ANNUAL REPORT

1991 — 92

भाकृअप
ICAR

NATIONAL RESEARCH CENTRE FOR SPICES

(Indian Council of Agricultural Research)

CALICUT - 673 012 KERALA INDIA

ANNUAL REPORT

1991 — 92

NATIONAL RESEARCH CENTRE FOR SPICES

(Indian Council of Agricultural Research)

CALICUT - 673 012 KERALA INDIA

Published by:

Director
National Research Centre for Spices
Calicut - 673 012
Kerala, India.

Compiled and edited by:

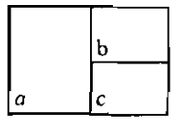
José Abraham and K Nirmal Babu

Citation:

National Research Centre for Spices, 1992.
Annual Report for 1991-92, Calicut. Kerala, India.

Cover photo:

Biological Control of black pepper top shoot borer -
a. Damage caused by top shoot borer
b. Adult, c. Larva infested by *Hexamermis* sp.



Composing, Layout designing and Printing

Carmel Industries,
Cochin - 31

CONTENTS

DIRECTOR'S REPORT

The National Research Centre for Spices, Calicut was established in April 1986. It's mandates include conduct and co-ordination of need based research on all aspects of spice crops, establishment of global gene bank for spices, evolution of varieties/hybrids with high yield, better quality and resistance to biotic and abiotic factors, and identification of low input responsive genotypes for use in sustainable cropping systems and varieties suited for export. Development of appropriate production technologies including plant protection and biocontrol, production of quality planting materials and transfer of technology(s) are a few of other mandates of the Research Centre. The year 1991-92 witnessed emphasis on germplasm enrichment, standardisation of vegetative propagation methods in tree spices, in vitro mace production, biological control of insect pests of black pepper and quality studies on turmeric, cinnamon and nutmeg. Production and distribution of quality planting materials of black pepper, turmeric, clove, cinnamon and nutmeg were given added importance. Biotechnology of spices received special attention during the year.

Strengthening basic facilities

Basic facilities like one HPLC unit, Electrophoresis LKB, Stereo microscope, Automatic Nitrogen analyser and Shimadzu Spectrophotometer were added during the year. Structural facilities are developed to produce 2 lakh single node pepper cuttings and 50000 plantlets of tree spices per year. The National Informatic Centre on Spices is being further strengthened.

All India Co-ordinated Research Project on Spices

Tree spices, nutmeg and cinnamon are added to the all India Network. Two more centres are added to the AICRP on Spices during VIIIth plan period.

Staff and Budget

The sanctioned staff strength of NRCS is 154 consisting 41 scientific, 18 administrative, 28 technical, 5 auxillary and 62 supporting staff. During 1991-92, the actual expenditure was Rs.81 lakhs under plan and Rs.86 lakhs under Non-plan totaling Rs.167 lakhs.

Research Programmes

The Research Programmes of NRCS are organised into three Mini Missions and a Supportive Research Programme. There are 14 projects under Mini Mission I, 3 under Mini Mission II, 12 under Mini Mission III and 2 under Supportive Research Programmes. During the year, the project on "Investigation on rhizome rot disease of cardamom" was concluded and the final report is being prepared.

Research Council Meetings

The fifth Annual Research Council Meeting was held in May 1992. It reviewed the progress of research projects and approved new programmes.

New Research Projects

The Department of Biotechnology sanctioned two new schemes, one on "In vitro conservation of pepper and cardamom germplasm" and another on "Rapid multiplication of tree spices other than allspice". The IPDS scheme funded by Ministry of Agriculture GOI is further strengthened.

Calicut
20-11-92

(K.V.PETER)
Director

RESEARCH HIGHLIGHTS

Genetic Resources

Germplasm of spices was further enriched by adding 56 collections consisting of 11 *Piper* species, 2 species each of *Zingiber* and *Curcuma*, 27 collections of *Cassia*, three wild cinnamon, two *Cinnamomum tamala* (Tejpat), 55 collections of *Myristica* and other related species.

Cytological studies revealed that the chromosome number of *P. barberi* is 2n=52 and the chromosome length ranged from 0.74 to 1.85μ.

A catalogue was prepared for 100 cultivated black pepper accessions.

Crop Improvement

Black pepper hybrids HP-732 and HP-813 were superior among 100 hybrids evaluated at high altitutde at Valparai. A natural triploid of cultivated black pepper is identified for the first time with a somatic chromosome number of 78. Progenies of this cultivar exhibited high quantitative variation for many seedling traits and their somatic chromosome number (2n) varied from 52 to 104.

In cardamom 19 "katte" escapes continued to show resistance in field evaluation. Ginger cultivar 'Wynad local' was superior in yield at Peruvannamuzhi and Moovattupuzha. Considerable variations in biometrical characters were observed in 100 ginger germplasm collections. Evaluation of OP progenies of turmeric revealed that a line derived from Moovattupuzha Local is superior in yield.

In tree spices, 52 elite nutmeg trees were identified for seed collection. Progenies of 9 elite cinnamon lines showed significant variation in bark oil and leaf oil. In cinnamon germplasm, significant variations were observed in dry weight and fresh weight of bark. Bark oil content and leaf oil content were negatively correlated.

Juvenile allspice cuttings dipped in a commercial rooting hormone gave 50% rooting,

Biotechnology

Micropropagation of *Piper colubrinum* and *P. longum* were standardised. Shoot tip cultures of endangered species *P. barberi* were established. *In vitro* fruit formation was achieved in single flower as well as inflorescence cultures of ginger. *In vitro* proliferation of mace (aril of nutmeg) was made possible by culturing fully matured mace.

Quality Evaluation of Spices

Black pepper accessions, CLTP-49, 56 and 194 were rich in essential oil, oleoresin and piperin. Drying black pepper on polyethylene sheets helped in getting dirt free produce in the shortest time. In turmeric, no significant change was found in curcumin and oleoresin levels due to storage of rhizomes.

Crop Nutrition

Studies on nutritional requirement of bush pepper showed that bimonthly application of NPK @ 1.0, 0.5 and 2g/pot of 10 kg soil as optimum. For turmeric, NPK @ 60:60:120 kg/ha was optimum and among cultivars, maximum response was in Sudarshana. In ginger, application of organic cakes significantly increased soil availability, uptake of nutrients and increased yield by 12% over fertilizer applied plots.

Crop Protection

Dimethomorph, a new anti-oomycetous fungicide was found highly sensitive *in vitro* to *Phytophthora capsici* of black pepper.

Two bacterial isolates *(Pseudomonas sp.)* showed *in vitro* inhibition against *P. capsici*. Inoculation of black pepper with VAM fungus *Glomus fasciculatum* prior to inoculation of three major root pathogens viz. *P. capsici*, *R. similis* and *M. incognita* reduced root damage and enhanced growth.

Infestation of top shoot borer *(Cydia hemidoxa)* on young black pepper vines retarded the growth significantly. Viz. *Hexamermis* sp., *Clinotrombium* sp. and *Apanteles cypris* were new records as natural enemies of top shoot borer.

A new virus disease of cardamom which causes typical vein clearing on leaves was identified in Hongadahalla zone of Karnataka. Experimental transmission of this virus through aphid vector *Pentalonia nigronervosa f. caladi* was established.

Rotylenchulus reniformis was recorded on cardamom roots for the first time.

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

The AICRP on spices holds germplasm of nine spices. A germplasm collection of 311 black pepper, 352 of small cardamom, 34 of large cardamom, 307 of ginger, 532 of turmeric, 997 of coriander, 468 of fenugreek, 391 of cumin and 314 of fennel are maintained at various centres.

Eleven varieties of spices consisting of 2 in black pepper, 5 in small cardamom, one in ginger, 2 in coriander and one in cumin were recommended for release. In cardamom, clone P-6 showed good degree of drought tolerance.

NPK @ 14,60,180 kg/ha gave the highest yield in turmeric. Red gram and French bean were good intercrops for ginger. Sowing of cumin at 22.5cm row spacing and at a seed rate of 12 kg/ha are recommended for maximum yield.

अनुसंधान उपलब्धियाँ

जेनेटिक रिसोर्सस्

मसालों के जर्मप्लास्म को वन्य तथा उन्नत किस्मों के 56 नमूने मिलाकर और भी बढ़ाया गया। उसमे 11 पैपर स्पेसिज, 2 अदरक, 2 हल्दी, 2 7 तेजपात, 3 दालचीनी (वन्य) 2 सिनमन् टमला, 5 मिरीस्टिका शामिल है।

सौयटालाजिकल परीक्षण से पी. बारबेरी मे 2 एन = 52 क्रोमोझोम तथा उनकी लम्बाई 0.74 से 1.85μ तक पायी गयी।

सौ उन्नत काली मिर्च के ऑकसेशन के वर्णक्रमानुसार सूचीपत्र तैयार किए गए।

क्रॉप इमप्रूवमेन्ट

काली मिर्च के वर्ण संकरण (हाइब्रिडस) एच पी 732 और एच पी 813 उँचाई के परीक्षण से वालपाराई में बेहतर पाये गये पहली बार उन्नत काली मिर्च का एक प्राकृतिक ट्रिपलॉइड (सैमीटिक नंबर 78) पहचाना गया। उनके नन्हें पौधों के लक्षणों में क्वॉन्टिटेटिव विभिन्नता दिखाई दी, तथा सैमीटिक नंबर 2 एन = 52 से 104 तक पाये गये।

इलायची के 19 इस्केपस खेत के परीक्षण में कट्टे (katte) प्रतिरोधक पाये गये।

अदरक की उन्नत किस्म (वायनाड लोकल) की पेरुवन्नामुषि तथा मुवाट्टुपुषा में बढ़िया उत्पादन पाया गया।

अदरक के 100 जर्मप्लासम के नमूनों के बायोमेट्रिकल लक्षणों में अधिक विभिन्नता पाई गयी।

मुवाट्टुपुषा लोकलसे उदभूत हुई हल्दी की लाईन के ओ. पी. प्रॉजनिस परीक्षणों में बढ़िया उत्पादन मिला।

जायफल के बीज कलेक्शन करने के लिए किसानों के खेतों में 52 ऍलीट पेडों को पहचाना।

दालचीनी के नौ ऍलीट लाईन के प्रॉजेनिज के परीक्षणों में उनके लक्षणों में अर्थपूर्ण विभिन्नता दिखायी गयी।

दालचीनी के जर्मप्लासम के छाल के सूखा और ताजा भार में अर्थपूर्ण विभिन्नता मिली है, लेकिन छाल तेल तथा पत्तों के तेल में नकारात्मक परस्पर सम्बन्ध देखा गया।

ऑल स्पाइस कटींगस कॉमरशल रूटींग न्यासर्ग (हारमोन) में डुबाने से पचास प्रतिशत ज़्यादा जड़ों की पैदाइ हुई।

बायोटेक्नालीजी

पैपर कोलुब्रैनम और पैपर लोंगम के सूक्ष्मसंसाधित विधि (माइक्रो प्रापोगशन) विकसित की गयी।

पी. कोलुब्रैनम तथा एन्डेन्जरड प्रजातियो पी. बारबेरी के शूट (तनों) टिपस स्थापित किये।

अदरक के अमिश्रित पुष्प और इनफलोरेसनस, कलचर से इन विट्रो में फल बना पाया गया।

परिपक्व जावित्री कलचर करने से जावित्री में वृद्धि हो गयी।

मसालों का गुणवत्ता-परीक्षण

काली मिर्च के 56 ऑक्शनस की तुलना में सी. एल. टी. पी. 49, 56, और 194 में पैपरिन ओलियोरेसिन, एसनषियल आयिल की मात्रा अधिकतम पायी गयी।

काली मिर्च पॉलिथिन शीट पर सुखाने से साफ और कम अवधि में सुखा गई।

हल्दी के कन्द भंडार करने से कुरकुमिन और ओलियोरेसिन की मात्रा में कोई फरक नहीं पाया गया।

क्रॉप नूट्रिशन

बुश मिर्च के लिए एन. पी. के 10:0.5:2 ग्राम मात्रा/गमला की दर पर दो महिने में एक बार देना बढिया पाया गया। हल्दी को 60:60:120 किलोग्राम एन. पी. के./हे काफी पाया गया। अन्य उन्नत जातियों में से सर्वाधिक सुदर्शना का रिस्पॉन्स मिला। सेन्द्रिय केक्स का अदरक को फसल के लिए प्रयोग करने से उर्वर खाद की तुलना से अधिक मात्रा में पोषक वस्तुओं की मिट्टी में उपलब्धता पायी गई। तथा पौधे ज़्यादा मात्रा में शोषण (अपटेक) कर पाये इसलिए उत्पादन में 12 प्रतिशत बढत हो गयी।

क्रॉप प्रोटेक्शन

इन विट्रो परीक्षणों में फाइटोफथोरा कापसिसी के विरुद्ध डायमेथोफॉर्म प्रभावी पाया गया। फायटोफथोरा कापसिसी की बढत दो सुडोमोनास, स्पेसिज (जीवाणु) के प्रयोग से रोकी गयी। ग्लोमस् फेक्सकुलेटम (VAM) का प्रयोग (काली मिर्च के तीन जडों की बिमारियों के रोगात्मक कीटाणु लगाने के पहले) करने

से पी. कापसिसी, रोडोफोलस सिमीलिस तथा मेलोडोगयन इनकाग्निटा से काली मिर्च के जडों को कम हानि पहुँचाई पौधों की अच्छी बढ़त हुई।

काली मिर्च की बडी लता टॉप सुर बोररसे से (सायडिसा हेमिडोक्सा) पीडित होने से उनकी बढत में बाधा आयी।

निमाटोडस, माइटस, तथा हायमेन्प्टेरा जो पहली बार टॉप शूट बोरर के प्राकृत्तिक दुश्मन के रूप में पाये गये थे, उनकी पहचान की गयी (हेक्सामरमिस स्पे) कॅलनोद्रोम्बीयम स्पे (अँकरिना) और अँपान्टेलिस सायप्रिस ।

कर्नाटक राज्य के होगाड्हाला विभाग में इलायची के रोगकारक विषाणु से होनेवाली बिमारी की पहचान की उसमें पत्तियों के शिरों की (लाक्षणिक रूप से) कलीअरिंग होते हुई पायी गई। रोगकारक विषाणु का फैलाव पेन्टालोनिया नायग्रोनरहोसा कालाडी नामक ऑफिडस् द्वारा होता है।

रेटीलेक्युलास रेनिफॉर्म निमाटोड पहली बार इलायची के जडों को हानि पहूँचाते हुए पाए गए।

अखिल भारतीय समन्वित अनुसंधान परियोजना (मसालों पर) नौ मसाले फसलों के जर्मप्लासम 3011, काली मिर्च 352 छोटी इलायची, 34 बडी इलायची, 307 अदरक, 532 हल्दी, 997 छनियों, 468 मेथी, 391 जीरा और सौंफ, 314 ए. आई सी. आर पी. (मसालों पर) के केन्द्रों में बनाई रखी हैं।

काली मिर्च के दो, इलायची 5, अदरक 1, छनियों 2, जीरा शूट की किस्मों को बाहर करने की सिफारिश की गई।

इलायची के कलोन (पी. 6) उषर प्रतिरोधक दिखाई पडे।

हल्दी को 140:60:180 किलोग्राम एन. पी के./ हे देने से ज़्यादा उपज मिली अदरक के बीच (Inter cropping) तुअर और फ्रेंच बीन की फसल लेने से अदरक की फसल बेहतर दिखाई पडी जीरा की ज़्यादा उपज लेने के लिए पंक्ति में 22.5 से मी. की दूरी और 12 किलोग्राम/ हे बीज बोने की सिफारिश की गयी है।

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

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

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

a. Interaction of *Phytophthora* and nematodes

The experiment on interaction of *Phytophthora* and plant parasitic nematodes in causing slow decline disease of black pepper under simulated field conditions was continued. The declining symptoms noticed in the vines inoculated with *Phytophthora capsici*, *Radopholus similis*, *Meloidogyne incognita* or their combinations were similar (Fig 1 a b c) indicating that feeder root loss caused by any of these pathogens leads to declining symptoms. In treatments where *P. capsici* was inoculated alone or in combination with *R. similis*, 50 per cent mortality was noticed, 18 months after inoculation, there by indicating that combined infection enhances the root rot (Table 1).

b. Effect of VAM on pathogens of black pepper

The effect of VAM on root rot of black peper caused by *P. capsici* and nematodes was studied in a pot culture experiment. A split plot design with and without VAM inoculation as main plot treatments and inoculation of pathogens viz. *P. capsici (P.C.)*, *R.similis (R.S.)*.

Fig : 1 Symptoms of slow decline in black pepper - Symptoms caused by (a) *P. capsici*, (b) *P. capsici* + *M. incognita*, (c) *R. similis*

Table 1. Interaction of *Phytophthora* and nematodes in causing slow decline in black pepper

Treatment	Vines showing no symptoms (%)	Vines showing declining symptoms (%)	Vines dead (%)
P.C.*	33.3	16.7	50.0
*R.S.***	33.3	33.3	33.3
M.I.***	100.0	0.0	0.0
**P.C + R.S*	50.0	0.0	50.0
P.C + M.I.	66.7	33.3	0.0
R.S. + M.I.	66.7	0.0	33.3
P.C + R.S + M.I	0.0	66.7	33.3
Control	100.0	0.0	0.0
Control + Phorate + Copper oxychloride	100.0	0.0	0.0

* R.S *Radopholus similis*
** P.C *Phytophthora capsici*
*** M.I *Meloidogyne incognita*

P.C. + R.S. and R.S. + M.I., P.C. + R.S. + M.I., P.C. + M.I and control as sub plot treatments was adopted with four replications. VAM was inoculated prior to inoculation of pathogens. Growth parameters were recorded at monthly intervals and root rot was scored adopting a scale of 0-3.

VAM inoculated plants showed enhanced growth and dry matter production irrespective of presence of pathogen (Tables 2 & 3).

Table 2. Effect of VAM inoculation on growth of black pepper cuttings : (Mean plant height in cm)

Subplot (s)	V	NV	S-Mean	Diff.
CON	348.50 b	172.25 a	260.38	176.25
PC	420.50 a	91.75 g	256.13	328.75
RS	296.00 c	150.75 b	223.38	145.25
PC + RS	190.50 e	144.00 c	167.25	46.50
RS + MI	223.00 d	112.75 f	167.88	110.25
PC + RS + MI	176.25 g	131.50 e	153.88	44.75
PC + MI	185.75 f	133.25 d	159.50	52.50
M-Mean	262.93	133.75	198.34	129.18

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

Table 3. Effect of VAM inoculation on root rot of black pepper

Subplot(s)	V	NV	S-Mean	Diff
CON	0.00 f	1.00 e	0.50	-1.00
PC	0.75 e	3.00 a	1.88	-2.25
RS	2.25 a	2.00 d	2.13	0.25
PC + RS	1.75 c	2.00 d	1.88	-0.25
RS + MI	2.00 b	2.50 c	2.25	-0.50
PC + RS + MI	2.00 b	3.00 a	2.5	-1.00
PC + MI	1.00 d	2.75 b	1.88	-1.75
M-Mean	1.39	2.32	1.86	-0.93

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

c. Mode of survival

P. cvapsici was cultured with vital flourescent strains and introduced into soil. Periodic observations showed presence of chlamydospores in addition to mycelial pigments.

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

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

Three field trials laid out at Peruvannamuzhi, Wynad and Idukki during 1990 with 12 treatments each in Wynad and Idukki and 14 at Peruvannamuzhi, consisting of systemic and non systemic fungicides, with different frequencies were continued. Clear cut indication on the efficacy of the treatments has not been obtained so far. Appreciable remission of foliar yellowing and defoliation were not noticed. However treatments are superior to control.

Metalaxyl-chlorothalonil, Metalaxyl-copper, Metalaxyl-ziram and Metalaxyl-mancozeb were tested for their comparative efficacy in pot culture @ 10 pots/treatment with 3 rounds of soil drenching at 100 ppm metalaxyl concentration. Of these, Metalaxyl-ziram and Metalaxyl-mancozeb gave comparatively better disease suppression (Table 4). Dimethomorph, a new anti-oomycetous systemic fungicide inhibits growth and sporulation of *P. capsici* even at 5 ppm, and its *in vivo* efficacy is being tested.

Table 4. Efficacy of metalaxyl formulations on *Phytophthora* foot rot in pot culture (10 pots/treatment)

Treatment	*Number infected
1. Metalaxyl-ziram (4:24)	0
2. Metalaxyl-copper (5:40)	1
3. Metalaxyl-mancozeb (8:64)	2
4. Metalaxyl-chlorothalonil (10:50)	4
5. Control	10

** No of plants infected out of 10 plants treated*

Two bacterial isolates *Pseudomonas* and *Trichoderma* sp. showed *in vitro* inhibition of *P. capsici* and also protective effects *in vivo* in pot culture with pepper seedlings.

A demonstration trial was taken up with Akomin and Bordeaux mixture to find out their comparative efficacy against *P. capsici* infection.

In view of the protective effect of VAM against *P. capsici, Radopholus similis* and *M. incognita* an observational field trial was laid out in an infected field to study performance of VAM inoculated black pepper. VAM inoculum was applied to nursery bags and were planted in the field. Initial indications showed better growth of treated plants compared to untreated plants.

3. Path II. 2 (813) : Screening germplasm materials for reaction to *Phytophthora* foot rot disease of black pepper

(Y.R. Sarma and M. Anandaraj)

a. Screening of OP Seedlings

Of the 31,600 seeds from 165 types sown in sterile soil, the germination percentage was 15.6 and 40 seedlings escaped disease. In sick soil, of the 1,38,025 seeds sown, the germination was 5 per cent, of this 10 seedlings have been saved for further testing.

b. Screening of rooted cuttings

Of the 300 types (cultivars and hybrids) screened , one cultivar (1485) and three hybrids HP-1026, HP-984, HP-96 gave tolerant reaction.

c. Field testing

At Sirsi of 15 tolerant types tested, P-24 and P-1352 after 5 years of evaluation were found healthy compared to other types which succumbed. In view of the good field tolerance of P-24 and P-1352, a large scale field evaluation trial was laid out in Areca-pepper crop mix. Accordingly P-24 and P-1352 alongwith P-339, P- 1534, P-107 (OP lines), KS-27, 1367 (Panniyur culture) and Malligesara were planted in 5 plots for further evaluation.

The other field evaluation trials of *Phytophthora* tolerant genotypes in Peruvannamuzhi and Valparai are in progress.

