वार्षिक प्रतिवेदन 1997
Annual Report 1997

Indian Institute of Spices Research
Calicut - 673 012, Kerala, India

INDIAN INSTITUTE OF SPICES RESEARCH

An organization under Indian Council of Agricultural Research

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ANNUAL REPORT
1997

INDIAN INSTITUTE OF SPICES RESEARCH
CALICUT - 673 012, KERALA, INDIA

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Front Cover: Golden jubilee of India's independence and the array of spices contributing to the national economy

Back cover: 1. Hardened tissue culture plant of curry leaf
2. A ginger selection ideal to prepare salted ginger

CONTENTS

PREFACE

It is a pleasure to present the Annual Report of IISR for the year 1997. The Institute had spectacular growth during the past two decades from being a Regional Station of the Central Plantation Crops Research Institute in 1975 to the present Indian Institute of Spices Research. IISR witnessed an eventful 1997. The Institute bagged three major awards during the year. The Biotechnology and Crop Improvement Division received the ICAR team award, the Cardamom Research Centre, Appangala received the ICAR Hari Om Ashram Trust Award and Dr. Rajendra Hegde won the ICAR Young Scientist Award

The National Net work project on *Phytophthora* Diseases of Horticultural Crops (PHYTONET) with IISR and eight other co- ordinating centres, with a total outlay of Rs. 357.5 lakhs, started functioning during the year. The institute also expects external funding through the Black Pepper Technology Mission of Kerala Government and from NATP. The consultancy processing cell of the Institute has also made substantial contribution during the year.

The export of spices witnessed a spectacular leap in 1997-98. The country exported 2.187 lakh tonnes of spices valued Rs 1352.15 crore (US $ 363.62 million). The unit value of black pepper has reached Rs. 140.02 compared to Rs. 80.00 in 1996 Oils, oleoresin and other value added products from spices also showed good export potential. As in recent years cardamom registered a general decline in export due to competition from Guatemala.

The institute organized a National Seminar on Water and Nutrient Management for Sustainable Production and Quality of Spices at Madikeri (Karnataka) during 1997 in collaboration with Indian Society for Spices and ICAR. In commemoration of the 50th year of India's independence IISR is organizing a National Seminar on Biodiversity of Medicinal and Aromatic Plants during August 1998. The Institute participated in the PEPPERTECH meeting of International Pepper Community during October 1997 at Kochi.

The budget of the Institute was Rs. 90 lakhs under Plan and Rs. 148 lakhs under Non plan. Besides, a sum of Rs. 75 lakhs was received from AP Cess Fund Schemes The Institute Management Committee, Research Advisory Committee and Staff Research Council met and gave necessary counsel for the future programmes.

The accomplishments made through 47 Institute projects and externally funded projects are comprehended in this report.

I take this opportunity to thank DG, ICAR, DDG (Hort) and ADG (PC) for the necessary help and scientists and staff of IISR for their contributions.

5 June 1998

(K.V. PETER)
DIRECTOR

EXECUTIVE SUMMARY

CROP IMPROVEMENT AND BIOTECHNOLOGY

The germplasm conservatory of the institute was enriched by collections of *Piper* species, cardamom, ginger, turmeric, vanilla, and tree spices. The important collections during the year are:

- ☆ Fifty accessions of *Piper* spp. from Nilgiri, Nilambur, Munnar and Pollibeta. Species collected from Paikara (Ooty) resemble *P. mullesua* and *P. silentvalleyensis* and the one from Munnar resembles *P. galeatum*. Thirty five accessions of cultivated black pepper were collected from Kannur, Palode, Thenmala and Pollibeta.
- ☆ Seven proximal branching types and one compact panicle type in cardamom.
- ☆ Thirty seven accessions of ginger from Nedumangad, Aryanad, Kuttickal, Munnar and Ooty.
- ☆ Five accessions of turmeric from Nedumangad and Ooty.
- ☆ Three *Amomum* spp. from Gudalur.
- ☆ Nine vanilla accessions from Thamarassery (Calicut) and Ernakulam.
- ☆ Twelve wild types of *Cinnamomum* (one, a very scented type), two wild types of *Myristica*, two species of *Knema*, one high yielding allspice, four types of *Garcinia* and one type of *atao* were collected during this year.

Black pepper : Hybrids HP 813, 34, 105 and collection 1041 maintained superiority for yield at Valparai.

Cardamom : A 8x8 full diallel involving selections RR-1, CCS-1 and 'Katte' resistant lines NKE-3, NKE-9, NKE-12, NKE-19, NKE-27 and NKE-34 was made. Ninety two percent fruit set was observed in NKE 19 x NKE-34 followed by NKE-12 x NKE-19 (77%) and NKE-12 x RR-1 (69%).

Ginger : Accessions 15 and 27 performed better consistently in the second consecutive year with 25% dry recovery. Acc. 15 had 2.5% volatile oil and 3.2% crude fibre.

Turmeric: A high yielding and high quality Alleppey turmeric (Acc. 585) is identified (30 kg fresh rhizome per 3 cm^3 bed with 7% curcumin).

Clove. B-95 is a promising line with high yield.

Paprika: Morphological and biochemical characters of 29 lines of *Capsicum annuum* indicated paprika types PBC- 385, PBC- 066 and Kt. pl- 19 as the best selections. PBC-385 had the highest colour value (205 ASTA) followed by Kt. pl-19 (139.5 ASTA) and PBC- 066 (131 ASTA).

Characterization of inter specific hybrids

Two inter specific hybrids of *Piper* viz. *P. nigrum* x *P.attenuatum*, *P. nigrum* x *P. barberi* were characterised based on morphology, anatomy, isozymes and resistance to ' Pollu beetle'. The hybrids possessed heterosis and inherited resistance to 'pollu beetle' from resistant male parents

Isolation of DNA

Genomic DNA was isolated from ginger, turmeric and nutmeg.

Cytogenetics and reproductive biology

Variation in chromosome number was detected in ginger cultivar Sabarimala as 2n= 24. Three tetraploid plants were produced from IISR- Varada by colchicine (2%) treatment. Diploid number of nutmeg is 2n = 38.

Developmental morphology

Effect of growth hormones, Triacontanol, Paclobutrazole and GA3 were studied in ginger and turmeric. GA_3 enhanced procambial activity, dimensional variation in xylem, phloem and fibre, thick cuticle in the epidermis and less fibre in ginger plants. In turmeric, GA_3 increased the cell size and number, more starch deposition and the plant height while paclobutrazole induced dwarfening.

Propagation

- ☆ Successful graft union was obtained with twenty varieties of black pepper and *P.colubrinum* Link as rootstock, which is relatively resistant to *Phytophthora capsici*.
- ☆ Allspice cuttings treated with IBA 2500 ppm + NAA 2500 ppm in charcoal gave 63 % rooting.

BIOTECHNOLOGY

- ☆ A hardening facility with temperature, light and humidity control was established.
- ☆ Interspecific hybridization was achieved between *Vanilla planifolia* (♀) x *Vanilla aphylla* (♂) using embryo rescue technique.
- ☆ Plant regeneration was successfully induced in C*apsicum annuum* using shoot tip and leaf explants.
- ☆ Protoplasts were isolated from *C. annuum*.
- ☆ Micropropagation protocols of curry leaf (*Murraya koenigii*) was standardised and micropropagated plants were hardened and established in soil.

CROP PRODUCTION AND POST HARVEST TECHNOLOGY

Agro-physiological studies

Black pepper OP line P-24 acquired maximum canopy height of 504 cm and radius 117cm during fourth year of planting. This was followed by Panniyur- 1 (492 cm and 105 cm) and the least was in Panniyur- 3 and Subhakara (313cm and 77.7 cm). Among the 10 varieties evaluated Panniyur-5 gave the highest fresh yield of 2734 g/vine followed by Subhakara (1337g/vine).

Biofertilizers

Soil inoculation of *Azospirillum*, phosphobacteria and Vesicular Arbuscular Mycorrhizae (VAM) alone and in combinations increased biomass, dry matter production and nutrient uptake of black pepper.

Spices based cropping sytem

A crop combination with cardamom as a base crop with tree spices (clove, nutmeg, cinnamon and allspice), pepper and arabica coffee is under evaluation for the fifth year.

Production of nucleus planting materials

One lakh black pepper rooted cuttings, 500 laterals, 12000 cardamom seedlings of elite lines, 550 cardamom suckers, 29 kg cardamom seed capsules, 30 tonnes of turmeric, 5 tonnes of ginger, 2500 nutmeg grafts, 3000 cinnamon seedlings, 2000 clove seedlings, 2500 allspice seedlings and 8000 rooted vanilla cuttings were produced and distributed this year.

Nutritional requirements

- ☆ In black pepper, application of Zn, B and Mo @, 5,2 and 1 kg/ha along with 150, 60 and 270 kg/ha of N, P and K increased the yield by 134%.
- ☆ In turmeric, application of rock phosphate @ 25 kg P/ha with FYM 100t/ha and micronutrients like Zn, B and Mo @ 5, 2 and 1 kg/ha gave 27 % increased yield.
- ☆ Introduction of earthworms *in situ* in pots supplemented with FYM and *Glyricidia* leaves increased the nutrient availability in black pepper, ginger and turmeric.
- ☆ Application of coir compost (Terra Care) + neem cake + chemical fertilizer in turmeric increased the yield by 53% compared to chemical fertilizers.
- ☆ Application of coir compost (Terra Care) + FYM increased the ginger yield by 85% compared to sole application of chemical fertilizers.

Protected bush pepper cultivation

Technologies for protected cultivation of bush pepper with high density (350 pots per 140 m^2) are standardised and 150 g dry pepper per pot was recorded during the first year. There was no *Phytophthora* incidence.

Drought tolerance in black pepper

Based on physiological parameters like cell membrane stability, relative water content, stomatal resistance and transpiration rate black pepper accessions 1493 and 1372 were found tolerant to drought.

PRE AND POST HARVEST STUDIES

Chemical changes during maturity

Levels of mono and sesquiterpenes of black pepper essential oil were very low at 120 days after flowering which showed a sudden increase between 160-180 DAF and remained steady up to maturity. Varietal and agroclimatic influence were seen in the levels of oil, oleoresin and crude fibre among the 15 ginger accessions at different maturity stages.

White pepper

Spraying ethrel on the harvested black pepper berries hastened ripening and reduced the retting period for preparing white pepper.

Salted ginger

Based on colour, appearance, flavour and texture, ginger accessions 35, 179, 64, 71 and 117 were found good to prepare salted ginger.

Curcumin rich turmeric lines

Acc. 583, 585, 605,608 and 630 among the Alleppey collections and 691,651 and 650 among Andhra Pradesh collections had more than 6.5% curcumin.

High quality cassia lines

C-5, C-7, D-7, D-3, B-1, D-1, B-2, A-7, D-6 and D-2 are a few of cassia lines with high leaf oil, bark oil and bark oleoresin.

Isozyme characterisation of ginger and turmeric

Characterisation of 77 turmeric and 14 ginger accessions using Poly Acrylamide Gel Electrophoresis (PAGE) indicated more variability in turmeric (39-100%) compared to ginger (85-100%). Ten separate clusters in the former and two in the latter were established using dendrograms.

CROP PROTECTION

PLANT PATHOLOGY

Biological control

- *Verticillium tenerum* isolated from black pepper rhizosphere is antagonistic to *Phytophthora capsici*. A new strain of *Trichoderma* tolerant to copper has also been isolated.
- Three fungal parasites viz. *Penicillium fellutanum* Bourge, *Paecilomyces lilacinus* (Thom) Samson and *Verticillium lecanii* (Zimm) Vicgns were isolated from the vector *Pentalonia nigronervosa* f. *caladii* for the first time.
- Biological control against *Phytophthora* has been demonstrated in 2254 hectares in Kerala, Tamil Nadu and Karnataka.

New medium for *Trichoderma*

Tea waste is more ideal than all other agricultural wastes for large scale multiplication of *Trichoderma* and *Gliocladium*. Tea waste supported a spore load of 1780 x 10^6/ g of *Trichoderma* after 21 days and 829 x 10^6 /g of *Gliocladium* after 28 days.

Etiology

Potyviral nature of the particles involved in 'Kokke kandu' disease of cardamom was established through Direct Antigen Coating (DAC) ELISA.

Disease resistance

- Eleven black pepper hybrid lines tolerant to *Phytophthora capsici* have been identified viz.HP 1786, 756, 1380, 1728, 754, 1344, 1382, 1748, 478, 92 and 490. Further evaluation is under progress.
- Accumulation of orthodihydroxy phenol and additional electrophoretic bands were observed in the tolerant lines of black pepper during pathogenesis.
- Black pepper OP line P24 continued to show field resistance against *Phytophthora capsici* in large scale demonstration trials.
- Thirty four disease escapes against 'Kokke kandu' were identified in cardamom.

Disease management

- Integrated disease management involving potassium phosphonate spraying, application of neem cake at one kg /vine and biocontrol agents showed the lowest disease incidence in black pepper.
- Treatment of rhizomes with Ridomil mancozeb and soil application with *Trichoderma harzianum* reduced rhizome rot of ginger and turmeric.

ENTOMOLOGY

Natural enemies

Important natural enemies of insect pests of spices documented include *Blepyrus insularis* (Encyrtidae) on mealy bug *(Planococcus* sp.) infesting black pepper; *Anisopteromalus calandrae* (Pteromalidae) on cigarette beetle (*Lasioderma serricorne*) infesting stored ginger and turmeric; *Megommata* sp.(Cecidomyiidae) on shield scale (*Pulvinaria psidii*) infesting clove and *Sympiesis dolichogaster* (Eulophidae) on leaf miner (*Conopomorpha cirica*) infesting cinnamon.

Biological control

- ☆ Release of 125 eggs/vine of the coccinellid predator *Chilocorus nigrita* for the control of mussel scale *(Lepidosaphes piperis)* infesting black pepper (5 release at 7-10 day intervals) reduced the population by 44.5%.
- ☆ Release of 85 larvae (5 releases at 7-10 day intervals) of the coccinellid predator *C. circumdatus* against coconut scale (*Aspidiotus destructor*) reduced scale insects by 68.5%.
- ☆ Green lacewing (*Chysoperla carnea* Stephens) a predator of aphids was highly predaceous to cardamom aphid.

Toxicity of insecticides to biocontrol agents

Neem oil (0.3%), Neemgold (0.3%) and fish oil rosin (3%) were safe to the predator *C.nigrita* while monocrotophos (0.1%) and dimethoate (0.1%) were toxic up to 7 and 1 day after treatment, respectively.

NEMATOLOGY

Resistance screening

Nineteen ginger accessions showed resistant reaction to *Meloidogyne incognita*. Turmeric accession 84 showed high degree of resistance to *M.incognita*.

Biological control

Three isolates of bacteria showed 100% suppression of root knot nematodes within 6 hours of exposure under *in vitro* conditions. Both *Verticillium chlamydosporium* and *Pasteuria penetrans* improved the growth of cardamom seedlings by suppressing root knot nematodes under field conditions.

SOCIAL SCIENCES

Effectiveness of Kurumulaku Samrakshana Samities

A study was conducted to evaluate the effectiveness of pepper welfare societies (Kurumulaku Samrakshana Samities) in black pepper production in Kerala. Due to various reasons, the perception of farmers about the samiti is only satisfactory. Farmers generally adopt advices on correct harvesting stage, cropping system, processing of pepper and adoption of improved varieties. Samities must be strengthened as they have good linkages with Krishi Bhavans, Cooperative Banks, voluntary organisations and other input agencies.

Government should encourage the samities so that farmers will have more trust in its functioning.

Training programmes

Six training programmes were conducted during the year for agricultural officers, agricultural students and plantation officials. The programmes were on Spices Production Technology, Nursery Management and On Farm Processing of spices.

Demonstration of improved technologies

Low lying marshy areas unsuitable for cultivation for any commercial plantation crops were successfully converted for profitable cultivation of cardamom at Appangala (Karnataka).

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES(AICRPS)

AICRPS recommended release of three new varieties viz. cardamom (ICRI-4), mango ginger (Amba) and fennel (Guj Fen -2). ICRI-4 is an early maturing, Malabar type with bold capsules and an yield of 455 kg/ha under rainfed conditions.

Irrigation at IW/CPE ratio of 0.25 (100 l once in 8-10 days) during Dec- April increased the yield by 72 % over no irrigation.

Fertilizer dose of 75:75:150 kg NPK/ha was recommended for cardamom under natural shade in Karnataka.

Application of Bordeaux mixture (1%) at 15 days intervals controls nursery diseases in black pepper.

Treating turmeric seed rhizomes with monocrotophos (@2 ml /l of water for 15 mins.) is recommended to prevent scale insects. To prevent rhizome rot, bavistin treatment (2 g / l) is recommended.

KRISHI VIGYAN KENDRA

KVK organised 49 training programmes for farmers, rural youths and extension workers and conducted five exhibitions. Two innovative programmes, one on Horticultural Therapy for mentally handicapped and another on organisation of a Voluntary Vikas Vahini club sponsored by NABARD at Kallanode (Calicut) were organised.

INTRODUCTION

The Indian Institute of Spices Research (IISR) was started in July 1995 upgrading the erstwhile National Research Centre for Spices (NRCS) based on recommendations made by various committees like QRT and the Parliament delegation.

Mandate

The Indian Institute of Spices Research will serve as an institute of excellence for conducting and co ordinating research on all aspects of spices improvement, production, protection and post harvest technology.

- ☆ To extend services and technologies to conserve spices genetic resources as well as soil, water and air of spices agroecosystems
- ☆ To develop high yielding and high quality spices varieties and sustainable production and protection systems using traditional and nontraditional techniques and novel biotechnology approaches
- ☆ To develop post harvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes
- ☆ To act as a centre for training in research methodology and technology upgradation of spices and to coordinate national research projects
- ☆ To monitor the adoption of new and existing technologies to make sure that research is targeted to the needs of the farming community
- ☆ To serve as a national centre for storage, retrieval and dissemination of technological information on spices

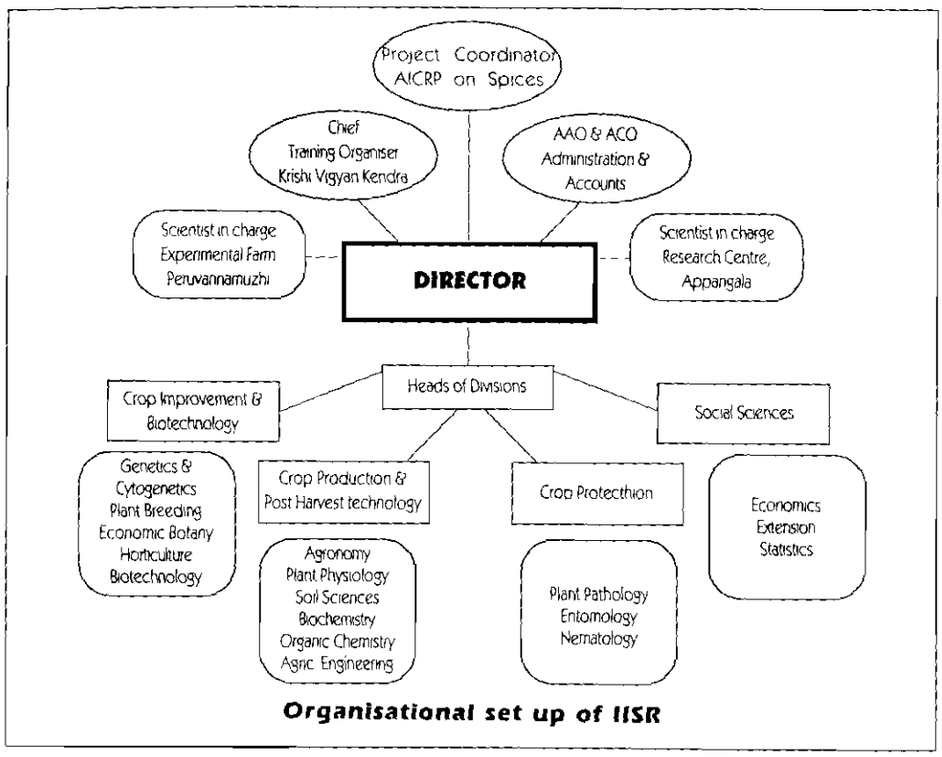
Location

The headquarters of the IISR is situated in Calicut (Kozhikode) city, where Vasco de Gama had landed on 20 May 1498. The experimental farm of the Institute is located at Peruvannamuzhi, in the foot-hills of the Western Ghats. The only subcentre, the Cardamom Research Centre, is at Appangala in Coorg (Kodagu) District, Karnataka.

Organizational setup

The Director is the administrative head of the Institute and its other centres. The Institute Management Committee, Research Advisory Committee, Policy Committee and Staff Research Council assist the Director in matters relating to management, research and extension. Multidisciplinary research on different aspects of black pepper, cardamom, ginger, turmeric, nutmeg, clove, cinnamon, allspice, vanilla and paprika is conducted in three divisions and a section- Division of Crop Improvement & Biotechnology, Division of Crop Production & Post Harvest Technology, Division of Crop Protection and Social Science Section. Besides, IISR is also the head quarters of the All India Coordinated Research Project on Spices with a network of 20 centres spread over 15 states. Krishi Vigyan Kendra, established in 1992 at the Experimental Farm, Peruvannamuzhi, concentrates on transfer

of technology. Apart from the research activities, the Institute is recognized as a centre for post graduate studies by the University of Calicut. It offers consultancy and training in different fields and disseminates the information generated through regular publications and other mass media.



Organisational set up of IISR

PAST ACHIEVEMENTS

Crop Improvement and Biotechnology

The Institute has a large collection of spices germplasm consisting of 2568 black pepper, 293 cardamom, 428 ginger, 697 turmeric, 423 nutmeg, 213 clove, 262 cinnamon, 137 allspice and 9 vanilla accessions.

High curcumin and high yielding turmeric varieties viz. Suvarna, Sudarshana, Suguna, Prabha and Pratibha, high yielding black pepper varieties like Sreekara, Subhakara, Pournami and Panchami, high yielding and high quality cinnamon varieties Navasree and Nithyasree were released to farmers.

Vegetative propagation methods were standardised in clove, nutmeg and cinnamon.

Methods for long term storage and cryopreservation of genetic resources of spices in *in vitro* conditions are being standardised and *in vitro* repository for spices germplasm was established.

Regeneration of plantlets from calli of ginger, turmeric, black pepper, vanilla, lavender, anise and cardamom were achieved to exploit the somaclonal variation and for *in vitro* selection of lines resistant to biotic and abiotic stresses.

Crop Production and Post Harvest Technology

Rapid and efficient methods for clonal multiplication of black pepper and cardamom were standardised.

A fertilizer dose of 140:55.270 g of NPK/vine/ year is optimum to increase yield of black pepper in laterite soils

Application of neemcake (2t/ha) increased nutrient availability in soil and ginger yield by 33% and restricted rhizome rot incidence of ginger to 5%.

High production technologies developed at the Institute for sustainable high yield of pepper and cardamom have been adopted by farmers.

Panniyur-1 and Valiakanlakkadan are ideal among the pepper varieties to prepare white pepper. Black pepper varieties with high pungency are cv. Kottanadan and Kumbhakodi Cardamom accessions with high oil and flavour are APG 30, 55, 221 and 223; ginger varieties with high oleoresin and gingerol are Rio-de-Janeiro and Wynad Kunnamangalam and turmeric varieties with high curcumin are Prabha and Prathibha.

Crop Protection

Among the several black pepper lines screened for their reaction to *Phytophthora capsici*, the causal agent of foot rot disease, P24, an open pollinated progeny has been identified as tolerant. An integrated management strategy involving phytosanitation, cultural practices and application of Bordeaux mixture (1%) and copper oxychloride or potassium phosphonate (Akomin) is effective against foot rot disease.

Field trials showed effectiveness of *Trichoderma hamatum, T. harzianum* and *Gliocladium virens* to manage *Phytophthora* foot rot.

Integrated disease management involving phytosanitation, soil solarisation, seed treatment were found effective in reducing rhizome rot and increasing ginger yield.

Cultivated and wild *Piper* accessions resistant to pollu beetle, the most serious pest of black pepper, has been identified. The pest could be controlled by spraying endosulfan 0.05% or quinalphos 0.05%.

A number of potential biocontrol agents have been identified against major insect pests of black pepper.

The role of *Radopholus similis, Meloidogyne incognita* and *Phytophthora capsici* in the etiology of slow decline disease complex of black pepper was established.

Transfer of Technology

Yield increase of over 200% was achieved as a result of the adoption of High Production Technology in black pepper.

In cardamom, an all time high yield of 1600 kg of dry cardamom /ha was obtained as a result of adopting the High Production Technology developed by IISR.

Weather Data for 1997

Month	No. of rainy days		Rainfall (mm)	
	Peruvannamuzhi	Appangala	Peruvannamuzhi	Appangala
January	2	2	2.50	3.4
February	-	-	-	-
March	3	8	15.00	45.4
April	2	2	3.50	26.8
May	12	5	208.00	57.4
June	19	20	812.00	556.9
July	31	28	1970.00	896.1
August	30	28	1287.00	819.0
September	13	16	356.50	87.7
October	18	12	452.00	230.0
November	17	12	419.00	121.2
December	11	5	263.00	32.1
Total	158	138	5788.5	2876.0

Budget

Particulars	Plan	Non Plan	Total
Establishment	-	136.00	136.00
Travelling allowance	2.50	3.50	6.00
Works	20.00	-	20.00
Other charges including equipments	67.50	8.50	76.00
Total	90.00	148.00	238.00

Other Sources

Particulars	Amount
A.P. cess fund schemes	30.08
KVK	51.52
NATP	3.00
AICRP Spices	60.00
DBT Schemes	5.29
IPDS	7.69
Visiting scientist scheme	0.81
Pension and gratuity	2.50
Total	160.89

Staff Position

	Sanctioned	Filled	Vacant
Scientific	41	39	2
Technical	37	36	1
Administrative	21	21	-
Supporting	67	67	-

RESEARCH ACHIEVEMENTS

CROP IMPROVEMENT & BIOTECHNOLOGY

GEN. I (813)

COLLECTION, CONSERVATION AND EVALUATION OF BLACK PEPPER GERMPLASM

(K.V. Saji, P.N. Ravindran, B. Sasikumar, V.S.Korikanthimath and B. Chempakam)

A. Collection and conservation of germplasm

Fifty accessions of wild *Piper* were collected from Nilambur, Gudallur, Naduvattom, Nilgiris, Munnar and Pollibetta. This include almost all the wild species reported in South India (Table.1). A rare species which resmbles *Piper silentvalleyensis* was also collected from Palkara near Ooty. *P. longum* collected from Nilambur had long spike and another species which resembles *P. galeatum* but having bisexual inflorescence was collected from Munnar. A survey was conducted in Kannur district for the collection of drought escapes and 22 accessions of cultivated pepper were collected (Table 1). One hundred and thirty one accessions of cultivars were planted in the field.

B. Characterization of *Piper* species

A highly scented *Piper* species was identified from the North East collections. Twenty one accessions including released varieties were analysed for total protein. Matured leaves and berries were sampled for SDS-PAGE. In majority of cases 11-18 bands were noted.

Table 1: *Piper* species collected during the year.

Species	No. of acc. collected	Place	Remarks
A. Wild Species			
Piper nigrum	6	Nilambur	
	10	Munnar	Bold berries
P. longum	1	Kannur	
	3	Nilambur	Long spike, climbing habit
	1	Cheruthoni	
P. mullesua (♂&♀)	4	Naduvattom	
	4	Munnar	
P. schmidtii (♂&♀)	3	Nilgiri	High altitude species
P wightii (♂&♀)	2	Nilgiri	High altitude species
Piper sp.	1	Naduvattom	resembles *P. silentvalleyensis*
P. argyrophyllum (♂&♀)	2	Gudallur	Scented spikes
P. hymenophyllum (♂&♀)	2	Gudallur	-
	1	Munnar	-
	1	Pollibetta	-
P. galeatum (♀)	1	Gudallur	-
P trichostachyon	1	Gudallur	-
Piper sp.	2	Munnar	A species resembling *P. galeatum* but having bisexual flowers
P. sugandhi (♂&♀)	3	Munnar	long spike
P. attenuatum	1	Munnar	-
B. Cultivars			
Piper nigrum (Uthirankotta, Kalluvally & Karimunda)	22	Kannur	Collected from the drought prone areas
P. nigrum (Kottanadan)	1	Palode	A released variety for South Kerala
P. nigrum (Karuvilanchi)	1	Thenmala	oblong fruits - like pappaya seeds
P. nigrum	11	Pollibetta	-

GEN. IX (813)

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF CARDAMOM GERMPLASM

(M.N. Venugopal and K. Padmini)

Thirty one cardamom accessions were assessed for their natural reaction to leaf blight (*Colletotrichum gleosporoides*) and leaf blotch (*Phaeodactytium venkatesamum*). Accession numbers were given to disease tolerant/ resistant types. One compact panicle type was added to cardamom genebank bringing the total accessions to 319.

