# वार्षिक प्रतिवेदन
# Annual Report
# 1999



**Indian Institute of Spices Research**
*(Indian Council of Agricultural Research)*
Calicut - 673 012, Kerala.

## INDIAN INSTITUTE OF SPICES RESEARCH

An organization under Indian Council of Agriculturol Research


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12. Jobner
13. Solan
14. Hisar
15. Dholi
16. Gangtok
17. Pundibhari
18. Dapoli
19. Raigarh
20. Kumarganj

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**Photographs**

Front cover:

Pepper Plantation of P. *nigrum* grafted on *P. colubrinum*

Back cover:

Director IISR receiving the best ICAR institute award from Hon'ble Union Minister for Agriculture Sri. Nitish Kumar

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## PREFACE

I have extreme pleasure to present the Annual Report of IISR for the year1999. As a person grown along with the Institute it is heartening to note the spectacular growth the Institute has made in the last three decades. From a regional station of Central Plantation Crops Research Institute in 1975 it has acquired the Institute status in 1995. ICAR has bestowed the best Institute award to IISR in July 2000. As the award document covered the period 1994-1999 I consider it as a covetable achievement.

As per International Trade Centre, Geneva report that India accounts for 50% of world's export of spices in terms of quantity and 25% in terms of value. The total export of spices in 1998-1999 was around 2,10,000 tons. Even though there was decline in the quantity exported there was 17% increase in value compared to previous year. Spices still posses good market compared to other plantation crops.

The Institute still possess the world's largest germplasm in black pepper, ginger and turmeric. Institute has participated in the XV workshop of AICRPS HELD AT Calicut during 18-21, November 1999 and recommended rhizome rot resistant cardamom line RR-1 and a phytophthora resistant black pepper line P-24 for release.

In the crop production programmes application of FYM significantly increased the yield of bush pepper followed by vermicompost and leaf compost.

In the post harvest programmes the effect of different agroclimatic conditions on the curcumin content of turmeric was documented pertaining to newly released varieties Prabha and Prathiba.

The institute has lot of many progress during last year. It has made new collections in black pepper, ginger, turmeric, vanilla, cinnamon, nutmeg and garcinia. Techniques have been developed for characterisation of *Ralstonia* sp. the causal organism of bacterial wilt of ginger. A combination of biocontrol agents and potassium phosphonate is found to be very effective in the control of *Phytophthora* foot rot of black pepper. National project on *phytophtora* species (PHYTONET) is progressing well in collecting and documenting the different *Phytophthora* diseases affecting the horticultural crops.

Fundamental studies like PR proteins, isozyme studies etc are being undertaken to establish the biochemical mechanism of disease resistance. Root mealy bugs is a new problem emerging in black pepper. Chemical and biological measures are being undertaken to control the menace. Fundamental studies are being carried out to characterize the different races of nematodes affecting spices. Last year Institute has joined the field survey to evaluate the impact of the Central Government sponsored programme on integrated measures against *Phytophthora* foot rot disease of black pepper. The XV group meeting of AICRP on spices was also held at Calicut. The workshop has recommended new varieties and packages for control of *Phytophthora*. The Krishi Vigyan Kendra under the Institute also performed well. An Agriculture Technology Information Centre and a Bioinformatic Centre also started functioning in the Institute.

I take this opportunity to thank Director General, ICAR, Deputy Director General (Hort.) and ADG (PC) and other government departments like DBT, Pepper Technology Mission (Government of Kerala) etc. for their continuing support to the Institute's programmes. I thank the scientists and staff of IISR for their valuable contribution and whole hearted support.

Y. R. Sarma
Director

Calicut
30 September, 2000.

# EXECUTIVE SUMMARY

**NEW GERMPLASM**

**Black Pepper**: A total of 108 accessions were collected during this year. Sixty-four wild types and 44 cultivars were collected from Sirsi, Sagar and Coorg (Karnataka), Idukki and Kottayam (Kerala). Cultivated types collected include local types like Karimalligesara, Bilemalligesara, Vokkalu, Vellanamban, Thevanmundi etc.

**Ginger**: A total of 13 collections were made from Sagar (Karnataka), Nepal (through NBPGR, New Delhi), Cooch Behar, North Bengal etc.

**Turmeric:** Five collections were made this year. This include *C. caesia* (black turmeric-AICRPS, Pundibari).

**Vanilla:** Four collections were added to germplasm. This include *Vanilla pilifera, V. vatsalae, V. taltensis* and *V. planifolia* with variegated leaves.

**Tree Spices**: One *Cinnamomum verum* (Chettalli), one double nut type of nutmeg (Feroke, Calicut), one *Myristica beddomeii* (Idukki), two accessions of *M. malabarica*(Wynad) and five accessions of *Garcinia gummigutta* (Thrissur, Kerala and Mercara, Karnataka) were added this year.

**Crop improvement and maintenance**

- Black Pepper hybrids HP 105 maintained superiority in yield at Valparai(6.025 Kg/vine) followed by HP 728 (5.67kg/vine) in the fifth year of yielding. Coll. 1041 continued to show tolerance to *Phytophthora* foot rot and yellowing with a mean yield of 4.7 kg/vine. HP 1411(Aimpirian x Panniyur-1) and an open pollinated line of Karimunda (OPKM) also performed excellent at Peruvannamuzhi.
- Bold rhizome selections of ginger viz., Acc.35 and 117 were evaluated in farmers' plot along with Varada. A multiplication ratio of 1.20 was obtained in these varieties at farmers' plot as against 1:18 of Varada. Acc.35 had a dry recovery of 21% and Acc.117-19%.
- Alleppey Finger Turmeric (AFT) Acc. 584 and 585 recorded 24.5 and 30.3 t/ha (fresh rhizome yield) respectively with a driage of 17 and 16 per cent. They had more than 6% curcumin.
- Paprika types consisting of 64 exotic and 77 indigenous (Bydagi Dabba) collections were field tested. Exotic collections were more prone to bacterial wilt (59.2%) compared to indigenous material

(39.9%). Though Bydagi Dabba types were pungent, colour values were higher (131-349 ASTA units) compared to exotic types (34-246ASTA)indicating possibility of getting high colour lines from Bydagi Dabba which is more adapted to local conditions.

- In the trial in cardamom to evaluate hybrids of crosses between mosaic resistant lines and high yielding pre-released selection,CCS-1 x NKE-12 and NKE-19 x NKE-27 cross combination recorded maximum heterosis for plant height and number of tillers.
- Survival of black pepper graft on *P. colubrinum* stock after three years of planting indicated double root stock method as the best(88.9%) followed by tongue and saddle grafting (61.1%). *Colubrinum* root stock has been found to be susceptible to mealy bugs that affects the collar region and root system resulting in death of grafts.
- A 9/4 in nutmeg and $A_2$, C, D and $D_3$ in *Cassia* are the promising lines in tree spices.
- *Myristica beddomeii* and *M. malabarica* were found to be compatible root stocks for approach grafting of *M. fragrans*, the cultivated nutmeg. Grafting of clove on *Syzigium beynianum* root stock is successful.

**Cytogenetics & embryology**

Studies on embryo development in black pepper indicated that, three months after pollination embryo attains heart-shape structure. Further development takes place only after seed shedding, during the process of seed germination.

Cytological analysis of ten seedling progenies of turmeric had shown chromosome number variations such as 63,74,77 and 84.

Cytological analysis of four species of Amomum viz., *A. subulatum, A. muricatum, A. microstephanum* and *A. canneicarpum* revealed 2n =48 for all.

**Biotechnology**

*In vitro* multiplication has been induced in *Piper cubeba* and *Piper attenuatum*. The *in vitro* gene bank has been strengthened by the addition of *P. cubeba, P. attenuatum* and seed spices viz., *Nigella sativa* and *Trachyspermum ammii*.

**Nucleus Planting material**

Black pepper rooted cuttings (93,000), black pepper rooted laterals (500), turmeric seed rhizome (6 ton), ginger seed rhizome (1.5 ton), nutmeg grafts (2,630) and cinnamon seedlings (180) were produced and distributed.

**Drought tolerance in black pepper**

Black pepper accessions 4216 and 4226 were relatively tolerant to water stress.

**Nutrition and management**

- Application of FYM significantly increased the yield in bush pepper (both in var. Panniyur-1 and Karimunda) followed by vermi compost and leaf compost applications. The yield increase was upto 104% in Panniyur-1 and 35% in Karimunda over the application of chemical fertilizers alone.

- In ginger, application of micro-nutrients viz., boron and molybdenum along with FYM (10t/ha) and the recommended NPK increased the yield by 32% and 43% respectively.

- In turmeric, among different organic sources applied, chilli spent waste (@250g/pot) yielded highest and was comparable to FYM application (@1kg/pot)

**Quality evaluation**

- Among the black pepper hybrids and collections evaluated at Valparai (high altitude area in Tamil Nadu) HP 34 had a high bulk density (wt/litre) of 628 g and coll.1041 had 536g. HP 728 and 813 had high oleoresin(>10%) and piperine(~5%).

- Curcumin content of Prabha and Prathibha showed location effect at Sangli (Maharashtra). Thirty five to forty per cent reduction was observed there compared to Calicut.

- Among the ginger accessions evaluated, Acc.511 recorded 8.9% oleoresin and Acc.191,288 and 302 recorded low fibre (<3%).Acc.411 and 420 recorded 2.7%essential oil.

## PLANT PATHOLOGY

### Disease etiology and pathogen characterisation

A simple biovar characterisation technique using microtiter plate and small quantity of reagent was standardised for rapid identification of biovars. *Ralstonia solanacearum* was also isolated from tomato, potato, chilli, eupatorium and ageratum in order to know their role in the epidemics of bacterial wilt of ginger in India. Difference among the isolates in colony character, carbohydrate utilization pattern, pathogenic potential, antibiotic resistance etc. could be found. Characterisation based on membrane protein pattern revealed the presence of 37-40 Kda protein in all the isolates of *Ralstonia solanacearum*. This protein may be useful as a species specific antigen for producing antibodies for developing an immuno-kit.

### Serological detection of *Ralstonia solanacearum*

- Dot-immuno-binding assay kit (NCMELISA) developed at International Potato Centre (CIP, Lima, Peru) was evaluated to know the adaptability of the kit for ginger. The result indicates that the kit is suitable for detection of bacterium in ginger sample.
- *P. colubrinum* with multiple resistance for *Phytophthora capsici, Radopholus similis* and *M. incognita* was found susceptible to CMV. This was based on graft transmission and subsequently checked by ELISA.
- A severe incidence of leaf rot and wilt in vanilla was noticed in the IISR farm, Peruvannamuzhi. *Fusarium* sp. was found to cause both leaf rot and wilt. *Fusarium* sp.was also isolated from vanilla from Valparai. A new fungicide formulation of carbendazim and mancozeb marketed under the trade name 'saff' was tested both *in vitro* and *in vivo* and was found effective in inhibiting the growth of *Fusarium* at 100 ppm.

### Screening germplasm for reaction to diseases

Of the 133 germplasm types screened for their reaction to *P.capsici*, 3 germplasm types (HP 295, W 3241 and W 3073) showed resistant reaction in the initial screening. Field trials at Pulpally and Valparai showed consistent performance for tolerance to *Phytophthora* foot rot.

**Inoculation technique** : Simple inoculation technique was standard-

ized to screen germplasm of ginger for bacterial wilt tolerance. The technique was very rapid and easy to follow. Reaction could be noticed within 10 days of inoculation. The inoculation procedure was used for evaluation of ginger germplasm.

A total of 21 somaclones were evaluated in green house for bacterial wilt tolerance. The somaclones were as susceptible as the variety Himachal.

**Biological control**

The synergistic growth promotive effect of efficient isolates of VAM and *Trichoderma* was studied in black pepper nursery. The variety Karimunda responded better than Panniyur-1.The combination of VAM and *Trichoderma harzianum* and *T.virens* enhanced sprouting and root growth in both the varieties.

The population of *Trichoderma* in biocontrol plot was upto $10^4$ cfu/g compared to zero level in uninoculated field.

**Disease management**

The activity of potassium phosphonate against *P. capsici* in black pepper at the recommended dose of 3 ml/l declines after 4 days. Studies with higher concentrations of potassium phosphonate (4ml/1 to 10 ml/l) were tried. The treatments,6-10 ml could give greater protection upto 30 days after drenching. At these concentrations no phytotoxicity was noticed. In a pot culture experiment with biocontrol agents alone and in combination with potassium phosphonate on root rot, least mortality was recorded in treatment with a combination of *verticillium tenerum* and potassium phosphonate (11.1%), followed by *Trichoderma virens* and *T.harzianum* in combination with potassium phosphonate (16.6%) compared to control (83.3%).

Studies on integrated approach to rejuvenate the foot rot affected black pepper garden, growth of plants as indicated by crop stand, number of leaves and height of the plants were better in treatments with clean cultivation compared to treatments with no inter-cultivation.

In integrated disease management plot, the mortality was least in P-24 (1/40) followed by Panniyur-4 (4/40).

**Mechanism of disease resistance**

In order to analyze RAPD profiles of disease resistant cardamom

lines, 20 operon random primers were tried. Two of them OPA 08 and OPA 12 gave good amplification. The annealing temperature for cardamom was standardised as 40°C. In rhizome rot resistant cardamom variety RR 1, a distinct band was seen compared to the susceptible check.

**PHYTONET**

A total of 514 *Phytophthora* isolates from different hosts all over India are being maintained at National Repository of *Phytophthora* (NARPh). Morphological characteristics were studied in detail in 48 *Phytophthora* isolates of black pepper and 32 *Phytophthora* isolates of betel vine. Out of 48 isolates, 44 are typical *P. capsici* with long pedicels (20-206 mm) and umbellate ontogeny whereas four were with sympodial ontogeny with sporangial stock length of 23-195 mm. Out of 32 betel vine isolates studied, 22 isolates were of typical *P. parasitica* with variable pedicels (0-20.7mm) and sympodial ontogeny whereas 10 were typical *P. capsici* with long pedicels (20-246mm) and umbellate ontogeny.

Induction of pathogenesis related proteins (PR-proteins) were reported in black pepper on inoculation with *P.capsici.* Occurrence of chitinases and β-1,3 glucanases in the *Phytophthora* tolerant black pepper line, P 24 have been recognised using anti-rabbit antibodies. The 30 and 35 kDa proteins recognised as β-1,3 glucanase and chitinase isoforms respectively were electroeluted and these eluted proteins showed antifungal activity.

Isozyme work for characterization of the *Phytophthora* isolates was initiated with superoxide dismutase and catalase. Several extraction buffers were tried. For SOD two loci and one locus for catalase has been identified in *P. capsici* isolate 99-101.

*Trichoderma virens* isolates were screened *in vivo* for growth promotion of black pepper and suppression of *Phytophthora*. Isolate GV5 favoured maximum plant growth. Organic amendments such as coir pith, FYM, neem cake and leaf litter of Glyricidia supported the survival of *T. harzianum* in soil. There was clear increase in the number of colony forming units of *T. harzianum* when there was higher amount of these organic matter. Coir pith, coir compost and lignite were studied as carrier media for liquid fermentation products. All the three media recorded high colony forming units even after 60 days of mixing when

used in the sterile condition. Twenty five isolates of *Trichoderma* spp., 23 isolates of bacteria and 16 other fungal antagonists were isolated from the rhizosphere of the black pepper. Biocontrol agent, *T. harzianum* was found to be compatible with phorate and chlorpyriphos at the recommended doses. A technique has been standardised for the isolation of protoplasts from *Trichoderma harzianum* using driselase, hemicellulase and cellulase (Onuzuka).

**ENTOMOLOGY**

♣ **Identification and characterisation of host resistance**

The black pepper accessions, wild piper species and interspecific hybrids identified to be resistant to pollu beetle were characterised for their biochemical constituents. The levels of free amino acids and surface wax were significantly higher in the resistant lines when compared to the susceptible check.

♣ **Evaluation of natural products**

Laboratory bioassays were conducted to evaluate the anti feedant activity of chilli extract and seed kernel of *Melia composita* against 'Pollu' beetle. Chilli extract and *M.composita* seed kernel extracts possessed appreciable antifeedant activity, causing above 90% feeding deterrence at 1 and 2% concentrations, respectively.

♣ **Determination of pesticide residues in black pepper**

The pesticide residues in black pepper in which the recommended spraying schedules of endosulfan and neem products were adopted were determined. Spraying of 2 rounds of endosulfan 0.05%; 1 round of endosulfan 0.05%, 3 rounds of Neemgold 0.6%and 4 rounds of Neemgold 0.6% resulted in 0.041 ppm, 0.009ppm and non detectable levels of endosulfan residues in black pepper at harvest. These residue levels were well below the permissible level of 0.1 ppm fixed by the importing countries.

♣ **Distribution of root mealy bugs and nature of damage on black pepper**

Surveys were conducted at 8 locations in Wynad district, Kerala to study the distribution of root mealy bugs (*Planococcus* sp.) on black pepper. The pest infestation was observed in 6 locations where 6.7 to 42.2% of the vines were infested with root mealy bugs. Thirty three

per cent of the vines infested with root mealy bugs were also affected with *Phytophthora* foot rot disease. Infestation by mealy bugs caused yellowing and wilting of leaves, defoliation and mortality of vines. However, most of these vines were also affected by *P. capsici* and nematodes.

♣ **Biological control of mealy bugs**

An unidentified species of fungus was collected from dead mealy bugs colonies in the field at Peruvannamuzhi. Laboratory bioassays were conducted to evaluate the pathogenicity of entomopathogenic fungi, viz., *Beauveria bassiana*, *Paecilomyces lilacinus*, *Verticillium chlamydosporium* and *Metarrhizium anisopliae* against root mealy bugs. The bioassays indicated that among the various fungi, *M. anisopliae* was the most promising, causing 80% reduction in mealy bug colonies when compared to 175% increase in control.

♣ **Management of rhizome scale**

Various insecticides, plant and organic products were evaluated for the management of rhizome scale (*Aspidiella hartii*) on ginger during storage. The trials indicated that among the various treatments, dipping of seed rhizomes in quinalphos 0.075% or methyl parathion 0.075% or dimethoate 0.075% were more effective for obtaining a higher recovery of rhizomes, higher number of sprouts and lesser incidence of rhizome scale.

♣ **Management of shoot borer**

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

***NEMATOLOGY***

♣ **Host resistance**

Evaluation under simulated field conditions confirmed the resistance of four turmeric (Acc.84,142,182and 198) and two ginger

(Acc.36 and 59) germplasm accessions to root-knot nematodes. In the second round of screening, another four turmeric (Acc.31,82,178 and 200) and one ginger (Acc.221) accessions were resistant to *Meloidogyne incognita*.

Five wild *Piper nigrum* accessions(W.3141, 3200, 3283, 3291 and 3299) and one hybrid black pepper (HP 309) were resistant to *Radopholus similis*.

Post infectional changes in defense related enzymes, viz., superoxide dismutase(SOD), peroxidase (PO) and catalase (cat) were monitored qualitatively by SDS-PAGE in root-knot nematode tolerant ('Pournami') and susceptible ('Panniyur-1') black pepper varieties. Isoforms of PO and cat enzymes were observed in 'Pournami' at 24 and 48 h after inoculation which disintegrated subsequently.

### ♣ Nematode diversity

Five more root-knot nematode population were added to the nematode live collections. A new root-knot nematode species, *M. keralensis*, was identified from Peruvannamuzhi.

### ♣ Biological control

Egg parasitic fungal isolates of *Verticillium* spp., *Paecilomyces lilacinus*, *Trichoderma* spp., *Fusarium* spp., *Aspergillus* spp., and the obligate bacterial hyper parasite *Pasteuria* spp., were identified through *in vitro* bioassays. In greenhouse studies, *V. chlamydosporium* partly suppressed *R.similis* population in black pepper rooted cuttings.

Sorghum and decomposed coffee husk supported maximum growth and sporulation of *V. chlamydosporium*, while FYM and vermi compost were the least preferred substrates. But maximum growth and multiplication of *P. lilacinus* were observed in rice and ginger leaf powder.

The nematicidal compounds in *P. colubrinum* leaves were characterized as 5,4'-dihydroxy-7-methoxy flavone and 5,3',4'-trihydroxy-7-methoxy flavone.

## SOCIAL SCIENCE

### Training programmes

Training programmes were conducted on 'Spices production technology', 'Nursery management' and 'On – farm processing of spices'.

About 53 officers from seven states attended the training programmes. On request training to over 50 farmers from north-east and other states sponsored by Spices Board was also arranged.

**Economics of spices production and marketing**

The decentralized marketing channel for pepper with 11% price spread and few intermediaries is more efficient that that for ginger

Cost of production of pepper in the year 1998-99 was Rs. 33/kg against the estimated full supply price of Rs.43.50

An expost evaluation of the central government sponsored programme on integrated measures against *Phytophthora* root rot disease of black pepper in Kerala was done.

Most farmers (about 97%) in the region are aware of the programme and its components. About 73% farmers adopted the recommended cultural and phytosanitation measures (component-I).

Adoption quotient for chemical control measures (both pre-and post monsoon sprays) i.e., component-II was 41.4% only.

Application of manures and fertilizers is not in the lines of recommended agronomic practices

Positive growth rates of 6.54% and 3.37% respectively in the spice districts of Idukki and Wynad was attributed to the success of the technology.

The survey indicated reduction in vine mortality from 7-44% to 3-7%.

Productivity increased from 268 kg/ha during 1994 (base year) to 315 kg/ha in 1999.

**KRISHI VIGYAN KENDRA**

Krishi Vigyan Kendra conducted 60 training programmes during the period that include 45 training for practicing farmers, 14 for rural youth and one for extension functionaries in the disciplines of agronomy, horticulture, fisheries and animal science. Altogether 2180 trainees attended the programmes.

KVK also participated in 5 exhibitions and delivered 13 radio talks on various subjects through AIR, Calicut.

Under the revolving fund programme, planting materials worth Rs.1.97 lakhs were sold.

In the Plant and Animal Health Centre, a total of 923 cases were attended and 368 AI were done. The Kendra also conducted 3 animal health campaigns and attended one camp conducted by other agencies.

## ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES

Two new varieties in black pepper (Panniyur –6 and Panniyur – 7), one in cardamom (RR-1), three in coriander (RCr-684, RCr-436 and RCr-435), two in fenugreek (Guj. Methi-1 and RMt-303), one in cumin (Guj.Cumin-3) and one in fennel (RF-101) were proposed for release in the workshop held at Calicut during November 18-21, 1999.

A fertilizer lever of 150:60:210 g of NPK $vine^{-1}$ with irrigation at IW/CPE ratio of 0.33 is recommended for economic yield in black pepper in Karnataka. Sowing cumin during 15$^{th}$ October reduced the cumin wilt while in coriander November 4$^{th}$ sowing gave best yield.

A spacing of 30 x 20 cm and an increased level of nitrogen @ 150 kg/ ha is preferred for turmeric at Kumarganj (U.P.).

The package of technology, recommended for the control of *Phytophthora* foot rot in black pepper involves application of 1 kg neem cake per vine, first round pre-monsoon spraying with Bordeaux mixture followed by copper oxychloride drenching and second round Akomin spray followed by Akomin drenching as post-monsoon treatment is recommended for Kerala condition in addition to the normal phytosanitary measures.

Phorate @ 3 g a.i. can be given for nematode incidence.

# 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).

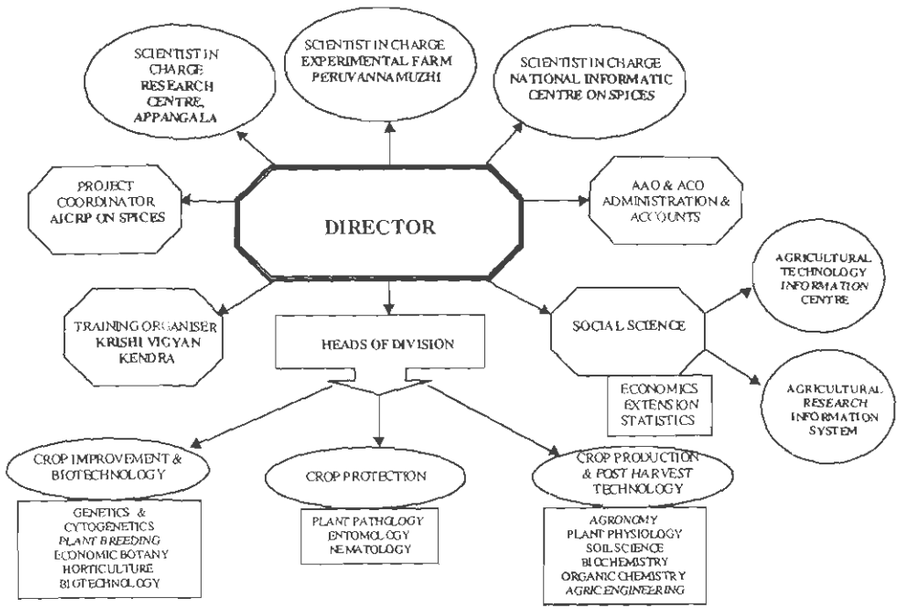
The Indian Institute of Spices Research will serve as an institute of excellence for conducting and co-ordinating research on all aspects of spices improvement, production, protection and post harvest technology.

**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 da 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 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 viz., 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) and an ARIS (Agricultural Research Information System) cell are also operating since last year. Bioinformatics project has also been initiated in the institute. 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 all spice and 28 vanilla accessions.

High yielding black pepper varieties like Sreekara, Subhakara, Pournami and Panchami, high quality cinnamon varieties Navashree and Nithyashree 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. Micro propagation 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 standardized. 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 bio fertilizers promoted growth in black pepper, cardamom and clove. Application of neem cake (2t/ha) increased nutrient availability in soil, increased ginger yield by 33% and restricted rhizome rot incidence of ginger to 50%.

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 flavor 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 standardized.