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

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

In field control trial, three fungicides viz. Ridomil MZ 72 WP, Copper oxychloride and Aliette and the nematicide Phorate were tested separately and in combination with Phorate. The rhizome rot severity in various treatments was assessed periodically by adopting 1-5 rating scale. All the fungicides and their combination with phorate reduced disease index significantly (Table 5). However, the combined treatment of Ridomil MZ + Phorate and Copper oxychloride alone were more effective in bringing down the disease index by 42- 50%, Phorate alone and in combination with fungicides could bring down the nematode population as compared to control and fungicidal treatments. Phorate application alone reduced rhizome rot severity by 27% besides reduc-

ing the nematode population by 46.30 - 82.77%. These results are in confirmity with the trend observed in the first two years's results.

Table 5. Effect of fungicides and phorate on rhizome rot severity in cardamom

	Treatments	Disease index (%) (Mean of 4 replications)
1.	Ridomil MZ 72 WP	13.43
2.	Aliette	18.48
3.	Copper oxychloride	13.64
4.	Ridomil MZ 72 WP + Phorate	12.52
5.	Aliette + Phorate	15.68
6.	Copper oxychloride + Phorate	12.13
7.	Phorate	15.21
8.	Control	21.04
	L.S.D (1%)	3.01

5. Path III. 3 (813) : Rhizome rot of ginger and Turmeric

(T.G.N. Rao and Y.R. Sarma)

Turmeric Storage rot : From the diseased seed rhizome, *Aspergillus* sp. *Fusarium* sp. *Rhizoctonia* sp. and a bacterium were isolated and pathogenicity tests are under progress.

Survey: A survey was undertaken in turmeric tracts of Wynad and disease incidence was negligible. From the rhizome rot affected samples, *Pythium* and *Fusarium* sp. were isolated and detailed pathogenicity tests are under progress.

6. Ent. X. (813) : Bionomics of major pests of black pepper and evolving integrated control measures against them.

(S. Devasahayam, K.M.Abdulla Koya & T. John Zachariah)

a. 'Pollu beetle' *(Longitarsus nigripennis)*

1. Screening of black pepper germplasm

The number of 'pollu' beetle infested berries were recorded on 30 cultivated germplasm accessions maintained at Peruvannamuzhi and identified as relatively 'resistant' to the pest in the field (based on previous years screening). However only seven of them viz., Accn. Nos. 816, 841, 994, 1057, 1060, 1079 and 1114 continued to be resistant this year also. Laterals of these accessions were raised for screening under insect cage conditions.

2. Studies with antifeedants

Four compounds with suspected antifeedant properties were isolated from *Piper attenuatum* (a known resistant species

of *Piper*) at Regional Research Laboratory, Trivandrum and crude extracts of the same species were tested for their antifeedant activity against 'pollu' beetle under laboratory conditions by adopting the leaf disc technique. Leaf discs of 1cm diameter were dipped in various concentrations of these compounds/extracts and the area fed by the beetles after a 24 h period was determined. The percent feeding deterrance (PFD) caused by various compounds/extracts was determined by using the relationship:

$$PFD = \frac{C-T}{C+T} \times 100$$

Where C = Area fed on control

T = Area fed in treatment

The crude extracts completely inhibited feeding at 6-8% concentrations. However, the four compounds did not exhibit appreciable antifeedant activity when tested upto 1% concentration (Table 6).

Table 6. Effect of crude extracts of *Piper attenuatum* on feeding behaviour of 'pollu' beetle

Concentrations %	RRL-7 (Hexane extract)	RRL-8 (Hexane extract)	RRL-9 (Chloroform extract)	RRL-10 (Methanol extract)
0.01	0.0	0.0	2.9	0.0
0.05	3.7	5.2	2.6	1.9
0.1	21.6	6.3	5.6	3.9
0.5	38.2	32.8	22.0	0.0
1	46.9	32.6	32.4	5.5
2	70.7	73.9	47.8	2.0
3	79.3	77.5	67.8	0.0
4	85.5	80.3	89.3	6.1
5	96.8	87.7	98.1	12.6
6	100.0	100.0	100.0	27.0
7	—	—	—	55.0
8	—	—	—	100.0

Values indicate Percent Feeding Deterrance

3. Reproductive biology

Studies on reproductive biology of 'pollu' beetle were initiated. Male and female beetles were dissected and the reproductive structures studied. The typical feature in the male reproductive system was presence of a single testis formed by fusion of four lobes. An accessory gland was also present. In females the ovary was composed of five to six ovarioles indicating its prolonged oviposition period. A spermatheca was also present.

The sex ratio, dry weight and water and fat contents which are important indices of the reproductive and physiological condition of field populations of male and female beetles were monitored at bimonthly intervals throughout the year. Sex ratio was fairly constant throughout the year with a preponderance of males, the female : male

ratio ranging from 1:1.1 to 1:1.5. Dry weight of females was higher than males throughout the year. In females, the fat content declined with the onset of breeding season. Water content was higher during the active feeding season and declined thereafter. Fat and water contents were higher in females almost throughout the year.

B. Top shoot borer *(Cydia hemidoxa)*

1. Nature of damage

A trial was undertaken on 1 year old vines (var. Panniyur- 1) at Peruvannamuzhi during July-December, to study effect of top shoot borer infestation on its growth and production of more number of branches. A CRD was adopted and there were four treatments viz. T1 - control (No infestation), T2 - One infestation, T3 - Two infestations, T4 - Three infestations. There were 25 vines per treatment. The number of infestations on the experimental vines were maintained at the desired levels by spraying with monocrotophos 0.05% at appropriate periods. At the end of the experimental period, the height of the vine and number of leaves and branches present were recorded and the data subjected to statistical analysis. There were significant differences in the height and number of leaves present on the vines under various treatments (Table 7). The height of vines was maximum in control (166.6cm) and minimum in vines with three infestations (72.2cm). The retardation in growth was mainly due to the delay caused in the production of a new shoot from an axillary bud subsequent to the drying of the old shoot due to the pest infestaion. The number of leaves was maximum in control (23.8) and minimum in vines with three infestations (10.1). There was no significant difference in the number of branches produced in various treatments. Hence the pest infestation is of no advantage in causing the production of more number of branches.

Table 7. Effect of top shoot borer infestation on young black pepper vines

Treatment	Height (cm)	Percentage reduction in height	No. of leaves	No. of branches
T1 - Control (No infestation)	166.6	—	23.8	1.8
T2 - (One infestation	140.0	16.6	21.0	2.1
T3 - (Two infestations)	108.0	35.0	15.0	2.2
T4 - (Three infestations)	72.2	57.0	10.1	2.0
CD (P=0.05)	10.7	—	1.6	NS

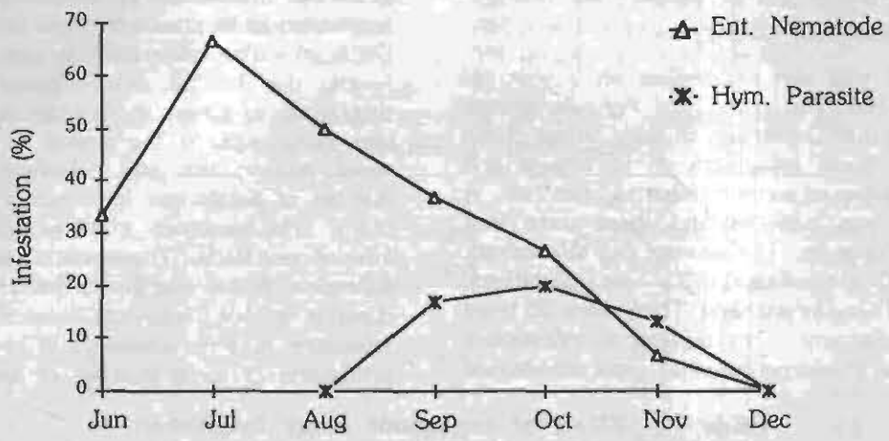
Figures indicate mean values

2. **Incidence of natural enemies**

The seasonal incidence of natural enemies of top shoot borer was studied by collecting the larvae from the field at monthly intervals from Peruvannamuzhi and observing the occurrence of natural enemies. The natural enemies obtained include *Hexamermis* sp. (Mermithidae : Nematoda), *Apanteles cypris* (Braconidae : Hymenoptera), *Goniozus* sp. (Bethylidae : Hymenoptera) and an unidentified species of hymenopteran parasite; the former two are new records for the pest. Infestation by the entomophagous nematode was as high as 67% during August and by the hymenopteran parasite as high

as 20 % during October (Fig.1) Each infested larva had 1-12 nematodes measuring 7 - 133 mm in length. The parasitic mite recorded on the larvae during the previous year was identified as *Clinotrombium* sp. (Trombidiidae : Acarina) which is a new record on the pest.

Fig. 2. Seasonal incidence of natural enemies of top shoot borer at Peruvannamuzhi



7. Ent. IX (813) : Studies on coccids infesting black pepper

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

a. Incidence of scale insects

Surveys were conducted in black pepper growing areas of Kerala, Tamil Nadu and Karnataka to record incidence of scale insects. Infestation by *Lepidosaphes piperis* ranged from 6.7 - 24.4% in Thiruvananthapuram district and 2.2 - 55.6% in Kodagu district. In the case of *Aspidiotus destructor* the range of infestation was 0 - 15.5% and 2.2 - 53.3% respectively, in these districts. Surveys were conducted in 9 locations in Thiruvananthapuram district and 15 locations in Kodagu district. Surveys conducted in Yercaud (Salem district) of Tamil Nadu indicated that *A. destructor* was the only species present and an average of 45.7% infestation was recorded.

b. Seasonal population of scale insects

The seasonal population of *L. piperis* and *A. destructor* were recorded at monthly intervals at Kalpetta (Wynad district). The population of *A. destructor* was low during April and steadily increased up to September. However, the population was low during October and December as compared to that of November. From January onwards the population increased.

The population of *L. piperis* was low during July and August. From January onwards there was increase in the population.

c. Seasonal population of natural enemies

The seasonal populations of natural enemies were also recorded at Kalpetta. During November and January, population of the coccinellid predators viz. *Cybocephalus* sp. and *Chilocorus circumdatus* were high. Populations of the hymenopteran parasite *Encarsia lounsburyi* were high during January. The predatory mite *Bdella* sp. was conspicuous during February, and the predatory thrips *Aleurodothrips fasciatus* during August. These natural enemies were checking the population of *A. destructor*.

Encarsia lounsburyi which parasitises *L. piperis* also was abundant during April and Febuary. *Bdella* sp. was observed during May, July, August, December and February.

d. Field control trial

A field control trial was laid out at Kuppadi (Wynad) using six insecticides viz. monocrotophos, dimethoate, methyl parathion, dichlorovos, phosphamidon and malathion, all at 0.05% concentrations. Samples were collected for assessing the population before spraying and 15 and 30 days after each spraying. The second spraying was given 30 days after the first one. The data were analysed and it was seen that all insecticides were superior to control but the effect was seen only 30 days after spraying (Table 8).

Table 8. Efficacy of insecticides against *Lepidosaphes piperis* on black pepper

Treatment	Mean population after (days) 15	30	45	60
Monocrotophos	17.3	8.3	3.7	1.7
Phosphamidon	33.8	11.9	5.8	4.7
Dimethoate	39.6	6.6	2.4	3.1
Dichlorvos	42.2	8.9	3.9	0.7
Methyl parathion	36.1	14.7	0.3	2.3
Malathion	29.2	15.0	1.0	1.7
Control	68.7	83.5	72.9	103.2
C.D(5%)	NS	25.7	12.4	3.3

e. **Screening of insecticides**

Screening more insecticides against *L. piperis* under laboratory conditions were carried out. Insecticides used were dichlorovos, phosphamidon and mythyl parathion all at 0.05% concentration. The observations were recorded on 3,7,14 and 21 days after spraying. Immediate knock down action was obtained in the case of mythyl parathion. Methyl parathion acted on eggs also.

8. Nema III (813) : Investigations on nematodes associated with ginger, turneric and black pepper

(K.V. Ramana)

a. Survey for nematodes associated with ginger

Survey was conducted in Wynad district, Kerala during August and October, 1991. A total of 47 ginger fields were selected at random representing major growing areas of the district. A total of 131 samples each of soil and rhizomes were collected, processed and nematode population estimated. Six genera, *Meloidogyne, Rotylenchulus, Helicotylenchus, Xiphinema, Longidorus* and *Criconemoides* were recorded.

Rotylenchulus reniformis is the most predominant nematode associated with ginger with fairly high population in rhizosphere soils followed by root knot nematodes *Meloidogyne* sp. and *Helicotylenchus* sp.

b. Screening black pepper germplasm to root knot and burrowing nematodes

Single noded rooted cuttings of 20 black pepper accessions were planted singly in polythene bags containing fumigated soil mixture. Five cutttings each of the accessions were inoculated with *M. incognita* and *R. similis* during January '92 and are being maintained for recording reaction to nematodes.

Open Pollinated Seedlings: Open pollinated seedlings of Panniyur-1 (2000), Arakulamunda (2000), Karimunda (2000), Aimpiriyan (2000) and Ottaplackal-1(2000) were raised in fumigated soil mixture in aluminium trays @ 1000 seedlings/tray. In each cultivar, half of the seedlings were inoculated with *M. incognita* and remaining half with *R. similis* during August to September, 1991. Six months after inoculation, all the plants were uprooted and root knot and root lesion indices were recorded. None of the seedlings recorded root lesion index less than 3 and hence considered susceptible to the nematode.

With regard to reaction to *M. incognita* 35 seedlings (Panniyur-1 -9; Arakulamunda-10; Aimpiriyan-9; Ottaplackal-7) recorded root knot index less than 3 (Medium to mild galling) and hence saved for further testing.

About 12,000 open pollinated seeds of popular cultivars like Panniyur-1, Kuching, Karimunda , Arakulamunda, Aimpiriyan and Ottaplackal-1 were sown in trays containing fumigated soil mixture for studying reaction to nematodes. These pot culture studies were conducted to assess efficacy of biocontrol agents in suppressing nematode infestations in black pepper.

c. Efficacy of *Paecilomyces lilacinus* in suppressing nematode infestations in black pepper

Pot culture study was conducted to assess efficacy of *P. lilacinus* in suppressing nematode infestation in black pepper. Single noded rooted cuttings of Panniyur-1 were planted in pots with 6.5kg fumigated soil mixture. Following treatments were given in 5 replications

T1 - Control
T2 - Phorate 10G
T3 - *M. incognita*
T4 - *R. similis*
T5 - *P. lilacinus*
T6 - *M. incognita* + *P. lilacinus*
T7 - *R. similis* + *P. lilacinus*
T8 - *M. incognita* + *R. similis*
T9 - *M. incognita* + *R. similis* + *P. lilacinus*
T10 - *M. incognita* + *R. similis* + Phorate 10G

After three months of planting, fungus was incorporated into the root zone as per the treatments listed above. Phorate 10G @ 3g/pot was applied at quarterly intervals starting from 3rd month after planting. *M. incognita* @ 2000 second stage juveniles/ plant and *R. similis* @ 100 nematodes/plant were introduced into the root zone 20 days after fungal inoculation as per the treatments. Twelve months after planting, all the plants were uprooted. Fresh weight of shoot, root, root knot index, and root lesion index were recorded (Table 9).

Both the nematode species caused significant reduction in biomass production. *M. incognita* caused 18.1% and 31.6% reduction in fresh weight of shoot and root respectively. Effect of *R. similis* inoculation was more severe, which resulted in 39.2% and 64.8% reduction in fresh weight of shoot and root. When both nematode species were inoculated reductions in these growth parameters were 61.2% and 74.5%.

Inoculation of fungus and application of phorate improved growth of the vines and are on par. Fungus inoculation resulted in signifiant increase in growth parameter, even though the plants were inoculated with *M. incognita*. Loss in root mass due to *M. incognita* infestation was reduced from 31.6% to 21.1% in presence of fungus. Similarly fungus inoculation resulted in increase in root mass production in plants inoculated with *R. similis*.

Root lesion index was maximum (3.6) in plants inoculated with *R. similis* alone followed by combined inoculation of two nematodes. When fungus was incorporated, R.L.I. was significantly reduced. Similar effects were also noticed in the treatment having fungus inoculated with *M. incognita*. R.K.I. was brought down from 4.4 in plants inoculated with *M. incognita* alone to 2.4 in the presence of fungus.

The results indicated that though the fungus could not result in absolute control of the nematodes, it had significantly suppressed nematodes infestation and increased root mass production.

Table 9. Efficacy of *Paecilomyces lilacinus* in suppressing nematode infestations in black pepper

Treatment	Shoot wt. g (fresh)	Root wt. g (fresh)	R.K.I.	R.L.I.
Control	267.54 d	68.22 d	1.4 f	1.4 f
Phorate	296.74 a (+10.9)	71.84 e (+5.3)	1.0 g	1.0 g
M. incognita	219.06 g (-18.1)	46.64 g (-31.6)	4.4 a	1.0 g
R. similis	162.66 i (-39.2)	23.98 i (-64.8)	1.0 g	3.6 a
P. lilacinus	275.28 b (+2.9)	73.84 b (+8.2)	1.0 g	1.0 g
M. incognita + *P. lilacinus*	230.72 g (-13.8)	82.72 a (+21.2)	2.4 c	1.0 g
R. similis + *P. lilacinus*	190.04 h (-28.9)	35.96 h (-47.3)	1.0 g	2.4 c
M. incognita + *R. similis*	103.80 g (-61.2)	17.40 j (-74.5)	2.8 b	3.4 b
M. incognita + *R. similis* + *P. lilacinus*	249.64 e (-6.7)	60.18 f (-11.8)	2.0 d	2.2 d
M. incognita + *R. similis* + Phorate	268.78 c (+0.5)	64.56 e (-5.4)	1.6 e	1.8 e
L.S.D. (P.005)	38.03	16.63	0.6	0.6

Figures in parentheses denote % reduction (-)/increase (+)over control

Means followed by a common letter are not significatnly different at 5% level.

R.K.I 1. No galls 2. Mild galling
3. Medium galling 4. High galling and
5. Very high galling and root rotting.

R.L.I 1. No lesion 2. A few isolated lesions
3. Many lesions, a few coalescing root tips damaged 4. Many lesions, coalescing encircling the main root lateral roots damaged

Root lesion index was maximum (3.6) in plants inoculated with *R. similis* alone followed by combined inoculation of two nematodes . When fungus was incorporated, R.L.I was significantly reduced. Similar effects were also noticed in the treatment having fungus inoculated with *M .incognita*. R.K.I was brought down from 4.4 in plants inoculated with *M. incognita* alone to 2.4 in the presence of fungus.

The results indicated that though the fungus could not result in absolute control of the nematodes, it had significantly suppressed nematodes infestation and increased root mass production.

b. **Effect of mulching with *Chromolaenaodoratum* in suppressing root knot nematode infestation in black pepper**

An observational trial in pot culture was undertaken to test the effect of mulching with *Chromolaena odorata* on suppression of root knot nematodes infestation in black pepper. Single noded rooted cuttings of Panniyur-1 were planted singly in earthen pots of 20 cm diameter containing 6.5kg fumigated soil mixture. Three months after planting, 30 plants were selected. Freshly hatched second stage juveniles of *M. incognita* @ 2,000/plant were collected and were inoculated to 20 plants. Twenty days after inoculation, 0.5kg of *C. odorata* (fresh), cut into small bits was added as a mulch in 10 pots. The plants without nematode inoculation and mulch served as control. Four months after nematode inoculation, all the plants were depotted, root-knot index, fresh weight of shoot and root were recorded (Table 10).

Root knot index varied from 2.0 to 4.0 (average 3.3) in plants inoculated with nematodes and it ranged from 4.0 to 5.0 (average 4.3) in plants inoculated with nematode and mulched. Nematode inoculation caused significant reduction in fresh weight of shoot. However, there was increase in root weight (fresh) in plants inoculated with nematodes with or without mulch due to heavy root galling which contributed to increase in root weight.

The results showed that mulching pepper plants with *C. odoratum* did not help in reducing root knot nematode infestation and multiplication.

Table 10. Effect of *Chromolaena odoratum* mulching in suppressing root knot nematode infestation in black pepper

Treatment	Shoot wt. g (fresh)	Root wt. g (fresh)	R.K.I.
Control	178.5	27.6	1.0
M. incognita	142.9 (-19.9)	32.5 (+17.7)	3.3
M. incognita + mulching	128.2 (-28.2)	37.7 (+36.6)	4.3
L.S.D. (P = 0.05	**16.2**	**6.0**	0.5

Figures in parenthesis denote % reduction (-) increase (+) over control

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

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

a. Pathogenicity trial The trial was concluded in June 1991 after recording all the final observations (Table 11). The damage due to root knot nematode infestation was more prominent in plants which received lower initial population. The infested plants exhibited stunting, narrowing of leaves and reduction in tillering. The nematode multiplication was inversely proportional to the initial inoculum level.

Table 11. Effect of Meloidogyne incognite on growth of cardamom-after three years (Mean of 10 replications)

Initial Population (Pi)/100	Height (cm)	No. of tillers	Total biomass (kg)	Leaf Length	Leaf Breadth	Number of Leaves	Number of Roots	Number of Panicles	Number of Capsules	Final Population/ (g)
0	2.05	41.0	16.71	47.95	6.08	456.00	724.10	35.37	491.37	0
0.4	1.78	20.4	7.06	43.06	6.11	151.00	225.30	16.00	116.40	179.40
4.0	1.36	19.5	5.35	44.64	6.23	139.50	304.90	10.40	90.8	179.50
40.00	1.60	22.4	11.14	47.71	6.71	226.87	451.98	19.69	161 26	108.00
400.00	1.63	22.0	8.73	47.46	6.49	204.30	410.40	22.50	207.40	99.90
LSD (0.05)	0.3	7.14	4.77	3.75	0.57	144.81	282.15	9.58	185.39	98.42

b. Screening of germplasm

Screening of cardamom germplasm against root knot nematodes was continued. All the 15 accessions screened during the year were susceptible.

c. Evaluation of nematicides and neem oil cake

Various chemicals (except quinalphos) were applied alone (@2.5 and 5 g a.i /plant) and in combination with neem oil cake (@ 250 and 500 g/plant). As in previous years, phorate and carbofuran @ 5 g a.i/plant were the best with regard to yield and control of nematodes (Table 12). irrespective of the neem cake levels used.

d. **Population dynamics**

Root knot nematode population in cardamom plants increased during the post monsoon period and the peak population was seen during Nov.-Dec. However there was no significant difference in the soil population with regard to sampling depth (15, 30 and 45 cm) and distance from plant base. (30 and 45cm).

e. **Solarisation studies**

Soil solarisation of nursery sites for 45 days in April-May using 300 guage transparent polythene sheets in an open area (0.15ha) increased soil temperature by 8.7°C. Number of days the soil temperature crossed 40°C ranged 2-17 at different soil depths. *Pythium vexans* was totally eliminated in solarised beds, while populations of *Rhizoctonia solani, Phyllosticta elettaria* and various plant parasitic nematodes were suppressed to varying levels. Germination of cardamom seeds was en-

hanced by 25.5% and weed growth was reduced by 82% in solarised beds. Growth and vigour of cardamom seedlings were excellent while the disease incidence was comparatively less in solarised plot.