GEN. II (813)

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

(P.N. Ravindran, B. Sasikumar, K.V. Saji, and K.P.M. Dhamayanthi)

A. Maintenance of germplasm

Five hundred and fifteen accessions of ginger and 730 accessions of turmeric and nine accessions of *Kacmpferia* are maintained.

B. Collection of germplasm

New collections of ginger and turmeric were made from Kerala and Tamil Nadu. Thirty seven accessions of ginger and 5 accessions of turmeric were collected besides 3 *Curcuma* sp. 3 *Amomum* sp. and one *Hedichyium* sp. from Gudalur (Nadugani).

C. Isolation of DNA from ginger and turmeric

Genomic DNA was isolated from ginger and turmeric following 2% CTAB method.

D. Yield evaluation of ginger (bold rhizome accessions)

Fifteen selected bold rhizome accessions of ginger were evaluated for yield and dry recovery at Peruvannamuzhi, Kumarakom, Anantharajupet, Shillong and Muvattupuzha. Two of these bold rhizome accessions were evaluated at Wynad also. Mean yield and dry recovery of the accessions from Peruvannamuzhi and Muvattupuzha are presented in Table. 2.

E. Multiplication of A.P. collections of ginger

Seventeen accessions of ginger collected from Visakhapatnam and Warangal districts of Andhrapradesh were multiplied in replicated 3 m^2 beds. The yield of these accessions varied from 7.25 (Acc. 412) to 14.38 (Acc. 418) kg/3m^2 bed whereas dry recovery of the accessions ranged from 22.55 (Acc. 413) to 30.5 % (Acc. 398).

F. Yield evaluation of high curcumin turmeric lines

Ten selected high curcumin lines of turmeric were evaluated in a replicated trial at

Table 2: Mean yield and dry recovery of bold rhizome ginger accessions.

Accession	Peruvannamuzhi		Muvattupuzha
	Yield (fresh) kg/3m² bed	Dry reovery (%)	Yield (fresh) kg /3m² bed
15	13.1	24.8	11.67
27	11.3	26.3	14.33
204	10.93	25.5	11.00
35	11.93	21.2	11 00
179	10.10	26.5	10.33
244	9.93	22.0	9.17
415	11.42	24.3	9.83
64	11.42	24.3	11.00
49	10.33	21.3	9.30
71	7.40	23 8	9.17
294	10.48	27.0	9.65
3573	9.63	25 5	9.33
117	9.90	25.5	10.33
116	10.65	22.0	10.83
142	6.89	26.8	7.50
CD(P<0.05)	1.86	-	0.83
CV %	12.9	-	10.7

Based on yield/ bed and dry revcovery Acc. 27 and Acc.15 are found to be promising. Acc. 15 had 2.5% oil and its crude fibre content was less than 3%.
Peruvannamuzhi. Yield of these accessions ranged from 13.9 (Acc. 329) to 26.13 (Acc. 173) kg per 3 m² bed.

G. Evaluation of 'Alleppey' turmeric

Fifteen selected accessions of 'Alleppey turmeric' (AFT) were evaluated in a replicated trial at Peruvannamuzhi. The yield (Fig .1) ranged from 19.50 (Acc. 596) to 29.67 (Acc. 585) kg (fresh) / 3m² bed.

The Acc. 585 recorded 7% curcumin whereas the Acc. 584 and 591 had curcumin content of 6.5%.

H. Variability studies for the storage life of dry ginger

Dry ginger of 30 accessions were studied for their reaction to storage pest attack. Thirty accessions of ginger (dry ginger) were evaluated for variability in shelf life. Dry

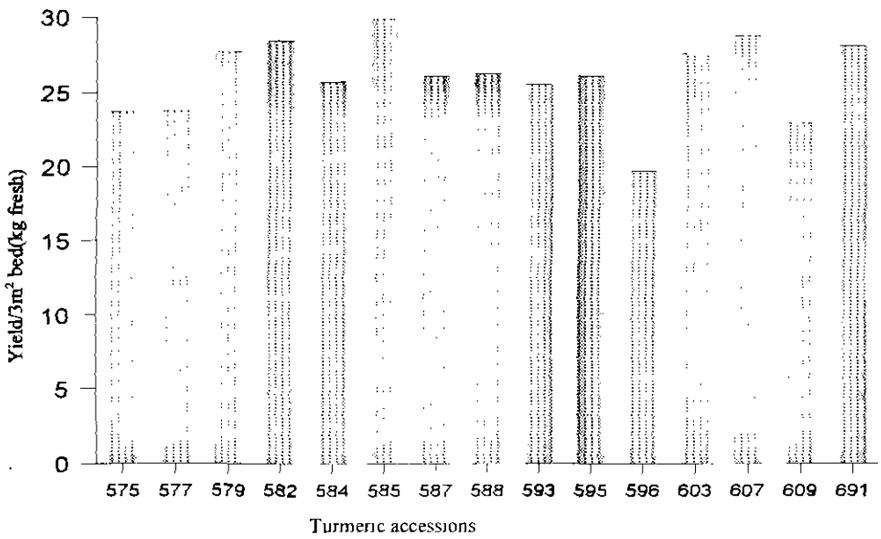


Fig. 1. Mean yield of selected accessions of Alleppey turmeric

samples were kept in small plastic jars covered with muslin coth. These samples were artificially infested with adults of *Lasicoderma sericorne* sp. and kept for 4 months. The weight of the ginger samples left after feeding as well as the weight of powder (frass) were recorded. Damage due to the pest attack varied from 10-50 per cent. Least damage was recorded in Acc. 74, followed by Acc. 35, 244 and 415 (bold rhizome selections) Maximum damage of 50 percent was recorded in Acc. 252. The released variety Varada had recorded 28 per cent damage.

Table 3: Mean, range and variance for yield and yield attributes in ginger accessions.

Character	Mean	Range	Variance
Plant height (cm)	64.26	40-90	108.73
Number of tillers	13.35	5-37	37.66
Leaf number	21.85	8.31	38.18
Leaf length (cm)	19.42	14-27	8.95
Leaf width (cm)	2.18	1.5-3.1	0.14
Stomatal index	13.93	8-19	4.59
Yield (kg/3m² bed) fresh	10.08	2.5-16.5	8.22
Dry recocery (%)	25.79	21-31	-

I. Cataloguing of ginger

Seventytwo accessions of ginger were planted in 3 m^2 bed and data on yield and yield attributes are recorded (Table 3). Some of the accessions registered a dry revovery of about 31% (Acc. 257, 234 & 215).

GEN. VI (813)

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

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

A. Collection and conservation

Germplasm collection surveys were undertaken to Ramamangalam, Manjapra (Ernakulam district), Ulliyeri (Calicut district), Meppadi (Wynad district), Taliparamba (Cannanore district) and Vittal (South Kanara, Karnataka). Three wild species of *Cinnamomum*, one wild *Myristica* species and another morphological variant of *Myristica fragrans* one *Pimenta dioica*, four *Garcinia* spp. and one atao were added to the conservatory (Table 4).

Table 4: Tree spices collected during 1997.

Crop	Place	Number	Remarks
Cinnamomum sp.	Bennegatta Forest Division, Karnataka	3	Wild species
Myristica sp.	Vittal	1	*Chendalika*
	Ulliyeri	1	Morphological variant of cultivated species
Pimenta dioica	Meppadi (Wynad)	1	Prolific bearer, Isolated tree
Garcinia sp.			
G. cambogia	Appangala	1	Seedlings
G. mulleasa	Taliparamba	1	Big fruited seedless type
G. gummi gutta	Taliparamba	1	Small fruited
Garcinia sp.	Taliparamba	1	Seedless type
Artocarpus lakoocha	Appangala	1	Seedlings

B. Field trials with pre-release varieties of nutmeg and cassia

Three trials with progenies of A9/4 nutmeg were laid out, one each at Peruvannamuzhi farm, Ramamangalam and Manjapra (the last two selected by Spices Board, Kochi). A field trial with four quality cassia lines (A_2, C_1, D_1 and D_3) was also laid out in RBD with 5 replications at 2 ½ x 2 ½ m spacing.

C. Identification of bald and bold nutmeg selections from conservatory

Nutmeg accession A 9/69 was found to have a bold seed (3g) and thick mace (4.3 g), though the fruit weight was only medium (74.4 g). This yielded 729 fruits in 1997. This was multiplied by vegetative and seed propagation for further studies.

Nutmeg accession A2 was found to have a typical baldness of all its seeds. That is, the mace is covering only one end and two sides leaving clear bald end.

D. Cytogenetics in nutmeg

In nutmeg, the diploid chomosome number was found to be 2n 38.

E. Multiplication of promising selections/ varieties of tree spices

Released cinnamon varieties and pre release cassia lines were multiplied vegetatively. The nutmeg selections A 9/20, A9/22, A9/25, A9 /69, A9/79, A9/86, A4/12, A4/22, A4/52, A11/29 and A11/70 were multiplied vegetatively. Application of rooting hormone (IBA 2500 + NAA 2500 ppm in charcoal) aided in production of adventitious roots in mature allspice cuttings with about 63% rooting in February.

GEN. XIII (813)

COLLECTION, CONSERVATION AND IMPROVEMENT OF VANILLA

(P.N. Ravindran, B. Krishnamoorthy and B. Sasikumar)

Nine accessions of vanilla were collected from Ernakulam and Calicut districts (farmers plot). Twenty two accessions were planted in the field during the current year.

Three hundred more of vanilla seed generated plants were developed for evaluation. Interspecific hybrids between *V. planifolia* x *V. aphylla* were attempted. Six progenies obtained from this cross are being cultured *in vitro.*

GEN. VII 1 (813)

BREEDING BLACK PEPPER FOR HIGH YIELD, QUALITY AND DROUGHT

(B. Sasikumar, P.N. Ravindran, T. John Zachariah and K.S. Krishnamurthy)

A. Planting of promising hybrids and cultivars (Valparai)

Five promising hybrids, shortlisted for release viz. HP-34, HP-105, HP-813, HP-728, HP-778 and a cultivar Coll. 1041, were planted in blocks of 50 plants each on *Erythrina* with Panniyur-1 as the control at Tata Tea Estate, Valparai. This work was done in collaboration with Tata Tea Ltd.

B. Field planting of Neelamundi accessions and other promising lines (Peruvannamuzhi)

Seventeen accessions of Neelamundi (clonal material) along with O.P. seedlings of 37 mother plants are planted at Peruvannamuzhi (*Glyricidia* standard: 2 standards/accession)

A separate replicated trial involving 10 promising selections and control (Sreekara) (Hybrids HP- 780, HP-2 and HP-141, Cultivar 4133, 1365,889and 1041, O.P. Karimunda) was laid out using *Glyricidia* standards.

C. Characterisation of interspecific hybrids of black pepper

Two interspecific hybrids of *Piper* viz.. *Piper nigrum x P. attenuatum* and *P nigrum x P. barberi* were characterised based on morphology, anatomy, isozymes, cytology and reaction to '*pollu*' beetle (*P. attenuatum* and *P. barberi* are resistant to '*pollu*' beetle infestation)

i). *Morphology*

In general the hybrids were intermediate between the parental species for most of the morphological (metric) characters. However, for the other characters such as shoot tip colour, leaf tip shape and leaf shape, the hybrid *P.nigrum x P. attenuatum* resembled the female parent, *P. nigrum*. The hybrid *P. nigrum x P. barberi* inherited the shoot tip colour and leaf tip nature from the maternal parent, whereas its leaf shape was intermediate between the parents.

ii). *Anatomy*

Mucilage canals position and number of vascular bundles (V.B) are considered for characterising the hybrids. Stem anatomy of the species and the hybrids showed both structural as well as dimensional variations, (Table 5& 6)

Table 5: Anatomical features of hybrids.

Species / hybrid	Position of mucilage canal and vascular bundle
P. nigrum (cv. Aimpiran & Karimunda)	Center of the pith as well as in the periphery. V B more
P. attenuattum	Comparatively small mucilage canal in the center. V B less
P. barberi	Six mucilage canals in the periphery and a very large cavity in the center of the pith. V B less as compared to *P. nigrum*
P. nigrum x *P. attenuatum*	Intermediate between the parents for the nature of the mucilage canal and V B
P. nigrum x *P. barberi*	A single large sized mucilage cavity was observed in the center of the pith. The number of V B were more or less same as in the female parent.

iii) *Isozymes*

Four isozymes viz. peroxidase, esterase, polyphenol oxidase (PPO) and superoxide dismutase (SOD) were studied in the hybrids and parents.

In addition to the hybrid specific bands male specific bands were also observed in the isozyme studies. However, no hybrid specific bands were observed in case of SOD. Most of the isozyme loci were common to the three parent species and hybrids studied.

Table 6: Dimensional variation for anatomical traits in Piper species and species hybrids.

Species/hybrid	No.of peripheral vascular bundles	No of medullary vascular bundles	No of tracheids in peripheral bundles	No. of tracheids in medullary bundles	Width of tracheids in peripheral bundles	Width of tracheids in medullary bundles	Diameter of central mucilage canal	Diameter of mucilage canal in outer pith region
P nigrum (cv Ampinan)	30±12	8±0	96±13	104±15	316±85	666	325±25	1596±9
P attenuatum	16±01	4±0	128±44	10±18	368±23	622	867±10	Nil
P nigrum x *P attenuatum*	25±01	6±0	104±18	66±14	255±22	31±26	1784±78	Nil
P nigrum (C V Karimunta)	26±14	8±0	81±24	186±28	348±34	625	1945±53	765±155
P barberi	16±08	7±0	15±28	133±37	263±25	363	410±88	222±57
P nigrum x *P barberi*	29±08	9±0	29±15	106±26	262±26	346±27	446±27	Nil

Paired affinity indices of the four isozymes revealed more similarity between the hybrid and the female parents (Table 7)

Table 7: Percentage similarity indices for four isozymes in interspecific hybrids and their parents.

Hybrid/ Parent	Esterase	Peroxidase	Polyphenol oxidase	Super oxide dismutase	Total for 4 isozymes
Hybrid 1 with *P.barberi*	16.6	28.5	0.0	33.3	19.6
Hybrid 1 with *P.nigrum*	41.7	37.5	16.7	25.0	31.2
Hybrid 2 with *P.attenuatum*	36.3	28.6	25.0	33.3	30.8
Hybrid 2 with *P.nigrum*	27.2	33.3	50.0	28.6	34.8

(Hybrid 1 = P. nigrum x P. barberi, Hybrid 2 = P. nigrum x P. attenuatum)

iv). *Reaction to 'pollu' beetle infestation*

Reaction of 'pollu' beetle infestation is assessed by leaf disc screening method. Significant differences are observed, in the reaction of the hybrids and parent species to 'pollu' beetle infestation. The hybrids inherited the resistance genes from the male parents as they are not preferred by the beetles.

GEN. X (813)

BREEDING CARDAMOM FOR HIGH YIELD AND RESISTANCE TO KATTE DISEASE

(M.N. Venugopal and K. Padmini)

A. Multiplication of promising clonal accessions

Three Wynad accessions (APG - 221, APG - 223 and APG - 215) are being multiplied. Six "katte" resistant plants and one rhizome rot tolerant RR-1 type are being multiplied clonally in a separate clonal multiplication block.

B. Hybridisation between selections

A 8 x 8 full diallel set of crosses involving the new selections of IISR namely, RR-1, CCS-1 and "katte" resistant lines namely, NKE-12, NKE-27, NKE-34, NKE-9, NKE-3 and NKE-19 were made. The per cent fruit set was highest and significant for the cross NKE-19 x NKE-34 of 92 followed by NKE-12 x NKE-19 of 77 and NKE-12 x RR-1 of 69. The fruit setting percentage was least and significant in the cross NKE-9 x CCS-1. The per cent fruit set was least and non-significant in the cross NKE- 12 x NKE-9. In general, the fruit set percentage is significant when RR-1 is the male parent and NKE-27 is the female parent (Table 8).

Table 8: Per cent fruit set in diallel crosses involving 'katte' resistant lines.

	RR-1	CCS-1	NKE-12	NKE-27	NKE-34	NKE-9	NKE-3	NKE-19
RR-1	-	32	31	19	41	36	28	37
CCS-1	56*	-	49*	33	28	24	24	45
NKE-12	69*	22	-	24	27	10	45*	77
NKE-27	49*	66*	20	-	53*	56*	50*	45*
NKE-34	21	27	38	-	-	67*	25	32
NKE-9	56*	44*	38	31	55*	-	33	22
NKE-3	59*	46*	47*	36	18	15	-	39
NKE-19	36	48*	40	43*	92*	36	20	-

Mean 39.235 SE: 2.221

GEN. XIV (813)

CYTOGENETICS AND REPRODUCTIVE BIOLOGY OF GINGER AND TURMERIC

(K.P.M. Damayanthi and B. Sasikumar)

A. Cytogenetics

Twenty two ginger accessions of different morphotypes were randomly selected from ginger germplasm collection for the chromosome analysis. All the accessions were found to be 2n = 22, except Acc. 246 (cv. Sabarimala), which was found to be 2n = 24. Karyotype analysis was done in four ginger cultivars viz. cv. Maran, cv. China, IISR-Varada and Sabarimala and their karyological features were compared to estimate the genetic variability among them

Ginger cultivar Sabarimala (2n = 24)

Chromosome studies and *in situ* estimation of nuclear DNA content were carried out in two different cultivars viz., China and Maran. Somatic chromosome number 2n = 22 was found to be constant in both the cultivars. However, three B chromosomes were observed in cultivar China. DNA content of these two cultivars were highly varied and the correlation could be obtained between the 4c nuclear DNA and the total chromosome length. Average packing ratio was worked out from which the relation between 4c nuclear DNA content and the total chromosome length were established. Karyomorphological analysis showed significant variation in the total chromosome length, distribution of secondary constriction and SAT- chromosome between Sabarimala and Varada. The variation in total genomic length and chromosome volume of the cultivar suggest occurrence of structural changes during cultivar diversification. Stickiness characterised by intense clustering were recorded in Sabarimala.

Seventy two ginger accessions were examined for their heterostylic condition, all were invariably found to be 'pin' type.

B. Pollination studies

Since all the assisted pollination methods have failed, intra ovarian pollination methods were adopted.

Intra ovarian pollination was done at 3 P.M. The ovary was examined after 2 h, 12h, 24 h and 48 h through hand lens. In normal cases, the ovary fall down 12 h after anthesis, but in case of intra ovarian pollination method though the flower withered, the ovary remained in position for 45 days.

C. Induction of polyploidy

Five hundred buds each of Varada and Sabarimala were treated with colchicine (2%) and only 127 plantlets of IISR-Varada and 11 plantlets of Sabarimala survived. Those were planted in poly bags for further establishment. Out of 127 plants of IISR- Varada 3 plants were cytologically proved as polyploid lines (2n = 44), whereas in Sabarimala the ploidy response was poor.

HORT. II(813)

UTILIZATION OF PIPER COLUBRINUM LINK AND *P. ARBOREUM* AS ROOT STOCKS IN THE MANAGEMENT OF FOOT ROT DISEASE OF BLACK PEPPER

(P.A. Mathew, J. Rema, T.J. Zachariah and Y.R. Sarma)

The approach grafts of black pepper on *Piper arboreum* prepared during 1996-97 were monitored for a possible union. Even after one year no union could be obtained. Though the scion survived after separation, it did not put forth new leaves but shriveled and died after a few months.

Successful grafts of Subhakara on *P. colubrinum* rootstock were field planted in a replicated trial. The best survival was seen in double grafting, where two root stocks were used. However, in many grafts one out of the two root stocks died and the other kept the graft growing. Cleft, saddle, splice and tongue methods of grafting and yemma budding gave more than 50% survival. Very low survival was noted in the case of modified splice grafting and it was observed to be due to the breaking of scions at the union on account of the deep cuts at grafting time and improper callus formation. The top shoot graft also did not survive which may be due to the sufficient hardening of graft union Splice grafts tended to give a smoother union for the present. The survival of approach grafts was poor. The survival of various grafts is given below as observed after one year of planting (Fig. 2).

Grafting of 50 seedlings and clonal stocks of *P. colubrinum* with laterals of Subhakara was completed and the growth is being monitored for effect of root stock variability.

Twenty pepper varieties were grafted on *P. colubrinum* and preliminary indications are that these are compatible with the root stock used. Field evaluation of these grafts are in progress.

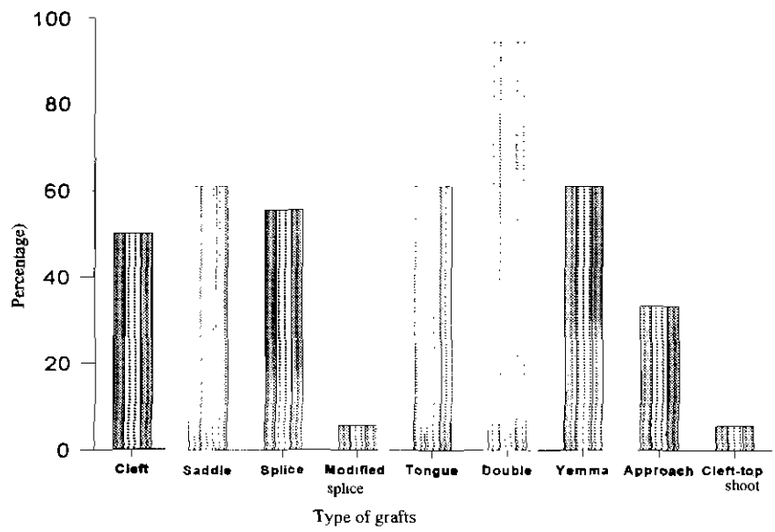


Fig. 2. Survival of black pepper grafts var. Subhakara on *P. colubrinum* Link

HORT. III (813)

DEVELOPMENT OF PAPRIKA FOR WARM HUMID TROPICS

(P.A. Mathew, T.J. Zachariah and K.V. Peter)

During the year 1997, three accessions were collected from Guadeloupe and four from AVRDC, Taiwan. However, only one accession germinated which is being multiplied. In Byadagi Dabba, 12 accessions were collected from Yeliwal and 24 accessions were collected from Kubihal villages of Dharwad district of Karnataka. The total collection presently include 50 exotic and 162 accessions of indigenous type. The germination of the accessions after the rainy season has been found to be poor.

An adaptive trial of 46 exotic accessions were carried out during 1997.The number of days required for 50% flowering after germination varied from 78-115 days. High variability was observed in all the vegetative characters like plant height (12-100cm), number of primary branches (1-5), number of fruits/plant (1-22), individual fruit weigth (2.3-7.5g), fruit length (2-20.5cm) and fruit breadth (1-5.2cm). The fruit colour ranged from red (32), dark red (11), orange (2) to lemon yellow (1). Most of the fruits were elongated and pendulous.

Accessions with dark red colour, suitable for paprika, are limited. An accession with lemon yellow colour may be useful in extraction of yellow paprika. None of the accessions were hot or pungent. The plants also came up well indicating the adaptability to tropical situations. Even within each exotic accession progeny variation was observed that need further purification. Therefore the indications are preliminary.

A total of 21 exotic accessions and 4 indigenous accessions were evaluated for colour by the ASTA method. Colour values ranged from 2.7 to 139 ASTA units.

The results indicated that the exotic types have very low values. The indigenous type Kt-PI-19 gave the highest value of 139.50 ASTA units which is above 100 ASTA units being the standard. However, Kt-PI-19 is not suitable for humid tropics, since it is highly susceptible to bacterial wilt.

BIOTECH. II (813)

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

(K. Nirmal Babu, T.E. Sheeja and A. Kumar)

A. Production and multiplication of somaclones

Over 720 somaclones were transferred to the field and over 925 cultures of plantlets regenerated from anther, ovary and leaf were maintained in the laboratory. Four promising lines viz. MP 61-9, MP 61-10, MP 75-1 and OCP 816 were multiplied for further evaluation.

B. Anther culture

Over 625 cultures of anther regenerated plants have been multiplied and 385 were planted out

C. Protoplast cuture

The protoplasts were cultured and cell division was noticed after 2-3 days of culture. Within 3-4 weeks of culture the cells started dividing and developed into microcalli in 50-70 days on MS medium supplemented with 1 mg/l each of NAA and BA.

D. Development of plantlets from transgenic calli

The transgenic calli bombarded with pAHC 25 vector containing GUS and phosphinothricin resistance were put for plant regeneration. The calli of ginger could not regenerate due to contamination and were lost. However, the calli of cardamom regenerated and developed into plantlets.

BIOTECH. III (813)

MICROPROPAGATION OF BLACK PEPPER

(J. Rema and K. Nirmal Babu)

A.Field evaluation of tissue cultured plantlets

Two trials were taken up for evaluating the field performace of tissue cultured black pepper. One of the trials was laid out at the Experimental Farm Peruvannamuzhi and another at the Indian Cardamom Research Institute, Myladumpara. Twenty five percent of the tissue cultured plants of black pepper has flowered and set fruit during the third year of planting.

BIOTECH. IV (813)

BIOTECHNOLOGICAL APPROACHES FOR CROP IMPROVEMENT IN BLACK PEPPER

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

A. Production of somaclones

Over 400 cultures of black pepper somaclones were multiplied and 50 of them were transferred to soil.

B. Embryo culture and induction of somatic embryogenesis

Two hundred cultures of zygotic embryos were established and 5% of the cultures showed induction of somatic embryogenesis. Somatic embryos are ideal for genetic transformation experiments using either biolistics or *Agrobacterium*.

AD HOC PROJECT

DEVELOPING HARDENING PROTOCOLS FOR TISSUE CULTURED PLANTS OF SPICES

(J. Rema, P.N. Ravindran and Minoo D.)

A. Establishment of hardening facility

A hardening facility with controlled conditions viz. temperature, light and humidity has been established to develop hardening protocols for spices with different habits (perennial climbers, annuals, seasonal herbs, trees etc.) and different climatic zones (tropical to temperate).

B. Developing hardening protocols for tissue cultured plants

To study the suitable conditions for hardening, sufficient material is being established *in vitro* which includes black pepper and related species, cardamom, tree spices viz. *Cinnamoum verum, C. cassia, C. camphora*, clove and *Ocimum* spp.

In vitro cultures of established material is being multiplied and about 350 plants each have been developed *in vitro* in cardamom and black pepper.

Initial experimentation in the hardening facility to identify favorable conditions for acclimatising the transferred plants are under way.

CLOSED PROJECTS

BIOTECH(813)

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

(M.N. Venugopal)

OBJECTIVES

- ☆ Developing protocols for rapid multiplication of elite clones of cardamom
- ☆ Production and field evaluation of micropropagated plants
- ☆ Developing protocols for callus induction, multiplication and regeneration
- ☆ Screening of somaclones against cardamom mosaic virus

A. Micropropagation

For multiplication of selected clones, young suckers and panicle buds were used as explants. Multiple shoots were induced in vegetative buds by suppressing the apical growth and activating the development of axillary buds. Young vegetative buds after sterilisation with 0.1-0.2% mercuric chloride were multiplied on MS basal medium (Murshighe and Skoog, 1962) containing coconut water 20%, naphthaleneacetic acid (NAA) 0.5 mg/litre, indolebutyric acid (IBA) 0.2 mg/litre, 6-benzylaminopurine (BA) 1.0 mg/litre, kinetin 0.2 mg/litre and agar 6g/litre. The plantlets developed were rooted in White's basal medium containing NAA 0.5 mg/litre and then hardened in soil+vermiculate (1:1) mixture.

a. Source of explants

Young vegetative buds of field grown plants collected in April-May and September-December were more suitable as explants and were comparatively free from contamination. While inoculating, the buds had to be trimmed and outer sheathing leaf bases were removed which had resulted in reducing browning and contamination.

b. Sterilisation of explants

Testing of mercuric chloride 0.1% and 0.2%, calcium hypochlorite, sodium hypochlorite, silver nitrate and antibiotics at different concentrations indicated that mercuric chloride at 0.1% and 0.2% for 18-20 minutes is effective in reducing surface contamination. Pre-sterilisation washing with sterile water containing few drops of wetting agent (Teepol) and post surface sterilisation washing with sterile water is also required to remove adhering dirt and traces of sterilants.

c. Multiplication of buds

The response and composition of medium suitable for multiplication is given in Table 9 & 10. The surface sterilised trimmed buds showed response in multiplication medium within 15-20 days. In the second transfer, 3-5 plantlets developed to full size within 40-60 days. Further, separated plantlets have to be allowed to grow on semisolid or liquid

M.S. medium (multiplication medium) for further growth. In a year, 20-22 plantlets can be generated from one explant and in two years time, 20,000 - 22,000 plantlets can be generated from one established plantlet.

d. Rooting of buds

Micropropagated buds developed two to four strong roots in the modified White's rooting medium. The plantlets cultured in liquid medium in 250 ml wide mouthed conical flasks kept on rotary shaker were found to produce more suckers than the cultures on semisolid medium. The above cycle of multiplication can be continued for about 10 rounds of transfer.

e. Hardening of micropropagated plantlets

In vitro propagated rooted plants established well in 1:1(v/v) soil vermiculate mixture with controlled conditions such as light, temperature and humidity. Haugland's solution supplied at 3 days interval promoted proper growth of established plants. Humidity can be provided by covering the plants with 300 gauge U.V.stabilised polythene sheets. The plants established upto 92-98 per cent in different seasons. The established plants from the controlled medium need to be shifted to polybag in the nursery for promoting normal growth with recommended package of practices which involve spacing, filtered light, watering, plant protection to avoid nursery leaf spot, rhizome rot, borer and leaf thrips infestation. Within 4-5 months of transferring to poly bags, the plantlets obtained standard seedling stage (45-60 cm height with more than 2 tillers).