**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 *Phytophthora* 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 bio control 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 were found to be 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 1999

| Month | No. of rainy days | | Rainfall (mm) | |
|---|---|---|---|---|
| | Peruvannamuzhi | Appangala | Peruvannamuzhi | Appangala |
| January | 2 | - | - | - |
| February | 1 | - | 34.6 | - |
| March | 7 | - | 2.5 | - |
| April | 21 | 2 | 54.60 | 14.6 |
| May | 24 | 10 | 635.30 | 247.2 |
| June | 28 | 16 | 869.00 | 313.5 |
| July | 23 | 27 | 1362.00 | 1047.8 |
| August | 9 | 13 | 768.00 | 234.5 |
| September | 27 | 10 | 122.0 | 67.9 |
| October | 8 | 11 | 685.50 | 241.0 |
| November | 1 | - | 42.50 | - |
| December | 1 | - | 12.00 | - |
| Total | 151 - | 89 | 4588.00 | 2166.50 |

**Budget (Rupees in lakhs)**

| Particulars | Plan | Non plan | Total |
|---|---|---|---|
| Establishment | - | 186.90 | 186.90 |
| Travelling allowance | 4.00 | 4.50 | 8.50 |
| Works | 43.20 | - | 43.20 |
| Other charges including equipment | 87.80 | 25.43 | 113.23 |
| Total | 135.00 | 216.83 | 351.83 |

## Other Sources

| Particulars | Amount |
|---|---|
| A.P. cess fund schemes | 62.28 |
| KVK | 26.79 |
| NATP | 12.05 |
| AICRP Spices | 89.98 |
| DBT schemes | 14.37 |
| IPDS | 6.93 |
| Pepper technology mission | 15.60 |
| Pension and gratuity | 9.50 |
| Total | 237.50 |

**Staff Position**

| | Sanctioned | Filled | Vacant |
|---|---|---|---|
| RMP | 1 | 1 | - |
| Scientific | 41 | 34 | 7 |
| Technical | 44 | 44 | - |
| Administrative | 22* | 22 | - |
| Supporting | 72* | 72 | - |

*Sanctioned and filled posts were included in KVK

# RESEARCH ACHIEVEMENTS

## CROP IMPROVEMENT AND BIOTECHNOLOGY

### GEN. 1.(813)

### COLLECTION, CONSERVATION CATALOGUING AND EVALUATION OF BLACK PEPPER GERMPLASM

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

**Aim and scope**

1. Collection, conservation and evaluation of black pepper germplasm
2. Establishment of black pepper germplasm in the nursery and field.

**Past achievements**

1. Collections of Piper germplasm were made from both the centres of origin in India, viz. Western Ghats and North Eastern region.
2. About 3000 accessions are maintained in the germplasm nursery.
3. Collected and conserved almost all the local cultivars and land races of black pepper grown in South India
4. Rediscovered and described *Piper barberi* – an endangered species.
5. Three new taxa of *Piper* were reported. This includes two new species Viz. *P. silentvallyensis* and *P. sugandhi* and one sub species viz. *P. sugandhi.var. brevipilis*
6. Four varieties of black pepper were released from the existing collections.

GEN.IX(813)

### COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF CARDAMAOM GERMPLASM

**(K.Padmini, V.S. Korikanthimath and D. Prasath)**

**Aim and scope**

a) To collect cultivated as well as related genera of cardamom so as to make a genebank for various characters

b) To evaluate the germplasm for yield and other desirable characters in cultivated types of cardamom.

**Past achievements**

**collection :**

310 cardamom accessions including related genera have been collected from cardamom growing areas such as Wynad, Anamalais, Majoli Hills, Karnataka, Nelliampathy, Lower Pulneys, Meghamalai, cardamom hills and maintained in the germplasm repository. An accession with compact panicle is added to the genebank.

In addition to the cultivated types of cardamon ten allied genera viz., *Zingiber zerumbet, Alpinia galanga, Alpinia mutica, Alpinia albugus, Amomum muricatum, Amomum micro stephanum, Amomum cannericarpum, Hedychium coccineum, Hedychium green* and a Florida type are also being maintained in the germplasm repository

The germplasm collections include variants for almost all the characters, the interesting among them are pink stemmed type, Narrow leaf, Alfred clone (with basal and terminal inflorescence with few leafy bracts), multibranched panicle types, bold capsules and compact panicles.

**Evaluation :**

Evaluation of cardamom accessions in the germplasm repository has led to the identification of two Wynad selections APG-221 and APG-218 which contained more than 7.8% essential oil containing high α-terpinyl acetate which is responsible for the pleasant aroma.

A selection of 873 which yielded 400kg of dry capsules/hectare selected from OP progenies of Cl-37 suitable for high density planting was selected for release as CCS-1 (Coorg Cardamom Selection-1). This selection is suited for cultivation in cardamom growing areas of Karnataka.

**Cataloguing**

Cataloguing of multibranched collections for inflorescence and fruit characters is being done. Eight open pollinated progenies of multibranched 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 except for the branching habit. However, the percent fruit set recorded in the various multibranched types range from 12.99 to 50.00.

**Progress Report**

Three hundred accessions are being maintained and seventy five entries have been shifted and are being maintained.

**Evaluation and characterization of cardamom accessions:**

Two hundred and ten accessions were evaluated based on the IPGRI discriptor for 15 characters. The mean number of panicles per plant was highest in Malabar (42.65) followed by Mysore (40.18) and Vazhukka (937.25). The mean yield per plant (wet weight in g) was highest in Vazhukka type (212.12) followed by Mysore (198.53) and malabar (192.70).

**Variability in Malabar types:**

The coefficient of variation was highest for number of panicles per plant (78.86) followed by capsule breadth (69.77) and bearing tillers per plant (56.30). The number of panicles per plant was highest in the Acc.75 (139.33). The capsule breadth was maximum in the Acc.40 (3.20). The Acc.58 recorded the highest number of tillers per plant (27). The inter nodal length was maximum (2.17cm) in Acc.8. The leaf length and breadth exhibited low variability. Number of capsules per plant varied from 0 to 2055.9.

**Variability in Mysore types:**

The maximum number of panicles per plant (135.60) was recorded in Acc.98. The internodal length ranged from 1.30 to 4.63cm, the highest being recorded in Acc.109. The mean number of capsules per plant was 250.82 and it ranged from 0 to 1322.90

**Variability in Vazhuka types :**

Highest coefficient of variation was recorded for number of panicles per plant (74.50%) followed by number of bearing tillers per plant (62.32%). The number of panicles per plant ranged from 2 to 138.7, the highest was recorded in Acc.138. The number of tillers ranged from 1.33 to 33 and that of capsules per plant from 0 to 1156.20.

GEN.11 (813):

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

**(B. Sasikumar, K.V. Saji, Johnson K. George and K.M. Abdullakoya)**

### Aim and Scope

1. Collection, conservation, cataloguing and evaluation of the germplasm of ginger and turmeric in addition to other related species of the family.
2. Evolving high yielding, value added varieties of ginger and turmeric.

### Achievements

The ginger gene bank at present possesses 580 accessions of Zingiber while the turmeric repository contains 735 accessions of *Curcuma*. *Zingiber* and *Curcuma* accessions and 9 Kampferia collections are also maintained . The germplasm collections include some types like putative wild type ginger, Kasturi turmeric (*C.aromatica*) , black turmeric (*C.caesia*) etc.

Five turmeric varieties viz. Suvarna, Suguna, Sudarshana , Prabha and Pratibha are released. Prabha and Pratibha are the first ever varieties of turmeric developed through open pollinated progeny selection.

Varada, a low fiber, high yielding ginger is also the outcome of the project. This variety is very popular with growers throughout the country.

Two Alleppey finger turmeric (AFT) lines and 2 bold rhizome ginger lines are in the pipeline.

### Germplasm collection

A total of 13 new accessions of ginger were collected such as from Sagar market-2; Farmers plot, Manegatta, Sagar, Karnataka-1, Nepal - 2 (through NBPGR, New Delhi), Amaravathi, Maharashtra-1, Satara-1 ('Mahim' variety), Cooch Bihar-Bhutan border market-5, North Bengal-1 ('Baise' variety)

Five curcuma accessions were also collected and added to the genebank viz. *C.caesia* (black turmeric) and *C.amada* from AICRPS, Pundibari, West Bengal; *C. longa* one each from Nepal (through NBPGR,

New Delhi) and Cooch Bihar.

**Multiplication of bold rhizome accessions of ginger**

Two pre released bold rhizome lines of ginger viz. Acc 35 and Acc 117, selected after 4 years trial at 3 locations and also at farmer's plot were multiplied again at research farm, Peruvannamuzhi and farmer's plot along with Varada variety.

a) Research farm

Nucleus seed material of 175kg (Acc 117); 100kg (Acc 35) and 75kg (Varada) were produced.

b) Farmer's plot

205kg of Acc 35 and 96kg of Acc 117 were produced through foundation seed production programme.

***Mean performance of Acc 35 and Acc. 117 over seasons and locations along with Varada (control)***

Overall year performance of Acc 35 and Acc 117 along with Varada is given in Table-1.

**Table-1. Overall mean performance of Acc 35 and Acc 117 along with Varada.**

| Acc./ variety | Yield/3 $m^2$ bed (kg,) | Dry recovery (fresh) | E. oil(%) | Fibre (%) | Oleoresin (%) |
|---|---|---|---|---|---|
| Acc.35 | 12.27 | 20.81 | 2.36 | 4.0 | 6.34 |
| Acc.117 | 11.43 | 18.50 | 1.72 | 3.26 | 4.48 |
| Varada | 11.99 | 19.59 | 1.68 | 2.71 | 3.96 |

**Cataloguing of ginger germplasm**

Fifty two ginger accessions were evaluated in 3 $m^2$ bed for yield and its attributes (Table-2)

**Variability studies for storage life of ginger**

Dry ginger from 41 accessions were screened against storage pest, *Lasioderma serricorne*. Frass weight of the samples were recorded after 8 months of storage of the samples in plastic jars. The samples were artificially infected with the pest.

**Table 2. Yield and yield attributes of ginger germplasm**

| Character | Range | Mean |
|---|---|---|
| Plant height (cm) | 49.8-79.4 | 65.15 |
| No. of leaves in the main shoot | 16-24 | 19.82 |
| No. of tillers/plant | 5-18 | 5.78 |
| Leaf length (cm) | 22-31 | 23.68 |
| Leaf width (cm) | 2.6-3.5 | 3.10 |
| Yield/clump(g) | 120-488 | 327.0 |
| Branching habit | 1-2 tiers | — |
| Scale colour | Pale brown-brown | — |
| Inner core colour | Light yellow-yellowish blue | — |

Frass weight of the specimens ranged from 2-13g . Frass yield of less than 3g was recorded in the accessions Acc.420, 215, 84 and 182 indicating the tolerance.

### Evaluation of AFT and other high *curcumin* turmeric lines

Eleven high curcumin lines of turmeric including six AFT lines as well as Prabha and Pratibha were evaluated in replicated trial at Peruvannamuzhi (Table 3). AFT line 593 had maximum curcumin percentage whereas in terms of yield / bed and dry recovery Acc.657 was better.

**Table 3. Yield, dry recovery and curcumin content of high curcumin turmeric lines.**

| Acc. No. | Yield/3m$^2$ bed (kg) fresh | Dry recovery (%) | Curcumin (%) |
|---|---|---|---|
| 126 | 12.5 | 17.0 | 6.0 |
| 295 | 13.25 | 17.0 | 6.3 |
| 360 (Prabha) | 12.25 | 18.3 | 6.7 |
| 361 (Pratibha) | 13.0 | 16.0 | 7.1 |
| 584 (AFT line) | 12.20 | 17.0 | 7.0 |
| 585 (AFT line) | 11.40 | 15.7 | 6.7 |
| 591 (AFT line) | 9.0 | 20.0 | - |
| 593 (AFT line) | 11.25 | 18.3 | 7.7 |
| 656 (AFT line) | 17.1 | 14.7 | 5.9 |
| 657 (AFT line) | 14.9 | 18.0 | 7.5 |

GEN.VI (813) :

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

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

### Aim and Scope

To step up production of tree spices in this country it is essential to make available elite seeds to the growers at reasonable prices. Under the project it is envisaged to collect the available variability in cultivated types and related species of nutmeg, clove, and cinnamon from India and abroad to initiate research work on improving them.

The present production of tree spices is far below our internal demands and we import clove, nutmeg and cinnamon worth about 25 crore rupees annually. In order to reduce our import and become self sufficient, it is necessary to step up the production considerably. This could be achieved only by assembling the available variability from within the country and outside which will form the starting material for improvement of these crops.

### Past achievements

A) National germplasm conservatories have been established for nutmeg, clove, cinnamon, allspice and garcinia (Table 4)

***Table 4. Genetic resources of tree spices conserved at IISR, Calicut.***

| Sl. No. | Crop | No. of Acc. | Important species maintained |
|---|---|---|---|
| 1 | Nutmeg | 475 | *Myristica fragrans, M. futua var.magnifica, M.malabarica, M.beddomeii, M.andamanica, knema andamanica* etc. |
| 2 | Clove | 220 | *Syzygium aromaticum, S. jumbolana* |
| 3 | Cinnamon | 299 | *Cinnamomum verum, C. aromaticum, C. camphora, C. malabatrum, C.riparium* etc. |
| 4 | Allspice | 180 | *Pimenta dioica* |
| 5 | Garcinia | 26 | *G.gummi-gutta, G.indica, G.tinctoria* |

B) New varieties have been developed (Table 5)

**Table 5. Development of new varieties**

| Sl. No. | Crop | Variety | Particulars |
|---|---|---|---|
| 1. | Cinnamon | Navashree and Nithyashree | Selection from germplasm. High quality lines, varieties released as National varieties in 1997 |
| 2. | Cassia | $A_2$, $C_1$, $D_1$, $D_3$ | Selections from OP progenies of Chinese cassia - high quality - Prerelease. |
| 3. | Nutmeg | A-9/4 | Stabilised very good yield, 8th year yield : 1000 fruits -Prerelease. |

**Collection and conservation :** The germplasm conservatory consisting of 299 accessions of cinnamon, 220 clove, 475 nutmeg, 180 allspice and 26 garcinia. One *Cinnamomum verum* accession from Chettalli, one double nut type of nutmeg from Feroke, Calicut, one *Myristica beddomeii* accession from Idukki, 2 *M.malabarica* accessions from Wayanad and 5 garcinia accessions from Jog falls, (Karnataka), Thrissur and Mercara were collected and added to the conservatory.

**Evaluation:**

1. **Cassia:** Twelve accessions of *Cinnamomum cassia* viz. A2, B1, B2, B4, B6, C2, C3, C4, C5, D2, D6 and D7 (four plants of A2 and 5 each of the rest, totalling 59 plants) were planted at Chelavoor farm.
2. **Clove:** Progeny evaluation trials of elite lines of clove at Appangala, Peruvannamuzhi and Chelavoor farms were maintained.
3. **Nutmeg:** Seventy per cent of clones of A9/4 planted at Peruvannamuzhi, had flowered and yielded during the fourth year, after planting. The clonal block of elite nutmeg lines is maintained.
4. **Allspice:** Eight approach grafts of allspice variant type (i.e. dwarf and bushy type) and eight rooted cuttings of allspice were field planted at Appangala farm.
5. **Garcinia:** Five accessions of garcinia viz., Koovayil, (Peruvannamuzhi), Chavaramuzhi, Teeos-1 and Teeos-2 (all *G. gummi-gutta*) and K.136685-21 (*Garcinia indica*) were planted at

Chelavoor farm @ 4 plants/ accession, thus making the total number of garcinia accessions conserved at Chelavoor farm to 19.

Eight seedlings each of *G. indica, G. hombroniana, G. cowa* and 8 grafts each of NIC 5062-2, IC 3679, Koovayil, Chavaramuzhi, Alakode T2, Alakode T1, Kelakam (all *G.gummi-gutta*) and 8 grafts of *G.tinctoria*, thus, a total of 11 accessions were planted at Peruvannamuzhi. Damage due to deer and wild boar attack is severe.

**Evaluation :**

Existing collections and progenies of *C.cassia*, progenies of clove, A9/4 clones of nutmeg, grafts of all spice and garcinia accessions were maintained and evaluated.

**GEN.XIII (813)**

**COLLECTION, CONSERVATION AND IMPROVEMENT OF VANILLA**

**(P.N. Ravindran, B. Krishnamoorthy, B. Sasikumar, K. Nirmal Babu and K.V. Saji)**

1. Collection of Germplasm

Six new collections of *Vanilla* spp. were collected during the viz.,

V. piliferae

*V. vatsalae*...from TBGRI

V. tahitensis

*V. planifolia*-variegated type....from ICRI, Myladumpara

Two collections made during last year viz., V. *planifolia* (Madagascar)

*V.planifolia* (Coimbatore) were multiplied.

2. Inter specific hybrids between *V. planifolia* and *V. aphylla* are being hardened and established in soil.

HORT.IV (813)

**ROOTSTOCK SCION INTERACTION IN TREE SPICES**

**(J. Rema, P. A. Mathew, B. Krishnamoorthy and K. S. Krishnamurthy)**

**Objectives :**

1. To study the influence of rootstock on productivity and abiotic stresses in nutmeg.

2. To study the influence of rootstock on productivity and tree vigour in clove

A. Collection of rootstocks and raising for grafting.

**Nutmeg** : Survey was carried out in different parts of Calicut and Wynad districts and seeds of *Myristica* species were collected and raised this year also to be used as rootstocks. The wild species collected include *M.malabarica, M.beddomeii, M. andamacica, M.attenuata*, and *Gymnocranthera canaria*

**Clove** : The rootstocks of *Syzygium* and related genera namely *S.heynianum, S.fryutucisym, S.cumini* and *S.zeylanicum* were maintained for grafting.

B. Standardization of grafting in nutmeg

**Nutmeg** : High yielding *Myristica fragrans* were used as scion and grafted on to different rootstocks namely *M. malabarica, M. beddomeii, M. fragrans* and *M.attenuata*. Cleft grafting and approach grafting was carried out to standardize an ideal method for grafting nutmeg. Cleft grafting and approach grafting was successful on *M.malabarica, M.beddomeii* and *M.fragran*.

**Clove** : Soft wood grafting using scion

Semi-hard wood shoots were grafted on to different rootstocks namely *S. cumini.S. fruiticosum, S. lanceolatum, S. Zeylanium* and *E.uniflora* and approach grafting was carried out on the rootstocks of *S. heynianum, S. jambos* and *E. uniflora* . Soft wood grafting was found to be successful in *S. heynianum, S. cumini* and *S. fruiticosum*.

GEN. VII. 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 performance of promising hybrids and cultivars at Valparai (3000 ft. MSL) varied from 0.33 (Sreekara) to 6.08 kg (HP 105) per vine during the 5th yielding year. Yield and quality attributes

of the promising lines are given in Table 6

**Table 6. Yield and quality attributes of promising lines of black pepper at Valparai (Collaberative trial with Tata Tea Ltd.)**

| Line | Mean yield/vine (kg. Fresh) | Bulk density (g) | Piperine (%) | Oleoresin (%) | E.oil (%) |
|---|---|---|---|---|---|
| HP 34 | 2.08 | 628 | 2.5 | 7.0 | 2.0 |
| HP 105 | 6.08 | 516 | 3.8 | 7.2 | 2.0 |
| HP 728 | 5.67 | 468 | 4.9 | 10.0 | 3.0 |
| HP 778 | 2.55 | 476 | 4.4 | 9.2 | 2.0 |
| HP 813 | 2.90 | 564 | 5.4 | 10.4 | 3.3 |
| Coll.1041 | 4.71 | 536 | 3.1 | 7.3 | 2.0 |
| Panniyur 1 | 2.75 | 500 | 4.0 | 9.3 | 2.7 |
| Sreekara | 0.33 | - | - | - | - |
| Subhakara | 0.93 | - | - | - | - |

Coll. 1041, the foot rot tolerant cultivar recorded 4.71 kg fresh berries/vine and was medium with respect to quality trials.

### Evaluation of Neelamundi collections

17 Neelamundi clones and 37 O.P lines of Neelamundi were evaluated (2 plants/each). First year yield data of clonal lines ranged from 0.5 to 1 kg and that of O P lines varied from 0.2 to 1 kg/vine (fresh).

GEN. X(813)

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

**(K. Padmini, M.N. Venugopal and D. Prasath)**

### Aim and scope

a) To identify high yielding types from the available germplasm and using them in the breeding programme to incorporate the characters into the cultivated types.

b) Isolating plants possessing resistance to katte disease and using them in the breeding programme to incorporate resistance to the cultivated types.

**Past achievements**

*Selection from OP progenies :*

Open pollinated progenies of NKE types, CCS-1 and RR-1 have been planted in the main field to select promising cardamom lines.

**Screening of plants for katte resistance**

The per cent infection of katte viral disease was comparatively lesser in natural katte escapes (NKE) than M-1, a released variety 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 in NKE-8 (after two rounds of screening) and the highest percent infection was recorded in NKE-18(16.00).

Evaluation of natural katte escapes (NKE) for yield and other desirable characters have resulted in identification of two NKE types viz. NKE-12 and NKE 19 which are on par with the released variety M-1.

Certain natural katte escapes (NKE) have been identified which are superior to Malabar types with 5 capsules/node and basal branching character with 10-14 capsules.

**Current achievements**

In the field trial aimed to evaluate the hybrids of crosses between mosaic resistance lines and high yielding pre-release selections, initial observations reveal varying degrees of heterosis ranging from –26.22 to 171.81 for plant height and –48.82 to 177.30 for total number of tillers per plant in the pre bearing stage. CCS-1x NKE-12 and NKE-19xNKE-27 cross combination recorded maximum heterosis for plant height and number of tillers respectively.

Seedlings of natural polycross progenies of NKE selections have been raised for further evaluation.

Field planting of hybrids obtained from MB-3 x RR-1 and RR-1x MB-3 have been carried out for further evaluation.

GEN: XII (813)

## CYTOGENETIC INVESTIGATIONS IN BLACK PEPPER AND RELATED TAXA

**(R. Ramakrishnan Nair)**

The project was started in 1993 with the following objectives

(1) to study the natural polyploidy and its distribution in black pepper,

(2) to study the cytotaxonomic relation between *P.nigrum* and related taxa and

(3) to induce artificial polyploidy in black pepper cultivars.

So far, chromosome indexing in 281 accessions of *Piper* including 234 cultivars and 47 wild types was completed. One natural triploid of black pepper having 2n=78 (Acc.No.1344) was identified and numerical variation of chromosomes was established among its OP progenies. Another six accessions having variable chromosome number (2n=52) were identified. An induced polyploid with 2n=104 was recovered from the seedlings raised from colchicine treated seeds of cultivar Panniyur-1. Chromosome numbers of *P. colubrinum, P. magnificum*, and *P. arboreum* were confirmed as 2n=26. Chromosome number of *P.barberi* was reported for the first time as 2n=52 and P.chaba (female) found to have 2n=104. Karyotype of cultivar 'Kurialmundi' and wild species P.*magnificum* and *P.colubrinum* were analyzed.

During this year chromosome indexing was completed in 50 more accessions. Out of the 43 cultivated types analyzed 41 were found to be normal having 2n=52. Acc.No.1253 had 2n=48 and Acc.No.4140 had 2n=94. Among the 7 wild accessions analyzed, 6 were found to be normal and Acc.No.4509 had 2n=91.

A polyploid plant with 2n=104 was identified from the plants regenerated from old (> 1 year) somatic embryogenic cultures of cultivar 'Karimunda'.

Embryo development in black pepper was studied by anatomical sectioning of developing fruits of black pepper after 20, 30, 60 and 90 days of pollination. Mature fruits, ripened fruits and seeds after 5, 10, 15 and 20 days of sowing. The results indicated that, by three months after pollination embryo attains 'heart-shaped' structure. This 'heart-shaped embryo remains in the same stage till seed ripening and further

development takes place only after seed shedding, during the process of seed ripening further during seed germination.

GEN. XIV (813)

**CYTOGENETICS AND REPRODUCTIVE BIOLOGY OF GINGER, TURMERIC AND CARDAMOM.**

**(R. Ramakrishnan Nair)**

The project was started in 1996 to investigate on cytogenetics and reproductive biology of ginger, turmeric and cardamom. The studies conducted in this project indicated that some accessions of ginger are having B chromosomes and Acc.No.246 is having 2n=24 instead of normal 2n=22. Karyomorphological studies were also conducted in cultivars China, Maran, and Varada. Polyploidy studies were attempted using different cultivars of ginger. Attempts to induce seed set in ginger through artificial pollination failed so far.

Cytological analysis of 10 seedling progenies of turmeric indicated variation in chromosome number. Six of them found to have 2n=84 (Acc.No.723, 716, 727, 721, 722, 725), two with 2n=63 (Acc.No.729 and cv.Prabha ) and one each having 2n=74 (Acc.719) and 2n=77 (Acc.715).

Cytological analysis of chromosome number in four species of *Amomum* viz. *A.subulatum* (large cardamom), *A.muricatum*, *A.microstephanum* and *A.canneicarpum* revealed that all are having 2n=48. But the difference in size of chromosomes between these species were evident.

HORT. II(813)

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

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

**Aim and Scope**

The project was started to evaluate and study i) a suitable grafting technique ii) growth and productivity iii) anatomy of graft union iv) compatibility of varieties of black pepper to the above species v) clonal and seedling root stock effects vi) the quality of berries and vii) the incidence of foot rot on a long term perspective.

**Past achievements:**

Among the two species, union could be obtained only between black pepper and *P. colubrinum*. *P. arboreum* failed to form a union even after one year. Out of eight methods i.e., cleft, saddle, splice, modified splice, tongue, approach and double rootstock methods of grafting and yemma budding, the best success was obtained with double rootstock method in terms of best union and early sprouting. After one year of planting also the best survival was indicated in this method. Both clonal as well as seedlings were good as rootstocks. Orthotropic shoot cuttings were found to give the best union compared to the laterals of *colubrinum*. Anatomical studies indicated that the union is between the parenchyma of both stock and scion which is completed in 60 days and later on vascular tissues arise from both to form conducting vessels for sustenance. For early formation of laterals it is found advantageous to graft top shoots of pepper instead of runners. So far no incidence of *Phytophthora* foot rot has been observed. Eighteen pepper varieties were successfully grafted with *Piper colubrinum* and were established in field.

