ANNUAL REPORT
1998



INDIAN INSTITUTE OF SPICES RESEARCH
(Indian Council of Agricultural Research)
Calicut - 673 012, Kerala.

INDIAN INSTITUTE OF SPICES RESEARCH

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ANNUAL REPORT
1998

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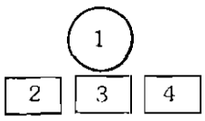

1. P-24 Pepper berries
2. High quality Nutmeg & Mace
3. High quality Clove buds
4. Dry ginger from IISR, Varada

Back cover: P-24 *Phytophthora* tolerant Pepper vine

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PREFACE

Production of spices in India during 1998 showed increase in black pepper (57,270 tonnes), large cardamom (5,390 tonnes) and ginger (2,33,660 tonnes). Reduction was recorded in chilli (8,21,800 tonnes), turmeric (4,87,400 tonnes) and small cardamom (7,150 tonnes). The unofficial estimates of production during 1998-99 show an all time record of about one-lakh tonnes in black pepper and one million tonnes in chilli, causing fall in unit price detrimental to farmers. A shortage in production of dry ginger especially for export has boosted up unit price to a level uncompetitive in international trade. Export of spices and spice products registered a 17% increase in 1998-99 touching Rs. 1,650.03 crores against Rs.1,408.3 crores during 1997-98. In dollar terms, earnings increased by four per cent (US $ 393.9 million from US $ 378.72 million during 1997-98). The volume of export declined by 8% from 2.288 lakh tonnes during 1997-98 to 2.103 lakh tonnes during 1998-99.

There was effective management of *Phytophthora* foot rot in black pepper in Kerala by following the integrated disease management strategy formulated by the Institute along with Kerala Agricultural University. The survey on the effectiveness of the IPM strategy, to control *Phytophthora* foot rot over 86,000 ha in Kerala alone, implemented from 1992 onwards at a total cost of Rs. 28 crores, is in progress. The stunted disease in black pepper and incidence of mealy bugs are receiving research attention. Productivity in cardamom has gone up to 154 kg/ha and the unit price touched Rs. 633.73/kg. Incidence of 'Kokke kandu' has been contained through uprooting of infected plants and through quarantine. Sources of resistance to *Meloidogyne sp.* was identified in ginger. Biocontrol agents, *Verticillium chlamydosporium*, *Trichoderma* sp. and VAM were found effective against nematodes. A black pepper collection (1041) from Idukki (Kerala) is also found tolerant to *Phytophthora* foot rot. In ginger, Acc. 35 and 117 were found better consistently with 25% dry recovery and fiber content lesser than 3.5%. In clove lines, B.955 and B.59 are promising. Exploiting somaclonal variation through tissue culture and bold rhizome types have been done in ginger. Evaluation of soft rot resistant lines in ginger developed through *in vitro* callus culture is in progress. The technology of salted ginger production is now

ready for transfer. The hitech horticulture in bush pepper is being demonstrated. The Institute collaborates effectively with the Indo-Swiss Project Sikkim to manage eye rot, dry rot and bacterial wilt of ginger in Sikkim.

The year 1998 witnessed growth in infrastructure for strengthening the spices research to enter the next millenium. A National Informatics Centre on Spices was initiated. A pilot plant to mass multiply biocontrol agents was established. Two main laboratories to intensify research on *Phytophthora* were established. The Cardamom Research Centre, Appangala was proposed for upgradation into a Regional Station. The All India Coordinated Research Project on Spices with 20 Centres spread over the country could identify location specific technologies to boost up productivity in spices. The Krishi Vigyan Kendra imparted on campus and off campus training programmes on agriculture including animal husbandry and fisheries.

The budget was a sum of Rs. 130 lakh (Plan) and Rs. 228.53 lakhs (Non-Plan) apart from 100.5 lakhs from ad-hoc research schemes from A.P. Cess Fund, KVK, IPDS and DBT. During the year, one lakh cuttings of black pepper, 25 tonnes of turmeric, 2000 grafts of nutmeg and 5000 cinnamon seedlings were distributed. The Institute continued as a Post-Graduate Centre for doctoral research recognised by the Calicut University and Kerala Agricultural University.

(K.V. PETER)
DIRECTOR

EXECUTIVE SUMMARY

CROP IMPROVEMENT AND BIOTECHNOLOGY

GENETIC RESOURCES

Black pepper: Twenty four accessions of wild *Piper* species and nine cultivars were collected during the year. A data base programme for genetic resources of spices at IISR was developed using MS-Access-97.

Ginger: Eight new accessions were added to the germplasm from Kalimpong (Bhasey and Nangrey), Nepal (3), Delhi (1), Palampur (1) and Kanpur (1).

Turmeric: Three *Curcuma* spp. and one cultivated type each from Andhra Pradesh and Nepal were added to the germplasm.

Vanilla: *Vanilla pilifera* and *Vanilla valsalae* were collected from Tropical Botanical Garden Research Institute, Palode, Thiruvananthapuram on exchange with *V. andamanica.*

Tree spices: Fourteen accessions of *Garcinia* sp., four accessions of *Cinnamomum* sp., and one accession of *Myristica fatua* var. *magnifica* (female) were added to the germplasm.

CROP IMPROVEMENT

The black pepper hybrid HP 105 maintained superiority in yield at Valparai (4.8 kg/vine) followed by Coll. 1041 (4.25 kg/vine). Other promising black pepper hybrids at Valparai are HP-728, HP-813, HP-34 and HP-778. Coll. 1041, a Neelamundi clone was completely free from *Phytophthora* foot rot disease after 9 years of planting.

- Grafts of twenty varieties of black pepper have been found to grow satisfactorily on *P. colubrinum* root stock in the first year of planting.
- Among the bold rhizome selections of ginger Acc. 15 and Acc. 27 continued to perform well.
- Alleppey finger turmeric (AFT) Acc. 585 continued to maintain superiority in yield and quality.
- Evaluation of Chinese cassia (*Cinnamomum cassia*) indicated that accessions A1 and C1 had high bark oleoresin (10.2 and 10.5 %) and D1, D3

and D5 had high bark oil (4.7, 4.9 and 4.3%) with high cinnamaldehyde content (86.5, 90.5 and 85.5%).

- Grafting of nutmeg on root stocks of *Myristica malabarica* and *M. bedomeii* through soft wood grafting was successful.

- Among the Byadgi paprika collections made this year, the colour value ranged from 100 to 500 ASTA units. K-11, K-17, K-24 and Y-6 showed more than 400 ASTA value.

BIOTECHNOLOGY

- Successful transformation of black pepper somatic embryos, leaves and embryogenic calli of ginger and cardamom was achieved using *Agrobacterium* as well as biolistics mediated transformation. Putative transgenics were regenerated from ginger and cardamom calli on selection medium. DNA was isolated from 14 lines of vanilla for conservation as well as for development of RAPD profiles.

- High elevation *Piper* sp. Like *P. silentvalleyensis, P. wightii, P. mullesua* and *P. schmidtti* were successfully established using hardening facility.

CROP PRODUCTION AND POST HARVEST TECHNOLOGY

Production of nucleus planting materials

Nucleus planting material of black pepper rooted cuttings (1 lakh), black pepper rooted laterals (1500), turmeric seed rhizome (25t), ginger seed rhizome (3t), nutmeg grafts (2500), cinnamon seedlings (5000), allspice seedlings (2000) and vanilla rooted cuttings (10,000) were produced and distributed.

Plant nutrition

In acid soil, rock phosphate (Rajphos/Mussoorie phos/Gufsa phos) was a good source of phosphorus for ginger and turmeric. The agronomic efficiency of these materials could be effectively increased by incubating with Farm Yard Manure (FYM) by which P application could be reduced to half the recommended dose.

Cultivation of vanilla and cardamom with coconut

Vanilla could be successfully grown in coconut gardens with 1.5 x 1.5 m spacing on *Gliricidia* standards leaving apart 3m radius all around the coconut palm trunk (base). Cardamom could also be grown successfully under coconut at a spacing of 1.5 x 1.5m.

Drought tolerance

Preliminary screening of black pepper and *Piper* sp. to water stress tolerance based on catalase, acid phosphatase, superoxide dismutase and peroxidase activities and relative water content and solute leakage percentage indicated that *P. colubrinum* was relatively susceptible while *P. chaba* and *P. longum* were relatively tolerant to water stress.

Pre and post harvest studies

- For preparation of white pepper treating ripe black pepper berries with 1000 ppm ethephon reduced the retting period considerably (>50%) without affecting appearance and quality.
- Employing 'Dosi fiber' or similar automated unit for extracting crude fibre in ginger was found to yield rapid, consistent and accurate results compared to conventional fibre estimation.
- Among the ginger accessions evaluated for chemical quality Acc. 418 and 420 had high essential oil (>2%) and oleoresin (>6%) contents.
- Phenylalanine ammonia lyase (PAL), the key enzyme involved in curcumin biosynthesis in turmeric, exhibited higher activity in the early stages of rhizome development (150-180 days after planting) indicating higher rate of synthesis of curcumin precursors. The enzyme activity was low in both leaves and roots concomitant with a low level of curcumin in these tissues.

Plant products

Two crystalline compounds with nematicidal activity were isolated from *Piper colubrinum* leaves.

CROP PROTECTION

PLANT PATHOLOGY

Disease resistance

- Five *Phytophthora* tolerant black pepper lines were identified. The already identified tolerant line, P24, continued to perform well at Sirsi (Karnataka) and Peruvannamuzhi (Kerala) and the yield ranged from 0.8 kg to 9.75 kg green/vine. A dry recovery of 40% was also recorded. 1, 3-glucanase was identified as a marker associated with tolerance to *P. capsici* in black pepper.
- The breeding potential of *Pentalonia nigronervosa*, the aphid vector of Katte disease of cardamom, was studied on 17 Katte resistant lines. There was no feeding deterrance in any of the resistant lines indicating that resistance is due to other host factors and not due to feeding deterrance.
- Apart from Biovar-3 of *Ralstonia solanacearum*, an aberrant biovar-3, which is dulcitol negative, was found to infect ginger in Wynad region in Kerala and also in Sikkim.
- Based on ELISA test *Piper colubrinum* was found susceptible to stunted disease of black pepper.

Disease management

- Spraying potassium phosphonate resulted in better inhibitory effect on foliar infections of *P. capsici* in black pepper compared to drenching, and maximum effect was noted on 4th day after spraying. The effect declined after 8 days.
- Pot culture experiments with fungal biocontrol agents and fluorescent pseudomonads alone and in combination with potassium phosphonate showed efficacy of biocontrol agents in controlling foot rot infection and their compatibility with potassium phosphonate.
- Among three carrier media used for mass multiplication of *Trichoderma*, the shelf life of talc was low compared to coir pith. After 3 months, no colony of *Trichoderma* could be recovered in talc.

- *Trichoderma* isolates were screened for antagonism to *P. capsici* using dual culture technique. *T. virens* (21 isolates), *T. aureoviride* (27), *T. hamatum* (23 isolates), *T. harzianum* (20 isolates) and *T. pseudokoningii* showed varying degrees (0-84%) of inhibition.
- More than 80% of farmers who have adopted application of *Trichoderma harzianum* in the control of *Phytophthora* foot rot of black pepper have confirmed its efficacy.

Integrated management of rhizome rot of ginger

Demonstration trials conducted at farmers' fields revealed that seed treatment with fungicide (Ridomil mancozeb) and soil application of *Trichoderma harzianum* reduced rhizome rot of ginger significantly.

Repository of *Phytophthora* isolates

A national repository of *Phytophthora* (National Network on *Phytophthora* Diseases of Horticultural Crops) cultures comprising of 333 isolates from plantation crops, spices and other horticultural crops are being maintained.

Phytophthora infections have been reported for the first time on vanilla, bauhimia, nutmeg, coffee and *P.chaba*.

Biofermenter

A biofermenter has been installed at IISR, Calicut with the technical help of Regional Research Laboratory, Jammu.

ENTOMOLOGY

Host resistance

Screening of 11 wild *Piper nigrum* accessions and six high yielding released varieties of black pepper against pollu beetle, a major pest of black pepper indicated that all of them were susceptible to the pest.

Incidence of mealy bugs on black pepper

The incidence of mealy bugs on roots of black pepper at Wynad was more severe during monsoon period (20 to 80 % of vines infested) when compared to summer (4.4 to 17.8% of vines infested).

Mass culturing of mealy bugs

Pumpkins (*Curcurbita moschata*) and squashes (*Cucurbita pepo*) were found most suitable for mass culturing of root mealy bugs of black pepper in the laboratory.

Pest management

Drenching the affected vines with chloropyriphos 0.1% or quinalphos 0.1% was more effective for the management of root mealy bugs on black pepper.

Adoption of cultural practices such as pruning of infested shoots during July-August along with spraying malathion 0.1% or monocrotophos 0.075% during September-October was promising for the management of shoot borer on ginger.

NEMATOLOGY

Host resistance

Among the 60 black pepper lines tested against root knot nematodes, 4 cultivars (Acc. 4103, 4175, 334 and 1090) and 4 wild accessions (Acc. 3219, 3286, 3287, 3311) were resistant in the preliminary screening tests. Reinoculated resistant lines of ginger and turmeric were found promising.

Mechanism of nematode resistance

Activity of superoxide dismutase and catalase was very high in the root knot nematode susceptible line (Panniyur-1) compared to that of Pournami (a resistant line) while polyphenol oxidase activity was consistently high in Poumami.

Population variability in root knot nematodes

Variability for esterase and malate dehydrognase isozymes was observed among the 12 root knot nematode populations.

Biological control of nematodes

1 Eleven fungi and 7 bacteria were isolated from soil samples collected from healthy black pepper vines in sick plots. Three fungal isolates (F5, F6 and 11/3b) and six bacterial isolates (1,3,4,8,9 and 10) possessed nematicidal

properties. Three isolates of *Pastueria penetrans* were collected from ginger soil samples collected from Sikkim, Wynad and Kasaragod. Secondary metabolites from mycelial fragments of *T. harzianum* were also nematicidal.

- A biocontrol laboratory was set up for intensifying the work on biological control of nematodes.

SOCIAL SCIENCE

TRAINING PROGRAMMES

Training programmes were conducted on spices production technology, nursery management and on-farm processing of spices. Sixty one officers from nine states and over 150 farmers were imparted training on the above aspects

ECONOMICS

Adoption of rapid multiplication technology for production of rooted pepper cuttings (5000-20000 nos./year) was found profitable. The small scale venture with a payback period of less than 2 years will yield benefit cost ratio of 2.2 and the cost of black pepper cuttings was estimated to be Rs. 3.16 cutting. Production of white pepper can earn an extra benefit of Rs. 570/-per 100 kg of green pepper harvested and processed. A cottage industry with an initial investment of less than Rs.5000/- to make pepper in brine fetches Rs.715/- quintal (green harvest) as extra income over the black pepper. With an initial investment of Rs. 10,000/- a small scale unit to make salted ginger can earn a benefit cost ratio of 1.85.

KRISHI VIGYAN KENDRA (KVK)

The Krishi Vigyan Kendra conducted 47 training programmes during the period in which 1248 trainees including farmers, rural youth and extension personnel attended. KVK also participated in 3 exhibitions and delivered 9 radio talks. In the plant and animal health centre 1131 cases were attended and 403 AI were done. The Kendra also conducted 22 animal health campaigns and attended 2 other camps conducted by other agencies.

Padmabhushan Dr. R.S.Paroda, Director General, ICAR and Secretary DARE inaugurated the Krishi Vigyan Kendra (Peruvannamuzhi) building and the trainees hostel on 7 December 1998.

INTRODUCTION

The Indian Institute of Spices Research (IISR) was started in July 1995 by upgrading the erstwhile National Research Centre for Spices (NRCS), based on the recommendations made by various committees like QRT and the Parliament standing committees (Rajya sabha) on commerce (1994-95).

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.

Mandate

* 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

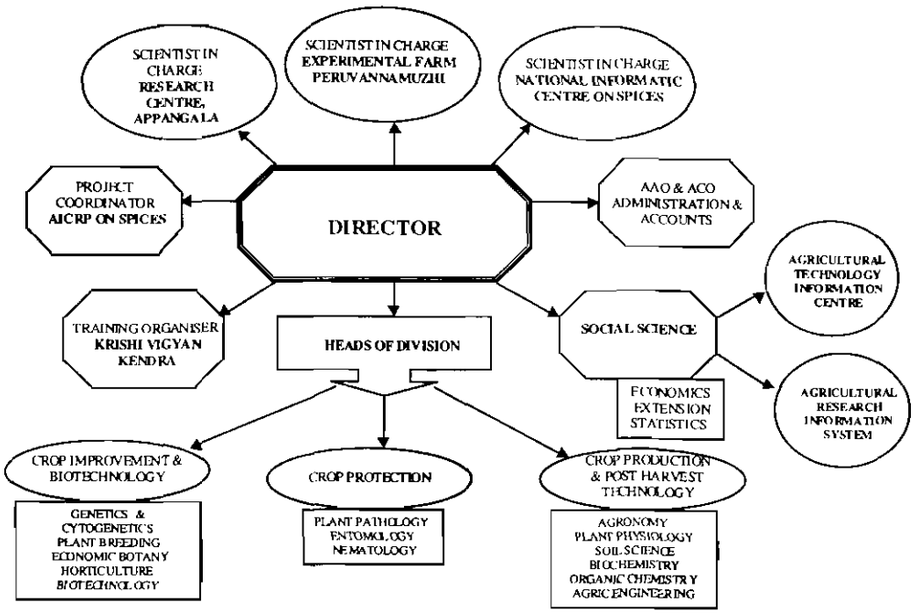
* To serve as a national centre for storage, retrieval and dissemination of technological information on spices

Location

The headquarters of the IISR is situated in Calicut (Kozhikode) city, where Vasco de Gama landed on 20 May 1498. The experimental farm of the institute is located at Peruvannamuzhi, in the foothills of the Western Ghats. The only sub-centre, 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 Council,



Organizational set-up of IISR

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. An ATIC (Agricultural Technology Information Centre) has been instituted at Calicut during the current year. An ARIS cell is also operational. Apart from the research activities, the University of Calicut and Kerala Agricultural University recognize the Institute as a centre for postgraduate studies. It offers consultancy

and training in different fields and disseminates the information generated through regular publications and other mass media.

PAST ACHIEVEMENTS

Crop Improvement and Biotechnology

The Institute has a large collection of spices germplasm consisting of 2778 black pepper, 293 cardamom, 499 ginger, 698 turmeric, 465 nutmeg, 220 clove, 281 cinnamon, 30 *Garcinia*, 137 allspice and 28 vanilla accessions.

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. Other varieties released by the institute are high yielding and low fiber ginger variety (Varada), high yielding cardamom variety (CCS-1) and high curcumin and high yielding turmeric varieties viz. Suvarna, Sudarshana, Suguna, Prabha and Pratibha.

Vegetative propagation methods were standardized in clove, nutmeg, cinnamon, cassia and allspice.

In vitro repository for spice germplasm was established. Methods for medium term storage and cryopreservation of genetic resources of spices in *in vitro* conditions are being standardized. Micropropagation protocols were standardized for major spices.

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. Addition of vermicompost and biofertilizers promoted growth in black pepper, cardamom and clove. Application of neemcake (2t/ha) increased nutrient availability in soil, increased ginger yield by 33% and restricted rhizome rot incidence of ginger to 5%.

Farmers have adopted high production technologies developed at the Institute for sustainable high yield of pepper and cardamom.

Panniyur-1 and Valiakaniakkadan 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 Pratibha. A technology to prepare salted ginger has been standardised.

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 of Perambramundi 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 harzianum* and *T. virens* to manage *Phyto-phthora* foot rot. Integrated disease management involving phytosanitation, soil solarisation and seed treatment was 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. Spraying endosulfan 0.05% or quinalphos 0.05% could control the pest. 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. A root knot nematode tolerant line, Pournami, has been released.

Several natural 'katte' escapes of cardamom were screened against cardamom mosaic virus and some of them found resistant and are under field evaluation. A rhizome rot tolerant cardamom line is identified and is being evaluated.

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 1998

	No. of rainy days		*Rainfall (mm)*	
Month	Peruvanna Muzhi	Appangala	Peruvanna muzhi	Appangala
January	-	-	-	-
Feb.	-	-	-	-
March	1	-	5.5	-
April	8	8	54.9	59.7
May	13	8	160.0	114.9
June	25	22	1070.6	792.9
July	30	28	1306.2	719 7
August	25	21	561.2	285.4
Sept.	23	25	655 0	249.7
Oct.	20	26	432.6	221 3
Nov.	10	9	155.0	155.9
Dec.	4	6	43 0	36.0
Total	159	153	4444.0	2635.5

Budget

Particulars	Plan	Non plan	Total
Establishment	-	199.03	199.03
Travelling allowance	3.00	4.50	7.50
Works	17.00	-	17 00
Other charges including equipment	110.00	25.00	135.00
Total	130.00	225.53	358.53

Other Sources

Particulars	Amount
A.P. cess fund schemes	100.50
KVK	20.54
NATP	25.15
AICRP Spices	85.70
DBT Schemes	3.10
IPDS	5.24
Visiting scientist scheme	0.80
Pension and gratuity	15.55
Total	256.58

Staff Position

	Sanctioned	Filled	Vacant
RMP	1	1	-
Scientific	41	39	2
Technical	48	43	5
Administrative	24*	25	-
Supporting	69*	73	

* Sanctioned and filled posts were included in KVK.

RESEARCH ACHIEVEMENTS

CROP IMPROVEMENT & BIOTECHNOLOGY

GEN. I (813)

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF BLACK PEPPER GERMPLASM

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

Wild *Piper* species were collected from the Western Ghats (Nilgiris, Munnar & Maukut forests). Seedlings of *P. schmidtii* collected during the trip could be established by keeping them at the hardening facility at Chelavoor. A set of germplasm collections including high elevations species like *P. schmidtii*, *P. mullesua* and N.E. collections were planted at CRC, Appangala.

Fifty accessions of cultivated black pepper were evaluated based on the IPGRI descriptor. A catalogue has been prepared for these fifty accessions. Vine diameter varied from 3(Acc. 1511, 1473, 1475) to 11.5 cm (Acc. 1387). Acc. 1387, 1487 and 1473 showed polymorphic branching habit and the rest had dimorphic branching habit. Twenty-four out of 50 accessions showed many runner shoot production and thirty-eight out of 50 accessions produced many adventitious roots. Spike orientation was generally pendent and shape filiform and green in colour. Spike length varied from 3.3 to 15.8 cm, no. of laterals per spike from 1 to 2.6. Flowers were free and sessile in general, anthers short with two stamens and spikes were glabrous. Fruit set percentage varied from 10 to 80. Other characters such as stem pubescence, lateral branching habit, juvenile leaf length, leaf length, leaf petiole length, nodes/lateral branch, leaf width, leaf lamina shape, leaf base shape, leaf margin type, leaf texture, leaf scales etc. were also studied and documented.

A data base programme was developed for documenting the germplasm database using MS. Access-7. The data derived by evaluating the germplasm are documented using this program.

Three hundred and seventy five numbers of black pepper hybrids and 153 cultivars were planted in the field gene bank.

GEN. IX(813)

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF CARDAMOM GERMPLASM

(K. Padmini and V.S. Korikanthimath)

Recording of panicle emergence for precocity and yield of germplasm entries

Among the 198 cardamom accessions studied, 41 belonged to very early (20.71%), 53 to early (26.77%), 61 to medium (30.81%) and 43 to late (21.72%) flowering group. A total of 94 accessions (47.48%) fell under very early and early flowering types.

On classification of cardamom accessions based on earlyness and yield (based on maiden yield) it was found that the highest percentage (20.75) of occurrence of high yielders (>500 g mean total yield/plant) was in early types followed by very early types (19.51) (Table 1). The occurrence of high yielders in medium flowering types was less (3.28%) and totally absent in late types.