Efficacy of biocontrol agents viz. *Paecilomyces lilacinus* and *Trichoderma harzianum* are being evaluated in these beds alongwith fungicides and nematicides.

Table 12. Effect of various chemicals and neem oil cake on yield of cardamom (net weight in kg/plant) during 1991-92 (Mean of four replications)

Chemicals	Neem oil cake (g/plant)			
	0	250	500	Mean
Carbofuran 2.5 g a.i.	0.36	0.33	0.27	0.32
Carbofuran 5 g a.i.	0.51	0.40	0.36	0.43
Phorate 2.5 g a.i.	0.42	0.56	0.37	0.45
Phorate 5 g a.i.	0.59	0.63	0.47	0.56
Quinalphos 2.5 g a.i.	0.35	0.26	0.26	0.29
Quinalphos 5 g a.i.	0.30	0.39	0.19	0.29
Check	0.31	0.31	0.29	0.31
Mean	0.41	0.41	0.32	0.38

C.D. 5% for chemicals = 0.139
C.D. for neem oil cake = NS

Ad-hoc Scheme 1. Multilocational project on rhizome rot of ginger

(Y.R. Sarma (Principle Investigator) P. Balakrishnan and N. Usman (Research Associates)

a. Survey: Survey carried out in Wynad district showed 5-90% incidence of rhizome rot and bacterial wilt. Out of 47 diseased samples tested, 14 yielded *Pythium*, 14 *Pseudomonas solanacearum* and 19 gave combinations of both. Frequency of isolation of *Pythium* were high from roots indicating importance of root infection. In addition, *Meloidogyne incognita* root knot nematode association was noticed with infected plants.

b. Screening for disease resistance : Of the 91 types screened for their reaction to *P. aphanidermatum* 63 types showed disease incidence 75-100%, 22 types showed 50-75% and 6 types showed below 50%, thereby indicating lack of high degree of resistance. All four exotic types viz., Jamaica, China, Rio-de-janeiro and Taffingiva were susceptible.

c. Disease Management

1. Soil solarisation and non solarisation :

Field trials were conducted in solarised and non solarised soil conditions separately. Further, fungicides viz. Dithane M-45 (0.3%), Captafol (0.3%), Chlorothalonil (0.3%), Ridomil MZ 72WP (500ppm metalaxyl) with and

without Phorate (30g/bed) were superimposed as seed treatments and soil drenches. However, in case of Ridomil MZ, soil drench was given at a concentration of 100 ppm metalaxyl.

In field control trial, germination percentage ranged from 99.8 to 100 in solarised plots, where as it was 94.0 to 99.4 in non solarised plots. The disease incidence was lower in solarised field (Table 13). It ranged from 6.4 to 23.3 in solarised plots and 15.9 to 65.3 in non solarised plots. The same trend was observed in yield also. In solarised plots, the fresh weight of rhizome ranged from 0.71 kg to 5 kg per bed where as it was 0.164 to 0.855 kg in non solarised plots.

Among the fungicides tested, Dithane M-45 in combination with phorate gave maximum yield (5 kg) in solarised plot compared to untreated control (1.9 kg) (Table 13). This is followed by Ridomil MZ in combination with Phorate (3.9 kg). In non solarised plot, Ridomil MZ in combination with Phorate was superior in yield (0.855 kg) compared to all other chemicals. This was followed by Captafol (0.71kg).

Table 13. Effect of fungicides (Seed treatment + Soil drench) on disease incidence and yield (Total)

Treatments	Solarised		Non solarised	
	D.I %	Yield (Kg)	D.I %	Yield(Kg)
D.M-45 0.3%	13.2	3.2	31.6	0.2
Captafol 0.3%	6.4	2.6	24.9	0.7
Chlorothalonil 0.3%	9.6	1.7	65.3	0.3
RMZ 500 ppm	10.2	2.5	15.9	0.2
Phorate 30g/bed	11.3	0.7	35.3	0.1
D.M-45 + Phorate	13.1	5.0	38.5	0.4
RMZ + Phorate	12.5	3.9	22.5	0.8
Control	23.3	1.9	48.3	0.2

There was no significant difference in disease incidence and yield with respect to seed treatment and soil drenches.

2. Biocontrol

During the survey, rhizosphere soils were collected from ginger fields, 72 isolates of *Trichoderma* were isolated and 10 isolates showed varying degrees of inhibition on *P. aphanidermatum*. *Absidia* sp. was also isolated from the healthy rhizomes. In addition, 22 isolates of VAM (Vesicular Arbuscular Mycorrhizae) were also collected from the roots and rhizospheres of ginger to test their disease suppressive effects.

3. Effect of organic amendments

Among the organic amendments/plant residues tested in sick soils in pot culture, disease incidence was variable, the severity was less in neem cake and saw dust treatments, viz. 12.7% and 14.1% respectively compared to 60.1% in untreated control (Table 14).

Table 14. Effect of soil amendments/plant residues on Rhizome rot of ginger (Pot culture)

Treatments	D.I %	D.S %	Yield (Kg)
Glycosmis	90	51.1	0.032
Eupatorium	60	17.5	0.096
Stryhcnos	60	23.5	0.079
Glyricidia	50	32.1	0.042
Neem cake	80	12.7	0.207
Saw dust	70	14.1	0.118
Control	90	60.1	0.020

MINI MISSION II : DEVELOPING AGRO-TECHNIQUES FOR INCREASING PRODUCTION OF SPICE CROPS

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

(B.N.Reddy, K.Sivaraman & A.K. Sadanandan)

a. Spacing cum varietal trial

A field experiment was initiated during 1983 to obtain optimum plant density of black pepper varieties trained on RCC posts. The treatments included three varieties viz. Panniyur-1, Karimunda and Aimpiriyan and four spacings viz. 3m x 3m; 2.5m x 2.5m; 2.5m x 1.5m and 2m x 1m laid out in a strip plot design with four replications. The yield data for green pepper during 1991-92 did not indicate significant difference in yield among the varieties (Table 15). However, the highest yield (2555kg/ha) was recorded by Karimunda followed by Panniyur-1 (2500 kg/ha). The yield differences were significant among the various spacings. The highest yield was recorded in the closest spacing of 2m x 1m. There was no significant interaction between varieties and spacing with respect to yield. The highest yield (4818kg/ha) ws obtained in Karimunda in the spacing of 2m x 1m followed by Panniyur-1 (4284 kg/ha) at the same spacing. The cumulative yield for the last 7 years was the highest in the spacing of 2m x 1m (5000 vines /ha) in all the varieties (Table 16). The highest yield (5785 kg/ha) was obtained from Karimunda at 2m x 1m spacing followed by Panniyur-1 (3991 kg/ha) at the same spacing.

b. Fertilizer trial

Fertilizer trial with four levels of nitrogen (50,100,150 and 200g/vine/year) and potash (70,140,210 and 280g/vine/year) with five additional treatments viz. $N_0 P_0 K_0$, $N_{50} P_{60} K_{140}$, $N_{50} P_{60} K_{140} Ca_{50} Mg_0$, $N_{50} P_{60} K_{140} Ca_0 Mg_{50}$ and $N_{50} P_{60} K_{140} Ca_{50} Mg_{50}$ was initiated during 1987 with Karimunda as test crop. The yield data (Table 17) indicated that the maximum yield was obtained by the application of 100g N. The main effect of K and the interaction between N and K were non significant.

c. Irrigation experiment

A trial on irrigation requirement of black pepper Cv. Karimunda was initiated during 1988 using *Erythrina indica* as standard. There are 13 treatments with 2 replications and a plot size of 6 vines. The design followed is CRD. The details of the treatments are

I Levels of Irrigation

1. Irrigation at IW/CPE ratio of 0.50
2. Irrigation at IW/CPE ratio of 0.25
3. Drip Irrigation at 2 l/day
4. Drip Irrigation at 4 l/day
5. Control (No irrigation)

II. Duration of Irrigation

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

The yield data (Table 18) indicated that drip irrigation of pepper @ 2 l/day from October to April recorded the maximum yield of 1.216 kg /vine/year. However there was no significant difference between treatments as compared to control.

Table 15. Mean yield of green pepper for 1991-92 (kg/ha) (Averaged over 4 replications)

	Varieties (V)			
Spacing	Panniyur-1	Karimunda	Aimpiriyan	S-Mean
3 x 3m	1165	1336	1070	1191 d
2.5 x 2.5m	2196	1359	1327	1627 c
2.5 x 1.5m	2356	2709	2384	2483 b
2 x 1m	4284	4818	3693	4265 a
V-Mean	2500	2555	2119	2391

In a column, means followed by a common letter are not significantly different at the 5% level.

Table 16. Mean cumulative yield of green pepper 1986-1992 (kg/ha) (Averaged over 4 replications)

Spacing	Panniyur-1	Karimunda	Aimpiriyan	S-Mean
3 x 3m	1185 d	1266 d	1030 d	1160
2.5 x 2.5m	1785 c	1770 c	1363 c	1639
2.5 x 1.5m	2844 b	3356 b	2369 b	2856
2 x 1m	3991 a	5785 a	3872 a	4549
V-Mean	2451	3044	2158	2551

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

Table 17. Mean yield of green pepper (kg/ha) (Average of 3 replications)

Potassium (K)	N 50	N 100	N 150	N 200	K-Mean
K70	0.790	2.121	1.473	2.192	1.644
K140	0.993	1.381	2.106	1.842	1.580
K210	0.736	2.441	2.011	1.486	1.669
K280	1.643	1.958	1.591	1.571	1.691
N Mean	1.040 d	1.975 a	1.795 b	1.773 c	1.646

In a raw, means followed by a common letter are not significantly different at the 5% level.

Table 18. Treatment means for green pepper yield (kg/vines) (Average of 2 replications)

Treatments	Means Yield(kg/vine)	Difference from control
1. (IW/CPE 0.50) X Oct to March	0.748	0.011 ns
2. -do- April	0.659	-0.079 ns
3. -do- May	0.419	-0.319 ns
4. (IW/CPE 0.25) X Oct to March	0.645	-0.093 ns
5. -do- April	0.877	0.139 ns
6. -do- May	0.846	0.109 ns
7. (D-I 2 l/day) X Oct to March	0.635	-0.102 ns
8. -do- April	1.216	0.478 ns
9. -do- May	0.997	0.259 ns
10. (D-I 4 l/day) X Oct to March	0.762	0.025 ns
11. -do- April	0.948	0.211 ns
12. -do- May	1.102	0.365 ns
13. Control (No irrigation)	0.738	

ns Not significant

2. SSc II (813) Nutritional requirement of improved varieties of spice crops

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

a. Black Pepper

The field experiment laid out in 1990-91, to study mineral nutrient requirement of Sreekara and Subhakara was maintained and morphological observations recorded. The chemical characterisation of the soil revealed that the soils belong to the order oxisols, reddish brown in colour, sandy clay loam in texture, acidic in reaction, rich in organic matter and Bray-1 P, medium in exchangable K and poor in exchangable Ca and Mg. As regards micronutrients, DTPA extractable Fe, Mn and Cu are at desirable level while Zn, B and Mo are below critical levels. The soil is moderately deep with good drainage and low water table.

1. Effect of long term mineral fertilization on black pepper

The effect of continuous NPK fertilization for twelve years in an oxisol under humid tropical conditions was studied from a field experiment laid out in 1979. The results showed that the application of N significantly influenced micronutrient status in the soil. As N level increased, there was corresponding decrease in soil pH with an increase in Fe, Mn, Cu and Al. As P levels increased there was significant increase in Fe and Cu status in the soil. Application of K significantly influenced the status of Mn and B in the soil.

. Application of N significantly altered major and micronutrient composition of plant. As N level increased, there was corresponding increase in NPK status in plant. The changes were, however, not marked in the case of secondary nutrients. Regarding micronutrients, a negative trend was seen in the case of Fe, Mn, Zn and Al content while it was positive in the case of Mo.

Application of P has significantly contributed to major and micronutrient content of pepper. As P application increased, there was significant increase in N,P,K, Ca, S and Mo levels in the leaf, while there was a decreasing trend in the case of Zn.

Application of K has significantly increased N,K and S. As K level increased, there was significant increase in N,K. and a negative trend in the case of Mo.

2. Nutrient requirement of bush pepper

Inorganic farming : A pot culture trial was laid out in June 1991 in an oxisol to find out the nutritional requirement of bush pepper with two varieties viz. Panniyur-1 and Karimunda. Application of NPK significntly increased the leaf concentration of P,K and Ca. As regards to micronutrients, fertilization has significantly increased Fe and Mn content. Preliminary results indicated that application of NPK @ 1.0, 0.5 and 2.0 gram per 10 kg of soil, significantly increased leaf and spike production and yield in both the varieties studied (Table 19).

Regarding the reaction of genotype to nutrients there was no significant difference in the content of nutrients in the leaf nor in the yield. In the soil also there was no significant difference in availability of nutrients indicating more or less similar pattern of utilization of nutrients by both genotypes.

Table 19. Effect of inorganic fertilizers on leaf nutrient status, morphological characters and yield of bush pepper

Treatments	Leaf nutrient status								No. of			
	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Leaves	Laterals	Spikes	Yield g/spot
F1 Control	0.29^{b}	2.1d	2.2^{c}	0.19	69^{b}	39^{b}	30^{b}	7.6	32^{b}	9^{b}	24^{b}	33.5^{b}
F2 NPK @ 05,0.25,1g	0.33	2.7^{c}	2.4^{b}	0.20	85^{a}	71^{a}	34^{a}	9.3	58^{c}	17^{a}	34^{ab}	82.1^{a}
F3 NPK @ 1,0.5,2 g	0.37^{a}	3.0^{b}	2.6^{a}	0.18	85^{a}	83^{a}	32^{a}	8.5	55^{a}	15^{a}	44^{ab}	96.8^{a}
F4 NPK @ 1.5,0.75,3g	0.2^{a}	3.4^{a}	2.7^{a}	0.19	93^{a}	82^{a}	32^{ab}	8.1	52^{a}	13^{ao}	36^{a}	92.1^{a}
C.D. (P 0.05)	0.03	0.3	0.2	NS	14	20	3	NS	16	5	15	38.6

In a column, means followed by the same letter are not significantly different at 5% level.

Organic farming: A pot culture experiment was laid out in June 1991 using an oxisol, sandy clay loam in texture to find out the relative efficacy of organics in the form of 5 cakes compared with fertilizer as a common check. There were seven treatments replicated three times using two varieties of pepper.

3. Soil availability of nutrients

Application of organic cakes in general significantly contributed to soil organic matter, the availability of Bray P, K, Mg and Micronutrients like Fe, Mn, Zn and Cu compared to fertilizer (Table 20).

Table 20. Effect of organics on the leaf nutrient status, yield and morphological characters of bush pepper

Treatments	Leaf nutrient status								No. of			
	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Leaves	Laterals	Spikes	Yield g/spot
Control	0.29^{b}	2.1d	2.1^{d}	0.18^{b}	0.67^{c}	38^{b}	28^{d}	7^{c}	29.3^{c}	8^{b}	30^{b}	37.0^{c}
Fertilizers	0.32^{ab}	2.6^{bc}	2.4^{c}	0.20^{ab}	0.85^{b}	72^{a}	34^{c}	8^{c}	66.7^{ab}	18^{a}	34^{b}	79.2^{b}
Neem cake	0.33^{a}	2.5^{c}	2.6^{bc}	0.20^{ab}	0.101^{a}	69^{a}	35^{bc}	8^{c}	54.2^{b}	14^{a}	40^{ab}	70.1^{bc}
Brassia cake	0.34^{a}	2.5^{c}	2.3^{d}	0.20^{ab}	0.87^{b}	74^{a}	35^{bc}	9^{ba}	59.3^{ab}	16^{a}	38^{b}	95.5^{ab}
Groundnut cake	0.37^{a}	2.9^{ab}	2.9^{a}	0.21^{ab}	0.81^{b}	72^{a}	38^{b}	8^{c}	74.2^{a}	18^{a}	44^{a}	98.8^{ab}
Gingely cake	0.35^{a}	3.0^{a}	2.8^{ab}	0.22^{a}	0.04^{a}	82^{a}	41^{a}	12^{a}	50.3^{b}	14^{a}	29^{b}	79.7^{b}
C.D. (P 0.05)	0.04	0.3	0.2	0.03	0.12	17	3	2	16.5	6	16	38.3

In a column, means followed by the same letter are not significantly different at 5% level.

4. Yield and leaf nutrient composition

Organic cakes in general, significantly contributed to the nutrient status in the leaf, viz. K, Ca, Fe, Zn and Cu. Regarding morphological characters like number of spikes and yield, organic cakes were in general superior to fertilizers.

As regards to reaction of varieties to nutrient content on the leaf and yield, there is no significant difference between varieties. Regarding availability of nutrients in the soil, there was no significant difference with regard to major nutrients indicating that nutrient utilization in general is similar in both varieties.

B. Turmeric

1. Effect of inorganic fertilization on turmeric varieties

Field experiment was laid out in 1991 (May) to study the nutritional requirement of improved varieties of turmeric viz. Suvarna, Suguna, Sudarshana which were compared with a local Cv. Alleppey. There were seven treatments comprising NPK fertilzers each at three levels and four micronutrients (Mn, Zn, B, Mo) each at two levels with a common control. The effect of micro -nutrients was studied as foliar as well as soil application.

Among varieties, significant increase in yield was obtained in Sudarshana 40.57 t which was on par with Suguna 37.42 t. Alleppey and Suvarna recorded 33.0 and 23.91 t (all in fresh weight/ha). The highest curcumin content was observed in Alleppey and least for Suvarna (Table 21).

Among the fertilizer levels, maximum yield was obtained due to application of NPK @ 90:75:180 kg /ha with micronutrients. As the NPK level increased there was a corresponding increase in P, K, Ca, Fe, Mn and Zn status in the leaf and rhizome. Application of micronutrients as foliar spray increased significantly the micro nutrient status in both leaf and rhizome.

2. Organic Farming

A field experiment was conducted during May - Dec. 1991 in an oxisol by growing turmeric genotypes (viz. Suvarna, Suguna, Sudharshana and Alleppey) in a split plot design with varieties in the main plot and organics in the sub plots with three replications.

Table 21. Nutrient content of rhizome and yield of turmeric varieties to fertilization

Turermic varieties	P	K	Ca g/100 g	Mg	Fe	Mn	Zn mg/kg	Cu	Curcu min%	Yield (t/ha) Fresh
Suvarma	0.28^{a}	3.61^{b}	0.37^{c}	0.25^{c}	461.50^{b}	75.21^{a}	37.96^{c}	9.16^{b}	3.7^{d}	23.91^{c}
Sugana	0.27^{ab}	3.83^{a}	0.43^{b}	0.34^{b}	503.75^{a}	128.46^{a}	42.68^{a}	10.79^{a}	6.0^{c}	37.42^{a}
Sudarsjama	0.25^{c}	3.82^{a}	0.40^{bc}	0.40^{a}	498.36^{ab}	80.57^{c}	41.29^{ab}	11.31^{a}	6.3^{b}	40.57^{a}
Alleppey	0.26^{bc}	3.75^{a}	0.54^{a}	0.36^{b}	382.43^{dc}	98.00^{b}	39.18^{bc}	11.36^{a}	7.3^{a}	33.00^{b}
C.D. at 5%	0.01	0.15	0.05	0.03	36.97	12.39	2.13	1.14	0.1	4.18

In a column, means followed by the same letter are not significantly different at 5% level.

There were eight treatments consisting of six organics, one fertilizer and a control. Application of organics significantly increased the organic matter, major and micronutrient content in the soil. The nutrient contents in the leaf and rhizome were significantly higher in organic cakes applied plots.

Among the varieties in general, maximum nutrient composition and rhizome yield were obtained in the case of Suguna which was on par with Sudarshana and was followed by Alleppey.

Among the cakes, maximum yield was obtained due to application of cotton cake, which was at par with other cakes and fertilizer (30, 25, 60 kg NPK /ha) and maximum curcumin was recorded from ground nut cake applied plot which was on par with brassica cake. In general, organic amendments gave more curcumin compared to fertilizer. Mean maximum curcumin content was recorded in Cv. Alleppey and the least in Suvarna.

3. Effect of organic cakes on nutrient composition, yield and quality of ginger

A field experiment was laid out during May-December 1991 in an oxisol by growing ginger *(Zingiber officinale)* Cv. Maran with the objective of studying the effect of organics on nutrition, yield and quality of ginger. There were nine treatments which included six organic sources, inorganic NPK fertilizers with and without micronutrients and one check. There were five replications. Results showed that the application of organic cakes significantly increaed the organic matter, major and micronutrient status in the soil and nutrient content in the leaf and rhizome. Among the cakes, maximum yield was obtained in the case of groundnut cake which was on par with other cakes and fertilizers. The oleoresin recovery was maximum in ginger due to brassica cake application which was on par with cotton cake and FYM applied plots.

C. Cardamom

Studies on mineral nutrient concentration of tissue cultured plants, suckers and seedling progenies of cardamom cv. PV-1 showed no significant difference either in the yield or in the leaf concentration of nutrients except manganese. These three sources of planting materials of cardamom are behaving more or less in an identical manner.

3. Agr. XIV (813) : Investigations on spices based cropping system

(V.S. Korikanthimath & B.N. Reddy)

a. Investigations on spices based cropping system were taken up with the following objectives

1. To study the crop compatibility
2. Harnessing solar energy at different crop canopies
3. To study the root distribution, allelopathic and synergistic effects and absorption of nutrients from varying depths/profile.
4. Organic recycling of various crop residues in the cropping system
5. Impact of crop combinations on VAM, bacteria, fungi and actinomycetes and other beneficial soil micro organisms.
6. Minimising cost of cultivation by sharing some of the common cultural operations with various crop combinations
7. Increasing production and productivity per unit area
8. Generating gainful employment to small and marginal farmers and agricultural labourers round the year
9. Generating congenial micro-climate with various crop combinations
10. Generating steady flow of income throughout the year as the harvest and yielding times of various crops in the system differ
11. Integrated pest and disease management in cropping systems.
12. Economic analysis of the cropping system

A field trial was laid out with 8 crop combinations (Table 22) at Cardamom Research Centre, Appangala, to identify suitable cropping system for the region.