**Progress of work**

The growth of grafts were monitored. Formation of spikes on laterals of three year old grafts were observed. However, the yields were very low due to the lack of sufficient lateral formation throughout the standard. The runner shoots used as scion grew into single vines on the standard without forming any laterals in the entire length but only at the top. This indicated that only top shoots need to be grafted to get early lateral formation and good crops. Data on survival of grafts indicated that double root stock method is the best (95.85%) though statistically it was on par with saddle (62.02%), tongue (69.93%) grafting and yemma budding. *Colubrinum* was severely affected by mealy bugs (18%) which could be controlled with chlorpyrifos in the early stages. *Albizzia falcataria* planted as shade tree has adversely affected the growth of grafts.

Grafted plants of bush pepper with clonal and seedling root stocks of *colubrinum* did not show any appreciable difference in vegetative growth. Some grafts were found to become yellow on the root stock side and on examination, the fibrous roots have been found damaged and ridomil application has helped in survival of grafts in early stages.

Grafts and *colubrinum* were planted in the Kuttanad area to monitor the performance owing to the adaptability of the rootstock to marshy areas.

*HORT III (813)*

**DEVELOPMENT OF PAPRIKA FOR WARM HUMID TROPICS.**

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

**Aim and Scope**

The project was started to i) develop a germplasm resource of Paprika ii) evaluate germplasm for high colour, low pungency and high yield and iii) identify resistant lines against bacterial wilt and leaf curl virus.

**Past achievements :**

A total of 56 exotic lines with variability for different characters were collected. These entries were found to be susceptible to bacterial wilt, leaf curl virus and fruit rot. The colour values were analysed and it was found to be low under tropical conditions (4.2 to 89.00 ASTA units). These lines also were susceptible to leaf spot and rain damage. The only indigenously developed line kt-Pl-19 was tested but was found to be completely susceptible to bacterial wilt, fruit rot and virus though the colour value was good (139.5 ASTA units) and free from pungency.

Surveys were carried out in Byadagi Dabba growing areas of Dharwad district in Karnataka and a total of 162 single plant accessions were collected. However, many of these accessions perished due to low germination, bacterial wilt and mudra complex, a virus problem. However, these types offered good variability and adaptability for tropical situations. The colour values were also higher than exotic types (51 to 500 ASTA units) indicating good scope for selection. Low seed germination has been observed under humid tropical situations.

**Progress of work :**

A total of 97 exotic lines and 137 Byadagi Dabba lines were sown but the germination was affected in many lines. There was no appreciable difference with regards to time taken for flowering or time taken for harvest in exotics and indigenous lines. The indigenous lines were taller than exotic lines. Both fresh and dry weight of fruits were higher in Byadagi Dabba lines. Byadagi Dabba types had longer fruits while

the exotic lines recorded better fruit girth (8.48 cm). The colour value range in ASTA units was higher in Byadagi Dabba (131 – 349) as compared to exotics (34 – 246). However, the former were not free from pungency. Therefore, these types need further evaluation for isolation of zero pungent types. Both exotic and indigenous lines were susceptible to bacterial wilt but the indigenous types recorded lesser incidence indicating some degree of tolerance.

*BIO TECH II (813)*

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

**(A. Kumar)**

Somaclonal variants of ginger were evaluated for bacterial wilt resistance. It was carried out using pseudostem inoculation technique.

**Field experiments**

Trials were conducted in two locations of Wynad, the endemic area for bacterial wilt of ginger

**Trial at Vythiri**

Plot section was made after thorough inspection of site and also after obtaining previous history of the field. Experiment was conducted in Randomized Block Design with four replications. The soma clones were planted in 1 x 1 m bed at the rate of 16 seed rhizomes per bed. OCP 1222, OCP 816, RRE-1, 72-8, 70-3, 64-2, 61-9, Himachal

No ginger rhizome could be harvested from Vythiri as none of the plants survived after 120 days.

***Trial at Pulpally***

Field trial for bacterial wilt tolerance was laid out at Pulpally with the following soma clones

61-9, RRE-1,OCP-816, 64-2, 72-8, 70-3, OCP-1222, 72-4, 101, 50-3, MP76-3, 49-7, 61-7, 1441, MP90-8, 61-4, MP74-5, 61-10, 70-5, 65-7, 68-4, 74-4, 64-4, 70-7, 68-3, 72-6, 54-4, 54-2,72-4.

At Pulpally no incidence of bacterial wilt could be noticed throughout the cropping season..

BIOTECH IV (813)

## BIOTECHNOLOGICAL APPROACHES FOR CROP IMPROVEMENT IN BLACK PEPPER

**(J. Rema, B. Sasikumar and P.N. Ravindran)**

### Somaclones

About 100 cultures of black pepper somaclones were maintained.

### Field evaluation of somaclones

Two yield trials one in Peruvannamuzhi and another in farmers field in Calicut district were maintained.

## ICAR AD-HOC PROJECTS

### *Developing hardening protocols for tissue cultured plants of spices*

**(J. Rema and P. N. Ravindran)**

### Final Report

The objectives as envisaged in the project are

1. Establishing hardening facility for spices
2. Developing protocols for hardening spices.

Crops ranging from different habits (perennial climbers, annuals, seasonal herbs, trees), climatic zones (tropical to temperate), dicots and monocots, were selected for the present study. They were :

| | | |
|---|---|---|
| Piper species | : | Black pepper and related species like *Piper betel, P. chaba, P. longum, P. colubrinum, P. barberi.* |
| Zingiberaceous taxa | : | Cardamom, ginger and turmeric |
| Tree spices | : | Cinnamon, curry leaf, camphor |
| Herbal spices | : | Peppermint, marjoram, thyme, ocimum. |
| Orchid spice | : | Vanilla. |

## ESTABLISHMENT OF HARDENING FACILITY

A hardening facility with separate control for temperature, light and humidity has been established. The roofing and side wall of the structure is with 8mm thick polycarbonate sheets. This facility consists of three separate chambers, the temperature in the middle chamber can

be maintained at low temperature (upto 15°C), so as to provide conducive conditions for the establishment of crops growing under different habits (tropical to temperate). In each chamber the humidity can be adjusted by humidity controlled microclimate. The humidity is maintained between 30-100%, by the misting system, which is placed on both sides of the chamber. The temperature in two chambers is controlled by temperature controlled microclimate. It consists of a pump and cooling panel, which is placed on one side of the wall, and an exhaust fan placed on the opposite wall. Each room of the hardening facility is fitted with 11 PAR lamps with photostimulator and the photoperiod can be adjusted according to the requirements. The experiments were carried out using this facility.

## DEVELOPING PROTOCOLS FOR HARDENING OF TISSUE CULTURED SPICES

The project was envisaged to develop protocols for hardening of tissue cultured plants of tropical spices. Thus the elements of work include 1) establishment and multiplication of sufficient planting material 2) induction of rooting 3)hardening and planting out.

## MULTIPLICATION OF PLANTING MATERIAL

Multiplication of sufficient material for experimentation was done in Piper species *(P. nigrum, P. longum, P. betel, P. colubrinum, P. barberi)* , Zingiberaceous taxa (ginger, turmeric, cardamom), tree spices (cinnamon, curry leaf, camphor), temperate herbal spices (pepper mint, ocimum, thyme and Marjoram) and orchid spice (vanilla), for experiments on hardening and their establishment. Some of the species included in the study are endangered and few are high elevation species.

### Piper species

### *In vitro* multiplication

Explants (shoot tips and nodal segments) of black pepper (*Piper nigrum),* betel vine (*P. betle*), *P. barberi, P. silentvalleyensis, P. schmidti* and long pepper (*Piper longum*) were collected from nursery grown plants which were sprayed with fungicide regularly. They were wiped with weak detergent solution and immersed in fungicide solution for 45 minutes and later transferred to laminar air flow chamber where they were treated with mercuric chloride (0.1%) for 5-7 minutes. After washing the explants with sterilised distilled water and giving a fresh

basal cut, they were inoculated in the culture initiation medium.

Embryo culture, from ripe seeds of black pepper cultivars was also attempted since embryo cultures were reported to respond faster and have a lower contamination rate. Mature berries were collected and treated with fungicide solution for 30 minutes after which the pulp was removed and the seeds were rinsed in 70% alcohol and treated with 0.05% mercuric chloride for 3 minutes. The embryos were then excised and inoculated.

***Culture medium and multiplication***

Based on earlier work done in this laboratory, Woody Plant Medium (WPM) was utilised for Piper species. Growth regulator free medium was used for establishing fresh cultures, after which they were transferred to medium supplemented with cytokinins (BAP and Kinetin) for multiplication and auxins (IBA) for rooting. All cultures were incubated under 2500 lux with 14h photoperiod. Embryo cultures were incubated initially in the dark for 21 days.

Thirty five per cent of shoot tip and nodal segment cultures were lost by fungal and 40% by bacterial contamination. In 10% of the cultures, buds opened in to leaves by the 26 day of culture. Among embryo cultures, rate of contamination was comparatively low. Embryos were established on growth regulator free medium. They were shifted to light after initiation of the growth of radicle and plumule 50% of them germinated by the 15$^{th}$ day.

Established cultures were sub-cultured on multiplication media i.e. WPM supplemented with BAP (3.0 mgl $^{-1}$) and kinetin (1.0 mgl $^{-1}$). Multiple shoots (3-4) could be induced from these in 70 days where as *P. barberi, P. chaba, P. betle and P. colubrinum* induced about 7-10 multiple shoots within two months.

**Hardening and Planting out**

Different parameters have been known to affect hardening and establishment of tissue cultured plants. Initial factors like size and stage of the plantlets, the number of leaves, rooting pattern (root length and number of roots), water holding capacity and nature of planting mixture (light or heavy, porous or compact), and the environmental conditions to which they are transferred were studied.

Isolated shoots (from multiplying cultures) were transferred to media, free of growth regulators. Root initiation was observed by the seventh day onwards, in growth regulator free medium, without the addition of auxins. *Ex vitro* rooting was also tried in the case of *P. nigrum* by dipping the shoots in ceradix. 60-70% of the shoots produce good root system in sandy pots. About 200 shoots of black pepper have been rooted *in vitro* for hardening experiments.

Shoots with well developed roots were taken for hardening. Plantlets of different sizes were tried to identify the ideal size suited for better acclimatization. Plantlets were taken out carefully from the culture vessels, by disrupting the agar and washing the plantlet thoroughly to remove any traces of nutrient media and treating with a fungicide solution to prevent any microbial growth, before planting into the rooting mixture in plastic cups.

Different planting out mixtures viz., soil, sand, cow dung and coir dust were tried singly and in combinations. Among these, sand is found ideal for initial hardening when compared to the others. Among the different environmental conditions in the hardening chamber, black pepper plantlets hardened faster when subjected to a relative humidity of 70%, combined with a temperature of 28-30 $^{0}$C, in the hardening chamber for the first 15 days.

Plants ranging from heights of 3.7 to 5.7 cm, number of leaves (3-6), roots (2-6) and root length (3.2 to 7.6) were included in the study (Stage 1). After 15 days in the hardening chamber, the plants were transplanted to polybags (Stage 2) containing soil, sand and farmyard manure in 1 : 1 : 1 proportion, in nursery. The average increase in the growth of plantlets at Stage 2, is summarised in Table 7. Piper species showed 80% field survival.

**Zingiberaceous spices**

***In vitro* multiplication**

For ginger, turmeric, cardamom and large cardamom explants used were apical and axillary buds of rhizome. They were cleaned, cut in to pieces and washed with weak detergent solution and immersed in fungicide solution for 1 hour and washed thoroughly with running water and transferred to laminar air flow chamber where they were treated with sterilized distilled water. The shoot apical portions of the

**Table 7. Growth pattern of spices during hardening process**

| Crop | Plant height (cm) | | No. of roots | | Root length (cm) | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 |
| *P. nigrum* | 4.2 | 1.4 | 4.6 | 4.4 | 3.7 | 2.6 |
| *P. betle* | 4.5 | 2.1 | 5.0 | 4.0 | 4.5 | 2.8 |
| *P. barberi* | 4.9 | 1.7 | 4.0 | 6.0 | 5.1 | 3.1 |
| *P. chaba* | 4.1 | 1.5 | 5.9 | 3.3 | 4.9 | 3.4 |
| *P. colubrinum* | 5.6 | 2.1 | 5.3 | 4.3 | 5.7 | 3.8 |
| *P. longum* | 4.8 | 2.0 | 4.8 | 4.0 | 5.3 | 3.5 |

1. Initial size at the time of hardening (stage – 1)

2. Increase in the stage 1 to transplanting (stage – 2)

rhizomes were carefully taken and inoculated in the culture initiation medium.

### *Culture media and multiplication*

Cultures of cardamom, large cardamom, turmeric and ginger were initiated in Murashige and Skoog's medium supplemented with kinetin (0.5 $mg^{-1}$) and then multiplied on BAP (1.0 $mg^{-1}$) and NAA (0.5 $mg^{-1}$).

Altering culture medium for shoot and root development in cardamom, to identify the more suited combination for better establishment and also to initiate hardening *in vitro*, by varying sucrose concentrations (0%, 2% & 4%) and addition of non toxic osmoticums (mannitol, sorbitol), was tried. Equal sized plantlets, with a shoot length of 2.0 cm, were separated from the multiplication medium and utilized for the experiment. All the replications were incubated under the same culture conditions.

Initial observations on effect of hardening treatments on shoot development and root development, after 60 days were incubated under the same culture conditions.

Initial observations on the effect of hardening treatments on shoot development and root development, after 60 days were recorded. Shoot growth was maximum, with an average of 11 leaves per culture, in half strength MS with 2% sucrose. The different treatments tried are summarised in Table 8. Each treatment had twenty replications and

the response was observed with over sixty percent similarity.

Maximum number of roots (9/culture) as well as increase in root length was observed in half strength MS with 4% sucrose. In medium devoid of sucrose, root development was negligible. The results thus indicated that higher sucrose concentration (2%, 4%) favoured root and shoot development, withdrawing carbohydrate sucrose and supplementing the medium with auxins (IBA and NAA) did not initiate rooting in cardamom. However, earlier studies have indicated rooting in medium with auxins, when supplemented with carbohydrate source. Thus sucrose was essential for development of roots. Dark green colour of leaves were exhibited in treatments 3 and 9 whereas, a general yellowing and poor shoot growth was observed in treatments 1, 4, 5 and 7. The identification of favourable treatments from the above will depend on their hardening and establishment rate.

**Table 8. Media tried for root and shoot development in cardamom**

| Treatment | Media composition |
|---|---|
| 1 | ½ MS |
| 2 | ½ MS + 2% sucrose |
| 3 | ½ MS + 4% sucrose |
| 4 | ½ MS + 2% mannitol |
| 5 | ½ MS + 2% sorbitol |
| 6 | ½ MS + IBA (0.5 mg/l) |
| 7 | ½ MS + NAA (0.5 mg/l) |
| 8 | ½ MS + *activated charcoal* (0.2%) |
| 9 | MS + 2% sucrose. |

### *Hardening and planting out*

*In vitro* rooted plantlets were utilised for hardening. In cardamom, plants of height ranging from 4-5 cm with 3-4 well developed leaves and 3-4 roots was ideal for hardening. Among the different environmental conditions tried for hardening, temperature of 24-26 $^{0}$C and relative humidity of 50-60% and covering the plants with poly bags inside the chamber, was suited for initial hardening of cardamom

plantlets. The different potting mixtures (sand 100%, sand + coir dust 70%, sand + soil + cow dung 50%, vermiculate 50% and coir pith 40%) used showed different survival rate and growth. Among these potting mixtures sand was found to be the best medium for initial root development followed by sand and coir dust. Sand, used as planting mixture, was essential during the first 30-40 days and the morphological changes in the plants were recorded. About one hundred plants of cardamom were successfully hardened and has been transplanted in to field.

In ginger, large cardamom and turmeric, among the different size of plantlets tried (1.5 cm- 7.0 cm length), the optimum size required for better establishment during hardening was 4-5 cm with 3-5 leaves and with a minimum of two roots. Different potting mixtures were used and sand was found to be best suited for early root development. A humidity of 70-80% coupled with a temperature of 28-30°C resulted in 80% survival rates.

**Tree spices**

*In vitro multiplication*

Multiple shoots and roots could be induced from mature explants of two species of cinnamon viz., *Cinnamomum verum* and *C. camphora*, as well as curry leaf (*Murraya koenigii*)

*Culture medium and multiplication*

*Cinnamomum* spp.

Multiple shoots from nodal segments were induced in WPM supplemented with BAP (3.0 $mgl^{-1}$) and kinetin (1.0 $mgl^{-1}$) in cinnamon species. Shoots separated from multiplying cultures when transferred to rooting medium, *C.verum* shoots developed roots in medium supplemented with auxins (IBA 0.5 $mgl^{-1}$) whereas *C.camphora* shoots developed roots when transferred to growth regulator free medium supplemented with activated charcoal (2.0 $gl^{-1}$)

*Murraya koenigii.*

Nodal explants were taken from root suckers of mature 7 years old curry leaf plants. After routine surface sterilisation methods, they were transferred to Woody Plant Basal Medium supplemented with various combinations of growth regulators like (BAP) 1-4 mg/l, kinetin 1-4 mg/l and Indolebutric acid (IBA) 1-4 mg/L. The multiple shoots

developed were separated and transferred to culture medium of same composition for further multiplication and to medium containing naphthaleneacetic acid (NAA) 0.25-2 mg/l and IBA 1-4 mg/l for rooting

***Ex vitro* rooting**

*Ex vitro* rooting of shoots were tried with a dip in ceradix and 80% of the shoots produced well developed roots within three weeks. The shoots were given a pulse treatment in IBA 0.5 mg/l for 1 minute and planted in cups containing sand and was kept in the hardening facility with 80-70% humidity, 80% of the plants developed healthy roots. This technique can be used as an alternative to *in vitro* rooting, since it reduces the cost and time of production considerably.

*Hardening and planting out*

Shoots of 3-4cms (length) with 3-5 leaves and 2-4 roots were chosen for hardening (Stage 1). Shoots with well developed roots were transferred to pots after washing in running water to remove agar. About three hundred rooted plants were subjected to hardening under different potting substrate (sand, sand : coir dust, sand : cow dung, soil, coir dust) and different humidity (90-60) levels. Hardening was achieved in a hardening chamber with 70-80% relative humidity and a temperature of 28 ± 2 $^{0}$ C using sand as potting mixture. After 30 days of hardening (Stage II) the morphological observations were recorded.

**Herbal Spices**

***In vitro* multiplication and culture conditions**

Cultures of peppermint (*Mentha Piperata*), marjoram (*Marjorana hortensis*), thyme, (*Thymus vulgaris*) parsely (*Petro selinium crispum*) and Gernan basuk (*Ocimum basilicium*) were multiplied in MS medium with IBA and BAP, to generate adequate material for further experiments. About 100 plantlets of were multiplied and transferred for rooting under *in vitro* condition. Well developed in vitro rooted plantlets were utilised for hardening.

**Hardening and planting out**

A minimum shoot length of 5-6 cm with 4-5 leaves and 5-6 roots is essential at the transferring stage. A temperature maintained at 24-

26 °C and relative humidity of 50-60% helped in establishment of peppermint, marjoram and *Ocimum spp.* (Table 9). Tissue cultured plants *of Mentha piperata, O.basticum* were hardened and field planted with 80% survival rate.

## Vanilla

**Table 9 : Environmental conditions favourable for herbal spices**

| Crops | Temperature (°C) | Humidity (%) | Survival rate (%) | Potting *media* | Field *survival* |
|---|---|---|---|---|---|
| *Ocimum* | 24 - 26 | 50-60 | 80 | Sand | 80 |
| Thyme | 24 - 26 | 50-60 | 60 | Sand | 80 |
| *Mentha* | 24 - 26 | 50-60 | 80 | Sand | 90 |

### *In vitro multiplication and culture conditions*

Based on earlier work in the laboratory vanilla shoots were multiplied in MS medium containing BAP (1mgl $^{-1}$) and NAA (0.5mgl $^{-1}$) and shoots with well developed roots were transferred for hardening.

### *Hardening and planting out*

Plantlets with atleast two nodes planted in sand, are more suited for hardening and establishment. Normally orchids are planted in equal proportion of charcoal and brick pieces. For better survival of vanilla a temperature of 28-30 °C and relative humidity of 70-80% was found to be the best. After 25 days of hardening plantlets were transplanted to the field and with 90% survival.

### *Ex situ* conservation

### High elevation species of *Piper.*

The high elevation *Piper spp.* Viz. *P.silentvallyensis* (male and female), *P.peepuloides*, collected from Nepal, *P.wightii* (male and female) *P.schmidtii* (male and female) were also conserved in the hardening facility. Two nodal cuttings were planted in polybags containing the potting mixture sand : soil : cow dung (1: 1 : 1) and kept in the hardening chamber with a temperature of 24 ± 2 °C and 70-60% relative humidity. 80% of the cuttings established within one month.

*Herbal spices*

The temperate herbal spices like parsely, sage and chives were established in the hardening facility at 24 ± 2 °C with a relative humidity of 70-60%. *In vitro* cultures were established for further hardening studies

**Differentiation of tissues**

As the plantlets pass from the *in vitro* condition to nursery through the process of hardening, a lot of anatomical changes take place in the tissue. Factors like stomatal functioning have been implicated in the water imbalance exhibited by micropropagated plants on transfer to soil.

The lower epidermis was peeled off from the leaves for observing the stomatal structure, from both *in vitro* as well as field grown plants. Cross sections of *in vitro* derived leaves of black pepper showed poorly developed epicuticular wax epidermal cells, mesophylls and vascular bundles when compared to that of field grown plants where the tissues especially the mesophylls which are well developed and vascular tissues with functional phloem and xylem. It shows that the leaves are photosynthetically active and get hardened for field planting. Similarly, stem sections of *in vitro* leaves showed highly compact not well differentiated cortex vascular elements and pith. The vascular bundle shows primary structure and meristematic tissues but 15 days old hardened plants showed epidermis, cortex with intercellular spaces and fully developed bundles with functional xylem and phloem. The plants with roots which has connections with the main vasculature shows 80% survival and the sections taken at the region of root initiation zone, showed that the root primordia originated from the pericycle of the stem.

In zingiberacious crops the sections of *in vitro* leaves showed very thin walled cells with less chlorophyllous spongy tissues. Vascular bundles were poorly developed with very few phloem cells and xylem elements with very thin lignification. The vascular bundles were surrounded by thin bundle sheath.. The hardened leaves have a thin layer of epicuticular wax and the spongy tissues are more chlorophyllous than *in vitro* leaves. The T.S. of stem indicate that the roots originate endogenously and are in direct connection with the main vasculature.

**Biochemical changes**

To assess the biochemical changes associated with the process of hardening, analysis of various biochemical components like chlorophyll, reducing sugars, proteins and enzymes viz. peroxidase and catalase at various stages of plant growth starting from the *in vitro* stage to the nursery passing through the twenty days of hardening were studied. Ginger and cardamom were used for the study.

A gradual increase in chlorophyll content from *in vitro* to nursery was observed. The low concentration of chlorophyll in *in vitro* raised plants may be attributed to the immature stage of the plant and low PAR availability. With gradual maturity and exposure to external environment in the hardening facility and nursery a gradual increase in chlorophyll content was observed.

The sugar production in the leaves was less in the early stages and as the leaves developed production of sugars also increased. This is because of lesser photosynthetic activity of leaves in their initial stages of development . In fact, leaves act as a sink during this stage. Also some photosynthates would have been translocated to the roots for their development. In the hardening stage the roots were comparatively more and well developed and the translocation to the roots may have been reduced. As the photosynthetic capacity increased because of higher leaf area and also increased PAR availability which in turn must have resulted in the increased synthesis of sugars.

A high concentration of protein was obtained in *in vitro* plants and a gradual reduction was observed as the plants were hardened. In the initial stages the leaf acts as protein sink. Since the plant has not developed, the protein may not have been used for other metabolic activities or translocated to other plant parts. Hence, high concentration of protein was observed in the early stage of development. As the plant reaches the hardening stage, its growth gets boosted, the metabolic activity increases and some proteins would have been utilized in the process. Also, it is possible that some proteins would have been translocated to other plant parts resulting in lesser quantities in the leaf.

The activity of peroxidase and catalase were high in *in vitro* stage and as the plants were hardened their activity reduced. Peroxidase and catalase are detoxifying enzymes. Under *in vitro* conditions plants are

exposed to various kinds of stresses such as light, nutrients etc. and under such conditions more toxic compounds are produced. Hence, enzyme activity would have been high to detoxify such chemicals. As the plants were moved to the hardening facility the stress was gradually removed and hence activity of detoxifying enzymes also would have got reduced.

**Biological hardening**

*Black pepper*

Biological hardening of plants is necessary for increasing resistance against soil borne diseases. It further helps in the nutrient absorption and enhances the growth of the plant. The *in vitro* grown black pepper plantlets were treated with *trichoderma* at the time of hardening the plantlets and at the time of transferring them in to potting mixture. The growth of the plants was comparatively better than the untreated plantlets. These plants were then transferred to field with 90% success.

*Ginger*

In ginger an experiment with five strains of beneficial bacteria obtained from the rhizosphere was tested with ten replicates during the hardening process. Morphological observations showed no significant difference with that of control.

**Summary**

A hardening facility with automatic light, temperature and humidity control was established to develop protocols for hardening of different spices.

In vitro cultures of black pepper, long pepper, betel vine, *P. colubrinum, Elettaria cardamomum, Zingiber officinale, Curcuma longa, Amomum subulatum, Vanilla planifolia* and tree spices like *Cinnamomum verum, C.camphora, Murraya koenigii* were established for experiments on hardening.

Protocols for hardening of *Piper nigrum, P. betle, P. barberi, P. colubrinum*, ginger turmeric, cardamom and minor spices like ocimum, mentha, marjoram and thyme and tree spices namely curry leaf, camphora and cinnamon were standardised.

*Ex vitro* rooting studies were standardised in *in vitro* raised black

pepper and curry leaf. This can be used as an alternative to *in vitro* rooting there by reducing the cost of production and time before field planting considerably.

