prof.Sulladmath
Member QRT(KVK)

Mr.S.Sadasivan
Director of Agriculture
Government of Kerala

Dr.Mohammed Kunju
Director of Academic and PG Studies
Kerala Agricultural University
Vellanikkara, Thrissur

Mr.Ujagar Singh
Director of Horticulture
Government of Tamil Nadu

Mr. V.Krishna Brahmam
Director, CEDT, Calicut.

Mr.Walter Bonhaulf
UNDP Expert
Mr.S.K.Sharma
PRO, ICAR, NEW Delhi

Mr.Jayaraj
Agriculture Correspondent, UNI

Mr.M.Suresh
Science correspondent
Times of India

Mr.M.Somasekhar
Science Correspondent
The Hindu

Mr.G.K.Sinha
Special Correspondent
PTI

RAINFALL DATA OF PERUVANNAMUZHI FARM

Months	Rainfall(mm)	No. of Rainy days
April 1993	117	7
May	411	14
June	771	26
July	1207	30
August	708	29
September	128	13
October	793	27
November	158	10
December	79	3
January 1994	68	2
February	-	-
March	54	2