Table 22 Cardamom based spices cropping system

Sl.No.	Crop Combination	Spacing
1.	Cardamom + Nutmeg	9.0 x 9.0 m
2.	Cardamom + Clove	7.2 x 7.2 m
3.	Cardamom + Allspice	7.2 x 7.2 m
4.	Cardamom + Pepper	3.6 x 3.6 m
5.	Cardamom + Cinnamon	3.6 x 3.6 m
6.	Cardamom + Coffee	3.6 x 3.6 m
7.	Sole crop of coffee	1.8 x 1.8 m
8.	Sole crop of cardamom	1.8 x 1.8 m

Common spacing for cardamom 1.8 x 1.8m (in all the trial plots)

Plot size : 0.1 ha each

b. Preplanting status of soil

Soil samples were collected and analysed for studying the chemical and microbial status. The nutrient status of the soil is given in Table 23.

Soil samples collected at three locations for studying the VAM load showed a micorrhizal spores count of 21.33/100 cc of soil. The counts of other micro organisms in the soil are given in Table 24.

The light intensity at the top of the canopy, branching point and also at the base of the shade trees and at the top and base of cardamom plants were also recorded (Table 25).

Table 23. Pre planting nutrient status of soil

Constituents/Elements	Depth 0-15cm	Depth 15-30cm
1. pH	5.3	5.1
2. Organic carbon (%)	2.2	1.7
3. Bray P (mg/kg)	6.9	8.0
4. Exch. K "	45.0	31.0
5. Exch. Ca "	879.0	480.0
6. Exch. Mg "	184.0	107.0
7. Fe "	44.0	41.0
8. Mn "	26.7	14.6
9. Zn "	0.8	0.7
10 Cu "	Traces	Traces

Table 24. Associated micro-organisms (Other than VAM)

Depth of soil	Bacteria (x 10^5)	Fungi (x 10^3)	Actinomycetes (x 10^5)	N2-Fixers (x 10^3)	P-solubiliser of (x 10^4)
1-15 cm	18.35	14.10	5.56	8.71	5.93
15-30 cm	9.97	7.18	3.81	16.77	43.73

Table 25. Light intensity at varying heights

Height/ Light intensity	Shade trees			Cardamom	
	Top	Branching Point	Bottom	Top canopy	Bottom
Height(m)	19.20	6.21	—	0.87	—
Light intensity in F C	2914.30	2485.70	109	2485.7	103

On farm trials on mix cropping of cardamom under two agroecological predominant cropping situations viz., Robusta coffee in Coorg and Arecanut in Uttar Kannada districts of Karnataka were monitored.

c. Cardamom and Arecanut

Two on farm trials laid out with cardamom mix cropped with Arecanut in an area of 0.4 ha. were monitored at Sirsi (Uttar Kannada district) in Karnataka.

d. Studies on coffee based pepper cropping system :

In coffee plantations, the cropping strategy has to be on the lines of multistoried cropping systems. Majority of the coffee plantations are in small holdings below 2 ha (86.3%). Productivity of these units should be increased by intensive cultivation of coffee, resorting to diversification with suitable crops to improve and sustain high income by efficient utilization of solar radiation, land and water resources.

Cost benefit analysis of mix cropping of pepper with Arabica and Robusta coffee reveal that a net benefit Rs.13717 and Rs.36073 could be obtained in respect of mixed cropping with pepper + Arabica coffee and pepper + Robusta coffee respectively. A moderate yield of 662 Kg/ha of coffee and 375kg/ha of pepper were obtained in the case of mixed cropping of Arabica coffee with pepper at the 5th year of planting.

In mixed cropping of Robusta coffee with pepper, the yield obtained in the fifth year was 530kg/ha of coffee and 345kg/ha of pepper respectively.

On farm trials of inter cropping of ginger and turmeric in Cauvery coffee were also monitored. Local variety of ginger raised as an intercrop with Cauvery Coffee, at the second year of planting of coffee yielded 11,400 kg/ha of ginger (fresh) and local variety of turmeric raised as an intercrop as well as in rotation during the third year of planting, yielded 14525 kg/ha (fresh) turmeric respectively.

Inspite of taking two inter crops viz. Ginger and Turmeric in rotation, growth performance of coffee is quite promising compared to coffee as sole crop. Income so obtained during the pre-bearing period of coffee is of great help to the growers for meeting the initial expenditure.

4. Stat. IV (813) : Evolving a disease index for Phytophthora/nematode induced damage in black pepper

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

Studies carried out on 1000 pepper vines in three locations for evolving a disease index for *Phytophthora*/nematode induced damage in black pepper revealed that the predominant and more persisting symptoms in the diseased vines are the foliar yellowing and defoliation. A pot culture study with 360 vines inoculated with *Phytophthora capsici* showed significant positive correlation between root rot index and foliar yellowing index while growth factors like no. of nodes, height, no. of leaves, root weight, shoot weight and root volume had significant negative correlation with root rot index.

The percentage distribution of Foliar Index (FI) in relation to Root Index (RI) is given in Table 26)

Table 26. Percentage distribution of FI and RI

	Percentage of vines showing expression on	
Index	Root	Foliage
0	8.2	37.4
1	25.7	46.5
2	34.2	12.6
3	31.9	3.5

It is seen that even though only 8.2% of the vines are free from root infection, (Index=0), 37.4% were apparantly healthy indicating that at the initial stages of infection at the roots, do not express any external

symptoms. This is more apparant in the case of vines having the root index 3. While 31.9% of the vines were in the advanced stages of root infection only 3.5% were showing advanced stages of yellowing. It is evident that detection of incidence of the disease based on external symptoms often causes a time lag resulting in a negative response to the control measures recommended.

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

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

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

a. Collection and Conservation

Collection surveys were undertaken for wild *Piper* germplasm from different forest ranges of western ghats in Kerala and Tamil Nadu. Fifty six collections consisting of 11 species were collected including *an exotic species P. arborium*. Four black pepper cultivars were introduced from Indonesia and Malaysia.

b. Characterisation and cataloguing

Morphological and agronomic characters of one hundred cultivated black pepper accessions were compiled and catalogued and inter relationships between different characters worked out.

Based on yield, leaf morphology, spike and quality characters, the cultivars are broadly grouped into 5 groups.

I	Very high :	Cultivars with values equal to or more than A
II	High :	Cultivars with values more than B but less than A
III	Medium :	Cultivars with values equal to or between 'B' & 'C'
IV	low :	Cultivars with values less than C but more than D.
V	Very low :	Cultivars with values equal to or less than D

Where A = Mean + (2 x Standard deviation)

B = Mean + Standard deviation

C = Mean - Standard deviation

D = Mean - (2 x Standard deviation)

c. Cytological studies

Somatic chromosome numbers of eighteen *Piper* accessions were determined. All have the somatic chromosome number of 2n=52 except one which has 2n=78. The somatic chromosome number of *P. barberi* is found to be 2n=52 and the chromosome size ranged from 0.74 to 1.85µ.

d. Bio systematics

A biosystematic study of the South Indian taxa of *Piper* was carried out using both numero-taxonomical and chemo-taxonomical methods. A cluster analysis based on 30 morphological characters led to grouping of *Piper*_ species into six distinct groups based on relative similarities. These groups consisted of :

Group 1. *P. attenuatum*, and *P. argyrophyllum*

2. *P. galeatum*, *P. trichostac-hyon* and *P. schmidtii*

3. *P. nigrum*, *P. nigrum* var *hirtellosum* and *P. weightii*

4. *P. hymenophyllum*

5. *P. mullesua* and *P. silentvall-eyensis*

The intercluster D^2 analysis showed that clusters 1 and 4 are more or less closely related. A principal component analysis was also carried out to study the nature of divergence between the taxa.

The chemical affinity of South Indian taxa was also studied using flavanoid profiles. Results of the study supported the grouping arrived at by cluster analysis.

Reasonably high chemical affinities were noted between morphologically allied taxa. The percentage of affinity between the different species of *Piper* are as follows:

P. galeatum - *P. trichostachyon* - 87%

P. attenuatum - *P. argyrophyllum* - 79%

P. argyrophyllum - *P. hymenophyllum* 78%

P. galeatum - *P. sugandhi* - 82%

P. sugandhi - *P. sugandhi var leiospicata* - 88%

P. nigrum - *p. nigrum var hirtellosum* - 87%

Of the 15 South Indian taxa studied, *P. longum*, *P. mullesua* and *P. silentvalleyensis* were unique chemically, not showing much of chemical affinities.

2. Gen. IX (813) : Collection, conservation, cataloguing and evaluation of Cardamom germplasm

(Regy Luckose)

In the evaluation of germplasm collections for yield, significant differences were found among collections from Wynad. APG. 221 gave higher yields (611g wet capsules/ plant) compared to the controls viz. Cl. 37 seedling and Cl.37 suckers with an yield of 415g and 363g wet capsules respectively, APG. 215 is the second with 600g of wet capsules/plant. No significant differences were found with regard to number of tillers per clump.

About 240 germplasm collections of cardamom related species are maintained at the centre.

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

(P.N. Ravindran, R. Ramakrishnan Nair B. Sasikumar and K. Nirmal Babu)

a. Germplasm collection and conservation

Two each of Curcuma and Zingiber accessions from Western ghats were added to the germplasm. A significant addition to the cultivated ginger germplasm was a tetraploid of Cv. 'Mananthodi' obtained from Kerala University, Trivandrum.

b. Germplasm evaluation

One hundred germplasm accessions of ginger were evaulated for yield and yield attributes. Mean yield/plant ranged from 112.5g to 667.5g fresh ginger per plant. Dry recovery varied from 14.2 to 29.8%. Yield and dry recovery of some of the promising entries are given in Table 27.

c. Biometrical studies

Biometrical studies in 100 accessions of ginger germplasm revealed good variability for tiller number and rhizome yield/plant. Plant hight, leaf number, tiller number as well as length and width of leaves had significant positive correlation with rhizome yield/plant. Plant height followed by leaf length had maximum direct effect on rhizome yield/plant.

Table 27. Yield and dry recovery of promising ginger germlasm lines

Accession/ Collection	Name	Mean yield (fresh) of rhizome (g/plant)	Dry recovery %
Acc. 2	Bahrica	592.50	29.8
Acc. 5	Bitturkatta	503.75	19.0
Acc. 179	H.P. Pulpally	571.25	23.2
Acc. 193	Chamal local	651.50	20.0
Coll. 2604	Nowsham 1	528.75	24.6
Coll. 2624	Bokalia	510.00	25.6
Coll. 3484	Arakuzha	575.00	23.6
Coll. 3485	Thodupuzha	568.75	25.2
	Nadan	667.50	23.6
	Pottangi	526.25	23.6
	Manantodi (4x)	545.00	28.0

d. Pollen fertility

Pollen stainability in 10 ginger accessions, by glycero-carmine staining, indicates that the pollen sterility is high and the frequency of unstained (sterile) pollen ranged from 73.74 to 87.73%.

e. Polyploidy

In order to induce polyploidy in ginger two cultivars viz. Maran and Thiruvalla were treated with different concentrations of colchicine for varying duration. Reduction in germination percentage of the treated buds were observed. In the case of cv. Maran some of the treated buds produced stunted and abberent plants.

f. Comparative yield evaluation of ginger

For identifying high yielding ginger cultivars, 15 ginger cultivars were evaluated at two locations viz. Peruvannamuzhi and Muvattupuzha. The yield of the cultivars from this experiment are presented in Table 28. At both the locations Wynad local ranked first.

Table 28. Yield of ginger cultivars at two locations

Cultivar	Mean fresh rhizome yield (kg/bed)	
	Peruvan-namuzhi	Muvattu puzha
Suprabha (Control)	14.38	10.31
Acc. 141	12.05	10.49
Acc. 65	12.45	11.39
Acc. 51	11.70	8.88
Acc. 63	13.95	10.69
Acc. 151	9.93	11.26
Wynad local	15.53	13.15
Jorhat	10.75	12.23
Tetraploid Cv. Maran	10.40	8.43
Maran	12.65	11.71
Himachal	12.45	11.84
Muvattupuzha local	11.15	10.56
Acc. 53	13.93	11.31
Acc. 64	13.48	10.51
Acc. 11	14.10	12.06
L.S.D 5%	2.92	2.23
CV(%)	10.8	9.5

g. Comparative yield evaluation of turmeric progenies

Seven selected seedling progenies of turmeric were evaluated at Peruvannamuzhi.

Progeny C-10 is at par with controls with regard to yield but recorded high dry recovery as compared to the controls. (Table 29)

Table 29. Yield and dry recovery of selected turmeric progenies and control

Entries	Yield (fresh) (Kg/3M^{2}bed)	Dry recovery (%)
Shillong	25.6	12.50
Moovattupuzha	20.83	13.25
C-10	25.00	19.75
One (1)	*	19.50
Cls No:11A	19.87	18.50
Amalapuram	17.10	15.00
5(c)	25.23	12.25
PCT-8 (control)	*	16.75
PCT-13 (")	25.07	13.25
PCT-14 (")	25.0	13.00
CD (5%)	5.15	
CV%	13.0	

* crop damaged

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

(B.Krishnamoorthy and J. Rema)

a. Collection and Conservation

i. Cinnamon : Germplasm collections were made from forest ranges of Anamalai, Ponmudi, Calicut, Virajpet, Bihar and Meghalaya. A total of 48 collections, including 'cassia' *(Cinnamomum aromaticum)* and 'Tejpat' types were made.

ii. Nutmeg : Collections were made from Kodaiyar forests, Andaman Islands and various parts of Kerala. Fifty one cultivated types of high yielding superior nutmeg trees and four wild types including *Myristica andamanensis* and *Knema andamanica* are added to the germplasm. The most important collection was that of cultivating nutmeg with most of the fruits having more than one seed and aril.

b. Characterisation

Nutmeg : Study on variability and intercharacter association for fruit and seed characters (mean of 3 years data) revealed maximum variability for yield (number of fruits/tree), followed by fruit weight.

The study indicated that the number of fruits per tree had a significant negative correlation with mace weight. Seed weight had a high positive significant correlation with mace weight. (Tables 30 & 31).

Table 30. Mean, range and C.V (%) for fruit characters in nutmeg

Characters	Mean	Range	CV(%)
Fruit number	116.55	8.67 - 559.0	112.2
Fruit weight (g)	53.24	39.18 - 77.16	17.5
Seed plus mace wt.(g)	10.12	8.48 - 13.42	12.8
Seed weight (g)	8.5	7.03 - 11.34	12.3
Mace weight (g)	1.63	1.24 - 2.28	19.4

Table 31. Correlations among fruit characters in nutmeg

Fruit characters	Fruit weight	Seed plus mace wt.	Seed weight	Mace weight
Fruit number	0.004	-0.29	0.20	-0.47*
Fruit weight		0.63**	0.64**	0.42*
Seed plus mace wt.			0.98**	0.78**
Seed weight				0.65**

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

c. Incidence of immature fruit drop

A survey was conducted in 42 private gardens for studying incidence of immature fruit drop in nutmeg. In 50% of the gardens there is no incidence of fruit drop. In 10% of the gardens, the loss was observed upto 40% and in the remaining gardens, the fruit drop is negligible (less than 5% fall). Maximum fruit drop was observed in April - May.

d. Evaluation of Cinnamon germplasm:

Seventy one cinnamon accessions, studiesd for variability and association revealed high coefficient of variation for dry and fresh bark yield, bark oleoresin, leaf oil, bark oil, leaf size index and percentage recovery of bark (Table 32). Correlation analysis revealed significant correlation of fresh weight of bark and leaf oil with dry bark yield. Bark oil was negatively correlated with leaf oil.

Cinnamon elite lines:

In the yield evaluation trial of elite progenies, morphological and yield attributes were recorded. Growth, regeneration capacity and fresh weight of bark/plant of the seedling progenies were better as compared to clonal progenies. A similar trend was observed during 1990 also.

Progeny trial of elite clove lines

A progeny trial of elite lines of clove was laid out at the NRCS, Cardamom Research Centre, Appangala with 14 elite lines.

e. Production of nucleus planting material in nutmeg

Seedlings and grafts of certain selected trees were raised

Table 32. Cinnamon Germplasm Evaluation - Important morphological characters and yield attributes

Characters	Mean	Range	CV(%)
Leaf length (cm)	13.08	8.75 - 20.69	17.83
Leaf breadth (cm)	5.06	3.31 - 8.30	18.74
Leaf size index	0.763	0.29 - 1.71	35.13
Fresh wt. of bark (g)	207.41	30.00 - 840.00	67.19
Recovery of bark (%)	32.08	10.7 - 80.00	34.00
Bark oleoresin (%)	8.48	1.32 - 20.02	57.08
Bark oil (%)	1.81	0.51 - 3.85	36.28
Leaf oil (%)	1.87	0.72 - 4.80	48.46
Dry weight of bark (g)	64.70	8.0 - 305.0	74.73

5. Hort.1 (813) : Vegetative propagation of tree spices

(J.Rema and B. Krishnamoorthy)

a. Field planting of approach grafts of clove

One year old grafts of 8 accessions of clove were planted in an RBD with 6 replications at a spacing of 9m x 9m for field evaluation in the existing coconut plantation. Nine seedlings were used as control.

b. Inducing orthotropic shoots in nutmeg

Use of orthotropic shoots as scions are necessary in nutmeg to get an erect growing graft. Detopping old trees at a height of 1 to 3 meters produce more number of orthotropic shoots which could be used for grafting.

Attempts to produce orthotropic shoots from plagiotropic grafts by bending the scion was not successful, though natural production of orthotropic shoots were observed in certain plagiotropic grafts.

c. Storage of nutmeg scions

Transport of nutmeg scions to far off places for grafting has become a difficult proposition. An experiment was carried out to study the usefulness of different materials like polythene, coir dust, moist gunny bag, charcoal, soil paper etc. for storing scions during transport. The results revealed that scions could be stored upto 11 days in polythene bags with 52% success in grafting.

d. Vegetative propagation of All spice

Vegatative propagation of allspice by cutting and layering were attempted. Etiolated cuttings and non etiolated cuttings from 10 year old trees treated with IBA 5000 ppm and 'quic root' did not root. However, juvenile allspice cuttings treated with 'quic root' gave 50% rooting. Layering (without any hormones) did not encourage production of adventitious roots in allspice.

6. Gen. VIII (813) : 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)

a. Comparative yield trials (CYT) at Peruvannamuzhi

Two Karimunda selections, KS-103 and KS-107 were found superior to other selections for the 4th consecutive year.

CYT - III

In CYT-III, involving 10 hybrids, 18 cultivars and 2 controls. Coll. 1501 and Coll. 1109 were superior based on the first year yield.

In a comparative yield evaluation of 100 black pepper hybrids at Tata tea estate, Valparai (3500 ft above msl), Tamil Nadu, yield data revealed superiority of hybrids HP-732 and HP-813 in the first year.

In the yield evaluation trial of 100 black pepper hybrids at Central State Farm, Aralam, Kannoor District, 2 hybrids of Cholamundi x Panniyur 1 (HP-846 and HP-833) were found superior to all others based on first year yield data.

New trials

Peruvannamuzhi : A trial comprising thirty six selected open pollinated progenies from four cultivors alongwith the mother vines was laid out with three replications and a plot size of four plants.

The existing yield trial CYT.IV was dismantled and reconstituted with six new cultivars, 11 hybrids and 2 controls.

b. Cytological studies : A polyploid line of cultivated black pepper is identified for the first time. This line (coll. 1344) had a somatic chromosome number of 2n = 78 which may be considered as a hexaploid on the basic number of x=13. Progenies of this cultivar exhibited high quantitative variation for six seedling characters and their chromosome numbers.

c. Polyploidy

Fifty seeds each of Panniyur-1 and Karimunda were treated with 0.05 and 0.1% colchicine and EMS separately for 4 hrs and sown after 20 hrs. Observations on germination percentage and morphological variation were recorded.

7. Gen X (813) : Breeding cardamom for high yield and resistance to Katte disease

(Regy Lukose & M.N. Venugopal)

a. Hybridisation

Six cross combinations were made between high yielding selections of cardamom viz. 872 (CCS-1) 800 & 893 with E.B. About 3350 seeds obtained from these combinations were sown for germination.

b. Screening for 'Katte' resistance

In the ongoing screening trial in the sickplot 19 entires continue to show field resistance to the natural infection of 'katte' disease.

The twenty one germplasm entries, which did not take infection in the first

inoculation under green house screening trial, are found to be susceptible to natural infection in sick plots.

Clonal multiplication of 19 promising natural 'Katte', escapes is taken up.

c. Mutation breeding

The three M1 mutants continue to show field resistance after one year of exposure in the sick plots. High yielding selections viz., 872 (C.C.S-1) 800 & 893 were multiplied and about 800 clonal planting units were produced.

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

(S. Vasantha and A. Ramadasan)

a. Screening of germplasm

Screening of Kottanadan selections employing *in vitro* methods viz. using leaf discs, hydroponics and leaf callus was done. In all these methods induction of stress at -2.5 MPa was achieved using PEG 6000 solution. While incubation of leaf discs and leaf callus tissue in the desired stress level lasted only for a few hours, the whole plant method using Hoagland solution maintained at -2.5 MPa using PEG - 6000 lasted less than a month. In all these cases the RWC accessions selected as relatively drought tolerant are accession Nos. 2559, 2563, 2546, 2433 and 2548. These will be planted in the field for evaluation.

b. Field evaluation of promising lines

Karimunda selection 69 performed better than others at 12% moisture level. At relatively high stomatal conductance by cutting down the transpiration drastically, this accession is capable of new growth.

The field evaluations of KS-69 and Kottanadan selections are in progress.

c. Biochemical characterisation

The activities of nitrates reductase, acid phosphatase and peroxidase under moisture stress were studied, in Karimunda. Aimpiriyan and Kottanadan selections. While acid phosphatase and peroxidase activities increased under stress the nitrate reductase activity decreased.

9. Phy III (813) : Quality evaluation in spices

(T. John Zachariah)

a. Black Pepper

Among the 56 germplasm accessions evaluated for essential oil, oleoresin and piperine contents, three accessions viz. 49, 194, 56 were of high quality, three accessions viz. 166, 194, 44 were high in oleoresin and piperine and 3 accessions viz. 49, 56 and 92 were high in Essential oil (4.3% v/w)

Effect of sundrying of black pepper on different materials like HDPE, LDPE, bamboo mat and cement floor were compared. Though there was no significant variation in the chemical quality, pepper obtained by drying on LDPE and HDPE was clean and free of dirt.