High evaluation and endangered species of *Piper spp*. like *P. silentvallyensis, P. schmidti* (male and female), *P. wightii* (male and female), *P. mullesua* (male and female), *P. galeatum* (male and female), *P. peepuloides* and herbal spices like parsely, chives, sage, *Ocimum spp,* which normally don't establish in the tropical climate were established *ex vitro* in one of the hardening chamber, which is maintained at 24 $^{0}$C.

Anatomical changes associated with the hardening of black pepper and cardamom / ginger were determined. The tissues were well developed in hardened tissues than in the *in vitro* plantlets.

Biological hardening of black pepper using *Trichoderma harzianum* was done during the process of hardening for protection against *Phythophthora* foot rot, a dreaded disease of black pepper. However, application of biocontrol agents did not show any significant difference with that of the control in ginger.

## ESTABLISHING *IN VITRO* CONSERVATORY OF SPICES GERMPLASM

**(K.V. Peter, PN Ravindran, K. Nirmal Babu, B Sasikumar, SP Geetha and K Rajalakshmi)**

1. Developing cryopreservation protocols

*Black Pepper* : Methods such as vitrification and encapsulation / dehydration were tried for developing cryopreservation protocols using encapsulated black pepper embryos. Embryos along with endosperm encapsulated in 3% sodium alginate, when cryoprotected in 15% DMSO, 10% sucrose and 10% glycerol for 30 minutes showed partial recovery and regrowth after freezing in Liquid $N_2$.

*Cardamom* : Apical and axillary buds of about 1mm – 2mm were precultured , vitrified and plunged into Liquid $N_2$. The shoot buds remained green and showed viability on post-thaw reculture.

Vanilla : Vanilla shoot buds (2-3mm) were encapsulated in 3% sodium alginate and dessicated in air flow for 1-4 hrs. The shoot buds dessicated for 1 hr showed viability and regrowth on par with control.

2. Establishment of new accessions.

Piper species such as *P. peepuloides*, a high elevation species, *P.cubeba*, a medicinally important species, CCS-1 released variety of cardamom and RR1 – rhizome rot tolerant variety were established *in vitro*. 3 new species of vanilla viz., *V. vatsalae, V. piliferae* and *V.andamanica*, and two important collections (Madagascar and Coimbatore) were established in the *in vitro* gene repository.

3. Maintenance of cultures under minimal growth

About 500 *in vitro* cultures under minimal growth storage and newly established accessions are being maintained.

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

**(PN Ravindran, K. Nirmal Babu, J Dominic)**

Based on the last years success in inducing somatic embryo like structures, from anthers, more number of inoculations of anthers were made in different basal media like, Brewbaker and Kwack's, B5, Keller's, MS, N6, Nitsch and Nitsch and SH with different growth regulators like 2, 4-D (0.0 – 10.0mg/l), IAA (0.0 – 10.0mg/l), IBA (0.0 - 3.0mg/l), NAA (0.0-3.0mg/l), BA (0.0-10.0mg/l) and Kinetin (0.0-10.0 mg/l) at different concentrations and combinations, to identify better medium combinations and ideal stage of anther for androgenesis.

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

(K.V. Peter, P.N. Ravindran, K. Nirmal Babu, B. Daniel and P. V. Liji)

*Multiplication of somaclones for screening against katte*

Plants regenerated from callus cultures of PV1 x Cl 37 were transferred to the nursery for screening against katte. About 1500 somaclones are ready for screening.

*Field evaluation of somaclones*

Somaclones planted in the field (400 nos. ) are in the 4$^{th}$ year of evaluation. They exhibited considerable variation in terms of morphological and yield characteristics.

*Protoplast isolation and culture*

Protoplast isolated from leaf mesophyll tissue did not develop further than the microcallus stage, even though different cultural combinations were tried. Embryogenic callus and suspension cultures were initiated for the isolation of protoplasts. These embryogenic cultures are being used for the isolation of protoplasts. Efforts are on to obtain protoplasts in sufficient numbers to get further proliferation and regeneration.

*Plant regeneration from callus cultures of NKE lines*

Callus was initiated from pseudostem section explants of two NKE lines in MS medium containing 2,4-D and BA in dark. The callus turned embryogenic when transferred to medium containing TDZ alone or in combination with BA. The embryos developed into plantlets on subculture to ½ strength MS basal medium.

## CROP PRODUCTION AND POST HARVEST TECHNOLOGY

AGR. XIV (813)

### INVESTIGATIONS ON SPICES BASED CROPPING SYSTEMS

**(V. S. Korikanthimath, Rajendra Hegde, K. Kandiannan, S. J. Anke Gowda and V. Srinivasan)**

**Aim and Scope**

*Investigations on spices based cropping systems aims* at studying the compatibility of spices, efficient utilization of natural resources and the economic analysis of promising spices crop combinations.

**Past achievements**

The field experiments on spices based cropping systems have been in progress from 1991 onwards. Various growth and yield pattern, ground coverage, physiological and micro climatical parameters, organic recycling and soil fertility buildup, microbial load etc have been studied. Amongst various tree spices, the combination of clove and cardamom continues to perform better.

**Progress report**

*Ground coverage and growth*

Amongst various crop combinations, cardamom + clove continued to record maximum ground coverage (9200.4 sq. m.), leaving only 799.6 sq. m. of the ground area uncovered. Least ground/canopy coverage was observed in combination of cardamom and coffee (6552.3 sq. m.). Cardamom continued to show better growth in terms of its height in combination with allspice, whereas its growth showed reduction in combination with pepper. Sole crop of cardamom continued to record maximum number of bearing tillers and total tillers. Among the mixed crop treatments, cardamom in combination with clove showed better tillering.

*Yield*

During this year also, cardamom grown in combination with clove recorded higher yield (817 kg/ha) compared to all other combinations. Lowest yield of cardamom was recorded when it was grown with coffee (285 kg/ha) and cinnamon (328 kg/ha). Sole crop of cardamom with its full plant population (3086/ha) recorded highest average yield (833 kg/

ha). All the component crops (except nutmeg) viz., coffee, pepper, clove and cinnamon have commenced yielding.

*Soil status*

The soils were acidic in reaction and pH ranged from 5.0 to 6.1. In general the surface soil had higher pH than the sub-surface layer. The soil was high in organic carbon content and it was more in component crop of coffee (3.3%) when mixed with cardamom followed by cardamom (3.0%) in mixed cropping of cardamom + coffee combination. Interestingly a lowest organic carbon of 1.3% was noticed in sole crop of coffee. The P was higher in nutmeg (22.6ppm) cultivated in combination with cardamom. The lowest P was observed in cardamom (3.2ppm) cultivated along with cinnamon. The highest content of K (498ppm) was noticed in clove cultivated with cardamom followed by allspice (366ppm), nutmeg (321), cinnamon (308) and coffee (233) while (105ppm) lowest was observed in cardamom grown with pepper.

The Ca and Mg contents in surface soil was more in cardamom sole crop than the coffee alone. However, highest content of Ca (1238ppm) was observed in coffee grown with cardamom followed by nutmeg (967ppm).

The highest iron content (26.8ppm) was observed in clove and allspice grown with combination of cardamom and lowest was with pepper (14.3ppm). Allspice, cinnamon and clove recorded higher content of Mn than the sole crop of cardamom. In general, Zn and Cu availability in soil did not influence by cardamom based cropping system. However, slightly higher availability of Zn was observed with clove (1.0ppm) and allspice (0.9ppm) than the sole crop of coffee. But in general, the copper content was high in mixed cropping system than the sole crop of cardamom.

*Leaf nutrient content*

Leaf N content (3.5%) and P content (0.21%) were highest incase of coffee mix cropped with cardamom. Cardamom plants in combination with pepper as well as mono (sole) crop recorded highest K (3.0%) content. Allspice leaves contained highest Ca of 3.4% whereas Mg was maximum in nutmeg leaves (0.42%). The Fe content was maximum (237ppm) in coffee mixed cropped with cardamom. The Mn was highest (805ppm) in cardamom mix cropped with coffee. The Zn content

was highest in nutmeg mix cropped with cardamom. It was interesting to note that Cu content was highest (119.9ppm) in case of pepper mix cropped with cardamom.

*Light distribution pattern*

Photosynthetically active radiation (PAR) was measured in open, below shade tree, above cardamom and below cardamom plants. Light available (PAR) in open condition ranged from 1296 to 1559.7μ mole $m^{-2}$ $sec^{-1}$. Light filtered through shade trees and available to component crops was in the range of 64.5 to 610.2 μ mole $m^{-2}$ $sec^{-1}$. Light received by cardamom in various cropping system ranged from 54.2 to 906.4μ mole $m^{-2}$ $sec^{-1}$ with a mean of 265.92 μ mole $m^{-2}$ $sec^{-1}$. Available light filtered through cardamom canopy and that reached near to ground ranged from 15.0 to 111.35 with a mean of 63.94 μ mole $m^{-2}$ $sec^{-1}$. Light intercepted by cardamom canopy ranged from 28 to 89.5 per cent. Approximate leaf area index of cardamom ranged from 0.65 to 2.08.

AGR XVI (813)

## IRRIGATION REQUIREMENT OF BLACK PEPPER MIXED CROPPING SYSTEM

**(C.K. Thankamani, K. Kandiannan and K. S. Krishnamurthy)**

The experiment is intended to find out irrigation requirement of *black pepper – clove mixed cropping system*. *Black pepper plants* have been planted with a spacing of 3m X 3m using *Ailanthus* as standard. On inter spaces, clove plants can be planted with a spacing of 6m x 6m.

AGR.XVII (813)

## VERMICOMPOSTING USING ORGANIC WASTES AVAILABLE IN CARDAMOM AREAS.

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

### Aim and Scope

Project was aimed at comparing the efficacy of vermicomposting of organic wastes v/s normal composting and determining the effect of vermicompost v/s normal compost on the growth and yield of cardamom.

**Past achievements**

The study indicated that earthworms *Endrillus enginea* is more efficient compared to local types. Mixture of various types of wastes is more ideal than any single type of waste. Vermi comsposting is costlier method of composting when compared to Bangalore method. Experiment on vermi compost v/s normal compost with and without fertilizers in cardamom is in progress.

**Progress report**

*Growth parameters*

The observations on number of tillers per plant, number of leaves per tiller and plant height recorded at 6 MAIT (6 months after initiation of treatment). There was no significant difference among the treatments in number of tillers per plant and plant height, however there was significant difference between the treatments in number of leaves per tiller. The more number of leaves per tiller (37.66) in treatments which receive vermi compost alone ($T_5$) and treatments receive 50% VC+50% NC+50% NPK ($T_{10}$), which were statistically different from $T_6$ (100% NPK + FYM), which recorded lowest number of leaves per tiller (33.22).

*Nutrient content in soils*

The application of organic and inorganic fertilizers significantly influence the nitrogen and phosphorus content in the soil. There was no significant difference among the treatments on the content of potassium in soil.

The application of organic and inorganic fertilizer increased the status of nitrogen and phosphorus as well as potassium content in soil. The highest content of 241.67 kg $ha^{-1}$ of nitrogen, 88.93 kg $ha^{-1}$ of phosphorus and 737.67 kg $ha^{-1}$ of potassium was observed in $T_8$ (100% NPK +VC), $T_6$ (100% NPK +FYM) and $T_6$ (100% NPK +FYM), respectively. The lowest amount of N (135.33 kg $ha^{-1}$), P(14.33 kg $ha^{-1}$) and K(165.00 kg $ha^{-1}$) was observed in $T_9$ (50% VC+50% NC), $T_1$ (control) and $T_5$ (vermi compost) respectively. Relatively higher build up of nutrients in soil was observed in combination RDF (recommended dose of fertilizer) plus organic fertilizers than using alone.

*Secondary and micro nutrients*

The content of secondary and micro nutrients in soil was not significantly influenced by application of organic and inorganic fertilizers except Mn content in soil.

The relatively highest content of $Ca^{2+}$ (585.33ppm), $Mg^{2+}$ (204.67ppm) and Fe (43.67ppm), Mn(43.00ppm), Zn(2.6ppm) and Cu (7.93ppm) were observed in $T_{11,}$ $T_{3,}$ $T_{9,}$ $T_6$ and $T_3$ respectively. The lowest content of Zn (1.67ppm) and Fe (27.67ppm) were observed in control while that of Ca $^{2+}$ (404.33ppm) and $Mg^{2+}$ (111.0) in $T_{10}$, Mn (14.33) in $T_5$ and Cu (4.50ppm) in $T_8$. (Table 10)

Microbial population such as bacteria, fungi, actinomycetes and beijerinckia was studied in different treatments (Table 11). They recorded wide variation among the treatments. Bacterial population was ranged from 140.19 x $10^5$ to 27.99 x $10^5$ with a mean of 195.63 x $10^5$. Fungi population ranged from 58.41 x $10^4$ to 135.7 x $10^4$ with a mean of 80.21 x $10^4$. Actinomycetes ranged from 28.46 x $10^3$ to 76.26 x $10^3$

**Table 10. Micro nutrient content in soils as influenced by different treatments (6 MAIT)**

| Tr. No. | Treatment | $Ca^{2+}$ (ppm) | $Mg^{2+}$ (ppm) | Fe (pm) | Mn (ppm) | Zn (ppm) | Cu |
|---|---|---|---|---|---|---|---|
| 1 | Control | 512.00 | 121.00 | 27.67 | 17.00 | 1.67 | 5.03 |
| 2 | 100% NPK | 460.00 | 121.00 | 42.67 | 29 00 | 2.10 | 7.13 |
| 3 | FYM | 498.67 | 204.67 | 43.67 | 23.67 | 2.17 | 7.93 |
| 4 | Neem cake | 553.67 | 199.00 | 38.33 | 23.00 | 2.10 | 6.33 |
| 5 | Vermicompost | 449.00 | 112.00 | 32.67 | 24.33 | 2.07 | 6.43 |
| 6 | 100%NPK+FYM | 425.00 | 136.33 | 38.03 | 22.00 | 2.60 | 5.37 |
| 7 | 100%NPK+NC | 427.67 | 129.67 | 09.33 | 30.67 | 2.23 | 5.50 |
| 8 | 100%NPK+VC | 437.67 | 120.33 | 31.33 | 15.67 | 2.20 | 4.50 |
| 9 | 50%VC+50%NC | 542.67 | 542.67 | 138.33 | 43.00 | 2.10 | 4.57 |
| 10 | 50%VC+50%NC+ 50%NPK | 404.33 | 111.00 | 32.00 | 21.17 | 2.43 | 5.47 |
| 11 | 50%FYM+50%VC | 585.33 | 189.33 | 40.00 | 21.33 | 2.57 | 6.80 |
| 12 | 50%FYM+50%VC+50%NPK | 418.33 | 158.67 | 35.67 | 24.67 | 2.17 | 6.23 |
| CD at 5% | | NS | NS | NS | 24.631 | NS | NS |

with a mean of 43.78 x $10^3$. Beijerinckia population ranged from 15.33 to 71.64 with a mean of 37.7.

Light availability (PAR) in different treatments were studied. Light availability in Coorg condition is 1520.78 micro mole/$m^2$/sec. Almost 70.69% of light was intercepted by the shade trees. On an average leaf area index of shade tree is 1.4 (approximate). Cardamom crop receives light (PAR) on an average 335.36 micro mole/ $m^2$/sec and intercepted 62.91%.

**Table 11. Microbial population in the soil after 1 year of planting**

| Tr. No | Treatment | Bacteria x $10^5$ | Fungi x $10^4$ | Actinomyctes x $10^3$ | Beijerinckia x $10^2$ |
|---|---|---|---|---|---|
| 1 | Control | 186.88 | 97.55 | 45.84 | 43.45 |
| 2 | 100% NPK | 209.55 | 72.18 | 36.09 | 36.09 |
| 3 | FYM | 195.92 | 66.87 | 43.01 | 35.20 |
| 4 | Neem cake | 183.45 | 86.47 | 42.07 | 18.70 |
| 5 | Vermicompost | 150.94 | 62.50 | 57.78 | 15.33 |
| 6 | 100% NPK+FYM | 274.93 | 83.19 | 76.26 | 71.64 |
| 7 | 100%NPK+Neem cake | 209.13 | 93.87 | 35.65 | 57.03 |
| 8 | 100%NPK+VC | 140.19 | 58.41 | 40.89 | 58.41 |
| 9 | 50%VC+50%NC | 153.85 | 69.82 | 36.69 | 50.89 |
| 10 | 50%VC+50%NC+50%NPK | 211.75 | 135.70 | 31.59 | 19.89 |
| 11 | 50%FYM +50%NC | 219.23 | 68.44 | 51.04 | 20.87 |
| 12 | 50%FYM+50%NC+50%NPK | 211.79 | 67.59 | 28.46 | 24.90 |
| Mean | | 195.63 | 80.21 | 43.78 | 37.70 |

AGR. XIX (813)

## MANAGEMENT EFFICACY OF WHOLE FARM APPROACH IN FARMING – A STUDY ON CARDAMOM BASED CROPPING SYSTEMS.

**(V.S. Korikanthimath and S.J. Ankegowda)**

### Aim and Scope

It aims at evolving and demonstrating an efficient farming system for the region, for small and marginal farmers, and study the economics of efficient farming system by comparing with existing system.

**Progress report**

Various systems included in the study are-

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

Co – 1 grass was used for Bangalore method of composting. Five hundred pepper rooted cuttings were raised for planting in the main field. Arecanut has establishment is well. Two hundred *Garcinia gummigutta* grafts were procured. Light interception studies using Accupar Ceptometer was done. Vanilla plants started producing flower. Fruit set was observed due to hand pollination.

AGR. XX (813)

## PRODUCTION OF NUCLEUS PLANTING MATERIALS OF IMPROVED VARIETIES OF SPICE CROPS.

**(C. K. Thankamani, V. S. Korikanthimath, P. A. Mathew and P. Rajeev)**

**Aim and Scope**

Central Sector Scheme on Integrated Programme for Development of Spices was implemented at IISR, Peruvannamuzhi farm with the objectives of supplying nucleus planting materials of improved varieties of spices to the various developmental agencies through out the country. The scheme was implemented from August 1991 onwards.

**Progress report**

Black pepper rooted cuttings (93,000), Black pepper rooted laterals (500), Turmeric seed rhizomes (6 tons), Ginger seed rhizomes (1.5 tons), Cinnamon seedlings (2,000 Nos), Clove seedlings (2,000 Nos), Nutmeg grafts (3,100 Nos), Vanilla cuttings (8,000 Nos), Cardamom seedlings (14,000 Nos) and Cardamom seed capsule (100 Kg) were produced and distributed.

SSC II (813)

## NUTRITIONAL REQUIREMENT OF IMPROVED VARIETIES OF SPICES

**(V. Srinivasan, K. S. Krishnamurthy and K. Kandiannan)**

### Aim and Scope

To find out the nutritional requirement (Major, secondary, micro nutrients and organic) of improved varieties of black pepper, ginger and turmeric for yield and quality.

### Past achievements:

Optimum dosage of NPK @ 140,55,270 kg/ha is standardized for black pepper in laterite soils of Calicut region.

Lime @ half the requirement of soil in alternative years increased the yield of spices by 25%.

Under organic farming, application of 10 kg each of FYM and leaf mulch together with 0.5 kg groundnut cake, 2.2 kg neem cake, 200 g rock phosphate and 2 kg wood ash with 20 g bio fertilizer per vine per year is best for sustainable production of black pepper.

For bush pepper in pots organic application as 30g neem cake or 15 g groundnut cake or 50g vermi compost together with bimonthly NPK application @ 1,0.5,2 g is found to be optimum.

Planting bush pepper in field at a spacing of 2 x 2m and manuring 5 Kg FYM with NPK @ 10, 5, 20g per plant in January, May and September is highly remunerative.

Diagnosis Recommendation Integrating System (DRIS) norms standardized for soil and leaf nutrient concentration in black pepper.

For released turmeric varieties 20 ton of FYM with NPK @ 60, 50, 120 kg/ha and 15 tons of leaf mulch in two split is standardized as optimum.

For ginger 20 tons of FYM with NPK @ 75, 50, 50 kg/ha and with 15 tons of leaf mulch is optimum. Under organic farming NPK can be replaced by 350 kg groundnut and 1700 kg neem cake, 250 kg rock phosphate and 1 ton of wood ash.

**Progress report**

*i) Nutritional requirement of improved varieties of black pepper*

Response of black pepper varieties *viz.*, Sreekara and Subhakara to the application of NPK and micro nutrients under living and non-living standards was studied. Soil and leaf analysis showed increased availability and uptake of applied nutrients with increasing levels. Highest yield (1.591 kg/vine) was recorded with the application of NPK @ 150, 60, 270 together with Zn, B, Mo @ 5, 2, 1 kg/ha. Non-living standard gave comparatively higher yield (1.25 kg) than living standard (1.06 kg/vine).

*ii) Effect of micro nutrients on yield and quality of ginger and turmeric.*

Effect of micro nutrients Zn, B and Mo applied individually and in combination on ginger and turmeric was studied. Soil analysis showed increased availability of Zn, B and Mo with application. In turmeric, application of Zn + B @ 5.2 kg/ha recorded the highest yield (12.5 kg/3m$^2$) which was 25% increase over control. In ginger, B application @ 2kg/ha recorded the highest yield (10 kg/3m$^2$) followed by Zn, B, Mo @ 5, 2, 1 kg/ha. The quality of ginger and turmeric also increased due to micro nutrient application.

*iii) Effect of organic residue on yield and quality of ginge and turmeric*

Ginger and turmeric were grown in pots with different organic residues, chilli spent waste, turmeric spent waste, mustard compost, cake and powder and FYM. In ginger, turmeric spent waste application @ 200g/pot recorded the highest yield (427 g/pot) whereas in turmeric FYM @ 1kg/pot recorded the yield of 1,100g/pot, which was on par with chilli spend waste application @ 250 g/pot (1083 g/ pot).

PHY V(813)

**CHARACTERIZATION OF DROUGHT TOLERANCE IN BLACK PEPPER**

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

**Aim and Scope**

Since black pepper is mainly grown as a rain fed crop, it suffers from acute water shortage during summer months. In this context,

identification of drought tolerant varieties assumes great importance. The main aim of the project is to screen black pepper germplasm for drought tolerance and identify a few tolerant lines so that these lines can be used for further crop improvement. So far, over 250 black pepper germplasm accessions have been screened and screening a few of these accessions under field conditions is being taken up.

**Progress report**

Sixty four black pepper germplasm accessions were screened for drought tolerance in sets of 25, 20 and 19 accessions. The parameters used for screening were relative water content and cell membrane damage.

Among them, 4216 in the first set (consisting of 25 accessions), 1266 in the second set (consisting of 20 accessions), and 1251 in the third set (consisting of 19 accessions) showed relative tolerance.

Further, the ten released varieties of black pepper were screened for drought tolerance in pots under open conditions. Parameters such as leaf water potential, relative water content, membrane leakage, catalase and peroxidase enzyme activities etc., were assayed.

There was a drastic reduction in the leaf water potential in all the ten varieties due to water stress. The reduction was more pronounced in Pournami, Panniyur-5 and P24 while Panchami maintained higher leaf water potential than the rest.

Leaf water potential ranged from 8.5 to 16 (-bars) at four days after stress inoculation (DASI) and it ranged from 14.0 to 26 (-bars) at 8 DASI.

Cv Panchami also maintained higher relative water content and lesser membrane damage compared to other cultivars. Catalase activity generally increased in all varieties under stress while peroxidase did not show any trend. In general, among the varieties, Panchami was better in terms of coping with stress though none of the varieties showed tolerance to water stress.

Enzyme activities, RWC and membrane leakage in black pepper varieties as affected by water stress are presented in Table 12.

Apart from these, quantification of individual amino acids (accumulation/disappearence in relatively tolerant varieties which can be used as a marker for identifying the tolerant varieties was done). Though

such trend was not observed, it was found that the tolerant accession (Acc.4216) had very high levels of all the amino acids (greater than 50% increase over control) under stress condition compared to the other accessions.

**Table 12. Variation in enzyme activities, membrane leakage and relative water content(RWC) due to stress**

| Variety | Cat (%↑) | PRX (%↑/↓) | Memb. leak (%) | RWC (%) |
|---|---|---|---|---|
| P-24 | 69 | 2 ↑ | 21.3 | 50.4 |
| Panchami | 83 | 27 ↓ | 18.2 | 56.5 |
| Pournami | 16 | 0 | 23.5 | 48.5 |
| Sreekara | 150 | 34↑ | 20.4 | 49.7 |
| Subhakara | 185 | 40 ↓ | 22.6 | 46.4 |
| Panniyur – 1 | 48 | 51 ↓ | 23.8 | 48.7 |
| Panniyur – 2 | 0 | 32 ↑ | 24.5 | 49.8 |
| Panniyur – 3 | 12 | 38 ↓ | 22.7 | 51.8 |
| Panniyur – 4 | 18 | 50 ↓ | 21.8 | 53.4 |
| Panniyur – 5 | 190 | 70 ↑ | 25.3 | 44.7 |

PHY VI (813)

## CHARACTERIZATION OF DROUGHT TOLERANCE IN CARDAMOM

**(S.J. Ankegowda, K. S. Krishnamurthy and K. Padmini)**

### Aim and Scope:

The broad aim of this study is characterization of drought tolerance in cardamom in selected cultivars.

The majority of land area under cardamom is rainfed. Cardamom experience drought situation from December to May. The screening of germplasm based on identified parameters of drought tolerance will help in development of drought tolerant lines suited for rainfed cultivation.

### Past achievements

Studies conducted earlier revealed that plant height, number of tillers; dry weight of leaves, stem and root were reduced under stress treatment. Number of dried leaves increased under stress, which clearly

indicated the leaves are the ones which are affected first under stress. Relative water content decreased and membrane leakage increased under stress treatment. Mysore types are susceptible to moisture stress compared to Malabar and Vazhuka.