Similarly the category 300-500g of mean total yield/plant included highest percentage of very early types (21.95%), followed by early types (18.87%). In the medium types a lesser percentage of medium yielders (9.84) was observed. The occurrence of medium yielders (300-500 g mean total yield/plant) was absent in late types.

Cataloguing of multi-branched collections for inflorescence and fruit characters

Eight open pollinated progenies of multi-branched panicle types viz., MB-45, MB-60, MB-29, MB-26, MB-3, MB-27, MB-25, and MB-6 were studied for inflorescence and fruit characters. The performance of the OP progenies was inferior to that of the data recorded in the mother clumps. However, the

Table 1. Classification of cardamom accessions based on days to first flowering and yield

Flowering Type	Mean total yield (g/plant)			
	0-100	100-300	300-500	>500
Very early	14.63*	43.90	21.95	19.51
Early	20.75	39.62	18.87	20.75
Medium	50.82	36.07	9.84	3.28
Late	81.40	18.61	0	0

* Data are given in percentage

per cent fruit set recorded in the various multi-branched types ranged from 12.99 to 50.00.

GEN II (813)

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

(P.N. Ravindran, B. Sasikumar, K.V. Saji, R.R. Nair and K.M.A. Koya)

New accessions of ginger i.e., 'Bhasey' and Nangrey from Kalimpong, 38 collections from Nepal, one each from Delhi, Palampur and Kanpur has been added to the germplasm.

Similarly, in turmeric, one *Curcuma* sp. each from Thiruneliy, Wayanad, Trissur and Karivallur, 'Kadappa' collection from Andhra Pradesh, one *Curcuma longa* from Nepal have been added to the germplasm.

Evaluation of bold rhizome selections of ginger

Fifteen bold rhizome of ginger are evaluated for yield and quality at Peruvannamuzhi, Muvattupuzha, Kumarakam and Sangli in replicated trials. Two of the promising accessions are also tested in farmers' plot at Wayanad and Nedumangad (Table. 2).

Table 2. Yield of bold rhizome selections of ginger (Peruvannamuzhi)

Acc. No	Mean fresh yield/($3m^2$) in kg.
415	10.83
49	9.33
117	11.0
294	9.83
179	11.67
142	12.67
71	10.33
116	8.16
204	9.33
3573	7.0
64	12.5
244	10.67
27	11.83
35	14.67
15	9.67
CD 5%	1.22
CV %	13.0

Evaluation of AFT and other high curcumin turmeric lines

Eleven lines including three AFT selections are planted in replicated trial at Peruvannamuzhi (four replications) Sangli and Tenali (AP). Out of these, Tenali experiment was damaged due to flood. At Peruvannamuzhi, Acc. 584 recorded highest yield (fresh 18.25 kg/3m^2/bed) followed by 691 (17.67 kg) and 361 (16.75 kg). The dry recovery was highest in Acc. 295 (21.3%) followed by 657 (20.3%) and 584 (20.0%).

Variability study for the storage life of dry ginger

Dry ginger (50g) of 73 accessions were studied for their reaction to storage pest attack i.e. variability in shelf life of dry ginger. Dry samples were kept in small plastic jars closed with perforated screw cap. These samples were artificially infested with adults of *Lasioderma servicorne* and kept for 8 months. The loss in weight of the samples were recorded. No weight loss (10%) was observed in 20 accessions viz. Acc. 25, 28, 29, 36, 62, 66, 83, 131, 134, 182, 208, 214, 215, 240, 244, 295, 409, 414, 415 and Maran.

GEN. VI (813)

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

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

Collection

Germplasm collection surveys were undertaken to Nilambur, Ooty, Coorg, Munnar and Thrissur. Nine accessions of *Garcinia gummigutta*, 3 accessions of *Garcinia indica*, one accession of *Garcinia xanthochymus*, one wild *Garcinia* type, one lemon grass oil smelling *Cinnamomum* sp., *C. litzia* and *C. wightii*, two wild nutmeg types and one elite nutmeg type were collected and added to germplasm.

Conservation

Forty-two plants from 14 accessions of *Garcinia* sp. were field planted at Chelavoor farm. Ten A9/4 nutmeg (pre-release variety) grafts, using 3 rootstocks, viz., *M. fragrans*, *M. malabarica* and *M. beddomeii* were planted at Chelavoor farm.

Characterisation and evaluation

Cassia: Twenty five Chinese cassia (*Cinnamomum cassia* Blume) accessions were analysed for bark oil, bark oleoresin and leaf oil percentages. Bark oil ranged from 1.2 to 4.9%. Leaf oil ranged from 0.4 to 6% and bark oleoresin ranged from 6 to 10.5%. Leaf and bark oils possessed cinnamaldehyde as the major constituent. Accessions A1 and C1 had high bark oleoresin (10.2% and 10.5% respectively) and D1, D3 and D5 had high bark oil (4.70, 4.90 and 4.25% respectively) with high cinnamaldehyde content (86, 50, 90, 50 and 85.50%, respectively). The clonal progeny evaluation trial of A2, C1, D1 and D3 elite lines is in the second year stage.

Nutmeg: Multilocation trials of the pre release variety A9/4 at Peruvannamuzhi, Ramamangalam and Manjapara are in the 2nd year stage. Heavy casualty due to water scarcity was noted at on farm trials in Ramamangalam and Manjapara. Fifty per cent of A9/4 clonal progenies have flowered just in the 2nd year after planting at Peruvannamuzhi. Morphological characterisation A 9/4 close are presented in Table.3.

Table 3. Evaluation of pre-release nutmeg variety A9/4

Clone No.	Clone ht. (cm)	Girth at 30 cm ht. (mm)	Canopy (cm)	No. of flowers	No. of Fruits
1	210	4.6	129	4	-
2	108	3.0	71	-	-
3	156	3.7	77	3	-
4	170	5.0	123	-	-
5	82	3.7	105	31	1
6	105	2.5	52	-	-
7	74	2.6	25	-	-
8	60	5.8	92	16	-
9	117	4.6	95	2	-
10	184	5.0	100	-	-
11	133	4.6	86	-	-
12	162	5.7	130	18	-
13	153	4.6	143	-	-
14	113	5.3	64	-	-
15	181	6.8	153	5	3
16	140	9.0	169	9	

Clove: Progeny evaluation of elite clove lines indicated that both at Peruvannamuzhi and Appangala B-95 out yielded others during 1997-98.

GEN. VIII (813)

COLLECTION, CONSERVATION AND IMPROVEMENT OF VANILLA

(P.N. Ravindran, B. Krishnamoorthy and K. Nirmal Babu)

Three vanilla accessions have been collected and added to germplasm. Five hundred seed derived plantlets were produced during this year. Four Inter specific hybrids regenerated from the crosses involving *Vanilla planifolia* X *V. aphylla* were multiplied during the year and are ready for field transfer. Fifty seed derived progenies were planted in field, each with two replications. Also, DNA was isolated from 15 lines of vanilla for conservation as well as for development of RAPD profiles.

HORT. IV (813)

ROOTSTOCK SCION INTERACTION IN TREE SPICES

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

Collection and raising of rootstock

Seeds of *Myristica* species namely *M. malabarica, M. beddomeii, M. fragrans, M. attenuata and M. dactyloides* were collected and raised. Different *Syzygium* species namely *S. fruiticosum, S. haneanum, S. cumini, S. zeylanicum* and *Eugenia uniflora* are also available for use as rootstock.

Production of nutmeg grafts

Cleft grafting and approach grafting of nutmeg on 1 and 2 year old rootstocks were carried out on different *Myristica* species mentioned above. Success was obtained on *M. beddomeii, M. malabarica* and *M. fragrans*. The successful grafts are at present maintained in the tree species nursery for establishment.

GEN. VII.1 (813)

BREEDING BLACK PEPPER FOR HIGH YIELD, QUALITY AND DROUGHT

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

The mean yield (4th year yield) of the promising hybrids and cultivars at Valparai (3000 ft. MSL) varied from 1.84 kg (Panniyur-1) to 4.8 kg/vine (HP 105). Botanical and agronomic traits and yield (1997-98) are given in the table below (Table 4.).

Interspecific hybridization of *P. nigrum* grafted on to *P. colubrinum* with *P. colubrinum*

In order to overcome the species incompatibility in *P. nigrum*, *P. colubrinum* hybridization, *P. nigrum* grafted on to *P. colubrinum* was used as a female parent and *P. colubrinum* as the male parent. Panniyur-1, Karimunda and Narayakody grafts were used. Success of pollination was less in all the cultivars during the month of March-May. However, in the subsequent months good fruit set was observed.

Table 4. Botanical and agronomic trials and yield of the promising hybrids and cultivar at Valparai

Character	HP 34	HP 105	HP 813	HP 728	HP 778 1041	Coll
Yield during 1997-98 (kg/vine, fresh)	2.42	4.80	2.42	3.78	3.27	4.25
Maximum length of spike (cm)	14.0	12.0	14.0	12.0	13.0	12.0
Mean spike length (cm)	10.05	8.86	8.25	8.33	7.05	8.48
Maximum no. of berries in a spike	49	48	48	49	41	51
Mean no. of half developed berries	7	10	5	8	7	4
Wt. of fresh spike (kg/vine)	3.05	5.3	2.88	4.67	3.88	5.31
Wt. of threshed berries (kg/vine)	2.42	4.80	2.41	3.78	3.27	4.21
100 berry weight (g)	13.0	11.66	11.0	10.0	12.0	15.0
100 berry volume (cc)	13.25	12.10	13.0	8.25	12.10	14.9
Threshing percentage	79.38	90.05	83.85	81.03	84.26	79.19
Drying percentage	37	35	33	33	36	30

Coll. 1041 is found to be highly tolerant to foot rot disease at Valparai

Matured berries were harvested, cleaned and soaked in water for 24 hrs. followed by a 6hr. treatment with 25 ppm GA as failure of seed germination was observed in the earlier study. Germination of the seeds is started. Few seedlings are exhibiting intermediate nature.

GEN. X (813)

BREEDING CARDAMOM FOR HIGH YIELD AND RESISTANCE TO KATTE DISEASE

(K. Padmini and M.N. Venugopal)

Cardamom accessions viz. APG-215, APG-221, APG-223, NKE-3, NKE-9, NKE-12, NKE-27 and RR-1 were multiplied. Fifty-four diallel crosses along with the selfed parents have been field planted to evaluate genetic parameters and also yield. The per cent fruit set recorded during pre-monsoon period was higher in the cross RR-1 x MB-3 (29.17) than MB-3 x RR-1 (22.55).

Screening of open pollinated progenies of natural katte escapes (NKE) was carried out for katte resistance. The per cent infection was comparatively lesser in NKE types than M-1 and Malabar control. The Malabar control recorded the highest per cent of infection (70.00) followed by M-1 (58.00). There was totally no infection (after two rounds) in NKE-8 and highest per cent infection was recorded in NKE-78 (16.00). Local severe isolate was used for inoculation @ 10 viruliferous aphids/plant.

GEN. XII (813)

CYTOGENETIC INVESTIGATIONS IN BLACK PEPPER AND RELATED TAXA

(R. Ramakrishnan Nair)

Seventy-five accessions of *Piper nigrum* including 53 cultivars and 22 wild collections were cytologically analyzed for chromosome number indexing. All except Coll. No. 3282 were found to have normal chromosome number 2n=52. Collection No. 3282 showed lot of variation such as 2n=52, 44, 48 and 51. The chromosome number of *Piper chaba* was confirmed as 2n = 104.

Karyotype analysis of *Piper colubrinum* revealed that chromosome length ranged from 1.08 to 3.26 µm. It had seven pairs of metacentric, five pairs of submetacentric and one pair of acrocentric chromosomes.

Somatic embryos of black pepper cultivar 'Karimunda' were treated with 0.1% colchicine for 24 hours, in liquid medium and subsequently transferred to normal medium for growth. Even though the treated embryos showed the syndrome associated with colchicine treatment, all the regenerants were found to be albinos.

Segments of black pepper spikes having anthers with uninuculeate pollen when cultured in hormone free E1 medium (Gamborg, 1983) under 24 hrs. dark period, indicated the growth of anthers without callusing.

GEN. XIV (813)

CYTOGENETICS AND REPRODUCTIVE BIOLOGY OF GINGER AND TURMERIC

(R. Ramakrishnan Nair and B. Sasikumar)

To assess the influence of genotypes on polyploidy induction, axillary buds of five ginger cultivars viz. Maran, Varada, Mananthody, HP and Suprabha were treated with 0.1% colchicine and planted. The plants derived from treated buds were monitored for symptoms of colchiploidy and selected for future cytological analysis. Cultivar HP produced maximum (6) number of plants showing polyploidy symptoms followed by Maran (4) and Varada (3). Only one plant each of Suprabha and Mananthody showed polyploidy symptoms.

Observations on reproductive biology of turmeric indicated that, the time required for the appearance of inflorescence is 102 to 116 days, and number of flowers per inflorescence ranged from 47 to 55. The opening of flowers start from 7.00 AM and even continue up to 4.00 PM. The time of anther dehiscence is between 10.15 and 11.40 AM.

Pollen fertility studies in 5 accessions showed that even though pollen stainability is reasonably high in turmeric (53-58%), actual germination *in vitro* is less than 10%. The pollen tube may attain a length of even 2.5 mm *in vitro*.

HORT. II (813)

UTILIZATION OF *PIPER COLUBRINUM* LINK AND *PIPER ARBOREUM* AS ROOTSTOCKS IN THE MANAGEMENT OF FOOT ROT DISEASE OF BLACK PEPPER

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

Grafts of varieties, Panniyur-I, Panniyur-II, Panniyur-III, Panniyur-IV, Panniyur-V, Pournami, Panchami, Sreekara, Poonjaranmunda, Udhakara, Balankotta, Kuching, Malligesara, Neelamundi, Kottanadan, Kuthiravally, Kalluvally, Panniyur culture and Nedumchola on *Piper colubrinum* rootstock were established in the field along with rooted cuttings as control with a plot size of six plants. Cent per cent survival has been observed. Drip irrigation is installed for these grafts. Growth was monitored for the year.

Anatomical studies have been carried out on black pepper, *P. colubrinum* and the graft joints. Union was observed in all the different methods of grafting by formation of new vascular bundles from parenchymatous tissues of both species. The grafts prepared on seedlings and clonal rootstock of *P. colubrinum* are growing satisfactorily. No foot rot incidence has been observed so far in the plots.

HORT. III (813)

DEVELOPMENT OF PAPRIKA FOR WARM HUMID TROPICS

(P.A. Mathew, K.V. Peter, T. John Zachariah and C. Vasugi)

Germplasm collection

During the year a survey was conducted and single plant collections of Byadagi Dhabba were made from the villages of Yeliwal (12 acc.), Kubihal (24 acc.) and Navanagar APMC Yard, Hubli (14 acc.) at Dharwad district of Karnataka. Thus the total collection consisted of 62 exotic, 3 indigenous and 180 Byadagi Dhabba accessions.

Evaluation

The accessions grown and field tested during 1998 are indicated in table.5.

It is observed that germination of sizeable number of accessions were affected. The high humidity prevailing at Peruvannamuzhi appears to be detrimental to seed viability inspite of the seeds being kept in a desiccator with silicar gel. The accessions were grown in black polybags of 50cm x 25cm with a potting mixture of soil, sand and dung. The fertilizer used was NPK @ 180:120:100 kilogram per hectare. No insecticides and

Table 5. Details of paprika accessions tested in 1998

Type	No. of acc. sown	No. of acc. germinated and raised	No. of acc. survived	No. of acc. removed due to virus incidence	Remarks
Exotic	62	62	33	29	Dried due to bacterial wilt. 43 accessions did not germinate
Indigenous collection	3	3	0	-	
Indigenous collection Byadagi					
Dhabba (ICBD)	130	87	35	52	

fungicides were used to facilitate evaluation against pests and diseases. The biometric observations recorded on the survived accessions are given in table 6. The accessions exhibited wide variability for various characters

The Byadagi types were tolerant to heavy downpours, while the exotic types exhibited severe leaf shedding in such situations. The ICBD accessions expressed very wide variation in fruit and plant characters offering very good scope for selection. The number of days taken for flowering varied from 37 to 103 days in the exotic types whereas it was from 52 to 101 days in ICBD lines. The number of days from flowering to harvest did not show much variation in both categories. The number of fruits per plant was higher in the exotic collections (1-29) than the ICBD types (1-17). The minimum and maximum fruit weights (2.13 and 49.78 g) were recorded in exotic lines. Nevertheless the ICBD

Table. 6. Biometric data on paprika accessions tested in 1998 (Range)

Type of Acc	No. of acc. tested	Days to 50% flowering	Days to harvest from flowering	Av. no of fts/ plant	Av. ft wt. (g)	Av. ft length (cm)	Av. ft breadth (cm)	Av. pl. ht. (cm)	Av. no. sec. branches /plant
Exotic	33	37 103	51.99	1.29	2.13-49.78	5.0-22 83	2.0-16 33	12.0-46 0	2 3
ICBD	35	52-101	55-91	1-17	2 83-36 0	9.17-16 67	3 0-7 67	16 0-44 0	2-3

types gave fruits weighing upto 36g. Good range for fruit length was expressed in exotics than ICBD types.

Colour estimation of ICBD collections of the year was carried out for 36 samples by the ASTA method. Some accessions indicated very high values, i.e. ICBD-Y-6 (400 units), ICBD-K-11 (400 units), ICBD-K-17 (450 units) and ICBD-K-24 (500 units) offering great potential for good selections with high colour values.

BIOTECH. III (813)

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

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

Production and multiplication of somaclones

Somaclones were multiplied and over 500 somaclones were transferred to the field. About 600 cultures of plantlets regenerated from anther, ovary and leaf were maintained in the laboratory for further multiplication and field transfer.

Field multiplication of rhizome rot escapes

Seven promising lines viz., MP 61-9, MP 61-10, MP 75-1, OCP 1222, OCP 817 and OCP 816 were multiplied for further field evaluation.

Over 200 lines of somaclones were evaluated in pot culture for morphological characterisation.

Isolation of DNA

DNA was isolated from 14 important cultivars of ginger. They are Maran, Jamaica, Bhaise, MP 61-9, OCP 1222, OCP 817, tetraploid Manandavadi, Gurbathani etc. This DNA is being used for developing RAPD profiles of these lines.

BIOTECH. IV (813)

BIOTECHNOLOGICAL APPROACHES FOR CROP IMPROVEMENT IN BLACK PEPPER

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

Production of somaclones

About 100 cultures of black pepper somaclones were multiplied and maintained.

Field planting of tissue cultured black pepper

About 100 tissue cultured black pepper plantlets were given to a progressive farmer at Kodencherry for field planting. The field establishment is 75%.

Transformation studies

Studies on development of transgenics using both *Agrobacterium* as well as biolistics mediated transformation are in progress. The constructs used contains osmotin gene. GFP along with kanamycin as selectable marker. The putative transgenics are in the process of multiplication. Both leaves as well as somatic embryos were used as explants.

Isolation of DNA

DNA was isolated from 13 important cultivars and species of black pepper. They are Sreekara, Subhakara, T.C. plant of Subhakara, Panchami, T.C. plant of Panchami, P 24, HP 780, Panniyur-1, Panniyur-5, *Piper chaba, P. longum, P. arborium and P. colubrinum*. This DNA is being used for developing RAPD profiles of these lines.

CLOSED PROJECTS

BIOTECH. III (813)

MICROPROPAGATION OF BLACK PEPPER (*PIPER NIGRUM* L.)

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

The project was initiated with the following objectives

1. To standardize micropropagation protocols for *in vitro* clonal multiplica-

tion of black pepper and a few related taxa namely *P. longum* (Indian long pepper), *P. chaba* (Java long pepper), *P. betel* (Betel vine) and *P. barberi.*

2. To standardize effective protocols for direct and indirect organogenesis from leaf, stem and root in black pepper and a few related taxa namely *P. longum* (Indian long pepper), *P. chaba* (Java long pepper), *P. colubrinum*, *P. betel* (Betel vine) and *P. barberi.*

1. *IN VITRO* CLONAL MULTIPLICATION OF PIPER SPECIES

The *in vitro* clonal multiplication of black pepper and related species will help in producing disease free planting material on a large scale and will also be useful in other crop improvement programmes. The details of *in vitro* clonal multiplication are given below (Table 7).

2. *IN VITRO* REGENERATION OF *PIPER* SPECIES

2.1 *Piper colubrinum* Link

Piper colubrinum Link is a South American species of *Piper* and is distantly related to *P. nigrum* L., the black pepper of commerce. The cultivation of black pepper is threatened by *Phytophthora* foot rot and all the cultivars are susceptible to this disease. Burrowing nematode (*Radopholus similis*) and pollu beetle (*Longitarsus nigripennis*) are the other major pests limiting production. *P. colubrinum* is immune to foot rot disease and is highly resistant to burrowing nematode and pollu beetle. Conventional hybridization between these two species to transfer resistance is not possible, as the species are very distant and incompatible. Biotechnological means like somatic hybridization and gene transfer are more appropriate to develop resistant black pepper lines. For any such efforts development of plant regeneration protocols forms the basic requirement. Grafting of *P. nigrum on P. colubrinum* rootstock was another possibility where grafted plantlets may overcome nematode as well as *Phytophthora* foot rot problems. This requires large number of plantlets to be used as rootstocks. In this experiment we report the successful standardization of plant regeneration protocols mainly from leaf and callus cultures of *P. colubrinum.*

Table 7. Details on *in vitro* clonal multiplication of Piper species

Piper species	Source of explants	Culture media	Establishment of culture	Hardening and planting out
Piper nigrum	Shoot tips	Woody plant medium	10% in explants of field grown plants. 30-40% in green house grown plants	Transferred to sterilized sand and hardened in humid chamber (80-90% RH)
Piper longum	Shoot tips	Woody plant Medium (Mc Cowen & Amos 1979)	Contamination due to endogenous bacteria	Establishment in soil is over 90% when transferred plantlets were kept in humid chamber for 20 30 days for hardening
Piper chaba	Shoot tips		Poor establishment. Overcome by frequent transfers to fresh medium every 20-30 days.	
Piper barberi Gamble	Shoot tips	WPM	Shoot explant from field grown plants were difficult to establishment due to contamination by endogenous bacteria	*In vitro* raised roots plantlets were transferred to potted soil mixture (garden soil : perlite : sand (1 : 1 : 1) and hardened in humid chamber
Piper betel	Young shoot tips	WPM	Responded well to the media	Well rooted plantlets were transferred to sterile sand and placed in humid chamber

Source of explant, culture medium and culture conditions: Tender shoot tips (dipped in 3% bavistin for 10 minutes and surface sterilized with 0.1% $HgCl_2$ for 5-10 minutes) were used as explants. The Woody Plant Medium (WPM) was used as basal media, supplemented with 2, 4-D (0.5 and 1 mgl^{-1}) BA 0.5 and 1.5 mgl^{-1} and NAA (0.5 and 1.5 mgl^{-1}) in various combinations. The culture medium was gelled with 6.5 gl^{-1} of bacteriological grade agar (Hi Media). All the cultures were incubated at 25 ± 2° C with 14 hrs of photoperiod produced by cool white fluorescent tubes with a light intensity of 30 µmol m^{-2} s^{-1}.

Establishment of cultures: When topmost segments of tender actively growing orthotropic shoots were used as explants about 50 to 60% cultures were free from contamination though in a few samples the bacterial contamination

occurred again. Browning of tissues due to phenolic exudates was another problem. This was overcome by frequent transfer to fresh medium, in initial stages and subsequently, such transfers were made in every 15 to 20 days.