Planting black pepper at different spacings has no significant effect on the chemical quality.

b. Cardamom

Eight accessions each of OP of *interse* selections were analysed for their quality. Among the OP selections, No. 871 contained 6.7% oil with 40% 1, 8 cineole and 39% alpha terpinyl acetate. Among the *interse* selections No. 880 contained 7.5% oil and sel 118 contained 7.3% oil with 41.8% 1.8 cineole and 40% alpha terpinyl acetate.

c. Turmeric

The effect of storage of rhizomes on the levels of curcumin and oleoresin were evaluated. The turmeric varieties Suvarna, Suguna and Sudarshana were harvested and stored for a period of nine months. Samples were analysed at monthly intervals during the period of storage. These constituents, in general, remained unaffected during the period.

d. Ginger

Preliminary evaluation of 86 germplasm accessions for dry recovery, crude fibre and oleoresin have indicated a few accessions with high quality and low fibre. Inter characters accociation analysis of various constituents revealed that dry recovery had significant negative correlation with crude fibre, oleoresin, gingerol and shogaol contents. Crude fibre content had significant positive correlation with oleoresin

10. Biotech. III (813) : Micropropagation of black pepper

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

a. Micropropagation : Shoot tip explants from mature and juvenile plants were cultured on MS and Woody Plants media in 30 different combinations. WPM supplemented with $3mgl^{-1}$ BA and $1mgl^{-1}$ Kinetin was the best for multiple shoot production. The multiplication rate ranged from 4-8 shoots per explant with in 60 days of culture. The shoots developed good root system in growth regulator free WPM. The rooted plantlets were transferred to soil with almost 90% establishment when they were placed in humid chamber for 20-30 days after transfer.

Adventitious bud formation has been observed in seedling shoot explants in half strength MS media supplemented with IAA ($1mgl^{-1}$) and BA ($1mgl^{-1}$).

b. Callus regeneration

Plant regeneration either directly or through intervening callus phase from leaf and shoot tip explants of mature as well as juvenile plants was achieved on WPM supplemented with cytokinins (BA and Kinetin). Leaf tissue was found to be better suited for this purpose.

c. Anther and Inflorecence culture:

When inflorecences were inoculated on culture medium, anther growth, fruit development and callus production were observed.

d. Micropropagation of related species of Piper :

a. *Piper colubrinum*: Multiple shoots were induced from shoot tip cultues in WPM supplemented with BA and Kinetin. Direct plant regeneration was a major achievement from leaf, stem and petiole tissues when cultured on WPM supplemented with cytokinin. Plants could be regenerated from these tissues through callus phase also in the same medium. The frequency of regeneration is very high with 200-500 plantlets in each culture. The plants developed root system to some extent in the same medium. The root system was excellent on hormone free medium.

b. *Piper longum*: Micropropagation in the shoot tip cultures of *P. longum* were achieved on WPM supplemented with cytokinin. Rate of multiplication was very high.

Plant regeneration from leaf nodal and internodal segments of stem, petiole etc were obtained with or without intervening callus phase.

c. *Other species* : Shoot tip cultures of *P. betle* and *P. chaba* were established.

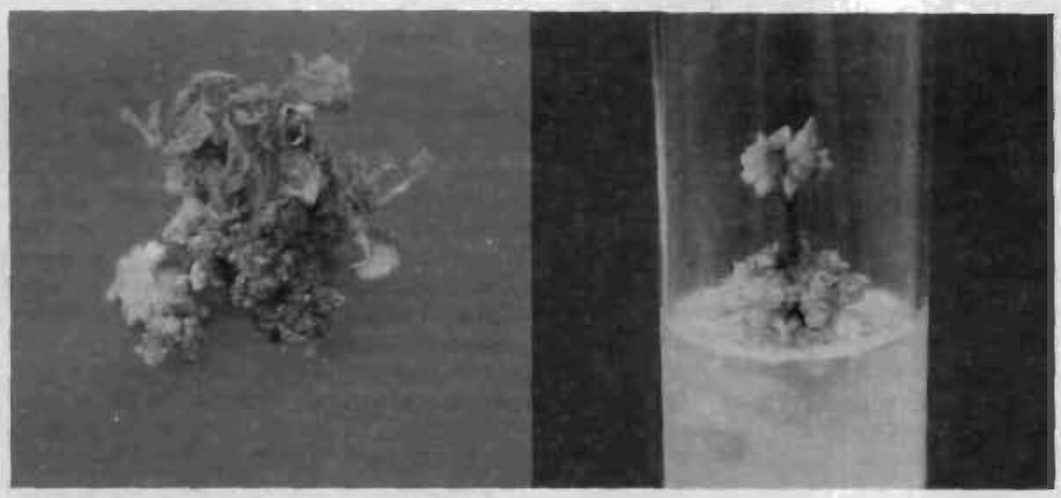


Fig. 3. Micropropagation of *Piper Colubrinum* from leaf explants.

Fig. 4. Micropropagation of *Piper Longum* from shoot explants.

11. Biotech I (813) : Tissue culture for rapid multiplication of elite clones of cardamom

(Regy. Luckose)

A protocol for regeneration of plantlets from callus induced from the rhizome of the hybrid Cl-37 x PV1 was standardised. About 50 plantlets were obtained from callus, which were subsequently transferred to White's basal medium + 0.5 mgl^{-1} NAA for rooting. Callus was treated with colchicine at two concentrations for inducing *in vitro* polyploidy. In CYT-1, where tissue cultured plants, seedlings and suckers of Cl-37 were compared, significant differences were found between treatments for number of tillers, number of yielding tillers, height of the tallest tiller, number of panicles and yield. In CYT-II, where monoclonal tissue cultured plants, suckers and seedlings of Mudigere P1 were compared, significant differences were found between treatments for number of tillers, number of yielding tillers and no. of capsules. However, no significant difference was noticed with regard to yield in CYT-II.

12. Bio-tech II (813) : *In vitro* selection for resistance of soft rot and bacterial wilt in ginger

(K. Nirmal Babu and T.G. Nageshwar Rao)

a. *In vitro* polyploidy : Over three hundred embryoid cultures treated with colchicine are maintained. These embryoids showing colchiploid nature are to be cytologically indexed for estimation of their ploidy level.

b. Field evaluation of somaclones: Two hundred tissue cultured plants were planted in pots for morphological characterisation to study their genetic stability. There is considerable variability for plant height, number of leaves, number of tillers, rhizome size, rhizome yield etc. among the micropropagated plants derived from vegetative bud cultures as well as callus cultures in 2nd year and 1st year of field evaluation respectively. However, at this stage, these differences may not be due to genetic differences.

c. Multiplication of somaclones : Over 500 cultures of somaclones are maintained in the laboratory for further multiplication based on demand. Two hundred somaclones were transferred to soil.

d. Standardisation of *in vitro* selection technique : In an attempt to standardise in vitro selection technique, culture filterates (CF) of *Pseudomonas solanacearum* and *Pythium aphanidermatum* were concentrated to 1/10th and were used as selecting agents in the culture medium. When embryoids of ginger were grown over this medium with CF, it resulted in death of 80% of the embryoids within 30 days, where as in control there is no mortality and the embryoids multiplied further. However the CF is to be purified further for its effective utilisation as a selective agent.

e. Screening of somaclones against *Pythium aphanidermatum* and *Pseudomonas solanacearum* : One hundred and fifty somaclones planted in polybags were inoculated with *Pythium aphanidermatum* and *Pseudomonas solanacearum* separately to study their tolerance reaction. All of them except five sccumbed to infection. These five escapes are being retested.

SUPPORTIVE RESEARCH PROGRAMMES

1. Ext. I(813) : Increasing productivity of black pepper and cardamom through large scale demonstration of improved technology in farmers fields

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

Black Pepper

In addition to the existing five plots at the transfer of technology centre (TTC) Chakkittapara (Kozhikode District), more plots were selected at Pulpally (Wynad district) which is a traditional pepper growing area. In this new centre there are a total of 4200 vines. Studies on the varietal distribution showed Karimunda (63%), Aimpiriyam (8%), Jeerakamundi (6%), Panniyur-1(4%) and unspecified varieties 19%. Due to the adoption of improved technology 43.4% increase in yield was obtained over farmers practices in the first year. The productivity was 3.1 Kg (dry) compared to 2.2 Kg and the disease incidence was 0.73% in the experimental plot in comparison to 1.8% in the control plot.

Cardamom

A 10 ha. cardamom plantation (M/s. Lakshmi estate, Halery North Coorg) which was planted in 1972 and later severely infested by 'katte' disease was rejuvenated and high production technology (HPT) was adopted in the year 1983. The plantation which was under conventional management prior to the HPT programme had an average yield of 116.5 Kg/ha of dry cardamom, which increased to 460 Kg/ha under HPT with a maiden crop of 850 Kg/ha in 1985.

2. Gen. I(443) : Production of parental materials and breeders stock of black pepper and cardamom

(B.N. Reddy, K. Sivaraman and V.S. Korikanthimath)

Calicut

Multiplication and distribution of high yielding black pepper varieties like Sreekara and Subhakara were taken up. A total of 25,500 single noded rooted cuttings of black pepper was distributed to departmental agencies and progressive farmers for further multiplication.

Appangala

Seed capsules of Cl-37 (175 Kg) from the seed plot of NRCS, CRC Appangala and 680 Kg seed capsules from the research cum demonstration plots were supplied to key developmental agencies and progressive growers. In black pepper, 3386 rooted cuttings of popular high yielding Karimunda and Aimpiriyan cultivars, 903 rooted cuttings of Sreekara and 1487 rooted cuttings of Subhakara were distributed to certified nurseries as nucleus planting materials.

A rapid method of proliferation of suckers in cardamom was developed and popularised. High density planting in trenches with a spacing of 1.8m x 0.6m under controlled overhead shade of a coir mat recorded an average 60-70 tillers per unit after 12 months of planting, giving rise to 30-35 units of planting material (each unit of planting material consists a minimum of two suckers, one grown up and another growing shoot).

3. Extn. I(443) : Training of Research and Extension workers and Farmers

(K.M. Abdulla Koya and M.N. Venugopal)

This centre organised 13 training courses, 9 at Calicut and 4 at Appangala on various aspects of spices research and development. These programmes were attended by 190 officials sponsored by different departments of the country (Table 33). Duration of the courses varied from 1-5 days. The participants included officers upto the level of sub divisional officers, officials from commercial bodies, trainees from Forest School, field officers and field assistants. Trainings on cultivation, plant protection and processing of spices were imparted to 50 selected farmers in 3 batches.

Practical training in cultivation of spices was imparted to 15 B.Sc (Ag.) students for a period of one week and facilities for field and laboratory work were provided to 45 Zoology/Botany students from Calicut University.

Kisan Mela conducted at Peruvannamuzhi was attended by about 250 progressive farmers. An exhibition depicting various problems in spices and a field trip were organised in connection with Kisan Mela.

The scientists attended the Agricultural Seminars/Off-campus training and educated the gatherings regarding problems facing spices cultivation and cleared doubts of participants.

The centre also participated and organised 5 exhibitions one each at Thiruvananthapuram, Wynad, Peruvannamuzhi, Kasaragod and Kannur.

Table 33. Training courses conducted at Calicut and Appangala

Title	Venue	No. of Courses	No. of Participants	State/ Union Territory
Nursery management in spices	Calicut	4	39	Kerala Karnataka Tamil Nadu West Bengal
Spices production technology	Calicut	3	58	Kerala Karnataka Assam
Spices cultivation	Calicut	2	38	Kerala
Katte disease management	Appangala	1	25	Karnataka
HPT in Cardamom	Appangala	2	26	Karnataka
Nursery management in spices	Appangala	1	4	Karnataka

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES

All India Co-ordinated Research Project on Spices

S. Edison

1. Genetic Resources

The following are the number of different germplasm accessions (including wild) being maintained in the Coordinating Centres.

Black Pepper	
Panniyur	153
Sirsi	47
Chintapalli	40
Yercaud	102
Cardamom	
Pampadumpara	67
Yercaud	35
Mudigere	340
Ginger	
Pottangi	144
Solan	152
Turmeric	
Pottangi	185
Solan	146
Coimbatore	105
Large Cardamom	
Gangtok	34
Coriander	
Jobner	444
Jagudan	295
Coimbatore	151
Guntur	120
Cumin	
Jobner	219
Jagudan	174
Fennel	
Jobner	134
Jagudan	183
Fenugreek	
Jobner	142
Jagudan	172
Coimbatore	84
Guntur	70

Extensive germplasm collection surveys were conducted by the Panniyur (KAU) Centre for black pepper in the forest areas of Tirunelveli district. *Piper hapnium* and *P. barberi* were collected for the first time by this Centre. In large cardamom, a new germplasm was collected from the forest areas of Gangtok at an altitude of 6000 ft. MSL; this type belonged to an allied species in genus *Amomum* which bears fleshy fruits with smooth purplish epicarp, the mesocarp being fleshy and fibrous; the plant is vigorous and has thick large leaves.

About 37 germplasm accessions of seed spices viz., Coriander, Cumin and Fenugreek obtained from the NBPGR were handed over to the Jagudan Centre for their multiplication, maintenance and evaluation; the material will be spared to other centres afterwards.

2. CROP IMPROVEMENT

2.1 Black Pepper

Three high yielding varieties viz., Panniyur-2, Panniyur-3 and Panniyur-4 were released from Panniyur (KAU) centre; these 3 varieties gave estimated mean yields (dry pepper) of 2570 kg, 1953 kg and 1277 kg respectively per hectare (@ 1600 vines/ha at 2.5 x 2.5 m spacing) and have an yield potential of 3313 kg, 3269 kg and 2443 kg per hectare respectively.

Three promising cultures were identified at Panniyur (KAU) viz., Cu. 1558, Cu. 5128 and Cu. 239. In culture 1558, an OP progeny of Cv. Kalluvally, the spikes are extra-ordinarily long, berries bold, 15-20% of spikes are branched , berries set on all bran-ches. About 800 seedlings of hybrids/ OP progenies were evaluated at Panniyur. In the MLT, cultures 239, 54 and 331 were top yielders in 1990-91 and 1991-92 at Panniyur.

2.2 Cardamom

Four varieties of cardamom viz., PV-1 (KAU), Mudigere-1 (UAS-B), and MCC-49 & MCC-61 (ICRI) were recommended for release. MCC-61 is a Mysore type and the others are Malabar. PV-1, a selection from Walayar Local has good suckering habit and bold capsules and gave a mean yield of 260 kg/ha, the yield potential being 500 kg/ha. Mudigere-1, which gives an average yield of 275 kg/ha is recommended for cultivation for Malnad region of Karnataka. The two high yielding selections MCC-49 (ICRI-1) and MCC-61 (ICRI-2) gave an average yield of 325 kg/ha and 375 kg/ha respectively, under rainfed condition; these have the potential of yielding 656 kg/ha and 766 kg/ha respectively when irrigated. Two promising selections viz., P-3 and P-5 have been identified for prerelease multiplication at Mudigere. The clones Cl-679, Cl-683 and Cl-726 (UAS- Mudigere), Ps-10, PV-4, PV-12, PV-3 (KAU-Pampadumpara) and Selection APG-7 (TNAU-Yercaud) were identified as high yielding accessions.

At Mudigere, 245 germplasm collections are being evaluated and Cl-692, P-20, Cl-683 and Cl-802 appeared promising (out of 195 collections), with Cl-692 giving the highest yield of 2.015 Kg/clump. Among the elite clones maintained in germplasm block, the preliminary data revealed the superiority of P-1 by producing more than 2 kg green capsules/clump. Among the 66 elite clones studied, thrips and borer damage were minimum (less than 10%) in five entries viz., D-163, D-457, D-446, D-514 and D-1. Significant variability was observed for pseudostem height, suckers/clump and yield in OP seedling progenies of selected hybrids and promising clones. In the evaluation of 35 germplasm at Yercaud, YC-14 (Cl.37 from Appangala) and YC-1 (from Pampadumpara) registered the maximum dry yield of 12.78 and 12.28 g/clump respectively. In the MLT-88 with 12 entries at Yercaud, Sel. 112 registered the highest yield of 194.4 kg dry capsules/ha while at Mudigere, Sel. 112, SKP-51 and P-1 recorded significantly higher pseudostem length. Under higher light intensity, pseudostem height and sucker number were significantly more in hybrid than in clones at Mudigere. Pseudostem height, capsule number and yield per clump reduced significantly following gamma irradiation with 1,2,3,4 and 5 kr. treatment. In the evaluation for drought tolerance, significant differences were observed in plant height and number of suckers between levels of irrigation and between clones, clone P-2 recorded maximum height of 183.89 cm followed by clone P-6 (180-72 cm) in Mudigere.

2.3 Large Cardamom

The accessions 'Pink Golsey' and Clone-4 (green cardamom) were identified as superior; Pink Golsey has the maximum yield potential, followed by Ramsey, Sawney and Clone-2 in the CYT-1 at the Gangtok centre. Dzongu-Golsey was totally free from the chirkey disease.

2.4 Ginger

Two high yielding varieties SURUCHI and SURAVI have been released for commercial cultivation (after the release of Suprabha (PGS-35) in 1988-89) by Pottangi centre. Suravi is an induced vegetative mutant (V_1K_1-3) having an average yield of 17.4 t/ha of fresh rhizomes with low fibre content (4%) and 10.2% oleoresin. Suruchi gives 11.6 t/ha average yield with 3.8% fibre and 10% oleoresin. At Solan, SG-666 has been identified for recommendation as a variety.

The high yielding mutants V_1E_4-4, V_1S_1-2 and V_2S_1-7 are identified as promising in the MLT at Pottangi based on rhizome yield for two years; V_2S_1-7 recorded the highest yield of 18.869 t/ha; V_1E_4-4, V_2S_1-7 and Maran did not show soft rot incidence. The IET, pooled data for 3 years indicated the superiority in yield by V_1E_4-4 (12.479 t/ha) followed by V_1S_1-2 (11.359 t/ha).

At Solan, 163 germplasm were evaluated and SG-692, SG-695, SG-247, SG-700, SG-554 and SG-638 gave comparatively higher yields. In the IET with 18 accessions at Solan, highest yield per plot was recorded by SG-600 followed by SG-54.

2.5 Turmeric

Two high yielding varieties RANGA (PTS-38) and RASMI (PTS-9) have been released from Pottangi. Ranga gave an average yield of 29 t fresh rhizomes/ha, 6.3% curcumin, 13.5% oleoresin and 4.4% essential oil while Rasmi gave an average yield of 31.3 t fresh rhizomes/ha, 6.4% curcumin, 13.4% oleoresin and 4.4% essential oil content. High yielding mutants PTS-19 (OUAT-Pottangi) and TC-2 (TNAU-Coimbatore) were identified to be promising.

In the evaluation of 146 nos. of germplasm at Solan, the per plot yields were high in ST-315, ST-55, ST-60, ST-54 & ST-77; in the IET with 16 accessions, ST-43 and ST-247 recorded the maximum yield per plot.

2.6 Coriander

Varieties SINDHU (APAU Guntur) and Co-3 (TNAU Coimbatore) have been released. Early maturing variety Co-3 has an yield potential of 650 kg/ha. with medium sized seeds, contains 0.4% oil and showed lower incidence of grain mould and wilt diseases. The variety Sindhu gave an yield of 1050 kg/ha with 0.4% essential oil and 11.2% fixed oil.

At Guntur, 120 germplasm accessions were evaluated in which ATP-102, followed by the accessions West Bengal, UD-153, ATP-115, and ATP-103 gave higher yield; in the evaluation of 11 promising lines of selected coriander entries, "composite" and ATP-147 recorded high yield of 1016.7 kg/ha. In the CYT with 13 entries at Guntur, ATP-82 recorded the highest yield of 1122.2 kg/ha followed by DH-5 (1061 kg/ha), JCo-81 (1027.8 kg/ha), No. 695 (988.9 kg/ha), CS-335 (938.9 kg/ha) and CS-45 (933.3 kg/ha). At Coimbatore, in the IET with 12 entries, Acc. 812 and 496 gave the highest yield of 770 kg/ha and in CYT, highest yield of 730 kg/ha recorded by UD-435, followed by CS-695 (Co-3) with an yield of 700 kg/ha. Entry CS-695 showed good performance in yield during last two years (1681 kg/ha) in the MLT at Jagudan.

An early maturing accession from Coimbatore centre, CS-287 (reselection from CS-6) yielding 595 kg/ha, suitable for the rainfed tracts of Tamil Nadu, recorded less incidence of wilt and grain mould, other accessions 695, CS-335, 745, CS-45 and 466 also registered low incidence, (below 5%) of grain mould. At jobner, UD-1, UD-20 and UD-21 showed resistance against root knot nematode; accessions UD-373 and UD-374 exhibited field tolerance against powdery mildew.

2.7 Cumin

Gujarat Cumin-2 (GAU-Jagudan), an induced mutant with an yield potential of 573 kg/ha, 4% oil content, and moderate tolerance against blight has been recommended for release as a variety.

In the evaluation of 85 cumin varieties, 12 entries outyielded the check RZ-19 at Jobner. In the varietal trial with 14 entries, maximum yield of 5.34 q/ha was recorded in JC-147 followed by UC-209 (5.24 q/ha), RZ-19 (5.03 q/ha) and UC-216 4.67 q/ha).

In the screening of seven selected entries against wilt under artificial conditions, the lowest mortality was revealed in UC-19 (20.13%) followed by UC-198 (20.37%) at Jobner. Exotic collection EC-109035 continued to be moderately resistant to wilt at Jagudan.

2.8 Fennel

In the Coordinated varietal trial with 12 entries, UF(M)1 recorded maximum yield of 22.88 /ha followed by UM-131 (22.70 q/ha) as compared to local check (22.28 q/ha) at Jobner.

2.9 Fenugreek

Lam Sel.1 is awaiting release from Guntur. Accessions UM-34 , UM-116, and UM-118 have shown promise with higher yields at Jobner. In the MLT with 14 entries at Jobner, UM-127 gave higher yield; entries UM-34, UM-35, UM-67, UM-79, UM-113 and Co-1 showed high tolerance against root knot nematode. Entry UM-127 gave the highest yield of 1648 kg/ha in the MLT at Jagudan. Among the seventy accessions evaluated during 1991-92 at Guntur, IC-4935 recorded the highest grain yield of 1333.3 kg/ha followed by EC-7742 and EC-14173 with yields of 1266.7 kg/ha and 1166.7 kg/ha respectively. In the CYT with 14 entries at Guntur, TG-194 recorded maximum yield of 1116.7 kg/ha followed by TG-947 (1077.8 kg/ha), TG-268 (1072.2 kg/ha), JF-8 (1038.9 kg/ha) and HM-46 (1016.7 kg/ha) as well as the local check (783.3 kg/ha). At Coimbatore acc. 424 recorded the highest yield of 630 kg/ha in the IET, TG-268 and TG-947 recorded maximum yield of 760 kg/ha in the evaluation of 13 entries in the CYT. Acc. HM-57, Acc. 464 and 113 registered low incidence (below 5%) of root rot at Coimbatore centre.