**Progress report**

Six accessions namely NKE-12, NKE-9, RR-1, RR-2, 893 and LR-1 were planted in cement pots under rainout shelter and grown for one year. Moisture stress was imposed by withholding irrigation and data on morphology, physiology and biochemistry related to drought tolerance were recorded at initiation of stress. Thirty-five accessions were screened for relative water content, specific leaf weight and stomatal counts. They recorded significant variation. Relative water content (per cent over control) ranged from 11.56 to 25.43% with a mean of 21.6%. Specific leaf weight ranged from 4.06 to 5.71 with a mean of 4.56 mg/cm$^2$. Number of stomata per microscopic field ranged from 8.25 to 16.75 with a mean of 11.57. Ten accessions were collected from farmer's field for further multiplication and evaluation.

BIOCHEM.I (813)

## BIOGENESIS OF PIGMENTS IN SPICE CROPS

**(B. Chempakam and T. John Zachariah)**

**Aim and Scope**

Studies on the biosynthesis of curcumin in turmeric was initiated in 1996. The major objectives of the project were to assay, localise and characterize the key enzymes involved in the biosynthetic pathway, to identify the precursors and intermediates during biosynthesis using tracer studies. The levels of curcumin and other secondary metabolites (oleoresin and essential oil) were seen during rhizome development. These constituents were maximum at 150 DAP (Days After Planting).

**Progress report**

Variation in the starch content and percentage of dry recovery was seen in 5 varieties of turmeric viz. Prabha, Prathibha, Alleppey, Suguna and Sudarsana. Higher starch content was seen in Prabha and Prathibha at maturity (59.4 and 56.1% respectively),while Suguna and Sudarsana contained only 51.7 and 50.2% respectively. In Prabha, Pratibha and Alleppey, higher dry recovery was seen at maturity, while very little variation was observed during the early stages of rhizome growth.

PHT.I(813)

## QUALITY EVALUATION IN SPICES

**(T. John Zachariah, P. Heartwin Amaladhas and B. Chempakam)**

### Aim and Scope

To characterise various spices for its chemical quality constituents and monitor the changes during maturity and at different locations.

### Past achievements

Essential oil, oleoresin and piperine levels of 69 popular cultivars and many cultivated accessions of black pepper has already been carried out. Two high quality lines released based on the study are Sreekara and Subhakara. Traditional cultivars with high quality are Kottanadan, Kumbhakodi, Aimpirian, Balankotta and Jeerakamundi. About 50 accessions have been evaluated for essential oil constituents like caryophyllene, myrcene, limonene etc and the best lines were identified. Panniyur-1, Valiakaniakkadan and Balankotta were identified as the cultivars ideal to prepare white pepper. Synthesis of oil, oleoresin and piperine reach its maximum at 180-200 days after flowering.

Ginger lines with high oil, oleoresin and gingerol were identified. Cultivar Varada is identified as the line with a fibre content of only 2.9% and many such lines with low fibre content were identified.

Many turmeric lines with high curcumin content were identified. Prabha, and Prathiba the newly released turmeric lines possess more that 6.5% curcumin. It was found that planting turmeric in April/May and harvesting in November give more curcumin recovery compared to full maturity. Curcumin remain unaffected if the rhizomes are stored properly even up to four months after harvest.

### Progress report

*Refining methods to prepare white pepper*

Ripe berries were treated with 2% pectinase and cellulase provided by CTCRI, Thiruvananthapuram and kept for retting for 3 days. The colour of white pepper is not as attractive as the traditional product by retting for 7-8 days.

*Storage changes in black pepper*

Black pepper variety Karimunda is kept for long term storage in

gunny bag, polyethylene bag, gunny bag lined with polyethylene and thick polyethylene bag. Two years of storage did not affect the chemical quality in all the containers. Essential oil content is around 3%, oleoresin 8% and piperine 2.8%.

*Quality evaluation of ginger*

Bold rhizome samples of 20 ginger lines planted at Kumarakam were evaluated for crude fibre, essential oil and oleoresin. Fibre content varied from 2- 5.3%. (Acc.244, 116, 27, 415, 179 and Varada had below 3% fibre.) Essential oil content varied from 1- 3.0 % and oleoresin 3.2 to 6.1%.

Among the 13 ginger accessions, Acc.511 had 8.9% oleoresin and 199, 288 and 302 had less than 3% fibre.

Among the ginger accessions evaluated for cataloguing, Acc. 411 and 420 had 2.7% oil and 213, 114, 385, 167, 50, 269 and 386 had about 3% crude fibre.

Quality of ginger accessions planted under shade net were evaluated. Levels of oil, oleoresin and fibre did not show any variation with and without shade net.

*Quality evaluation in turmeric*

Turmeric samples which include released varieties planted at Sangli (Maharashtra) were evaluated for curcumin (Table 13).

There was a reduction of about 40% in curcumin content at Sangli compared to Kerala.

**Table 13. Curcumin content of selected turmeric accessions at Peruvannamuzhi**

| Accession | % curcumin |
|---|---|
| 584 | 7.0 |
| 295 | 6.3 |
| 361 (Prathiba) | 7.1 |
| 657 | 7.5 |
| 360 (Prabha) | 6.7 |
| 656 | 5.9 |
| 585 | 6.7 |
| 165 | 7.1 |
| 121 | 6.5 |
| 593 | 7.7 |

*Colour value from paprika collections*

One hundred and seventy three collections were evaluated for ASTA colour value. Accessions with high colour value are listed below.

Accessions Y-2, Y-4, K-16, K-10, K-11, K-12, K-4, K-17, Y-3, K-2, Dabba and Dabba Deluxe had more than 300 ASTA units colour value.

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)**

### *Aim and scope*

To screen some botanicals for nematicidal and antifungal activities against the root-knot nematode *Meloidogyne incognita* and *Phytophthora capsici respectively* and to characterise the active principle if any.

### Past achievements

Aqueous leaf extracts of *Piper colubrinum*, *Chromolaena odorata*, *Azadirachta indica*, *Lantana camara*, *Strychnos nuxvomica* and the essential oil of allspice leaves were bioassayed *in vitro* for their nematicidal and antifungal activities. Aqueous leaf extract of *C. odorata* at 2% concentration completely inhibited growth, sporulation, zoospore release and zoospore germination of *P. capsici* whereas that of *P. colubrinum* and *A.indica* exhibited significant inhibition of growth and sporulation only. Among the above extracts tested, significant nematicidal activity was observed with allspice leaf oil, leaf extracts of *S. nuxvomica* and *P. colubrinum*. The nematicidal principle in allspice leaf oil was identified as eugenol.

Since the aqueous leaf extract of *P.colubrinum* showed both antifungal and nematicidal activities, it was further studied to isolate the active principle.

**Progress report**

Bioassay guided fractionation of the aqueous leaf extract of *P. colubrinum* led to the identification of the nematicidal principles Genkwanin and 7-methyl ether of luteolin.

PHT. II. (813)

## HARVESTING AND PROCESSING TECHNIQUES IN SPICES

**(P. Heartwin Amala Dhas, T. John Zachariah and A. Kumar)**

### Aim and Scope

1. To survey the indigenous technologies followed in drying and processing of various spices
2. To compare the quality aspects of spices processed by traditional method with the improved mechanical methods
3. To study the drying characteristics of nutmeg and optimise the drying parameters
4. To study the death time characteristics of wilt causing bacteria in ginger and development of heat treatment unit
5. To develop a thresher for black pepper suited to small and marginal farmers
6. To develop a cleaning and grading system for black pepper.

**Progress report**

Energy expenditure on cultivation and harvesting of ginger and turmeric in the Peruvannamuzhi farm was observed. It is done to identify the operation that consumes maximum energy and to study the scope of introducing tool level mechanization in those operation. It was found that 35% of the total energy is spent on initial clearing, digging and bed preparation of the soil. Men carryout 55% of the work in terms of energy expenditure while the women folk contribute 45%. Labour requirement in cultivation of ginger and turmeric are given in Table 14.

**Table 14. Per acre labour requirement in cultivation of ginger and turmeric**

| S. No. | Operation | Labour requirement | Type of labour employed | Energy Requirement MJ |
|---|---|---|---|---|
| 1 | Digging | 38 | Men | 484.12 |
| 2 | Peg marking and bed preparation | 72 | Men | 917.28 |
| 3 | Cow dung application | 1 + 4 | Men/women | 53.56 |
| 4 | Pit making | 20 | Women | 204.10 |
| 5 | Fertilizer application | 5 | Women | 51.03 |
| 6 | Seeding | 4 | Women | 40.82 |
| 7 | Covering | 4 | Women | 40.82 |
| 8 | Mulching | 15 | Women | 153.08 |
| 9 | Stick removal and weeding | 30 | Women | 306.15 |
| 10 | Fertilizer application and raking | 10 | Women | 102.05 |
| 11 | Mulching | 22 | Women | 224.50 |
| 12 | Earthing up | 19 | Men | 242.06 |
| 13 | Steps 9 to 12 repeated | 19 + 62 | Men/women | 874.46 |
| 14 | Harvesting | 27 | Men | 343.98 |
| | | Total | | 4038.01 |

Digging and bed preparation – 34.7%

Men - 55.5%

Women - 44.5%

## ADHOC PROJECTS

### INVESTIGATIONS ON CARDAMOM BASED CROPPING SYSTEMS

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

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

1. Cardamom + Robusta coffee + Black pepper
2. Cardamom + Arabica cofee + Black pepper

3. Cardamom + Arecanut
4. Cardamom + Coconut
5. Cardamom + Tree spices + Black pepper

Agroforestry approaches in cultivation of cardamom and black pepper by afforestation of vacant/open slopy marginal areas was taken in 3 locations in Kodagu district of Karnataka. The results of these trials conducted in the farmers plantations are being compiled and the same is used for economic analysis. The photosynthetically active radiation (PAR) and the microclimate are also being studied. The soil and leaf samples in various cardamom based cropping systems have been collected and analyzed for nutrient content to work out the organic recycling of the farm wastes. The microbial load in the rhizosphere of various crop combinations are being analyzed. 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 Chikmagalur district in Karnataka. It has given an encouraging yield of vanilla as well as coconut. The data collected on various input costs is being analyzed for studying the economic viability of the system.

## EFFECT OF ORGANIC FERTILIZER ON SOIL QUALITY, PRODUCTIVITY AND QUALITY OF BLACK PEPPER AND CARDAMOM

**(V. Srinivasan, M.R. Rubina)**

This experiment was carried out for standardizing the organic farming techniques to produce optimum yield and quality in black pepper and cardamom.

Field experiment was laid out in Coorg district of Karnataka, on pepper and cardamom. Main plot treatments are with and without pesticides and sub-plot treatments are check, FYM, neem cake, leaf compost, vermi compost and NPK @ 100:40:140 kg/ha. A greenhouse experiment with the same treatments is also in progress at IISR experimental farm, Peruvannamuzhi.

Investigation showed an increase in the soil availability of organic carbon, phosphorus, calcium, magnesium and micro nutrients due to organics application. The macro nutrient availability was high in leaf compost treatment followed by vermi compost treatment. Yield and N, P, K uptake was highest in FYM treatment followed by vermi compost for bush pepper.

The humic and fulvic acid fractions of the organic matter of pepper and cardamom soils have been separated and quantified.

The population of phosphate solublizing bacteria was highest in vermicompost treatment for both black pepper and cardamom soils. Nitrogen fixing bacterial count was highest in vermi compost treatment in black pepper and FYM treatment in cardamom soils.

For cardamom highest yield of 1.1 Kg/clump was recorded for neem cake and was on par with vermi compost treatment. Due to bad climatological factors in Madikeri area where field experiment is laid out, poor yield was obtained for pepper. With regard to quality, leaf compost treatment recorded highest percentage of piperine and oleo-resin in bush black pepper. Quality analysis of cardamom showed that, 1-8 cineole content was highest in FYM treatment where as alpha terpinyl actetate was highest in leaf compost treatment.

**CONTRACT RESEARCH PROJECT**

## STUDIES ON EVALUATION OF TERRA CARE FOR GROWTH, NUTRITIONAL AVAILABILITY, YIELD RESPONSE AND QUALITY OF SPICES

**(V. Srinivasan, M.R. Rubina, Kavitha Ramachandran)**

The experiment is conducted for the third consecutive year to find out the effect of soil conditioner (terra care) on growth, yield and quality of black pepper, ginger and turmeric. Field experiment on black pepper at Coorg district of Karnataka and that of ginger and turmeric at IISR farm, Peruvannamuzhi are taken up. Treatment consists of two levels of terra care in combination with N, P, K, FYM and biofertilizer.

Terra care (TC) can be used as a good substitute for soil or sand in nursery mixture for production of rooted black pepper cuttings.

Application of double dose of TC + ½ NPK + Biofertilizer, FYM + single dose of TC + ½ NPK + Biofertilizer and FYM + TC + full NPK were found to be superior with regard to yield and quality of bush pepper.

In black pepper, TC (2.5 t/ha) + FYM + ½ NPK + Biofertilizer recorded highest yield (4.03 kg/vine). In ginger highest yield (9.33 kg/ $3m^2$ bed) was recorded in FYM + TC (1.25 t/ha) + Biofertilizer treatment

and was on par with that of TC (2.5 t/ha) + recommended NPK fertilizer. In turmeric, FYM + TC at 2.5 t/ha + NPK fertilizer recorded highest yield (11.47 kg/3m$^2$ bed).

Highest phosphate solublizing bacterial population was recorded for the treatment where terra care alone was applied at a rate of 1.25 tons/ha.

Nitrogen fixing bacterial population(*Beijerinchia and Azotobactor*) was highest for the combination of Terra Care + ½ NPK + Biofertilizer.

## CROP PROTECTION

PATH. II.3 (813)

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

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

### Aim and Scope

The disease management programmes which were confined earlier only to chemical control have been strategically altered to incorporate cultural, chemical and biocontrol methods coupled with host resistance/tolerance in order to develop IDM strategy. The leads obtained in earlier trial like efficacy of potassium phosphonate, biocontrol etc. are incorporated and varietal mixture has been taken up to avoid the vulnerability of monoculture to infection.

### Progress report

*a. Studies with potassium phosphonate:*

Initial study with potassium phosphonate (3ml/l) showed that inhibitory effect on root rot caused by *P.capsici* declined considerably

**Table 15 : Effect of potassium phosphonate on *P.capsici* in black pepper**

| Treatment number | Conc.ml/l | Healthy Plants% | | |
|---|---|---|---|---|
| | | *10 days | 20 days | 30 days |
| 1 | 3 | 53.3(46.9)C | 39.3(38.8)D | 32.9(35.0)C |
| 2 | 4 | 53.3(46.9)C | 46.7(43.1)D | 40.1(39.2)C |
| 3 | 5 | 67.0(54.9)C | 54.0(47.3)CD | 46.7(43.1)BC |
| 4 | 6 | 90.7(72.3)B | 79.9(63.4)BC | 73.7(59.2)AB |
| 5 | 7 | 100(90.0)A | 97.6(81.1)AB | 86.0(68.0)A |
| 6 | 8 | 100(90.0)A | 97.6(81.1)AB | 79.9(63.4)A |
| 7 | 9 | 100(90.0)A | 100(90.0)A | 90.7(72.3)A |
| 8 | 10 | 100(90.0)A | 100(90.0)A | 90.7(72.3)A |
| 9 | Control | 19.9(26.6)D | 26.2(30.8)D | 19.9(26.6)C |
| | | LSD-11.10 | LSD-17.25 | LSD 18.36 |

Figures followed by same letters within a column are not significant in DMRT (Duncan's Multiple Range Test)

Values in parentheses are transformed values.

8 days after application. An experiment was conducted to find out the effect of higher concentration on disease suppression and persistence. The higher concentrations (7ml/1-10ml/1) showed significantly effective protection even after 30 days and none of the concentrations showed phyto-toxic effect(Table 15).

b. Effect of vermi compost on root rot caused by P.capsici.

The treatment consisted of:

1) Vermi compost 100% 2) Vermi compost 50% 3) Vermicompost 25%

4) *T. harzianum* (P-26) 5) *T. harzianum*+Vermicompost 6)Ridomil

7) Control.

**Table 16. Effect of vermicompost on root rot caused by *P.capsici.***

| Treatment number | Treatment | Survival(%) | Root rot index |
|---|---|---|---|
| 1 | Vermi compost 100% | 54.0(47.3)A | 2.7 |
| 2 | Vermi compost 50% | 49.3(44.6)A | 3.2 |
| 3 | Vermi compost 25% | 74.3(59.6)A | 2.5 |
| 4 | P-26, | 72.2(58.2)A | 2.4 |
| 5 | P-26, Vermi compost | 40.9(39.7)A | 3.0 |
| 6 | Ridomil | 62.6(52.3)A | 2.6 |
| 7 | Control | 35.7(36.7)A | 3.5 |

Figures followed by same letters within a column are not significant in DMRT (Duncan's Multiple Range Test)
Values in parentheses are transformed values.

Root rot index: 0-Healthy, 1-Upto 25% rotting, 2-Upto 50% rotting, 3-Upto 75% rotting, 4-Above 75% rotting.

The root rot index was minimum (2.4) in *T. harzianum* and vermicompost (25%) (2.5) and maximum (3.5) in control (Table 16).

c. *Rejuvenation of black pepper in diseased garden:*

This field trial consists of 32 treatments (it includes effects of weeds, banana, susceptible and tolerant lines, organic and inorganic nutrition, chemical and biological control), growth parameters such as height (75.7-133.6 cm),number of leaves

(9.6-18.1) girth(5.9mm-10.0mm) and mortality (0-3.6/6 plants) were recorded. Significant differences were not noticed among the 32 treatments. In general, the growth of the vines was prominent in clean cultivation plots. In plots without weed control, 61 out of 288 plants succumbed to infection compared to 20/288 in plots with clean cultivation(Table 17).

d. *Efficacy of biocontrol agents and their compatibility with potassium phosphonate*. The results clearly showed the efficiency of BCA's and their compatibility with potassium phosphonate.

**Table 17. Effect of BCA, Potassium phosphonate and their combination on *P.capsici*.**

| | Treatment | Healthy (%) |
|---|---|---|
| 1 | Pseudomonas fluorescens | 77.7 (61.8) ABC |
| 2 | Treatment 1 + Potassium phosphonate | 77.7 (61.8) ABC |
| 3 | *T.harzianum* | 65.9 (54.3) BCD |
| 4 | Treatment 3 + Potassium phosphonate | 82.9 (65.6) AB |
| 5 | *T.virens* | 65.9 (54.3) BCD |
| 6 | Treatment 5+ Potassium phosphonate | 82.9 (65.6) AB |
| 7 | Verticillium chlamydosporium | 77.7 (61.8) ABC |
| 8 | Treatment 7 + Potassium phosphonate | 38.5 (38.4) EF |
| 9 | *V.tenerum* | 38.5 (38.4) EF |
| 10 | Treatment 9 + Potassium phosphonate | 91.7 (73.7) A |
| 11 | Treatment 1 + 3 and 5 | 42.9 (40.9) EF |
| 12 | Treat 2 + Potassium phosphonate | 44.2 (41.6) DE |
| 13 | CoC | 72.0 (58.0) BC |
| 14 | Potassium phosphonate | 55.3 (48.1) CDE |
| 15 | Control | 21.1 (27.3) F |
| | LSD – | 12.10 |

Figures followed by same letters within a column are not significant in DMRT

Values in parentheses are transformed values.

PATH.X(813)

## INVESTIGATION ON VEIN CLEARING VIRUS OF SMALL CARDAMOM

**(M.N.Venugopal)**

### Aim and Scope

1. Identification of hot spots and yield losses caused by disease
2. Transmission of disease and study of virus vector relationship
3. Epidemiology of disease and identification of virus sources
4. Identification of resistant sources
5. Characterization of virus
6. Optimization of disease management measures

Cardamom cultivation is threatened by the incidence of vein clearing disease (kokke kandu) in many endemic pockets particularly in Karnataka. The information gathered from various facets of disease can be directly used to contain this new threat to many productive cardamom zones.

### Past achievements

- Random survey was conducted to identify the locations infected with kokke kandu and mosaic disease of cardamom in collaboration with spices board.
- Several training programmes were conducted in hotspots and adjacent areas to create awareness and also disease management measures through audiovisual aids.
- Detailed studies conducted on transmission through seed, soil, mechanical contact, thrips and aphids. Transmission was established through cardamom aphid *(Pentalonia nigronervosa f.caladii)*
- Kokke kandu disease causes yield losses up to 98 % within two years of virus infection.
- Dual pattern of disease spread was recorded in the infected gardens and new infections are centered around primary sources.
- Roguing is found to be feasible as a strategy to contain both mosaic and vein clearing diseases in large holdings only (more than 4 hectares).

- Immunological testing with poty, cucuma, potex and carla virus antibodies indicated that vein clearing disease is a possible member of poty virus.

**Progress report**

Screening of 52 disease escapes was undertaken through viruliferous aphids (*Pentalonia nigronervosa*). After two individual screening 21 inoculants have not expressed symptoms. In the first round of screening six out of 16 mosaic resistant selections were found to be susceptible to vein clearing disease.

PATH XI (813)

**STUDIES ON BACTERIAL WILT OF GINGER**

**(A.Kumar and Y. R. Sarma)**

**Project report**

*Characterization of pathogen*

*Ralstonia solanacearum,* the causal agent of wilt of ginger was isolated from major ginger growing areas of India that include Kerala and Sikkim. Phenotypic characterization revealed that they belong to biovar-III. An aberrant biovar-III with dulcitol negaive phenotype could be isolated from Sikkim.

*Ralstonia Solanacearum,* was also isolated from tomato, potato, chilli, eupatorium and ageratum in order to know their role in the epidemics of bacterial wilt of ginger in India.

Simple biovar characterization technique using mircrotiter plate & small quantity of reagent was standardized for rapid identification of biovar.

Differences among the isolates in clolony character, carbohydrate utilization pattern, pathogenic potential etc. could be found.

Basic information on generation time of *Ralstonia*, suitable media for isolation and infectivity titer of bacterium were also generated. (Table 18)

All the isolates were also characterized for their intrinsic antibiotic resistance. Differences in sensitivity among the isolates to antibiotics could be noticed.

Characterization based on membrane protein pattern revealed the presence of 37 – 40 Kda protein in all the isolates of *Ralstonia solanacearum* (Fig. 1). This protein may be useful as a species specific antigen for producing antibodies for developing an immunokit.

**Table 18. Infectivity titer of *Ralstonia Solanacearum* in ginger**

| Sl.No. | Conc. of cells(No. of cells per Plant) | Pseudostem inoculation (100µl) | | Pouring around base (1000µl) | |
|---|---|---|---|---|---|
| | | Days to start infection | % wilt | Days to start infection | % wilt |
| 1 | $3.2 \times 10^8$ | 6 | 100 (8) | 12 | 100 (19) |
| 2 | $3.2 \times 10^7$ | 6 | 100 (9) | 12 | 30 (13) |
| 3 | $3.2 \times 10^6$ | 7 | 100 (20) | 13 | 30 (14) |
| 4 | $3.2 \times 10^5$ | 7 | 100 (15) | 14 | 10 (14) |
| 5 | $3.2 \times 10^4$ | 8 | 80 (35) | — | — |
| 6 | $3.2 \times 10^3$ | 8 | 80 (35) | — | — |
| 7 | $3.2 \times 10^2$ | 9 | 80 (35) | — | — |

*Figures* in parenthesis – Days to wilt ginger

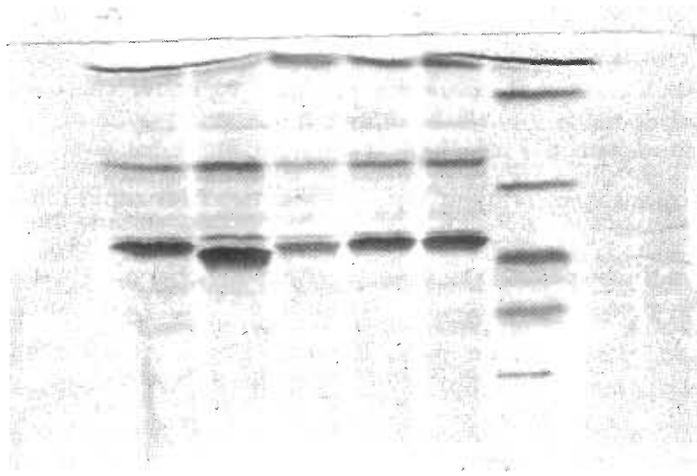


Fig. 1. Membrane protein pattern in isolates of *Ralstonia solanacearum*

*Inoculation technique*

Simple inoculation technique was standardized in seven germplasm of ginger for bacterial wilt tolerance. The technique was very rapid and easy to follow. Reaction could be noticed within 10 days of inoculation. The inoculation procedure was used for evaluation of ginger germplasm.

*Serological detection of Ralstonia solanacearum*

Dot-Immuno-binding assay kit (NCM-ELISA) developed at International Potato Center (CIP, Lima, Peru) was evaluated to know the adaptability of the kit for ginger. The result indicates that the kit is suitable for detection of bacterium in ginger sample. However, it has got the limitation of high cost and safe transport from Peru as some of the reagents are sensitive to heat.

*Biocontrol of bacterial wilt of ginger*

Eight bacteria isolated from ginger field and rhizosphere soil were evaluated for antagonistic effect on *Ralstonia* in green house. None of the bacteria evaluated could increase the yield of ginger under pot culture experiment.

*Disease management strategies*

In order to evolve environment and farmer's friendly disease management an experiment was set up to know the effect of temperature on survival and virulence of *R. solanacearum*. Temperature above 45°C was found to be lethal to the bacterium.

PATH XII (813)

## INVESTIGATIONS ON STUNTED DISEASE OF BLACK PEPPER

**(Y.R. Sarma and K.M. Abdulla Koya)**

### Aim and Scope

Stunted disease of black pepper was recorded from Mullankolly area of Pulpally in Wynad during 1978. Subsequently , it started spreading. Since no information was available on the etiology of dis-

ease, studies were undertaken. Recently it has been confirmed that it is caused by a strain of Cucumber Mosaic Virus (CMV) based on serological tests and EM studies.

**Progress report**

Studies on virus vector relationship and transmission with an aphid tentatively identified as *Toxoptera citridus* were negative. Aphid colonies when collected from black pepper and transferred to healthy pepper, there was no subsequent colonisation and multiplication. Aphids from disease affected vines when transferred to healthy plants, transmission could not be established.