Table 9: Effect of different media on shoot formation in micropropagation of cardamom.

Medium	Supplements	Growth response
1	Kn or BAP (0.1,0.2,1 0 and 2.0 mg/l)	*
2	Kn or BAP (0.5 mg/l)	**
3	Z (1.0, 2.0, 4.0 and 5.0)	*
4	CW (1,2,10 and 20%)	*
5	Kn (0.5 mg/l+BAP(0.5 mg/l) CW(5%) (MS-1)	***
6	Kn (0.5 mg/l) +BAP(0.5mg/l) CW(5%) + Calcium pantothenate (0.1 mg/l) I biotin (0.1mg/l)1 IAA (2.0 mg/l) (MS-2)	****

Basal medium used - MS, period of incubation - 4-8 weeks

* Buds remain green without elongation
** Green buds, elongate to about 25 mm
*** Green buds, elongate to about 30 mm
**** Green buds, elongate to about 40 mm

10 replicates were kept for each experiment. Visual observation showed over 90% similarity and 5 to 10% variation in the results.

Table10: Composition of medium used in rapid multiplication of cardamom.

Explant	Composition		
	Sub-culture medium	Rooting medium	Multiplication medium
MS basal+medium+	MS basal+medium I	White's basal	MS basal medium+
0.2 mg/l NAA	0.5 mg/l NAA	media (liquid) +	0.5 mg/l NAA
1.0 mg/l BAP	0.5 mg/l BAP	0.5 mg/l NAA	1.0 mg/l BAP
200 ml/l coconut water	0.2 mg/l Kinetin	30 g/l Sucrose	0.2 mg/l IBA
30 g/l Sucrose	200 ml/l coconut water 30 g/l Sucrose		200 ml/l coconut water 30 g/l Sucrose

B. Field performance of in vitro propagated plants

Three replicated field trials were conducted to evaluate the performance of *in vitro* propagated plants. The tissue cultured plants showed better establishment(95%) than the seedlings(80%) and suckers(85%) in the field after 3 months of planting. This may be due to the better root system of the tissue cultured plants, high endogenous levels of growth regulators supplied at multiplication and shooting stage and freedom from soil borne root pathogens.

In Trial I & II, analysis of results of three crop seasons (pooled analysis) revealed significant differences with regard to important yield attributes viz number of yielding tillers/plant, panicles/plant, green yield/plant and cumulative yield (Table 11). Non-significance was observed in the parameters like tillers/plant and leaves/plant. In both the above trials, the tissue cultured plants were found to be superior compared to clones and seedlings.

Table 11: Growth and yield parameters of tissue cultured Cl-37 and Mudigre-1 plants (1992 crop season).

Growth character	Cl - 37 Plants				Mudigere - 1 Plants			
	T.C plants	Suckers	Seedings	CD (0.05)	T.C plants	Suckers	Seedings	CD (0.05)
Tillers/plant	24.6	22.4	21.7	NS	20.9	19.8	17.1	NS
Yielding tillers/plant	15.9	11.1	12.3	2.8	14.1	12.3	9.5	3.5
Height of the tallest tiller (cm)	167.0*	150.0	170.0*	13.8	162.0	141.0	166.0	NS
Leaves/plant	134.0	114.0	135.0	NS	130.0	119.0	109.0	NS
Panicles/plant	21.1*	15.2	18.0*	2.5	17.1*	14.6	11.9	3.8
Green yield (g/plant)	434.0*	194.0	305.0	112.0	267.0*50	165.0	162.0	51.3
Cumulative yield (1990-92) (g/plant)	774.0*	476.0	628.0	226.0	6.0*	385.0	329.0	113.0

In Trial III, tissue cultured clones performed better compared to seedlings of local check (C1-37) for number of leaves, plant height, total number of yielding tillers and number of panicles per plant (Table 12). Tissue cultured clones, Hy-43, Hy C1-37 x PV-1 were significantly superior to local check with respect to green yield.

Table 12: Yield parameters and yield of tissue cultured hybrids and *elite* plants.

Clone	No. of yielding tillers per plant	No. of panicles per plant	Wet yield (g) per plant
1271/2-6	9 1	8 3	401
1271/2-10	11 0	8 9	443
Hy 43	8 5	7 4	539
Hy 668	9 9	8 3	416
C1-671	8 7	5 7	435
CI-37 x PV-1	8 3	6.7	523
CI-37x(Check)	7 8	6 8	495
CD at 5%	2 15	1 77	12.5

Superiority of tissue cultured plants for yield was attributed to better growth in terms of superior yield contributing characters. Sucker propagated plants were superior compared to seedlings in Mudigere-1 while seed propagated plants were superior over sucker propagated plants in CL-37. These selections were developed through clonal selections and cardamom being a highly cross pollinated crop, seed propagation will result into genetic drift leading to superiority of seed propagated plants over sucker propagated plants with respect to number of panicles in CI-37. Superiority of clonal progenies of some high yielding clones was reported in cardamom (Pattanshetti and Sulikeri, 1985), but in the present study sucker propagation and seed propagation were on par for growth and yield characters in Mudigere-1.

The above yield evaluation studies have clearly established the satisfactory field performance of micropropagated plants obtained from 8 elite cardamom lines. These studies clearly established that tissue culture technique can be used for future multiplication of elite clones and introduction of pests and pathogens through planting material which take toll in the nurseries and plantations can be avoided.

C. Callus induction and regeneration

Rhizome bud explants cultured on MS medium with 4.5 μM 2, 4-D, 0.5μ M NAA, 4.4 μM BA and 2.3 μM Kinetin and incubated in the dark began to swell after 40 days. Callus started appearing 3 months after inoculation in the dark. The growth of the callus which was separated from the rhizome explants after its initiation and kept in light was slow initially but later growth was profuse. The rhizome explants kept in light from the start turned brown and finally died. The callus induced could be maintained in light for 24 months as long as it was subcultured to fresh medium every 20-30 days. The callus of cardamom when incubated in light on MS medium produced 2 morphologically distinct types of calli, a pale yellow compact callus which was capable of regeneration and a

whitish non morphogenic friable callus. Shoot regeneration was not observed when the friable callus was incubated on MS medium with 13.3 - 44.4μM BA and 13.9-46.5μM Kinetin. The compact callus incubated in dark from beginning did not differentiate into shoots. The compact callus of cardamom was found to retain its morphogenic potential even after 2 years in culture after repeated subcultures

Among the treatments supporting morphogenesis, the one with 22.2μM BA and 23.2 μM Kinetin was the best causing more than 20 shoots to be produced. In an earlier report regeneration was reported from young seedlings of cardamom in medium with IAA, CW(coconut water) and BA(Srinivasa Rao *et al*, 1982). CW contains many components including gibberellins, cytokinins, auxins and 1,3 diphenyl urea (Raghavan, 1976). The addition of CW to the medium reduces the reproducibility of the results and makes it difficult to study the interactions of various growth regulators due to the presence of unknown components.

The plantlets produced 4-6 roots when transferred to White's basal medium with 2.7μM NAA. Seventy per cent of the plantlets survived when transferred to a 1 soil: 1 vermiculate mixture (v/v) in poly bags kept in 90-95% relative humidity in a green house. Higher regeneration of plantlets from callus is an essential step in utilising tissue culture technique for plant improvement. Production of as many as 20 shoots per culture achieved in this study enables one to obtain large number of plantlets from callus in a short period.

Callus induction and multiplication

For induction of callus, young suckers of invitro plantlets (12 months old) were used as explant. Four explants were inoculated in each culture tube of semi solid MS medium supplemented with 4.5 μM 2, 4-D, 4.4μM BA, 2.3 μM Kinetin and 0.5 μM NAA and incubated in the dark. One piece of callus (0.5cm^3) per culture vessel was transferred to fresh medium of same composition at an interval of 20 days for the maintenance of callus. All the cultures were incubated at 25$\pm$2^{0}C in light at 20 μ mol m^{-2}s^{-1} provided by Phillips cool white fluorescent lamps.

Regeneration of callus

In order to optimise growth regulator requirements for the regeneration of plantlets from callus, one piece(1 cm^3) each of the established calli was inoculated separately in each culture tube on a series of MS medium supplemented with various concentrations of NAA (0, 2.7, 13.4μM), 2, 4-D (0, 0.5μM), BA (0-44.4, 133.2 and 222.2 μM) and Kinetin (0-46.5 and 139.4μM). One piece (1 cm^3) each of the cultures was transferred to fresh medium of same composition every 20 days until final observations were made. The response of the culture was recorded after 3 months as the mean number of shoots (>1cm long) produced per culture. The experiment was conducted 10 replicates during each run.

D. Rooting of regenerated plants

Shoots developed from the callus were separated and rooted in White's basal liquid medium (White, 1963) containing 2.7μM NAA using filter paper rafts in culture tubes. Rooted plants were transferred to 1 soil: 1 vermiculate (by volume) mixture in polythene bags (250 cm^3) and kept under 90-95% relative humidity in a green house for 15 days before placing them under nurse

E. Screening of somaclones against Car MV

In the three successive inoculations effected at an interval of 45 days, the batches of somaclones were assessed in 1994, 1995 and 1996. Out of the 785 somaclones tested, 86 percent of plants took infection in first inoculation (Table 13) and only 0.4 per cent remained free from infection after second screening and the remaining took infection in the third inoculation and all the plantlets showed severe mosaic symptoms

Table 13: Screening of somaclones against cardamom mosaic virus.

Year	Inoculated	No. of somaclones infected after		
		Ist screening	IInd screening	IIIrd screening
1994	237	191	34	1
1995	230	202	28	--
1996	328	284	42	2
Total	785	677	105	3

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Regy Lukose, Saji K.V., Venugopal M.N., and Korikanthimath, V.S. 1993. Comparative field performance of micropropagated plants of cardamom (*Elettaria cardamomum* Maton). Indian Journal of Agricultural Sciences 63(7):417-418.

Papers presented in Seminars and symposia

Regi Lukose, Korikanthimath V.S., Venugopal M.N. and Ravindra Mulge 1996. Field evaluation of six tissue culture clones of cardamom. National Seminar on Horticultural Biotechnology, 28-30 Oct., 1996. University of Agricultural Sciences, Bangalore.

HORT. 1 (813)

VEGETATIVE PROPAGATION OF TREE SPICES

(J. Rema, B. Krishnamoorthy and P. A. Mathew)

OBJECTIVES

The project was initiated with the objective of standardizing vegetative propagation techniques in cinnamon (*Cinnamomum verum*), cassia (*C. aromaticum*), clove (*Syzigium aromaticum*), allspice (*Pimenta dioica*) and nutmeg (*Myristica fragrans*).

A. CINNAMON

a. Cuttings

Three auxins namely indolebutyric acid (IBA), indoleacetic acid (IAA) and naphthaleneacetic acid (NAA) at five concentrations, 1000, 2000, 3000, 4000 and 6000 ppm were tried for rooting of cinnamon cuttings. The cuttings of shoot terminals of about 15 cm length were given a dip in the hormone and planted in moist coir dust media filled in polythene bags and the rooting percentage was observed after 60 days.

IBA and IAA at 2000 ppm proved to be the best with a rooting percentage of 73.2 and 65.1, respectively, followed by IBA 3000 ppm (60 .5%). The number of roots produced per cutting also appeared to favour IBA 3000 and 2000 ppm with an average of 4.7 and 3.7, respectively. A maximum root length of 6.5 cm was observed in IAA 2000 ppm. The root length were on par with that of control for IBA treatments, indicating that root emergence could probably be relatively at slower rate for IBA. IBA and IAA treatment stimulated rooting effectively.

b. Air layering

Uniform sized shoots were air layered about 30 cm below the shoot of uniformly sized cinnamon trees grown in the field under ideal condition. A 2 cm wide ring of bark was removed and IBA at 1000, 2000 and 3000 ppm in lanolin paste was applied. In another treatment the shoots were etiolated 15 days prior to layering and IBA 3000 ppm in lanolin paste was applied. Air layering with lanolin paste alone formed the control. All the layers were wrapped in moist coir dust and were further wrapped in polythene film to prevent water loss. Rooting was observed in all the treatments, including control. Maximum rooting (70%) was observed with IBA 3000 ppm when applied without etiolation.

Terminal cuttings of the elite lines were treated with IBA 2000 ppm (the best treatment for rooting of cinnamon) and were planted in sterile soil filled in polythene bags to find out the rootability of nine elite lines of cinnamon. The experiment was laid out in a CRBD with 3 replications and 9 treatments and with 15 cuttings in each replications. Biochemical status of the cuttings were estimated at the time of planting to correlate with rooting percentage. Total carbohydrates, nitrogen, C:N ratio, reducing sugars, nonreducing sugars and total phenols were estimated in SL- 44, SL-53 and SL-63.

A high variability was observed in the rooting capacity of elite lines, the percentage of rooting ranging between 3.3 to 60.5 (mean of 2 years), maximum success was obtained in SL- 5 (60.5). Number of secondary roots was maximum in IN-310 followed by SL-65. In general, SL-5 was the best with high rooting percentage and good development of primary and secondary roots, followed by IN-189. SL-44 which showed higher rooting percentage had a higher C:N ratio, total sugars, total phenols and low nitrogen than SL- 53 indicating that biochemical constituents of the cuttings influenced the rooting.

B. CASSIA

a. Cuttings

Terminal cuttings of about 15-20 cm in length from two year old cassia were given a quick dip in the rooting hormone IAA (500,1000,2000 and 2500 ppm) and were planted in moist coir dust during October. The mouth of the polythene bags were sealed to prevent moisture loss.

All the treatments including the control gave rooting with the highest in IBA 500 ppm (70.4%)..

b. Air layering

Air layers were made on 2 year old cassia seedlings during July and November. Lateral branches, 1.0-1.5 cm in diameter, were girdled by removing 5 cm of bark band. Seradix-B (a commercial rooting hormone) was applied at the girdled region and covered with moist coir dust and wrapped with polythene sheet to prevent moisture loss. The air layers were detached after 2-3 months and observations on rooting and survival percentage, number of primary and secondary roots and length of primary roots were recorded. A success of 87.5% was obtained during July with an average of 6.4 primary and 12.1 secondary roots.

The success in layering was higher during July probably due to the higher humidity prevailing in the atmosphere due to rain which is congenial for production of adventitious roots. All the air layers established in the field.

C. CLOVE

a. Cuttings

Hardwood, semi-hardwood and softwood cuttings of (15cm in length) taken from etiolated (covered with a slip of black cloth for 45 days after which the stem was detached at the covered portion) and non-etiolated shoots after girdling were used for the study conducted during September. Three hormones, namely indoleacetic acid (IAA) at 1000, 2000 and 4000 ppm, naphthaleneacetic acid (NAA) at 150, 300, 450 and 600 ppm and indole-3-butyric acid (IBA) at 2500, 5000, 7500 and 10,000 ppm were used for non-etiolated shoots. The etiolated shoots were treated with IBA (2500 ppm). The cuttings were given a 45 second dip in the respective hormone concentrations and were planted vertically in sterile soil in polythene bags. Individual bags were covered with polythene bags to maintain humidity and temperature.

Adventitious roots failed to develop in clove cuttings. The cuttings remained healthy for a period of 2 weeks and dried off gradually without rooting in all the treatments

b. Epicotyl grafting

Terminal shoots with intact apical buds taken from high yielding mother trees and of similar thickness to that of the rootstock were selected as scions and were grafted on to two rootstocks namely *Syzigium aromaticum* (clove) and *S. jambolana* (jamun)

Success in epicotyl grafting was obtained with 4 week old rootstocks of *S. jambolana* and *S. aromaticum* during a preliminary trial. Survival percentage was very low and only two grafts on each of the rootstock survived.

c. Cleft grafting

Cleft grafting on *S. jambolana* and *S. aromaticum* was carried out at 4 week intervals on 2 year old rootstocks and at 12 week intervals on 3 year old rootstocks.

A 60% success was obtained when cleft grafting was done on 2 year old seedlings. The rate of success is variable and probably low because of poor cambial contact or that the detached scion lost its potential to produce parenchyma cells for further differentiation.

d. Approach grafting

Healthy uniform sized trees were selected as mother plants which formed the source of scion. Two year old seedlings of *S. jambolana* and *S. aromaticum* of uniform vigour were selected as rootstock. Slice approach grafting was adopted. A slice of bark and wood was cut from both the stems and the cut surface secured together for close cambial contact by wax tape. After the union, the stock above the union and the scion below the union were cut and the grafts detached and maintained in the nursery for a period of 12 weeks, and planted in the field after one year.

Clove on a rootstock of the own species (*S. aromaticum*) was more compatible than clove on other rootstock species. Monthly variations is shown in Table 14. The best results were obtained in December (80%) and August (70%), respectively. March and May had the lowest successes, possibly because high temperatures and low humidity prevail at that time.The grafting of *S. jambolana* and *S. aromaticum* is not possible because of stock - scion incompatibility, the cause of which needs further investigation.

e. Field evaluation of approach grafts of clove

One year old grafts of 8 accessions of clove were planted in a Randomized Block Design with 6 replications at a spacing of 9 m x 9 m for field evaluation in an existing coconut plantation at the Experimental Farm, Peruvannamuzhi. Nine seedlings were used as control. Growth observations of height, number of primary and secondary branches, canopy and girth above the graft union were recorded at regular intervals

Growth observations indicated that the growth of the grafts were much slower than that of seedlings and that a short statured plant could be obtained through grafting. Flowering was initiated in few of the grafts in the 4th year of planting.

Table 14: Survival of approach grafts of clove on rootstocks of *S. aromaticum* and *S. jambolana.**

1989-90	Rootstock of *S. aromaticum* (% graft survival)	1990-91	Rootstock of *S. aromaticum* (% graft survival)
May	36.3l		
June	43.3f	June-Aug.	41.4b
July	53.3c		
August	70.5b		
September	50.0d	Sept.-Nov.	87.5 a
October	39.9g		
November	46.6e		
December	80.4a	Dec.-Feb.	53.2b
January	43.3f		
February	22.5k		
March	36 6l	March-May	22.4
April	23.2j		

*Per cent survival of grafts on *S. jambolana* rootstock was zero for 1989-90 and 1990-91.

D. ALLSPICE

a. Cuttings

i). Quicroot: Fifty three per cent rooting was observed in the juvenile shoots of all spice,treated with Quicroot, a commercial hormone. Rooting was initiated after 6-7 months of planting.

ii). IBA + NAA. Terminal cuttings of allspice (about 12 cm in length) with two leaves were used for the study. There were six treatments namely, IBA 1000 ppm, IBA 2500 ppm, NAA 1000 ppm, NAA 2500 ppm, IBA 2500 + NAA 2500 ppm and control. All the hormonal formulations were prepared in powder formulations in activated charcoal. Cuttings were given a quick dip in the hormonal treatments and planted in a soil mixture of sand and coir dust in the ratio 1:1. Individual bags were covered with polythene bags to maintain humidity.

Variations in rooting was observed during different months with different hormones. In general, December and February were found to be favourable for rooting of allspice. A maximum of 63.3% rooting was observed during February with IBA 2500 + NAA 2500 ppm. The primary root production was highest in IBA 1000 ppm. In general the length and production of primary, secondary and tertiary roots were more in IBA treatments.

b. Air layering

Healthy, uniformly sized allspice trees were selected and the shoots were air layered about 15 and 45 cm below the shoot apex. A 2 cm wide ring of bark was removed and IBA at 1000 ppm, Seradix, IBA 4000 ppm + NAA 4000 ppm in charcoal were applied to the portion where the bark was removed. Air layering without the application of any hormone formed the control. All the layers were wrapped in moist coir dust and were further wrapped in polythene film to prevent moisture loss. Layering was done at 2 months intervals for one year.

Rooting was observed in all the months in all the treatments. However, variations in rooting was observed with different hormones. Higher rooting was observed when layered at 15 cm below the shoot apex than at 45 cm. IBA 4000 ppm + NAA 4000 ppm in charcoal was found to be the best treatment with 73% success during December.

c. Stooling

Twelve year old allspice trees were detopped at a height of 2 foot from the ground level just before the start of monsoon. A ring of bark was removed from the base of the newly emerged shoots and IBA 500 ppm was applied. This was repeated on all the newly emerged shoots. The shoots were mounted with pure sand, so as to cover the hormone applied region with the sand and the mount was watered daily.

Adventitious root production was observed in 75% of the shoots when the mount was removed after 8 months. The rooted shoots were separated and transferred to polybags and kept in the nursery. Though rooting per cent is better than other methods of propagation this method is more cumbersome when compared to other methods.

E. NUTMEG

a. Storage of nutmeg scions

Healthy uniform sized scions were detached from the tree and were treated with fungicide (copperoxychloride (0.5%). The treated scions were stored in polythene bag, moist soil, moist coir dust, sugar solution (1%), moist newspaper and moist jute bag. The lower end of the scions (3-4 cm) alone were immersed in the moist storage medium in the case of soil, coir dust and sugar solution and they were sealed in polythene bag to prevent moisture loss. The scions wrapped in moist newspaper were also sealed in polybags. Scions that were left exposed after the fungicidal treatment formed the control. Grafting was carried out on three month old rootstock with fresh scions (scions collected just before grafting) on all the days of grafting. The top portion of the rootstock was cut and a vertical downward slit was made in the center of the stock. A wedge shaped cut was made at the base of the scion and was grafted on to the rootstock using a polythene ribbon of 2 cm width. Grafting was undertaken on the 3rd, 7th, 10th and 12th day of storage and data on drying of scion at the time of grafting and percentage success in grafting were recorded.

All the packing materials evaluated for success in grafting except moist jute bag were superior to control (exposed scions) on all the days (Table 15) Transporting scion

Table 15: Effect of storage of scions on grafting of nutmeg.

Treatment	Sucess rate at different storage Intervals (days)			
	3	7	10	12
Fresh scion	98.2 (83)	100 (89.7)	96.3 (77.0)	93.8 (75.3)
Polythene bag	96.3 (77.0)	82.8 (65.5)	63 7 (52.5)	52.3 (46.3)
Coir dust	90.2 (71.7)	67.4 (55.5)	62.2 (52.0)	42.8 (40 8)
Soil	46.6 (43.6)	42.6 (40.7)	42.5 (40.7)	33.5 (35.4)
Sugar solution 1%	81.3 (64.4)	47.3 (43.4)	32.0 (34.4)	26.5 (30.9)
Moist news paper	67.8 (55.4)	41 7 (40.2)	28.5 (32.2)	18.6 (25.5)
Moist jute bag	36.8 (37.3)	9.8 (18.2)	6.6 (14.9)	0.00 (0.29)
Exposed	18.8 (25.7)	0.0 (0.29)	0.0 (0.29)	0.00 (0.29)
CD at 5%	22.5	22.8	24.9	16.1

Values in parentheses are transformed values.

materials stored in coir dust, poly bags and sugar solution was found to be on par with the adopted practice of using fresh scion for grafting up to the 3rd day. The scions could be trasnported in sealed polybags and used for grafting with 63.7% success even on the 10th day of storage. However, in general there was a decline in the success in grafting as the number of days of storage increased. Visual drying was not observed in any of the treatments up to the 7th day.

b. Inducing orthotropic shoots

i). Hormonal amendments : In order to convert the plagiotropic grafts to orthotropic grafts various physiological manipulations and hormonal applications were carried out. There were 18 treatments and 4 replications in each treatment. The major treatments included pruning and smearing with growth hormones and spraying growth hormones like BAP (10 & 20 ppm), GA (10, 20 & 100 ppm), IAA (10,20 & 50 ppm) and different combinations of these hormones.

None of the treatments helped in the production of orthotropic shoots from a plagiotropic graft. Instead a large number of plagiotropic shoots were produced. Production of such shoots too have a lot of implications and use in propagation practices. However, natural production of orthotropic shoots were observed in field planted grafts after 6-7 years of planting.

ii). Detopping of old tree: Nutmeg trees of 8-9 year old and with uniform girth were detopped at 1m, 1.5 m and 2 m height from the ground level during the last week of May and the cut end of the trunk was smeared with Bordeaux paste to prevent any fungal attack or damage. All the experimental trees were irrigated daily till the monsoon started. The new sprouts were allowed to grow and the number of orthotropic shoots produced in each treatments were recorded. The orthotropic shoots produced were further pruned to see their performance in orthotropic shoot production.

The detopped trees produced new sprouts in a period of 45-60 days. The orthotropic shoots were counted after it had attained sufficient growth to be distinguished from a plagiotropic shoot. It was observed that detopping trees at 2 m above the ground level produced on an average 38 shoots which could be used for epicotyl grafting. These shoots on further pruning produced 1 - 3 orthotropic shoots from each shoot. All the shoots could be used for grafting. The method could be made use of for the continuous supply of orthotropic shoots for epicotyl grafting of nutmeg.

c. In situ epicotyl grafting in nutmeg

Epicotyl grafting adopted for commercial multiplication of nutmeg though highly successful, is labour intensive. Hence the present study was undertaken to see whether *in situ* grafting can be carried out in the nursery and the successful grafts alone transplanted to polythene bags.

Four treatments with five replications were adopted with 20 grafts in each replication. The following treatments were adopted

T_1 Rootstocks maintained in the nursery beds were grafted and each graft was covered with separate poly bags to maintain humidity.

T_2 Rootstocks maintained in the nursery beds were grafted and each replication were enclosed in a mini mist chamber.

T_3 Each rootstock was bagged separatly, grafted and each replication was enclosed in a mini mist chamber

T_4 Each rootstock were bagged separately, grafted and each graft was enclosed in separate poly bags for maintaining humidity.

The grafting was done in February and observations were taken after 45 days.

Among the various methods studied, the percentage of success was more in treatment T_4, where individual rootstocks were separated out from the bed, grafted and the grafts were covered with separate polythene bags for maintaining humidity. The next best treatment was T_3 where all the individual grafts were enclosed in a mini humid chamber.

d. Production of epicotyl grafts in nutmeg with different types of scions

A study was undertaken to understand whether the nature of scions (orthotopic or plagiotropic) used for grafting influence the shape of the canopy of the graft and their spread.

The experiment consisted of 4 types of shoots namely scions from orthotropic shoots, scions from primary plagiotropic shoots, scions from secondary plagiotropic shoots and scions from tertiary plagiotropic shoots. Epicotyl grafting was carried out following the normal procedure and the success percentage was recorded after 45 days.

There was no significant difference between the methods of grafting and the success percentage. The successful grafts produced with different scions were field planted for studying their further performance with regard to their canopy shape and spread

e. Top working of nutmeg male trees

Male trees of nutmeg were detopped at 1 foot from the ground level during May, just before the monsoon. Cut end was smeared with Bordeaux paste to prevent any fungal infection and decay. The new shoots developed from the trunk were wedge grafted with orthotropic scions (of same thickness) collected from high yielding female trees and were covered with polythene bags to prevent drying of scions. A temporary shelter was provided above the tree after grafting to prevent the harmful effect of rain and sun

New sprouts developed from the main trunk in a period of 45 - 60 days. Grafting was done with scions from high yielding female trees on newly emerged shoots after they attained about 15 - 20 cm length. A success of 75% was obtained with the first grafting and the rest 25% success was obtained on regrafting. The top worked trees started flowering from the third to fourth year of grafting. This method can be successfully used for the conversion of male trees to female trees and also for conversion of unproductive female trees.