2.10 Quality evaluation

Sixty five germplasm accessions of ginger were analysed at Solan for quality and among them, SG-666 has the highest essential oil viz., 2.5%. Harvesting of ginger after 165 days of sowing increased the dry matter while essential oil and oleoresin contents decreased gradually with days at Solan.

Turmeric accession "ST-323 yellow" gave highest curcumin and oleoresin contents. There was not loss of curcumin during storage after 2 months of harvest whereas 15-22% loss was observed when stored for six months. Studies conducted at Coimbatore registered maximum curcumin content in cured mother rhizomes followed by primary and secondary fingers.

The maximum volatile oil in coriander was found in JCo-126 and UD-435 (0.4%). In case of cumin, volatile oil content ranged from 2.52% to 5.30% with the maximum in UC-198 (5.30%), followed by UC-199 (4.4%) and JC-147 (3.47%). In Fennel, UF-90 and UF-131 were best with 1.8% volatile oil followed by UF-101 and HF-39 (1.6%).

3. CROP PRODUCTION

3.1 Cardamom

Pre-treatment of cardamom seeds with 2.5% Nitric acid for 10 min. before sowing increased the germination percentage. Treatment of seeds with 50% ether for 10 min. followed by soaking the seeds in dilute HNO3 (2%) for 5 hrs. also gave higher germination. Germination of seeds during winter can be enhanced to 65.5% by giving a polythene sheet covering on seed beds. The response of cardamom to NPK fertilizers under irrigation in uniform shade was significant for capsule yield, and the response was higher with higher levels of fertilizers. In cardamom, irrigation must be commenced between mid December to mid January, since yield levels are affected by late irrigation.

3.2 Ginger

The optimum date of planting ginger is the first week of April; raised beds (15 cm height) of 1m width at convenient length has been standardised. Red gram and French beans appeared to be the best intercrops. In ginger, "the pure crop with mulching" gives highest yield; three years' pooled data indicated that "pure crop with 3 mulchings" gave highest fresh rhizomes yield (8.133 t/ha) followed by "one mulch" with soybean-

intercrop (7.844 t/ha of ginger and 0.485 t/ha soybean). The cost benefit analysis revealed highest benefit from the treatment "1st mulch along with soybean intercropping".

3.3 Turmeric

In turmeric a spacing of 25 cm x 25 cm in raised beds of 3m x 1m was found optimum; mother rhizomes (25-30g pieces) have been identified as best seed material. Pure crop with three mulches gave maximum turmeric yield followed by intercropping with one row of horse gram in between each alternate inter-row space of turmeric. For turmeric, the manurial dose is fixed as FYM 7.5 kg/m^2 and 2.5 kg. green leaf mulch/m^2 supplemented by N:P_2O_5:K_2O @ 60:30:90 Kg/ha.

3.4 Coriander

In Coriander, a spacing of 30 cm between rows is recommended at Jobner. Leaf plucking up to 50% if done 75 days after sowing did not affect the grain yield. Harvesting of variety Gujarat Coriander-2 when 100% fruits turn to yellow colour in whole plant is recommended for higher yields (1355 kg/ha) in Gujarat.

3.5 Cumin

At Jagudan, yield difference due to crop geometry and seed rate were found to be non-significant, however a row spacing of 15 cm and seed rate of 12 kg/ha gave higher yield (572.985 kg/ha). Sowing of cumin at 22.5 cm row spacing and a seed rate of 12 kg/ha has been recommended for maximum yield at Jobner against broadcast method at a seed rate of 8 kg/ha; Cumin when broadcast coupled with Nitrogen @ 30 kg/ha in single dose, gave higher yields.

3.6 Fennel

For obtaining higher yield in fennel (var. Guj. Fennel-1) it is recommended to apply 90 kg N/ha (i.e., 36 kg N as basal + 27 kg N after 30 days and 27 kg after 60 days of transplanting) and 45 kg P_2O_5/ha (as basal dose).

3.7 Fenugreek

Sowing fenugreek in the first week of November gave a profitable crop and a seed rate of 25 kg/ha gave maximum seed yield of 11.56 q/ha at Jobner. Application of 40 kg N and 40 kg P/ha resulted in maximum seed yield of 12.19 q/ha. Seven irrigations at IW/CPE ratio of 1.0 combined with application of 80 kg P_2O_5/ha has been recommended for obtaining highest yield for fenugreek at Jagudan.

4. CROP PROTECTION

4.1 Black Pepper

Treatment with Bordeaux mixture (1%) as well as Ridomil MZ 72 (100 ppm) were effective in the management of foot rot. Application of neem cake @ 2 kg/vine and 1 kg lime/vine besides Bordeaux mixture spray (1%) reduced the slow wilt incidence. At Chintapalli, drenching with 1% Bordeaux mixture @ 5 lit/vine around the basin and two rounds of 1% Bordeaux mixture as foliar spray during May-June and July-August gave significantly better recovery of vines. Fortnightly sprayings with Bordeaux mixture (1%) followed by Difolatan (0.1%) controlled nursery diseases.

4.2 Cardamom

Spraying with combination of Dithane M-45 (0.25%) + Ridomil MZ-72 WP (0.1%) or Bavistin (0.02%) + Ridomil controlled damping off and leaf spot diseases in nursery effectively. Application of granular insecticides like carbofuran 3 G @ 8-10 g/clone during June-July and November-December were quite effective in controlling root grub. Endosulfan and Carbaryl (0.15%) were found effective against cardamom thrips. Thrashing of cardamom plants in May or thrashing followed by three insecticidal sprays at monthly intervals is essential to reduce the thrips damage. Spraying phosalone, endosulfan or

malathion (0.05%) during peak flowering period did not affect honey bee activity and pollination.

4.3 Large Cardamom

Leaf streak, a serious disease of large cardamom Var. Golsey was controlled by spraying with blitox-50 or fytolan @ 0.3%.

4.4 Ginger

Seed treatment with bavistin 0.1% followed by captan (0.25%) for 60 min. increased germination and reduced post emergence rot in ginger.

4.5 Seed Spices

Spraying carbendazim 0.1% given 20 days after grain set, is recommended for grain mould control in coriander. Cumin blight can be controlled by spraying Dithane M-45 or Cupramar @ 0.8 to 1.0 kg/ha at fortnightly intervals. For reducing the incidence of cumin wilt, it is necessary to follow at least a "3 year crop rotation" cycle. Weed control in cumin could be achieved with Terbutryn @ 2.5 kg a.i./ha. Application of neem cake @ 1t/ha combined with seed pelletting with *Trichoderma viride* resulted in reduced root rot incidence (3.5%) in fenugreek; this is however on par with 0.1% carbendazim soil drenching.

5. PRODUCTION OF PLANTING MATERIALS

One of the important activities taken up by the AICRP centres has been the production and distribution of elite planting materials in collaboration with Spices Board and Directorate of Cocoa, Arecanut & Spices Development.

The details of planting materials supplied are :

1) Panniyur Centre has supplied 93459 rooted cuttings of black pepper varieties Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-4 as well as Karimunda.

2) Pottangi Centre has supplied approximately 5 tonnes of seed material of ginger varieties Suprebha and Suruchi as well as turmeric varieties Roma and Suroma.

3) Two quintals of seed rhizomes of improved ginger selection SG-666 were distributed to the Department of Agriculture, Govt. of Himachal Pradesh, by the Solan Centre.

4) Mudigere centre supplied 21869 seedlings, 2537 suckers and 50.2 kg of seeds of variety Mudigere-1 to the various developmental agencies.

5) Cardamom seed capsules (4.5 kg) of PV-1 variety, 3.0 kg of cv. Vazhuka and 1.5 kg of cv. Malabar were distributed by Pampadumpara Centre.

6) Guntur Centre has distributed one tonne of seeds of improved varieties of Swathi & Sadhana in Coriander. Mini-kit trials have also been sponsored by the centre in collaboration with the Department of Agriculture, Govt. of Andhra Pradesh.

7) Jobner Centre has taken up 10 ha. of seed production of Cumin variety RZ-19, Coriander RCr-41 and Fenugreek variety RMt-1 during the year.

8) At Jagudan Centre Cumin seeds (460 kg) of varieties MC-43 and Guj. Cumin-1, fennel seeds (515 kg) of varieties PF-35 & Guj. Fennel-1 and 268 kg of Guj. Coriander-2 were distributed to developmental agencies and farmers. Minikit trials have also been sponsored by the Centre for the development of cumin, fennel & fenugreek in Gujarat. The Centre has taken up 5 ha. of seed multiplication of Guj. Cumin-1, 35 ha of Guj. Fennel-1 and 3 ha. of Fenugreek Local during this year.

9) Three tonnes of turmeric variety Suguna and one tonne of turmeric variety Sudharshana have been multiplied for distribution by Jagtial Centre.

6. AICRPS WORKSHOPS

The All India Coordinated Research Project on Spices held the XI Workshop/ Group Meeting at the Kanakakunnu Palace, Trivandrum during July 26-28, 1991 and the progress made in the research experiments at the various Research Centres are reviewed and new programmes were identified. A Group discussion of the Entomologists working under the AICRP on Spices along with other Entomologists under the Coordinated Projects in Horticultural Division was also held at Lucknow and the programmes reviewed. Yercaud centre of the AICRP was identified by the ICAR to conduct research on tree Spices. The Project Coordinator conducted an exploratory survey for Tree Spices in collaboration with the Dept. of Horticulture, Govt. of Tamil Nadu and the Horticultural Research Station, Yercaud.

FINAL REPORT OF CLOSED PROJECTS

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

(S. Devasahayam)

Objectives

The project aims at studying the biology and ecology of gall thrips *Liothrips karnyi* infesting black pepper with a view to evolve control measures against the pest.

Technical Programme

a. Survey for distribution of gall thrips in major black pepper areas
b. Bioecology of gall thrips
c. Studies on natural enemies of gall thrips
d. Studies on other fauna associated with thrip galls
e. Susceptibility of black pepper germplasm to gall thrips
f. Bioassay of insecticides against gall thrips
g. Field trials with insecticides for control of gall thrips

MATERIALS AND METHODS

a. Distribution

Surveys were conducted in major black pepper areas in Kerala, Karnataka and Tamil Nadu to record the incidence of gall thrips. Three gardens were surveyed in each location and 15 vines were selected at random in each garden; the incidence of infested leaves was recorded on these vines.

b. Bioecology

i. **Life cycle**: Virgin males and females were released on tender black pepper leaves containing galls and placed in glass chimney cages. The galls were carefully opened at regular intervals to observe the progress in development of various stages. The nature of damage caused by gall thrips with particular reference to morphological aberrations was also studied.

ii. **Seasonal population**: Leaf galls of black pepper were collected at monthly intervals from Kalpetta (Wynad district) and brought to the laboratory. The galls were carefully opened and the number of eggs, juveniles and adult stages counted.

c. Natural enemies

i. **Distribuition**: Leaf galls of black pepper were collected from various localities and occurrence of natural enemies identified.

ii. **Predatory potential**: The predatory potential of *Montandoniola moraguesi* and *Androthrips flavipes* were determined. Adults and juveniles of these predators were placed individually in glass vials into which larvae II and eggs of gall thrips were introduced and the number of prey consumed was determined.

iii. **Life cycle**: Eggs of *M. moraguesi* and *A. flavipes* were observed for hatching and the newly hatched nymphs and larvae were transferred to glass vials. Larvae II and eggs of gall thrips were provided as prey and the development of various stages was observed.

iv. **Effect of insecticides**: The effect of monocrotophos (0.05%) and dimethoate (0.05%) on adults of *M. moraguesi* and *A. flavipes* was studied. Rooted black pepper cuttings were sprayed with the test insecticides and leaves were removed at 2 days intervals and placed in test tubes into which adult predators were released. The predators were

removed after 6 h and their mortality recorded after 24 h.

v. **Propagation of *M. moraguesi*** : The feasibility of propagating *M. moraguesi* on black pepper and *Mimusops elangii* infested by *L. karnyi* and *Androthrips ramakrishnae* respectively, was studied. The plants were raised in pots and inoculated with thrips and the predator to observe their establishment and multiplication.

d. Fauna of thrip galls

The fauna associated with thrip galls were identified and their occurrence noted in relation to the age of the gall. The interrelationships between various fauna were also studied.

e. Susceptibility of germplasm

Rooted cuttings of 132 accessions of black pepper cultivars were screened for natural infestation by gall thrips in the nursery. Four cuttings were maintained per accession and the percentage of leaves infested by gall thrips was recorded.

f. Bioassay of insecticides

The residual toxicity of nine insecticides viz. dimethoate, formothion, monocrotophos, phosphamidon, dichlorvos, endosulfan, methyl parathion, quinalphos (0.05% each) and malathion (0.1%) was determined. Rooted cuttings of black pepper were sprayed with the test insecticides and a single leaf was removed from each plant 1,3 and 7 days after treatment and thereafter at weekly intervals and placed in test tubes. Adult gall thrips were introduced into the tubes and their mortality recorded after 24 h. The corrected percentage of mortality in various treatments and PT (Persistence x Toxicity) values were calculated.

g. Field trial

A field trial to evaluate the efficacy of six insecticides viz. endosulfan, quinalphos, dimethoate, monocrotophos, phosphamidon (0.05% each) and malathion (0.1%) was conducted at Kuppadi (Wynad district). A Randomised Block Design was adopted with three replications. The insecticides were sprayed during July coinciding with emergence of new flushes. The percentage of leaves infested by gall thrips in various treatments was determined 15 and 30 days after treatment. The trials were conducted for three years and the data subjected to pooled analysis.

RESULTS AND DISCUSSION

a. Distribution

The survey for the incidence of gall thrips on black pepper was conducted in 116 locations. The incidence of the pest was higher in Idukki, Wynad, Trivandrum, Shimoga, Coorg, and Nilgris districts.

A significant and positive correlation existed between pest incidence and altitude of the location. In the plains the pest was common on rooted cuttings in nurseries .

b. Bioecology

i. **Life cycle**: Studies on life cycle of gall thrips indicated that the duration of egg, larva I, larva II, prepupa, pupa I and pupa II stages ranged between 5-8, 5-7, 4-6, 1-2, 1-2 and 2 days, respectively.

ii. **Nature of damage:** The morphological aberrations caused by gall thrips infestation on leaves were studied. The galls induced by the thrips infestation were of hypophyllous laminar fold/roll gall type, both the types occurring in the same leaf. The margins of affected leaves were considerably thickened at the gall region when compared to that of normal leaves. The other changes induced by the pest infestation included crinkling of leaf surface, reduction in leaf size, loss in flaccidity, formation of depressions and necrotic patches within the galls and yellowing around the gall region.

iii. **Seasonal population**: Studies on the seasonal population of gall thrips conducted at Kalpetta (Wynad district) indicated that the pest population was high during June-September. Studies on the increase in the number of gall thrips within a leaf in relation to its age indicated that maximum number of individuals occurred in galls that were about 2 months old.

c. Natural Enemies

i. **Identification**: The following natural enemies were recorded on gall thrips.

1. Geogarypus sp. (Pseudoscor-piones : Geogarypidae)
   Predaceous on larvae and pupae
2. *Montandoniola moraguesi* Puton (Heteroptera:Anthocoridae)
   Predaceous on all stages
3. *Androthrips flavipes* Karny (Thysanoptera:Phlaeothripidae)
   Predaceous on eggs and juveniles
4. *Lestodiplosis* sp. (Diptera: Cecidomyiidae)
   Larva predaceous on juveniles

M. moraguesi and *A. flavipes* were important and widely distributed. The other three predators were recorded for the first time on gall thrips.

5. *Rhodesiella* sp. (Diptera : Chloropidae)
   Larva predaceous on juveniles

ii. **Predatory potential** : Adults and IVth instar nymphs of *M. moraguesi* and on all stages of gall thrips though larvae and pupae were preferred. Early instar (I and II) nymphs fed on eggs, larvae and pupae though eggs and larvae were preferred. Late instar nymphs (IV and V) consumed more prey than early instars (I and II) (Table 34). Adults fed on 5-8, 3-5 and 2-4 individuals of adults, pupae and larvae of gall thrips, respectively, per day.

Table 34. Life cycle and predatory potential of *Montandoniola moraguesi*

Stage	Duration (days) Range	Mean	Prey consumed*	Mean consumption of prey per day
Egg	3 - 5	4.0		
I instar nymph	2 - 3	2.4	2 - 4	1.2
II instar nymph	2 - 3	2.6	3 - 5	1.6
III instar nymph	3 - 4	3.4	7 - 9	2.1
IV instar nymph	3 - 5	4.2	9 - 13	2.5
V instar nymph	4 - 6	5.0	14 - 18	3.3

n=5
*Prey=Larva II of gall thrips

Adults and larvae of *A. flavipes* generally fed on eggs and juveniles of gall thrips though eggs were preferred. Adults, larva I and larva II consumed 4-8, 4-7 and 2-4 eggs of gall thrips, respectively, per day.

iii. **Life cycle**: The life cycle of *M. moraguesi* from egg-adult was completed in 19-23 days. The duration of egg, I, II, III, IV and V instar nymphs lasted for 3-5, 2-3, 2-3, 3-4, 3-5 and

4-6 days, respectively. Females oviposited the eggs within the plant tissues in the gall region. In the field, the population of the predator was high during July-September.

The life cycle of *A. flavipes* from egg-adult was completed in 15-18 days. The duration of egg, larva I , larva II, prepupa, pupa I and pupa II stages lasted for 5-7, 3-5, 3-4, 1, 1-2 and 2 days, respectively. Females deposited the eggs in groups among the eggs of gall thrips. In the field, the population of the predator was high during July-September.

iv. **Effect of insecticides**: Monocrotophos 0.05% and dimethoate 0.05% were toxic to *M. moraguesi* upto 3 days after treatment. The insecticides were toxic to *A. flavipes* upto 5 and 3 days respectively, after treatment.

d. Fauna associated with thrip galls

Leaf galls of black pepper offered a unique micro habitat for inhabitation by a wide variety of fauna during different stages of its development. These included primary consumers of gall tissues (11 species), their natural enemies (10 species), detritus feeders (3 species) and other fauna that made their appearance at a later stage (6 species) when the galls became senescent.

e. Susceptibility of germplasm

One hundred and thirty two accessions of rooted cuttings (6 months old) of black pepper maintained in the nursery were screened for natural infestation by gall thrips. The percentage of infested leaves in various accessions ranged between 0.0 - 31.6. Thirty one accessions were free of pest infestation. However the differences were not significant probably because the number of leaves available on the cuttings were few and hence there were wide variations among the replications.

f. Bioassay of insecticides

The residual toxicity of nine insecticides was evaluated against gall thrips under green house conditions. Initial toxicity was maximum in monocrotophos which caused 90 per cent mortality upto 14 days after treatment followed by formothion, phosphamidon, dimethoate and endosulfan which caused 90 per cent mortality upto 7 days. Residual toxicity was maximum in monocrotophos and malathion which caused some mortality upto 42 days after treatment. The prolonged residual toxicity of monocrotophos and malathion was also evident from their high PT (Persistence X Toxicity) values.

g. Field trial

Six insecticides were evaluated for the control of gall thrips in the field (Table 35). The percentage of infested leaves was significantly less in all treatments compared to control.15 and 30 days after treatment. At the end of 15 days after treatment, dimethoate was significantly superior to phosphamidon, malathion and quinalphos and was on par with monocrotophos and endosulfan. Plots treated with dimethoate had the lowest percentage of infested leaves followed by those treated with monocrotophos. At the end of 30 days after treatment, monocrotophos was significantly superior to all the treatments. Plots treated with monocrotophos had the lowest percentage of infested leaves followed by those treated with dimethoate.

The trials indicated that spraying of monocrotophos or dimethoate 0.05% could be recommended for the control of gall thrips. The first spray is to be given during June/July coinciding with emergence of new flushes. A second spray may be given after 25-30 days in case the infestation persists.

Table 35. Effect of insecticides on the control of gall thrips on black pepper

Treatment	Mean percentage of infested leaves 15 dat	30 dat
Endosulfan 0.05%	5.6(13.68)	20.6(27.01)
Malathion 0.1%	9.4(17.91)	21.1(27.35)
Quinalphos 0.05%	9.9(18.37)	22.7(28.48)
Dimethoate 0.05%	3.2(10.38)	16.8(24.20)
Monocrotophos 0.05%	4.1(11.66)	12.0(20.27)
Phosphamidon 0.05%	9.3(17.73)	21.3(27.52)
Control	24.2(29.50)	26.4(30.95)
C.D at 5% level	4.02	2.22

Figures in parentheses are transformed values
dat = days after treatment

Nema II(813) (KADP XIII) : Role of nematodes in the incidence of slow decline (Slow wilt disease) of black pepper and screening pepper germplasm against nematodes

(K.V. Ramana and C. Mohandas)

TECHNICAL PROGRAMME

1. survey of slow wilt affected pepper gardens for plant parasitic nematodes in general and root knot and burrowing nematodes in particular in roots of pepper and in soils.

2. Establishing the pathogenicity of nematodes on pepper in pot culture experiments.

3. Standarisation of screening techniques

4. Developing control measures

I **Survey for plant parasitic nematodes associated with black pepper**

Materials and methods : Surveys to identify plant parasitic nematodes associated with black pepper were conducted in all major pepper growing areas in Kerala and Karnataka. A total of 410 each of soil and root samples from 217 gardens were collected and analysed for plant parasitic nematodes.

Results and discussions : Fourteen genera of plant parasitic nematodes (Table 36) were found in rhizosphere of black pepper which includes two endoparasitic nematodes viz. *Meloidogyne incognita* and *Radopholus similis* and a semi-endo parasitic nematode *Trophot-ylenchulus piperis*. The semi-endo parasitic nematode was recorded for the first time in India and also on black pepper.

The most predominant species associated with black pepper are *M. incognita, R. similis* and *Helicotylen-chulus* sp.

Based on the differential host study, *R. similis* population of black pepper was identified as 'banana race' since it did not infest all 16 *Citrus* sp. tested.

Table 36. Plant parasitic nematodes associated with black pepper in Kerala and Karnataka.