Susceptibility of *P. colubrinum* with multiple resistance was tested by grafting healthy *P.colubrinum* scion on infected pepper plants. Grafting infected pepper scion on *P.colubrinum* showed virus transmission by producing interveinal chlorosis symptom. The transmission was further confirmed with ELISA tests. Thus it is confirmed that *P.colubrinum* is susceptible to CMV.

CROP PROT. 1.1 (813)

**SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO DISEASES**

**(Y.R. Sarma, M. Anandaraj, S.S. Veena, M.N. Venugopal and K.V. Saji)**

**Aim and Scope**

Identification of resistance/tolerance in black pepper to *P.capsici*, causal agent of root rot is of high priority. The open pollinated seedling progenies, cultivars, hybrids and wild types are tested for their field reaction in hot spot areas of disease.

**Progress report**

During the year, 17918 open pollinated seedling progenies of 22 cultivated hybrids were screened and all did succumb to infection.

Disease escapes of 22 numbers i.e. two Karimunda types, two vellamundi type and 6 Neelamundi types from Idukki, Chomala (3),

Uddagare (2), Vadakkan(4), Urutugere, Aimpiriyan and Okkalu one each from Kodagu were collected and are being multiplied for further screening.

*Screening of cultivars/hybrids*

Besides 41 hybrids, 41 wild and 51 cultivars (totally 133) were screened. Of these HP 295, wild 3241 and 3073 showed tolerant reaction. 24/133, which showed tolerance is subjected to further screening for confirmation .

*Field trials*

Field trial at Pulpally is continued. P 24, C1049, HP 780 and Karimunda (susceptible) showed good crop stand and no conclusion could be drawn. At Myladumpara, HP 780 and P1534 were found tolerant with good crop stand.

CROP PROT. 1.2 (813)

## SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO INSECT PESTS

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

### Aim and Scope

The project aims at locating sources of resistance to 'Pollu' beetle in cultivated and wild Piper accessions for utilization in hybridization programmes and to develop black pepper varieties resistant to the pest.

### Past achievements

Four accessions of black pepper (Accession numbers 816, 841, 1084 and 1114) were found resistant to 'Pollu' beetle attack. Out of all the wild *Piper nigrum* screened only one accession was found to be resistant. Six species of wild *Piper nigrum* viz., *Piper attenuataum, P. barberi, P. colubrinum, P. hymenophyllum, P. longum* and *P. chaba* were found to be resistant. Out of the hybrids screened, two inter specific hybrids viz., *Piper attenuataum* x *P. nigrum* and *P. barberi* x *P. nigrum* were found to be resistant to the pest.

### Progress report

All the seven high yielding varieties screened during the period

under report were found to be susceptible. The mean percentage infestation varied from 2.84 in Subhakara to 5.76 in Sreekara. Panniyur-4 recorded less damage compared to Panniyur-2 and Panniyur-3.

None of the 18 accessions of wild *P. nigrum* germplasm screened showed any resistance to 'Pollu' beetle. The percentage infestation in these accessions ranged from 14.4 to 43.2.

CROP PROT. 1.3 (813)

## SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO NEMATODES

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

### Aim and Scope

To locate sources of resistance to root knot and burrowing nematodes and to develop resistant black pepper varieties.

### Past achievements

Several accessions of black pepper germplasm including wild related species, intercultivar hybrids, open pollinated seedlings of popular

**Table 19. Screening of black pepper germplasm accessions against plant parasitic nematodes-results of the preliminary screening.**

| Nematode | Cultivated | Released | Wild | Hybrids | Phytophthora tolerant lines | Somaclones |
|---|---|---|---|---|---|---|
| *R.similis* | 24 | 9 | 4(4) | 13(1) | 5 | 4 |
| *M.incognita* | 13(2) | 8(1) | 11(1) | 12(3) | 4(3) | - |

Figures in parentheses are number of resistant lines.

cultivars, selections of cv.Karimunda, released varieties and *Phytophthora* tolerant lines were screened for their reaction to *Meloidogyne incognita* and *Radopholus similis*. Acc.812 (Ottaplakkal-1), found resistant to *M. incognita*, was released as 'Pournami' for cultivation in root-knot nematode infested gardens. *Piper colubrinum*, a wild species is resistant to both *M. incognita* and *R. similis*. Some more wild accessions are resistant to *M. incognita*.

### Progress report

One hundred and seven black pepper germplasm accessions were screened against nematodes (48 accessions against *Meloidogyne incog-*

*nita* and 59 accessions against *Radopholus similis*) in the preliminary round of screening . The results are given in Table 19. Besides more than 110 germplasm accessions and somaclones were multiplied and maintained for screening work. Cultures of root knot and burrowing nematodes are being maintained.

CROP.PROT . II (813)

## MECHANISM OF RESISTANCE TO PESTS AND PATHOGENS IN SPICE CROPS

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

### Aim and Scope

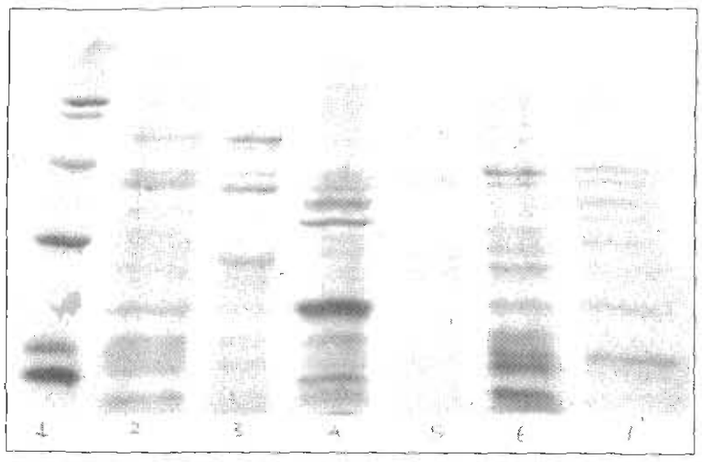
The project is aimed to identify the factors responsible for the resistance to various pests and pathogens affecting the spice crops.

*Characterization of nematode tolerant lines*

The activities of defense related enzymes such as SOD, catalase and peroxidase were studied in black pepper varieties, 'Pournami', the nematode tolerant line and 'Panniyur-1' the susceptible one. The experiment was done in a green house on two months old rooted cuttings. Enzyme activities were studied after inoculating with *Meloidogyne incognita* at 24, 48, 72 and 168h materials. There was no definite pattern in SOD isoforms. Peroxidase isoforms from roots of tolerant variety showed an additional slow moving band from cathode side after 24h and 48h which disappeared thereafter. Catalase isoforms exhibited degradation of polymeric forms with appearance of two sharp bands with lower EM at 24h and 48h. This showed that those two defense related enzymes undergo some confirmational changes during the early period of infection in the nematode tolerant line.

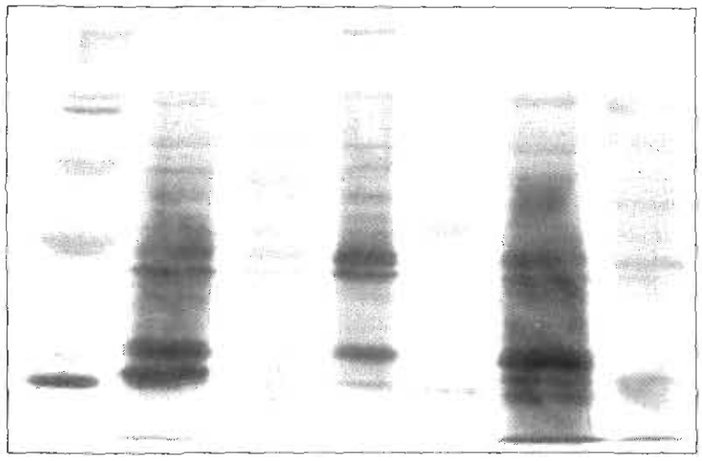
*Characterization of 'pollu' resistant lines*

Biochemical characterization of 'pollu' resistant lines were done for total sugars, reducing sugars, total phenols and OD phenols. In all the resistant lines the OD phenols were significantly higher. SDS-PAGE analysis did not show any significant differences in the protein profiles of resistant lines. The free amino acid and surface wax contents were significantly higher in resistant lines.



Lane1: Marker; 2:P24(H); 3:P24(I); 4:Pan1(H); 5:Pan1(I); 6:Subhakara(H); 7:Subhakara(I);

Fig 2. Induction of PR-proteins in black pepper leaf extracts



Lane1: Marker; 2:P24(H); 3:P24(I); 4:Pan1(H); 5:Pan1(I); 6:Subhakara(H); 7:Subhakara(I);

Fig 3. Induction of PR-proteins in black pepper root extracts

*P. capsici of Black pepper*

The activities of related enzymes in black pepper variety P.24 was studied during pathogenesis. The activities of PAL is higher in P-24 compared to the susceptible KS 27. So also the β 1,3, glucanase activity. There was induction of PR proteins during pathogenesis in *Phytophthora* tolerant variety P-24. There was found to be isoform of β 1,3 glucanase which was confirmed by western blot. The induced protein was electroeluted and tested *in vitro*, showed antifungal activity on the pathogens(Fig. 2&3).

To study the RAPD profiles of *Phytophthora* tolerant line amplification parameters were standardized. About 20 operon random primers were tried for RAPD studies. OPA 9 gave differential amplification.

In cardamom the katte resistant lines and rhizome rot resistant RR-1 were studied for RAPD profiles. The rhizome rot resistant RR-1 line showed differential amplification for OPA-8 and OPA-12 primers.

NEMA III (813):

## INVESTIGATIONS ON NEMATODES ASSOCIATED WITH SPICES

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

### Aim and Scope

The primary objective of the project is to develop nematode management strategies to boost up the yields in spice crops.

i. To identify plant parasitic nematodes associated with spice crops.

ii. To identify economically important nematode species.

iii. To screen spices germplasm for reaction to important nematode species.

### Past achievements

Surveys to identify the nematodes infesting spice crops like black pepper, cardamom, ginger and turmeric in all the major areas of cultivation were carried out. Out of the several plant parasitic nematodes identified with these crops only a few species like root knot nematodes (*Meloidogyne* spp.), burrowing nematode (*Radopholus similis*), pepper nematode (*Trophotylenchulus piperis*) and lesion nematode (*Pratylenchus* spp.) are of economic importance. Pathology of these nematodes was established. The etiology of 'slow decline' disease was confirmed. Based on large-scale field trials, strategies for the management of

nematodes of black pepper and cardamom, both in nurseries and plantations, were recommended for adoption. Basic studies on host resistance, genetic variability in nematodes were also taken up.

**Progress report**

*1. Screening of germplasm*

Ginger, turmeric and cardamom germplasm accessions were screened against root knot nematodes (*Meloidogyne incognita*). Twelve ginger accessions out of 43 and 10 turmeric accessions out of 73 showed resistance to *M. incognita* in the preliminary screening. Seven ginger and four turmeric accessions were retested for confirming their resistant reaction to root knot nematodes. Acc.221 in ginger and Acc.31, 82 and 178 in turmeric repeatedly showed resistance to the nematodes.

Two ginger (Acc.36 and 59) and four turmeric (Acc.84,142,182 and 198) accessions, which are root knot nematode tolerant lines, were evaluated under simulated field conditions for the second consecutive year. Though their host status is confirmed none of them are agronomically superior to the released varieties. However, these accessions can be utilized as a source of resistance to the nematode in future research programmes.

*2. Studies on organic amendments*

A microplot study (Design RBD; replications 5) has been set up to study the effect of organic amendments on the growth and yield of nematode-infested and nematode-free black pepper vines. The treatments incorporated are vermicompost (@2kg/plant), mulching with leaves of *Piper colubrinum* and *Strychnos nuxvomica* (@2kg/plant). The amendments were applied in last November and March. The growth of plants and the nematode population in the rhizosphere are being monitored.

*3. Population diversity in root knot nematodes of spices*

Isolates of root knot nematodes were collected from five locations (Peruvannamuzhi on *Piper chaba*, Pulpally, Koppa, Mohitnagar and Kahikuchi on black pepper). Perinneal patterns of eight populations were studied through image analysis and documented. An isolate of root knot nematode from Peruvannamuzhi, Kerala infesting black pepper was identified as a new species and is tentatively named as *Meloidogyne keralensis* (Courtesy : Division of Nematology, IARI, New Delhi)

BIOCONTROL 1.1 (813)

## BIOLOGICAL CONTROL OF DISEASES OF SPICE CROPS

**(M. Ananadaraj, Y. R. Sarma, A. Kumar and S. S. Veena)**

### Aim and Scope

The project is aimed at developing biological control measures to control the various pathogens which affect spices especially black pepper.

### *Past achievements*

IISR has already developed and propagated among farmers the efficacy of *Trichoderma* and VAM. Demonstrations have been carried out in large areas of farmers field and they are convinced about its potential.

### Progress report

The population build up of *Trichoderma* in biocontrol applied plots was monitored before and after the monsoon period. The population in *Trichoderma* applied plots ranged from $10^3$ to $10^4$. There was no incidence of *phytophthora* foot rot. But *phytophthora* could be detected in the soils through baiting.

The suitability of coir pith as carrier medium for *Trichoderma* was studied using addition of mature coconut water to the coir pith. When coir pith amended with coconut water was inoculated with *Trichoderma* the population reached from $!0^3$ to $!0^5$ in five days and reduced to $10^4$ in 10 days. If the coir pith is autoclaved after addition of coconut water the population of *Trichoderma* reached from $10^3$ to $10^7$ in five days and was maintained upto ten days. The population could be maintained upto 50 days in coir pith amended with coconut water. The efficient isolates of VAM identified earlier were treated along with *Trichoderma* for their synergistic activity. VAM incorporation in nursery mixture besides enhancing rooting also activated the native *Trichoderma* in the rhizosphore. There was no mutual antagonism among the efficient isolates of VAM and biocontrol organisms tested.

BIOCONTROL 1.2 (813)

## BIOLOGICAL CONTROL OF INSECT PESTS OF SPICES

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

### Aim and Scope

The project aims at developing biological control schedules for the

management of insect pest of spices.

**Past achievements**

The natural enemies of major insect pest of black pepper, ginger, turmeric, cinnamon, clove and nutmeg were documented and potential biocontrol agents were identified. Two commercial formulations of *Bacillus thuringiensis* were evaluated for the management of shoot borer on ginger and turmeric, among which dipel 0.3% was the most effective. An integrated approach for the management of shoot borer including pruning of infested shoots during July-August and spraying insecticides during September-October was effective. Various entomopathogenic fungi were evaluated against root mealy bug infesting black pepper among which *Metarrhizium anisopliae* and *Paecilomyces lilacinus* were promising.

**Progress report**

*1. Bioassay of entomopathogens against root mealy bug*

Various entomopathogenic fungi namely, *Aspergillus rugulosus, Paecilomyces lilacinus, Verticillium chlamydosporium* (2 isolates), *V. lecanii* and *Fusarium oxysporum* isolated from rhizospere of black pepper, were multiplied in the laboratory and bioassays conducted to evaluate their pathogenecity against root mealy bug (*Planococcus* sp.) infesting black pepper. The bioassay indicated that among the various fungi, *A. rugulosus* was the most promising causing 63% reduction in mealy bug population when compared to 60% increase in control, 15 days after spray.

*2. Evaluation of plant products against 'Pollu' beetle*

Three plant products namely, neem extract, chilli extract (Source: M/s Synthite Chemicals) and seed kernel extract of *Melia composita* were evaluated in laboratory bioassays adopting no choice feeding tests at 0.1 to 5% concentrations to determine their antifeedant activity against 'Pollu' beetle (*Longitarsus nigripennis*). The bioassay indicated that among the products, chilli extract and seed kernel extract of *M.composita* were more promising causing above 50% feeding deterrence at 0.1% and 0.5% concentrations, respectively.

*3. Pesticide residues in black pepper*

The pesticide residues in black pepper, in which the recommended spraying schedules of endosulfan and neem-based insecticide were

adopted, were determined at Quality Evaluation Laboratory, Spices Board, Kochi. Spraying 2 rounds of endosulfan 0.05% (July and October); 1 round of endosulfan 0.05% (July) + 3 rounds of Neemgold 0.6% (August-October) and 4 rounds of Neemgold 0.6% (July-October) resulted in 0.041ppm, 0.009ppm and non detectable levels of endosulfan residues, respectively, on black pepper berries at harvest. These residue levels were below the permissible level of 0.1ppm fixed by the importing countries indicating that the recommended management schedule against 'pollu' beetle does not result in pesticide residues in the product.

*4. Demonstration of management of 'pollu' beetle with neem-based insecticide*

The efficacy of spraying neem-based insecticide such as Neemgold for the management of 'Pollu' beetle was demonstrated in a farmers field at Thiruvambady (Kozhikode district, Kerala). The treatments included spraying 2 rounds of endosulfan 0.05% (July and October); 1 round of endosulfan 0.05% (July) + 3 rounds of Neemgold 0.6% (August-October); 2 rounds of quinalphos 0.05% (July and October); 1 round of quinalphos 0.05% (July) + 3 rounds of Neemgold 0.6% (August-October) and 4 rounds of Neemgold 0.6% (July-October). The trials indicated that all the treatments were effective and were on par with each other and superior to control, for the management of the pest.

*5. Integrated management of shoot borer*

Cultural methods such as pruning infested shoots, pruning infested shoots + spraying insecticides and spraying insecticides alone were evaluated in the field for the management of shoot borer (*Conogethes punctiferalis*) on ginger. The trials indicated that pruning infested shoots (at fortnightly intervals) during July-August and spraying insecticides (malathion 0.1% at monthly intervals) during September-October resulted in significantly lesser incidence of shoot borer and higher yield of rhizomes. By adopting this method, two insecticide sprays can be avoided, thus causing less harm to the ecosystem.

*6. Management of rhizome scale*

Six insecticides namely, malathion, methyl parathion, quinalphos, phosphamidon, dimethoate and monocrotophos (0.075% each) and four plant/organic products namely, Neemgold 0.5%, Nimbicidine 0.5%, neem

oil 1% and fish oil rosin 3% were evaluated for the management of rhizome scale (*Aspidiella hartii*) of ginger in storage. The trials indicated that among the various chemicals, dipping seed rhizomes in quinalphos 0.075% prior to storage was significantly the most effective treatment for the management of the pest resulting in maximum seed recovery, minimum scale population and maximum sprouts on the seed rhizomes. Dipping seed rhizomes in methyl parathion also resulted in higher seed recovery, lower scale population and higher sprout formation.

BIOCONTROL 1.3 (813)

## BIOLOGICAL CONTROL OF NEMATODES OF SPICES

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

### Aim and Scope

The primary objective of the project is to develop bio-intensive and eco-friendly management measures to control nematodes of spices.

a. To isolate and identify local isolates of biocontrol agents in spice crops

b. To assess their efficacy and to identify efficient isolates

c. To scale up their multiplication

### Past achievements

A number of native isolates of fungi and bacteria were isolated from the rhizosphere of spices like black pepper, cardamom, ginger and turmeric.

They were evaluated under *in vitro* conditions for their nematicidal properties and those short-listed were further tested under greenhouse conditions. The promising isolates so far identified are *Verticillium chlamydosporium, Pasteuria penetrans* and several vesicular arbuscular mycorrhizal fungi. *Trichoderma* spp. and *P. lilacinus* were field tested in cardamom nurseries and have been recommended for use.

### Progress report

*1. In vitro bioassay*

*In vitro* bioassays to evaluate the efficacy of fungi isolates were

performed in different ways like colonising nematode egg masses with fungi to study their effect on egg hatching, baiting with individual eggs to study the direct parasitization, if any, and toxicity studies using fungal metabolites . Egg hatching has been significantly suppressed with 10 isolates of fungi (Is. 4, 18, 27, 31, 32, 33, 35, 36, 40 and 53). Ten fungal isolates were good colonisers of root knot nematode eggs.

Metabolites of 19 bacterial isolates were tested for their nematicidal activity. Out of these six isolates suppressed the egg hatchability by 71.7-92% and increased the nematode mortality by 75-100%.

*2. Mode of action of Trichoderma*

Secondary metabolites of five isolates of *Trichoderma* (*T. harzianum*, *Trichoderma* Is. Tri. 6, *Trichoderma* mutant Mi 25, *T. harzianum* Is. 7 and *T. aureoviride* Tav 34) on screening for their nematicidal activity, varied in their toxicity to second stage juveniles of root knot nematode. The extracts were redissolved in 0.5% dimethyl sulfoxide to overcome the interference of organic solvents.

*3. Field evaluation*

A new trial has been laid out in a root knot nematode infested black pepper garden in Pulpally, Wyanad. The mean root knot nematode population in this garden was 1615.97 nematodes per gram of root and 13.11 $J_2$ per 100 cc soil.

Three biocontrol agents viz. *Trichoderma harzianum*, *Verticillium chlamydosporium* and *Pasteuria penetrans* are being evaluated in comparison with the application of phorate. Observations on nematode incidence, yellowing and mortality of vines were recorded

*V. chlamydosporium* could be reisolated from the soil 6 and 12 months after application in an observational trial conducted in a cardamom nursery at Igoor, Kodagu. In a green house trial, *V. chlamydosporium* suppressed *Radopholus similis* in black pepper rooted cuttings. Black pepper cuttings treated with the fungus showed significantly less root damage and very good growth compared to those plants treated with nematodes alone (Table 20)

**Table 20. Plant growth and burrowing nematode population in black pepper rooted cuttings treated with *Verticillium chlamydosporium* and *Radopholus similis* (mean of 20 replications).**

| Treatment | RLI[A] | Height cm | Biomass (g) | | Final nematode population (No.) | | |
|---|---|---|---|---|---|---|---|
| | | | Total | Root | In soil[B] | In roots[C] |
| RS alone | 4.7 | 30.5 | 6.2 | 11.0 | 0.6 | 8.0 | 110.0 |
| VC+RS | 1.0* | 38.2* | 9.0 | 19.2* | 1.9* | 3.0 | 450.0* |

[a] Root lesion index (1-5 scale); [b] in 100 cc soil; [c] in one gram root.
*Means in the column are significantly different (P=0.05)
RS- *Radopholus similis*, VC- *Verticillium chlamydosporium*

ENT. XI (813)

## BIOECOLOGY AND MANAGEMENT OF MEALY BUGS INFESTING BLACK PEPPER

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

### Aim and Scope

The project aims at conducting surveys to record the incidence of mealy bugs on roots of black pepper in various location and to assess the extent of damage caused by them and evolve integrated control measures against the pest.

### Past achievements

Surveys conducted in Wynad showed that 20-80% and 4.4-17.8% of the vines were infested by mealy bugs during the monsoon and summer periods respectively.

Studies on nature of damage showed that mealy bugs wee present on the roots up to a depth of 2 feet. They were noticed on main roots, secondary roots and also on tertiary roots.

Out of seven host materials evaluated for culturing mealy bugs in the laboratory, pumpkins and squash were most ideal. Preliminary field trial conducted in the farmers field at Wynad indicated that chlorpyriphos 0.1% and quinalphos 0.1% were more promising against the pest, when the root zones were drenched with insecticide solution.

**Progress report**

Surveys conducted in Wynad district showed that the incidence by mealy bugs varied from 6.7% to 42.2% in seven locations. However, at two locations mealy bugs were not noticed.

Studies using mealy bugs, *Phytophthora capsici* and *Radopholus similis* in various combinations under green house conditions to study the interaction between the insect and pathogens are in progress.

## AD-HOC PROJECT

### Biological control of plant parasitic nematodes of major spices

**(K V Ramana, Santhosh J. Eapen and B. Beena)**

Random samples were collected from Calicut, Idukki and Ernakulam districts from the rhizosphere of ginger and turmeric. Out of these, 33 isolates of bacteria and 43 isolates of fungi were obtained. *In vitro* bioassay was completed using 20 isolates while 25 isolates were screened for egg parasitization and promising isolates were short-listed. Growth and morphology of 57 and 20 fungal isolates, respectively, were studied and documented. Culture filtrates of *Verticillium* spp. and *Paecilomyces lilacinus* were highly toxic to second stage juveniles of *Meloidogyne incognita*. Screening of different solid substrates for multiplication of promising biocontrol agents showed that *P. lilacinus* multiplied profusely on rice (cfu 254 x $10^{11}$/g) followed by ginger leaf powder (cfu 210.3'$10^{11}$/g). Similarly, tea waste, ginger leaf powder and rice supported good multiplication of another isolate, *Aspergillus rugulosus*. Growth of different isolates of *Verticillium* spp. varied with the isolate and the culture media used. In green house tests *Aspergillus* sp. and *Trichoderma* sp. controlled root knot nematodes and increased the growth and yield of nematode infested ginger plants. Three different pot trials are in progress to evaluate isolates of *P. lilacinus, A.rugulosus, Fusarium oxysporum, Trichoderma harzianum* and *V. chlamydosporium*.

## SOCIAL SCIENCE

EXT.IV (813)

### TRAINING OF RESEARCH AND EXTENSION WORKERS

**(M.S. Madan and P. Rajeev)**

Training programmes were conducted on 'Spices production technology', 'Nursery management' and 'On – farm processing of spices'. Fifty-three officers from seven states attended the training programs. On request training to over 50 farmers from various parts of the country were also arranged. On behalf of Spices board, sponsored training programme on 'Spices production technology' to spices growers and extension officials from northeastern states were conducted.

ECON. 1(813)

### ECONOMICS OF SPICES PRODUCTION AND MARKETING

**(M.S. Madan and Jose Abraham)**

- ☆ The estimated average cost of production per kilogram of black pepper excluding rental value of land in Kerala was Rs.35.59 in the year 1998-99 (Table 21.) The estimated full supply price at 20% rate of return was around Rs.42/- and the minimum expected price of farmer was between Rs.50-60/kg. Thus looking to the estimated cost and expected price, the prevailed farm gate price (Rs.160/kg.) during the crop year was high enough to work as an incentive to increase production and productivity. On an average the crop needs at least 178 man days per annum per hectare. This number will go up, when the intended end product is either white pepper or green pepper. Around 60% of the paid out cost of producing 1kg of pepper is attributed towards labour cost. Price of labour has increased by about 400% in the state of Kerala during the past decade.
- ☆ The decentralized commodity distribution system (marketing system) for black pepper with less number of intermediaries is comparatively more efficient that that for ginger. With 11% price spread and low marketing cost (6.74%) the system provides better share (87.7%)to the producer in the consumer price (Table 22).