TECHNOLOGIES EVOLVED FROM THE PROJECT

1. Vegetative propagation of clove through approach grafts
2. Vegetative propagation of cinnamon through cuttings and air layering
3. Vegetative propagation of cassia through cuttings and air layering
4. Top working of nutmeg
5. Vegetative propagation of allspice through cuttings and air layering
6. Storage of nutmeg scions

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CROP PRODUCTION AND POST HARVEST TECHNOLOGY

AGR VI (813)

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

(K.Kandiannan, A.K. Sadanandan and K.S. Krishnamurthy)

Agro- physiological studies of black pepper varieties

Black pepper varieties planted on *Ailanthus* standard are being compared for their growth and yield performances. The growth parameters such as canopy height and radius at 2 meter height are recorded during fourth year of planting. The result (Table 16) indicated that canopy height was maximum (504 cm) in P- 24. This was on par with Panniyur -1 (492 cm) and Subhakara (489 cm). In the case of canopy radius P-24 recorded highest (117 cm) followed by Panniyur-2 (110.9 cm) and Panniyur -1 (105.3 cm).

Table 16: Canopy growth of black pepper varieties during fourth year of planting.

Variety	Canopy Height (cm)	Canopy Radius (cm) at 2 m height
Subhakara	489	78.8
Sreekara	395	77.7
Panchami	315	91.4
Pournami	328	93.3
P - 24	504	117.0
Panniyur-1	492	105.3
Panniyur-2	441	110.9
Panniyur-3	313	95.0
Panniyur-4	317	86.7
Panniyur-5	370	92.7
LSD 0.05	41.8	9.97

AGR. XIV (813)

INVESTIGATIONS ON SPICES BASED CROPPING SYSTEMS

(V.S. Korikanthimath, Rajendra Hegde, K.Kandiannan, M.N. Venugopal and A.K.Sadanandan)

During the year 1997, the growth and yield characters of cardamom and component crops like tree spices (clove, nutmeg, cinnamon and allspices), black pepper and coffee were recorded in the experiment.

AGR. XVII (813)

VERMICOMPOST PRODUCTION USING ORGANIC WASTES AVAILABLE IN CARDAMOM AREAS

(Rajendra Hegde, V.S.Korikanthimath and S.J. Anke Gowda)

A group meeting was held at Indian Institute of Spices Research, Cardamom Research Centre, Appangala on 18 June 97 to deliberate on various aspects of vermicompost research.

Following areas of research were identified.

1. Fortification of coffee wastes with other organic wastes.
2. Long term effects of application of vermicompost v/s ordinary compost on the physical, chemical and biological properties of the soil.
3. Effect of vermicompost v/s ordinary compost on the growth and yield of various spice crops.
4. Studies to find out the optimum combination of vermicompost and other nutrient sources.
5. Studies on the performance of species mixture of earthworms.
6. Establishing a vermiculture research network to exchange the ideas and research results.

AGR. XIX (813)

MANAGEMENT EFFICACY OF WHOLE FARM APPROACH IN FARMING - A STUDY ON CARDAMOM BASED FARMING SYSTEMS

(Rajendra Hegde, S.J. Anke Gowda and V.S. Korikanthimath)

During the year, in an acre area robusta and arabica coffee mixed system has been planted. In the interspaces, green manuring for biomass generation is being taken up. *Ex-situ* biomass generation and nutrient recycling is in progress (using Co-1 grass). Planting materials of vanilla, its standards, *Gliricidia*, black pepper, clove, nutmeg grafts, allspice and *Garcinia gummigutta* grafts have been raised to be included in the study. In banana + arecanut system, banana has started yielding. Microclimatic parameters as well as soil characters in the system are under study.

AGR XVIII (813)

BIOFERTILIZER APPLICATION ON GROWTH, YIELD AND QUALITY OF BLACK PEPPER

(K. Kandiannan, M. Anandaraj and K.S. Krishnamurthy)

Biofertilizers viz. *Azospirillum*, Phosphobacteria and Vesicular Arbuscular Mycorrhizae (VAM) alone, their combinations and uninoculated control were tested on black pepper growth under nursery condition. The biomass recorded at 18 months after planting indicated that inoculation of biofertilisers enhanced the biomass production. The combined application of all the three bilfertilizers recorded maximum biomass (146.45 g per plant) followed by phosphobacteria and VAM combined inoculation (132.7 g) compared to control (57.13 g/plant) (Table 17).

Table 17: Biofertilizers effect on biomass production of black pepper.

Treatment	Biomass production (g)
Azospirillum (Azo)	61.3
Phosphobacteria (Phospho)	72.8
VAM	74.2
Azo + Phosphor	89.3
Azo + VAM	91.8
Phosphor + VAM	132.7
Azo + Phospho + VAM	146.5
Control	57.1
Lsd 0.05	22.00

AGR. XX (813)

PRODUCTION OF NUCLEUS PLANTING MATERIALS OF IMPROVED VARIETIES OF SPICE CROPS

(K. Kandiannan, V.S. Korikanthimath, P.A. Mathew and P. Rajeev)

Improved varieties of black pepper, turmeric, ginger, cardamom, nutmeg, cinnamon and elite lines of clove and vanilla are produced and distributed to various developmental agencies and progressive farmers in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa, Andaman and Nicobar Islands and North Eastern States (Table 18).

Table 18: Planting materials produced during 1997.

Black pepper rooted cuttings	80,000
Black pepper rooted laterals	400
Turmeric seed rhizomes	20 tonnes
Ginger seed rhizomes	5 tonnes
Cinnamon seedlings	2,000
Clove seedlings	1,500
Nutmeg grafts	2,000
Vanilla cuttings	750
Cardamom seedlings	10,000
Cardamom seed capsules	29 Kg
Cardamom suckers	550

SSC.II (813)

NUTRITIONAL REQUIREMENT OF IMPROVED VARIETIES OF SPICES

(A.K. Sadanandan, K.S. Krishnamurthy and K. Kandiannan)

A. Inorganic nutrition of spices

Response of black pepper varieties viz Sreekara and Subhakara to the application of NPK and micro nutrients were studied for the fourth year. Soil and plant samples were collected to assess the soil nutrient availability and plant uptake. The soil analysis showed that the availability of P has significantly increased with the increased dosage and the availability of N & K were on par among the doses applied. But, a significant increase in the soil availability of micro nutrients viz Zn, B and Mo wherever it has been applied was also noticed (Table 19).

Table 19: Effect of fertilizer application on the soil availability of nutrients and yield in black pepper.

Treatment	Org.C (%)	Bray P	Ex K	Zn	B	Mo	Yield (kg/ ha)	
							V_1	V_2
T_1 Check	1.25	45.8	42.8	1.06	0.14	0.10	468	543
T_2 $N_1P_1K_1$	1.66	57.8	84.8	1.23	0.19	0.11	820	830
T_3 $N_2P_2K_2$	1.66	101.8	91.8	1.12	0.19	0.11	868	860
T_4 $N_3P_3K_3$	1.93	113.2	118.2	1.16	0.20	0.10	1018	1008
T_5 T_2 + Micro nutrients	1.80	65.3	92.0	1.42	0.52	0.21	1150	1220
T_6 T_4 + ,, ,,	2.05	117.5	99.5	2.90	0.58	0.21	1050	1003
CD (5%)	0.45	38.9	54.1	0.32	0.04	0.01	NS	NS

B. Studies on the effect of organic farming in black pepper

To evaluate the efficiency of organics as nutrient sources to increase the yield and quality of black pepper, a field experiment was laid out with cv. Subhakara. The survival was of 85%. The treatments include FYM, vermi and leaf composts, neem cake, chemical fertilizers and control. In a preliminary pot trial application of vermicompost yielded on par with the chemical fertilizers.

C. Different sources of rock phosphate on soil P availability and yield of ginger and turmeric

Three sources of rock phosphates viz Mussoorie Phos (MRP), Raj Phos (RP) and Gufsa Phos (GP) individually and in combination with FYM and Super Phosphate (SP) were tried to evaluate their agronomic efficiencies in ginger and turmeric. Soil samples were collected to estimate the P availability and the growth parameters were also recorded. The soil P availability was highest in 2/3 RP + 1/3 P as SP application which was on par with other sources of rock phosphates, but significantly higher than the control. In case of soil availability of N, K, Ca and Mg contents, application of different rock phosphate sources with FYM and application of NPK fertilizers alone a significantly increased availability as compared to other combinations and control (Table 20) No similar trend was observed in the Zn availability of the soil

Table 20: Effect of different sources and combination of rock phosphate on the soil nutrient availability and yield in turmeric.

Treatment	Avail. N	P	Ca	Mg	Zn	Yield (t/ha)
T1 Check	104	6.2	335	110	0.57	20.2
T2 NPK	126	8.4	424	134	0.62	29.8
T3 2/3 MRP + 1/3 SS	127	7.4	367	104	0.68	31.0
T4 2/3 RP +1/3 SS	124	9.2	317	104	0 59	27.0
T5 2/3 GP + 1/3 SS	126	9 1	345	103	0.59	25.2
T_6 FYM + 1/2 P as MRP	126	8.8	374	123	0.70	30.0
T_7 FYM + 1/2 P as MRP	150	8.9	381	125	0.58	32.2
T_8 FYM + 1/2 P as MRP	136	8.6	376	128	0.68	31.8
T_9 FYM + 1/2 P as MRP	136	9.1	381	120	0.54	30.6
CD (5%)	5.2	0.42	41.3	13.6	0.081	2.0

* Phosphorus use efficiency increased by the application of 1/2 P as rock phosphate (as Raj Phos) along with FYM and has given an higher rhizome yield of 32 2 t/ha

D. Micro nutrient experiment in ginger and turmeric

Effect of micro nutrients Zn, B and Mo applied individually and in combination on ginger and turmeric was studied in a field experiment for the second year. Soil samples were taken and analyzed for their nutrient availability. The availability of DTPA extractable Zn was higher in ginger than turmeric and it was significantly higher in treatments where Zn was applied @ 5 kg/ha^{-1} in both the crops studied. The soil availability of B and Mo were on par among the treatments where B and Mo were applied and were significantly higher than control.

PHY. V (813)

CHARACTERIZATION OF DROUGHT TOLERANCE IN BLACK PEPPER

(K.S. Krishnamurthy and S.J. Anke gowda)

Preliminary screening of twenty five germplasm accessions of black pepper was carried out based on relative water content, cell membrane stability, stomatal resistance and transpiration rate. Cell membrane damage increased with stress intensity in all accessions.. However, Acc.1372 and 1368 showed very less increase in leakage percentage with stress intensity. On the other hand, Acc.1402, 1411, 1421 and 1409 showed very high leakage percentages (> 30%) with stress intensity.

Table 21: Relative water content (percentage) of black pepper germplasm accessions as affected by water stress.

Acc.	Control	Water stress		
		4 days	8 days	12 days
1366	95.7	94.1	93.4	86.5
1375	95.6	90.8	84.3	79 6
1402	96.1	93.8	52.5	43.5
1370	91.5	90.2	86.1	80.4
1371	95.1	94.6	62.3	58.4
1372	91.4	89.0	94.3	88.9
1387	94.0	93.4	50.6	45.3
1382	98.0	94.1	88.9	83.1
1376	94.4	90.6	77.0	70.4
1414	95.6	91.3	87.3	81.6
1399	90.3	93.4	91.4	83.4
1392	95.7	66.3	73.2	64.3
1381	94.4	93.0	55.0	53.1
1377	96.5	72.1	60.4	55.1
1395	93.3	90.1	46.4	44.8
1393	95.5	91.5	56.6	51.8
1411	96.3	93.9	51.7	46.3
1421	64.4	91.7	50.9	45.5
1466	96.5	75.0	81.0	76.5
1409	90.6	91.9	52.6	44.3
1368	97.3	90.7	87.6	83.1
1373	95.1	91.7	59.9	54.1
1394	94.8	86.5	65.8	63.3
1390	95.1		79.8	68.9
C D (5%)	1.41	3.41	3.45	3.78

Relative water content decreased with stress intensity in all accessions (Table 21). However, Acc. 1372, 1366, 1382, 1399 and 1368 maintained more than 83% relative water content even after 12 days of stress induction while Acc.1402, 1409, 1411 and 1421 showed relative water content of only around 45% after 12 days of stress induction.

Based on the observations on relative water content and cell membrane damage, Acc. 1368, 1372, 1382 and 1399 are relatively tolerant to drought.

PHY. VI (813)

CHARACTERIZATION OF DROUGHT TOLERANCE IN CARDAMOM

(S.J. Ankegowda and K.S. Krishnamurthy)

Three ecological types namely Malabar (CCS-1), Mysore (ICRI -2) and Vazhukka (MCC-21) were grown in cement pots for 1½ year with twelve treatments and three replications. Moisture stress has been imposed. Eight genotypes were collected from drought prone areas. The genotypes are under rapid clonal multiplication.

A. Preliminary screening of germplasm

Thirty six genotypes were assessed for relative water content and specific leaf weight (SLW). Genotypes showed significant variation for both the parameters. Relative water content (per cent reduction over control) ranged from 13.15 - 47.85 with a mean of 26.49 per cent. APG 76 showed least reduction whereas APG 37 showed maximum reduction under stress. Specific leaf weight (mg cm^{-2}) ranged from 3.33-4.95 with a mean of 4.23. APG 81 showed less SLW and APG 41 showed maximum SLW.

PHT.I (813)

QUALITY EVALUATION IN SPICES

(T. John Zachariah and B. Chempakam)

A.Black pepper

Biological constituents at different developmental stages of black pepper : Five varieties of black pepper viz. P-24, Subhakara, Panniyur-1, Panniyur-2 and Panniyur-4 were *evaluated for essential oil, oleoresin, piperine and volatile oil constituents* at different maturity stages of berry. Starch, phenyl alanine ammonia lyase and amylase activities were also monitored at different stages of the berry development. In general, it was found that the secondary metabolites were more during the initial stages ie., between 150-190 days and later on it decreased. Starch, was found maximum during full maturity Gas *chromatographic evaluation* of black pepper oil constituents indicate that monoterpenes and sesquiterpenes were gradually increasing up to 210 days and then showed decline. Details of the oil constituents of Cv., Panniyur-4 and Subhakara are given in Fig.3&4.

B.Ginger

i) Quality evaluation of bold rhizomes of ginger : Fifteen bold rhizome accessions were evaluated for essential oil, oleoresin and crude fibre. Accession 64 had 2.7% oil followed by 15 with 2.5% oil. In general the accessions has relatively low fibre except Acc. 35 and 244 (>4.5%).

ii) Salted ginger : Fifteen bold rhizome ginger accessions were harvested at four to five month stage of maturity and soaked in brine containing citric acid for fourteen days. *Rhizomes were removed from brine, washed and preserved. Fifteen accessions were* evaluated based on colour, appearance, texture and taste and found that accession 35, 179, 64, 71, 117, 116 and 294 are ideal for preparing salted ginger.

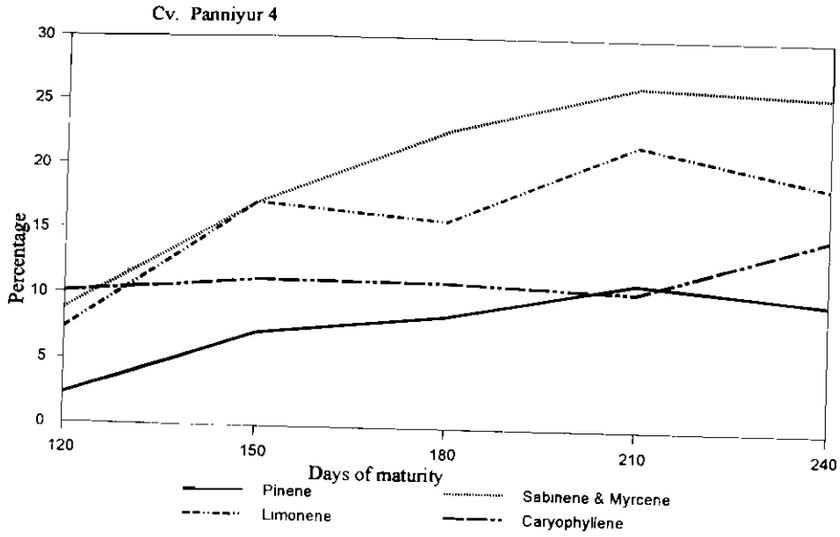

Fig. 3. Constituents of black pepper oil during berry development

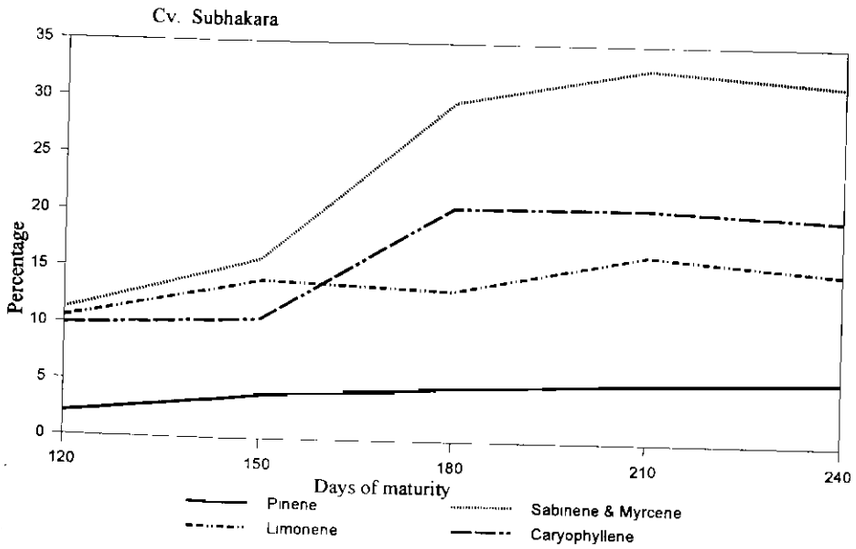

Fig. 4. Constituents of black pepper oil during berry development

iii) Quality evaluation of ginger germplasm accessions :Fifty germplasm accessions were evaluated for oil, oleoresin, crude fibre and the pungent principles in oleoresin, 6-gingerol and 8-gingerol. Acc.197 had 2.4% oil and 7.5% oleoresin. Acc.141 and 22 had high 6-gingerol the main pungent principle present in oleoresin (Table 22).

Table 22: Quality evaluation of selected ginger germplasm accessions.

Acc.	Ess.oil	Oleoresin	C.fibre	6-gingerol	8-gingerol
2	1.4	4.7	2.0	14.3	2.0
22	1.7	6.0	3.3	21.5	2.1
26	1.8	6.8	3.8	11.3	4.5
50	2.0	5.7	2.5	12.7	2.3
57	2.2	6.6	2.0	12.8	2.1
60	1.6	6.0	4.0	14.2	13.3
86	2.0	4.9	4.4	14.0	3.0
130	1.5	6.1	2.5	10.9	5.0
135	1.8	5.8	2.7	10.6	2.9
141	2.1	5.7	3.3	17.6	3.1
197	2.4	7.5	2.5	10.1	4.1
217	2.2	4.8	2.8	3.0	1.5

iv) Changes during rhizome development in ginger: Sixteen ginger accessions were harvested at 150, 170, 190 and 240 days after planting and analyzed for oil and oleoresin. It was observed that accumulation of secondary metabolites were maximum during 170 to 190 days after planting. However, varietal variation was noticed. For instance Acc .35 gave maximum oleoresin at 150 days while Acc.15 gave higher oleoresin at 170 days of maturity.

C. Turmeric

Turmeric accessions from Andhra Pradesh and Alleppey finger turmeric collections were evaluated for curcumin content. Accessions with more than 6% curcumin are listed below (Fig.5 & 6).

D. Cinnamon and Cassia

Thirtyone cassia lines were screened for leaf oil, bark oil and bark oleoresin.

Accessions with high leaf oil are A-3, C-4, C-5, C-7, D-7, A-6 and D-5 (1.5%) and accessions with high bark oil are D-3, B-1, D-8, B-2, B-6, C-4, D-1 and B-5(>4%). A-7, D-4, D-6, D-2 (>9%) are accessions with high bark oleoresin.

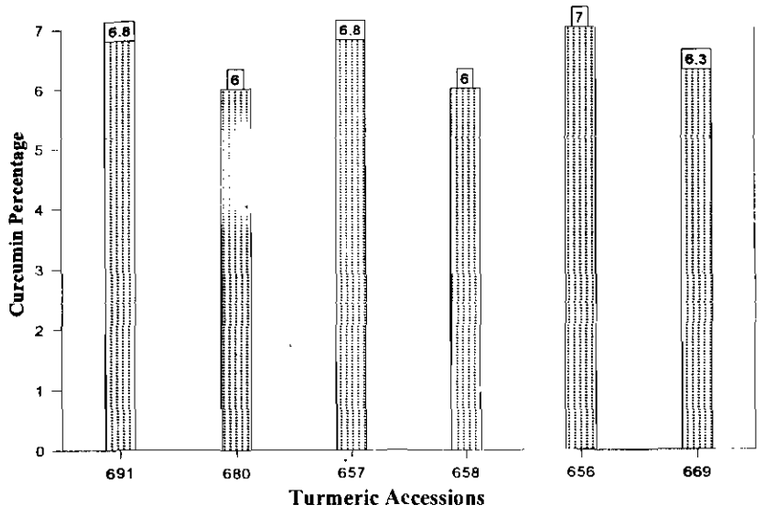

Fig. 5. High curcumin AP turmeric collections

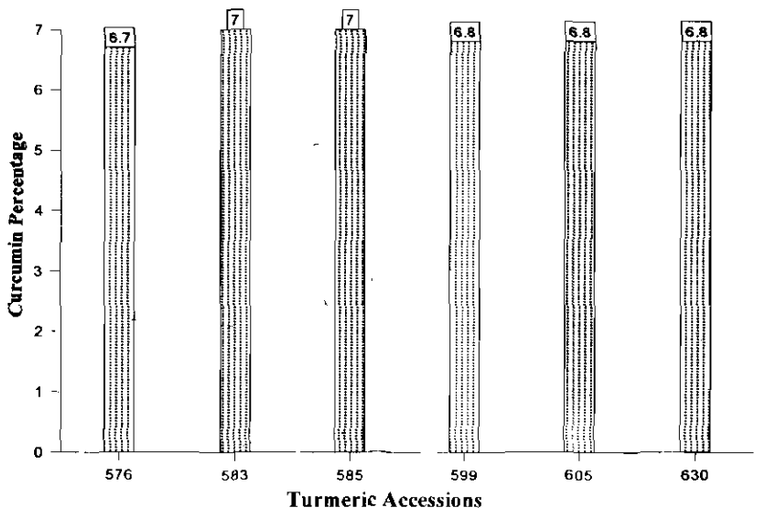

Fig. 6. High curcumin Alleppey collections

E. Paprika

Colour value in chillies . *39 chilli samples were screened for ASTA colour value.* Colour value ranged from 5 ASTA units to 154 ASTA units. Kt PI-19 had the highest colour value

BIOCHEM. I (813)

BIOGENESIS OF PIGMENTS IN SPICE CROPS

(B.Chempakam and T.John Zachariah)

Curcumin levels were determined in leaf, root and rhizome from five varieties of *turmeric viz . Alleppy, Prabha, Prathibha, Suguna and* Sudarsana. Highest curcumin levels were shown at 150 DAP (Days After Planting) , in mother, primary and secondary rhizomes. Uniform distribution of the pigment was seen in finger rhizomes after 150 DAP *upto maturity. However, the mother rhizomes had lower content than the fingers* (Fig 7). Activity of PAL (Phenylalanine Ammonia Lyase) in the rhizomes was maximum

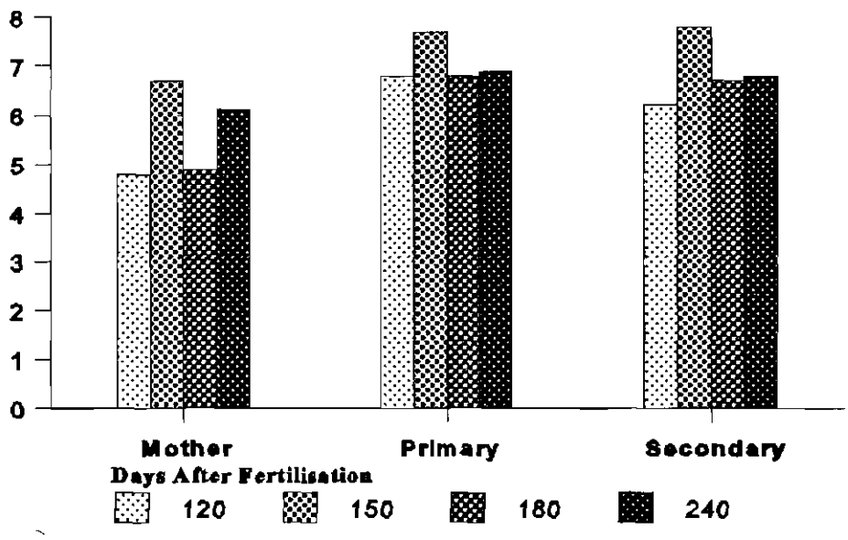

Fig. 7. Curcumin levels during rhizome development

at 150 DAP, which coincided with the curcumin levels. Other secondary metabolites viz. Oleoresin and Essential Oil exhibited a pattern as in the previous year showing an increase upto 180 DAP (about 2- fold) and decreased gradually during rhizome development.

AD-HOC PROJECTS

1. EFFECT OF ORGANIC FERTILIZERS ON SOIL QUALITY, PRODUCTIVITY AND QUALITY OF BLACK PEPPER AND CARDAMOM

(A.K. Sadanandan)

Preliminary study in a pot culture experiment on bush black pepper with different organic sources showed, that introduction of worms *in situ* in the pots supplemented with *Glyricidia* leaves has increased the nutrient availability in the soil by almost two fold as compared to vermicompost application.

2. INVESTIGATIONS ON CARDAMOM BASED CROPPING SYSTEMS

(V.S. Korikanthimath, Rajendra Hegde, G.M. Hiremath and A. Gayathri)

Survey on the cardamom based cropping systems was undertaken in Kodagu, Uttar Kannada, Hassan, Chickamagalur and Shimoga districts of Karnataka to study the ecological feasibility and economic viability of crop combinations viz.

1. Cardamom + Robusta coffee + Black pepper
2. Cardamom + Arabica coffee + Black pepper
3. Cardamom + Arecanut
4. Cardamom + Coconut.
5. Cardamom + Tree spices + Black pepper

Agroforestry approaches in cultivation of cardamom and black pepper by afforestation of vacant/open slopy marginal areas was also attempted in 3 locations in Kodagu district of Karnataka. The crop combination of coconut and vanilla is being studied in a large scale on farm trial (9.72 ha) near Kadur in maiden areas of Chickmagalur district in Karnataka.

3. BIOCHEMICAL CHARACTERIZATION OF GINGER AND TURMERIC

(T. John Zachariah, B. Sasikumar and A. Shamina)

Seventy seven turmeric and 14 ginger accessions were characterised using PAGE of isozymes viz. acid phosphatase, catalase, super oxide dismutase, polyphenol oxidase and peroxidase.The accessions were originally collected from Kerala, Andhra Pradesh, Orissa and North Eastern States. Variability was high in turmeric (39-100%) compared to ginger (88-100%). Ten distinct groups in turmeric and two in ginger were found using dendrogram. Accessions collected from neighboring areas clustered. A distinct turmeric accession different from all others was also found.

STUDIES ON EVALUATION OF TERRA CARE FOR GROWTH, NUTRIENT AVAILABILITY, YIELD RESPONSE AND QUALITY OF SPICES CONTRACT RESEARCH PROJECT

(A.K. Sadanandan)

Pot culture and field experiments were laid out to study the efficiency of *Terra Care*, a commercial product of Marson Biocare Pvt. Ltd. in combination with other sources of nutrients like organic, chemical and biofertilizers in black pepper, ginger and turmeric

Protected cultivation of bush pepper

Application of *Terra Care* (TC) along with FYM, neem cake (NC), chemical (CF) and biofertilizer (BF) combinations significantly increased the soil availability of nutrients N, P, Ca, Mg and micro nutrients like Fe, Zn and Cu as compared to the application of chemical fertilizers alone and control, in both ginger and turmeric, whereas the available K content was significantly high in Terra Care + FYM combination. The application of *Terra Care* with FYM and biofertilizers recorded highest number of tillers and plant height followed by *Terra Care* + FYM application under both field and pot culture conditions in ginger. In turmeric, even though all the treatments were on par, the highest height was recorded in FYM treatment and maximum tillers were observed in *Terra Care* applied with FYM and biofertilizers.