***In vitro* responses:** All explants responded readily to WPM supplemented with BA (0.5, 1.0, 2.0 mgl^{-1}). Callus production and shoot regeneration was noticed to certain extent in all the combinations of BA, kinetin and 2, 4-D. However, $^1/_2$ WPM with 3 mgl^{-1} BA and 1 mgl^{-1} kinetin gave best results. Excellent rooting of the shoots were obtained by transferring the shoots to hormone free media. These plants could be easily established in soil after hardening.

2.2 *P. nigrum, P. longum, P. chaba* and *P. barberi*

Sources of explants, culture media and conditions: Small bits of leaves and shoot tissue surface sterilized with 0.1% $HgCl_2$ (containing tween 20) were used as explants. The basal nutrient medium used was Woody Plant Medium (WPM) (Mc Cowen and Amos 1979). The medium was composed of half strength WPM salts and vitamins supplemented with sucrose 30 gl^{-1} and bacteriological grade agar 7 gl^{-1}. The medium was further supplemented with 3 mgl^{-1} benzyladenine (BA) and 1 mgl^{-1} kinetin. Growth regulator free basal medium was suitable for root induction of *in vitro* grown shoots and hence this media was used for rooting. The explants were cultured under 25±2°C with 14 hours photoperiod provided by cool white fluorescent tubes with a light intensity of 30 µmol m^{-2} sec^{-1}. The response of different *Piper* sp. to culture media is presented in Table 8.

***In vitro* rooting of shoots:** The *in vitro* grown plantlets were transferred to hormone free WPM for rooting. Rooting was observed in all species. *P. longum* and *P. nigrum* were easy to root when compared to *P. chaba* and *P. betel*. Rooting success was 80-90%.

Hardening and transfer to soil: The *in vitro* rooted plantlets were transferred to polybag containing sterilized sand and nutrient solution was supplied on alternate days. The plantlets were kept in humid chamber for 20-30 days. The establishment of plantlets in soil was over 90 per cent in all the species.

Table 8. Response of *Piper* sp. to culture media

Piper species	Culture media			
	WPM + BA 3 mgl^{-1} + kin 1 mgl^{-1}		WPM (1/2 strength) + BA3 mgl^{-1} +kin 1mgl^{-1}	
	Shoot	Leaf	Root	Shoot
P. nigrum	Production of loose and friable as well as hard callus, development of multiple shoots and regeneration of plantlets	Production of callus, regeneration of plantlets either directly from leaf without callus or from callus		Rooting of shoot explants No. of roots . 4-9
P. betel	Production of callus, development of multiple shoots and regeneration of plantlets	Production of callus and regeneration of plantlets directly and through callus		Rooting of shoot explants. No. of roots : 2-5
P. longum	Production of callus, development of multiple shoots and regeneration of plantlets	Production of callus, regeneration of plantlets either directly from leaf tissue or from callus	Production of plantlets from swollen roots	Rooting of shoot explants. No. of roots : 3-5.
P. chaba	Production of hard callus, production of multiple shoots and regeneration of plantlets	Production of callus and regeneration of plantlets directly and indirectly		Rooting of shoot explants. No of roots 2-4

The results indicate that all the four species of *Piper* species studied viz. *P. nigrum, P. longum, P. chaba* and *P. betel* could be successfully regenerated on WPM supplemented with BA and kinetin. WPM was ideal for direct and indirect shoot regeneration and their subsequent growth from both leaf and shoot explants of all the species and root explants of *P. longum*. The study also indicated that the same media could be used for regeneration of various species.

The somaclonal variations derived from plants regenerated from callus cultures could form a source of variation for selection of agronomically superior lines in black pepper, betel vine and long peppers. Efficient regeneration systems from callus cultures also form the base for *in vitro* synthesis of alkaloids

such as pipalartine for which the long pepper roots are valued in indigenous medicines.

3. COST OF PRODUCTION OF BLACK PEPPER

The cost of production was worked out taking into consideration the fixed cost and variable cost for production of lakh cuttings in a period of 10 years. The cost of production of *in vitro* raised plantlets was estimated to be Rs. 8.75 (Table 9).

In conclusion, the present results reveal that *P. longum* and *P. chaba* can be micropropagated from leaf and stem tissues and in addition *P. longum* could be propagated from root tissues also. WPM is highly suitable as basal medium. No growth regulators are required for *in vitro* rooting of shoots. Cytokinins (BA and kinetin) were helpful in organogenesis and plantlet regeneration from shoot and leaf explants of *P. longum* and *P. chaba* and root tissues of *P. longum*.

The cost of production of tissue cultured plantlets was estimated to be Rs. 8.75/plantlet.

4. TECHNOLOGY DEVELOPED

a. Micropropagation protocols for clonal multiplication

b. Protocols for direct and indirect organogenesis from all the plant parts in five species of *Piper* namely *P. nigrum, P. longum, P. chaba, P. colubrinum* and *P. betel.*

Table 9. Cost of production of black pepper plantlets through tissue culture

Item	Cost (Rs)
Investment during establishment	16,14,200
Interest @ 15% compounded	2,42,130
Total investment	18,56,300
Annuity value @ 15%	3,69,882
Annual maintenance cost	5,05,200
Total cost year^{-1}	8,75,082
Average number of plantlets year^{-1}	1,00,000
Cost per plant	8.75

ICAR AD-HOC PROJECTS

1. *IN VITRO* CONSERVATION OF SPICES GERMPLASM

(K.V. Peter, P.N. Ravindran, K. Nirmal Babu, D. Minoo and K. Rajalakshmi)

Maintenance of existing cultures

About 500 accessions in the gene bank were subcultured and maintained.

Establishment of new accessions

Four new accessions of vanilla (inter specific hybrids of *V. planifolia x V. aphylla*), twenty each of ginger, turmeric and ten lines of cardamom were added to the gene bank.

Cryo-preservation

Capsicum seeds and ginger synseeds have been cyro-preserved for long term conservation of germplasm.

2. PRODUCTION OF HAPLOIDS OF CARDAMOM (*ELETTARIA CARDAMOMUM* MATON) THROUGH ANTHER/POLLEN CULTURE

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

Somatic embryo like structures were induced by direct regeneration from cardamom anthers on MS medium supplemented with 1 mgl^{-1} BA + 0.5 mgl^{-1} kinetin + 0.5 mgl^{-1} 2, 4-D.

3. PRODUCTION OF SOMACLONES AND SOMATIC HYBRIDS IN CARDAMOM (*ELETTARIA CARDAMOMUM* MATON) FOR HIGH YIELD AND RESISTANCE TO DISEASES

(K. V. Peter, P.N. Ravindran, D. Benny and P. Girija)

Multiplication of somaclones

Over 1500 cultures of cardamom somaclones were multiplied and 300 somaclones were transferred to soil for screening.

Filed evaluation of somaclones

Over 150 somaclones were field planted. They are in 1st, 2nd and 3rd year of evaluation. They exhibited variation with regard to plant height, position of inflorescence, growth vigour etc. Some promising somaclones with vigorous bushy habit were identified.

Final report(ICAR ad-hoc project)

DEVELOPMENTAL MORPHOLOGY OF RHIZOMES OF GINGER AND TURMERIC

(P. N. Ravindran, A. B. Remasre and S. P. Sherlija)

The developmental morphology of rhizomes of ginger and turmeric was studied in detail. The process of cytohistological zonation of apical meristem, development of procambial cells from meristematic region initiation of new rhizome fingers, ontogeny of axillary bud initiation, root initiation, development of oil cells, curcumin cells etc. were analysed in detail. The presence of cambium elements in ginger and turmeric rhizomes is a new report and it is a rare feature in monocot plants. Oil cell are present more in the shoot apices and nodal regions. They are located below the epidermal layer, in the cortical as well as in the inner core of the rhizome. Oil cells development follows the bysagenous path by the dissolution of individual meristematic cells. They subsequently develop into oil canals. Because the oil cell differentiation starts early in the developmental stages, any attempt to increase the essential oil cells should begin during the early stages of development itself. Fibre development occurs during the maturity of rhizome. Deposition of lignin in the cellulosic cell wall of both phloem and xylem occurs in the secondary stages.

The comparative anatomy and histochemical studies of four species of ginger and turmeric showed differences in their rhizome anatomy, histochemical pattern, leaf anatomy, stomatal characters, oil cell index and fiber dimensions. These characters are useful in crop improvement work for identifying cultivars having more tolerance to leaf spot disease and higher metabolite rates and also for assessing the nature and extent of variability among species. Anatomical characters are also helpful in species delimitation.

The influence of growth regulators on ginger and turmeric rhizome development was also studied. For more root induction and less fibre content

GA_3 was found to be useful. Comparatively starch content was more in triacontanol and paclobutrazole treated plants. The fibre content also was more in triacontanol and paclobutrazole treated plants though the differences were not significant.

The application of three growth regulators enhanced the vascularization of the rhizome and increased the size and number of vascular bundles and finally influenced the transport capacity of the phloem. In short, exogenously applied growth regulator cause several physiological and biochemical alterations that generally lead to morphological modification which may have positive influence on the yield.

The present study contributed substantially to our understanding on rhizome ontogeny and anatomy of ginger and turmeric.

CROP PRODUCTION AND POST HARVEST TECHNOLOGY

AGR. XIV (813)

INVESTIGATIONS ON SPICES BASED CROPPING SYSTEMS

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

Amongt various crop combinations, cardamom + clove recorded the maximum ground coverage (9219.46 sq.m.) leaving only 780.5 sq.m. of the ground area uncovered. Least ground/canopy coverage was observed in combination of cardamom and coffee (6465.2 sq.m.). Cardamom showed better growth in terms of its height in combination with allspice, whereas its growth showed remarkable reduction in combination with pepper. Sole crop recorded the maximum bearing tillers and total tillers. Among the mixed crop treatments, cardamom in combination with clove showed higher tillering mainly due to higher light interception in the treatment. Cardamom received highest (75%) PAR when grown in association with coffee and nutmeg. The differences in light interception were only marginal among different component crops.

During the year, cardamom grown in combination with clove recorded higher number of capsules per plant (908), fresh weight of capsules per plant (885.4 g) and yield per hectare (512.41 kg) compared to all other combinations. Lowest yield of cardamom was recorded when it was grown with coffee (169.02 kg/ha) and cinnamon (179.18 kg/ha). Sole crop of cardamom (mean of five seasons) recorded highest average yield (645.60 kg/ha) which is 43 per cent higher than the average yield of cardamom under mixed crop situation (449.01 kg/ha) and 83 per cent higher than the lowest yield combination (cardamom + pepper, 346.15 kg/ha) and 18 per cent higher than the highest yield combination (cardamom + clove, 547.08 kg/ha). All the component crops *viz.* coffee, pepper, clove and cinnamon also performed better both as sole and mixed crops.

Bacterial population in the rhizosphere of cardamom under mixed crop was lower compared to its sole crop but contained consistently higher population of fungi, phosphate solubilizers and nitrogen fixers. Soil samples were analysed for pH, organic carbon, phosphorus, potassium, calcium and

magnesium collected at two depths (0-15 and 16-30cm). Surface soil was rich in all nutrients in general and had higher pH than sub surface soil. Allspice and pepper in combination with cardamom and sole cardamom recorded higher organic carbon. The leaf nutrient status of cardamom when grown with different component crops is given in Table 10. All the major nutrients were generally higher when cardamom was grown with pepper and the minor

Table 10. Nutrient content in leaves of cardamom and coffee

Crop	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
			%				ppm		
Cardamom (+ Nutmeg)	2.6	0.01	0.75	0.12	0.05	2.0	9.2	2.0	1.0
Cardamom (+ Clove)	2.3	0.02	0.70	0.16	0.06	4.0	41.5	8.0	1.0
Cardamom (+ Cinnamon)	2.2	0.02	0.82	0.10	0.05	Traces	20.5	6.0	1.0
Cardamom (+ All spice)	2.4	0.02	0.74	0.10	0.05	4.0	34.5	8.0	1.0
Cardamom (+ Pepper)	2.6	0.01	0.85	0.16	0.06	Traces	26.1	8.0	1.0
Cardamom (+ Coffee)	0.5	0.02	1.00	0.16	0.06	Traces	46.3	9.0	2.0
Cardamom (Sole crop)	2.4	0.02	0.60	0.11	0.06	Traces	81.5	10.0	2.0
Coffee	3.5	0.05	1.32	0.21	0.76	Traces	31.5	6.0	5.0

nutrients were generally higher when cardamom was grown as sole crop. Rhizome rot of cardamom was least with less than 0.6% disease index. Leaf rust of coffee was 9 and 16% in cardamom + coffee and sole crop of coffee, respectively.

AGR. XVII (813)

VERMICOMPOSTING OF ORGANIC WASTES AVAILABLE IN CARDAMOM AREAS

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

The nutrient (P, K, Mg, and Ca) and the organic carbon content of the cardamom rhizosphere soil almost doubled when it was supplied with

Table 11 Nutrient content of vermicompost and compost from the organic residues of cardamom plantation

Nutrient	Vermicompost	Compost
N (%)	1.20	1.10
P (%)	0.53	0.23
K (%)	0.10	0.43
Ca (%)	0.92	0.75
Fe (ppm)	4179	4119
Mn (ppm)	401	400
Zn (ppm)	78	78
Cu (ppm)	56	50
S (%)	0.86	0.48

vermicompost or FYM for over two seasons. pH of soil changed towards neutrality. However, there was negligible difference between vermicompost and FYM with respect to nutrients and organic carbon. The contents of most nutrients were only marginally higher in vermicompost compared to normal compost (Table 11).

AGR. XIX (813)

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

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

Various systems included in the study are -

1. Arecanut, banana and pepper
2. Coffee (Robusta + Arabica) and pepper
3. *Garcinia gummigutta*, monkey jack, cardamom and pepper
4. Cardamom and pepper
5. Bee keeping
6. Biomass generation and nutrient recycling

Biomass generation (*ex situ*) potential of Co-1 grass was 67.33 tons/ha as against 13.88 tons in cardamom garden (shade tree leaf litter) and 6.94 tons in coffee garden (1 year after planting). Light interception studies using ACCU

Table 12. Light interception in various component crops (II year of planting)

Sl. No.	Crop	Direct Sun light			Shaded condition		
		PAR in open area (µmol $m^{-2}sec^{-1}$)	Par Below	Interception (%)	PAR above canopy (µmol $m^{-2}sec^{-1}$)	PAR below	Interception (%)
1	Arecanut +	1627	43.6	97.3	300.86	100.33	63 21
2	Banana +	1616	70.6	95.7	227 22	60.18	68.66
3	Cardamom	1632	40.2	97.5	324.17	116.35	55 61
4	Garcinia +	1426	152 22	89.3	145.56	103.33	63 21
5	Monkey jack +	1426	149.45	89 5	140.76	100.25	62.25
6	Cardamom (RH=49.5%)	1632	40 64	97.5	324 17	116 35	55 61

PAR Ceptometer both under shaded and open conditions were carried out. Cardamom intercepted maximum light under open condition and minimum under shaded condition compared to other component crops (Table 12).

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)

One lakh black pepper rooted cuttings and 1500 rooted laterals, 25 tons of turmeric and 3 tons of ginger seed rhizomes, 10,000 cardamom seedlings, 1300 suckers, 100 kg seed capsules, 2500 nutmeg grafts, 5000 cinnamon seedlings, 2000 clove seedlings, 2000 all spice seedlings and 10,000 vanilla cuttings were produced and distributed to various agencies and farmers of Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa and North Eastern states.

SSC. II (813)

NUTRITIONAL REQUIREMENT OF IMPROVED VARIETIES OF SPICES

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

Response of black pepper varieties viz., Sreekara and Subhakara to the

application of NPK and micronutrients were studied for the fifth year. Soil analysis showed that increasing level of NPK and micronutrients increased their availability in soil. Application of NPK and Zn, B, Mo @ 150, 60, 270 and 5, 2, 1 kg ha^{-1} recorded maximum yield as in previous year. Both varieties performed well when trailed on living standard *Garuga pinnata* compared to non-living standard.

Three sources of rock phosphates viz., mussoorie phos (MRP), Raj phos. (RP) and Gufsa phos (GP) individually and in combination with super phosphate, FYM and lime (pre treatment) were tried to evaluate their Agronomic Efficiencies (AE) and Apparent Phosphate Recovery (APR), and their effect on yield and quality of ginger and turmeric for the third year. Bray's P availability increased with the application of rock phosphate. Highest Bray's P was recorded for FYM + 1/2 recommended P as Raj phos followed by Gufsa. Super phosphate and Mussoorie phos. The maximum number of tillers, yield, P uptake of ginger and turmeric (Table. 13) were also obtained in the treatment combination of FYM with Gufsa phos followed by Raj phos which were on par. With regard to yield response, AE and APR in ginger and turmeric, application of P (half the recommended dose) as Gufsa followed by Raj phos together with FYM (10 t ha^{-1}) was superior.

Table 13. Effect of different sources and combination of phosphate with FYM and lime on morphological growth, P uptake, yield and quality of ginger and curcumin content and yield of turmeric

					GINGER			TURMERIC
Treatment	Tiller No. ($3m^2$)	Leaf P (%)	Rhizome P (%)	Oleoresin kg ha^{-1}	P uptake kg ha^{-1}	Yield (t ha^{-1})	Curcumin kg ha^{-1}	Yield (t ha^{-1})
Check	309	0.14	0.20	120	5 86	2.92	154	3.66
Sp	430	0.16	0.30	147	10.66	3.67	254	4.98
MRP + SP	425	0.18	0.27	159	10.55	3.89	227	5.04
RP + SP	440	0.15	0.27	142	9.71	3.55	299	5.54
GP + SP	429	0.15	0.27	151	9.83	3.59	256	5.11
FYM + MRP	422	0.16	0 29	143	10.76	3.66	309	5.83
FYM + RP	402	0.17	0.29	168	12.32	4.21	287	5 86
FYM + GP	476	0.17	0.29	179	12 66	4.37	311	6.22
FYM + SP	398	0.18	0.30	164	11.11	3.92	260	5.54
LIME + MRP	397	0.12	0.21	148	7.05	3.71	189	4.62
LIME + RP	385	0.16	0.21	141	7.32	3.43	193	4.59
LIME + GP	374	0.17	0.23	154	8.73	3.86	186	4.76
LIME + SP	410	0.18	0.25	156	9.17	3.99	165	4.22
CD (5%)	43	0.01	0.01	20	0.60	0 21	26	0 17

Effect of micronutrients viz., Zn, B and Mo applied individually and in combination on ginger and turmeric was studied in a field experiment for the second year. Soil analysis showed increased availability with the application. In turmeric 23% increase in yield was observed by applying Zn, B and Mo @ 5, 2, 1 kg ha^{-1} over control. The quality of turmeric also increased.

PHY V(813)

CHARACTERIZATION OF DROUGHT TOLERANCE IN BLACK PEPPER

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

To assess their relative tolerance to water stress, related species of Piper *nigrum* viz. *Piper colubrinum, Piper longum* and *Piper chaba* were also screened for drought tolerance along with the cultivated *Piper nigrum* types. The results showed that *Piper colubrinum* is susceptible to water stress. Peroxidase activity reached very high levels (350% increase over control) under stress while acid phosphatase (90%) catalase (76%) and SOD activities (23%) decreased under stress. Relative water content reached lowest levels (18.4% reduction over control) and solute leakage values reached highest levels (141% increase over control) compared to other piper sp. It had very low protein levels and it further decreased (25.7%) under stress. *Piper longum* and *Piper chaba* had lower peroxidase and higher catalase activities and lower protein content compared to other *Piper nigrum* accessions. But these maintained lesser reduction in catalase activity, relative water content, lower solute leakage values and higher SOD activity under water stress. These preliminary results indicate that *Piper chaba* and *Piper longum* perform better under water stress condition.

PHY VI(813)

CHARACTERIZATION OF DROUGHT TOLERANCE IN CARDAMOM

(S.J. Anke Gowda, K.S. Krishnamurthy and K. Padmini)

Three ecological types namely Malabar (CCS-1), Mysore (ICRI-2) and Vazhukka (MCC-21) were grown in cement pots for 1 1/2 years with twelve treatments and three replications. Moisture stress treatment was imposed by

withholding irrigation. Moisture stress treatment reduced the leaf number, plant height, number of tillers, dry weight of root and shoot. Mysore type (ICRI-2) was found to be highly susceptible. Malabar (CCS-1) and Vazhukka (MCC-21) recorded good recovery in terms of new growth. Seven genotypes which are performing better in farmers' field were collected and multiplied for further evaluation.

BIOCHEM.1 (813)

BIOGENESIS OF PIGMENTS IN SPICE CROPS

(B. Chempakam and T. John Zachariah)

Distribution pattern of the three forms of curcumin (curcumin I, II & III) was studied in mother, primary and secondary rhizomes during development. This information is a prerequisite for initiating radio labeled studies on curcumin precursors.

Curcumin I (Bis demethoxy curcumin, abs. maxima 419 nm) showed a gradual increase in the mother rhizomes during growth, while in primary and secondary rhizomes a decrease was seen. Curcumin II (De methoxy curcumin, abs. max. 423 nm) gradually decreased during growth in the primary and secondary rhizomes, but was maximum at 150 DAP (Table14)

Table14. Distribution of curcuminoids in turmeric oleoresin during rhizome development

Days after planting	Curcumin fraction	Per cent distribution		
			Mother	Primary Secondary
120	Curcumin I	18.4	26.8	25.1
DAP	Curcumin II	27.5	20.9	17.8
	Curcumin III	54.1	52.3	57.1
150	Curcumin I	26.1	24.5	10.8
DAP	Curcumin II	32.1	19.9	16.5
	Curcumin III	41.8	55.5	55.1
180	Curcumin I	21.1	17.0	14.8
DAP	Curcumin II	17.1	16.9	11.6
	Curcumin III	61 8	66.1	73.6
210	Curcumin I	29.6	19.7	13.7
DAP	Curcumin II	24.1	17.5	31 3
	Curcumin III	46.4	62.8	55.0

Curcumin III (curcumin, abs. max. 428 nm), the major colouring principle, was the highest among the three curcuminoids and showed a maximum value at 180 DAP. This coincided with the acitivty of PAL (Phenylalanine ammonia lyase) in the rhizomes, as reported earlier.

PHT.I (813)

QUALITY EVALUATION IN SPICES

(T. John Zachariah and B. Chempakam)

Refining methods to prepare white pepper

Mature green berries of pepper treated with ethephon (500, 1000, 2000 ppm) to enhance ripening did not show much effect. Ripe red berries soaked with 1000 ppm ethephon for 24 hours showed reduction in retting time for white pepper. In conventional method, ripe berries take 7-8 days for microbial degradation of skin while ethephon treated berries took only 3-4 days. The product had attractive colour.

Physical and chemical changes in black pepper during storage

Dried black pepper berries were stored in 1) gunny bag 2) polyethylene coated gunny bag 3) polyethylene bag and 4) white thick polyethylene bag. Storage for a period of one year did not show significant change in bulk density, essential oil content, oleoresin and moisture content.

Black pepper from Kahikuchi (Assam)

Five samples from Kahikuchi were evaluated for chemical quality constituents. Bulk density ranged from 265 gm to 450 gm, essential oil from 1.9 to 3% and oleoresin from 7.7 to 15%. The GC profile showed that caryophyllene, the main aroma principle ranged from 13 to 34%.

Evaluation of ginger samples

Among the 61 ginger samples evaluated, accessions 292 (2.8%), 251 (2.7%), 51 (2.7%), 41 (2.5%), 241 (2.3%), 70 (2.3%) and 165 (2%) had relatively high oil content.