Among the alternative channels available for pepper, more than 60% of the produce moves through the most common channel of :

Producer > village assembler > local trader > wholesaler > exporter

**Table 21. The estimated cost of production of black pepper (1998-99)**

| Cost component | Amount (Rs. /ha) |
|---|---|
| Investment during establishment | 65480 |
| Compound interest on investment @ 15% | 24623 |
| Total investment (S. No. 1+2) | 90118 |
| Annuity value @ 15% for 15 years | 14240 |
| Annual maintenance cost | 28466 |
| Total cost of production | 42706 |
| Average annual production (kgs) | 1200 |
| Cost of production (Rs./kg.) | 35.59 |
| Benefit cost ratio | 4.5 |

**Table 22. Distribution of marketing margin of black pepper**

| Institution | Percentage share from the f. o. b. price | | |
|---|---|---|---|
| | Export market | Domestic market | Overall |
| Farmers share | 86.34 | 89.09 | 87.72 |
| Marketing cost | 7.23 | 6.24 | 6.74 |
| Marketing margin | 5.94 | 4.68 | 5.31 |
| Price spread | 13.17 | 10.92 | 11.06 |
| Exporter's/Internal wholesaler's price | 100 | 100 | 100 |

- An ex-post evaluation of central government sponsored programme on 'Integrated measures against *Phytophthora* foot rot disease of black pepper in Kerala' revealed the following facts:
- Most farmers (about 97%) in the region are aware of the programme and its components.

- ☆ About 73% farmers adopted the recommended cultural and phytosanitation measures (Component – I)
- ☆ Adoption quotient for chemical control measures (Component – II) was only 41.1%.
- ☆ Application of manures and fertilizers is not in the lines of recommended agronomic practices.
- ☆ Positive growth rates of 6.54% and 3.37% respectively in the spice districts of Idukki and Wynad were attributed to the success of the technology.
- ☆ There is a reduction in vine mortality from 7.41% to 3.7%.
- ☆ Overall productivity in pepper increased from 268 kg/ha during 1994-95 (base year) to 315 kg/ha in 1998-99.

**Database on spices economics is being created and maintained.**

- ☆ Two software packages to store and retrieve spices database prepared and put into use:

i. Spices information system

ii. Spices economics system

Data from the database were tabulated and analyzed to bring out useful interpretations:

- ☆ Total export of pepper and pepper products from 1989/90 to 1998/99 increased annually by 14.07 per cent per annum in terms of quantity and 19.44 per cent in terms of value.
- ☆ There is also a marked change in share of value added products especially pepper oil and oleoresins (9.25% and 9.24% respectively) leading to a conclusion that the composition of export basket is changing rapidly.

Based on the instability index worked out for the above period, value of pepper exported is more stable (55.40%) than the export volume (46%).

STAT.VI (813)

## ECONOMICS OF GINGER CULTIVATION

**(Jose Abraham and M.S. Madan)**

### Final Report

### Introduction

Ginger (*Zingiber officinale*) is a herbaceous plant probably native to south-eastern Asia and now widely cultivated in tropical and warm temperate lands. It is cultivated commercially as an annual crop. The ginger of commerce is the dry product of the rhizome or underground stem. Harvesting is done by digging out the rhizomes from the soil, cleaning them, pealing the skin, and drying them in the sun. The dried ginger rhizomes are irregular in shape, and their colour varies from dark yellow through light brown to pale buff. They are usually ground to produce the spice commonly known as ginger. The spice has a slightly biting taste and is used to flavour breads, sauces, confections, pickles and gingerale.

India accounts for about 50 per cent of the total world production. Other major ginger producing countries are Jamaica, Nigeria, Sierra Leone, Thailand, Taiwan, China, Fiji Islands, Australia, Japan and Ceylon. Jamaican ginger is well known for its lemon-like flavor and qualities. Indian ginger is regarded as Cochin ginger in the world market and is considered next best to Jamaica.

Kerala is the major ginger producing State in India particularly the Wynad area. Karnataka, Tamil Nadu, Andhra Pradesh, Himachal Pradesh and Assam are the other major ginger producing states in India. Middle East is the biggest buyer of Indian ginger. There is great scope for ginger products like essence, oils, resinoids, oleoresins etc. in the Western countries of Europe and America. Saudi Arabia is the most important importer followed by Aden, Morocco, U.S. A., U.K., Holland and Sudan.

The major problems facing ginger production are the rhizome rot disease caused by the fungus *Pythium aphanidermatum* and bacterial wilt caused by *Pseudomonas solanacearum*. The unstable market price of the produce is another deterrent force in ginger production. The mounting cost of labour, farm yard manure and other essential inputs also makes ginger cultivation less remunerative. Indian Institute of

Spices Research (IISR), Calicut has developed effective biocontrol agents for rhizome rot disease and management practices to control bacterial wilt. IISR has also released high yielding, high quality selection of ginger as "Varada" which is getting very popular among the farmers.

The adoption of any technology, whether it is a new variety evolved, a process or machinery, depends mainly on its economics. Similarly cost of production of agricultural commodities is an important parameter often sought for by the traders and government agencies for formulating procurement and export policies as well as deciding support prices for the products. For the farmer, it is essential to know the economics of cultivation to select the crop so that it will be profitable for him. However, no reliable estimates are available on the cost of production of ginger, which being an export oriented spice as well as an important vegetable commonly used. A reliable estimate of its cost of production will be of immense utility for the farmers, policy makers, developmental agencies and crop insurance schemes.

The present study is intented to estimate cost of production of ginger based on costs of inputs and to evaluate the economic potential of ginger cultivation in Kerala under scientific management practices.

**Materials and methods**

Collection of primary and secondary data on components of cost on various inputs like planting material, labour, fertilizer and other inputs were done through survey conducted in Calicut and Wynad districts. Secondary information from the farm data on scientific cultivation and yield was also utilized for estimating the cost. Planting material and labour are the major components of cost in ginger production, accounting for 70% and cost of other inputs like FYM, chemical fertilizers and plant protection chemicals together constitute the remaining 30% of the cost. The productivity under scientific management was estimated to be 18 t/ha for a seed rate of 1.8 mt./ha with a moderate allowance for the losses due to soft rot and bacterial wilt. However, under the actual field conditions, the incidence of disease was in varying degrees, affecting the productivity drastically. Hence, for a realistic estimation of cost of production, data on the rate of incidence of disease and the resulting crop losses are to be worked out for which a detailed large scale survey is necessary. In the present context, the cost is worked out under the assumption of controlled disease incidence through scientific management.

**Results and discussion**

The components of cost in ginger cultivation is given in Table 23. The cost is worked under the prevailing cost situations during the year 1998-99.

Table 23. Cost of cultivation of ginger under scientific management

| S. No. | Component of cost | Cost (Rs./ha) |
|---|---|---|
| 1 | Seed @ Rs.25/kg for 1800 kg including transport charges | 45,000 |
| 2 | Seed treatment (including cost of chemicals and labour charges @ Rs.1/kg) | 1,800 |
| 3 | Land preparation including making of 3m x 1m beds (@ Rs.10/bed, for 1800 beds) | 18,000 |
| 4 | FYM @10kg/bed (18 tons x Rs.500) | 9,000 |
| 5 | Chemical fertilizers (130kg urea, 68kg rock phosphate and 100kg potash with labour charges) | 3,500 |
| 6 | Planting (cutting the seed rhizomes, making pits, planting and mulching) | 18,000 |
| 7 | Cost of mulch @ Rs.200/ton | 3,000 |
| 8 | Weeding, earthing up and green manure application (including cost of green manure) | 18,000 |
| 9 | Top dressing (two rounds) and pest and disease management | 6,000 |
| 10 | Harvesting, cleaning and transporting (18ton) | 9,000 |
| | **Total** **1,31,300** | |

The estimated cost of fresh ginger comes to Rs.7.29/kg

Dry ginger is prepared after peeling the outer skin, washing and drying in the sun. Peeling is usually done manually and hence involves labour. Peeling can also be done effectively and safely by keeping the rhizomes inside the rotating wire-mesh drums. Bleached ginger is obtained by soaking it in 3 per cent lime water for a few minutes and then fumigated with sulphur and then dried. This process is repeated once or twice to get a fully bleached white product. The recovery of dry ginger is 18 to 20 per cent.

## TECHNOLOGY ASSESSED AND TRANSFERRED

Based on the studies conducted at IISR, Calicut and Kerala Agricultural University, Trissur for the management of *Phytophthora* foot rot following recommendation has been given in the Staff Research Council.

Pre- and post application of Bordeaux mixture spray and Copper oxychloride drenching or potassium phosphonate (Akomin) @ 3ml/l as pre- and post-monsoon spraying and drenching or Soil application of *Trichoderma* (twice pre- and post-monsoon) with one foliar spray of Bordeaux mixture/ Akomin.

## EDUCATION AND TRAINING

### Krishi Vigyan Kendra, (IISR)

Krishi Vigyan Kendra conducted 60 training programmes (Table 24) during the period that include 45 training for practicing farmers, 14 for rural youth and one for extension functionaries in the disciplines of agronomy, horticulture, fisheries and animal science. Altogether, 2180 trainees attended the programmes.

**Table 24. Training programmes organized**

| S. No. | Category of trainees | No. of training programmes | Male | Female | Total |
|---|---|---|---|---|---|
| 1. | Practising farmers | 45 | 956 | 841 | 1800 |
| 2. | Rural youth | 14 | 153 | 187 | 340 |
| 3. | Extention functionaries | 1 | 11 | 29 | 40 |
| | Total | 60 | 1123 | 1057 | 2180 |

KVK also participated in 5 exhibitions and delivered 13 radio talks on various subjects through AIR, Calicut.

Under the revolving fund programme, planting materials worth Rs.1.97 lakhs were sold.

In the Plant and Animal Health Centre, a total of 923 cases were attended and 368 AI were done. The Kendra also conducted 3 animal health campaigns and attended one camp conducted by other agencies.

**Participation in exhibition :-** The Kendra has also participated in the following exhibition organized by the state department of agriculture and other agencies (Table 25).

**Table 25. Participation of KVK in exhibitions**

| Sl. No. | Date | Place | Organizing agency |
|---|---|---|---|
| 1. | 3.1.99 to 8.1.99 | Chennai | Indian Science Congress – 99 Exhibition |
| 2. | 8.1.99 to 11.1.99 | Thiruvananthapuram | Agri Fair – 99 organized by state department of Agriculture. |
| 3. | 31.1.99 to 2.2.99 | Olavanna | Botany exhibition organized by Kozhikode district panchayath and Malabar Botanical garden, Olavanna. |
| 4. | 4.2.99 to 10.2.99 | Calicut | Calicut flower show '99 organized by Agri Horti society |
| 5. | 2.11.99 to 4.11.99 | Calicut | Exhibition organized by KINFRA (Food tech world exhibition) |

## On farm testing programmes

### Crop science

*Management of Phytophthora foot rot of pepper through cultural practices and biocontrol agents*

The treatments were found to be effective in 3 out of 5 plots. In three plots, there was only 2% mortality due to the disease. In other 2 plots where there was heavy incidence of disease and had heavy and frequent rains, the mortality was up to 20%.

*Testing the performance of salt tolerant rice variety*

The salt tolerant rice variety Vyttila – 4 was given to five farmers @ 10 kg each. The seedlings were raised and transplanted in all the plots. In one plot, the crop is in the heading stage. The seasonal inundation of salt water is expected at any time. The crop is being monitored regularly.

*The control of YLD of arecanut using Trichoderma*

In this, *Trichoderma* alone (inorganics) and in combination with Ridomil were applied in 150 YLD affected palms in June 1999 taking farmers' practice as control. The remission symptoms are yet to be noticed.

**Fisheries**

*Composite fish culture*

In a newly constructed tank the fishes stocked were Rohu and Mrigal in 1:1 ratio. The stocking density was 50,000/ha . As the stocking density was high, running water was given in the pond throughout. The water running out of the pond was directed to the agriculture field. As the pond was small, the shed of pig is kept aside and only limited quantity of waste was allowed to enter into the pond. Utmost care was taken to maintain water quality. Once in a week, rice bran and ground nut oil cake in 1:1 ratio mixed, tied in net and kept suspended in pond. The weight of this supplementary feed was 2% of body weight of fish. After 18 months, fishes were harvested. Yield/ha/year was found to be 30 tons.

**Animal science**

*Efficacy of Ivermectin for control of ecto and endo parasites in bovines.*

Under this programme 31 cases were tested by injecting ivermectin on the basis of clinical symptoms. It has been found that Ivermectin is effective for controlling endo parasites. All the treated animals showed satisfactory growth rate. Ivermectin is also effective for controlling various types of dermatitis in growing calves.

**Collaborative activities undertaken with other institutions/development departments**

a. *VVV club*

The Vikas Volunteer Vahini club (VVV) by name Karshakasadhusree sponsored by NABARD and supported by KVK started functioning from 22.11.1997 at Koorachundu panchayath in Quilandy taluk, Calicut district. KVK organised need based vocational training programmes which aimed at bringing about lasting improvement in various enterprises carried out by the club members.

Eleven short duration training programmes for the club members as well as neighbouring farmers in various fields like goat and poultry rearing, nursery management in horticultural crops, vegetable seed production, scientific aspects of manuring, pineapple cultivation, composite fish culture, pig farming and post harvest technology of spices were organised. As a follow up of training programme, a group of 28

farmers were taken on a study tour to Dhony Cattle Farm, Palakkad.

*b. Centre for Overall Development (COD), Calicut.*

COD Thamarassery, Calicut is a reputed voluntary organisation engaged in rural development. KVK organised three training programmes on bush pepper production to 57 farmers who were the members of 'Karshaka Maithri' clubs supported by COD. As a follow up, the members of the club were engaged in production of bush pepper plants. KVK proposes to buy back the plants after proper establishment. Planting materials will be procured into revolving fund programme. KVK also provided consultancy services for the establishment of a horticulture nursery at Maruthonkara by the COD.

*c. Karshaka Munnetta Samithi* (Farmers' forum for development)

It is an organisation of farmers located at Peruvannamuzhi and Muthukadu area in Chakkitttapara panchayat, Calicut. KVK proposes to organise training programmes on alternate income generating activities apart from the traditional enterprises. A schedule for training in tropical fruit growing, nutrition garden and vermi compost production has been prepared.

*d. Routine linkages*

KVK is maintaining functional linkages with All India Radio, Krishi bhavans under the state department of Agriculture, Department of Animal Husbandry, Department of Fisheries, Matsyafed, Agri-horti Society, Calicut, Gramin Banks around KVK etc. to organize various training programmes and other extension activities like animal health camps, seminars and exhibitions.

**Training Conducted at IISR-CRC, Appangala**

A training programme on cardamom cultivars was imparted to 30 planters on 16-6-1999.

**Radio talks from IISR and KVK**

| | |
|---|---|
| Dr. S. S. Veena | 'Seed procurements in ginger and turmeric', AIR, Kozhikode. |
| S. J. Ankegowda | 'Agronomic practices in summer season in cardamom', AIR, Madikeri. |

| | |
|---|---|
| S. J. Ankegowda | 'Harvesting and processing of black pepper', AIR, Madikeri. |
| T. John Zachariah | 'Poovukalku vedanikkumo', AIR, Kozhikode. |
| T. John Zachariah | 'Value added products from pepper', AIR, Kozhikode. |
| Santhosh J. Eapen | 'Preservation and management of ginger and turmeric for seed purpose', AIR, Kozhikode. |
| Santhosh J. Eapen | 'Nematode management in black pepper', AIR, Kozhikode. |
| P. A. Mathew | 'Harvesting of nutmeg and clove', AIR, Kozhikode. |
| K. M. Prakash | 'Summer care of nutmeg and clove', AIR, Kozhikode. |
| K. M. Prakash | 'Methods of cultivation of ginger and turmeric and early cultural practices', AIR, Kozhikode. |
| Femeena Hassan | 'Prawn, crab farming', AIR, Kozhikode. |
| K. M. Prakash | 'Cultural operations of grown up vines of pepper', AIR, Kozhikode. |
| P. A. Mathew | 'Suitable standards for pepper', AIR, Kozhikode. |
| K.M. Prakash | Questions on 'cultural operations of grown up vines', AIR, Kozhikode. |
| P. S. Manoj | 'Planting of tree spices', AIR, Kozhikode. |
| P. A. Mathew | Questions and answer session on 'suitable standards of pepper', AIR, Kozhikode. |
| Femeena Hassan | 'Value added fish products for international market', AIR, Kozhikode. |
| S. Ravi | 'Food poisoning in cattle', AIR, Kozhikode. |

| | |
|---|---|
| P. Rajeev | 'Farmers role in technology transfer', AIR, Kozhikode. |
| K. M. Prakash | 'Control of quick wilt and 'Pollu' beetle of pepper', AIR, Kozhikode. |

**LECTURES DELIVERED**

**S. Devasahayam**

'Management of insect pests of spices'. Delivered to M.Sc. (Plantation development) Course, University of Calicut.

**K.V. Ramana**

'An introduction to the nematodes infecting plantation crops and spices', at department of Botany, University of Calicut.

**Santhosh J. Eapen**

'Information technology in spices and plantation crops', Department of Botany, University of Calicut.

'Diseases of black pepper', Farmers' Seminar, Choothupara, Wyanad.

'Pests and diseases of spices and their management', Farmers' seminar, Rajakkad, Idukki.

**S. S. Veena**

'Foot rot management' to Panchayath Presidents of Calicut district at F.T.C., Feroke.

'Integrated disease management with biocontrol agents in spice crops'. Sahyadri Training Center, Peermedu.

'Integrated disease management in pepper', Kambalakkad (Wynad) organised by RASTA.

'Biocontrol in pest management', Calicut organized by SMGB.

**T. John Zachariah**

'Instrument techniques in biological Sciences', M. Sc. students, Government College, Madappally

'Processing and value addition of spices', at District Industries Center, Kozhikode for prospective entrepreneurs.

'Processing of spices' to growers at Pepper Fest 1999 organized by Silk and Spices, Calicut at Vythiri resort.

'Instrumental techniques in biological Sciences', Calicut University, refresher course in Department of Zoology.

'Value added products from black pepper, cardamom and ginger', Food Tech World, organized by KINFRA at Hotel Taj Residency.

'Processing of Spices', to Trainees from North East.

## AWARDS AND RECOGNITIONS

1. Best Annual Report Award for the year 1996-97 is awarded to Indian Institute of Spices Research, Calicut.

2. Jawaharlal Nehru Award for outstanding postgraduate agricultural research for the year 1998 in the field of Agronomy, to Dr. V. S. Korikanthimath

3. Jawaharlal Nehru Award for outstanding post graduate agricultural research for the year 1998 in the field of Botany, to Dr. K. Nirmal Babu

4. Rafi Ahmed Kidwai Award for the Triennium 1996-98 is awarded to Dr. K. V. Peter and Dr. A. K. Sadanandan for their outstanding contribution in the field of spices research.

5. Award for the best research paper published in Journal of Spices and Aromatic Crops. Vol.7, 1998 for the paper "Anatomy of *Piper colubrinum* Link" to Dr. P. N. Ravindran and Dr. A. B. Remasree.

**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,<br>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 and M. Sc. Plantation Development courses |
| Regional Research Laboratory, Thiruvananthapuram | Research collaboration, partner in pepper technology mission |
| Centre for Water Resources Development and Management, Calicut. | Research collaboration,<br>Investigatorship in adhoc Schemes |
| Centre for Electronic Design and Technology, Calicut. | Technical collaboration,<br>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 |

| Agency | Linkage |
|---|---|
| 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

### Crop improvement

Ten new promising spices varieties developed by AICRPS centres/ IISR were recommended for release in the XV National Workshop of AICRPS held at Calicut during November 18-21, 1999. The varieties proposed/identified for state/central release are Panniyur-6 and Panniyur-7 in black pepper, RR-1 in cardamom, RCr-684, RCr-436, RCr-435 in coriander, Guj. Methi-1, RMt-303 in fenugreek, Guj.cumin-3 in cumin and RF-101 in fennel. Another two varieties in seed spices viz. RCr-20 in coriander, Co-2 in fenugreek were released by the respective State Variety Release committee.

The black pepper varieties Panniyur-6 and Panniyur-7 are developed by the Pepper Research Station, Panniyur, KAU. The RR-1 in cardamom, the first rhizome rot resistant line is from IISR, CRC Appangala. RCr-435, RCr-436, RCr-684 and RCr-20 in coriander, RMt-303 in fenugreek and RF-101 in fennel were developed by the Jobner centre of RAU, Rajastan, Guj. Methi-1 in fenugreek is identified by TNAU, Coimbatore.

### Crop production

In black pepper irrigation at IW/CPE ratio of 0.25 (100 lit. of water once in 8-10 days) during December-March followed by a stress period is recommended for Panniyur (Kerala). A fertilizer level of 150:60:210 g of NPK/vine with irrigation at IW/CPE ratio of 0.33 is recommended for economic yield in black pepper for Karnataka.

A quick method of clonal multiplication of cardamom suckers standardized involves close planting of suckers (0.9 x 0.9 m) in trenches and fertilizer application of 75:75:150 kg NPK/3000 plants in two equal

splits and regular plant protection measures, weeding, irrigation and mulching operations which yield 4-5 planting clonal units/tiller/year.

A new fertilizer dose of 75:75:150 kg NPK/ha in cardamom was recommended by Mudigere (Karnataka), while Raigarh centre recommended 150:125:125 kg NPK/ha for higher yield in turmeric. Jobner centre found that sowing of cumin during 15th October reduce the cumin wilt, while in coriander November 4th sowing gave best yield. Under Coimbatore, sowing at 15 x 10 cm spacing in October was best in coriander. A spacing of 30 x 20 cm and an increased level of nitrogen @ 150 kg N/ha is preferred for turmeric at Kumarganj (UP). The optimum fertilizer dose recommended for turmeric is 150:125:125 kg NPK/ha (Raigarh).

**Crop Protection**

The package of technology for the control of *Phytophthora* foot rot in black pepper recommended for adoption involves the application of 1 kg neem cake per vine, first found pre-monsoon spraying with Bordeaux mixture followed by copper oxychloride drenching and second round Akomin drenching as post monsoon recommended for Kerala condition in addition to the normal phytosanitary measures, and wherever nematode incidence is high phorate @ 3 g a. i. can be given during September-October.

In ginger, seed rhizome treatment with dithane M-45 (0.25%) + Bavistin (0.1%) along with soil application of thimmet 10 G (12 kg/ha) in Solan. *Taphrina* leaf blotch control on turmeric could be achieved with 1% Bordeaux mixture spray (Pundibari) and by 200ppm Ridomil spray (Raigarh). Coriander wilt could be controlled by seed treatment with *Trichoderma* and *Trichoderma* + Thiphonate methyl foliar spray (Coimbatore).

# General/Miscellaneous

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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 |

**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 cropping system |
| 3. Agr. XVII(813) | Vermi composting using organic wastes available in cardamom areas |
| 4. Agr. XIX (813) | Management efficacy of whole farm approach in farming – 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 compounds against major pests and pathogens of black pepper |
| 12. PHT.II (813) | Harvesting and processing techniques in spices |

**Crop Protection**

| | |
|---|---|
| 1. Path.II.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 black pepper 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. 1.1 (813) | Biological control of diseases of spice crops |
| 11. Biocontrol. 1.2(813) | Biological control of insect pests of spices |
| 12. Biocontrol 1.3(813) | Biological control of nematodes of spices |
| 13. Ent. XI (813) | Bioecology and management of mealy bugs infesting black pepper |

**Social Sciences**

| | |
|---|---|
| 1. Ext. IV (813) | Training of research and extension workers |
| 2. Stat. VI (813) | Economics of ginger |
| 3. Econ. 1 (813) | Economics of spices production and marketing |

## CONSULTANCY, PATENTS, AND COMMERCIALISATION OF TECHNOLOGY.

### Consultancy Processing Cell:

This year the Institute has commercialised the technology for large scale multiplication of *Trichoderma harzianum* P26 strain which is effective in suppressing the population of *Phytophthora capsici*, the causal organism of the major black pepper disease i.e. 'quick wilt'. The technology has been sold to six entrepreneurs @ Rs.10,000/- per entrepreneur. Through this the Institute has earned Rs.60,000/-. The Institute also received Rs.1,32,064/- from Marson Biocare Pvt. Ltd., Mumbai, the amount being the second installment for the contract research project undertaken by Soil Science Section on terra-care (coir compost). A few training programmes were also conducted, one each on nematological and pathological aspects and two one day training programmes were conducted at Cardamom Research Centre, Appangala, Madikeri for the benefit of farmers. Dr. Y. R. Sarma, Head, Crop Protection continues to be the consultant for the Indo-Swiss Project Sikkim on ginger disease programme. Contract services were also taken up in small quantities to help farmers as well as private estate owners. In all, the Institute earned about Rs.2,25,000/- through consultancy.

## RAC, MANAGEMENT COMMITTEE, SRC, QRT etc.

### Research Advisory Committee (RAC)

The RAC meeting was held on 2nd and 3rd February 1999. The members of the RAC are:

| | | |
|---|---|---|
| Prof. V.L. Chopra | : | Chairman |
| Prof. T. N. Ananthakrishnan | : | Member |
| Dr. Man Singh Manohar | : | Member |
| Dr. K. R. Maurya | : | Member |
| Mr. C. V. Jacob | : | Member |
| Dr. A. M. Michael | : | Member |
| Dr. P. N. Ravindran | : | Secretary |

The RAC gave the following recommendations

1. Genetic resources of black pepper and cardamom needs characterization using advanced molecular techniques.
2. IISR may try to enter into collaborative programmes with world class organizations.
3. IISR may develop specific varieties suited for different agro-ecological situations.
4. IISR may demonstrate biocontrol and IPM techniques in farmers' fields.
5. Institute may develop a module to study the impact of various technologies developed by the institute.