CROP PROTECTION

PATH.II.3 (813)

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

(Y.R.Sarma, M.Anandaraj, K.V.Ramana, A.Kumar, S.S.Veena and K.Kandiannan)

The field trial in IDM plot at IISR Farm, Peruvannamuzhi was continued with regular pre-monsoon and post-monsoon treatments with neem cake and potassium phosphonate. The varieties showed differential response to these treatments and the death of the vines ranged from 0-22.5% (Table.23). P24 was totally free from the disease whereas, Panchami and Panniyur-3 showed 22.5% vine death.

The experiments on the varietal mixture in relation to disease spread is in progress In a large scale field demonstration trial at Pulpally, the percentage of survival was 94.46% in treated plots compared to 53% in untreated plots and thus confirming the efficacy of disease management. A new field trial of IDM in areca based black pepper cropping system with 9 *Phytophthora* tolerant lines along with susceptible KS-27 (Subhakara) was started.

An observational trial was taken up to test the phytotoxicity, if any, of the oil based copper fungicides. No phytotoxic symptoms were noticed in sprayed plots even after three months of spraying.

Table 23: Integrated disease management of root rot of black pepper.

Sl No	Variety	No. of plants showing yellowing	No of plants replanted	No of plants died	Disease incidence (death) (%)	Death+ Foliar Yellowing (%)	Healthy (%)
1	Subhakara	1 (2.5%)	4	1	12.5	15	85
2	Panniyur-1	6 (15.0%)	4	1	12.5	27.5	72.5
3	Panniyur-4	9 (22.5%)	3	1	10	32.5	67.5
4	P-24	0	0	0	0	0	100
5	Panniyur-2	15(37.5%)	5	1	15	52.5	47.5
6	Pournami	27(42.5%)	5	0	12.5	55	45
7	Panniyur-3	26(65.0%)	5	4	22.5	87.5	12.5
8	Panchami	21(52.5%)	7	2	22.5	75	25
9	Panniyur-5	21(52.5%)	6	1	17.5	70	30
10	Sreekara	16(40.0%)	8	2	25.0	65	35

Plots were treated with *Potassium Phosphonate* twice and 1Kg neem cake.

PATH. X(813)

INVESTIGATIONS ON VEIN CLEARING VIRUS OF SMALL CARDAMOM

(M.N.Venugopal)

A. Standardisation of virus purification

Attempts were made to purify the Cardamom Vein Clearing Virus by using modification(s) of the procedure described for Blueberry Scotch Virus. The symptomic leaf sheath and leaf blade were pulverised in liquid nitrogen and homogenised in 0.1M sodium borate (pH 8.2) containing PVP (2%), EDTA (0.1%), 2-mercapto ethanol and 0.25/0.5M urea. Filtered sap was clarified with chloroform and n-butanol mixture (9:1 proportion) to the final concentration of 10% (v/v). After one round of low speed centrifugation, the aqueous phase was layered on 20% sucrose cushion. The final pellet was resuspended in resuspension buffer containing urea and subjected to one round of quick spin to remove insoluble materials. The samples were centrifuged at 110000g for 2 hours. The resuspended pellet was run on SDS- PAGE. Electrophoresis was performed on 5% stacking and 12% resolving gel. After staining, no additional band was observed in the purified preparation of infected material indicating further modifications of purificaiton procedure.

B. Screening of elite accessions

Fourteen elite clonal accessions of cardamom were screened in the sick plot. All the test accessions were found to be susceptible to natural infection of Kokke Kandu. Acc.893 which was less susceptible (50%) compared to other accessions including local check (75-100%).

PATH.XI (813)

STUDIES ON BACTERIAL WILT OF GINGER

(Y.R.Sarma and A.Kumar)

Wilted ginger plants collected from Wyanad and Madikeri were plated for the isolation of *Ralstonia solanacearum* on King 'B, sucrose, peptone agar and Tetrazolium chloride agar. Samples from Wyanad yielded several isolates of *Ralstonia solanacearum* and are being maintained in the laboratory both in nutrient agar slopes and in sterile water.

The biochemical tests for the biovar differentiation confirmed the prevalence of Biovar 3 in Wyanad area. However the isolates from Palghat tested positive for biovar 1. An isolate from *Kampheria galanga* was tested positive for Biovar 2. The biovars will be confirmed after performing the confirmatory tests.

Six isolates were tested for their sensitivity to antibiotics, Ampicillin, Chloramphenicol and Rifamphicin at 100ppm. This test revealed the variability among the isolates to tolerate the antibiotics *in vitro*. The oxidative and fermentative metabolism of six isolates were tested and which also showed variation among the isolates.

Few saprophytic bacteria were isolated from the rhizomes and stem of ginger and are being evaluated for bioefficacy against *Ralstonia solanacearum*.

PATH. XII (813)

INVESTIGATIONS ON STUNTED DISEASE OF BLACK PEPPER

(Y.R.Sarma, K.S.Rajendran and K.M.Abdulla Koya)

Five different population of *Toxoptera aurantii* were collected from Kalpetta (Wyanad), Thamarasseri, Calicut, Kasaragod and Pulpally from healthy plants. They were forced fed on CMV infected pepper plants. Transmission was not successful. However, the plants are under observation.

Scions of infected CMV pepper was established on *P.colubrinum*. After three months of grafting, the leaves of *P.colubrinum* showed interveinal chlorosis. Similar grafts on *P.arboreum* did not show such symptoms. The transmission needs to be confirmed with ELISA tests.

Purification of virus extracts were continued and partially purified virus gave positive reaction with CMV antiserum.

CROP PROT. 1.1(813)

SCREENING GERMPLASM FOR REACTION TO DISEASES

(Y.R.Sarma, M.Anandaraj, S.S.Veena, A.Kumar and K.V.Saji)

The field evaluation trials at Pulpally, Sirsi and Valparai were continued. In all the trials, P24 recorded minimum disease incidence demonstrating its field tolerance At Pulpally, the percentage of healthy plants ranged from 22.2 (P339) to 55.5% (P24, 1090 and 1047) (Fig.8).

At Sirsi, P24 recorded minimum disease incidence of 20.8% compared to 54.1% in KS-27 (Fig.9) At Valparai, P24 and C1090 were free from disease compared to KS-27.

Out of 13,000 seedlings screened (Panniyur-1, KS-27 and Aimpiriyan), 9 seedlings were saved which will be subjected for further screening.

Out of 185 hybrids screened, 11 showed resistant reaction which needs to be tested further.

CROP PROT.1.2(813)

SCREENING BLACK PEPPER GERMPLASM FOR REACTION TO INSECT PESTS

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

A. Screening of wild *Piper nigrum* germplasm

Ten accessions of wild *Piper nigrum* were subjected to screening for berry damage by pollu beetle (*Longitarsus nigripennus*). None of the accessions was found free of infestation. The incidence of pollu infested berries ranged between 5.8 to 25.9 per cent.

B. Screening of cultivated *Piper nigrum* germplasm

Forty accessions of *Piper nigrum* germplasm available at IISR Farm, Peruvannamuzhi were screened for berry damage by pollu beetle. All the accessions subjected to screening showed pollu beetle incidence in varying degrees. The percentage of pollu infected berries ranged between 18.3 to 51.9.

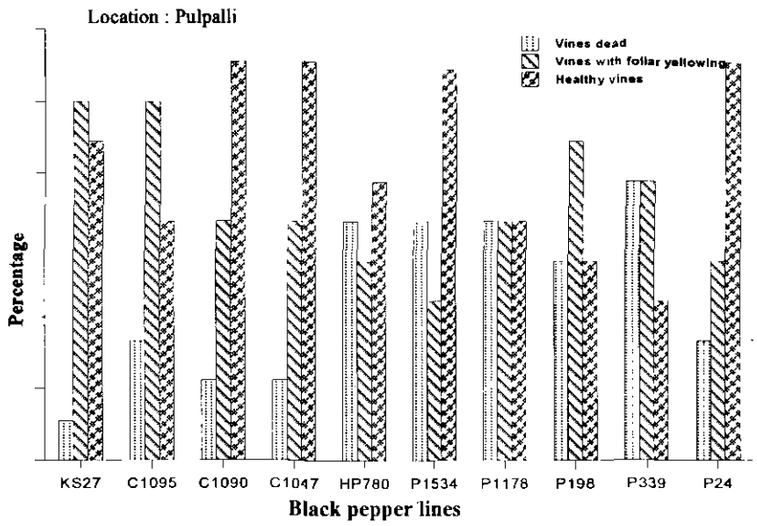

Fig. 8. Field evaluation of *Phytophthora* tolerant black pepper lines

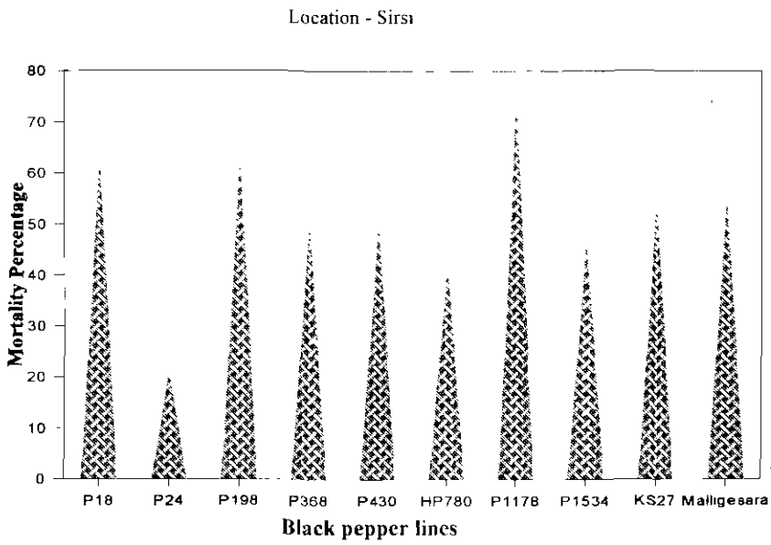

Fig. 9. Field evaluation of *Phytophthora* tolerant black pepper lines

C. Screening interspecific hybrids to pollu beetle

Two interspecific hybrids namely *P.nigrum*, *P.attenuatum* and *P nigrum* x *P.barberi* were subjected to screening for their reaction to leaf damage by pollu beetle. Both the hybrids showed significant reduction in leaf feeding by pollu beetle when compared to their female parents which are highly susceptible.

CROP PROT. 1.3(813)

SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO NEMATODES

(K.V.Ramana, Santhosh J.Eapen and K.V.Saji)

One hundred twenty one black pepper germplasm consisting of released varieties (9), cultivated types (25), intercultivar hybrids (25), wild *Piper* spp. (51), *Phytophthora* tolerant lines (11) were multiplied through rapid multiplication technique. Thirteen of these germplasm accessions were inoculated with root knot nematode, *M incognita* and are being maintained for recording their reaction to the nematode.

Black pepper varieties viz. Panniyur-1, 2, 3, 4 & 5, Sreekara, Subhakara, Panchami and Pournami are susceptible to the burrowing nematode *Radopholus similis*. *Phytophthora* tolerant line P 24 also showed susceptible reaction to the nematode.

Pure culture of *M.incognita* on black pepper and *R.similis* on carrot axenic culture are being multiplied and maintained.

CROP PROT. II (813)

MECHANISMS OF RESISTANCE TO PESTS AND PATHOGENS IN SPICE CROPS

(M. Anandaraj, B. Chempakam, M.N. Venugopal, S.Devasahayam, K.V. Ramana and Santhosh J. Eapen)

Biochemical changes occurring during pathogenesis of *Phytophthora capsici* on black pepper was studied in 5 lines viz. HP.1. A 456, P 198, P24 and KS 27. Among the five lines, KS 27 is the susceptible control where as all other are tolerant to *P.capsici* There was accumulation of OD phenols in tolerant lines compared to control. SDS- PAGE showed the presence of 14 bands with Em value ranging from 0.7 to 4.4. In A 456 additional slow moving band with Em 1.9 was seen on the inoculated leaves. In P 24 also an additional band with Em of 2.7 was noticed. Morphological characterisation of katte resistant cardamom lines did not show any variation and the breeding potential of the vector *Pentalonia nigronervosa f. caladii* did not show significant difference (Table 24).

NEMA. III (813)

INVESTIGATIONS ON NEMATODES ASSOCIATED WITH SPICES

(K.V.Ramana and Santhosh J.Eapen)

A. Screening of germplasm

Out of 45 ginger germplasm accessions screened against root knot nematode, *Meloidogyne incognita*, 19 accessions in the first round and 2 accessions in the second round of testing showed resistance/ tolerance to the nematode.

Table 24: Breeding potential of *Pentalonia nigronervosa f. caladii* on katte resistant plants.

Sl. No.	Clone	Rate of multiplication (days after introduction)	
		5	10
1	NKE - 3	3.92 ab	4.92 ab
2	NKE - 9	3.99 ab	5.77 a
3	NKE - 12	3.29 ab	4.88 a
4	NKE - 19	3.74 a	5.45 a
5	NKE - 27	4.45 a	4.48 a
6	NKE - 34	3.07 a	4.62 a
7	Mysore (control)	2.66 a	4.66 a
8	Malabar (control)	3.76 a	5.04 a
	CD at 5%	1.272	1.802
	SEM	0.172	0.212

In turmeric, 13 germplasm accessions were tested for their reaction to the nematode *M. incognita* and the results indicated that 5 accessions in the first round and one accession in the second round of screening are resistant/ tolerant to the nematode.

Twelve accessions of cardamom germplasm were inoculated with the root knot nematode *M. incognita* and are being maintained to record their reaction to the nematode.

B. Population variability in root knot nematode

Two more populations of root knot nematodes of black pepper from Tata Tea Estate, Valparai and Travancore Rubber and Tea Co.Ltd, Ambanad Estate were added to the nematode collection. A total of 36 nematode populations of different spice crops are being maintained on their respective hosts.

Perineal pattern and isozyme analysis of 3 nematode populations showed considerable variation in these two characteristics

C. Effect of organic wastes on the nematode population of black pepper

Forty pepper vines were established in the microplots containing fumigated soil mixture. The treatment will be imposed during September / October 1998 when the vines are about one year old.

BIOCONTROL 1.1 (813)

BIOLOGICAL CONTROL OF DISEASES OF SPICES CROPS

(M. Anandaraj, M.N. Venugopal, A. Kumar and Y. R. Sarma)

Field trials on biological suppression of *Phytophthora* foot rot through VAM and biocontrol agents were continued. The mean yield in the VAM main plot was 2156.0 g compared to 1427.3 g in non -VAM. (Table. 25) The yield of black pepper in plot where a combination of VAM and biocontrol agents were used did not differ significantly, but the disease incidence was less than 5%.

Table 25 : Effect of VAM and chemicals on *Phytophthora* foot rot.

Treatment	Yield -Fresh Wt. (g)		
	VAM	NON-VAM	Mean
Control	1960.0	1633.0	1796.0
VAM	2520 0	1520.0	2020.0
COC + BM	1806.0	1033.0	1420 0
RMZ	893.0	516.0	705.0
Akomin	3603	2433.3	3018.0
Mean	2156.0	1427.3	1371.0
CD at 5 %	--	--	1391.0

COC - Copper oxychloride, BM- Bordeaus mixture, RMZ - Ridonil Manozeb

Studies on evaluation of substrates for mass multiplication of *Trichoderma harzianum* and *Gliocladium virens* was carried out with tea waste, coffee husk, neem cake and farm yard manure Tea waste supported better growth and sporulation of both *T. harzianum and G. virens*, followed by coffee husk. In *G. virens* maximum population of 829 .3 colony forming units (CFU) was obtained after 28 days of inoculation, whereas *T. harzianum* reached a peak of 4602.0 CFU 45 days after inoculation in tea waste (Fig.10&11).

Over 20 fungi belonging to *Trichoderma Aspergillus,* and *Verticillium* and 11 *Pseudomonas fluorescence* were isolated from black pepper rhizosphere soil collected from different black pepper growing areas. One of the *Trichoderma* isolates is copper tolerant.

Compatability tests with *Trichoderma* and *P. fluorescens* showed that simultaneous inoculation with *Trichoderma* and bacteria in liquid medium allows only the growth of bacteria, whereas *Trichoderma* inoculation followed by bacteria allows growth of both organisms.

The synergistic effect of VAM and BCA on black pepper cuttings in rapid multiplication showed that whereever VAM has been added the growth was faster.

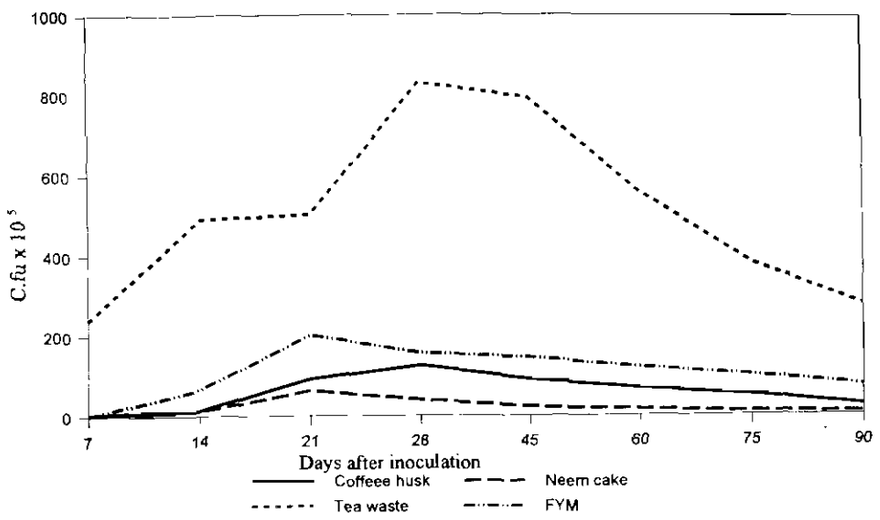

Fig. 10. Population of *Gliocladium virens* in different substrates

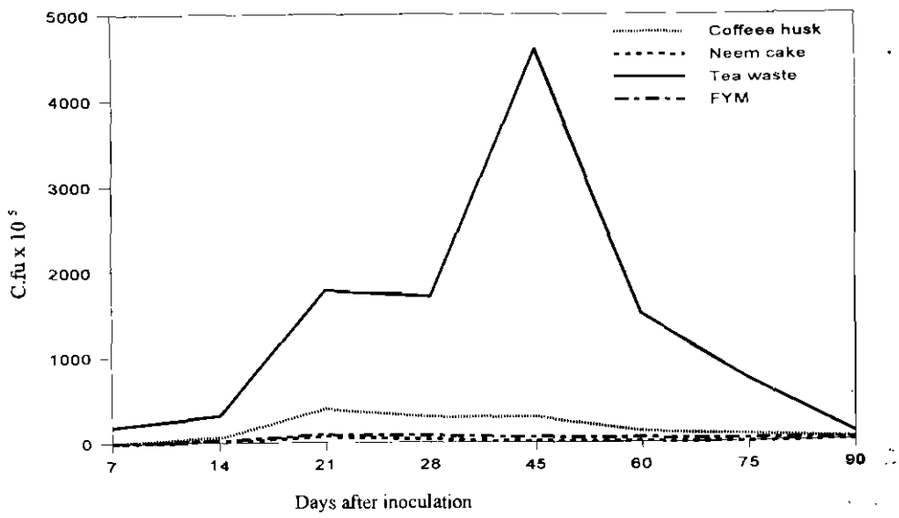

Fig. 11. Population of *Trichoderma harzianum* in different substrates

BIOCONTROL 1.2 (813)

BIOLOGICAL CONTROL OF INSECT PESTS OF SPICES

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

A. Documentation of natural enemies of insect pests of Spices

The natural enemies of various insect pests of spices were documented from Calicut and Peruvannamuzhi (Table. 26)

Table 26: Natural enemies of insect pests of spices documented during 1997-98.

Crop/Insect pest	Natural enemy	Taxonomic status
Black pepper		
Pseudococcus sp.	*Leptacis sp.*	Platygasteridae
Planococcus sp.	*Blepyrus insularis*	Encyrtidae
	Genus et sp. indet.	Hymenoptera
	Genus et sp. indet.	Coleoptera
	Genus et sp. indet.	Diptera
Protopulvinaria longivalvata	*Cocophagus ceroplastae*	Aphelinidae
Ginger and Turmeric		
Lasioderma sericorne	*Anisopteromalus calandrae*	Pteromalidae
Clove		
Pulvinaria psidii	*Megommata* sp.	Cecidomyiidae
Cinnamon and Cassia		
Conopomorpha civica	*Elasmus* sp.	Elasmidae
	Sympiesis dolichogaster	Eulophidae

B. Microbial control of Pollu beetle

Laboratory bioassays were conducted to evaluate the pathogenicity of two cultures (source: CCRI, Kalpetta and CCL, Polibetta) of *Beauveria bassiana* against adults of *Pollu* beetle infesting black pepper. *B.bassiana* caused up to 20 % mortality of pollu beetles when they were allowed to crawl over the fungal cultures.

C. Evaluation of cultural methods for the management of shoot borer

Various cultural methods were evaluated in the field for the management of shoot borer on ginger. The cultural methods evaluated include pruning of infested shoots + spraying of insecticides in various schedules and raising of trap crops in ginger fields. The incidence of shoot borer and yield of the crop in various treatments is being recorded.

BIOCONTROL 13(813)

BIOLOGICAL CONTROL OF NEMATODES OF SPICES

(Santhosh J. Eapen, K.V. Ramana and A. Kumar)

A. Isolation and identification of microorganisms

Soil samples collected from Valparai (Tamil Nadu) and Madikeri (Karnataka) were plated on Rose Bengal Agar, *Trichoderma* selective medium, King's B medium and modified King's B medium to isolate nematode antagonists. Fifteen bacterial and 21 fungal isolates were obtained by this process. All of them are being maintained at 28±1°C for further tests.

B. In vitro testing against nematodes

Two days old bacterial cultures (multiplied on nutrient broth) were tested, either live or heat killed, for their nematode suppression property under in vitro conditions. Isolates No. 6, 5 and 2 caused maximum mortality to root knot nematode juveniles, when live cultures were tested (Fig. 12). Heat killed bacterial suspensions had no effect on root knot nematode larvae. Further studies on the effect of bacterial metabolites are in progress.

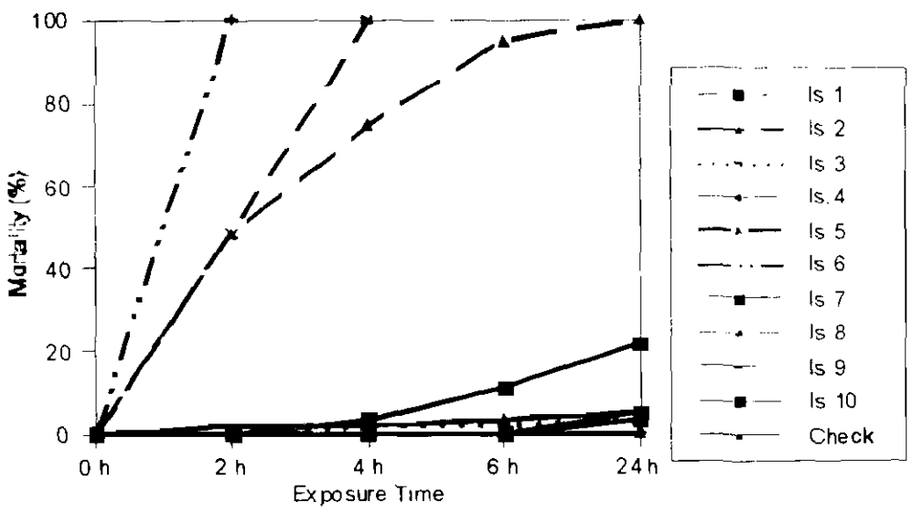

Fig. 12. Mortality of root knot nematode juveniles exposed to live bacterial cultures (Mean of three replications)

C. Effect of *Verticillium chlamydosporium* on root knot nematodes of cardamom

The pot culture trial to study the effect of *Verticillium chlamydosporium* on

suppressing root knot nematodes was concluded after 10 months.The final results are given in Table 27. Preinoculation of cardamom plants with *V.chlamydosporium* was found to be more effective in improving the growth of the seedlings. However, a single round of *V. chlamydosporium* application was not sufficient to give extended protection against nematodes.

Table 27: Effect of *Verticillium chlamydosporium* on growth of cardamom seedlings and on root knot nematodes (Mean of five replications).

Treatment	No.of tillers	Biomass (g)	Root wt. (g)	nematodes per g root (pf)
Check	3.33b	210.00 ab	31.67 abc	-
Vc	4.60 a	204.00 ab	30.00 bc	-
Mi	4 25 ab	133.33 b	38.33 ab	447.75 a
Vc + Mi	3.75 ab	263.33 a	33 33 abc	561.05 a
Vc>Mi	4.00 ab	261 00 a	43.33 a	1207.81 a
Mi>Vc	3.00 b	210 10 ab	23.33 c	500.03 a

Means in a column followed by the same letter are not significantly different

Vc - *Verticillium chlamydosporium*, Mi - *Meloidogyne incognita*

D. Effect of *Trichoderma* isolates on nematodes of black pepper

Another pot culture trial to evaluate the nematicidal effect of different isolates of *Trichoderma* spp. was also concluded. All the plants were uprooted and various growth parameters were recorded. It is observed that isolate T12 has got excellent growth promoting ability while isolates T12 and T10 are fairly good in reducing the damage by nematodes.

E. Evaluation of *Verticillium chlamydosporium* and *Pasteuria penetrans* in cardamom nurseries

The trial to evaluate the performance of *Verticillium chlamydosporium* and *Pasteuria penetrans* under field conditions was concluded. The results clearly demonstrated the vast potential of both these organisms as effective biocontrol agents against root knot nematodes in cardamom nurseries. Besides, both the organisms were successfully reisolated from the soil which again proved their rhizosphere competence in the soil (Table 28).

AD-HOC PROJECTS

1. INTEGRATED MANAGEMENT OF RHIZOME ROT OF GINGER

(Y.R.Sarma, P.P.Rajan and Beena.N)

Large scale demonstration trials in 4 districts in Kerala viz. Idukki, Wyanad, Kannur and Calicut consistently showed superiority of biocontrol (*T.harzianum* treated plot, either

Table 28: Effect of *Verticillium chlamydosporium* and *Pasteuria penetrans* on growth of cardamom seedlings and incidence of root knot nematodes (mean of four replications).

Treatment	No.of tillers	Height (cm)	Nematodes / g root (pf)
Check 1 (Uninoculated)	2.65 a	67.60 ab	-
Check 2 (Incoulated)	2.40 a	55.90 bc	323.33 a
Vc alone	3.15 a	64.80 ab	-
Vc + Mi	2.60 a	60.65 abc	47.75 b
Pp alone	2.35 a	50.12 c	116.75 ab
Pp + Mi	2.80 a	70.50 a	16.67 b

Means in a column followed by the same letter are not significantly different

Vc - *Verticillium chlamydosporium*, Mi - *Meloidogyne incognita*

alone or in combination with Metalaxyl Mancozeb). Apron seed treatment though showed good protection, was inferior to the biocontrol or Metalaxyl Mancozeb combinations. This seed formulation appears not suitable for large sized seed rhizomes compared to the seeds of cereals and grains where it is used as a dry seed dresser (Table.29).

2. DEVELOPMENT OF *PHYTOPHTHORA* RESISTANCE IN BLACK PEPPER (*PIPER NIGRUM* L.) THROUGH BIOTECHNOLOGICAL APPROACHES

(Y.R Sarma and M. Anandaraj)

Out of the 3,000 somaclones so far screened 20 have been short listed and will be further evaluated. Crude preparation of *Phytophthora* toxin was used in the cell suspension systems and so far, toxin insensitive cells/calli were not obtained. The callus obtained from protoplasts of *P.nigrum* still remains undifferentiated even after 6 months compared to a good regeneration to a plantlet level in the case of *P.colubrinum*

3. DEVELOPMENT, PRODUCTION AND DEMONSTRATION OF BIOLOGICAL CONTROL AGENTS UNDER INTEGRATED PEST MANAGEMENT

(Y.R Sarma and M. Anandaraj)

The field demonstration trials were continued in farmers fields. The treated plots both in Kerala and Karnataka showed gradual and steady improvement in the overall health of the vines as indicated by decreased foliar yellowing and vine death.

Seven farmer's seminars were conducted both in Kerala and Tamil Nadu. Popular articles were published in local languages in leading magazines.

Out of the 150 farmers who responded for our proforma, 80% confirmed the efficacy of biocontrol, 6.6% indicated it as ineffective and 13.3% could not decide the efficacy. This indicated the positive response for biocontrol and its popularity among the farming community.