Comparison of 'Dosi Fiber' with conventional fiber analysis

Employing of 'Dosi Fiber' an automated fiber estimation unit is found to be more ideal and consistent in estimating crude fiber from ginger (Table 15) . In conventional method there are two steps, viz., extraction with hot acid followed by washing with hot water, filter, transfer and again boil with hot alkali, wash in hot water, filter and dry. In 'Dosi Fiber' unit using built in condenser, heaters and filters the whole process is easy, with no loss of samples and it ensures complete digestion, thereby we get consistent values.

High curcumin lines were identified from Alleppey finger turmeric collections (Table 16) and from the turmeric germplasm available at Peruvannamuzhi.

ORG CHEM.I (813)

ISOLATION AND IDENTIFICATION OF NATURALLY OCCURRING COMPOUNDS AGAINST MAJOR PESTS AND PATHOGENS OF BLACK PEPPER

(N.K. Leela, M. Anandaraj and S.J. Eapen)

Two crystalline nematicidal compounds were isolated from *Piper colubrinum* leaves. *In vitro* bioassays have shown that 500 ppm suspension of these compounds caused 100% and 74% mortality of the larvae of the root-knot nematode *Meloidogyne incognita* after 18 hrs. exposure. These compounds will be characterised further.

Table15. Fiber content (%) in Acc 49 and IISR Varada

	Acc.49		IISR Varada	
	C	D	C	D
	5.6	4.5	4.7	2.9
	5.0	4.4	3.6	2.5
	5.9	4.8	3.7	2.7
	4.0	4.3	3.9	2.8
	4.9	4.4	3.8	3.0
Mean	5.6	4.6	3.9	2.8
CV	11.0	4.5	9.7	5.0

C = Conventional D = Dosi Fiber

Table 16. Alleppey finger turmeric collections

Acc	Curcumin (%)
584	7.4
595	6.3
591	7.0
585	7.6
609	7.4
587	7.5
596	7.6
588	7.0
603	6.8
607	7.5
579	8.2
593	8.1
577	7.6
575	8.3
582	6.8
High Curcumin lines	
173	8.3
126	7.8
42	8.5
319	8.4
330	7.6
295	7.7
109	8.6

By column chromatography of the leaf extracts partial purification of the antifungal principle in *Chromolaena odorata* has been achieved.

AD-HOC PROJECTS

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

(A.K. Sadanandan, V. Srinivasan, S. Hamza, A. M Sajna and M.R. Rubina)

Black pepper

A field experiment was laid out in farmers' field using 6 year old Panniyur-1 vines trailed on *Erythrina indica* in a traditional growing area, Boikeri, Coorg district of Karnataka. Treatments *viz.*, check, FYM, neem cake, leaf compost, vermi compost and chemical fertilizers were given during June 1998 and experiment is in progress. Soil analysis showed that application of

organics decreased bulk density, increased organic carbon, Bray P, exchangeable K, Ca etc.

Cardamom

Another field experiment was laid out in farmers' field at Madikeri. The treatments consisted of different organic materials as that of black pepper, imposed in two year old Clone-37 cardamom plantation during June 1998. Soil analysis showed increased nutrient availability due to application of organic amendments.

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, Chickmagalur 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 sloppy marginal areas were 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 maidan areas of Chickmagalur district in Karnataka.

3. Biochemical characterisation of ginger and turmeric

(T. John Zachariah and S.P. Shajiprabha)

Twenty-five accessions of ginger and 51 accessions of turmeric were evaluated for the isozyme polymorphism. The enzymes studied were acid

phosphatase, peroxidase, SOD and polyphenol oxidase. Curcumin content of all 51 accessions also was analysed. The paired affinity index calculation of the accessions is in progress. The curcumin content ranged from 0.9 to 8.0%.

DISTINGUISHED VISITING SCIENTIST SCHEME

YIELD TARGETTING IN SPICES THROUGH CONCEPTUAL CHANGES IN NUTRIENT MANAGEMENT

(K.P. Prabhakaran Nair)

A pot culture and also lab experiments were conducted to study the "buffering capacity of soil" in relation to zinc supply. For the study, soils from typical pepper growing areas *viz*., Thamarassery, Ambalavayal and Peruvannamuzhi showing latent Zn deficiency *(DTPA extractable Zn less than 1.2 ppm) were used. In* pot culture, 5 kg soil was added with graded levels of Zn 0, 100, 200, 300, 400 and 500 ppm and pepper cuttings (Panchami) were grown for 95 days to record the uptake and dry matter production. Column leaching and adsorption-desorption equilibrium experiments were conducted with similar levels of Zn loaded soil, to determine their intensity factor (0.01 M $CaCl_2$ extractable Zn fraction). Through quantity-intensity relations Zn buffer power was calculated and correlated with the crop uptake and dry matter yield. The results showed that DTPA extractable Zn and dry matter production were inversely related. But when buffer power values were incorporated, the relationship showed positive, which implied the importance of buffered Zn in determining Zn availability than DTPA extractable Zn. The Zn buffer power values of the soils used were 1.58, 3.03 and 0.78 for Thamarassery, Ambalavayal and Peruvannamuzhi, respectively. Even though all the soils used were of

the category "critically Zn deficient" as per DTPA extractable soil test. Ambalavayal was most buffered for Zn while Peruvannamuzhi was least, which in turn determines the availability of Zn in soils.

CLOSED PROJECT

AGR. VI (813)

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

(K. Kandiannan, K. Sivaraman and K.S. Krishnamurthy)

In order to standardize the agro-techniques for black pepper, an experiment was initiated during 1979. Agro-techniques like fertilizer application, spacing, irrigation and cultivars were investigated during different phase of the project.

Fertilizer requirement of Panniyur-1

A field experiment was laid out during 1979. The soil of the experimental plot was a latosol of sandy clay loam texture with medium organic carbon, medium in Bray-P, low in available K and low in CEC. The DTPA extractable micronutrients were Fe 15 ppm, Mn 5 ppm, Zn 2 ppm and Cu 3 ppm. The experiment was laid out in a 3^3 factorial confounded design with four replications with six vines per treatment. The test crop was hybrid variety Panniyur-1 trailed on *Erythrina indica* standards. The treatments were

N : 50, 100 and 200 g/vine/year as urea

P_2O_5 : 20, 40 and 80 g/vine/year as single super phosphate

K_2O : 70, 140 and 280 g/vine/year as muriate of potash

These were applied in all possible combinations. Only one third of the above doses were applied during the first year, two third during the second year and the full dose from third year onwards. Fertilizers were applied in two equal splits, half during May and the other in September except phosphorus, which was applied in a single dose. The fertilizers were applied at a distance of 30 cm all around the vines and covered with a thin layer of soil. A common control plot was maintained without addition of any fertilizers.

Application of N, P and K significantly increased the yield of pepper. Among the treatments, application of 100, 40 and 280g N, P_2O_5 and K_2O per vine registered the maximum yield. Among the levels of N, application at 100 and 200 g were on par. Regarding application of P, 40 and 80 g per vine were on par. Among the levels of K, application at the highest level (280 g/vine) recorded the highest yield. Response functions were worked out and it was found that application of N, P and K at 140, 55 and 270 g/vine/year was found to be optimum for obtaining 3.3 tons green pepper per ha per year.

Fertilizer requirement of Karimunda

The fertilizer trial with four levels of nitrogen (50, 100, 150 and 200 g/vine/year) and potash (70, 140, 120 and 280 g/vine/year) with five additional treatments *viz.*, ($N_0P_0K_0$, $N_{50}P_{50}K_{140}$, $N_{50}P_{60}K_{140}Ca_{50}Mg_0$, $N_{50}P_{60}K_{140}Ca_0Mg_{50}$ and $N_{50}P_{60}K_{140}Ca_{50}Mg_{50}$) was initiated during 1987 with Karimunda as test crop. Totally, 21 treatment combinations were laid out in RBD with three replications. The experimental unit and method of fertilizer applications were as described in the first experiment. The Karimunda was trailed on *Erythrina indica*. The final cumulative yield of five years showed that 150g N and 280 g K_2O/vine/year recorded highest yield.

Critical nutrient indexing

The experiment was initiated during 1993-94. Black pepper (Karimunda) garden selected for the study was located at typical black pepper growing tract (Pulpally, Wynad district). Based on previous yield history, the vines, 10 years old were classified as high (>5 kg green yield/vine/year), medium (3-5 kg/vine) and low (<3 kg/vine) bearers. Hundred high, fifty each medium and low bearing vines were marked and leaf samples (8 leaves/vine) were collected just before flushing (April) and analyzed for N, P, K, Ca, Mg, S, Zn, Mn, Fe and Cu by using standard procedures. The result showed that high yielding vines had more nutrient content than medium and low yielding group. The nutrient content was proportional to the yield levels.

Spacing experiment

A field experiment was laid out in 1983. The soil of the experiment plot was latosol of sandy clay loam texture with pH 5.1, organic carbon 1.2%, Bray P-10 ppm, K 50 ppm, CEC 7.8 C mol (p+) kg^{-1}. The treatments comprised of

four spacings *viz.* 3 x 3 m (1100 plants/ha), 2.5 x 2.5 m (1600 plants/ha), 2.5 x 1.5 m (2666 plants/ha) and 2 x 1 m (5000 plants/ha), and three varieties (Panniyur-1, Karimunda and Aimpiriyan). Black pepper vines were trailed on RCC posts (3 m height). On the border of each plot *Albizzia falcatarea* was planted to provide over head shade. A uniform dose of 100: 40: 140 N: P_2O_5: K_2O g/vine/year was applied from the third year onwards. During the first and second years only one third and two thirds of the full dose, respectively were applied. The N and K fertilizers were applied in two equal splits, one in June and the other in September. The analysis of data pertaining to cumulative yield for 7 years showed that closer planting (2 x 1 m) recorded maximum yield in all the three varieties, *viz.* Panniyur-1 (3991 kg/ha), Karimunda (3044 kg/ha) and Aimpiriyan (2158 kg/ha).

Irrigation experiment

A trial on irrigation requirement of black pepper cv Karimunda was initiated during 1988 using *Erythrina indica* as standard. There were 13 treatments and 2 replications in CRD design with 6 vines per replication and 4 irrigation treatments *viz.*, irrigation at IW/CPE ratios of 0.5 and 0.25 and drip irrigation at 2 and 4 liters per vine per day. But in 1993, treatments were modified *viz.*, irrigation at IW/CPE ratios of 0.9, 0.6 and 0.3 and drip irrigation of 7 litres per vine per day.

The drip irrigation @ 7 liters/day/vine during October to May recorded maximum yield (3.059 kg/vine) compared to control (1.287 kg/vine).

Varietal experiment

Black pepper improved cultivars viz. Sreekara, Subhakara, Panchami, Pournami, P-24, Panniyur-1,2,3,4 and 5 planted during July 1994 on *Ailanthus malabarica* support and their growth performance and physiological parameters were studied. During 1995-96, data recorded on morphological parameters indicated that the varieties Panniyur-1 and Panniyur-3 were superior.

Total soluble sugars in the leaves of black pepper varieties increased gradually from August and reached a peak during October, then showed a declining trend till February and again showed an upward trend in March. Total chlorophyll content varied significantly among the varieties in all months except December. In general, P-24 maintained higher chlorophyll content during all

months. The ratio of chlorophyll a to b (Chl.a/chl.b) was comparatively less during August-December and it increased during Feb-March in all varieties.

During 1996-97, the performance of Subhakara was superior in terms of growth and yield. Proteins, total phenols, total free amino acids and total non-structural carbohydrates were analyzed at bimonthly intervals. In general, all varieties showed similar trend with respect to accumulation of all these metabolites. Protein content was high during June, then started declining, again showed little increase in October and December and then reached the lowest in February. Sreekara and Subhakara maintained the highest level at all stages. All varieties recorded high amount of total phenols during June and August. The lowest amount was recorded in December, which coincided with berry maturity. Total free amino acids was low in June. All varieties maintained high levels in October and February. Sreekara accumulated the maximum amount at all stages. Total non-structural carbohydrates was low in June then increased in August in all varieties. After August, some varieties showed increase while others maintained the same level. Sreekara recorded maximum amount at all stages. In general, Sreekara, Subhakara and Panniyur-1 were superior with respect to these metabolites.

AGR.XVIII (813)

BIO-FERTILIZER APPLICATION ON GROWTH, YIELD AND QUALITY OF BLACK PEPPER

(K. Kandiannan)

Effect of sources of *Azospirillum* on growth of black pepper

A trial was conducted under pot condition to evaluate different sources of *Azospirillum* on growth of black pepper under fumigated and non-fumigated conditions during 1995-96. Four sources of *Azospirillum* (obtained from Tamil Nadu Agricultural University, Coimbatore; Central Plantation Crops Research Institute, Kasaragod; Indian Organic Chemicals, Pune, Purchased through Harithabandhu, Kottayam and Stanes Co. Ltd., Coimbatore) along with uninoculated control were tried under fumigated and non-fumigated media in a CRD with five replications. Plant height and leaf area at 30 and 90 days after planting (DAP), shoot and root dry matter at 90 DAP were recorded and data analyzed statistically (Table 17. A & B). No significant differences were ob-

Table 17 A Effect of Azospirillum on growth parameters of black pepper Fumigated mixture

Azospirillum source	Fumigated mixture					
	Plant height (cm)		Leaf area (cm^2)		Shoot dry wt. (g/plant)	Root dry wt. (g/plant)
	30 DAP	90 DAP	30 DAP	90 DAP	90 DAP	90 DAP
TNAU	20.40	45.59	69.09	2796.89	23.6	3.0
CPCRI	15.12	49.59	72.00	2584.54	24.4	2.8
IOC	13.56	46.48	66.36	2667.95	23.4	2.9
STANES	13.20	41.10	62.98	2534.94	22.9	2.8
CONTROL	13.45	29.94	55.94	1519.98	19.1	1.4
CD at 5%	NS	12.01	NS	937.34	2.1	1.3

served among different sources and uninoculated control on growth of black pepper at 30 DAP. However, at 90 DAP all the four sources enhanced the plant height, leaf area, shoot and root dry matter production of black pepper compared to uninoculated control. No significant differences were noticed among different sources of Azospirillum. Similarly, no significant difference among growth parameters were also observed between fumigated and non-fumigated mixture.

Effect of bio-fertilizers on growth of black pepper

A pot culture experiment was initiated to study the effect of biofertilizers *viz.*, *Azospirillum,* Phosphobacteria and Vesicular Arbuscular Mycorrhizae (VAM) alone and their combinations on black pepper growth and it was compared

Table 17 B. Non-fumigated mixture

Azospirillum Source	Non-Fumigated mixture					
	Plant height (cm)		Leaf area (cm^2)		Shoot dry wt. (g/plant)	Root dry wt. (g/plant)
	30 DAP	90 DAP	30 DAP	90 DAP	90 DAP	90 DAP
TNAU	14.12	44.80	73.47	2643.49	23.4	2.9
CPCRI	16.06	35.79	67.92	2680.59	23.8	3.1
IOC	16.66	38.93	74.64	2517.67	21.9	2.9
STANES	15.10	33.60	60.33	2584.65	22.5	2.7
CONTROL	10.87	22.38	79.63	1503.24	18.3	1.6
CD at 5%	NS	12.01	NS	937.34	2.1	1.3

with uninoculated control. The experiment was laid out in a CRD with five replications. *Azospirillum* (20g), phosphobacteria (20g) and VAM (100cc) were separately mixed with five kg potting mixture consisting of Soil: Sand: Farm yard Manure (1:1:1). The potting mixture had nutrient composition of 0.81% N, 0.32% P_2O_5, 0.78% K_2O and pH of 7.2. Periodical growth observations were made. Growth parameters like height, number of leaves and leaf area were recorded at 3 and 6 months after planting. Combined application of all the three biofertilizers recorded maximum growth compared to other treatments. Uninoculated control recorded minimum values and it was on par with individual application (Table 18). The biofertilizers inoculation enhanced the dry matter production (Fig.1) and leaf nutrient content of black pepper. The combined application of all the three biofertilizers recorded maximum dry matter production (34 g/vine) at 18 months after planting compared to control (19 g/vine). Similarly, nitrogen, phosphorus and potassium contents (3.26%, 0.21% and 1.94%, respectively) of leaves were maximum under combined inoculation (Fig.2). Thus biofertilizers application augments the growth and nutrient uptake in black pepper.

Table 18. Biofertilizers on black pepper growth

Biofertilizer	At 3 months			At 6 months		
	Height (cm)	No. of leaves	Leaf Area (cm^2)	Height (cm)	No. of leaves	Leaf Area (cm^2)
Azospirillum (Azo)	23.0	4.1	116.6	50.9	7 7	244.7
Phosphobacteria(Phospho)	23.6	4.1	119.5	51.5	8 2	255 7
Vesicular-arbuscular-mycorhizae (VAM)	25.5	4.3	120.2	53.2	8.6	279.3
Azo + Phospho	25.7	5.1	134.3	54.7	8.7	280.5
Azo + VAM	28.3	5.1	134.8	61.3	9.1	290.4
Phospho + VAM	30.2	5.3	150.2	66.6	9.3	309.9
Azo + Phospho + VAM	32.9	5.3	155.9	77.0	9.4	343.5
Control	18.9	3.9	111.7	45.6	7.7	235.0
CD	7 7	1.0	30.0	17.6	NS	66.3

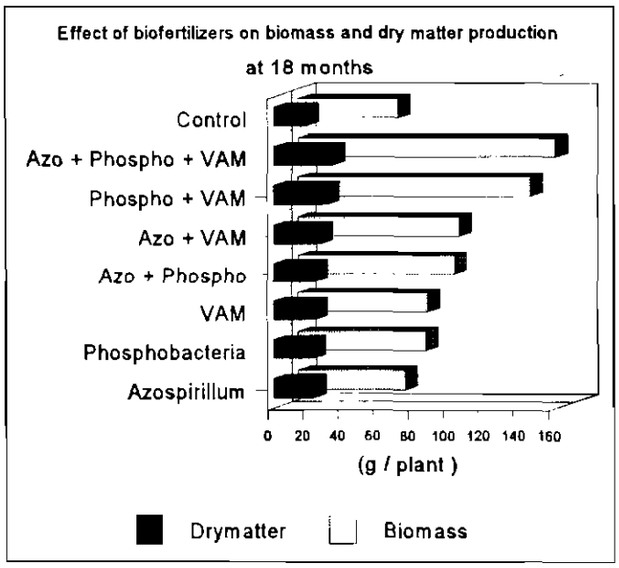


Fig.1. Effect of biofertilizers on biomass and dry matter production

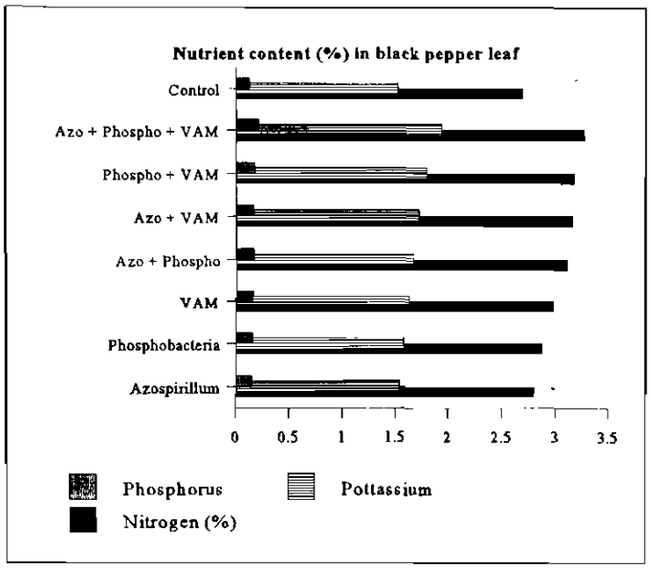


Fig.2. Nutrient content (%) in black pepper leaf

CONTRACT RESEARCH PROJECT

4. STUDIES ON EVALUATION OF TERRA CARE (COIR COMPOST) FOR GROWTH, NUTRIENT AVAILABILITY, YIELD RESPONSE AND QUALITY OF SPICES

(A.K. Sadanandan, V. Srinivasan and S. Hamza)

In bush black pepper, maximum number of laterals and spikes were obtained in treatment combination consisting of terra care (TC) + FYM + biofertilizers (BF) and an increased yield of 176% over control was recorded.

Under field condition, in both ginger and turmeric crops, TC + FYM + BF combination out yielded other combinations. In ginger, TC + FYM + BF treatment recorded 21.3 t fresh rhizome yield which is about 57% increase over chemical fertilizer application alone and was on par with TC + FYM. In turmeric, TC + FYM + BF combination yielded 29.2 t ha^{-1} showing an increased yield of 84.8% over control and 32.7% over chemical fertilizer. Microbial population also increased due to TC and FYM application.

From the nursery study, using terra care (TC) as a substitute for FYM/ soil/sand in potting mixture for growing rooted pepper cuttings, it was found that TC can be successfully used as a substitute for soil/sand in potting mixture.

CROP PROTECTION

PATH. II.3 (813)

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

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

A study was undertaken on the uptake, translocation, persistence and distribution of potassium phosphonate in black pepper. The chemical was tested at concentrations at 500, 1000 and 2000 ppm separately for its effect on foliar and root infections.

Maximum inhibition of foliar lesion was at 2000ppm spray (94.6%) followed by 1000 ppm spray (86.4%) (Table 19). In both cases, the peak activity was noted on 4th day and declined with time.

Spraying and drenching at 500ppm failed to check the root infection. The maximum inhibitory effect on root infection was with 2000ppm (spray and drench) and with 1000ppm (spray). In case of spray, the peak activity was on 16th day while it was on 4th day in case of drenching.

Integrated disease management trial at IISR farm, Peruvannamuzhi with ten cultivars (40 plants each) involving cultural practices, application of biocontrol agents (twice in an year) and also application of potassium phosphonate (spraying and drenching) is in progress (Table 20).

Table 19. Effect of potassium phosphonate on foliar infection in black pepper caused by *P. capsici*

Concentration (ppm)	Days after treatment			
	2	4	8	16
500 Spray	54.2*	51.4	46.0	12.8
500 Drench	27.9	37.3	27.0	2.9
1000 Spray	84.7	86.4	82.2	71.6
1000 drench	41.7	53.8	64.9	43.3
2000 Spray	94.3	94.6	86.6	78.3
2000 Drench	59.9	64 5	69.8	62.4

* (Per cent inhibition of foliar lesion over control)

Table 20. Disease incidence in 10 black pepper cultivars in the integrated disease management trial at Peruvannamuzhi

Cultivar	No. of replants	Dead vines
Subhakara	14	-
Sreekara	16	1
Panchami	15	4
Pournami	13	3
P24	1	1
Panniyur-1	5	10
Panniyur-2	8	4
Panniyur-3	8	3
Panniyur-4	4	3
Panniyur-5	13	3

All the ten cultivars were infected with *Radopholus similis*. The population of *R. similis* ranged from 2-32 nematodes/100cc soil and highest population of 32 nematodes/100cc soil was recorded in Panniyur-5. *Trichoderma* population increased over the pretreatment levels.

A pot culture experiment with fungal biocontrol agents (*T. harzianum*, *T. virens*, *Verticillium tenerum*, *V. chlamydosporium*), and fluorescent pseudomonads alone and in combination with potassium phosphonate was conducted to study their efficacy and compatibility. All the treatments, except the treatments with fluorescent pseudomonads, showed more than 75% control of *Phytophthora* infection in black pepper.

PATH. X (813)

INVESTIGATIONS ON VEIN CLEARING VIRUS OF SMALL CARDAMOM

(M.N. Venugopal)

Purification of virus

Two modified protocols suitable for elongated viruses were tried without much success. Attempts to find alternate multiplication host for virus purification was continued. *Maranta arundinacea* (Arrow root) was tried based on the suspected natural infection of Kokke kandu. So far field symptoms like intra veinal clearing, mottling on pseudostem and stunting could not be reproduced in the inoculants.