Nematode species	Presence in pepper
Acontylus so.	Negligible
Aphelenchus sp.	"
Criconemoides sp.	Minor
Helicotylenchus sp.	Major
Hoplolaimus sp.	Minor
Longidorus sp.	Negligible
Meloidogyne incognita	Major
Pratylenchus sp.	Negligible
Radopholus similis	Major
Rotylenchulus reniformis	"
Sctullonema sp.	Negligible
Trophotylenchulus piperis	Major
Tylenchorhynchus sp.	Negligible
Xiphinema sp.	"

Frequency distribution pattern of different population grades of *R. similis*, *M. incognita* and *T. piperis* showed significant variations in the roots of healthy and diseased plants. It was estimated that higher grades of *R. similis* population occurred in 1 out of 5 healthy plants and 4 out of 5 diseased plants. This consistant association of high population of *R. similis* with root system of diseased vines clearly indicated its role in slow decline syndrome of black pepper.

II **Pathogenecity of plant parasitic nematodes on black pepper**

Materials and Methods : Three experiments were conducted in cement tubs (Microplots of 1m diameter and 1m height) filled with soil mixture. The whole area under the experiments and the soil mixture in the microplots were fumigated with Methyl bromide. Pepper vines were trailed on *glyricidia sepium*.

a. Pathogenicity of *M. incognita*: Rooted cutings of Panniyur-1 were planted singly in the microplots and two months after, 25 plants were inoculated with freshly hatched second stage juveniles of *M. incognita* @ 100, 1,000, 10,000 and 1,00,000/plant in 5 replications along with uninoculated control. Treatments were distributed at random.

b. Pathogenicity of *R. similis*: Rooted cutings of Panniyur-1 were planted singly in the microplots and one year after planting the vines were inoculated with *R. similis* @ 10, 100, 1,000 and 10,000/vine in seven replications. Seven vines left uninoculated served as controls.

c. Pathogenicity of combined *R. similis* and *M. incognita* : Rooted cuttings of Panniyur-1 were planted singly in, microplots and one year after planting 66 vines were inoculated with nematodes in six replications as follows:

Uninoculated - Control

M. incognita 500

M. incognita 1000

M. similis 500

M. similis 1000

M. incognita 500 + *R. similis* 500 (simultaneously)

M. incognita 500 + *R. similis* 500 (20 days after)

R. similis 500 + *M. incognita* 500 (20 days after)

M. incognita 1000 + *R. similis* 1000 (simultaneously)

M. incognita 1000 + *R. similis* 1000 (20 days after)

R. similis 1000 + *M. incognita* 1000 (20 days after)

In all the experiments, foliar yellowing index (F.Y.I) and defoliation index (D.F.I) were recorded at quarterly intervals. At the time of concluding the experiments, obser-

vations on height of the vine, number of primary shoots, fresh and dry weights of shoot, leaf and root, root knot index (R.K.I) and root lesion index (R.L.I) were recorded. Nematode populations in soil (100 cm^3) and in roots (one gram) were estimated.

Results and Discussions

a. Pathogenicity of *M. incognita*: *M. incognita* inoculation to pepper vines caused foliar yellowing and defoliation which were severe in the vines inoculated with higher inoculum levels (10,000 and 1,00,000 nematodes).

There was a significant reduction in height and number of primary shoots in the vines inoculated with higher inoculum levels. Dry weights of shoot, leaf and root were also affected by nematode inoculation. Reduction in yield was significant in the vines inoculated with 1,00,000 nematodes (46.9%) and 10,000 nematodes (37.7%). Root knot index and nematode poplulations in soil and root increased with increase in inoculum level.

b. Pathogenicity of *R. similis* : Foliar yellowing and defoliation indices increased with increase in inoculum level and also intensified with time. Height of the vines was significantly reduced when inoculated with nematodes 1000 and above. More than 40% reduction in number of primary shoots was recorded in vines inoculated with 100 nematodes and more. Similarly the nematode caused significant reduction in dry weight of shoot, leaf and root.

R. similis caused severe damage to roots. Reduction in root mass was significant even in vines inoculated with 10 nematodes (34.5%). Damage caused to root system reflected on growth, yield was significantly reduced, the maximum reduction being 59.5% with 10,000 nematodes (Table 37).

Table 37. Effect of *Radopholus similis* on growth and yield of black pepper

Inoculum level	Height of vine (cm)	No. of primary shoots	Dry weight (g)			Yield (g) Dry berries (1987)
			Shoot	Leaf	Root	
Uninoculated control	329.57	31.28	2180.31	462.34	235.05	465.71
10 Nematodes	328.85 (0.21)	27.14 (13.23)	1640.72 (24.74)	345.14 25.34)	154.01 34.47)	464.28 (0.30)
100 Nematodes	291.28 (11.61)	17.42 (44.30)	1245.22 (42.88)	204.50 (55.76)	90.48 (60.50)	330.71 (28.98)
1,000 Nematodes	264.28 (19.81)	16.14 (48.40)	975.21 (55.27)	89.05 (80.73)	70.88 (69.84)	232.14 (50.15)
10,000 Nematodes	264.85 (19.63)	13.57 (56.61	854.81 (60.830	105.74 (77.12)	42.57 (81.88)	188.71 (59.47)
C.D. (p = 0.05)	45.65	6.40	371.90	69.11	31.43	82.76

Figures in parentheses are percentage reduction over uninoculated control.

c. Pathogenicity of combined *M. incognita* and *R. similis* : Foliar yellowing and defoliation indices were always high in vines inoculated with *R. similis* alone or in combination with *M. incognita*. In case of growth characteristics and yield, effect of *R. similis* was more conspicuous.

In vines inoculated with both nematode species, the root knot index was less compared to indices of vines inoculated with *M. incognita* alone. On the contrary, the root lesion inidices were about the same in vines inoculated with R.similis alone and in combination with *M. incognita*.

Results of these experiments showed that both nematode species affected growth and productivity of vines. Vines inoculated with *R. similis* alone or in combination with *M. inicognita* exhibited symptoms such as foliar yellowing which intensified with time leading to defoliation and dieback, typical of slow decline.

Studies conducted on the damage potential of plant parasitic nematodes to rooted cuttings of black pepper also indicated that both the nematodes caused considerable damage to the root system of the cuttings in nursery and the damage was more severe due to *R. similis*.

Further, black pepper vines of all age groups tested are susceptible to *R.similis* though symptom expression was delayed with increase in age of vine at inoculation.

III. **Standardisation of screening techniques and screening black pepper germplasm against *M. incognita* and *R. similis***

a. *Radopholus Similis*

Materials and Methods : Single noded rooted cuttings of Panniyer - 1 were planted singly in poly bags (15cm x 10cm) containing 1.5kg fumigated nursery mixture. Three months after planting, when plants were at 4-6 leaf stage, hundred plants were selected and grouped into five sets consisting of twenty plants each. In all sets, five plants were inoculated with 10, 50, 150 and 250 nematodes/plant and the remaining uninoculated plants in each set served as controls. Plants in each set were removed from polybags at monthly intervals starting from second month after inoculation. Nematode populations in root and soil were estimated. Root lesion index on 1-5 scale were also recorded.

Results and Discussions : Root lesion index (R.L.I.), nematode multiplication and plant growth characteristics recorded at monthly intervals are given in Table 5. Plants inoculated with 50, 150, and 250 nematodes showed significant reduction in root growth from third month. Results showed that with lower inoculum levels, a longer period is required for R.L.I. of 4.0 and above, a highly susceptible reaction of the host plant to the nematode. An inioculum of 250 nematodes and recording R.L.I. six months after inoculation is optimum for studying reaction of black pepper germplasm to *R. similis*.

b. *Meloidogyne incognita*

Materials and Methods : Three node cuttings of Panniyur - 1 were planted singly in polybags containing fumigated nursery mixture for rooting. Three months after planting, 150 plants having 4-5 leaves were selected and grouped into five sets, each consisting of 30 plants. Five plants each in all sets were inoculated with 100, 250, 500, 1000 and 2000 freshly hatched second stage juveniles of M. incognita. Five plants in each set were left unioculated to serve as control. Nematode population in roots were estimated. Root know index was recorded on 0-5 scale.

Results and Discussion : The R.K.I. increased gradually with increase in period of exposure of host plant to nematodes and

also correspondingly with increase in inoculum level. Highly susceptible reaction of host plant (R.K.I 4 and above) was recorded at fourth month with an inoculum of 1000 and 2000 nematodes. There was a significant reduction in the root weight from fourth month onwards in plants inoculated with nematodes 500 and above. An inoculum of 1000 second stage juveniles and assessing R.K.I four months after inoculation is optimum for screening black pepper germplasm to *M. incognita*.

Using the above standard techniques black pepper germplasm consisting of cultivated types, related *Piper* spp. high yielding Karimunda selections, inter-cultivar hybrids and seedlings of popular cultivars were screened for their reaction to *R. similis* and *M. incognita*.

All the germplasm accessions tested were susceptible to *R. similis* except a wild related species *P. colubrinum* (Table 38).

Table 38. Reaction of black pepper germplasm to *R. similis*

Germplasm	Numbers screened	Remarks
Cultivated types (*Piper nigrum* L.)	184	All are susceptible
Wild *Piper* spp.	37	*Piper colubrinum* resistant
High yielding Karimunda selections	178	All are susceptible
Inter-cultivar hybrids	149	All are susceptible
Open pollinated seedlings	54,000	All are susceptible

Cultivar Ottaplackal-1 (Acc.No:812) recorded root knot index 2.0 and rated as resistant to *M.incognita*, *P. colubrinum* was also found highly resistant to the nematode (Table 39).

Table 39. Reaction of black pepper germplasm to *M. incognita*.

Germplasm	Numbers screened	Remarks
Cultivated types (*Piper nigrum* L.)	158	Acc. No. 812 (Ottaplackal-1) Resistant
Wild *Piper* spp.	77	*P. colubrinum*-Resistant
High yielding Karimunda selections	178	All are susceptible
Inter-cultivar hybrids	149	All are susceptible
Open pollinated seedlings	63,700	All are susceptible

Developing control measures

a. Screening nematicides for efficacy in checking plant parasitic nematodes infesting black pepper

Two observational trials using three nematicides viz. Temik 10G (aldicab) Thimet 10G (phorate) and Furadan 3G (carbofuran) were conducted to assess the efficacy of these nematicides in reducting the nematode population in black pepper.

MATERIAL AND METHODS

District Agricultural Farm. A pepper plantation severely infested with R. similis was selected. In the plantation 60 vines showing varying degrees of foliar yellowing were selected and grouped into four blocks consisting of 15 vines each. Nematicides viz. Temik 10G; Thimet 10G and Furadan 3G @ 3g a.i./vine were applied twice a year, the first dose during May/June and the second during September for 3 years. Before giving first dose of nematicides, pre-treatment root samples from individual vines were taken in June 1983 and subsequent sampling was done every year in september before giving second dose of

nematicides. Nematode population in root and soil were estimated.

Farmers plantations : In this plantation root-knot nematode infestation was predominant. Forty vines were selected and divided into four blocks consisting of 10 vines each. Method of application of nematicides, sample collection and estimation of nematode population are similar to those in the previous trial.

RESULTS AND DISCUSSIONS

District Agricultural Farm: Mean population of *R.similis* in pretreatment sampling ranged from 108 to 140/g roots. This population level significantly increased during september 1983, prior to application of second dose of nematicides in all treatments and this was taken as initial populations (pi) to study the efficacy of nematicides in suppressing population build up in subsequent years. Nematode populations significantly increased in untreated (control) vines whereas it decreased considerably in vines treated with nematicides in subsequent years. Reduction in the final nematode population (pf) was maximum in Thimet treated vines (82.1%) followed by Temik (81.1%) and Furadan (57.4%). When the final population (pf) in different treatments alone was considered, maximum reduction was in Thimet (87.1%) followed by Temik (85.9%) followed by Furadan (75.3%). Further there was considerable reduction in foliar yellowing and improvement in vigour in most of the vines treated with nematicides with reduction in nematode load.

Farmers plantations : The initial population (pi) in various treatments ranged from 1050 to 2070/g roots. In untreated vines, nematode population considerably increased during 3 years of experimentation reaching to a population of 2444 nematodes/g roots. In all the vines treated with nematicides, there was significant decrease in nematode populations. Reduction in nematode population was maximum in Temik (89.7%) followed by Thimet (83.6%) and Furadan (78.1%)

Results of the two trials indicated that all 3 nematicides tested are effective in bringing down population levels of *R. similis* and *M. incognita* on black pepper. However Thimet is superior over other two nematicides in suppressing *R. similis* population on black pepper.

A large scale field trial was conducted in arecanut based black pepper cropping system with the following treatments:

T1 - Control (No treatment)
T2 - Phorate 10G @ 1.5 g a.i./vine
T3 - Phorate 10G @ 3 g a.i/vine
T4 - Bavistin (0.2%) soil drench @ 5 l/vine
T5 - Phorate 10G @ 3 g a.i/vine + Bavistin
T6 - Neem cake @ 2kg/vine

Treatments were given twice a year. First application during May/June and second application during September/October for 3 years. Phorate at both the dosages reduced significantly nematode populations (Table 40s and 41). Nematode population has increased considerably in the vines treated with bavistin alone. Maximum reduction in *M. incognita* population was observed in vines treated with neem cake. However, neem cake showed less efficacy in suppressing populations of *R. similis*. The study also indicated a high percentage of positive isolation of *Phytophthora capsici* from roots of vines showing severe foliar yellowing though nematode population was checked by nematicides.

The study indicated that infections by plant parasitic nematodes and fungi could result in root degeneration leading to slow decline.

b. Biocontrol

Tagetes patula : Preliminary studies on the efficary of marigold *(Tagetes patula)* in suppressing M. incognita and R. similis

infestation in black pepper were conducted in pot culture. Root knot index was 3.5 in pepper plants inoculated with *M. incognita* and grown without marigold and it was less (2.8) in pepper plants grown alongwith marigold. This indicated that marigold had effected the development of *M. incognita* resulting in the low root knot index. However, there was no variations in the root lesion index of plants inoculated with *R. similis* grown alone or along with marigold.

Vesicular arbuiscular mucorrhizae : A pot culture experiment was conducted to test the efficacy of VAM fungi viz. Glomus mosseae, Acaulospora laevis, Glomus fasciculatum, Gigospora margarita in suppressing M. incognita infestation in black pepper.

Root knot index in VAM treatments ranged from 0.75 to 2.0 and in Phorate treated plants it was 1.0 (Table 42). The lowest root knot index (0.75) was observed in plants colonised with *A. laevis*. Inoculation of soil with nematode severely affected plant development. Plants colonised with VAM fungi had lower root knot index than plants infected with nematode alone. The suppressive effects of VAM fungi on nematodes was comparable to that of Phorate treatment. The results of this study suggest the possibility of using VAM fungi in black pepper nursery to obtain healthy rooted cuttings.

Table 40. Population of root-knot nematode, *Meloidogyne incognita* in black pepper (given as per 5g root).

Treatment	1985 (Pi)	1986	1987	1988 (Pf)	% reduction (-) or increase (+) in Pf over Pi
Control (untreated)	788.9	1251.4	1334.9	1107.4	+ 40.4
Phorate 10 G @ 1.5g a.i./vine	815.8	927.6 (-25.9)	531.1 (-60.2)	296.7 (-73.2)	- 63.6
Phorate 10 G @ 3.0g a.i./vine	903.9	596.2 (-52.3)	440.6 (-67.0)	381.1 (-65.6)	- 57.8
Bavistin 0.25% @ 5l/vine	908.6	1298.0 (+3.7)	1451.8 (+8.8)	1530.0 (+38.2)	+ 68.4
Phorate 10 G @ 3g a.i. + Bavistin 0.2% @ 5l/vine	728.9	627.1 (-49.9)	449.4 (-66.3)	380.2 (-65.7)	- 47.8
Neem cake @ 2 kg/vine	760.7	477.3 (-61.9)	284.7 (-78.7)	229.8 (-79.3)	- 69.8
C.D. at 5%	NS	576	570	625	

Pi = Initial population; Pf = Final population
Figures in parentheses denote % reduction(-) or increase (+) over untreated control.

Table 41. Population of burrowing nematode, Radopholus similis in black pepper (given as per 5g of root)

Treatment	1985 (Pi)	1986	1987	1988 (Pf)	% reduction (-) or increase (+) in Pf over Pi
Control (untreated)	462.2	797.3	889.6	682.7	+ 47.7
Phorate 10 G @ 1.5g a.i./vine	351.2	270.8 (-66.0)	143.7 (-88.0)	162.8 (-76.2)	- 53.6
Phorate 10 G @ 3.0g a.i./vine	413.3	236.1 (-70.4)	49.6 (-94.4)	95.6 (-86.2)	- 77.1
Bavistin 0.25% @ 5l/vine	312.8	535.3 (-32.9)	603.9 (-32.1)	1107.6 (+62.2)	+ 254.1
Phorate 10 G @ 3g a.i. + Bavistin 0.2% @ 5l/vine	248.9	246.8 (-69.1)	179.5 (-79.8)	181.5 (-73.4)	- 27.1
Neem cake @ 2 kg/vine	343.7	388.7 (-51.3)	204.4 (-77.0)	396.5 (-41.9)	+ 15.4
C.D. at 5%	NS	280	349	377	

Pi = Initial population; Pf = Final population
Figures in parentheses denote % reduction(-) or increase (+) over untreated control.

Table 42. Effect of VAM fungi and pesticides on *M. incognita*

Treatment	Shoot length (cm)	No. of nodes	Root volume (cc)	Dry weight shoot (g)	Root-knot index
G. mosseae + *M. incognita*	147.3	24.5	6.1	9.0	1.25
A. laevis + M. incognita	150.5	25.8	5.3	9.2	0.75
G. fasiculatum + *M. incognita*	111.8	18.8	4.9	5.8	2.00
G. margarita + M. incognita	114.8	20.3	4.7	7.3	1.25
M. incognita + Phorate	89.5	14.8	3.9	4.4	1.00
M. incognita + Quinalphos	56.5	11.3	2.8	3.8	2.50
M. incognita	40.5	9.0	2.5	3.5	3.50
Uninoculated 71.2	13.8	3.6	3.6	0.00	
LSD at p = 0.01	26.6	5.14	0.86	2.34	

GENERAL INFORMATION

Library and Documentation Service

The library continued to provide documentation and information services to scientists of NRCS, various centres of the AICRPS and also to Research Workers of Universities/Institutes.

The library published 'Agri Sci Tit Bits' a quarterly information service, containing news items and notes pertaining to agriculture and related sciences. Reprographic services were provided to scientists of the Research Centre and to research workers of Universities/Institutes. Extension pamphlets, bulletins, annual reports and other publications were distributed to various organisations and individuals.

At Calicut 43 books, 10 bound volumes and 86 reprints were added to the library , 90 Indian and 52 foreign journals were subscribed and 12 journals were received on gratis.

A catalogue of all the holdings of the NRCS library till 1992 was prepared under the title "NRCS Library Holdings".

Extension bulletins on High Production Technology in Black pepper and Cardamom, Tips on control of *Phytophthora* foot rot and slow decline diseases of black pepper were published and are available in NRCS Library.

Twenty Eight Ph.D thesis on various aspects of Spices Research were added to the Library.

Publications

Research/Review articles

Abdulla Koya, K.M., Devasahayam, S. and Premkumar, T. 1991. Insect pests of ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* Linn.) in India - a review. *J. Plant. Crops 19* : 1 -13.

Ali, S.S. and Venugopal, M.N. 1992. Interaction between *Meloidogyne incognita* and *Rhizoctonia solani* in damping off or rhizome rot disease of cardamom seedlings. *Nematol. Medit. 20* : 65-66.

Anandaraj, M, Ramana. K.V. and Sarma Y.R. 1991. Interaction between vesicular arbuscular mycorrhizal fungi and *Meloidogyne incognita* in black pepper (In.). Mycorrhizal symbiosis and plant growth. Proceedings of the second National Conference on Mycorrhiza pp. 110 - 112. (ed) D.J. Bagyaraj and A. Manjunath. University of Agril. Sci. Bangalore.

Edison, S., Johny. A.K., Nirmal Babu, K. and Ramadasan, A, 1991 'Spices Varieties' 63 pp. NRCS, Calicut.

Gopalam, A., John Zacharia, T., Nrimal Babu, K., Sadanandan, A.K. and Ramadasan, A. 1991. Chemical quality of black pepper and white pepper. Spice India IV(4), 8-10.

Korikanthimath, V.S. 1992. Cardamom rapid clonal multiplication. *Indian Soc. Agron. News*, No:9, pp-5.

Korikanthimath, V.S. and Peter, K.V. 1992. Coffee based cropping system. *Indian Coffee* L VI(5) : 3-12.

Krishnamoorthy. B., Rema, J. and Sasikumar. B. 1991., Progeny analysis in cinnamon. *Indian Cocoa Arecanut and Spices J.* **14 (3)**: 124-125.

Krishnamoorthy, B., Sasikumar. B., Rema, J., Sayed, A.A.M. and Jose Abraham 1991. Variability and association in nutmeg. *Indian Cocoa Arecanut and Spices J.* **14(3)** : 121-122.

Mohandas, C. and Ramana, K.V. 1991. Pathogenicity of *Meloidogyne incognita* and *Radopholus similis* on black pepper *Piper nigrum* L. *J. Plant Crops.* **19**:14-53.

Nirmal Babu, K., Samsudeen, K. and Ravindran, P.N. 1992. Direct regeneration of plantlets from immature inflorescences of ginger (*Zingiber officinale* Rosc.) by tissue culture. *J. Spices and Aromatic Crops* **1**: 43-48.

Nirmal Babu, K., Ramakrishnan Nair, R., Johnson George K., and Ravindran P.N. 1992. *Piper barberi* Gamble - a redescription of the species with a note on the Karyotype. *J. Spices* and *Aromatic Crops* **1** : 88-93.

Ravindran, S., Balakrishnan, R., Manilal. K.S. and Ravindran P.N. 1991 A cluster analysis study on *Cinnamomum* from Kerala. India *Feddes. Reper.* **102** : 13-21.

Ravindran, P.N. Nair, M.K. and Nirmal Babu, K 1991. Panchami-a high yielding selection of Aimpiriyam. *Spice India* **5(6)** 11-13.

Ravindran, P.N., Balakrishnan, R and Nirmal Babu. K 1992. Numerical taxonomy of South India (Peperaceae) *Piper* sp. Cluster analysis *Rheedea* **2 (1)** : 55-61.

Ravindran, P.N., Sasikumar. B and Nirmal Babu K. 1991. Genetics of shoot tip colour in black pepper. *J. Plantation Crops* **20** : 76-78.

Reddy, B.N., K. Sivaraman and A.K. Sadanandan, 1991. High density approach to boost black pepper production. *Indian Cocoa, Arecanut and Spices J.* **15(2)** : 35-36.