Table 29: Integrated management of rhizome rot of ginger (multilocational field trial).

District	Treatments	No. of Sprouts/Bed	Disease (%)	Yield (1x3m/bed)
Idukki-1	RMZ (500ppm)	105.0	00.0	8.517-B
	RMZ+BCA	117.0	00.0	10 500-A
	BCA	098.0	00.0	8.550-B
	APRON (2g/Kg)	069.0	00.0	8400-B
	APRON+BCA	106.0	00.0	9.850-A
	CONTROL	062.0	10.0	6.267-C
Idukki-2	RMZ (500 ppm)	360.0	00.0	16.160-AB
	RMZ+BCA	360.0	00.0	17.930-A
	BCA	400.0	00.0	16.500-AB
	CONTROL	320.0	10 5	15.000-B
Wynad	RMZ (500 ppm)	167.3	00.0	9.900-B
	RMZ+BCA	208.0	00 0	11.000-A
	BCA	256.3	00.0	10.000-B
	APRON (2g/kg)	156 6	00.0	8.833-C
	APRON+BCA	193.3	00.0	10.830-AB
	CONTROL	217.3	20 0	6.750-D
Kannur	RMZ (500 ppm)	480.0	00.0	12.00-B
	RMZ i BCA	380.0	00.0	13.670-A
	BCA	380.0	00.0	14 170-A
	APRON (2g/kg)	420.0	00.0	12.000-B
	APRON+BCA	300.0	00.0	12.500-B
	CONTROL	280.0	25 0	5.5000-C
Wynad	RMZ (500 ppm)	200.0	00.0	8.000-B
	RMZ+BCA	202.0	00.0	8.667-B
	BCA	092.0	00.0	10.270-A
	CONTROL	080.0	10.0	5.000-C

The effect of biocontrol has been successfully demonstrated in three major estates. Out of the 2585 vines treated only 7.5% (190 vines) took infection. In a span of three years the effect of biocontrol has been demonstrated in 1,36,225 vines in Wynad and Calicut and only 153 vines reported mortality.

4. BIOLOGICAL CONTROL OF SCALE INSECTS INFESTING BLACK PEPPER

(S.Selvakumaran, Mini Kallil, K.M. Abdulla Koya and S. Devasahayam)

A. Evaluation of natural enemies

The coccinellid predator *Chilocorus nigrita* was mass reared in the laboratory and eggs of the predator were released @ 125 eggs/vine (5 releases at 7-10 day intervals) on black pepper vines infested with *Lepidosaphes piperis* at Meenangadi (Wyanad District) during April-June 1997. Observations recorded on the population of *L.piperis*, 3 months after release indicated that there was 44.5 % reduction in the pest population.

C. circumdatus was also evaluated in the field at Meenangadi for the control of *Aspidiotus destructor* infesting black pepper. The trials indicated that release of 85 larvae/ vine (5 releases at 7-10 day intervals) reduced the population of the scale insect by 68.5 %.

B. Toxicity of insecticides to natural enemies

The toxicity of insecticides, plant and organic products (recommended for the control of scale insects) to *C.nigrita* was evaluated to determine safe periods for release of the predator. The trials indicated that neem oil 0.3%, Neem gold 0.3% and fish oil rosin 3% were safe to the predator while monocrotophos 0.1% and dimethoate 0.1% were toxic up to 7 and 1 day after treatment.

5. CHARACTERISATION, EARLY DETECTION AND MANAGEMENT OF KOKKE KANDU DISEASE OF CARDAMOM

(M.N. Venugopal, K.A. Saju and M.J. Mathew)

A. Characterisation of Car VCV

Repeated mechanical inoculation experiments using eight Solanaceous and one Chenopodiaceous plants failed to transmit the Kokke kandu disease. In ELISA using infected leaves and pseudostems showed strong reaction to potyvirus (PMV, Car MV (Indian) and Car MV (Guatemalan) indicating its affinity to potyvirus group.

B. Screening of disease escapes

Thirty four disease escapes collected from hotspots were established for screening. Total disease escapes at hand including earlier collection are 44.

C. Vector control studies

The fungal parasites isolated from cardamom aphid were identified (Agharkar Research Institute -DST, Pune) as *Penicillium fellutanum* Bourge., *Paecilomyces lilacinus* (Thom)Samson and *Verticillium lecanii* (Zimm.) Viegas. All are first cases of reports on *Pentalonia nigronervosa* f.*caladii*.

In laboratory experiments, *Chrysoperla carnea* Stephens (Chrysopidae nueroptera), a predator of soft bodied insects such as aphid, thrips and insect eggs etc. was highly predaceous to *Pentalonia nigronervosa* f. *caladii*. Optimum predator pray ratio was found to be 1:5 .

A pilot field study was laid out for vector control in CRD comprising of 10 treatments in 3 replications each (2 neem oils, 2 plant exracts, 1 entomogenous fungus and 0.05 % monocrotophos for comparison). Initial observations on aphid colonisation showed that all the treatments are less efficient than the monocrotophos in reducing the aphid population development. However, neem oil margolin was found comparable with monocrotophos in controlling the vector.

CLOSED PROJECT

ICAR AD HOC PROJECT

THE PARASITIC NEMATODE, *TROPHOTYLENCHULUS PIPERIS* AND ITS INTERACTION WITH BLACK PEPPER

(K.V. Ramana, Santhosh J. Eapen and P. Sundararaju)

Trophotylenchulus piperis infesting black pepper in India was described as a new species recently and as such, no information is available on any aspect of this nematode. The results of this research project brought out information on some of the basic and applied aspects of the nematode which are entirely new information.

This nematode is widely prevalent in black pepper gardens in Kerala compared to its occurrence in Karnataka. In the major black pepper growing districts of Kerala viz. Wyanad, Idukki and Calicut, the prevalence and infestation levels of the nematode are high indicating the seriousness of the problem. However, the nematode has a limited host range *Glyricidia sepium* and *Artocarpus heterophyllus* (jack), which are commonly used as live standards for trailing black pepper vines in Kerala, are new host records of this nematode. Presence of these host plants in a black pepper garden would lead to the build up of the nematode population.

T.piperis is a semi-endoparasitic nematode and infests fibrous as well as main thick roots of black pepper vines, but prefers fibrous roots. On slender fibrous roots, nematode infestations are isolated and the nematode cases are distinctly separated whereas on the thick main roots, multiple infestations with closely packed cases are common. Sampling of fibrous roots without disturbing the main roots and extracting the second stage juveniles by Cobb's sieving and decanting method are advised for assessing the nematode infestation levels in a garden.

Vermiform second stage juvenile of the nematode is the infective stage. These juveniles infested black pepper roots within three days and completed life cycle in 55 days under artificial inoculation in the laboratory at room temperature (24-32 °C). The nematode case started developing as a transparent jelly at 30-40 days and became hard, dark brown and globular structure at 40-50 days after inoculation. The fecundity of the nematode is low and only 25-35 eggs are laid by a female. The eggs hatch inside the case and second stage juveniles emerge out of the cases for further infestation. Root exudates of the host plant, black pepper, had not shown any influence in the hatching of the eggs. The second

stage juveniles could survive upto eight days in host free soil. After the cases became empty, they dropped down to the soil leaving a scar on the root. All the cases collected from the soil were empty. Hence, the cases may not help the nematode to perpetuate in the soil like that of cyst nematodes. These cases on the roots with mucilaginous secretions may prevent the nematode from desiccation. Chemical and enzymatic tests indicated that the nematode cases are largely composed of chitin. Lignin and muco-polysaccharide are also constituents of the cases. This indicates that the cases are of nematode origin.

Histopathological studies showed that the nematode is a cortical feeder with the anterior portion of the nematode penetrating upto 3-4 cell layers and the tissues around the feeding site turned necrotic. The nematode cases can be easily separated from the root surface and there is no connection with the epidermal layer of the host plant root. This also indicates that the cases are formed due to secretions of the nematode. Pathogenicity tests showed that the nematode affected the growth parameters like height of the plant, number of leaves and nodes/vine under pot culture study and caused 3.29 to 16.54 per cent reduction in the growth of the plant inoculated with the nematodes in a course of four months. But these differences were not statistically significant. However, for proper assessment of the nematode's effect on growth and productivity of black pepper, long term studies under simulated field conditions are to be conducted, since black pepper is a perennial crop.

In black pepper gardens, the nematode population is lowest during August which gradually increased reaching the maximum peak during March. There is no significant correlation between the nematode population and the weather parameters like rainfall, number of rainy days and soil temperature, but rainfall has a negative influence on the population build up of the nematode.

Application of Phorate 10 G @ 3 g a.i./vine reduced the nematode population considerably, but its effect lasted only for one month. This may be due to the nature of the nematode which is enclosed in hard case and probably preventing the chemical in reaching the nematode.

Verticillium chlamydosporium, an opportunistic fungus, was isolated for the first time from *T. piperis* on black pepper roots. Efficacy of this local isolate of the fungus, as a biocontrol agent against plant parasitic nematodes has to be exploited.

SOCIAL SCIENCES

EXT.1 (813)

INCREASING PRODUCTIVITY OF BLACK PEPPER AND CARDAMOM THROUGH LARGE SCALE DEMONSTRATION OF IMPROVED TECHNOLOGIES IN FARMERS FIELD

(A.K. Sadanandan, Jose Abraham, V.S. Korikanthimath, Rajendra Hegde and M.N. Venugopal)

Cardamom

As performance of cardamom is location specific, on farm trials were conducted in Kodagu district, Karnataka in seven locations to assess the production potential of cardamom by adopting "high production technology" (HPT) in different topographical and climatic situations. On farm trials monitored during the period under report were

1. Introducing cardamom as a sole (mono) crop in place of arabica coffee.
2. Replanting of cardamom in a phased manner.
3. Comparative performance of cardamom and robusta coffee as sole (mono) crops.
4. Performance of cardamom and arabica coffee as sole (mono) crop.
5. Cultivation of cardamom under steep slope.
6. Conversion of marshy area for profitable cultivation of cardamom.
7. Trench system of planting with elite clonal material
8. Organic cardamom.

EXT III (813)

CONSTRAINT ANALYSIS IN CARDAMOM PRODUCTION - A SYSTEM APPROACH

(P. Rajeev and V.S. Korikanthimath)

The study was initiated in 1995 in Kodagu (Coorg) district of Karnataka to systematically identify, classify and analyse the major constraints of a viable cardamom industry.

The first phase involved the identification of constraints through pilot surveys. Several constraints were identified under the technology adoption domain which were rank ordered based on percentage of responses from study sample. The findings indicate that unscientific on farm nursery raising and management, problems of early detection and management of katte, persistence of root grub and stem borer attack and problems associated with scientific soil and water management continue to be major constraints that attribute for low productivity. Seasonal fluctuation in prices is a major disincentive for

consistent scientific management in plantations. Farmers also identified scarcity of labour force and associated problems of management as a major threat to viable production. This factor was further analysed in depth through case studies. The findings indicate that the labour market in Coorg district is in a transition phase; turning out to be more competitive and flexible, replacing the conventional bonded labour in the locality. Prominent institutional and structural changes in labour market are emerging.

EXT. 1 (443)

TRAINING OF RESEARCH AND EXTENSION WORKERS

(M.V. Prasad and Rajeev. P)

A total of 6 training programmes were conducted during 1997-98. Three programmes on 'Spices production technology', two on 'Nursery management in spices' and one on 'On farm processing of spices' were conducted. A total of 48 participants representing Government departments, private sector and agricultural universities from different parts of the country participated.

CLOSED PROJECTS

STAT. V(813)

ECONOMICS OF BLACK PEPPER CULTIVATION

(Jose Abraham and M.V.Prasad)

Black pepper being an export oriented spice, its market price mainly depends on the international price and demand. Though Indian spices in general and black pepper in particular is internationally popular for its quality, the high labour and other input cost make them relatively more costlier in the international market. In order to face this situation the only method is to increase productivity and there by bring down the cost of production. In this context, reliable estimates of cost of production of black pepper with high production technology applied both under monocropping system as well as mixed cropping system assumes its importance.

A survey was conducted in Calicut and Wynad districts to record data on various inputs like labour, fertilizers and plant protection chemicals and also to get information on the extent of damage to the crop due to foot rot disease.

Results

The information collected from 50 gardens in Calicut and 44 gardens in Wynad District showed that labour is the major component of cost in pepper cultivation. It was found that on an average a six fold increase in labour wages raising it to an average of Rs.60/head/day from the rate of Rs.10 during 1978-79. Regarding cost of other inputs like standards, rooted cuttings, FYM, fertilizers and plant protection chemicals also there is a similar increase of 6 to 10 times that of 1978-79 period. The cost of cultivation of black pepper under monocropping and mixed cropping systems are given in table 30. The estimated cost of production of black pepper during 1985 under local rainfed condition was only Rs.13.40 per kg (CPCRI, Kasaragod).

Table 30: Year wise cost of cultivation (Rs./ha).

Year	Mono-crop	Mixed crop
1	28,845	6,120
2	12,215	2,170
3	15,215	2,320
4	18,215	2,920
5th onwards	29,330	6,905

For computing factor costs including labour wages, the 1996-97 rates were taken into account. Since the operational wage rates vary widely from region to region in the state of Kerala between the seasons and among the categories of agricultural labour, the average wage of Rs 60 per labour was considered (this is taken as the average wages irrespective of men, women or child whether it is paid or family labour). Land was not considered as an item of the investment since it is not a wasting asset and also the appreciation of land value is considerably very high.

The Benefit-Cost Ratio table is worked out by the formula:

$$BCR = \frac{\sum_{i=1}^{n} \frac{B^i}{(1+r)^i}}{\sum_{i=1}^{n} \frac{C^i}{(1+r)^i}}$$

Where BCR = Benefit-Cost Ratio

B_i = Benefit at i^{th} year

C_i = Cost at i^{th} year

n = number of years and

r = discount rate

1. The fertilizer requirement were taken as 100 g N, 40 g P_2O_5 and 140 g K_2O per vine.

2. The crop density was taken as 1000 vines /ha under monocroping system and 300 vine /ha under mixed cropping system.

3. The average wage as Rs. 60 per labour irrespective of men, women or childwhether it is paid or family labour.

The cost and returns were discounted at 15 percent.

Table 31: Cost-benefit analysis

Sl. No.	Item	Cost (Rs./Ha) under Mixed cropping	Mono-cropping
1	Investment during establishment	13,530	65,490
2	Interest @ 15% compounded	6,900	44,608
3	Total investment	20,430	1,10,098
4	Annuity value @ 15%	3,494	18,829
5	Annual maintenance cost	6,905	29,330
6	Total cost/year/ha	10,399	48,159
7	Average estimated yield kg/ha*	330	1,700
8	Cost of production Rs./kg	31.30	28.30
9	Benefit Cost Ratio(BCR)	2.10	2.5

Even though the released varieties of pepper respond very well to ideal management, for avoiding the influence of weather and other natural hazards like pests and diseases, the yields have been considered at moderate rates of 1.7 kg per vine under mono-cropping system and 1.1 kg per vine under mixed cropping system and with an existing disease incidence rate of 5% per year as has been achieved under High Production Technology

In order to determine the flow of benefits in different years, the average market price of Rs 60 per kg was considered though the present price is over Rs.180 per kg.

The initial investment(pre-bearing establishment cost) and the compound interest there on were reduced to an annuity bearing 15% interest by the formula:

$$A = \frac{P}{\sum_{i=1}^{n} \frac{1}{(1+r)^i}}$$

Where A=Annuity value

P=Total investment

r=Rate of interest

n=Life of the plantation

The annuity value so obtained is added to the annual maintenance cost to obtain the total annual cost per hectare.

1. Plant density/ha is 300 vines under mixed cropping and 1000 vines under monocropping.
2. Average life of plantation is 15 years.
3. Interest rate is 15%.

4. Average yield/vine/year under mixed cropping is 1.1kg and under monocropping is 1.7kg.

5. Average market rate of pepper is Rs.60/kg.

The cost of production of pepper under mixed cropping system (Rs.31.3) is higher than that of pepper under mono-cropping system (Rs.28.3/kg). The reason being the low production potential of the different varieties usually planted by the farmers in the homestead gardens, the high competition between the component crops for sunlight, nutrients and water and the poor management practices followed by the farmers. Moreover in the present case we have considered only the income and expenditure of pepper ingnoring the impact of mixed cropping on the whole system.

In order to get a pooled estimate of cost of production of pepper, the ratio of average production of pepper in Idukky and Wynad districts having maximum area under mono-crop to the average production in the other districts having pepper mainly as mixed crop was utilised to get the weighting factors. The factors so obtained were 0.66 and 0.34 for mono-crop and inter crop respectively and hence the pooled estimate was worked out as :

Pooled estimate of cost of production = Cost/kg under mono-crop x 0.66

+ cost/kg under mixed crop x 0.34

= 28.3 x 0.66 + 31.3 x 0.34

= **Rs.29.32 per kg**

EXT. II (813)

EFFECTIVENESS OF KURUMULAKU SAMRAKSHNA SAMITIES IN BLACK PEPPER PRODUCTION IN KERALA-A CRITICAL ANALYSIS

(M.V.Prasad and Jose Abraham)

Objective

In the context of wide spread foot rot disease of black pepper, to solve the problems of the pepper growers, government of Kerala formulated 'Kurumulaku samrakshana samities' (pepper protection forums) during 1990-91. These samities are functioning under Krishibhavans' jurisdiction. Various pepper development programmes have been chalked out and implemented by Department of Agriculture in Kerala through these samities to promote pepper production. But as such there has been no effort made to study the effectiveness of these samities. This study is made to find out the effectiveness of these samities in pepper production in Kerala.

The present study has been carried out in four districts of Kerala viz.,Wynad, Calicut, Cannanore and Idukki . Three villages were selected at random from each district. A sample of 120 farmers were selected at random from twelve villages. Data was also collected on perception of constraints and suggestions by Agricultural Officers (selected at random) who are implementing these samities. A sample of 52 officials were selected for this purpose.

Following variables were selected for the study i.e.perception, extent of adoption, organisational climate, supply & service activities, linkages etc. The interview schedule consisting of these variables was pretested before actual use in the field investigation. To understand the various constraints perceived/faced by pepper growers and their suggestions for improving the production of pepper in future, the responses were elicited.

Results and Discussion

The study was designed to analyse the effectiveness of samities in pepper production, keeping the objectives of the study in view, the data was collected, processed through the tools of statistical analysis (Fig.13).

Results indicates that samiti members have got positive perception (61 per cent) regarding functioning of samiti. They felt that it needed to be strengthened and restructured for effective functioning. Farmers had positive perception with regard to the attributes of technology in the following order relative advantage (59 percent), relevancy (55 per cent), suitability(41 per cent), practicable(39 per cent) and triable (30 per cent).

Farmers adopted the practices in the following order harvesting stage, inter cropping, processing of pepper, improved varieties, recommended standards, gap filling, FYM application, cultural practices, pepper cuttings/ha, spacing, fertilizers application, plant protection measures etc. (Fig.14).

Organisational climate indicate that samiti farmers got cooperation and linkages with other organisations(53 per cent), have trust in decision (52 per cent), support from other organisations(48 per cent), and had less importance to follow up (16 per cent).

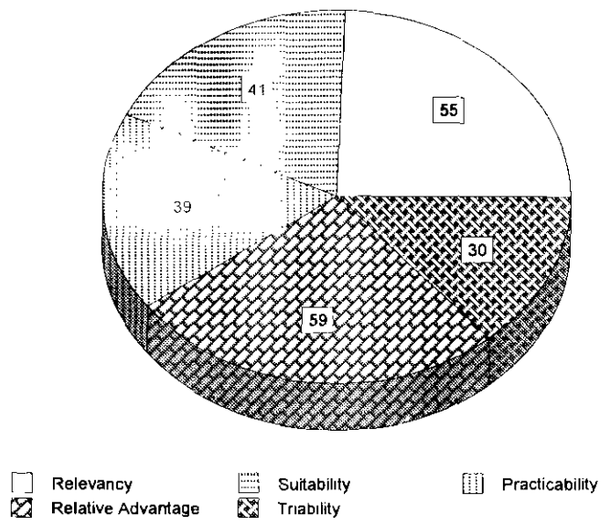

Fig. 13. Perception of farmers about black pepper technology(%)

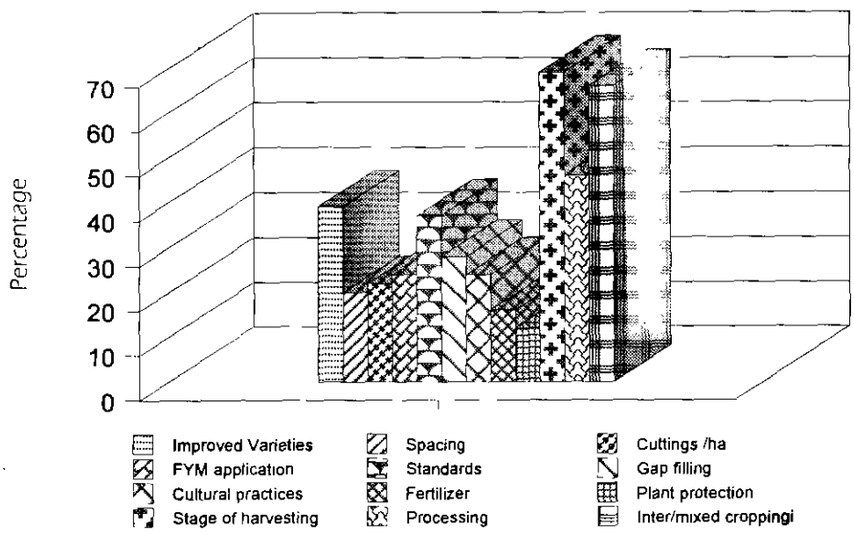

Fig. 14. Extent of adoption of recommended practices by farmers

Few farmers felt that the supply of inputs are adequate (29 per cent), information is disseminating(24 per cent), regular supply and services(23 per cent) are existing.(Fig. 15)

Table 32: Linkages between samiti and other organisations.

Organisation	F	%
IISR	18	15
PAO	35	29
Agril Asstt	37	31
Krishibhavan	107	89
Input Organizations	42	35
Voluntary Organizations	68	57
Coop. Banks	80	67
Commecial banks	41	34
Others (Spices Board & Coffee Board)	52	43

Above table (32) indicates that samiti has got linkages with Krishibhavans, cooperative banks, voluntary organisations, Spices Board and Coffee Board, input organisations, commercial organisations and Agricultural Assistants in that order. It was

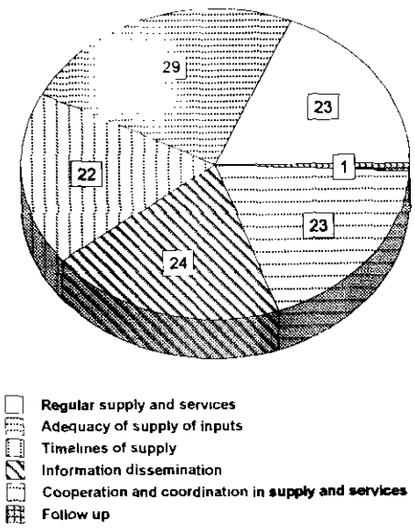

Fig. 15. Supply and service activities of samiti

observed that there was no difference in yield or income of the farmers(before and after forming of these samities).

The study revealed that majority of the farmers felt the following constraints in that order; non availability of enough quality planting material, non availability of pest and disease resistant varieties, non availability of inputs in right time in sufficient quantities, poor quality of chemicals, non availability of labour in peak seasons, non availability of plant protection equipments in time, high cost of fertilizers, lack of awareness about the improved varieties and untimely supply of inputs etc,

Farmers suggested that sufficient quantity of good quality inputs must be provided in right time. Pepper production, procurement and marketing facilities must be streamlined and stabilised. Samiti must formulate collection centres which avoid middlemen and contractors and organise training programmes for pepper growers.

1. The study indicated the following suggestions for successful implementation of samitis supply of quality planting material and inputs.

2. Separate supervision agency must be constituted for successful implementation of samities.

3. Make awareness about the importance of samiti among black pepper growing farmers.

4. Samities should be free from political intervention.

5. Extra staff must be appointed at least for 2-3 years for successful implementation by wide publicity and personal attention to each farmer.

6. Samiti work must be evaluated annually.

7. Demonstrations must be laid in farmers field on various technologies.

The study revealed that a majority of farmers had a positive perception on the need and mandate of the samity. Similarly the farmers also had a positive perception on the desirable attributes of the recommended cultivation practices of black pepper. On the contrary the extent of adoption of the scientific practices by the participating farmers was very low. Thus the samities failed to enhance the capacity of participating farmers to adopt the scientific cultivation practices through its service functions. As the major constraints faced by the growers in adopting the technologies still persist the functioning of the samities must be strengthened based on the needs of the members as identified in the study.

TECHNOLOGY ASSESSED /TRANSFERRED

1. Management of pollu *(Longitarsus nigripennis)* of black pepper

Spraying endosulfan 0.05% during July (after fruit setting) followed by three sprays of Neemgold 0.6% (neem based product) during August, September and October or four sprays of Neemgold 0.6% during July, August, September and October is effective for management of pollu beetle, a major pest of black pepper.

2. Management of root knot nematodes and damping off in cardamom nurseries

Solarize nursery beds/nursery mixture using 100-400 gauge transparent polythene sheets for 40-45 days before taking up sowing. Incorporate biocontrol agent *Trichoderma harzianum* multiplied on decomposed coffee husk (7 days old) at the time of sowing @ 2.5 kg/bed (4.5 x 1m) and after three months OR apply phorate @ 5 g a.i./ bed and 0.2% copper oxyhcloride @ 20 litre/bed two weeks after germination and again after three months.

3. Epicotyl grafting in nutmeg

Epicotyl grafting is adopted for commercial multiplication of nutmeg. Scions from high yielding female trees are grafted on to 20 days old *Myristica fragranice* seedings. One year old grafts can be field planted.

4. Top working in nutmeg

Male nutmeg trees are detopped at 1 foot above the ground level during the last week of May. The detopped trees produced new sprouts in a period of 45-60 days. Soft wood grafting on the new sprouts are carried out to convert male trees to female After successful union all the shoots are removed from the main trunk.

5. Approach grafting in clove

Clove can be vegetatively propagated through approach grafting on three year old clove rootstock with 80 % success during December.

6. Propagation of cinnamon through cuttings

Soft wood cuttings of about 15 cm length dipped in IBA or IAA (2000 ppm) gives 80% success. Air layering, semi hard wood cuttings with IBA 3000 ppm gives 70 - 80% rooting.

7. Air layering in cassia

Cassia can be successfully rooted in the month of July by air layering with IBA 500 ppm.

8. Bush pepper in field

Bush pepper can be planted in the field at a spacing of 2m x 2m to accomodate 2500 plants /ha. Apply NPK @10:5:20 g/bush twice during May and September to obtain yield of about 3200 kg/ha in Panniyur-1 and 2500 kg in Subhakara.

EDUCATION AND TRAINING

KRISHI VIGYAN KENDRA

The Krishi Vigyan Kendra, Calicut was established in 1992 under Indian Institute of Spices Research at Peruvannamuzhi 60 KM away from the headquarters. It organises need based training programmes for practicing farmers /farm women and rural youth.

A total of 49 trainings were conducted in Horticulture, Fisheries, Agronomy and Animal Sciences during 1997. The details of training programmes are given below.

Sl. No.	Category of Trainees	Male	Female	Total
1	Practising farmers	613	306	919
2	Rural youth	301	146	447
3	Extension Functionaries	3	76	79
	Total	917	528	1445

KVK is also associated with Kisan melas and Exhibitions conducted at various parts of the district in collaboration with Department of Agriculture and other organisations.

Establishment of demonstration units

Demonstration units of vermiculture, orchids, Anthuriams and palms, banana varieties, tropical and subtropical fruit plants and a rabbitry are maintained at KVK.

Plant and Animal Health Centre

A Plant and Animal Health Centre started two years back for the service of farmers have attracted the appreciation of farmers in and around the KVK. An artificial insemination unit has also started functioning. During 1997, a total of 1421 cases were attended and 295 artificial inseminations were done.The staff of this centre conducted two Animal Health Campaigns and attended nine campaigns and seminars.

Two innovative programmes were also initiated during the period. One is a "Horticultural therapy Programme" for the rehabilitation of mentally handicapped people organised in association with Bharathiya Vidya Bhavan, Calicut. Another is a Vikas

Volunteer Vahini Club organised at Kallanode in association with NABARD and South Malabar Grameen Bank. In this programme technical supprot will be provided to the club for organising self employment oriented programmes.