In ELISA, antiserum prepared against PSTV (Pea nut stripe virus) reacted more specifically to Kokke kandu infected cardamom and arrow root showed similar symptoms like intraveinal clearing, mottling on pseudostem and stunting. This system can be reliably used to identify Kokke kandu infected cardamom.

Screening of elite selections

The field screening trial in hot spot was concluded and only Acc. 893 was less susceptible among the twenty elite selections tested.

PATH. XI (813)

STUDIES ON BACTERIAL WILT OF GINGER

(A. Kumar and Y.R. Sarma)

Ralstonia solanacearum was isolated from wilt affected ginger plants obtained from Kerala (Wynad, Trichur, Peruvannamuzhi and Calicut), Sikkim and Andhra Pradesh. The bacterium was further characterized for biovar differentiation. Most of the isolates tested positive for biovar 3. Besides typical biovar 3, incidence of aberrant biovar 3 (Dulcitol negative phenotype) was observed in Sikkim and Kerala.

Screening technique for identification of tolerant/resistant lines of ginger was standardized.

PATH. XII (813)

INVESTIGATIONS ON STUNTED DISEASE OF BLACK PEPPER

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

Graft transmission

Sixty grafts of various scion-stock combinations with infected and healthy vines were established. The fresh growth from the scions of established grafts are to be tested with antiserum of CMV using ELISA for confirmation. *Piper colubrinum* was found to be carrying the virus transmitted from diseased scion.

Sap transmission

Partially clarified sap from infected tissues using Phosphate (0.2M, pH 7.0) and Tris (0.25M, pH 7.4) buffers separately with Phenol-Chloroform (1:3

v/v) and Triton - X (1%) at 1000g was used in this study. Sap from black pepper, banana and betelvine was smeared onto leaves of black pepper, banana, betelvine, tomato, chillies, cowpea, green gram, red gram, snake gourd, bitter gourd, pumpkin, *Nicotina tabacum*, Xanthi NC, *N. glulinosa*, *N. benthamiana* , and *N. rusticum*. Since symptoms did not appear even after 4 weeks post inoculation, the transmission has to be confirmed by ELISA using CMV-antiserum.

Insect transmission

Aphids (*Aphasia gossip, Toxoptera aurantii, Pentalonia nigronervosa*), mealy bugs and thrips have been force-fed on to the infected pepper vines and subsequently on the healthy vines. The plants are under observation and need to be tested with ELISA, as there are no visible symptoms observed.

CROP PROT 1.I(813)

SCREENING GERMPLASM FOR REACTION TO DISEASES

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

Screening of cultivars, hybrids and wild *Piper nigrum*

Out of 37 accessions screened, 5 hybrids (HP 750, HP 478, HP 490, HP 1382 and HP 1344) showed tolerant reaction to *P. capsici*.

The eleven accessions, which showed tolerant reaction during last season were further screened and their reactions are given in Table 21.

Field evaluation of *Phytophthora* tolerant lines

a) Sirsi

Phytophthora tolerant lines were evaluated in comparison with two susceptible cultivars (KS-27 and Malligesara) in two trials at Sirsi and 33.3 and 44 per cent of P24 plants remained healthy in these trials.

b) Pulpally

At Pulpally, disease incidence ranged from 5.5% (Karimunda) to 50%

Table 21. Reaction of black pepper hybrids to *P. capsici* infection

Hybrid	Lesion length in mm	Depth of penetration
HP 750	0.8	4
HP 478	4.6	4
HP 490	1.6	4
HP 1728	3.6	3.6
HP 92	10.4	2.2
HP 1786	2.2	3.8
HP 1382	0.4	4.0
HP 754	6.0	2.6
HP 1380	10.0	2.4
HP 1344	0.4	4.0
HP 1748	3.2	3 2

Note: 1- 100% rotting
2- 75% rotting
3- 50% rotting
4- less than 25% rotting

(P339) while P24 showed 16.6% disease incidence. The yield ranged from 0.430 kg (P339) to 4.26 kg (HP 780) and the yield in P24 was 0.610 kg.

c) Peruvannamuzhi

Out of the 10 varieties evaluated under field condition, the crop stand was 97.5% in P24 compared to 75% in Panniyur-1. The results in general indicate variable degrees of tolerance.

BIOCONTROL 1.2(813)

BIOLOGICAL CONTROL OF INSECT PESTS OF SPICES

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

Documentation of natural enemies of insect pests of spices

The natural enemies of mealy bugs infesting black pepper were documented. These include, three unidentified species of hymenopterous parasitoids and one unidentified species of coccinellid beetle on shoot mealy bugs (*Planococcus* sp. and *Pseudococcus* sp.) from Peruvannamuzhi and an unidentified entomopathogenic fungus and bacteria on root mealy bug (*Planococcus* sp.) from Wynad.

Bioassay of fungal pathogens against mealy bugs in laboratory

Cultures of entomopathogenic fungi namely, *Beauvaria bassiana*, *Paecilomyces lilacinus*, *Verticillium chlamydosporium* and *Metarrhizium anisopliae* were multiplied and maintained in the laboratory and bioassays conducted to evaluate their pathogenicity against root mealy bugs infesting black pepper. The bioassays indicated that among the various fungi, *M. anisopliae* and *P. lilacinus* were more effective causing 80 and 42 per cent reduction in mealy bug population when compared to 175 per cent increase in population in control, 30 days after spray, indicating their potential in the management of the pest.

Evaluation of cultural methods for management of shoot borer on ginger

Cultural methods such as pruning of infested shoots, pruning of infested shoots and spraying of insecticides and spraying of insecticides alone were evaluated in the field at Calicut for the management of shoot borer (*Conogethes punctiferalis*) on ginger. The trials indicated that pruning of infested shoots during July - August and spraying of insecticides during September - October resulted in lesser incidence of shoot borer and higher yield of rhizomes. By adopting this cultural method two insecticidal sprays can be avoided, thus conserving natural enemies and causing less harm to the ecosystem.

Maintenance of cultures of biocontrol agents

Cultures of predatory coccinellid namely, *Chilocorus circumdatus* and *C. nigrita*, biocontrol agents of scale insects infesting black pepper, and entomopathogenic fungi namely, *Beauvaria bassiana, Paecilomyces lilacinus, Verticillium chlamydosporium* and *Metarrhizium anisopliae* were maintained in the laboratory.

CROP PROT. I.3(813)

SCREENING BLACK PEPPER GERMPLASM FOR REACTION TO NEMATODES

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

Out of the sixty germplasm accessions tested against *M. incognita*, eight accessions (cultivated -Acc. 4103 and 4175; *Phytophthora* tolerant lines-P 339 and C 1090; wild related species - 3219, 3286, 3287 and 3311) were

resistant to root knot nematodes in the preliminary testing. All the ten accessions tested against *Radopholus similis* were susceptible.

NEMA. III(813)

INVESTIGATIONS ON NEMATODES ASSOCIATED WITH SPICES

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

Screening of germplasm

Eight ginger accessions out of 32 and all the three turmeric accessions tested were found resistant to root knot nematodes in the second round of screening. Twelve cardamom accessions tested against root knot nematodes were susceptible to the nematodes.

Six turmeric (Acc. 3, 79, 84, 142, 182 and 198) and two ginger (Acc. 36 and 59) accessions, which showed resistance to root knot nematodes in the preliminary evaluations, were tested further under simulated field conditions in microplots (1 x 1m). All the accessions were evaluated for the damage caused by root knot nematodes by testing them in nematode-free and nematode-infested plots with three replications each. The final observations are given in Table 22 .

Table 22. Effect of root knot nematodes on growth and yield of turmeric and ginger germplasm accession (Mean of 3 replications)

Germplasm accession	Height (cm)		No of tillers		Yield *		Dry recovery (%)	Curcumin content (%)
	NF	NI	NF	NI	NF	NI		
TURMERIC								
3	38.17	50.17**	4.67	11.00**	1.617	2.383	12.50	5.57
79	45.96	50.50	5.92	6.42	2.067	2.020	10.50	4 24
84	51.60	50.50	5.73	6.42	1.832	1.801	13.25	4.06
142	47.79	51.67	5.42	5.42	1.746	1.903	14.00	3.90
182	76.78	73.44	6.66	6.44	2.028	2.101	18.25	3.40
198	43.25	41.00	4.33	6.33	1.650	1.862	18.25	1 61
GINGER								
36	55.78	52.39	70.00	57.50	0.723	0.661	21.00	-
59	42.06	44.11	17.11	37.83	0.679	0.335	17.00	-

* Yield/plant - Kg (wet) NF = Nematode free

** Means in the pair are significantly different (P=0.05%) NI = Nematode infested

None of the plants were immune to nematodes and most of them allowed multiplication of nematodes, indicating that they are tolerant lines.

Isozyme studies

Esterase and malate dehydrogenase patterns in 12 root-knot nematode populations were studied by native PAGE on Phast system. The pattern varied widely from the standard patterns.

BIOCONTROL I.3(813)

BIOLOGICAL CONTROL OF NEMATODES OF SPICES

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

Isolation of nematode antagonists

Soil samples collected from the rhizosphere of healthy black pepper vines in sick plots were plated on respective media. This process isolated eleven fungi and 7 bacteria. *Pasteuria penetrons*, the bacterial nematode parasite, was isolated from ginger samples collected from Sikkim, Wynad and Kasaragod.

***In vitro* testing against nematodes**

Among fungal isolates tested against root knot nematodes, isolates F5, F6 and 11/3b showed nematode suppression. Bacterial isolates 1, 3, 4, 8, 9 and 10 were toxic to root knot nematode juveniles in *in vitro* tests.

Mode of action of *Trichoderma*

Secondary metabolites of *Trichoderma harzianum* extracted using different organic solvents like acetone, chloroform and ethylacetate from the fungus grown in PDB for 30, 60 and 120 days. The extracts were concentrated, dried and redissolved in the respective solvent and this was tested against *M. incognita* and *R. similis* for its toxicity. The ethylacetate fraction at 50% dilution killed the nematodes within two hours of exposure. The endogenous metabolites, extracted by homogenising mycelial fragments, also showed a similar trend.

Different protocols were tried for the assay of hydrolytic enzymes like B-1,4 endoglucosidase, B-1, 3-glucanase and chitinase of *Trichoderma*.

CROP PROT. 1. I (813)

MECHANISMS OF RESISTANCE TO PESTS AND PAHTOGENS IN SPICE CROPS

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

The biochemical changes occurring during pathogenesis in *Meloidogyne incognita* black pepper pathosystsem were studied at 24h, 48h, 72h, one week and one month after inoculation. There was accumulation of phenols in resistant lines both in leaves and roots. The activities of superoxide dismutase, peroxidase, catalase and polyphenol oxidase were monitored. Polyphenol oxidase activity was more in tolerant line compared to susceptible line. Post infectional changes in different enzyme activities are depicted in Fig. 3.

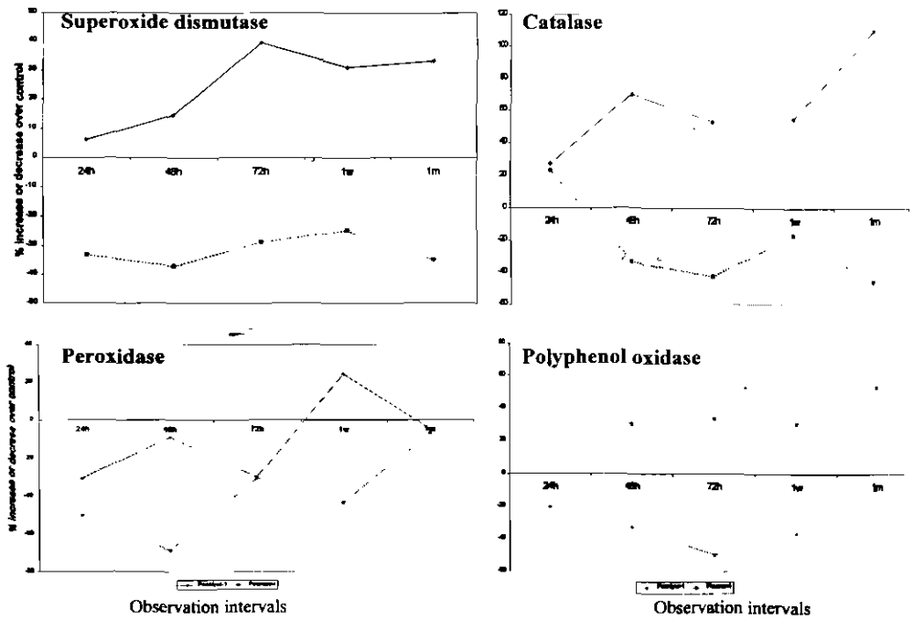


Fig. 3. Post infectional changes in levels of superoxide dismutase, catalase, peroxidase and polyphenol oxidase in roots of black pepper lines susceptible (Panniyur-1) and tolerant (Pournami) to *Meloidogyne incognita*

In pollu resistant lines of black pepper the levels of amino acids and surface wax was high compared to susceptible lines. The surface wax in Panniyur-1 was 9.78 µg/100g tissue compared to 20.0 to 80.8 µg/100g in pollu resistant lines.

The breeding potential of *Pentalonia nigronervosa* f. *caladii* the vector of katte disease of cardamom was studied on katte resistant cardamom plants. There was no feeding deterrence and the aphids settled and multiplied on all resistant lines. This suggests that the resistant trait be not in vector deterrence but host controlled. The vector also multiplied on non-hosts such as *Alpinia* and *Hedichium* (Table 23). In black pepper - *P. capsici* pathosystsem new protein bands were noticed during pathogenesis. The PR proteins are being characterized.

Table 23. Breeding potential of cardamom aphid on Alpinia mutica and *Hedichium* sp.

Entry	Rate of aphid multiplication after release	
	On 5th day	On 10th day
Alpinia mutica	2.73	2.18
Hedichium sp.	2.36	2.70
Cardamom (control)	2.86	4.78
CD at P=0.05	1.92	2.64
F Test	NS	*

NS: Not significant
*: Significant at 1% level

BIOCONTROL I.I(813)

BIOLOGICAL CONTROL OF DISEASES OF SPICES

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

The field trials with VAM and biocontrol agents were monitored. The population of *Trichoderma* varied from 3.1 to 5.4, 9.2 to 13.9 and 25.1 to 37.1 x 10^3 cfu/g in the plots applied with *Chromolaena odorata*, *Trichoderma harzianum* and *Gliocladium virens*, respectively. Positive baiting for *Phytophthora capsici* was also obtained in all the treatments. The mortality of lines was 16.6% in *G. virens*, 22.1% in *T. harzianum* and 19.0% in *C. odorata* applied plots. For large-scale multiplication of *Trichoderma* decomposed coir

pith was used. The colonization of *Trichoderma* on decomposed coirpith after sterilization was very high when compared to unsterilized pith (Table 24). The coir pith was decomposed by adding urea, then inoculating *Pleurotus platypus* and incubating for 60 days.

In another experiment decomposed coir pith was mixed with coconut water and inoculated with *Trichoderma*. The population of *Trichoderma*

Table 24. Population dynamics of *Trichoderma* spp. in decomposed coir pith (cfu* x 10^4)

Isolate	Initial sample population	Days after inoculation			
		10		30	
		Sterile	Unsterile	Sterile	Unsterile
NRLM	15.6	4366.7	4.7	1800.0	6.3
NRL	35.9	6666.7	5.7	3666.7	12.3
P26	90.5	9066.7	12.0	9420.0	7.7

* Population per g of decomposed coirpith on dry wt basis
NRLM - Nuclear Research Laboratory Mutant.

Table 25. Population dynamics of *Trichoderma* spp. in coconut water amended coirpith (cfu x 10^4 per gm of coir pith on dry weight basis)

Isolate	Initial Population	Days after inoculation					
		5		15		20	
		Sterilized	Unsterilized	Sterilized	Unsterilized	Sterilized	Unsterilized
NRLM	0.87	66.0	11.0	108.7	36.7	106.5	11..0
NRL	0.22	733.6	10.3	17.3	18.4	14.7	14.7
P26	3.57	9170.1	27.2	11163.7	29.4	10646.1	22.0

isolates was high in sterilized medium when compared to unsterilized medium (Table 25). Coir pith could be effectively utilised as a carrier medium for *Trichoderma* for application in the field.

ENT. XI (813)

BIOECOLOGY AND MANAGEMENT OF MEALY BUGS INFESTING BLACK PEPPER

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

Surveys conducted in Wynad district in farmers' fields revealed that 20 to

80 per cent of the vines had incidence of this pest during monsoon period. However, the incidence ranged from 4.4 to 17.8 per cent during summer months.

Studies on nature of damage caused by mealy bugs showed that they are present on main roots as well as secondary and tertiary roots. Their presence was noticed even upto a depth of 2 feet. Many of the vines having mealy bugs were also affected by *Phytophthora* foot rot disease and such vines exhibited yellowing, defoliation and wilting.

Seven host materials such as elephant foot yam, colocasia, tapioca, coleus, potato, pumpkin and squash were evaluated for culturing mealy bugs. Pumpkins and squash were most ideal for culturing.

Preliminary field trials conducted with insecticides, neem products and organic products indicated that chloropyriphos 0.1% and quinalphos were most effective when the root zones were drenched with the insecticides.

CROP PROT. 1.2(813)

SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO INSECT PESTS

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

The high yielding varieties *viz.*, Panniyur-2, Panniyur-3, Panniyur-4, Panchami, Sreekara and Subhakara were screened for the incidence of pollu beetle on the berries. All the varieties were found susceptible to the pest. The infestation ranged from 3.7 per cent in Panniyur-3 to 14 per cent in Panchami. Also, eleven wild *Piper nigrum* accessions available at Peruvannamuzhi farm were screened for the incidence of pollu beetle on the berries. All the accessions were found susceptible and the percentage infestation ranged from 8.3 to 27.4 per cent.

ICAR AD-HOC PROJECTS

NATIONAL NETWORK ON *PHYTOPHTHORA* DISEASES OF HORTICULTURAL CROPS (PHYTONET)

(Y.R. Sarma and M. Anandaraj)

During this year, National Repository of *Phytophthora* (NARPH) was started and 258 isolates from 14 host plants were deposited. Nine *P. capsici*

isolates from black pepper were studied for the morphological character in detail. Sporangial characters of new isolates from crops like tapioca, vanilla, nutmeg, bautinia and *P. chaba* were studied. Protocols for the isolation of DNA from *Phytophthora* as well as from black pepper has been standardised. Induction of PR-protein during pathogenesis has been studied. The activity of defense related enzymes like β-1,3 glucanase and PAL were estimated. A total of 160 *Trichoderma* isolates and 155 bacterial isolates were screened for the antagonism to *P. capsici in vitro*. Three field trials are in progress at different locations. Reprints of full papers on Phytophthora and related references were collected, catalogued and indexed.

ICAR AD HOC PROJECT

BIOLOGICAL CONTROL OF PLANT PRASITIC NEMATODES OF MAJOR SPICE CROPS

(K.V. Ramana, Santhosh J. Eapen & M.A. Arabi Mohamed Saleh)

Thirty root samples of ginger along with rhizosphere soil were collected in a random survery undertaken in four districts of Kerala viz., Wynad, Kannur, Kasargod and Calicut for isolation of naturally occurring BCAs (Fungi and bacteria). From these samples 20 each of bacterial and fungal isolates were obtained. The methods for culturing and maintaining pure cultures of microoranisms were standardized. For long term storage of fungal cultures, Potato Carrot Agar medium or liquid paraffin was used. *Trichoderma spp., Paecilomyces lilcinus, Verticillium chlamydosporium and Pseudomonas fluorescence* were isolated using specific, selective or semi-selective media. Various protocols for testing the bio-efficacy of test organisms on nematode suppression were also standardised.

All the fungal and bacterial isolates were tested for their suppressive effects on nematode hatching in the laboratory bio assays. There was a significant suppression (>80%) in the hatching of nematodes treated with the fungal isolates (No. 4, 5, 7, 8, 11, 14, 16, 23, 25 and 29). Further, 9 isolates also showed parasitization of nematode eggs. Among 29 bacterial isolates, isolate No. 1, 3, 4, 5, 8 and 10 caused 80 per cent or more mortality to second stage juveniles of root knot nematodes.

Final report (ICAR ad-hoc research scheme)

BIOLOGICAL CONTROL OF SCALE INSECTS INFESTING BLACK PEPPER

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

Documentation of natural enemies of scale insects

Surveys were conducted in major black pepper areas in Kerala, Karnataka and Tamil Nadu to document the natural enemies of scale insects infesting black pepper. Twenty one species/genera of natural enemies were recorded on *Lepidosaphes piperis* and *Aspidiotus destructor*, two major species of scale insects infesting black pepper in India, among which *Mallada boninensis*, *Chilocorus nigrita*, *Pseudoscymnus* sp. *Adelencyrtus* sp. and *Encarsia citrina* were new records. *Aphytis* sp., *Pseudoscymnus* sp. and *C. circumdatus* were widely distributed in the areas surveyed.

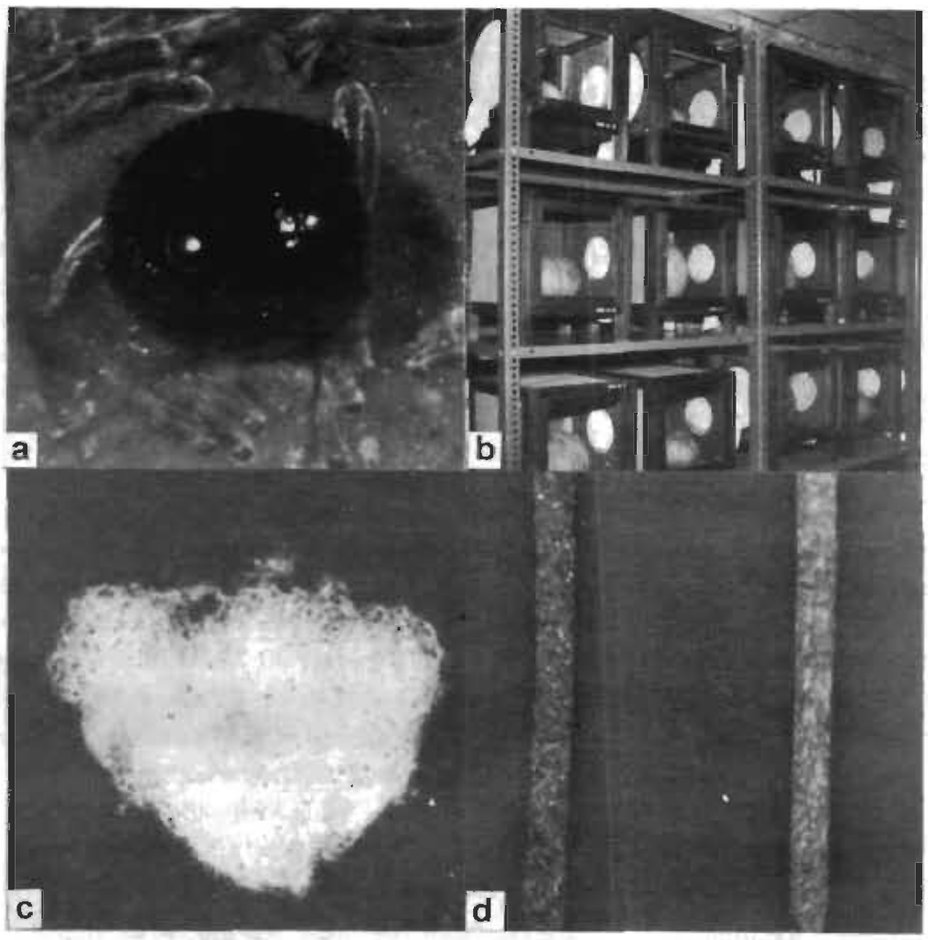
Biology of natural enemies

The predatory potential and life cycle of *Chilocorus circumdatus* and *C. nigrita* were studied in the laboratory to determine their suitability for the control of scale insects in the field. Among the two species of *Chilocorus*, *C. nigrita* had more potential as a biocontrol agent of *L. piperis*, the adults feeding on 27.0 ±11.5 scale insects per day, *C. circumdatus* fed more voraciously on *A. destructor*, the adults feeding on 37.8±11.4 scale insects per day.