Reddy, B.N., Sadanandan, A.K., Sivaraman K. and Jose Abraham 1992. Effect of Plant density on the yield and nutrient availability of black pepper (*Piper nigrum L.*) Varieties. *J. Plantation Crops.* **20 (Suppl.)** : 10-13.

Santhosh J. Eapen 1990. A methodology for evaluation of resistance in cardamom to root knot nematodes. *Indian J. Nematol.* **20** : 197-202.

Santhosh J. Eapen 1991. Nematode pests of small cardamom : Present status and future prospects. *Spice India* **4**:6 -12.

Sarma, Y.R., Anandaraj, M. and Ramana, K.V. 1991. Role of Phytophthora and plant parasitic nematodes in root rot of black pepper (*Piper nigrum L.*) in slow decline disease. *Phytophthora Newsletter* **17** :42-43.

Sasikumar B. 1991. A new technique for multiplication of black pepper. *Spice India* **4(10)**: 17-18.

Sheriff P.A. 1992. Spices Bibliography -1990 (Part I) *J. Spices & Aromatic Crops* **1 (1)** : 94-111.

Zachariah T.J. and Nirmal Babu K 1992. Effect of storage of fresh turmeric rhizomes on oleoresin and curcumin contents. *J. Spices and Aromatic crops* **1** : 55-58.

Papers presented in Symposia and Seminars

Ramadasan, A. and A.K. Sadanandan, 1991. Prospects of Spice Crops in Mono and Multiple Cropping System. National Symposium on Farming System for Sustained Productivity in Humid Tropics, CARI, Port Blair, 16-17. December 1991.

Ramadasan, A. Sadanandan, A.K., Reddy B.N. and Jose Abraham. 1991. Spices Production-Challenges and Research Thrust by 2000 AD. National Symposium on Challenges and Research needs 23-25, Oct. 1991, IARI, New Delhi.

Sadanandan A.K., B.N. Reddy and S. Hamza 1991. Effect of long term NPK fertilization in a laterite soil on availability and utilization of major and micro nutrients on black pepper. National Seminar on recent advances in Soil Research, Konkan

Krishi Vidyapeed, Dapoli 12-14 Dec. 1991.p 79.

Sadanandan, A.K. Reddy, B.N. Korikanthimath, V.S. and Hamza. S. 1992. Nutrient Management for sustained productivity of spice crops in India. International Symposium on Nutrient Management for sustained productivity 10-12 Feb. 1992 at Punjab Agricultural UNiversity, Ludhiana.

Sadanandan, A.K., Jose Abraham, Anandaraj, M. and Hamza. S. 1991. Effect of coconut pepper mixed cropping on soil fertility and crop productivity. International Symposium on Coconut Research and Development II, 26-29 November 1991 at CPCRI, Kasaragod. p. 54-55.

Sadanandan, A.K., Hamza, S and D'Souza T.J. 1991. Evaluation of Ammonium ortho and poly phosphate fertilizers for pepper. National Seminar on recent advances in Soil Research, Konkan, Krishi Vidyapeeth, Dapoli, 12-14 Dec. 1991. p-86.

Sadanandan A.K. 1991. Fertilizer use in pepper production. Workshop on Integrated Development of Spices and Horticultural Crops, RARS, Ambalavayal, 26-27 Oct. 1991.

Sadanandan, A.K. 1991. Water Management for Spice Crops. IMC training course on irrigation scheduling for perennial and annual crops. 21-26,. Oct. 1991 at CWRDM, Calicut, Kerala.

Sarma, Y.R., Ramana, K.V. and Anandaraj, M. 1991. Status of Slow Decline Disease of Black Pepper and approaches of disease management. International workshop on the production and development in the control of pepper diseases in the producing countries 3-5 December, Lampung, Indonesia.

Sarma Y.R. , Anandaraj M.,Venugopal M.N. and Ramana K.V. 1991. Major diseases of black pepper and cardamom and their management. Symposium on Pathological Problems of Economic Crop plants and their management 29-30 April, Central Potato Research Institute, Simla.

Sarma Y.R., Anandaraj M. and Ramana K.V. 1991. Disease management in black pepper and ginger. Workshop on Integrated Development of Spices and Horticultural Crops in Wynad 26-27 October, 1991 (Proceedings in Press).

Sarma Y.R., Nambiar K.K.N. and Anandaraj. M 1991. Foliar yellowing and root rot in coconut seedlings affected by *Phytophthora sp.* International Symposium on Coconut Research and Development II 26-29 November 1991 (Proceedings in Press).

Sarma Y.R., Anandaraj M and Ramana K.V. 1991. Present Status of black pepper diseases in India and their management. International Workshop on other production and development in the control of pepper disease in the producing countries 3-5 December, Lampung, Indonesia.

Sarma Y.R., Anandaraj M and Ramachandran N. 1991. Recent advances in *Phytophthora* foot rot research in India and the need for holistic approach.

Technical Reports

Edison. S. 1991. Stepping up productivity of spices, Report of the Forum for increasing export of spices, 38-45.

Edison. S. and John A. Kallupurakkal 1991. Increasing yield and spices by growing new varieties : a status report. *India Cocoa Arecanut & Spices J.* **14(4)** : 138-144.

Nirmal Babu K., Rema, J, Regy Luckose, Johnson George K. Sasikumar, B and Ravindran P.N. 1992. Status of Research on Spices biotechnology at NRC for Spices. (A technical report) NRCS, Calicut.

Ramana, K.V. 1992. Final Project report, Role of nematodes in the incidences of slow decline disease of pepper and screening the germplasm against the nematode. pp. 149. NRCS, Calicut.

Ravindran, P.N. and A.K. Sadanandan, 1991. Report of the feasibility study on growing Spice crops in Northern West Bengal and Poomia districts of Bihar. National Research Centre for Spices, Calicut. 20 pp.

Sarma, Y.R. Anandaraj M. and Ramana K.V. 1992. Tips on control of *Phytophthora* foot rot and slow decline disease of black pepper. (Folder, NRCS, Calicut).

Popular Articles

Edison, S. 1991. Spices - new varieties hold key Survey of Indian Agriculture, THE HINDU 1991: 149-151.

John Zachariah, T. 1992. Will storage affect the chemical constituents of turmeric? *Spice India* **5 (3)** : 9 (Mal.)

Krishnamoorthy, B. 1991. Cultivation of tree spices in Tamil Nadu *Spice India* **4 (6)** : 6-12 (Tamil)

Krishnamoorthy, B. 1991. Bush pepper. *Spice India* **4 (12)** : 22-24. (Tamil)

Krishnamoorthy, B., 1992. Vanilla. *Spice India* **5 (1)** : 20-25 (Tamil)

Krishnamoorthy, B and Arumugham G. 1992. Cultivate ginger in waste lands. *Spice India* **5 (2)** : 6-9 (Tamil)

Krishnamoorthy, B and Rema. J. 1991. Allspice *Spice India* **4 (10)** : 9-10

Ramadasan, A and Sasikumar, B. 1991. Black pepper Research at NRCS, Kozhikode *Spice India* **4 (11)** : 5-8. (Mal.)

Rethinam, P. and Edison, S. 1991. Trees with a spicy twang. *Indian Horticulture* **41 (8)** : 17-24.

Sasikumar, B. and John Zacheriah, T. 1991. Qualify Black pepper. Recent trends and reseaches findings. *Spice India* **4 (12)** : 15-18 (Mal.)

Sasikumar, B. 1991. A new technique for multiplication of black pepper. *Spice India* **4 (10)** : 17-18.

Participation in Symposia/Seminar

Eleventh Workshop/Group Meeting of Research Workers of AICRP on spices Trivandrum, July 26-28, 1991.

A Ramadasan, S. Edison, Y.R. Sarma, P.N. Ravindran, A.K. Sadanandan, Korikanthimath, K.V. Ramana, Jose Abraham, M.N. Venugopal, M. Anandaraj, S. Devasahayam, K. Nirmal Babu, B. Krishnamoorthy, John Zachariah, A.K. Johny.

International Symposium on Coconut Research and Development (ISOCRAD-II), CPCRI, Kasaragod, November 26-29, 1991.

K.V. Peter, S. Edison, A. Ramadasan, Y.R. Sarma, A.K. Sadanandan, Jose Abraham, M. Anandaraj.

International Workshop on Progress and Development in the Control of Pepper Diseases in the Producing Countries, Bandar-Lampumg, Indonesia, 3-5 December 1991.

Y.R. Sarma

Workshop on Management Information System for Agricultural

Research : 3-13 September 1991, NAARM, Hyderabad.

Jose Abraham.

Workshop on Integrated Development of Spices and Horticultural Crops : 26-27 October 1991 Regional Research Station, Ambalavayal, Wynad.

A Ramadasan, S. Edison, Y.R. Sarma, A.K. Sadanandan, Jose Abraham M. Anandaraj and B. Krishnamoorthy.

Workshop on Intergrated Development of Cashew : 1-2 February 1992, Kannur.

K.V. Peter, Jose Abraham.

National Seminar on Biological Control in Plantation Crops, Kottayam June 27-28 1991.

K.V. Ramana and S. Devasahayam, M. Anandaraj and T.G.N. Rao

Group Meeting of Entoomologists Working in Coordinated Projects of Horticultural crops. Lucknow, August 12-13, 1991.

S. Edison and S. Devasahayam.

Regional Workshop on Planting Agricultural Extension Training to broad based extention ICAR Research Complex, Shillong, November, 25-27 1991.

K.V. Ramana.

Participation in Training Programmes

S. Devasaharam, Sumer Institute on 'Host plant reistance to insect pests and its application in pest management' June 6-25, 1991, TNAU, Coimbatore.

John Zachariah, Short term training on advanced technology on processing of spices March 30 to April 10, 1992 CFTRI, Mysore.

Regy Luckose, Training programme on 'Techniques in Plant genetic engineering' February 20th to March, 11 IARI, New Delhi.

J. Rema, Short term training course on 'Application of Tissue culture to Crop improvement' Department of Botany, Calicut University, Kerala 7-25th October 1991.

Membership in Committees

K.V. PETER

Member, ICAR Scientific Panel on Olericulture and Floriculture Member, General Council of Kerala Agricultural University.

Member, Editorial Board of Indian Horticulture.

Member, Spices Board, Cochin.

Member, Spices and Condiments, Sub committee, Bureau of Indian Standards, New Delhi.

Executive Councillors, Society for the advancement of Hortyculture, Kalyani, West Bengal.

S. EDISON

Member, Forum for Export of Spices.

Member, Subcommittee on Spices and condiments , Bureau of Indian Standards, New Delhi.

Member, NRCS - Institute Management Committee.

Member, Executive Council, Indian Society for Spices.

Member/Chairman, Techical/Research *Staff Selection Committees of NRCS* and CWRDM.

A. RAMADASAN

President, Indian Society for Spices, Calicut.

Y.R. SARMA

Member, Expert team to investigate new diseases of black pepper prevalent at Alakode, Kannur.

Member, Expert team to investigate the little leaf disease of black pepper at Wynad.

Member, Expert team to assess damage due to *Phytophthora* foot rot disease of black pepper.

A.K. SADANANDAN

Member, NRCS Management Committee, Joint Secretary, Indian Society for Spices, Calicut.

P.N. RAVINDRAN

Member Secretary, Indian Society for Spices Calicut.

K.V. RAMANA

Chairman, Grievance Committee, NRCS, Calicut.

Member, Institute Joint Council, NRCS.

Treasurer, Indian Society for Spices, Calicut.

JOSE ABRAHAM

Secretary, Institute Joint Council, NRCS, Calicut.

V.S. KORIKANTHIMATH

Member, Technical Advisory committee of Sugandhagiri Project.

Member, NRCS Management Committee.

Staff - Calicut

MANAGERIAL

K.V. Peter, Ph.D
Director (from 20-11-91)

S. Edison, Ph.D
Project Coordinator (Spices)

SCIENTIFIC

Genetics and Plant Breeding

P.N. Ravindran, Ph.D
Senior Scientist

B. Krishnamoorthy, M.Sc (Ag)
Scientist

K. Nirmal Babu, M.Phil
Scientist

Johnson K. George, M.Sc (Ag)
Scientist

B. Sasikumar, Ph.D
Scientist

R. Ramakrishnan Nair, M.Sc
Scientist

Horticulture

J. Rema Ph.D
Scientist

Agronomy

K. Sivraraman, Ph.D
Scientist (SG)

C.K. Thankamani, M.Sc (Ag)
Scientist

Soil Science

A.K. Sadanandan, Ph.D
Senior Scientist

Plant Pathology

Y.R. Sarma, Ph.D
Senior Scientist

G.N. Dake, Ph.D
Senior Scientist

M. Anandaraj, M.Sc
Scientist (SG)

T.G. Nageshwar Rao, Ph.D
Scientist (Senior Scale)

Entomology

S. Devasahayam, M.Sc.
Scientist (SG)

K.M. Abdulla Koya, M.Sc (Ag)
Scientist

Nematology

K.V. Ramana, Ph.D
Senior Scientist

Plant Physiology

A. Ramadasan, Ph.D
Principal Scientist

S. Vasantha, M.Phil
Scientist

Biochemistry

T. John Zachariah, Ph.D
Scientist

Organic Chemistry

N.K. Leela, M.Sc.
Scientist

Statistics

Jose Abraham, M.A., M.Sc
Scientist (SG)

TECHNICAL

Jonhy A. Kallupurackal, Ph.D
Tech. Information Officer (T6)

P. Azgar Sherif, M.Lis.
Tech. Officer (Lib.) (T5)

S. Hamza, M.Sc
Tech. Officer (Lab) (T5)

V. Balakrishnan
Technical Assistant (T4)

K. Samsudeen, M.Sc.
Technical Assistant (T-II-3)

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

D. Shankaran
Jr. Technical Assistant (T-I-3)

V. Sivaraman
Jr. Technical Assistant (T-I-3)

P.K. Chandravally
Jr. Technical Assistant (T-1)

ADMINISTRATION

U. Sukumaran
Asst. Administrative Officer

T. Gopinathan, B.Sc.
Asst. Fin. & Accounts Officer

K. Usha, B.A.
Superintendent

M.K. Sachidananthan, B.Sc
Superintendent

A.P. Sankaran
Assistant

V.L. Jacob, B.A.
Assistant

C. Padmanabhan
Senior Clerk

V. Vijayan
Senior Clerk

V. Radha, B.A.
Senior Clerk

S.M. Chettiar
Stenographer

P.V. Sali
Stenographer

Alice Thomas
Jr. Stenographer

K.S. Sreekumaran, M.A.
Jr. Stenographer

C. Sunanda, M.Com
Jr. Clerk

P. Padmavathy
Jr. Clerk

P.K. Janardhanan
Jr. Clerk

AUXILIARY

M. Vijayaraghavan
Driver (T-I-3)

N. Chandrahasan
Driver (T-I-3)

K. Balan Nair
Driver (T2)

SUPPORTING

M. Padmanabhan
Peon (SS. Gr. III)

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

K. Keeran
Lab Attender (SS. Gr. I)

I. Unni Nair
Lab Attender (SS Gr. I)

V.V. Syed Mohammed
Lab Attender (SS. Gr. I)

S. Hareendrakumar
Lab Attender (SS. Gr. I)

T. Ahmmed Koya
Watchman (SS. Gr. I)

M. Koru
Watchman (SS. Gr. I)

V. Balakrishnan
Mazdoor (SS Gr. I)

T. Balakrishnan
Mazdoor (SS. Gr. I)

K. Balakrishnan Nair
Mazdoor (SS. Gr. I)

P. Prabhakaran Nair
Mazdoor (SS. Gr. I)

A.K. Raghavan
Mazdoor (SS. Gr. I)

K.P. Vijayan Nair
Mazdoor (SS. Gr. I)

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

N. Ravindran
Mazdoor (SS. Gr. I)

Peruvunnamuzhi Farm

TECHNICAL

V.K. Abubacker Koya
Farm Superintendent (T6)

M.M. Augusty, B.Sc
Technical Assistant (T4)

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

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

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

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

K. Kumaran
Jr. Technical Assistant (T2)

S. Gnanakkan
Jr. Technical Assistant (T2)

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

S. Natarajan
Jr. Technical Assistant (T1)

K. Chandran
Jr. Technical Assistant (T1)

P. Bhaskaran
Jr. Technical Assistant (T1)

K. Krishna Das
Mechanic cum Pump Operator (T1)

AUXILIARY

Ramanna Gowda
Tractor Driver (A)

SUPPORTING

K. Kunhayyappan
Watchman (SS. Gr. III)

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

N. Ayyappan
Mazdoor (SS. Gr. III)

P. Sadanandan
Watchman (SS. Gr. I)

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

C. Bhaskaran
Mazdoor (SS. Gr. II)

A.K. Balan
Mazdoor (SS. Gr. I)

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

M. Balakrishnan
Mazdoor (SS. Gr. I)

K. Chandran
Mazdoor (SS. Gr. I)

M. Choyikutty
Mazdoor (SS. Gr. I)

P. Damodaran
Mazdoor (SS. Gr. I)

K. Gangadharan
Mazdoor (SS. Gr. I)

P. Kunhikrishnan
Mazdoor (SS. Gr. I)

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

K. Raghavan
Mazdoor (SS. Gr. I)

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

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

P. Soman
Mazdoor (SS. Gr. I)

P. Sreedharan
Mazdoor (SS. Gr. I)

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

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

K.V. Prasanna Kumar
Mazdoor (SS. Gr. I)

Appangala

SCIENTIFIC

Agronomy

V.S. Koriakanthimath, M.Sc (Ag)
Scientist (SG) & Scientist in-charge

Genetics and Plant Breeding

Regy Lukose, M.Sc
Scientist

Plant Pathology

M.N. Venugopal, Ph.D
Senior Scientist

Nematology

Santhosh J. Eaper, M.Sc
Scientist

TECHNICAL

M.K. Appaiah
Tech. Officer (Farm) - T5

K.A. Somanna
Jr. Technical Assistant (T-I-3)

K. Ananda
Jr. Technical Assistant (T1)

G. Arumugham
Jr. Technical Assistant (T1)

L. Balakrishnan
Jr. Technical Assistant (T1)

ADMINISTRATION

K. Vasudevan
Assistant

Enid Savitha, B.A.
Assistant

AUXILIARY

H.G. Nanamaiah
Driver (T2)

SUPPORTING

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

H.Y. Erappa
Watchman (SS. Gr. III)

K.M. Thimmappa
Watchman (SS. Gr. II)

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

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

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

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

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

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

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

Gowdigere Shetty
Mazdoor (SS. Gr. I)

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

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

K.M. Mada Shetty
Mazdoor (SS. Gr. I)

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

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

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

S. Mahadeva
Mazdoor (SS. Gr. I)

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

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

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

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

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

Budget for 1991-92
(Rs. in Lakhs)

Items	Non-Plan	Plan	Total
1. Establishment charges	47.1	—	48.0
2. T.A.	3.0	0.25	3.2
3. Other charges	35.9	49.30	65.0
4. Works	—	31.45	19.8
Total	**86.0**	**81.00**	**167.00**

Staff Strength as on 1-4-1992

Category	Sanctioned strength	Staff in position	No. of SC employees	No. of ST employees
Scientific	41	27	2	—
Technical	28	27	5	—
Administrative	18	18	1	—
Auxiliary	5	5	—	—
Supporting	62	61	19	1
Total	**154**	**138**	**27**	**1**

IMPORTANT VISTORS - CALICUT

Mrs. Santha Sheela Nair
Joint Secretary & Horticultural Commissioner
Ministry of Agriculture
Krishi Bhavan
New Delhi - 110 001.

Dr. R. Naidu
(Director (Research)
Spices Board
Indian Cardamom Research Institute
Myladumpara - 685 538.

Dr. K.L. Chadha
Deputy Director General
Indian Council of Agricultural Research
Krishi Bhavan, New Delhi - 110 001.

Dr. M.K. Nair
Director
Central Plantation Crops Research Institute
Kasargod - 671 124.

Dr. M. Aravindakshan
Director of Research
Kerala Agriculture University
Vellanikkara, Trichur.

Swami Sidhinathananda
Ramakrishna Mission
Meenchantha
Calicut.

PERUVANNAMUZHI

Dr. I Irulappan
Dean of Horticulture
Tamil Nadu Agricultural University
Coimbatore - 643 003.

Dr. B.C. Uthaiah
Associate Director Research
University of Agricultural Sciences (B)
Regional Agricultural Research Station
Mudigere
Chickmagalur District
Karnataka - 577 132.

APPANGALA

J.P. Singh, IFS
Associate Professor
IGNFA
Dehradun.

Dr. K. Singh
Scientist-C
CIMAP
Lucknow.

Sri. K.M. Hegde
Member
NRCS Management Committee.

H.S. Srinivasa
Asst. Director (Dev.)
Spices Board
Mudigere.

Mr. Subbaiah
Manager (R & D)
Consolidated Coffee Limited
Pollibetta.

Dr. U.D. Bongale
Div. Chief (Moriculture)
Kamataka State Sericulture Dept.
Bangalore.

Dr. M.R. Narayanan
Scientist in charge
Central Instt. of Medicinal and Aromatic plants
Regional Centre, Bangalore.

Mr. Vijay Gore
Commissioner for Industrial Development
Government of Karnataka
Bangalore.

Mr. M.L. Chaurasia
Chief Engineer
C.G.W.B.
Faridabad
Haryana

Dr. K. Sooryanarayana
Secretary
Spices Growers Association
Puthur.

WEATHER DATA

Month	Peruvannamuzhi				Appangala			
	No. of rainy days	Total rain fall (mm)	Temperature (C) Max.	Min.	No. of rainy days	Total rain fall (mm)	Temperature (C) Max.	Min.
Jan.	—	—	29.0	23.1	—	—	28.6	13.4
Feb.	—	—	31.8	24.7	—	—	30.6	12.6
Mar.	1	3.5	32.7	28.0	—	—	32.2	16.3
Apr.	8	259.5	32.1	26.8	12	113.6	31.1	17.9
May	10	139.0	32.9	31.9	12	110.6	30.7	18.3
Jun.	25	1163.4	28.4	26.4	28	684.0	24.8	18.3
Jul.	30	1518.5	27.6	25.2	31	1015.8	22.6	17.0
Aug.	20	635.4	28.6	25.8	31	644.8	22.1	17.1
Sep.	5	110.9	32.6	27.6	10	133.2	26.2	17.2
Oct.	15	534.5	28.9	24.4	8	76.0	26.4	18.0
Nov.	5	115.0	29.0	25.0	6	34.4	25.9	16.8
Dec.	—	—	25.9	20.9	—	—	26.9	12.9