Revolving fund

The revolving fund flourished during the period. Planting materials of plantation crops, spices, ornamentals and fruits worth Rs. 1,24,137 were produced under the scheme. During the period a total amount of Rs. 33670 was collected from Plant and Animal Health Centre towards consultation fees.

Training of research and extension workers

A total of 6 training programmes were conducted by IISR during 1997-98. Three programmes on Spices production technology, two on Nursery management in spices and one On farm processing of spices were conducted. A total of 48 participants representing Government departments, private sector and agricultural universities from different parts of the country participated.

POST GRADUATE EDUCATION

Ph. D.s awarded during 1997

No.	Recipient	Guide	Title of Ph.D. Thesis
1	K. Nirmal Babu	Dr. M.K. Nair	In vitro studies in *Zingiber officinale* Rosc
2	K. Samsudeen	Dr. M.K. Nair	Studies on somaclonal variation introduced by *in vitro* culture in *Zingiber officinale* Rosc.
3.	T.M. Shaukathali	Dr. A. Ramadasan	Physiological and biochemical characterisation of yield and quality in black pepper with special reference to nitrogen nutrition
4	A. Shamina	Dr. Y.R. Sarma	Biochemical studies on host-pathogen interactions of black pepper (*Piper nigrum L.*) infected with *Phytophthora capsici*
5.	N.M. Usman	Dr. Y.R. Sarma	Biological control of rhizome rot of ginger
6.	M. Anandaraj	Dr. Y.R. Sarma	Ecology of *Phytophthora capsici* (Leonian 1922 emend A. Alizadeh and P.H. Tsao) causal organism of root rot disease of black pepper (*Piper nigrum L.*)

Radio talks (through AIR, Kozhikode)

Peter, K.V. : Dos and Don'ts in processing of spices
New diseases of pepper

Veena, S.S. : Soft rot and bacterial wilt of ginger

Santhosh J.Eapen : Control of wilt diseases of black pepper
Integrated approach to control wilt diseases of black pepper

Prakash K.M. : Vermicompost production

Manoj P.S. : Pepper varieties and its planting
Harvesting and processing of nutmeg

Fameena Hassan : Ornamental fish rearing
Fish cum duck culture

Prathapan K.D. : *Azhukkal* disease of cardamom

GUEST LECTURES

K.V.Ramana

1. *Training course on 'Burrowing nematode Radopholus similis,* C.P.C.R.I. Regional Station, Kayamkulam, Kerala

2. Nematode diseases and their management with special reference to biological control - Training course on "Quality Improvement of black pepper" organised by Spices Board, Gudalur

AWARDS AND RECOGNITIONS

Awards For Excellence in 1997

1. **ICAR Team Award for Multidisciplinary Research in Agriculture and Allied Sciences for the Triennium 1994-96** is presented to Dr. P.N. Ravindran, Dr. K. Nirmal Babu, Dr. (Mrs) J.Rema, Dr. B. Sasikumar, Sri K. Samsudeen, Ms. M. Divakaran, Ms. G.S. Pillai, Ms. A. Sajna, Ms. M.P. Mathai, Sri. J.C. Zachariah and Mrs. C. Manjula for their outstanding contribution in the field of Horticultural Science.

2. **ICAR Hari Om Ashram Trust Award** for the research work "Development of Location Specific High Production Technology in Cardamom and Demonstration of the Same in Farmer's Field" to Dr.V.S. Korikanthimath, Dr. M.N. Venugopal, Dr. Rajendra Hegde and Dr. Ravindra Mulge.

3. **ICAR Young Scientist Award** for the research scheme " Substitution of Chemical Fertilizers with Organic and Biological Nutrient Sources for the Sustainable Cultivation of Cardamom" to Dr. Rajendra Hegde.

4. **Dr. J.S. Pruthi Award** for the best research paper published in Journal of Spices and Aromatic Crops. Vol. 5, 1996 to Dr. B. Sasikumar, Sri. Johnson K. George, Dr. T.John Zachariah,Dr. (Mrs.) M.J. Ratnambal, Dr. K. Nirmal Babu and Dr. P.N. Ravindran.

LINKAGES AND COLLABORATIONS

Externally Funded Projects

No	Name of the project	Funding Agency
1.	National Net work on Phytophthora diseases of Horticultural Crops (PHYTONET) with eight coordinating centres.	ICAR- A P Cess Fund
2	Developing hardening protocols for tissue cultured plants of spices	ICAR- A.P. Cess Fund
3.	Developmental morphology of rhizomes of ginger and turmeric	,,
4	Production of somaclones and somatic hybrids of cardamom for high yield and resistance to diseases	ICAR- A P Cess Fund
5	Effect of organic fertilizers on soil quality, productivity and quality of black pepper and cardamom	
6	Biochemical characterisation of ginger and turmeric	,,
7.	Characterization, early detection and management of 'Kokke Kandu' disease of cardamom	,,
8.	Integrated management of rhizome rot of ginger	
9.	Investigations on cardamom based cropping systems	,,
10.	Development of *Phytophthora* resistance in black pepper (*Piper nigrum.L*) through biotechnological approaches	DBT
11.	Development, production and demonstration of biological control agents under Integrated Pest Management	DBT

ALL INDIA COORDINATED RESEARCH PROJECT

The AICRP on Spices has the mandate to conduct and coordinate research in 12 spice crops viz. black pepper, cardamom, ginger, turmeric, clove, nutmeg, cinnamom, cumin, coriander, fennel and fenugreek to develop location specific recommendations. Scientific research of these crops are being carried out under AICRPS in 20 coordinating centres (and 8 participating centres) based in 15 Agricultural Universities and one at Gangtok under ICAR, Research Complex, Shillong. The group meeting of the research workers under AICRP was held at UAS Bangalore during 7-9 July 1997. Salient achievements are given below.

Crop Improvement

Three new varieties in spices have been recommended for release at the AICRPS workshop 1997. They are: Cardamom (ICRI-4), Mango ginger (Amba) and Fennel (Guj Fen-2).

The cardamom variety ICRI-4 is an early maturing, typical Malabar type of cardamom, yields 455 kg/ha under rainfed situation and 648 kg/ha under irrigation and is capable of giving potential yield upto 960 kg/ha. The capsule contains 6% essential oil and gives 22.76% dry recovery. The variety is ideal to the cardamom growing tracts of the agroecological conditions of lower Palani hills in the Kodaikanal taluk of Tamil Nadu and other low rainfall (up to 1500mm) areas and is the first variety recommended for low rainfall areas.

Mango ginger (*Curcuma amada*) variety AMBA was proposed by the HARS (OUAT) Pottangi, Orissa and has been developed through clonal selection. This variety yields 33 t/ha (wet) and contains 0.8% essential oil and 6.4% oleoresin.

Fennel variety viz. Gujrat Fennel-2 was developed by Spices Research Station (GAU), Jagudan, Gujrat. This selection gives a seed yield of 1940 kg/ha and is recommended for growing in all fennel growing areas.

Crop Production and Management

For black pepper basin irrigation at *IW/CPE ratio* of 0.25 (100 litres of water once in 8-10 days) during Dec- April increased the yield by 72% over no irrigation. In black pepper-arecanut mixed cropping system at Sirsi, application fo 200g N, 80g P_2O_5 and 289g K_2O/plant in two equal splits during May-June and Sept - Oct under Malanad is optimum.

A fertilizer dose of 75:75:150 kg NPK/ha was recommended for cardamom under natural shade in Karnataka. For proliferation of suckers in cardamom, planting at 0.3m x 0.9m gave 88,000 suckers ha /year.

For tree spices, clove and cinnamon, application of 50g each of *Azospirillum* (10 - 6 cfu) and phosphobacteria (10 -5 cfu) with 40g N, 350g P_2O_5 and 120g K_2O /tree/year is recommended.

Against cumin wilt, three year crop rotation ie. Cluster bean - cumin; cluster bean-wheat; cluster bean- mustard is recommended. Irrigation of cumin at 10, 30, 50 and 70 days after sowing gave maximum yield in Gujrat.

For Fenugreek, application of 40 kg N and 40 kg P_2O_5 gave highest yield (Gujrat). Time of sowing in fenugreek is first week of November at a spacing of 30 x 10 cm (Hisar) and 20th October (Kumarganj).

Crop Protection

The *Phytophthora* foot rot disease of black pepper can be managed by following cultural practices, neem cake application (@ 1 kg/vine), Phorate (3G @ 30g/vine), Bordeaux mixture spray (@ 3l/vine) before the onset of monsoon as first round in June and Akomin (0.4%) as spray (@ 3l/vine) in August - Sept. Application of Bordeaux mixture 1% at 15 days intervals controls nursery disease in black pepper.

Treatment of turmeric seed rhizome with monocrotophos (@ 2ml/l. of water) for 15 minutes is recommended to prevent scale insects. To prevent rhizome rot of turmeric, Bavistin treatment 2g/l of water is recommended.

GENERAL/
MISCELLANEOUS

PUBLICATIONS

Review articles

Demeke, T., Sasikumar, B., Hucl, P and Chibbar, R.N. 1997. Random Amplified Polymorphic DNA(RAPD) in cereal improvement. *Maydica*, 42:133-142.

Rema, J., Krishnamoorthy, B and Mathew, P.A. 1997. Vegtative propagation of major spices- a review. *J. Spices and Aromatic Crops* 6 (2): 87-105.

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LIST OF APPROVED ON-GOING PROJECTS

Crop Improvement and Biotechnology

1.Gen.I(813)	Collection, conservation, cataloguing and evaluation of black pepper germplasm
2.Gen. IX(813)	Collection, conservation, cataloguing and evaluation of cardamom germplasm
3. Gen II (813)	Collection, conservation, cataloguing and evaluation of germplasm of ginger and turmeric
4. Gen.VI(813)	Collection conservation cataloguing and evaluation of germplasm in tree spices
5. *Gen. XIII (813)*	*Collection, conservation and improvement of vanilla*
6. Hort. IV (813)	Rootstock scion interactions in tree spices
7. Gen.VII.1 (813)	Breeding black pepper for high yield, quality and drought
8. Gen. VII.2 (813)	Breeding black pepper for resistance to *Phytophthora*, pests and nematodes
9. Gen. X (813)	Breeding cardamom for high yield and resistance to katte disease
10. Gen. XII (813)	Cytogenetic investigations in black pepper and related taxa
11. Gen. XIV (813)	Cytogenetics and reproductive biology of ginger and turmeric
12. Hort.II (813)	Utilization of *Piper colubrinum* link and *P.arboreum* as root stocks in the management of foot rot disease of black pepper.
13. Hort. III (813)	Development of Paprika for warm humid tropics
14. Biotech.II (813)	*In vitro* selection for resistance to soft rot and bacterial wilt in ginger
15. Biotech III (813)	Micropropagation of black pepper
16. Biotech.IV (813)	Biotechnological approaches for crop improvement in black pepper

Crop Production and Post Harvest Technology

1. Agr.VI (813)	Studies on the impact of input technologies on the yield performance and quality attributes of black pepper
2. Agr. XIV (813)	Investigations on spices based cropping systems
3. Agr. XVI (813)	Irrigation requirement of black pepper - clove mixed cropping system

4. Agr. XVII (813)	Vermicomposting using organic wastes available in cardamom areas
5. Agr. XVIII (813)	Biofertilizer application on growth, yield and quality of black pepper
6. Agr. XIX (813)	Management efficacy of whole farm approach in farming- A study on cardamom based farming system
7. Agr. XX (813)	Production of nucleus planting materials of improved varieties of spice crops
8. SSC.II (813)	Nutritional requirement of improved varieties of spices
9. Phy. V (813)	Characterization of drought tolerance in black pepper
10. Phy. VI (813)	Characterization of drought tolerance in cardamom
11. Biochem I(813)	Biogenesis of pigments in spice crops
12. PHT. 1 (813)	Quality evaluation in spices
13. Org.chem.I (813)	Isolation and identification of naturally occuring compunds against major pests and pathogens of black pepper.

Crop Protection

1. Path. 11.1 (813)	Disease management in *Phytophthora* foot rot affected black pepper plantations
2. Path. X (813)	Investigations on vein clearing virus of small cardamom
3. Path .XI (813)	Studies on bacterial wilt of ginger
4. Path. XII (813)	Investigations on stunted diseases of black pepper
5. *Crop.prot.I.I(813)*	Screening germplasm for reaction to diseases
6. Crop prot.1.2(813)	Screening black pepper germplasm for reaction to insect pests
7. Crop prot.1.3(813)	Screening black pepper germplasm for reaction to nematodes
8. Crop.Prot.11(813)	Mechanisms of resistance to pests and pathogens in spice crops
9. Nema.III (813)	Investigations on nematodes associated with spices
10.Biocontrol1.1(813)	Biological control of diseases of spice crops
11.Biocontrol1.2(813)	Biological control of insect pests of spices
12.Biocontrol1.3(813)	Biological control of nematodes of spices
13. Ent. XI (813)	Bioecology and management of mealy bugs infesting black pepper

Social Sciences

1. Ext. I (813)	Increasing productivity of black pepper and cardamom through large scale demonstration of improved technologies in farmers field
2. Ext. IV (813)	Training of research and extension workers
3. Ext. III (813)	Constraint analysis in cardamom production - A systems approach
4. Stat. VI (813)	Economics of ginger cultivation
5. Econ.1 (813)	Economics of spices production and marketing

CONSULTANCY, PATENTS, COMMERCIALISATION OF TECHNOLOGY

The consultancy processing cell of IISR has been established during April 1997. This cell gives broad guidelines for consultancy work, brings out consultancy information system, prepares and processes the training/consultancy/contract research/ contrat service proposals, identifies the team for consultancy assignments and monitors the progress of the work assigned. The consultancy /training programmes are offered on all aspects of spices production,protection, improvement, biotechnology and post-harvest technology.

Under Consultancy Processing Cell, one contract research project entitled "Studies on evaluation of *terracare* for growth, nutrient availability, yield performance and quality of spices is operating with a financial outlay of Rs. 6.0 lakhs. Dr. A.K. Sadanandan is the Principal Investigator of the project. Dr. Y.R. Sarma has been providing consultancy service to Indo-Swiss project,Sikkim- ginger programme which aims to control ginger rhizome rot disease. Contract service such as analysis of ginger and turmeric, GLC analysis of essential oils etc. have also been provided. A total amount of Rs. 7,60,000/- has been collected through above programmes. A team of scientists of all disciplines have been identified to take up consultancy of plantations.

RAC, MANAGEMENT COMMITTEE, SRC, QRT ETC.

Staff Research Council Meeting

Eleventh Staff Research Council Meeting was held at Chelavoor, Kozhikode from 1-3, May 1997. Dr. P.C. Sivaraman Nair, Director of Research, (Retd) KAU attended the meeting. There were four technical sessions in which the progress of 49 institute projects and other externally funded projects were discussed. Research Highlights 96-97 was also released during SRC Midterm review of the projects was held during November 1997.

Institute Management Committee

Institute Management Committee (IMC) of IISR was held on 26th July 1997 under the chairmanship of Dr. K.V. Peter IMC has approved various committees constituted in the Institute, purchase of site for construction of staff quarters and guest house at Madikeri and revised staff pattern of Krishi Vigyan Kendra.

Research Advisory Committee

It was held on 24th April 1997 at IISR, Kozhikode. Dr. S.N. Rao, Chairman, Dr. K.V. Peter Director, Prof. T.N. Ananthakrishnan, Dr. C.K. George, Dr. R.K. Sharma, Prof. M.C. Nair (Members) and Dr. Y.R. Sarma (Member Secretary , RAC) attended the meeting.

PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS, TRAINING ETC.

Name of workshop/ seminar	Name of officers attended
XIV workshop of research workers of All India Coordinated Research Project on Spices, 8-10 July 1997, Bangalore	K. V. Peter, S. Devasahayam, K. Kandiannan, K. Nirmal Babu, T. John Zachariah, K. S. Krishnamurthy, P. N. Ravindran, Y. R. Sarma, S. Edison & A. K. Sadanandan
National Seminar on Water and Nutrient Management for Sustainable Production and Quality of Spices, 5-6 October 1997, Mercara.	K. V. Peter, S. Edison, A. K. Sadanandan, V. S. Korikanthimath, M. N. Venugopal, K. V. Ramana, S. Devasahayam, K. S. Krishnamuthy, P. N. Ravindran, S. J. Ankegowda, Rajendra Hegde, P. Rajeev, J. Rema, S. S. Veena, Santhosh J. Eapen, M. Anandaraj & B. Sasikumar
First National Symposium on Pest Management in Horticultural Crops: Environmental Implications and Thrusts, 15-17 October 1997, Bangalore	S. Devasahayam & M.N.Venugopal
Seminar on Water Problems of Kozhikode, 23 August 1997, Calicut	S.Devasahayam
National Seminar on small millets-current Research Trends and Future Priorities as Food, Feed and in Processing for Value Addition, 23-24 April, 1997, Tamilnadu Agricultural University, Coimbatore.	S.J. Ankegowda

Western Ghat Biodiveristy Conference, 4-5 October 1997, Biodiveristy Intitiative Trust, Karkala.	V.S. Korikanthimath & P.Rajeev.
Workshop on Devarakadus- the hot spots of Biodiveristy in Coorg district, 27-28 December 1997, College of Forestry, University of Agricultural Sciences, Ponnampet.	P. Rajeev & S.J. Ankegowda
Symposium on Economically Important Diseases of Crop Plants, 18-20 December 1997, Bangalore.	M.N. Venugopal, S.S. Veena, K.V. Ramana, M. Anandaraj, Santhosh J. Eapen & Y.R.Sarma
Workshop on Introduction to General Information Service Terminal, National Informatic Centre Data Base Service, 17 May, 1997 Madikeri.	S.J. Ankegowda
National Symposium on Resurgence of Vector Borne Viral Diseases 1-3 August 1997, B.A.C.A., Gujarat Agricultural University, Anand	M.N. Venugopal
3rd IFOAM-ASIA Scientific Conference and General Assembly on Food Security in harmony with Nature, 1-4 December, 1997, UAS, Bangalore	V.S.Korikanthimath & A.K.Sadanandan
The 22nd PEPPERTECH meeting oragnised by the International Pepper community Kochi, October 6-7, 1997	K.V.Peter & T. John Zachariah
One day workshop organised by Fragrance and Flavours Association of India, Kochi, 15 November 1997,	T. John Zachariah
International Conference on Integrated Plant Disease Management for Sustainable Agriculture. 10-15 November 1997. New Delhi.	Y.R.Sarma, S.S. Veena, M. Anandaraj & A. Kumar
Hindi Workshop conducted by Town official Language Implementation Committee, Calicut on 20 and 21 October 1997	B. Krishnamoorthy

Sixth Biocontrol Workers Group Meeting-Project Directorate of Biologial Control, Bangalore 19-20 June 1997.	K.V. Ramana
Tenth Biennial Group Meeting of All India Coordinated Research Project on Plant Parasitic nematodes with Integrated Approach for Their Control. University of Agril. Sci. Bangalore 23-26 September 1997.	K. V. Ramana & Santhosh J. Eapen
Summer School on 'Problems and Progress of Nematology during the Past One Decade' at IARI New Delhi from 1-30 August 1997	Santhosh J. Eapen
International Bacterial Wilt Symposium, Guadeloupe (FWI) 22-27 June, 1997	K.V.Peter
ICS-UNIDO Training on Industrial Exploitation of Medicinal and Aromatic Plants,Beijing, China 17-27 June, 1997	T.John Zachariah
TCDC International Workshop on Application of Biofertilisers and Biopesticides, New Delhi 15-18 October, 1997	Y.R.Sarma
Training on Drip Irrigation System, CWRDM, Calicut 15-20 December, 1997	K.Kandiannan
Data Collection and Acquisition Techniques in Agricultural Meteorology, Pune, 3-17 February, 1997	K.Kandiannan

SEMINARS/ WORKSHOPS ORGANISED BY THE INSTITUTE

IISR in association with the Indian Society for spices has organised a National Seminar on "Water and Nutrient Management for Sustainable Production and Quality of Spices" on October 5-6, 1997 at Cardamom Research Centre, Appangala, Madikeri.

Inaugural session of National Seminar on "Water and Nutrient Management for Sustainable Production and Quality of Spices

There were three sessions viz. Integrated Nutrient Management, Water Use Efficiency & Developmental Problems and Strategies. Fifty three papers were presented orally and through poster. The seminar was inaugurated by Sri. M.C. Nanaiah, Hon'able Minister for Law and Parliamentary Affairs and Information and Publicity, Govt. of Karnataka. Dr. R.N. Pal, ADG (PC) ICAR and Sri. S.K. Pattanayak, Director of Horticulture, Govt. of Karnataka, Dr. G.K. Veeresh, Vice Chancellor, UAS Bangalore. Dr. K.L. Chadha, National Professor (Hort) IARI, New Delhi, Dr.B.R.Hegde, Director of Research, UAS, Bangalore and Dr.M.Velayudam, Director, NBBS&LUP attended the seminar.

Fourteenth group meeting of the research workers of **All India Coordinated Research Project on Spices** was held from 8-10 July 1998 at UAS, Bangalore. Inaugural function was presided by Dr.S.P.Ghosh, Deputy Director General (Horticulture) ICAR. Dr.G.K.Veeresh, Vice Chancellor, UAS, Bangalore inaugurated the meeting. Important dignitaries who have attended are Mr.S.K.Pattanaik, IAS, Director of Horticulture, Government of Karnataka, Dr.B.R. Hegde, Director of Research and Dr.M.C. Devaiahah, Dean, UAS, Bangalore. The centres have organised an exhibition of spices at the venue. Dr.Veeresh released the IISR Perspective Plan and Dr.S.P.Ghosh released the "Research Highlights" of AIRCP on spices. The meeting has deliberated on the various research projects operating in various centres.

DISTINGUISHED VISITORS

Name	Designation
Sri M P Veerendrakumar	Hon'ble Union minister of State for Labour
Dr. S.P Ghosh	DDG (Horticulture), ICAR New Delhi
Sri. Manoj Joshi IAS	District Collector,Kozhikode
Justice C.V N. Shastry	Judge. High Court of Andhra Pradesh
Dr. K L. Chadha	National Professor and DDG (Retd.) ICAR, New Delhi
Dr. V.L. Chopra	National Professor (Biotechnology) ICAR, New Delhi
Dr. P.Das	DDG (Extn) ICAR New Delhi
Dr. R D Sharma	Director P&I, ICAR
Dr M S Swaminathan	Eminent Agricultural Scientist & Chairman, MSSRF Chennai
Dr B.K Tripathi	Director Sugarcane Breeding Institute, Coimbatore
Dr. N. Mohanakumaran	Director of Research, Kerala Agricultural Univeristy.
Mr. N.L Srivasthava IAS	Additional Secretary, Ministry of Agriculture, Govt. Of India.
Dr C.S. Sreedharan	Prof and Head TNAU, Coimbatore
Dr. M Aravindakshan	Chairman, Coconut Board, Cochin
Dr. K V Ahamed Bavappa	Chairman QRT
Dr D J Bhagyraj	Professor & Head Dept. Of Microbiology UAS Bangalore
Dr R N Pal	Asst. Director General (PC), ICAR, New Delhi
Dr. R.P. Sethi	Chief Justice, Karnataka
Mohanlal Master	Minister of Forests, Government of Punjab

PERSONNEL

INDIAN INSTITUTE OF SPICES RESEARCH, CALICUT

Managerial

K. V. Peter Ph.D., Director

Scientific

Division of Crop Improvement & Biotechnology

P. N. Ravindran Ph.D., Principal Scientist (Plant Breeding) and Head in Charge

B. Krishnamoorthy M.Sc.(Ag.), Senior Scientist (Plant Breeding)

B. Sasikumar Ph.D., Scientist Sr.Scale (Plant Breeding)

J. Rema Ph.D., Scientist Sr.Scale (Horticulture)

K. Nirmal Babu Ph. D., Scientist Sr.Scale (Plant Breeding)

K. Johnson George M.Sc., Scientist Sr.Scale (Gen. & Cytogen) (On study leave)

K. P. M. Dhamayanthi M.Sc., Scientist Sr.Scale (Gen. & Cytogen)

R. Ramakrishnan Nair M.Sc., Scientist (Gen. & Cytogen) (On study leave)

T.E. Sheeja M.Sc., Scientist (Biotechnology)

Division of Crop Production and Post Harvest Technology

A. K. Sadanandan Ph.D., Principal Scientist (Soil Science) & Head in Charge

B. Chempakam Ph.D., Senior Scientist (Biochemistry)

T. John Zachariah Ph.D., Scientist Sr.Scale (Biochemistry)

N. K. Leela M.Sc., Scientist Sr.Scale (Organic Chemistry) (On study leave)

C. K. Thankamani M.Sc.(Ag.), Scientist (Agronomy) (On study leave)

K. Kandiannan M.Sc.(Ag.), Scientist (Agronomy)

K. S. Krishnamurthy Ph.D., Scientist (Plant Physiology)

V.Srinivasan Ph. D., Scientist (Soil Science)

Division of Crop Protection

Y. R. Sarma Ph.D., Principal Scientist (Plant Pathology) & Head in Charge

K. V. Ramana Ph.D., Principal Scientist (Nematology)

M. Anandaraj Ph. D., Senior Scientist (Plant Pathology)

S. Devasahayam M.Sc., Senior Scientist (Entomology)

K. M. Abdulla Koya M.Sc.(Ag.), Scientist Sr.Scale (Entomology)

Santhosh J. Eapen M.Sc. Scientist Sr.Scale (Nematology)

S. S. Veena Ph.D, Scientist (Plant Pathology)

A. Kumar Ph. D , Scientist (Plant Pathology)

K.S. Rajendran M.Sc (Ag.) Scientist (Plant Pathology)

Social Science Section

Jose Abraham M.A.,M.Sc., Senior Scientist (Statistics)

M. S. Madan Ph. D., Scientist Sr. Scale (Agrl.Economics)

M.V. Prasad Ph. D Scientist (Agrl.Extension)

Technical

P. Azgar Sheriff M.LIS, Technical Officer T5 (lib.)

Hamza Srambikkal M.Sc., Technical Officer T5 (lab)

M. M. Augusthy, Technical Officer (T5)

V. Balakrishnan, Technical Officer (T4)

Administration and Accounts

K. Usha, Asst. Administrative Officer

T. Gopinathan, Asst. Finance & Accts. Officer

M. K. Sachidanandan M.A., Superintendent (A&A)

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES, CALICUT

S. Edison Ph.D., Project Coordinator upto 30-07-97

A.K. Sadanandan Ph. D., P.C. in charge from 30-07-97.

C. Vasugi, M.Sc (Ag.) Scientist (Horticulture)

Johny A. Kallupurackal Ph.D., Sr. Technical Information Officer.(T7)

IISR EXPERIMENTAL FARM, PERUVANNAMUZHI

Scientific

P.A. Mathew M.Sc. (Ag.), Senior Scientist (Horticulture) and Scientist in charge

K.V. Saji M.Sc., Scientist (Eco. Botany)

Technical

V.K. Abubacker Koya, Farm Superintendent (T6)

CARDAMOM RESEARCH CENTRE, APPANGALA

Scientific

V. S. Korikanthimath Ph. D., Sr. Scientist (Agronomy) & Head

M. N. Venugopal Ph. D., Sr. Scientist (Plant Pathology)

P. Rajeev Ph.D., Scientist (Agri. Extension)

Rajendra Hedge Ph. D., Scientist (Agronomy)

S. J. Anke Gowda Ph.D., Scientist (Plant physiology)

K. Padmini M. Sc., (Ag.), Scientist (Horticulture)

KRISHI VIGYAN KENDRA, PERUVANNAMUZHI

Scientific

P. A. Mathew M.Sc. (Ag), CTO - in - charge

Technical

P. S. Manoj M. Sc. (Ag.), Tech. Officer (T6), Horticulture

K. D. Prathapan M Sc. (Ag.), Tech. Officer (T6), Plant Protection

S. Shanmugavel B. Vsc., Tech. Officer (T6) Veterinary Science

K. M. Prakash, M Sc. (Ag.) Tech. Officer (T6)

Femeena Hassan, Ph.D., Technical Officer (T6) Fisheries

ADMINISTRATIVE

V. L. Jacob, Superintendent (A&A)

OTHER ACTIVITIES IN THE INSTITUTE

ICAR - IISR annual day

Joint Annual day of ICAR & IISR was held on 16th July 1997 at Chelavoor, Kozhikode. Cross country race, eating and cooking competition, quiz and memory test, singing competition and tug of war were arranged and the staff members participated actively. Sri. M.P. Veerendra kumar, Honourable Union Minister of State for Labour was the chief guest. He has praised the activities of IISR and advised researchers to face the new challenges in the changed global scenario.