The total life cycle in *C. circumdatus* and *C. nigrita* was completed in 22.6 ± 1.9 and 29.9 ± 2.5 days, respectively. The fecundity of females was 270 ± 100.0 and 101.2 ± 42.7 eggs and adult longevity 32.0 ± 14.4 and 55.7 ± 13.3 days respectively in *C. circumdatus* and *C. nigrita*.

Standardization of techniques for mass rearing of natural enemies

Techniques were standardized for mass rearing of *C. nigrita* and *C. circumdatus* in the laboratory. Pumpkins *(Cucurbita moschata)* were the most suitable for the multiplication of the host scale *Aonidiella orientalis* and the predators. The critical stages of crawler production and inoculation periods for raising *A. orientalis* cultures on pumpkins were determined. Crawler production was maximum 25-27 days after inoculation and nine pumpkins could be inoculated with *A. orientalis* from a single mother pumpkin within a period of 6 days. The pumpkins with the established scale insects could be used as



Legends

Fig. 4. Biological control of scale insects infesting black pepper

a. *Chilocorus nigrita* b. Mass rearing of predator c. Collection of eggs of predator for field release d. Reduction in scale infestation on released vines (right).

food materials 12 days after settlement of crawlers. The optimum population levels of predators that could be maintained on a single pumpkin infested with *A. orientalis* was determined as 75 and 35 individuals of *C. nigrita* and *C. circumdatus*, respectively.

Evaluation of *C. nigrita* for the control of *L. piperis*

Evaluation of *C. nigrita* in the field at Wynad (Kerala) for the control of *L. piperis* indicated that release of 125 eggs per vine (5 releases at 7-10 day intervals) during April-May reduced the population of scale insects by 45 per cent.

Evaluation of *C. circumdatus* for the control of *A. destructor*

Evaluation of *C. circumdatus* in the field at Wynad (Kerala) for the control of *A. destructor* indicated that release of 85 larvae per vine (5 releases at 7-10 day intervals) during October-December reduced the population of scale insects by 69-92 per cent.

Integrated control of scale insects

The toxicity of plant and organic products such as neem oil 0.3% and 0.6%, Neemgold 0.6% and fish oil rosin 3% to *L. piperis* and *A. destructor* was determined along with the insecticides monocrotophos 0.1% and dimethoate 0.1%. All the plant and organic products were effective in reducing the population of *L. piperis* and were on par with the insecticides; in the case of *A. destructor*, fish oil rosin was more effective among the various products.

The toxicity of monocrotophos 0.1%, dimethoate 0.1% (recommended for the control of *L. piperis* and *A. destructor*), neem oil 0.3% and 0.6%, Neemgold 0.6% and fish oil rosin 3% to *C. nigrita* and *C. circumdatus* was determined. Monocrotophos and dimethoate were toxic to *C. nigrita* up to 7 and 1 days, respectively, after treatment. These two insecticides were toxic to *C. circumdatus* up to 15 to 7 days, respectively, after treatment. Neem oil, Neemgold and fish oil rosin were safe to the predators and no mortality was observed even on the day of spray.

The trials indicated the feasibility of utilization of plant and organic products along with release of *Chilocorus* spp. for the integrated management of scale insects infesting black pepper.

SOCIAL SCIENCE

EXT. 1(813)

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

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

Cardamom

As performance of cardamom is location specific, need based 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 specific situations as follows.

Comparative performance of sole crop of cardamom and coffee

As there has been a quantum jump in the price of coffee in the recent years, a study was initiated during 1993 to investigate the performance of sole crop of coffee both Arabica and Robusta vs sole crop of cardamom to workout the economic analysis under the same set of agro-ecological conditions.

i) Cardamom vs Robusta Coffee

The average yield of cardamom for four crop seasons was 335.75 g/acre. The average yield of Robusta coffee for the same period (1994-95 to 1997-98) was 962.50 kg/acre.

ii) Cardamom vs Arabica Coffee

Cardamom yield was 682 kg (dry)/ha in 1997-98 crop season. Arabica coffee yield was 1510 kg/ha in 1997-98. The average yield of cardamom for three crop seasons cultivated on steep slope was 560.33 kg (dry)/ha. Similarly, the average yield of cardamom for four crops seasons cultivated on marshy land (1994-95 to 1997-98) was 715.25 kg (dry)/ha. Sole crop of cardamom which replaced Arabica coffee recorded an average yield of 970 kg (dry)/ha for three cropping seasons. The growth and yield of cardamom grown purely

organically (using vermi compost) and cardamom grown in trench system are being monitored.

STAT. VI (813)

ECONOMICS OF GINGER CULTIVATION

(Jose Abraham)

Collection of primary and secondary data on components of cost on various inputs like planting material, labour, fertilizer and other inputs were done. Tentative estimates of cost of production of ginger (green) were worked out as Rs. 7.44/kg. Major components of cost in ginger production are the cost of planting material and labour which comes about 40% each approximately. The cost of other inputs like FYM, chemical fertilizers and plant protection chemicals together constitute the remaining 20% of the cost. The productivity under scientific management was assumed to be 16 t/ha for a seed rate of 2 t/ha and the losses due to soft rot and bacterial wilt are considered moderate. However, under actual field conditions, the incidence of disease was severe and in varying degrees affecting the productivity drastically.

EXT. IV (813)

TRAINING OF RESEARCH AND EXTENSION WORKERS

(M.S. Madan and P. Rajeev)

The sole objective of the project is to extend the technologies developed by the institute to the needy farmers and the same was achieved through direct as well as indirect training and extension activities.

Training programs conducted were:

* Spices Production Technology - For Officers from North-Eastern States
* Nursery Management in Spices
* Spices Production Technology
* On-farm Processing of Spices

Sixty-one officers from nine States were trained during the period 1998-99. More than 150 farmers from various parts of country were given awareness training on spices production technologies developed in the

Institute. About 146 students from various agricultural universities were given exposure to developments in spices research at the Institute. Eleven officers/ managers from govt. organizations were given one-day orientation training at the Institute.

ECON. 1(813)

ECONOMICS OF SPICES PRODUCTION AND MARKETING

(M.S. Madan and Jose Abraham)

Creation of database

Through desk research, available secondary data on area, production, productivity and prices for commercially important spice crops were collected to create a spice database. Primary data collected through field surveys were analysed and added to the database.

Estimation of cost of cultivation

A Rapid Rural (Market) Appraisal (RRA) was carried out in the spice districts of Kerala i.e. Wynad and Idukki and Coorg district of Karnataka to collect information on production and post-harvest practices including marketing of spices. Based on the RRA information, questionnaires were prepared to conduct survey on ginger and pepper and pre-tested in the spice districts of Kerala (Wynad and Idukki). The preliminary survey has revealed certain characteristic changes like predominance of mixed cropping system, improvement in productivity etc. in the spice production system. Cost of cultivation for pepper was worked out using the preliminary (pre-testing) and RRA data collected.

Technology evaluation

Under the 'economic evaluation of technology' program proven technologies for small-scale/cottage units to produce value added spice products were worked out:

Rapid Multiplication Technology for production of rooted pepper cuttings is the proven available technology, which provides an opportunity to start a profitable small-scale venture to produce 15000-20000 nos./yr. Financial analysis carried out reveals the fact that the unit with payback period of less than 2 years (Fig.5) will yield the benefit cost ratio of 2.2. and the estimated cost is Rs. 3.16/cutting.

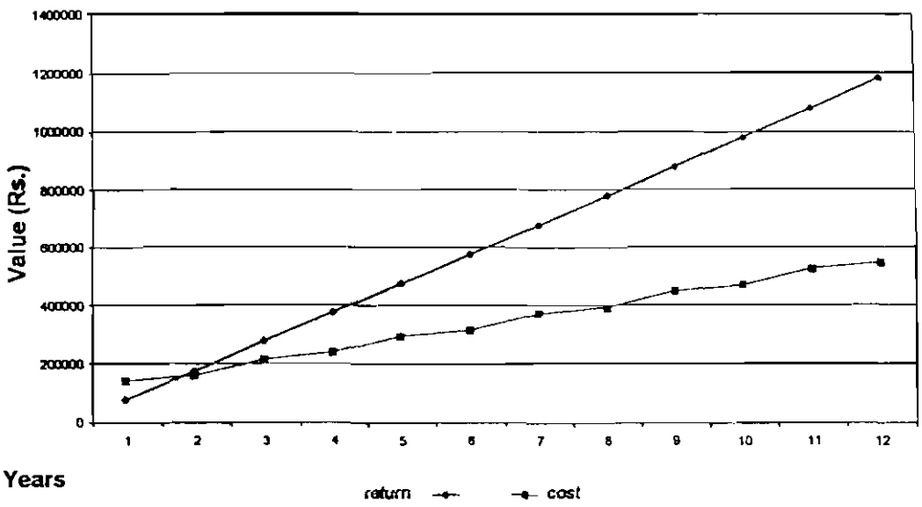


Fig.5. Cost and returns in production of rooted pepper cuttings

Table 26. Production budget for black and white pepper (Cost per 100 kgs of green pepper harvested)

Cost items	Cost (Rs.)	
	Black pepper	White pepper
Picking (harvesting) spikes	120.00	120.00
Separating berries (threshing)	30.00	120.00
Soaking in water (for 7 days) and removing skin.	-	90.00
Drying, Cleaning and packing	60.00	30.00
Total	210.00	360.00
Sale proceeds	2640.00	3360.00
Returns	2430.00	3000.00
Net Returns		570.00

Note: 1. Labour cost Rs. 60/day (an average of male, female, child and family labour wages)
2. 100 kg green harvest of pepper can give either 33.33 kgs of black pepper or 28 kgs of white pepper on processing.
3. White pepper price Rs. 1,20/kg (1996-97). Black pepper price Rs. 80/kg. (1996-97)

Value added products

The standardised IISR technology to make white pepper can earn an extra benefit of Rs.570/-per 100 kgs of green pepper harvested and processed over the traditional practice of making black pepper (Table 26).

A cottage industry with an initial investment of less than Rs. 5000 for making pepper in brine fetches Rs. 715/quintal (green harvest) as extra income over the black pepper.

With an initial investment of Rs.10, 000 a cottage unit to make salted ginger can earn the benefit cost ratio of 1.85.

The above products i.e., white pepper, pepper in brine and salted ginger has good demand not only in the export market but also in the domestic market.

Impact analysis

Under the programme to study impact of technology on improving production level, evaluation of chemical control measures against foot rot disease of black pepper is being carried out.

CLOSED PROJECT : Final Report

EXT. III (813)

CONSTRAINT ANALYSIS IN CARDAMOM PRODUCTION - A SYSTEM APPROACH

(P. Rajeev and V.S. Korikanthimath)

The broad objective of the study is to identify and analyse the major constraints faced by the cardamom growers in viable cardamom production. The specific objectives of the study are as follows.

1. To identify the constraints as perceived by the growers of viable cardamom production.
2. To classify and measure the identified constraints faced by the growers.
3. To analyse and study the impact of major constraints faced by the cardamom growers.

The data for the study was collected using a semistructured interview schedule with open-ended questions from a sample of 20 estates located in Coorg district.

Results and Discussion

The data collected through ex-post facto survey was subjected to rigorous qualitative and appropriate statistical analysis. Several constraints as perceived by the sample of growers were identified. Variation in availability of labour and related management issues, rampant occurrence of katte disease, scarce supply of elite planting material, low germination in on farm nurseries, scarcity and quality constraints of organic manure, soil erosion problems, recent low and fluctuating prices and lack of local auction facilities were identified as some of the major constraints of profitable cardamom production. The details of rank order of constraints based on percentage of responses of samples and their classification are furnished in Table 27.

Table 27. Constraints of cardamom production

Area	Constraints	Classification	% of response	Rank
Planting material & Nursery management	Low germination percentage	Knowledge constraint	70	3
	Scarcity of quality planting materials	Infrastructure constraint	30	7
	Failure of tissue cultured plants	Conviction constraint	20	9
Nutrition Management	Scarcity organic manure	Infrastructural of constraints	65	4
	Quality aspects Transportation			
Soil erosion	Leaching and gully formation	Knowledge constraint	25	8
Pest and disease Management	Detection and management of Katte	Knowledge constraint	75	2
	Persistence of stem borer and root grub		60	5
Labour management	Changes in labour availability	Socio-economic constraint	80	1
Marketing	Absence of local auction centre and price fluctuation	Socio-economic constraint	60	6

Socio-economic constraints

Low price for cardamom in recent years is turning out to be a major disincentive for consistent management of the crop. During the period 1988-1998 the average price of cardamom at Sakleshpur Auction Centre (nearest auction centre to Coorg District) was only Rs. 255/-. The details of year wise average price realised are furnished in Table-28. Because of low prices there seems to be a gradual shift in area under sole crop of cardamom in favour of component crops like coffee and pepper which is reflected in the decline in area under pure crop of cardamom in Coorg district from 14,000 ha in 1988 to 11,990 ha in 1997.

Cardamom is a labour intensive crop, which requires manual labour throughout the year to carry out cultural practices. The crop in the bearing stage requires on an average of 208 person-days per acre/year. Harvesting operation alone consumed 122 person-days.

Changes in labour availability pattern are perceived to be a major factor that would influence a viable cardamom sector in future. As 80% of the growers perceived scarcity of labour and escalating wages, an analysis of labour

Table 28 Auction Price of Cardamom in Karnataka

Year (April-March)	Average Price (Rs./kg)
1987-88	139.08
1988-89	128.95
1989-90	220.87
1990-91	302.17
1991-92	227.37
1992-93	335.25
1993-94	396.91
1994-95	286.00
1995-96	188.97
1996-97	312.02
1997-98	266.59

market in Coorg district was carried out as a part of the survey. Following structural changes in labour market are tracked.

1. Declining permanent and family labour : Thirty five per cent of the permanent labour force have moved out from surveyed estates. The age-old tradition of family labour is also showing a declining trend as members of the labour family opt for other remunerative avocations.

2. Dependence on contract labour : A proportional analysis of labour use pattern showed that on an average 65.8% of total labour requirement is met through contract labour (on work basis and daily wages) to carry out operations like shade lopping, harvesting etc. However, routine operations like mulching, fertiliser application, irrigation, plant protection, weeding and drying are employed through permanent labour, which constitute 30.29% of total mandays requirement. Trashing is employed through contract on daily wages.

3. Changes in wage structure and role of middlemen : The wages of permanent labour and other fringe benefits like gratuity, medical allowance, etc. are fixed through a tripartite arrangement involving the state landowners and labourers. However, the system of employing contract labour on work basis or daily wages are perceived to be more costly. In addition, the growers have to bear the commission for the middlemen/ contractors and more often transportation charges when the labour is brought from outside.

4. Changes in labour settlement : The Government has come up with a scheme of issuing revenue free lands to landless labourers as an egalitarian measure. Though exact figures on the extent of benefit acquired through the scheme is not available, evidence of the survey indicates that many of the labourers who used to work as permanent have opted to move out from the labour quarters within the estates and to work on contract basis.

5. In-migration of labour

Consequent to the spread of contract labour system, there is high in-

migration of labourers from adjoining districts and states like Kerala and Tamil Nadu during peak seasons of farming.

The cardamom growers perceived a general decline in labour efficiency coupled with difficulty in mobilising local labour in cardamom estates. Though the labour market in the district is emerging out to be more competitive and flexible due to contract labour system, there is an impending need for appropriate organisational innovations, management and legislation to improve labour use efficiency.

TECHNOLOGY ASSESSED AND TRANSFERRED

Biological control of foot rot of black pepper

Management of foot rot disease of black pepper involves an integrated approach involving phytosanitation, cultural practices, chemical and biological control.

Phytopthora capsici survives in soil and at the onset of monsoon with increase in soil moisture *P. capsici* population also increases. To prevent the population build up *P. capsici* antagonistic fungi such as *Trichoderma harazianum* and *Gliocladium virens* are added along with organic matter for each vine. The inoculum of *T. harzianum* or *G.virens* are grown on either sorghum meal or coffee husk is mixed @ 50g/kg of neem cake and applied around the base of each black pepper vine. When *Trichoderma* is applied copper fungicide such as copper oxychloride or bordeaux mixture should not be applied to the soil. However Bordeaux mixture spray on the foliage to prevent aerial infections may be given. A second dose of 50g inoculum is applied during August to September.

The biocontrol inoculum can also be mixed with coffee husk, tea waste or farm yard manure.

Biological bontrol has to be followed with other management practices to manage *Phytophthora* foot rot.

EDUCATION AND TRAINING

KRISHI VIGYAN KENDRA, (IISR)

A total of 47 training programmes were conducted in Horticulture, Fisheries, Agronomy & Animal Science during 1998. The details of training programmes are given below:

Sl.No.	Category of trainees	No. of training programmes	Male	Female	Total
1	Practising farmers	23	634	191	825
2	Rural youth	16	148	119	267
3	Extension functionaries	8	144	32	176
	TOTAL	47	926	342	1268

It was also associated with Kisan Melas and Exhibitions conducted at various parts of the district in collaboration with Department of Agriculture and other organisations as furnished below.

Sl. No.	Period	Place	Organised by
1	5.2.98 to 10.2.98	Calicut	Calicut Agri-Hort. Society in connection with Calicut Flower Show'98
2	10.5.98 to 12.5.98	Mavoor Calicut	In connection with Silver Jubilee Celebration of Farm & Home of AIR, Calicut
3	24.10.98 to 25.10.98	Kappur Edappal	Inauguration of Kappur watershed programme

A total of 9 radio talks were delivered during the period and 12 popular articles were also published.

On farm testing programs

a) Control of irregular bearing in mango

This programme is aimed at control of irregular bearing in mango cv Olour which is very delicious and a choice variety of the district. In this programme five trees each of 10, 15 and 25 years of age were selected and flowering inducing chemical Paclobutrazol (cultar) was applied @ 10ml, 15ml and 20ml, respectively per tree by August 1998. The results are awaited.

b) Integrated management of *Phytophthora* foot rot of black pepper through the use of cultural practices and biocontrol agents

In this programme five pepper farmers were selected from Chakkittapara and Changaroth Panchayat of Quilandy taluk. Biocontrol agents *viz. Trichoderma* spp. was given as critical input to cover 200 vines for each farmer. The bio-agent has been applied along with 1 kg neem cake/5kg FYM at the rate of 50g of culture/vine during the South-West-monsoon and cultural operations like making a mound to avoid water logging and mulching have been done around the vines. The incidence of wilt or other diseases are being monitored. The application of biocontrol agent was found effective in 3 plots and minor incidence of disease was reported in 2 plots.

c) Feasibility of composite fish culture with varying feeds

Under this programme, fingerlings of Rohu and Mrigal were released as critical inputs in one pond during August 1998. Observation of various growth parameters is being monitored.

d) Study of efficacy of phytollacca in bovine mastitis

The programme was initiated and about 15 cases registered in the Plant and Animal Health Centre of KVK has been tested so far. Phytollacca has been found very effective in chronic case mastitis to restore production where antibiotics are ineffective but is ineffective in acute cases where antibiotics are effective.

In addition to the above, the following programs were also taken up by KVK.

i)Horticulture therapy programme

Mentally unhealthy people are engaged in various horticulture-related activities such as planting and care of vegetables, ornamentals etc. and thus they are brought slowly to lead normal life. This programme has shown encouraging response and will be continued.

ii) Vikas Volunteer Vahini Club in association with NABARD and South Malabar Gramin Bank

During the period, various training programs such as bush pepper production, vermicomposting, pickling of seafood, nutrition garden, biocontrol

of *Phytophthora* foot rot of black pepper etc. were organised by the club in association with KVK. A study tour was conducted for the members of the club in various ICAR research institutes of the state to familiarise them with the latest research work carried out in these centres. A one-day coconut seminar inaugurated by Dr. H.P. Singh, Horticulture Commissioner, New Delhi was also organised on 18.4.98 under the club in which around 300 farmers attended.

iii) Plant and Animal Health Centre

A Plant and Animal Health Centre is working under KVK catering to the needs of farmers of the locality which attended a total of 1131 cases during the year. In addition to consultancy services, an Artificial Insemination unit is also working under this centre. This centre has contributed an amount of Rs. 31,310/- to the revolving fund of KVK during current year.

iv) Revolving fund

Under this programme, production of high value horticultural crops like Orchids, Anthurium and other useful plants are undertaken. During 1998 planting materials for about Rs. 0.68 lakhs were sold. At present the revolving fund is worth Rs. 2 lakhs including the cost of planting materials available for sales.

Farm Development

Seedlings of high yielding Mohitnagar varieties of arecanut were planted in KVK farm during the period as a demonstration unit and for seednut production. In addition, around 60 different species of medicinal plants were collected from Kottakkal Arya Vaidya Sala, and this will be planted this season to develop into a model medicinal plant demonstration unit. A scion bank of selected high yielding varieties of cashew was also established well. Red tilapia fish was introduced in KVK farm to study its feasibility as a component in fresh water fish culture. The growth of the fish is satisfactory and the first batch of fish introduced was also harvested.

Radio Talks from IISR and KVK

Veena, S.S. 'Mode of spread of foot rot and its management', AIR, Kozhikode.

John Zachariah, T.	'Harmful effects of chemicals used in food products for quality improvement', AIR, Kozhikode.
Santhosh J. Eapen	'Nematodes and spices', AIR, Kozhikode.
	'Foot rot disease in pepper and its control', AIR, Kozhikode
Mathew, P.A.	'Processing for making white pepper', AIR, Kozhikode.
	'Grafting in black pepper', AIR, Kozhikode.
Ravi, S.	'Rabbit rearing and its economic aspects', AIR, Kozhikode.
Manoj, P.S.	'Improved method of processing turmeric', AIR, Kozhikode.
	'Manuring of pepper', AIR, Kozhikode.
Femeena Hassan	'Cultivation of fresh water prawns', AIR, Kozhikode.
	'Different preservation methods of fish', AIR, Kozhikode.
	'Breeding techniques of ornamental fishes', AIR, Kozhikode.
Prakesh, K.M.	'Manuring of tree spices', AIR, Kozhikode.
Korikanthimath, V.S.	'Development of agriculture in Coorg District', AIR, Madikeri.
	'Water management in cardamom', AIR, Madikeri.
Rajendra Hegde	'Management of pepper wilt', AIR, Madikeri.
	'Integrated management of pests & diseases of cardamom', AIR, Madikeri.
	'Scope for cultivation of non-traditional spice crops in Kodagu', AIR, Madikeri.
	'Need for scientific attitude', AIR, Madikeri.
Ankegowda, S.J.	'Black pepper propagation and planting', AIR, Madikeri.

LECTURES DELIVERED

S.S. *Veena*

1. 'Disease management in black pepper' to Agricultural officers meeting, Spices Board, Calicut.
2. Foot rot management, Chakkittappara Panchayat.
3. Importance of biocontrol, Meppady Panchayat.

T. John Zachariah

1. Harvest and post harvest technology of spices - Summer school, C.P.C.R.I. Kasargod.
2. 'Post harvest products from spices' one day workshop organised by Indian Junior Chamber at Hotel Malabar Palace, Calicut.
3. 'Post harvest processing of pepper' at the Annual Conference of UPASI, Coonor.
4. Post harvest processing techniques in spices at the Post Graduate Diploma course of Goa University.

V.S. Korikanthimath

Scientific cultivation of cardamom and pepper, Indian Institute of Plantation Management, Bangalore.

Rajendra Hegde

1. Spice production - Constraints and solutions, Farmers meet, Shanthali, Kodagu.
2. Management of pepper gardens for sustainable production, Farmers meet, Sirsi.
3. Production Technology for cardamom and pepper, Farmers meet, Sampaje, Kodagu.

AWARDS AND RECOGNITIONS

1. Dr.J.S. Pruthi Award for the best research paper published in Journal of Spices and Aromatic Crops. Vol.6.1997 to Dr. P.N. Ravindran, R. Balakrishnan and Dr. Nirmal Babu.
2. Silver Jubilee Medal Award 1998 for outstanding contribution in vegetable research, Indian Society of Vegetable Science, Varanasi to Dr. K.V. Peter.
3. Silver Jubilee Memento awarded for appreciation of services rendered to Indian Society of Vegetable Science 1998 to Dr. K.V. Peter.
4. Allahabad Agricultural Institute Award 1998 for the best paper presented at National Symposium on "Combating pollutants accumulation in ecosystem for sustainable agriculture" to Dr. A.K. Sadanandan.
5. Young Scientist Award 1998 from Kerala Science Congress, Govt. of Kerala to Dr. Femeena Hassan.

LINKAGES AND COLLABORATION

Agency	Linkage
Spices Board, Kochi	Director, IISR, is a member of the Board
Directorate of Arecanut and Spices Development, Calicut	Collaboration for planning and monitoring of developmental schemes implemented by DOAC, MOA, Govt. of India
Department of Agriculture/ Horticulture of States	Transfer of technology, Technology assessment and Refinement (TAR)
Kerala Agricultural University	PG Centre for Post Graduate Research, TAR
Calicut University	PG Centre for Post Graduate Research, MOU for teaching M.Sc Biotechnology
Regional Research Laboratory, Thiruvananthapuram	Research collaboration, partner in pepper technology mission
Centre for Water Resources Development and Management, Calicut	Research collaboration, Investigatorship in adhoc schemes

Centre for Electronic Design and Technology, Calicut	Technical collaboration, computer database
Farm Information Bureau, Govt. of Kerala	Transfer of technology
S.V. University, Tirupathi	Research collaboration for viral diseases
Regional Research Laboratory, Jammu	Technical collaboration for biofermenter technology
Bureau of Indian Standards	Technical and scientific collaboration to chalk out specification
NABARD, Canara Bank, State Bank of India	Interface with KVK , Peruvannamuzhi for funding

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES (AICRPS)

The All India Coordinated Research Project on Spices (AICRPS) is the largest research network on spices operating in our country. It was initiated in 1971 as a combined project on cashew and spices and was bifurcated into two independent projects with the head quarters of AICRPS at IISR, Calicut.

The AICRPS started during IV plan with four crops in four centres is now expanded to 12 major spices (black pepper, cardamom, large cardamom, ginger, turmeric, cinnamon, clove, nutmeg, coriander, cumin, fennel and fenugreek) in 20 coordinating and 8 voluntary centres based at 15 Agricultural Universities under 13 agro climatic regions of India. It has the mandate to develop location specific agro techniques under various agroclimatic regions.

The research work is concentrated on all aspects of spices viz., crop improvement, crop production and post harvest technology and crop protection. As on today the research work is executed through 80 projects under various disciplines supported by 53 scientists and 32 technical/auxiliary staff.

The salient achievements are given below.

Crop Improvement

The AICRPS Centres strengthened the genetic resources by the addition of 40 new accessions of black pepper, 68 of ginger, 67 of turmeric, 16 of nutmeg, 19 of cinnamon, 89 of coriander, 22 of cumin, 60 of fennel and 76 of fenugreek.

In black pepper, Karimunda III acc. and open pollinated progenies *viz.*, 4879, 5089 and 5621 are preforming better. The cardamom entries Veeraputhran, M-1 and SKPT-14, ginger accessions *viz.*, Vengara, BDJR-1179 and V1E8-2 and the turmeric entries *viz.*, PTS-4, JTS-16 and PTS-43 are promising. In seed spices, the coriander entries *viz.*, LCC-128, LCC-15 and Acc. 745, the cumin entries EC-279081 and JF-94-37, the fennel entries UF-125 and JF-200 and the fenugreek entries acc. 464, 504-1, CF-390 and JF-102 are high yielders.

Crop Production

For vegetative propagation of nutmeg, grafting using two leafed stage root stock with both orthotropic and plagiotropic scions recorded highest percentage of success (53 and 50 respectively).

The ideal date of sowing at Jobner was first week of November, which recorded a higher grain yield (1198 kg ha^{-1}) with maximum B:C ratio of 1.96. The optimum fertilizer dose and spacing for coriander at Kumarganj was standardised as 60:30:30 kg NPK ha^{-1} and 30x10 cm. In fenugreek, the optimum spacing was standardised as 15x10 cm and sowing at first week of October under Coimbatore condition.

In ginger, the accessions V_1S_1-8, SG-553 and SG-54 and in turmeric the accessions Kurtan Tanake, PTS-10 and PCT-10 are promising for quality.

Crop Protection

For the control of nursery diseases of black pepper solarisation of potting mixture and spraying and drenching with 1% bordeaux mixture at fortnightly intervals was effective and produced quality cuttings.

For the control of cardamom thrips and borer, Phorate @ 10g per clump followed by two sprays of Phosalone (0.05%) during May and August was effective.

In turmeric, the entries Kohinur and G.L.Puram are resistant to leaf spot diseases caused by *Taphrina maculans*. In seed spices, the coriander entries RCr-41, CC-462, ATP-77, JCo.64 and Pant Haritima, the cumin entries RZ-19, EC-232584, EC-84-1 and EC-73-1 and the fenugreek entries UM-117, UM-128, UM-140, UM-302 and UM-9 are tolerant to major pests and diseases.

Production and Distribution of Planting Material

The AICRPS Centres took up the production of quality planting material and distributed to various agencies and progressive farmers. During the reported year, the centres produced and distributed 99,334 number of rooted black pepper cuttings, 1776 cardamom clones, 619 cinnamon seedlings, 211 nutmeg grafts, 0.73 tonnes of ginger, 8.4 tonnes of turmeric and 25.2 tonnes of seed spices.

General / Miscellaneous

PUBLICATIONS

Review articles

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LIST OF APPROVED ON-GOING PROJECTS

Crop Improvement and Biotechnology

1. Gen.1 (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. IV (813)	Biotechnological approaches for crop improvement in black pepper
16. Biotech. III (813)	Micropropagation of black pepper

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Crop Production and Post Harvest Technology

1. Agr. XIV (813)	Investigations on spices based cropping systems.
2. Agr. XVI (813)	Irrigation requirement of black pepper-clove mixed crop ping system
3. Agr. XVII (813)	Vermicomposting using organic wastes available in car damom areas
4. Agr. XIX (813)	Management efficacy of whole farm approach in farm ing-A study on cardamom based farming system
5. Agr. XX (813)	Production of nucleus planting materials of improved varieties of spice crops
6. SSC. II (813)	Nutritional requirement of improved varieties of spices
7. Phy. V (813)	Characterization of drought tolerance in black pepper
8. Phy. VI (813)	Characterization of drought tolerance in cardamom
9. Biochem. I (813)	Biogenesis of pigments in spice crops
10. PHT. 1(813)	Quality evaluation in spices
11. Org.Chem.1 (813)	Isolation and identification of naturally occurring com pounds against major pests and pathogens of black pepper

Crop Protection

1. Path. 11.3 (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. 1.1. (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. Biocontrol.1 (813)	Biological control of diseases of spice crops
11. Biocontrol. 2(813)	Biological control of insect pests of spices
12. Biocontrol. 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 throguh large scale demonstration of improved tech nologies in farmers field.
2. Ext. IV (813)	Training of research and extension workers
3. Stat. VI (813)	Economics of ginger cultivation
4. Econ. 1(813)	Economics of spices production and marketing

CONSULTANCY, PATENTS AND COMMERCIALISATION OF TECHNOLOGY

The consultancy processing cell of IISR gives broad guidelines for consultancy work, prepares and processes the training/consultancy/contract research/ contract service proposals and co-ordinates the work related to consultancy assignments. During 1998, a total of 14 consultancy assignments (including contract service) were undertaken in different areas of spices cultivation, pest and disease management, processing etc.) About Rs. 1.45 lakh was collected as consultation/contract service charges from these assignments. Dr.Y.R. Sarma, Principal Scientist and Head, Division of Crop Protection is serving as consultant for "Ginger disease control programme" operational at Indo-Swiss project Sikkim. Dr. K.V. Ramana, Principal Scientist (Nematology) also served as consultant for the above project during the year.

RAC, MANAGEMENT COMMITTEE, SRC, QRT etc.

Research Advisory Council (RAC)

The RAC meeting was held on 10th and 11th June 1998. The members of the RAC are:

Prof. S.N. Rao	:	Chairman
Prof. T.N. Ananthakrishnan	:	Member
Prof. M.C. Nair	:	Member
Dr.C.K. George	:	Member
Dr.R.K. Sharma	:	Member
Dr.R.N. Pal	:	Member
Mr.V.P. Joshi	:	Member
Mrs. Nirmala Sharma	:	Member
Dr.C.S. Narayanan	:	Member
Dr.Y.R. Sarma	:	Secretary

The RAC gave the following recommendations:

1. Programmes may be chalked out with the help of experts for water harvesting and for optimum utilisation.
2. Yield disparity may be studied critically for all spice crops and the yield gap should be bridged with appropriate technologies.
3. Vermicomposting technology is to be intensified among the farming community and its effect on soil borne diseases like *Pythium* and *Phytophthora* may be tested.
4. Studies may be undertaken to find the effectiveness of *Bacillus* sp. for the control of 'pollu' beetle, nematodes and other soil borne plant pathogens.

Staff Research Council

The XII Staff Research Council meeting was held during 22-24. April 1998 at Calicut. Dr.K.V. Peter, Director, IISR was the general chairman. Heads of Divisions functioned as co-chairmen. There were four technical sessions in

which the progress of 47 institute projects and externally funded projects were discussed. The plenary session was presided by Dr.K.V. Ahmed Bavappa, chairman, Quinquennial Review Team. He released the Research Highlights 1997-98. The technology developed were transferred to extension agencies during plenary session. Dr.T. John Zachariah, Senior Scientist (Biochemistry) functioned as the secretary.

Quinquennial Review Team

The QRT visited the Institute during April and May 1998. The team consists of:

Dr. K.V. Ahmed Bavappa	:	Chairman
Dr. R.P. Sharma	:	Member
Dr. S. Chaudhuri	:	Member
Dr. R.K. Sharma	:	Member
Dr. Rajendra Gupta	:	Member
Dr. A.K. Sadanandan	:	Member Secretary

Following were the major recommendations:

1 The indigenous germplasm of all the spices should be collected on a time bound programme so that total loss of some of the cultivars and endangered species is checked.

2 Institute may initiate the morphological and molecular characterisation of germplasm and *ex situ*, *in vitro* and cryopreservation of all the accessions of germplasm.

3 Released varieties along with their parents should be registered with NGPGR.

4 To achieve higher productivity in black pepper the yield potential of the varieties to be released in future may be fixed at 3t ha^{-1}.

5 Breeding for resistance to *Phytophthora* foot rot in pepper, rhizome rot of ginger and turmeric, katte disease in cardamom should be strengthened.

6 Biotechnology tools may be used for solving black pepper wilt and ginger rhizome rot.

7 In post harvest technology, a technique for drying black pepper, ginger and turmeric to meet international standards may be developed.

8 Resistance to *Pythium* and bacterial wilt of ginger should receive priority attention.

9 A model black pepper nursery may be established.

10 To meet emerging challenges integrated interdisciplinary approach involving plant breeders, molecular biologists, tissue culture specialists, plant pathologists etc. may be set up.

Management Committee

Institute Management Committee (IMC) consists of following members:

Dr. K.V. Peter	:	Chairman
Dr. R.N. Pal	:	Member
Dr. Y.R. Sarma	:	Member
Dr. V.S. Korikanthimath	:	Member
Mr. Jose Abraham	:	Member
Dr. K. Nirmal Babu	:	Member
Director, Academic & PG studies, KAU Jt. Director of Horticulture (Pl. Crops) Govt. of Karnataka	:	Member
Director of Agriculture, Govt. of Kerala	:	Member
Asst. Finance & Accounts Officer, IISR	:	Member
Asst. Administrative Officer, IISR	:	Member Secretary

The IMC met during June, 1998 and approved the purchase of equipments worth Rs.27.75 lakhs.

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

Name of Workshop/seminar	Name of officer(s) attended
National symposium on current trends in plant physiology and biochemistry, Hyderabad. 29-31 January 1998.	S.J. Ankegowda
Interaction workshop on sustainable Agriculture, Madikeri, Karnataka, 5-6 February 1998.	Rajendra Hegde
Advances and priorities in Fisheries Technology, CIFT, Kochi, Kerala, 11-13 February 1998.	Femeena Hassan
Meeting on preparing a compendium on all the major spices cultivated in India, Spices Board, Kochi, 9 March 1998.	P.N. Ravindran & T. John Zachariah
Status and protection of coral reefs: Long term perspectives, Dept. of Science, Technology and Environment UT of Lakshadweep, 11-13 March 1998.	Femeena Hassan
Seminar on importance of balanced plant nutrition in plantation crops, Madikeri, Karnataka, 2 April 1998	S.J. Ankegowda & Rajendra Hegde
Meeting of official language implementation committee,Calicut, 3 April 1998	B. Krishnamoorthy
Workshop on R and D industry meet in agro processing, RRL, Thiruvananthapuram, 3 April 1998	T John Zachariah
III International Symposium of Afro-Asian Society of Nematologists, Coimbatore, 16-19 April 1998.	K.V. Ramana

Coconut Seminar, Kallanode, Calicut, 18 April 1998	B.Krishnamoorthy
National workshop and exhibition on tribal medicine, Calicut, 5-9 May 1998	B. Sasikumar
Staff Research Council, ICRI, Myladumpara, Idukki, Kerala, 18-20 May 1998.	S. Devasahayam
Summer institute on advances in electronic instrumentation for field data collection in agriculture and ocean sciences, CIFT, Kochi, 18-27 May 1998.	S.J. Ankegowda
National seminar on Anthurium production, Chettalli, Karnataka, 2-3 June 1998.	S.J. Ankegowda, K. Padmini & Rajendra Hegde
Summer short course on physiological analysis of yield in crop plants, IARI, New Delhi, 15-24 June 1998.	S.J. Ankegowda
Training on Pressurized Irrigation Systems for Efficient Water Management, MPKV, Rahuri, Maharashtra, 14-23 July 1998.	K. Kandiannan
Golden Jubilee National Symposium-Spices, Medicinal and Aromatic Plants, Biodiversity, Conservation and Utilization, Calicut, Kerala, 10-12 August 1998.	K.V. Peter, Y.R. Sarma, P.N. Ravindran, A.K. Sadanandan, K.V. Ramana, M. Anandaraj, M.N. Venugopal, B. Chempakam, B. Krishnamoorthy, V.S. Korikanthimath, K.M. Abdulla Koya, S. Devasahayam, B. Sasikumar, T. John Zachariah, M.S. Madan, J. Rema, K. Kandiannan, K.V. Saji, P.A. Mathew, K.S. Krishnamurthy, N.K. Leela, Santhosh J. Eapen, S.S. Veena, A. Kumar, V. Srinivasan, S.J. Ankegowda, P. Rajeev, K. Padmini

Short term training on immune technology in disease diagnosis. Madras Veterinary College, 19 August to 8 September 1998.	S.S. Veena
Workshop on Western Ghats Forestry Project. Phase II. Madikeri, 27 October 1998.	Rajendra Hegde & S.J. Ankegowda
National symposium on combating Pollutants accumulation in ecosystem for sustainable agriculture, Allahabad., 27-28 October 1998.	A.K. Sadanandan
Hindi workshop, Calicut, Kerala, 28 October and 2 November, 1998.	B. Krishnamoorthy
National Seminar on Developments in Soil Science, Hisar, 16-18 November, 1998.	V. Srinivasan
National Symposium on rational approaches in nematode management for sustainable agriculture, Anand, Gujarat, 23-25 November, 1998.	K.V. Ramana & Santhosh J. Eapen
XIII ISAS National Symposium on Analytical Techniques, Bangalore, 24-25 November, 1998.	T. John Zachariah
Review-cum-action plan meeting of KVKs, Coimbatore, 28-30 November, 1998.	P.A. Mathew & P.S. Manoj
International Conference on Pest and Pesticide Management for Sustainable Agriculture. Kanpur, 11-13 December, 1998.	S. Devasahayam
PLACROSYM - XIII Plantation Crops Symposium, Coimbatore, 16-18 December, 1998.	K.V. Peter, P.N. Ravindran, Y.R. Sarma, B. Sasikumar, M. Anandaraj, K.V. Ramana, Santhosh J. Eapen, K. Kandiannan, B. Chempakam, K.S. Krishnamurthy, Rajendra Hegde, V.S. Korikanthimath, S.J. Ankegowda, M.S. Madan

National Symposium on Future Goals of Physiological Research for the Improvement of Plant Resources, Annamalai University, Chidambaram, 18-20 December, 1998.	B. Chempakam, K.S. Krishnamurthy & S.J. Ankegowda
Workshop on safe composting of urban wastes and organic farming, Bangalore, 18-20 December, 1998.	V.S. Korikanthimath
Hindi workshop at NAARM, Hyderabad, 28-29 December, 1998.	B. Krishnamoorthy

WORKSHOPS, SEMINARS, SUMMER INSTITUTES ORGANISED BY THE INSTITUTE

Indian Institute of Spices Research in association with Indian Council of Agricultural Research, New Delhi, Indian Society for Spices, Calicut and Regional Science Centre, Calicut organised the Independence Golden Jubilee National Symposium on Spices, Medicinal and Aromatic Plants: Biodiversity, Conservation and Utilisation at Regional Science Centre, Calicut during 10-12, August 1998. The symposium was inaugurated by Dr.K.N. Shyamasundaran Nair, Vice-chancellor, Kerala Agricultural University and presided by Dr.S.P. Ghosh, Deputy Director General (Hort.), ICAR, New Delhi. The Inaugural session was felicitated by Dr.H.P. Singh, Horticultural Commissioner, Govt. of India, Dr. Joseph Thomas, Vice-President, SPIC Science Foundation, Chennai and Dr.S. Edison, Director, Central Tuber Crops Research Institute, Thiruvananthapuram. The symposium had mainly four technical sessions viz., I. Biodiversity of spices and their conservation, II. Biodiversity of medicinal and aromatic plants and their conservation, III. Ethnobotany, ethnomedicine and folk medicine IV. Development, futurology and intellectual property rights. Each session had one invited theme paper and about 25 contributory papers. About 250 delegates from different parts of the country participated in the symposium.

DISTINGUISHED VISITORS

Name	Designation
Dr. R.S. Paroda	Director General, ICAR, New Delhi
Dr. A.D. Damodaran	Chairman, STEC, Govt. of Kerala

Dr. Subash Sharma	Director, Indian Institute of Plantation Management, Bangalore
Dr. K.V. Ahmed Bavappa	Chairman, QRT
Dr. Rajendra Gupta	Member, QRT
Dr. R.K. Sharma	Member, QRT
Dr. S.P. Ghosh	Deputy Director General (Hort.), ICAR, New Delhi
Dr. K.N. Shyamasundaran Nair	Vice Chancellor, Kerala Agricultural University
Mrs. M.M. Padmavathy	Mayor, Corporation of Calicut
Mrs. Indira Krishnakumar	Post Master General (North zone)
Dr. S.L. Mehta	Deputy Director General (Edn.), ICAR, New Delhi
Dr. P. Das	Deputy Director General (Extn.), ICAR, New Delhi
Dr. M.S. Swaminathan	Chairman, MSSRF, Chennai
Dr. R.P. Sharma	Director, NRC for Plant Biotechnology, IARI, New Delhi
Mr. V. Krishnamoorthy, IAS	Agricultural Production Commissioner, Govt. of Kerala

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)

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

B. Sasikumar Ph.D., Senior Scientist (Plant Breeding)

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

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

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

R. Ramakrishnan Nair M.Sc., Scientist Sr. Scale (Gen. & Cytogen)

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 upto 30.11.98

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

T. John Zachariah Ph.D., Senior .Scientist (Biochemistry)

N.K. Leela M.Sc.(Ag.), Scientist Sr.Scale (Organic Chemistry)

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

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.), Senior Scientist (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 (Agril. Economics)

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)

S.M. Chettiar, P.A. to Director

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES, CALICUT

A.K. Sadanandan Ph.D., P.C. in charge upto 30.11.1998

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

Johny A. Kallupurackal Ph.D., Sr. Technical Information Officer (T 7)

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)

P. Heartwin Amaldas M.Sc., Scientist (Ag. Engg.)

Technical

V.K. Abubacker Koya, Farm Superintendent (T 6)

CARDAMOM RESEARCH CENTRE, APPANGALA

Scientific

V.S. Korikanthimath Ph.D., Senior. Scientist (Agronomy) Head and HOD-in-charge, Crop Production

M.N. Venugopal Ph.D., Senior Scientist (Plant Pathology)
P. Rajeev Ph.D., Scientist Sr. Scale (Agri. Extension)
Rajendra Hegde Ph.D., Scientist Sr. Scale (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 (T 6), Horticulture
K.D. Prathapan M.Sc. (Ag.), Tech. Officer (T 6), Plant Protection
S. Shanmugavel B.VSc., Tech. Officer (T 6), Veterinary Science
K.M. Prakash M.Sc. (Ag.), Tech. Officer (T 6)
Femeena Hassan Ph.D., Technical Officer (T 6) Fisheries

ADMINISTRATIVE

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

OTHER ACTIVITIES IN THE INSTITUTE

National Information Centre

The Institute library has been upgraded into a National Informatics Centre on Spices by digitalising the information available on spices research and development and the facility was formally inaugurated by Dr.S.L. Mehta, Deputy Director General (Edn.), ICAR on 28 November 1998.

Women's Cell

The Women's cell at IISR inaugurated by Mrs. M.M. Padmavathy, Hon'ble Mayor, Corporation of Calicut on 18 November 1998. The meeting was presided by Mrs. Indira Krishnakumar, Post Master General (Northern Range). Dr. K.V. Peter, Director IISR delivered the welcome address

and Dr. B. Chempakam, Senior Scientist and Secretary, Women's Cell proposed vote of thanks.

Inauguration of KVK Building

The newly constructed administrative-cum-Farmer's Training building and Farmer's hostel were inaugurated on 7-December 1998 by the honourable Direct General Padmabushan Dr. R.S. Paroda. Large number of farmers, officials from CMFRI, Kochi, Deputy Director General (Extn.) Dr. P. Das, Deputy Director General (Fisheries) Dr. Gopakumar, Director, Directorate of Arecanut and Spices Development Dr. K. Sivaraman, officials from Department of Agriculture, Govt. of Kerala and Gram panchayat also attended the function.