Study circle

This is a forum of scientists and other research workers to discuss research papers and other relevant information pertaining to spices research and industry. Director is the chairman and Dr (Mrs). B. Chempakam, Sr. Scientist is the secretary. Twenty one research papers were discussed and approved for publication this year. The forum also organizes theme lectures by scientists and guest lectures by visiting dignitaries.

Women cell

An executive committee with Director as chairman and five members is already functioning to cater the needs of women's issues /grievances.

अनुसंधान विशिष्टताएँ 1997

फसल सुधार एवं जैवप्रौद्योगिकी प्रभाग

आनुवंशिक संसाधनें

संस्थान का जर्मप्लासम रक्षागृह *पाइपर* स्पीसीस इलायची, अदरक, हल्दी, वैनिला एवं वृक्ष मसालों के संग्रह द्वारा समृद्ध बना दिया। इस दौरान प्राप्त प्रमुख संग्रह निम्न प्रकार है।

1. नीलगिरी, निलम्बूर, मुन्नार और पोलीबेटा से *पाइपर* स्पीसीस के 50 अक्सशनस मिले। पैकारा (ऊटी) से संग्रह किये स्पीसीस *पाइपर मुल्लेसुआ* तथा *पाइपर सैलेंटवालियेनसिस* के सदृश होता है तथा मुन्नार से लिए एक स्पीसीस *पाइपर गेलियेटम* के सदृश होता है। कन्नूर, पालोड, तेनमला और पोल्लीबेटा से काली मिर्च के 35 कृष्ट अक्सशनस के संग्रह किये।
2. इलायची के 7 निकटस्थ शाखाओंवाले तथा एक संहत पुष्प गुच्छवाले किस्मों के संग्रह किये।
3. नेडुमंगाट, आर्यनाट, कुट्टिचल, मून्नार तथा ऊटी से अदरक के 37 अक्सशनस लिये।
4. नेडुमंगाट तथा ऊटी से हल्दी के 5 अक्सशनस लिये।
5. गूडलूर से तीन *अमोमम* स्पीसीस लिये।
6. तामरश्शेरी (कालिकट) तथा एरणाकुलम से वैनिला के 9 अक्सशनस के संग्रह किये।
7. *सिनमोमम* (एक अधिक सुगन्धित प्रकार) के 12 वन्य प्रकार, *मिरिस्टिका* के दो वन्य प्रकार, *नीमा* के दो स्पीसीस, आलस्पाइस के एक अधिक पैदावार वाली किस्म, गार्सीनिया के 4 प्रकार तथा अटाओ के एक प्रकार के भी संग्रह किये।

फसल सुधार

काली मिर्च : HP 813,34,105 जैसे संकर तथा 1041 संग्रह वालपराई में उच्चतम उपज के लिए अनुरक्षित किये।

इलायची: 8×8 पूर्ण डायलील युक्त चयन RR-1, CCS-1 तथा ''कट्टे'' प्रतिरोधी किस्म NKE - 3, NKE - 9, NKE - 12, NKE - 19 NKE - 27 और NKE -34 आदि बनाया। NKE 19 x NKE 34 में 92% फल देखे गये। NKE 12 x NKE 19 (77%) तथा NKE 12 x RR -1 (69%) जिसके पीछे आता है।

अदरक : अक्सशनस 15 और 27 दूसरे क्रमिक साल में 25% सूखे प्राप्तियुक्त बहुत अच्छे निष्पादन पाये। अक्सशनस 15 में 2.5% वाष्पशील तेल तथा 3.2% कड़ा रेशा थे।

हल्दी : अधिक पैदावार तथा अधिक गुणवाले आलप्पी हल्दी अक्सशन 585 का पहचान किया गया (प्रत्येक $3m^2$ जगह में 30 कि. ग्राम स्वच्छ राइसोम है जिसमें 7% कुरकुमिन होता है)

लौंग : B-95 अधिक उपजवाले एक आशाजनक किस्म है।

पप्रिका : *कैप्सिकम अनुम* के 29 किस्मों के आकृतिक तथा जैवरासायनिक लक्षण के अनुसार PBC - 385, PBC - 066 और Kt - PI - 19 जैसे पप्रिका प्रकार उत्तम चयन के रूप में सूचित किया। PBC - 385 उत्तम रंग मूल्य (205 ASTA) था जिसके पीछे Kt-PI-19 (139.5 ASTA) तथा PBC - 066 (131 ASTA) आते हैं।

अन्तर्विशिष्ट संकरों का विशेषीकरण

पाइपर नाइग्रम × *पाइपर अटेन्युआटम, पाइपर नाइग्रम* × *पाइपर बारबरी* जैसे पाइपर के दो अन्तर्विशिष्ट संकर को आकारिकी, शरीर रचना विज्ञान, इसोज़ाइम तथा पोल्लू बीटल के प्रतिरोध के आधार पर चरित्रांकित किया गया।

डी. एन. ए. का विगलन

अदरक, हल्दी और जायफल से जीनोमिक डी. एन. ए विगलित किया।

कोशिका जननिकी एवं पुनरुत्पादी जीवविज्ञान

शबरिमला अदरक में $2n = 24$ के रूप में क्रोमसोम संख्या के वैभिन्य का पता चला। कोलचिसिन (2%) उपचार द्वारा आई. आई. एस आर वरदा के तीन चतुर्गुणित पौधे उत्पादित किये। जायफल का द्विगुणित क्रोमसोम संख्या $2n = 38$ है।

विकासात्मक आकारिकी

अदरक एवं हल्दी में ट्रयाकोन्टानोल, पाक्लोबुट्राजोल और GA_3 होरमोन की वृद्धि के प्रभाव का अध्ययन किया गया। इनमें GA_3 ने अदरक पौधों में प्रोकाम्बियल आक्टिविटी, सैलम, फलोयम तथा रेशा में डायमनशनल विविधता, बाह्य चर्म में घने उपचर्म तथा कम रेशा आदि की संवृद्धि की। हल्दी GA_3 द्वारा कोश आकार और संख्या, स्टार्च निक्षेपण आदि बढा दिये। लेकिन पाक्लोबुट्राजोल हल्दी का बौनापन किया।

प्रवर्धन

काली मिर्च की 20 किस्में तथा पी. कोलुब्रिनम को, जो फाइटोफतोरा काप्सीसी के प्रतिरोधी बनता है प्रकन्द के रूप में लेने पर कामयाबी कलम पाये गये।

2. आलस्पाइस कतरन को IBA 2500 ppm + NAA 2500 ppm के साथ चारकोल उपचार करने पर 63% मूलन पाया।

जैवप्रौद्योगिकी

1. तापमान, प्रकाश तथा आर्द्रता नियंत्रण युक्त एक कठोरीकरण सुविधा स्थापित किया।
2. *वैनिला प्लानिफोलिया* (♀) *वी अफिल्ला* (♂) के बीच एम्ब्रयो रेस्कयू प्रविधियों का प्रयोग करके अन्तर्विशिष्ट संकरण पाया गया।
3. शीर्ष प्ररोह और लीफ एक्सफ्लान्ट्स का प्रयोग करके *कैप्सिकम अनुम* में पौध पुनर्जनन अच्छी तरह निवृत्त किया।
4. *सी. अन्नुम* से प्रोटोप्लास्ट्स विगलित किया गया।
5. कढी पत्तों (मुराया कोयनिगी) के सूक्ष्म प्रवर्धन प्रोटोकॉल मानकीकृत किया।

फसल उत्पादन एवं फसलोत्तर प्रौद्योगिकी का प्रभाग

फसल उत्पादन

कृषि क्रियात्मक अनुशीलन

काली मिर्च के ओ पी किस्म पी 24 ने रोपण के चौथे साल अधिकतम वितान ऊँचाई 504 से. मीटर तथा अर्द्धव्यास 117 से. मीटर अर्जित की। इसके पीछे पन्नियूर - 1 (492 से. मी और 105 से. मी) आते है तथा सबसे कम पन्नियूर - 3 और शुभकरा (313 से. मी और 77.7 से. मी) का होता है। मूल्यांकन किए गए 10 किस्मों में पन्नियूर- 5 प्रतिबेल 2734 ग्राम के अधिक स्वच्छ उपज दिये जिसके पीछे शुभकरा (प्रतिबेल 1337 ग्राम) आता है।

जैव उर्वरक

काली मिर्च के *अजोसपिरिल्लम* फोस्फो बाक्टीरिया तथा वसिकुलर अरबुस्कुलर माईकोहिज़े (VAM)खुद या मिश्रण करके मृदा निवेशन करने पर जैवमात्रा, शूखे उपज तथा पोषक पदार्थो की भी वृद्धि होती है।

मसालाधिष्ठित सस्यक्रम योजना

वृक्ष मसालों (लौंग, जायफल, दालचीनी और आलस्पाइस) काली मिर्च और अरबिका कॉफी के साथ मुख्य फसल के रूप में इलायची का सस्य संयोजन पाँचवें साल मूल्यांकन के अधीन होते हैं।

पोषक आवश्यकताएँ

1. काली मिर्च के लिए प्रति हेक्टर 150, 60 और 270 किलो ग्राम के दर में नाइट्रजन, फॉस्फारेस, पोटैशियम लगाने के साथ Zn, B और Mo प्रति हेक्टर 5, 2, 1 किलोग्राम के दर में लगाने पर 134% उपज वृद्धि हुई।

2. हल्दी में रॉक फॉस्फाइट प्रति हेक्टर 25 किलोग्राम के साथ FYM प्रति हेक्टर 100 टन तथा Zn, B और Mo जैसे सूक्ष्म पोषक प्रति हेक्टर 5, 2, 1 किलो ग्राम के दर में लगाने पर 27% उपज वृद्धि हुई।
3. FYM और ग्लिरिसिडिया के पत्तों के साथ गमले में केंचुआ उपस्थापित करने से काली मिर्च, अदरक एवं हल्दी की पोषक उपलब्धता में वृद्धि हुई।
4. हल्दी में नारियल जटा कम्पोस्ट (टेरा केर) + नीम केक + रासायनिक उर्वरक लगाने पर केवल रासायनिक उर्वरकों की तुलना में 53% अधिक उपज मिले।
5. अदरक में नारियल जटा कम्पोस्ट (टेरा केर) + FYM लगाने पर एकमात्र रासायनिक उर्वरक लगाने की अपेक्षा 85% उपज की वृद्धि हुई।

संरक्षित बुश पेप्पर खेती

बुश पेप्पर की संरक्षित खेती के लिए अधिक घनत्व (प्रत्येक 140m^2 में 350 गमले) युक्त प्रविधियाँ मानकीकृत किया। ऐसी खेती से पहले वर्ष प्रत्येक गमले से 150 ग्राम सूखे काली मिर्च पाया। इसमें फाइटोफतोरा का कोई आपतन नहीं है।

केन्द्रक रोपण सामग्रियों का उत्पादन

काली मिर्च के एक लाख मूल लगाए कतरन, काली मिर्च के 500 लेटरलस (बुश पेप्पर), इलायची के 12000 सीडलिंग्स, इलायची के 550 पौधे (सकेर्स) तथा 29 कि. ग्राम बीज कैप्स्यूल, 30 टन हल्दी, 5 टन अदरक, जायफल के 2500 कलम, दालचीनी के 3000 सीडलिंग्स, लौंग के 2000 सीडलिंग्स, आलस्पाइस के 2500 सीडलिंग्स तथा वैनिला के 8000 मूल लगाए कतरन आदि का उत्पादन और वितरण किया गया।

काली मिर्च में सूखा सहयता

फिसियोलजिकल पैरामीटर जैसे कोशिका झिल्ली स्थिरता, संबन्धित जलांश, रंध्री प्रतिरोध और बाष्पोत्सर्जन दर के आधार पर काली मिर्च के 1493 तथा 1372 अक्सशनस को सूखा सह्य देखे गये।

पक्वपूर्व तथा फसलोत्तर अनुशीलन

परिपक्वता की दशा में रासायनिक परिवर्तन :-

काली मिर्च के सुगन्धित तेल के मोनो तथा सेसक्विटरपेन्स के स्तर पुष्पण के 120 दिन के बाद बहुत कम होती है जिसमें पुष्पण के 160-180 दिन के बाद आकस्मिक वृद्धि दिखाई पडती है तथा फिर परिपक्वता तक स्थिर रहती है। 15 अदरक अक्सशनस के बीच परिपक्वता की विभिन्न अवस्थाओं में तेल, ओलिओरसिन तथा कड़ा रेशा के स्तर में उपजातीय तथा भूमि जलवायु का प्रभाव देखे गये।

सफेद काली मिर्च

सफेद काली मिर्च तैयार करने के लिए, तोड़े गये काली मिर्च फल पर एथरल छिड़ककर पक्वन को शीघ्र बनाके गलाने का समय कम कर सकते है।

नमकीन अदरक

अदरक के रंग, बाह्याकृति, स्वाद तथा गठन आदि के आधार पर 35,64,71, 117 तथा 179 जैसे अक्सशनस नमकीन अदरक बनाने के लिए अच्छा देखा गया।

अधिक कुरकुमिनवाले हल्दी किस्में

आलप्पी संचयन के Acc - 583, 585, 605, 608 तथा 630 एवं आन्ध्रप्रदेश संचयन के 650, 651 और 691 में 6.5% से अधिक कुरकुमिन थे।

अधिक गुणवाली कैसिया किस्में

C-5, C-7, D-7, D-3, B-1, D-1, B-2, A-7, D-6, और D-2 आदि कैसिया किस्मों में अधिक पर्ण तेल, छाल तेल तथा छाल ओलिओरसिन होता है।

अदरक एवं हल्दी के आइसोजाइम विशेषीकरण

77 हल्दी एवं 14 अदरक अक्सशनस के पोली अक्रिलर्मेड जेल इलकट्रोफोरसिस (PAGE) द्वारा विशेषीकरण करने पर अदरक (85-100%) की अपेक्षा हल्दी में (39-100%) अधिक भिन्नता दिखाई पडी। हल्दी में 10 भिन्न भिन्न गुच्छों तथा अदरक में 2 गुच्छों को डेन्ड्रोग्राम्स द्वारा स्थापित किया।

फसल संरक्षण प्रभाग

पौध रोगविज्ञान

जैविक नियंत्रण :-

1. काली मिर्च के मूल परिवेषी से विगलित किए *वेर्टिसिलियम टेनेरेम फाइटोफतोरा काप्सीसी* का विरोधी होता है। कॉपर सहय *ट्राइकोडरमा* की एक नयी किस्म भी विगलित की गयी।
2. तीन कवगीय परजीवी जैसे *पेनिसिलियम फेल्लुटानुम* वौरगे, *पेसिलोमाइसस* लिलासिनस (थोम) सांसन और *वेर्टिसिलियम लेकानी* (ज़िम) विगनस को *पेन्टलोनिया निग्रोनेरवोसा* एफ *कलाडी* जैसे कीट से पहली बार विगलित किया।
3. केरल, तमिलनाडु तथा कर्नाटक में *फाइटोफतोरा* के प्रति 2254 हेक्टर जगह में जैविक नियन्त्रण का प्रदर्शन किया गया।

ट्राइकोडेरमा के लिए नया माध्यम

ट्राइकोडेरमा तथा *ग्लियोक्लाडियम* की बडी मात्रा में गुणन के लिए सारे कृषि रद्दी वस्तुओं की अपेक्षा रद्दी चाय अधिक उत्तम होता है। रद्दी चाय में 21 दिन के बाद प्रतिग्राम 1780×10^6 के रूप मे *ट्राइकोडेरमा* बीजाणु तथा 28 दिन के बाद प्रतिग्राम 829×10^5 के रूप में *ग्लियोक्लाडियम* बीजाणु को समेटते है।

हेतुविज्ञान

डयरेक्ट आंटिजेन कोटिंग (DAC) एलिसा से इलायची के "कोक्के कन्तु" रोग वाहक पोटीवाइरल जैसे कणों को देखा गया।

रोग प्रतिरोध

1. *फाइटोफतोरा काप्सीसी* के सह्य काली मिर्च के 11 संकर किस्मों जैसे HP 1786, 756, 1380, 1728, 754, 1344, 1382, 1748, 478, 92 तथा 490 का पहचान किया गया। उनके अतिरिक्त मूल्यांकन चालू हो रहे।
2. रोगजनन के समय काली मिर्च के सह्य किस्मों में आर्थोडिहाइड्रोक्सी फिनोल का संचय तथा अतिरिक्त एलक्ट्रोफॉरटिक बैन्ड्स को देखा गया।
3. बडी मात्रा में प्रदर्शन परख करने पर काली मिर्च के ओ. पी. किस्म पी 24 फाइटोफतोरा काप्सीसी के प्रति खेत प्रतिरोध दिखाये जाते हैं।
4. इलायची में "कोक्के कन्तु" के प्रति 34 रोगमुक्त पौधों को देखा गया।

रोग प्रबन्ध

1. पोटैशियम फॉस्फोनइट का छिड़काव, प्रति बेल। किलो ग्राम के दर में नीम कैक लगाना तथा जैवनियन्त्रण एजेंट युक्त एकीकृत रोग प्रबन्ध करने पर काली मिर्च में रोग आपतन कम मात्रा में अंकित किया।
2. रिडोमिल मानकोज़ेब के साथ राइज़ोम का उपचार तथा *ट्राइकोडेरमा हर्ज़ियानम* मिट्टी में लगाने से अदरक एवं हल्दी का राइजोम राट कम हो गया।

कीट विज्ञान

स्वाभाविक शत्रुओं का प्रलेखन

काली मिर्च पर बाधित मीली बग (*प्लानोकोकस स्पीसीस*) पर होनेवाले ब्लेपिरस इनसुलारिस (एनसिरटिडे); संचित अदरक एवं हल्दी पर बाधित सिगरट बीटल (लासिओ डेरमा सेरिकोर्न) पर होनेवाले *अनिसोप्टेरोमालस* कलान्ड्रे (प्टेरोमालिडे); लौंग पर बाधित शील्ड शल्क (पुलरिनारिया सिडि) पर होनेवाले *मेगोमाटा स्पीसीस* (सेसिडोमिडे) तथा दालचीनी पर बाधित लीफ माइनर

(कोनोपोमोरफा सिविका) पर होनेवाले सिंपिसिस डोलिकोगास्टर (यूलोफिटे) जैसे मसालों के कीटों के प्रमुख स्वाभाविक शत्रुओं का प्रलेखन किया।

जैविक नियन्त्रण

1. कालीमिर्च पर बाधित मसल शल्क (लेपिडोसाफस पाइपरिस) का नियन्त्रण करने के लिए *कोक्सिनेल्लिड* परभक्षी *चिलोकोरस निग्रिटा* के अंडे प्रति बेल 125 के दर में जारी करने पर (7-10 दिन के अन्तराल में 5 बार जारी करना) उसकी संख्या 44.5% के रूप में घट गया।
2. नारियल शल्क (अस्पिडियोटस डिस्ट्रक्टर) के प्रति कोक्सिनेल्लिड परभक्षी *सी. सरकुमडाटस* के 85 लार्वे (7-10 दिन के अन्तराल में 5 बार ज़ारी करना)जारी करने पर शल्क कीट 68.5% तक घट गये।
3. इलायची अफिड के लिए अफिड्स के एक परभक्षी ग्रीन लैसिंग (*चिसोपेरला कार्निया स्टीफन्स)* उत्तम परभक्षी बन गये।

जैवनियन्त्रण एजेंटों के लिए कीटनाशी की विषाक्तता

नीम का तेल (0.3%) नीमगोल्ड (0.3%) और मच्छली तेल रोसिन (3%) परभक्षी *सी. नाइग्रिटा* के लिए सुरक्षित पाए गए जबकि मोनोक्रोटोफोस (0.1%) और डायमेतोयट (0.1%) उपचार के क्रमशः 7 और 1 दिन बाद तक विषाक्त रहते हैं।

नेमटोलजी

प्रतिरोध छानबीन

19 अदरक अक्सशनस *मेलोयडोगाइने इनकोग्निटा* के प्रति प्रतिरोधक देखे गये। हल्दी अक्सशन 84 *एम. इनकोग्निटा* के प्रति ज्यादा प्रतिरोध पाया गया।

जैविक नियन्त्रण

बैक्टीरिया के तीन विगलित इनविट्रो प्रभावन के 6 घंटों के अन्दर रूट नॉट नेमटोड के 100% निरोध दर्शाये। *वेर्टिसिलियम क्लामिडोस्पोरियम* तथा *पास्टेरिया पेनिट्रान्स* दोनों इलायची के रूट नॉट नेमटोड निरोध केलिए उत्तम पाए गए। इन दोनों से इलयाची सीडलिंग्स की वृद्धि हुई।

सामाजिक विज्ञान

कुरुमुलकु संरक्षण समितियों की प्रभाविता

केरल में काली मिर्च उत्पादन में काली मिर्च कल्याण समितियों (कुरुमुलकु संरक्षण समिति) के प्रभाव के मूल्यांकन के लिए एक अनुशीलन आयोजित किया। विभिन्न कारणों के फलस्वरूप समिति के बारे में किसानों का अवबोधन सन्तोषजनक है। किसान साधारणतया फसल तोड़ने का सही समय, सस्यक्रम

योजना, कालीमिर्च संसाधन तथा सुधारित किस्मों को स्वीकार करने के संबन्ध में उपदेश लेता है। कृषि भवनों, सहकारी बैंकों, ऐच्छिक संगठनों तथा अन्य निवेश एजेंसियों के साथ समिति के संबन्ध को सुदृढ बनाना चाहिए। सरकार को इसका प्रोत्साहन करना चाहिए, ताकि किसानों को इसके कार्य में ज्यादा रुचि हो जाय।

प्रशिक्षण कार्यक्रम

उक्त साल कृषि अधिकारियों, कृषि छात्रों तथा रोपण अधिकारियों के लिए 7 प्रशिक्षण कार्यक्रम आयोजित किये गये। ये कार्यक्रम ''मसाले उत्पादन प्रौद्योगिकी'', ''नर्सरी प्रबन्ध'' तथा ''खेतीगत संसाधन'' पर थे।

सुधारित प्रविधियों का प्रदर्शन

निम्न स्तर के दलदली क्षेत्र उत्पादन के लिए अनुचित है। अप्पंगला (कर्नाटक) में किसी भी वाणिज्यिक रोपण फसलों को लाभदायी इलायची खेती में सफल रुप से परिवर्तित किया गया।

मसालों पर अखिल भारतीय समन्वित अनुसंधान प्रायोजना

मसालों पर अखिल भारतीय समन्वित अनुसंधान प्रायोजना ने इलायची (ICRI - 4),आम अदरक (अम्बा) और बडी सौंफ (गुज फेन - 2) जैसे तीन नये किस्मों को ज़ारी करने के लिए संस्तुत किया। ICRI -4 अगेती परिपक्वता तथा बोल्ड कैप्स्यूल युक्त मलबार प्रकार है जिसका उपज वर्षाधीन दशा में प्रति हेक्टर 455 किलोग्राम होता है।

IW/CPE 0.25 (8-10 दिन के अन्दर एक बार 100 लिटर) के अनुपात में दिसंबर - अप्रैल के समय सिंचाई करने से सिंचाई रहित की अपेक्षा 72% अधिक उपज प्राप्त होते हैं। कर्नाटक में प्रकृतिक छाया के अधीन इलायची खेती करने के लिए प्रति हेक्टर 75:75:150 किलोग्राम की मात्रा में NPK उर्वरक डालने के लिए संस्तुत किया।

शल्क कीटों को रोकने के लिए हल्दी के बीज राइजोम को 15 मिनुट मोनोक्रोटोफोस (प्रतिलिटर पानी के लिए 2 लिटर के दर में) उपचार करने की सिफारिश की जाती है। राईज़ोम राट से बचने के लिए बाविस्टिन उपचार (प्रतिलिटर 2 ग्राम) संस्तुत है।

कृषि विज्ञान केन्द्र ने किसानों, ग्रामीण युवकों तथा विस्तार कर्मचारियों के लिए 49 प्रशिक्षण कार्यक्रम तथा 5 प्रदर्शन आयोजित किये। दो नये कार्यक्रम एक मानसिक वैक्ल्यवालों के लिए हार्टिकल्चरल तेरापी पर तथा दूसरे नबार्ड द्वारा प्रायेजित एक ऐच्छिक विकास वाहिनी क्लब के संगठन पर, कल्लानोट (कालिकट) में आयोजित किये।

परामर्श संसाधन सेल

संस्थान ने इस सेल के अधीन करार अनुसंधान सेवा तथा परामर्श लिया है। करार अनुसंधान के अधीन डॉ ए. के. सदानन्दन मुख्य अन्वेषक होकर ''मसालों की वृद्धि, पोषक उपलब्धता, उपज का प्रभाव तथा गुणवत्ता के लिए टेरा केर का मूल्यांकन'' पर 6 लाख रुपये वित्तीय पूंजी परिव्यय युक्त एक

प्रायोजना अब चालू हो रही है। डॉ वाई. आर. शर्मा अदरक के रोगनियन्त्रण के लिए इन्डो स्विस प्रोजकट, सिक्किम के लिए परामर्शादाता के रूप में कार्य कर रहे हैं।

संगोष्ठियाँ

इंडियन सोसाइटी फॉर स्पाइसस ने भारतीय मसाले फसल अनुसंधान संस्थान, कालिकट के सहयोग में ''मसालों के पर्याप्त उत्पादन एवं गुणवता के लिए पानी तथा पोषण प्रबन्ध'' पर कर्नाटक के मटिकेरी में 5-6 अक्तूबर 1997 को एक राष्ट्रीय संगोष्ठी आयोजित की। इस संगोष्ठी में तीन तकनीकी अधिवेशन जैसे एकीकृत पोषण प्रबन्ध, पर्याप्त पानी उपयोग तथा विकासात्मक समस्याएँ और समाधान थे।

1997 में उत्तम कार्य के लिए प्राप्त पुरस्कार

1. मल्टी डिसिप्लिनरी रिसर्च इन अग्रिकल्चर आन्ट अलाइड सायनसस के लिए भारतीय कृषि अनुसंधान परिषद का दल पुरस्कार:

डॉ. पी. एन रवीन्द्रन, डॉ के निर्मल बाबु, डॉ जे. रमा, डॉ बी शशिकुमार, डॉ के समसुद्धीन, श्रीमती मिनू दिवाकरन, कुमारी गीता एस पिल्ले, श्रीमती ए सजिना श्रीमती. मिनी पी मत्तायी, श्री. जॉन सी ज़करिया और श्रीमती सी. मंजुला को मल्टी डिसिप्लिनरी रिसर्च इन अग्रिकल्चर आन्ट अलाइड साइनसस पर बागवानी विज्ञान में 1994-96 के तीन साल के उत्कृष्ट देन के लिए भारतीय कृषि अनुसंधान परिषद का दल पुरस्कार मिला।

2. भारतीय कृषि अनुसंधान परिषद के हरी ओम आश्रम ट्रस्ट अवार्ड:

डॉ. वी. एस. कोरिकांतिमत, डॉ. एम. एन वेणुगोपाल, डॉ राजेन्द्र हेग्डे और डॉ रवीन्द्र मुल्गे को अनुसंधान कार्य ''इलायची में स्थान विशिष्ट उच्च उत्पादन तकनोलजी का विकास तथा किसानों के खेत में उसका प्रदर्शन'' के लिए भारतीय कृषि अनुसंधान परिषद के हरी ओम आश्रम ट्रस्ट अवार्ड मिला।

3. भारतीय कृषि अनुसंधान परिषद के युवा वैज्ञानिक पुरस्कार:

डॉ राजेन्द्र हेग्ड् को अनुसंधान योजना ''पर्याप्त इलायची खेती के लिए आरगानिक तथा जैविक पोषण श्रोत युक्त रासायनिक उर्वरकों का प्रतिस्थापन'' के लिए भारतीय कृषि अनुसंधान परिषद के युवा वैज्ञानिक पुरस्कार मिला।

4. डॉ. जे. एस. प्रुति पुरस्कार:

डॉ बी. शशिकुमार, श्री जॉनसन के जॉर्ज, डॉ टी जॉन ज़करिया डॉ (श्रीमती) एम. जे. रत्नाम्बाल, डॉ के निर्मल बाबु तथा डॉ. पी. एन. रवीन्द्रन को स्पाइसस आन्ट अरोमटिक क्रोप्स पत्रिका के बाल्यूम 5, 1996 में प्रकाशित उत्तम अनुसंधान पत्र के लिए डॉ. जे. एस. प्रुति पुरस्कार मिला।

अनुवाद : एन. प्रसन्नकुमारी

संपादन : श्री. बी. कृष्णमूर्ति

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