सारांश

फसल सुधार एवं. जैवप्रौद्योगिकी

अनुवंशिक संसाधनें

काली मिर्च : इस वर्ष के दौरान काली मिर्च के वन्य *पाईपर स्पीसीस* का चौबीस अक्सशन और नौ कृष्ट प्रकार का संग्रह किया गया। आई आई एस आर में एम एस अक्सस 99 द्वारा आनुवंशिक संसाधनों के लिए एक डेटा आधारित कार्यक्रम विकसित किया।

अदरक: कलिंपोंग (भेसी और नानग्रे), नेपाल (3), दिल्ली (1), पालमपुर (1) और कानपुर (1) से लिये आठ नये अक्सशन को जर्मप्लासम में जोड दिया गया।

हल्दी: आन्ध्रप्रदेश और नेपाल से लिये तीन *कुरकुमा स्पीसीस* और एक कृष्ट प्रकार, दोनों को जर्मप्लासम में जोड दिया।

वैनिला: ट्रॉपिकल बोटानिकल गार्डन रिसर्च इन्स्टिट्यूट, पालोड, तिरुवनन्तपुरम से वी. *अन्टामानिका* के साथ विनिमय करके *वैनिला पिलिफरा* और *वैनिला वटासले* का संग्रह किया गया।

वृक्ष मसाले: *गार्सीनिया* स्पीसीस का चौदह अक्सशन, *सिनामोमम* स्पीसीस का चार अक्सशन और *मिरिस्टिका* फेटुआ वार. *मग्रीफिका* (स्त्री) का एक अक्सशन जर्मप्लासम में जोड दिया।

फसल सुधार

वालपराई में काली मिर्च संकरज एच पी 105 ने उच्चतम उपजता (4.8 कि ग्रा/बेल) प्राप्त की और संग्रह 1041 (4.25 की ग्रा/बेल) दूसरे स्थान पर आता है। वालपराई में उपलब्ध काली मिर्च के अन्य आशाजनक संकरज है पच पी 728, एच पी 813, एच पी 34 और, एच पी 778 आदि। संग्रह 1041, जो नीलमुंडी क्लोन है, रोपण के 9 साल होकर भी पूरी तरह *फाईटोफतोरा* खुर गलन से मुक्त पाया गया।

पाईपर कोलुब्रिनम के मूल कांड (Rootstock) पर काली मिर्च की बीस किस्मों का कलम, रोपण के पहले साल में ही सन्तोषजनक वृद्धि दिखाती है।

अदरक के बोल्ड राईजोम चयन जैसे अक्सशन 15 और अक्सशन 27 ने अच्छा निष्पादन दिखाया।

आलप्पी फिंगर हल्दी अकसशन 585 अपनी उपजता और गुणवत्ता में उच्चतम स्थान प्राप्त हो रहा है।

चैनीस कैसिया (सिनमोमम कैसिया) का मूल्यांकन करने पर यही सूचित करता है कि अक्सशन A1 और C1 में अधिक छाल ओलिओरसिन (10.2 और 10.5%) तथा D1, D3 और D5 में अधिक सिनामलडिहाइड अंश (86.5, 90.5 और 85.5%) के साथ अधिक छाल तेल (4.7, 4.9 और 4.3%) है।

मिरिस्टिका मलबरिका और *एम. बडोमी* के मूल कांड (rootstock) पर मृदु काष्ठ ग्राफ्टिंग द्वारा जायफल का ग्राफ्टिंग करना सफल बन गये।

इस साल बनाये ब्यादगी पप्रिका संग्रह में रंग द्रव्य का मूल्य 100 से 500 ASTA इकाई तक अन्तरित हो गये। K11 K17 K24 और Y6 ने 400 ASTA से अधिक मूल्य दिखाया।

जैवप्रौद्योगिकी

एग्रोबैक्टीरियम का प्रयोग और क्योलिस्टिक्स द्वारा कालीमिर्च का सोमेटिक एमब्र्योस पत्ते एवं अदरक और इलायची का एमबर्योजिनिक काल्ली को सफलतापूर्वक रूपान्तरण कर दिया। अदरक एवं इलयाची कैली से चयन द्वारा स्वीकृत ट्रान्सजनिक्स का पुनर्जनन किया गया। अदरक के 14 किस्म, काली मिर्च के 13 किस्म और वैनिला के 15 किस्म से संरक्षण और RAPD प्रोफाइल बनने हेतु DNA को वियुक्त किया।

कठोरीकरण की सुविधाओं द्वारा उन्नत *पाइपर* स्पीसीस जैसे पी *साइलन्टवालीयनसिस*, पी. वईटी, पी. मुल्लेसुआ और *स्कमिडटी* को सफल रुप में स्थापित किया।

फसल उत्पादन और फसलोत्तर प्रौद्योगिकी

केन्द्रक रोपण सामग्रियों का उत्पादन

केन्द्रक रोपण सामग्रियों जैसे काली मिर्च के मूल लगाए कतरन (1 लाख), कालीमिर्च के मूल लगाए लेटरलस (1500), हल्दी का बीज राईज़ोम (25 टन), अदरक का बीज रईज़ोम (3 टन), जायफल का कलम (2500), दालचीनी के बीजपौधे (5000), आलस्पाइस के बीज पौधे (2000) और वैनिला का मूल लगाए कतरन (10,000) का उत्पादन और वितरण किया गया।

पादप पोषण

अदरक और हल्दी के लिए एसिडयुक्त मिट्टी में रॉक फॉसफइट (राजफॉस/मसूरी फॉस/ गुफसा फॉस) फॉसफोरस का अच्छा स्रोत है। इन्हीं सामग्रियों का वनस्पतिक कार्यक्षमता फार्म यार्ड खाद के साथ ऊष्मायन (incubating) करने पर बहुत अधिक बढ़ा जा सकता है। जिसके द्वारा फॉसफोरस लगाने की मात्रा संस्तुत मात्रा के आधे हिस्से तक कम किया जा सकता है।

नारियल के साथ वैनिला और इलायची का उत्पादन

नारियल के बाग में 1.5 × 1.5 मीटर अन्तराल के साथ नारियल ताड तने (बेस) के चारों और 3 मीटर अर्द्धव्यास की जगह छोडकर *ग्लिरिसिडिया* स्तर पर वैनिला की उगाई उत्तम रूप से की जा सकती है। नारियल के साथ 1.5 × 1.5 मीटर अन्तराल में इलायची की उगाई भी सफलतापूर्वक की जा सकती है।

सूखा सहयता

कैटालेस, एसिड फॉसफाटेस, सुपर ऑक्साइड डिस्म्युटेस और पेरोक्सिडेस का कार्य और संबन्धित जल मात्रा और विलेय टपकन प्रतिशत के आधार पर जल दबाव सह्यता हेतु काली मिर्च और *पाईपर* स्पीसीस का प्राथमिक छान-बीन करने पर यही सूचित करता है कि पी. छाबा और *पी. लोंगम* जल दबाव के लिए अपेक्षाकृत अति संवेदनशील हो गया।

कटाई के पूर्व या बादवाले अध्ययन

पके हुए काली मिर्च बेरी को उसके रूप और गुण पर कोई हानि न डाले अपगलन काल को कम करके (>50%) 1000 ppm एथीफन उपचार द्वारा सफेद काली मिर्च तैयार कर सकते है।

अदरक के कच्चा अर्क निकालने के लिए 'डोसी फाइबर' या उसी प्रकार का स्वचालन एकक में परंपरागत अर्क आकलन की अपेक्षा द्रुतगामी, संगत और परिशुद्ध उपजता का फल देखे गये।

रासायनिक गुणवत्ता के लिए मूल्यांकित अदरक अक्सशन में अक्सशन 418 और 420 पर अधिक सुगन्धित तेल (>2%) और ओलिओरसिन (>6%) अंश प्राप्त हुए।

हल्दी में कुरकुमिन जैव संश्लेषण में प्राप्त प्रमुख एनजाइम फिनैलअलनिन अमोणिया लयेस (PAL) द्वारा पूर्ववर्ती कुरकुमिन के संश्लेषण का उच्च दर सूचित करते हुए राईज़ोम विकास (रोपण के 150-180 दिन बाद) की प्रारंभिक दशा में उच्च सक्रियता प्रदर्शित की। इन्हीं ऊतकों में कुरकुमिन का निम्न स्तर युक्त सहवर्ती पत्ते और मूल दोनों में एनज़ाइम सक्रियता कम हुआ था।

पादप उपज

पाईपर कोलुब्रिनम के पत्तों से सूत्रकृमिनाशक सक्रियतावाले दो पारदर्शक मिश्र को वियुक्त किया गया।

पादप रोग विज्ञान

रोग प्रतिरोधकता: काली मिर्च के *फाइटोफतोरा* सह्य पांच वंश की पहचान की गयी। पहले पहचान किये गये सह्य वंश जो है पी 24. सिरसी (कर्नाटक) और पेरुवन्नामुषि (केरल) में अच्छा निष्पादन दिखा रहे है और उसके उपज में प्रतिबेल 0.8 से 9.75 कि. ग्राम हरे फल तक का अंतर होता है। सूखे फल प्राप्ति का दर 40% अंकित किया गया। काली मिर्च के *पी. काप्सीसी* की सह्यता में सहयोजित एक संकेतक के रूप में 1, 3 ग्लूकोनस की पहचान की गयी।

इलायची के 'कट्टे' रोग के रोगवाहक, *पेन्टालोनिया निग्रोनखोसा* की प्रजनन संभावनाओं के बारे में 17 कट्टे प्रतिरोधी वंशों पर अध्ययन किया गया। यहाँ किसी भी प्रतिरोधी वंशों में फीडिंग डिटरन्स (feeding deterrance) नही होता है, और यह सूचित करता है कि प्रतिरोधकता परपोषी उपादान के कारण होता है न कि फीडिंग डिटरन्स के कारण।

रालस्टोनिया सोलानसिरम के बयोवर 3 से परे, एक अबरन्ट बयोवर 3 होता है जो डुलसिटॉल नेगटीव है उसको केरल के वयनाडु क्षेत्र तथा सिक्किम में अदरक पर पडे कीट वाधा को देख पाया।

एलिसा (ELISA) परीक्षण के आधार पर *पाइपर कोलुब्रिनम* को काली मिर्च के वृद्धि रोध रोग के प्रति सुप्रभाव्य देखा गया।

रोग प्रबन्ध

काली मिर्च के *पी. काप्सीसी* के पर्ण संदुषण पर पोटैशियम फॉसफोनट छिड़कने पर दवा पिलाने की अपेक्षा उत्तम प्रावरोधी फल प्राप्त हुए और इसका अधिकतम फल छिड़काव के 4 दिन बाद देखे गये। आठ दिन बाद इसका फल नष्ट होता है।

गमले में उगाने की रीति के साथ कवग जैवनियन्त्रण एजेंट और फ्लूरासन्ट प्स्यूडोमोनाड्स अकेले या पोटैशियम फॉसफानट संयोजन के साथ लगाने पर खुर गलन संक्रमण नियंत्रित करने में जैवनियन्त्रण एजेंट की प्रभावोत्पादकता और पोटैशियम फॉसफानट के साथ उसकी संगतता भी दर्शाये।

ट्राइकोडरमा के व्यापक गुणन के लिए अपनाये तीन कीटाणुवाहक रीतियों में नारियल जटे की अपेक्षा टेल्क के निधानी आयु कम प्रभावी बन गये। तीन महीने बाद, *ट्राईकोडरमा* का कोई कालोनी टेल्क में प्राप्त नहीं किया जा सके।

द्वि संवर्धन प्रविधियों के प्रयोग द्वारा *पी. कापसीसी* के विरोध के लिए ट्राइकोडरमा वियुक्ति का छान बीन किया गया। *टी वाइरनस* (21 वियुक्तियाँ) टी. ओरियोविरिडे (27) टी हमाटम (23 वियुक्तियाँ) टी. हर्जियानम (20 वियुक्तियाँ) और *टी प्स्युडोकोनिंगी* प्रावरोध की डिग्री (0-84%) में अन्तर देखे गये।

कालीमिर्च के फाइटोफतोरा खुर गलन को नियंत्रित करने में 80% से अधिक किसानों ने ट्राइकोडरमा हर्जियानम को लगाया जिसने इसकी प्रभावोत्पादकता की पुष्टि की गई।

अदरक के राइज़ोम रोट का एकीकृत प्रबन्ध

किसानों के खेत में आयोजित प्रदर्शन जाँच से व्यक्त हुआ कि कवगनाशी (रिडोमिल मनकोज़ेब) के साथ बीज उपचार तथा ट्राइकोडरमा हरज़ियानम मिट्टी में लगाने पर अदरक का राइज़ोम रोट बड़ी मात्रा में कम कर सकता है।

फाइटोफतोरा वियुक्तियों का संग्रह

रोपण फसल, मसाले और अन्य बागवानी फसलों के 333 वियुक्तियों से समाविष्ट *फाइटोफतोरा* (बागवानी फसलों के फाईटोफतोरा रोगों पर राष्ट्रीय नेटवर्क) संवर्धन के एक राष्ट्रीय संग्रह बनायी जा रही है। वैनिला, बोहीमिया, जायफल, कॉफी और *पी. छाबा* पर पहली बार *फाइटोफतोरा* संक्रमण का रिपोर्ट किया गया।

बयोफरमन्टर

क्षेत्रीय अनुसंधान प्रयोगशाला, जम्मु के तकनीकी मदद के साथ आई. आई. एस. आर, कालिकट में एक बयोफरमन्टर स्थापित किया गया।

कीट विज्ञान

परपोषी प्रतिरोध

पोल्लू बीटल के प्रति काली मिर्च के 11 वन्य *पाईपर नाईग्रम* अक्सशन तथा छः उच्च उपजवाले विमोचित किस्मों का छानबीन करने पर पोल्लू बीटल, काली मिर्च के एक प्रमुख कीट, ने यही दिखाया कि ये सब कीटों के प्रति सुप्रभाव्य है।

काली मिर्च पर मीली बग का आपतन

वयनाडु में काली मिर्च के मूल पर मिली बग का आपतन ग्रीष्म (संक्रमित बेल के 4.4 से 17.8%) की अपेक्षा मनसुन काल (संक्रमित बेल के 20 से 80%) में अधिक सख्त हो गये।

मीली बग का व्यापक संवर्धन

प्रयोगशाला में काली मिर्च का मूल मीली बग का व्यापक संवर्धन के लिए कद्दू (कुकुरबिटा मोसकटा) और लुगदी (*कुकुरबिटा पेपो*) अधिक उचित देखे गये!

कीट प्रबन्ध

काली मिर्च पर पड़े मूल मीली बग के प्रबन्धन के लिए रोगबाधित बेल को क्लोरफिरिफोस 0.1% या क्विनालफोस 0.1% दवा पिलाना अधिक प्रभावी देखे गये।

अदरक पर प्ररोह बेधक के प्रबन्धन मालतियोन 0.1% या मोनोक्रोटोफॉस 0.075% सितम्बर-अक्तूबर के समय छिड़कने के साथ कर्षण प्रक्रियाओं को अपनाकर जुलाई-अगस्त के समय रोगबाधित प्ररोह का काट-छांट करना आवश्यक होता रहा।

सूत्रकृमि विज्ञान (Nematology)

परपोषी प्रतिरोध: मूल गांठ गोल कृमि के प्रति जाँच किये काली मिर्च की 60 किस्मों के बीच 4 कृष्ट प्रकार (अक्सशनस 4103, 4175, 334 और 1090) और 4 वन्य अक्सशनस (अक्सशन 3219, 3286, 3287, 3311) को प्राथमिक छानबीन में प्रतिरोधी पाये गये अदरक एवं हल्दी का पुनसंचारित प्रतिरोधी वंश अशाजनक देखे गये।

सूत्रकृमि (नेमटोड) प्रतिरोधकता का यंत्रवाद

सूपर ऑक्साइड डिस्मूटाइस की क्रियायें और कैटालस, पौर्णमी की तुलना में मूल गांठ गोलकृमि के प्रति सुग्रभाव्य वंश (पन्नियूर-1) में बहुत अधिक हो गये जबकि पोलिफिनोल ओक्सिडस क्रियायें पौर्णमी में सघनतापूर्वक अधिक होता है।

मूल गांठ गोलकृमि की संख्या में भिन्नता

12 मूल गांठ गोल कृमियों के बीच एस्टरेस और डिहाइड्रोजनस समएनजाइम लवण (Esterase and malate dehydrogenase isozymes) के लिए परिवर्तिता का निरीक्षण किया।

सूत्रकृमि (नेमटोड) का जैविक नियन्त्रण

रोग बाधित प्लॉट में स्वस्थ काली मिर्च बेल से संचय किये मृदा सैम्पिल से 11 कवग और 7 जीवाणुक को वियुक्त किया गया। तीन कवगीय वियुक्तियों (F5, F6 और 11/3b) और छ: जीवाणुक वियुक्तियों ने सूत्रकृमिनाशक विशेषता अर्जित की। सिक्किम, वयनाडु और कासरगोड से प्राप्त अदरक के मृदा सैम्पिल से *पास्तुरिया पेनिट्रान्स* की तीन वियुक्तियों का संग्रह किया गया। *टी. हार्जियानम* के माइसीलियल फ्रागमन्ट्स से लिये दूसरे उपापचय को भी सूत्रकृमि नाशक देखा गया।

सूत्रकृमियों (नेमटोड) के जैविक नियन्त्रण पर गहन कार्य करने के लिए एक जैविक नियन्त्रण प्रयोगशाला स्थापित किया।

समाज विज्ञान

प्रशिक्षण कार्यक्रम

मसाला उत्पादन तकनोलजी, नर्सरी प्रबन्धन तथा मसालों का खेतीगत संसाधन पर प्रशिक्षण कार्यक्रम आयोजित किया गया। उपरोक्त प्रशिक्षण में नौ राज्यों से आये 61 अधिकारीगण और 150 से अधिक किसान लाभान्वित हुए।

मसाले उत्पादन की आर्थिकी और विपणन

काली मिर्च के मूल लगाए कतरन के उत्पादन (15000-20000 संख्या/वर्ष) के लिए द्रुत गुणन तकनोलजी को अपनाना बहुत लाभप्रद देखे गये। दो साल से कम अवधि में लौटाने लायक एकक से 1.84 के अनुपात में मूल्य लाभ की उपजता होगी। कालीमिर्च कतरन का एकक मूल्य 3.57 रूपये/कतरन आकलित किया गया। तृडाई करके संसाधित प्रत्येक 100 कि. ग्राम हरे काली मिर्च से सफेद कालीमिर्च उत्पादन द्वारा 570 रुपए का अधिक लाभ अर्जित कर सकता है। प्रारंभ में 10,000 रुपए जमा करके छोटी मात्रा में नमकीन अदरक उत्पादित करने से 1.85 अनुपात का मूल्य लाभ अर्जित कर सकता है।

कृषि विज्ञान केन्द्र (KVK)

कृषि विज्ञान केन्द्र ने इस काल मे 47 प्रशिक्षण कार्यक्रम आयोजित किये जिनमें 1248 प्रशिक्षार्थियों, किसानों, ग्रामीण युवाओं और प्रसार कर्मचारियों ने भाग लिया। कृषि विज्ञान केन्द्र ने 3 प्रदर्शनी में भाग ली और 9 रेडियो भाषण भी प्रस्तुत किये। पादप और पशु स्वास्थ्य केन्द्र ने 1131 प्रकरण में भाग लिया और 403 AI किया गया। इस केन्द्र मे 22 पशु स्वास्थ्य अभियान आयोजित किया और अन्य एजोंसियों द्वारा आयोजित दो अन्य कैम्प में भाग भी लिया।

पद्मभूषण डॉ. आर. एस. परोदा, महानिदेशक, भारतीय कृषि अनुसंधान परिषद एवं सचिव, डेर ने 7 दिसंबर, 1998 को कृषि विज्ञान केन्द्र (पेरुवन्नामुषि) का भवन और प्रशिक्षार्थियों के छात्रावास का उद्घाटन किया।

मसालों पर अखिल भारतीय समन्वित अनुसंधान परियोजना

इस केन्द्र में विकसित कुछ आशाजनक वंश है OUAT के अधीन पोटांगी केन्द्र में पहचान की गयी हल्दी वंश सोनाली (27 टन नया राईज़ोम/हेक्टर), जोबनर केन्द्र (RAU) में पहचान की गयी मेथी RMT-143 (16.57 क्विंटल/हेक्टर) हिसार केन्द्र (CCS HAU) का मेथी HM-346 (23.6 क्विंटल) HM 350(21.3 क्विंटल) HM - 103 (20.1 क्विंटल/हेक्टर), धनिया Rcr - 446(12.81 क्विंटल) और जोबनर का बड़ी सोंफ UF-125 (12.8 क्विंटल) आदि।

काली मिर्च संवर्धन - 54 को फाइटोफतोरा खुर गलन का सहय देखे गये। धनिया Rcr - 41 (जोबनर) और UD-686 (धोली) को स्तम्भ पिटिका (Stem Gall) के प्रतिरोध और UD 241 और UD 296 (जोबनर) को मूलगांठ गोलकृमि (Root knot nematode) के प्रतिरोधक पाया गया।

राइगढ़ (IGKUU) में हल्दी की उच्च उपजता के लिए 150:125:125 कि. ग्राम/हेक्टर के दर में NPK लगाने की सिफारिश की जाती है।

बडी सोंफ के लिए 1.0 अनुपात में IW/CPE की सिंचाई और 90 कि. ग्राम नाइट्रोजन और 30 कि. ग्राम P_2O_5/ हेक्टर के दर में लगाना चाहिए तथा गुजरात में सफेद जीरा के लिए 1.0 अनुपात में IW/CPE की सिंचाई, 90 कि. ग्राम/हेक्टर के दर में नाईट्रोजन और 60 कि. ग्राम/हेक्टर के दर में P लगाना पर्याप्त देखे गये।

इलयाची के थ्रिप्स और बेधक (मुडिगरे) को नियांत्रित करने के लिए दो बार (मई और अगस्त के समय 0.05%) फोसालोन छिड़कना और उसके बाद प्रति झुरमुट (clump) 10 ग्राम के दर में फोराइट लगाना प्रभावी हो गये।

अन्य क्रियायें

गोल्डन जूबिली नेशनल सिम्पोसियम

भारतीय कृषि अनुसंधान परिषद और भारतीय मसाले फसल अनुसंधान संस्थान ने मिलकर इंडियन सोसाईटी फॉर स्पाइसस, कालिकट के सहयोग से क्षेत्रीय विज्ञान केन्द्र, कालिकट में 10-12 अगस्त, 1998 को मसाले, औषधीय और सुगन्धित पौधे: जैवविविधीकरण, संरक्षण और उपयोग पर इंडियन इंडिपन्डन्स गोल्डन जूबिली नेशनल सिम्पोसियम का आयोजन किया। इस सम्मेलन में प्रस्तुत प्रमुख विषय वस्तु है (1) मसालों का जैवविविधीकरण और उसका संरक्षण (2) औषधीय और सुगन्धित पादपों का जैवविविधीकरण और उसका संरक्षण (3) नृजाति वनस्पतिविज्ञान (Ethnobotany), नृजाति औषधिक (Ethno medicine) और लोक औषधि (Folk medicine) तथा (4) विकास, भावीकार्य (Futurology) और प्रज्ञात्मक संपत्ति अधिकार। इस संगोष्ठी में लगभग 150 प्रतिनिधियों ने भाग लिया।

डॉ. के. स्यामसुन्दरन नायर, उप कुलपति, केरल कृषि विश्व विद्यालय ने इस संगोष्ठी का उद्घाटन किया और डॉ. एस. पी. घोष, उप महानिदेशक (हॉर्टि), भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने इसकी अध्यक्षता की।

बनिता सेल

श्रीमती एम. एम. पद्मावती, माननीय मेयर, कालिकट नगर निगम ने 18 नवंबर, 1998 को भारतीय मसाले फसल अनुसंधान संस्थान में वनिता सेल का उद्घाटन किया। श्रीमती इंदिरा कृष्णकुमार, डाक महा अध्यक्ष (उत्तर क्षेत्र) ने बैठक की अध्यक्षता की।

राष्ट्रीय सूचना प्रदान केन्द्र

डॉ. एस. एल. मेहता, उप महानिदेशक (शिक्षा), भारतीय कृषि अनुसंधान परिषद ने भारतीय मम्साले फसल अनुसंधान संस्थान, कालिकट में 28 नवंबर 1998 को राष्ट्रीय सुचनाप्रदान केन्द्र का उद्घाटन किया।

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