**Staff Research Council**

The XIII Staff Research Council meeting was held during 21-23, April 1999 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 progress of 47 institute projects and externally funded projects were discussed. The plenary session was presided by Dr. K. V. Peter, Director. He released the Research Highlights 1998-99. The technology developed were transferred to extension agencies during plenary session. Dr. T. John Zachariah, Senior Scientist (Biochemistry) functioned as the secretary.

**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 | : | Member |
| 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 February, 1999 and reviewed the programmes.

**PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORK-SHOPS, TRAINING ETC.**

| Name of Workshop/Seminar | Name of officer(s) attended |
|---|---|
| VIII$^{th}$ National work shop of KVKs., Vidyabhavan KVK, Udaipur. 15-17 January 1999. | P. S. Manoj |
| National seminar on development for transfer of fisheries technology, Fisheries College and Research Centre, Tuticorin. 3-5 February 1999. | Femeena Hassen |
| National Symposium on Plant Physiology and Biochemistry in relation to Agriculture and Environment, School of Life Sciences. Devi Ahilya University, Indore. 15-17 February 1999. | K. S. Krishnamurthy<br>S. J. Ankegowda |
| 4$^{th}$ Agricultural Science Congress, National Academy of Agricultural Sciences. Rajastan Agricultural University Jaipur. 21-24 February, 1999. | T. John Zachariah |
| Refresher course in advances in Plant Biotechnology at Division of Biochemistry, IARI, New Delhi 20-26 March, 1999. | T. John Zachariah |

| | |
|---|---|
| National symposium on sustainable Development of fisheries towards 2020 AD Opportunities and challenges, School of Industrial Fisheries, Kochi 21-23 March 1999. | Femeena Hassen |
| Town Official Language Implementation Committee (TOLIC) meeting, Regional Science Centre, Calicut, 23 April, 1999. | B. Krishnamoorthy |
| Bay area-Plant Microbe Interaction Conference, University of California, Berkeley. 7 May, 1999. | K.Nirmal Babu |
| One day seminar on revival and integrated development of Coorg mandarin in traditional regions at Coorg orange growers co-operative society Ltd. Gonikoppal, Kodagu, May 7, 1999. | V. S. Korikanthimath<br>M. N. Venugopal<br>Rajendra Hegde<br>S. J. Ankegowda<br>K. Padmini |
| Condensed Translation Training Course conducted by Central Translation Bureau of Department of Official Language (Ministry of Home Affairs) at Hotel Asma Tower, Calicut 10 May 1999. | B. Krishnamoorthy |
| Commercialization of Plant Tissue Culture – Role of MTPS. Organized by Department of Biotechnology and Biotech Consortium India Limited, New Delhi. 14 July 1999. | J. Rema |
| Hatchery production and aquarium culture of ornamental fishes, TTC, CMFRI Cochin. 19-24 July 1999. | Femeena Hassen |
| A detailed map of lettuce downy mildew fungus *Bremea lactuacae* constructed from RFLP, AFLP and phenotypic markers. 9th International Congress on Molecular Plant Microbe Interactions held at Amsterdam 25-30 July, 1999. | Nirmal Babu, K. |

| | |
|---|---|
| National Seminar on Research and Development in aromatic plants: Current trends in biology, uses, production and marketing of essential oils held at CIMAP, Lucknow during 30-31, July 1999. | T. John Zachariah |
| NBPGR meeting on Biodiversity Conservation (NATP) at NBPGR (RS), Vellanikkara, Mannuthy, Thrissur on 12 August 1999. | B. Krishnamoorthy |
| National Seminar on Official Language Management at Central Institute of Fisheries Technology, Cochin on 18-20 August 1999. | B. Krishnamoorthy |
| Scope of introducting irradiation of spices at IISR, meeting at BARC, Mumbai on 23-26 August 1999. | T. John Zachariah |
| 'Brain storming session on post harvest research programmes in plantation and tuber crops', at meeting CTCRI, Thiruvananthapuram, 24-25 September, 1999. | T. John Zachariah |
| Attended training on cDNA cloning at CAS, Biochemistry, IARI New Delhi, during 16 – 30 September, 1999. | B. Sasikumar |
| Fodder production and utilization. KLDB, Delhi. 4-24 October 1999. | K. M. Prakash |
| Orientation for Plant Genetic Resources (PGR) Policy and Emerging Intellectual Property Rights (IPR) issues. NBPGR (ICAR) New Delhi. October 25 – November 3, 1999. | J. Rema |
| Swadeshi Science Congress, Fathima Matha National College, Kollam. 5-7 November 1999. | Femeena Hassan. |

| | |
|---|---|
| XV Workshop of the All India Co-ordinated Research Projects on Spices., Organized by Indian Council of Agricultural Research and India Society for Spices. Calicut, Kerala. 18-21, November 1999. | All Scientists |
| National seminar on Developments in Soil Science. TNAU, Coimbatore, 26-30 November 1999. | Hamza S., Sadanandan A. K. and Srinivasan V. |
| National Seminar on Paprika, organised by Ministry of Agriculture, New Delhi and Department of Horticulture, Government of Karnataka, 4 December, 1999. | V. S. Korikanthimath |
| Symposium on Integrated Plant Disease Management, CPCRI, Kayangulam, 14-16 December 1999. | S. S. Veena |
| Indo-UK workshop on Innovative integrated Crop protection practices, Chennai, 15 December 1999. | S. Devasahayam |
| National Seminar on Nematological Research in India, C. S. Azad University of Agriculture and Technology, Kanpur. 17 December 1999. | K. V. Ramana. |

## WORKSHOPS, SEMINARS, SUMMER INSTITUTES ORGANIZED BY THE INSTITUTE

Fifteenth workshop of All India Coordinated Research Project on Spices (AIRCPS) was held at Hotel Asma Tower, Calicut during 18-21 November, 1999.

A pre-workshop meet was organised on 18th November. Panel discussion was arranged to sort out the programmes going on in various centres. Separate Panel members and resource persons were there for crop improvement, crop production and crop protection. The workshop

was inaugurated on 19th November by Dr. K. N. Syamasundaran Nair, Vice Chancellor, Kerala Agricultural University and was presided by Dr. R. N. Pal, Assistant Director General (PC), ICAR. Dr. S. Edison Director CTCRI and former PC (spices) and Dr, J.S. Pruthi, distinguished scientist and founder Director CFTRI felicitated the inaugural session. Various centres presented the achievements in the technical sessions. Session on release of varieties and recommendations to extension agencies was held on 21st November. Plenary session was chaired by Dr. R. N. Pal. Three new varieties in black pepper, one in cardamom, three in coriander, two in fenugreek, one in cumin and one in fennel were recommended for release in the workshop. Various plant protection recommendations also were finalised in the workshop.

**DISTINGUISHED VISITORS**

**Calicut**

| Name | Designation |
|---|---|
| Prof. T. N. Ananthakrishnan | Member, RAC |
| Dr. Anwar Alam | Deputy Director General (Engg.), ICAR, New Delhi |
| Dr. K.L. Chadha | National Professor (Hort), ICAR, New Delhi |
| Dr. V.L. Chopra | B. P. Pal National Professor and Chairman, RAC |
| Dr. S. P. Ghosh | Deputy Director General (Hort), ICAR, New Delhi |
| Dr. C. V. Jacob | Member, RAC |
| Dr. Kirti Singh | Chairman, ASRB, New Delhi |
| Dr. A. M. Michael | Member, RAC |
| Dr. K. R. Mourya | Dean, Rajendra Agricultural University, Bihar |
| Dr. R. N. Pal | Assistant Director General (PC), ICAR, New Delhi |
| Mr. Paloli Muhammed Kutty | Hon'ble Minister, Govt. of Kerala, Thiruvananthapuram |

| Name | Designation |
|---|---|
| Dr. S. N. Puri | Director, National Centre for Integrated Pest Management, New Delhi |
| Dr. C. R. Sivadasan | Senior Scientist (QC), Spices Board, Kochi |
| Dr. M. S. Swaminathan | MSSRF, Chennai |
| Dr. K. N. Syamasundaran Nair | Vice Chancellor, Kerala Agricultural University, Trissur |
| **Appangala** | |
| Dr. U. N. Barma | Planter and Environmentalist, Orissa Coffee Growers Association, Orissa. |
| Mr. G.S. Gopalakrishna | Deputy Commissioner of Agricultural Income Tax (Assessment), Chikamagalur. |
| Mr. S.J. Kochar | Hon'ble Judge, High Court Mumbai |
| Dr. K. Nagarajan | Director, Central Tobacco Research Institute (ICAR), Rajmundry, Andhra Pradesh. |
| Dr. Pratibha, D. Upasani | Hon'ble Judge, High court, Mumbai |

**PERSONNEL**

**INDIAN INSTITUTE OF SPICES RESEARCH, CALICUT**

**Managerial**

**K. V. Peter Ph.D., Director**

**Scientific**

**Division of Crop Improvement & Biotechnology**

B. Krishnamoorthy M.Sc. (Ag.), Senior Scientist (Plant Breeding) and Head in charge

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)

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

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

**Division of Crop Production and Post Harvest Technology**

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)

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

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

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

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)

**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 Assistant (T5)

V. Sivaraman, Technical Assistant (T-II-3)

K. T. Muhammad, Technical Assistant (T-II-3)

K. Jayarajan, Stat. Assistant (T-II-3)

M. Vijayaraghavan, Driver (T-II-3)

N. Chandrahasan, Driver (T-II-3)

K. Balan Nair, Driver (T-II-3)

Prasanna Kumari, Hindi Translator (T-II-3)

Minoo Divakaran, Tech. Assistant (T-II-3)

A. Sudhakaran, Artist-Cum-Photographer (T-II-3)

P. K. Chandravalli, Jr. Tech. Assistant (T-I-3)

K. Krishna Das, Mechanic-cum-pump operator (T-I-3)

K. K. Sasidharan, Jr. Tech. Assistant (T-I-3)

Dr. Fameena Hassan, Technical Officer (T6) (KVK)

T. C. Prasad, Driver-cum-Mechanic (T1) (KVK)

**Administration and Accounts**

K. Usha, Asst. Administrative Officer

T. Gopinathan, Asst. Finance & Accts. Officer

M.K. Sachidanandan M.A., Asst. Finance and Accounts Officer

V.L. Jacob Asst. Finance and Accounts Officer

V. Radha, Assistant

A. P. Sankaran, Assistant

V. Vijayan, Assistant

C. Padmanabhan, Assistant

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

P. V. Sali, Stenographer

Alice Thomas, Stenographer

C.K. Beena, Jr. Stenographer

P.K. Janardhanan, Sr. Clerk

C. Venugopalan, Sr. Clerk

R.N. Subramanian, Sr. Clerk

K. Padminikutty, Sr. Clerk

V. C. Sunil, Sr. Clerk

P. Sundaran, Jr. Clerk (KVK)

S. Sunitha, Jr. Stenographer (KVK)

V.V. Sayed Muhammed, Jr. Clerk

N. Prasannakumari, Hindi translator

**ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES, CALICUT**

P.N. Ravindran Ph.D., Project Coordinator

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

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

**IISR EXPERIMENTAL FARM, PERUVANNAMUZHI**

**Scientific**

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

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

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

**Technical**

V.K. Abubacker Koya, Farm Superintendent (T7)

N. A. Madhavan, Jr. Tech. Assistant (T-II-3)

K. Kumaran, Jr. Tech. Assistant (T-II-3)

V. P. Sankaran, Jr. Tech. Assistant (T-I-3)

N. P. Padmanabhan, Jr. Tech. Assistant (T-I-3)

P. Baskaran, Jr. Tech. Assistant (T2)

A. K. Balan, Jr. Tech. Assistant (T2)

M. K. Ravindran, Jr. Tech. Assistant (T1)

K. Chandran, Jr. Tech. Assistant (T2)

K. P. Premachandran, Jr. Tech. Assistant (T1)

E. V. Ravindran, Jr. Tech. Assistant (T1)

M. Balakrishnan, Jr. Tech. Assistant (T1)

P. Sadanandan, Jr. Tech. Assistant (T1)

T. R Sadasivan, Pump Operator (T1)

P. K. Balan, Tractor Driver (T1)

**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)

Rajendra Hegde Ph.D., Scientist Sr. Scale (Agronomy)

S. J. Ankegowda Ph.D., Scientist (Plant Physiology)

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

D. Prasath Msc. (Ag.), Scientist (Horticulture)

**ADMINISTRATIVE**

Enid Savitha, Assistant Administrative Officer

K. Vasudevan, Assistant

Ramesh Babu, Jr. Stenographer

**Technical**

L. Balakrishna, Jr. Tech. Assistant (T2)

K. Ananda, Jr. Tech. Assistant (T1)

K. B. Prasanna Kumar, Jr. Tech. Assistant (T1)

K. A. Soman, Farm Assistant (T-II-3)

M.C. Rathish, Driver (T1)

**KRISHI VIGYAN KENDRA, PERUVANNAMUZHI**

**Scientific**

P. Rajeev, Ph.D., CTO-in-charge

**Technical**

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

K. D. Prathapan M.Sc. (Ag.), Tech. Officer (T6) (Pl.Protn.)
(on study leave)

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

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

S. Ravi, Ph.D., Trg. Asst.-cum-Tech. Asst. (T-II-3)

## OTHER ACTIVITIES IN THE INSTITUTE

### AICRP Workshop

The institute in collaboration with Indian Society for Spices has organised XV group meeting of the All India Coordinated Research Project on spices at Hotel Asma Tower, Calicut during 18-21 November 1999. The meeting was inaugurated by Dr. K. N. Shyamasundaran Nair, Vice Chancellor, Kerala Agricultural University, Thrissur and was presided by Dr. R. N. Pal, Assistant Director General (PC), Indian Council of Agricultural Research, New Delhi. Scientists from the 20 coordinating centres spread all over the country attended the meeting. About 150 delegates including spices scientist working in different centres

and experts from Spices Board, IISR, CPCRI, KAU, DASD, NBPGR, SAUs, Spice industry, farmers, representatives from Agro-input agencies etc participated in the four day deliberations. The workshop deliberated on the progress of research made in the centres and recommended ten new varieties of spices for release.

**Women's cell**

The IISR women's cell organised its annual day on 18 November 1999. Malayalam writer Mrs. P. Valsala was the chief guest. Mrs. Valsala Ramadasan, social activist and Lion's club member presided over the meeting. Dr. B. Sasiskumar and Dr. T. J. Zachariah, Scientists of IISR offered felicitations. Dr. K. V. Peter, Director welcomed the gathering and Dr. B. Chempakam, Chairperson, Women's cell proposed vote of thanks.

# अनुसंधान विशिष्टता

## सारांश

### नये जर्मप्लासम

काली मिर्च: इस साल लगभग 108 अक्सशनों का संग्रह किया गया। कर्नाटक के सिरसी, सागर और कूरग तथा केरल के इडुक्की से 64 क्य प्रकार तथा 44 कृष्ट प्रकार का संग्रह किया। संग्रह किये कृष्ट प्रकार में करिमल्लिकेशरा, बिलेमल्लिकेशरा, बोक्कालू, वेल्लनम्बन, तेबनमुण्डी जैसे स्थानीय प्रकार भी शामिल होता है।

अदरक: कर्नाटक के सागर, नेपाल (एन बी पी जी आर, नई दिल्ली के द्वारा) कूच बीहार, उत्तर बंगाल आदि जगहों से कुल मिलाकर 13 संग्रहों को लिया गया।

हल्दी: इस वर्ष पांच संग्रह लिया गया। इसमें सी सीसिया (काली हल्दी-अखिल भारतीय समन्वित अनुसंधान प्रायोजना - पुँडिबारी) भी शामिल होता है।

वैनिला: जर्मप्लासम में चार संग्रहों को जोड़ दिया। इसमें रंग - बिरंगे पत्तों सहित वैनिला पीलीफेरा, वी. वटसला, वी. टालटनसिस और वी. प्लानिफोलिया शमिल होता है।

वृक्ष मसाले: इस वर्ष सिनमोमम वीरम (चेताली) का एक अक्सशन, जायफल का एक दिगिरीदार प्रकार (फरोक, कालकिट) क मिरिस्टिका बडोमी (इडुक्की), एम. मलबरिका के दो अक्सशन (क्यनाडु) और गार्सिनिया गम्मिगट्टा के पांच अक्कश्न (त्रिचूर, केरल और मरकारा, करनाटक) भी जोड दिये।

### फसल सुधार एवं अनुरक्षण

काली मिर्च संकरज एच पी 105 उपजता के पांचवें साल वालपराई में उच्चतम उपजता (6.025 कि. ग्राम/बेल) बनाये रखते हैं जिसके पीछे एच पी 728 (5.67 कि. ग्राम/बेल) आता है। HP 1041 लगातार फाइटोफथारो खुर विगलन का सहय और पीलापन दिखाते हैं और उपजता 4.7 कि. ग्राम/बेल मध्यम होता है। एच पी 1411 (एयिम्पीरियन × पन्नियूर 1) तथा करिमुंडा के एक खुले परागित संग्रह भी पेरुक्नामुषि में उत्तम दक्षता प्राप्त की।

अदरक के स्थूल राइज़ोम चयन जैसे ए.सी.सी. 35 और 117 को बरदा के साथ किसानों के प्लाट में मूल्योंकित किया। इन्हीं किस्मों को किसानों के प्लोट में 1:20 गुणन अनुपात पाया गया जो वरदा के 1:18 अनुपात के खिलाफ होता है। ए सी सी 35 को 21% सूखे उपज मिलते वक्त एसी सी 117 से केवल 19% प्राप्त होता है।

आलप्पी फिंगर टमरिक ए सी सी 584 और 585 क्रमश: 24.5 और 30.3 टन/हेक्टर साफ राइजोम उपज की प्राप्ति अंकित की जिमें 17 और 16 प्रतिशत ड्रयेज होता है। उनमें 6% से अधिक कुरकुमिन होता है।

पप्रिका के 64 विजातीय और 77 देशी प्रकार (बिदगी डाब्बा) के संग्रहों में खेत निरीक्षण किया गया। विजातीय संग्रहों को देशी सामग्रियों (39.9%) का अपेक्षा जीवाणुक म्लांनी (59.2%) अधिक प्रकृत्त होने की संभावना है। फिर भी बिदगी डाब्बा प्रकार में विजातीय प्रकार (34-246 ASTA) की अपेक्षा तीक्ष्णता और रंगमूल्य अधिक (131-349 ASTA यूनिट) होता है। यह भी सूचित होता है की बिदगी डाब्बा से अधिक रंगप्राप्ति की संभावना है जो स्थानीय हालत में ज्यादा अपनाया जाता है।

इलायची के मोसेक प्रतिरोधी वंश एवं उच्च उपजता के पूर्व विमोचित चयन के आपसी संकरज का मूल्यांकन परीक्षण में *CCS-I* × *NKE-12* और *NKE-19* × *NKE-27* के परसंयोजन से पादप ऊंचाई एवं कृषकों की संख्या केलिए अधिकतम संकर ओज अंकित किया रोपण के तीन साल बाद पी कोलुब्रिनम स्वक पर काली मिर्च का अस्तित्व यह सूचित करता है कि द्विप्रकंद तरीका उत्तम (88.9%) होता है जिसके पीछे जीभी और काठी कलम बांधना (61.1%) आता है। कोलुब्रिनम पंकंद (रुट स्वक) मीली बग के प्रति सुग्राह्य दिखाया गया जो कोल्लार क्षेत्र में प्रभावित होता है और मूल रीति (root system) ग्राफटस का नाश कारक होता है।

वृक्ष मसालों में जायफल का A 9/4 और कैसिया का $A_2$, C, D और $D_3$ आदि आशाजनक वंश होता है।

एम. फ्राग्रन्स, कृष्ट जायफल की एप्रोच ग्राफिटग केलिए मिरिस्टिका बडोमी और एम. मलबरिका को संगत रुट स्टक होते देखा गया। सिज़िजियम हेनियानम रुट स्वक पर लौग का ग्राफ्टिंग सफल होता है।

## कोशिका जननिकी और भ्रूण विज्ञान

काली मिर्च के भ्रूण विकास पर अध्ययन करने से यही सूचित होता है कि परागण के तीन महीने बाद भ्रूण हृदय आकार संरचना प्राप्त होता है। अन्य विकास बीजांकुरण की प्रक्रिया के दौरान केवल बीज झडने के बाद प्राप्त होता है।

हल्दी के दस पौद संततियों के कोशिका विश्लेषण ने क्रोमसोम संख्या की भिन्नता जैसे 63, 74, 77 और 84 दिखा दी।

अमोमम के चार स्पीसीस जैसे ए सुबुलाटम, ए मुरिकाटम, ए माइक्रोस्टीफानम और ए कानयीकारपम के कोशिका विश्लेषण में सबके लिए 2n=48 प्रकट हुआ।

## जैवप्रौद्योगिकी

पाइपर कुबेबा और पाइपर अटेन्युआटम में इन विट्रो गुणन प्रकृत्त किया गया पी कुबेबा, पी अटेन्युआटम और बीज मसाले जेसे निगल्ला सटिवा और ट्रकिसपरमम अम्मी को जोडकर इन विट्रो जीन बैक को मज़बूत बनाया गया।

## केन्द्रक रोपण सामग्रियां

काली मिर्च के मूल लगाए कतरन 93,000 काली मिर्च के मूल लगाए लेटरल्स (500), हल्दी का बीज राइजोम ( 6 टन) अदरक का बीज राइज़ोम (1.5) टन जायफल का ग्राफट्स (2630) दालचीनी का सीडलिंग्स (180) आदि उत्पादित करके वितरित किया।

## काली मिर्च की सूखा सहयता

काली मिर्च अक्सशन 4216 और 4226 जल प्रतिबल (Water Stress) केलिए अपेक्षाकृत सहय होता है।

## पोषण एवं प्रबन्ध

FYM लगाने से बुश पेप्पर (पन्नियूर और करिमुंडा दोनों किस्मों में) की उपजता में वर्मी कम्पोस्ट और पर्ण कम्पोस्ट लगाने की अपेक्षा महत्वपूर्ण वृद्धि हुई। रासायनिक उर्वरक मात्रा लगाने की अपेक्षा पन्नियूर में 104% और करिमुंडा में 35% तक की उपज वृद्धि होती है।

अदरक में FYM (10 टन/हेक्टर) और संस्तुत मात्रा की NPK के साथ सूक्ष्म पोषण जैसे बोरोन और मोलीबडिनम लगाने से उपजता में क्रमश: 32% और 43% वृद्धि हुई।

हल्दी में, विभिन्न आरगानिक स्रोत लगाने में FYM (1 किलो ग्राम/गमला के दर में) लगाने की अपेक्षा मिर्च का अपव्यय (250 ग्राम/गमला के दर में) लगाने से उच्चतम उपजता मिली।

## गुण मूल्यांकन

वालपराई (तमिलनाडु के उच्तुंगता क्षेत्र) में मूल्योकित काली मिर्च संकरज और संग्रहों में HP 34 को 628 ग्राम के उच्च आभासी घनत्व (Wt/litre) होता है और संग्रह 1041 को 536 ग्राम होता है। HP 728 और 813 को उच्च ओलिओरसिन (>10%) और पाइपरिन (>5%) होता है।

प्रभा और प्रतभिा के कुरकुमिन घटक सांगली (महाराष्ट्रा) में स्थान प्रबाव दिका दिया। कालिकट की अपेक्षा वहां 35–40 प्रतिशत अपचयन दिखा दिया। मूल्योंकित किये अदरक अवसशनों में ACC 511 ने 8.9% ओलिओरसिन अंकित किया और ACC 191,288 और 302 ने कम रेशा (<3%) अंकित की। ACC 411 और 420 ने 2.7% सुगन्धित तेल अंकित किया।

## पादप रोग विज्ञान

बयोवार के दुत पहचान केलिए माइक्रोटाइटर 'प्लेट और छोटी मात्रा में अभिकारक के द्वारा एक सरल भयोवार लक्षण तकनीक को मानकीकृत किया। भारत में अदरक के जीवाणुक म्लानी जैसे महामारी की भूमिका समझने केलिए टमाटर, आलू, मिर्च, यूपोटोरियम और अगेरटम से रालस्टोनिया सोलानसीरम को क्युक्त किया। इन्हीं क्युक्तियों के बीच कालीनी लक्षण कार्बोहाड्रिट उपयोग की रीति, रोगजनक संभाव्यता, एन्टीबयोटिक प्रतिरोधकता आदि वैभिन्य देखा गया। मेम्बरेन प्रोटीन पर आधारित लक्षण से रालस्टोनिय सोलानसीयारम के सभी वियुक्तियों में 37–40Kda प्रोटीन का प्रभाव प्रत्यक्ष हुआ। यह प्रोटीन इम्यूणो किट के विकास केलिए प्रतिरक्षक उत्पादित करने हेतु स्पीसीस विशिष्ट प्रतिजन के रूप में इस्तेमाल किया जा सकता है।

## रालस्टोनिया सोलानसियारम के सेरोलजिकल डिटक्शन

अन्तर्राष्ट्रीय आलू केन्द्र (CIP, Lima, Peru) में विकसित होट इम्यूनो बाइन्टग ऐस्से किट (NCM-ELiSA) को अदरक केलिए किट की अनुकूलन शीलता जानने हेतु मूल्योकित किया। फलत: यह किट अदरक नमूने में बाक्टीरियम के पता लगाने हुतु उचित देखा गया।

फाइटोफथोरा काप्सीसी, राडोफोलस सिमिलसि और एम. इनकोग्निटा केलिए गुणन प्रतिरोधकता के साथ पी. कोलुब्रिनम को CMV केलिए सुग्रह्य देखा गया। यह ग्राफ्ट संचरण के आधार पर होता है और ELISA द्वारा अनुवर्ती जंच भी किया गया।

आई आई एस आर के प्रायोगिक क्षेत्र पेरुक्नामुषि में वैनिला में पत्र विगलन और म्लानी का छोटा आपतन दिखाई पड़ा। पत्र विगलन और म्लानी दोनों का कारण फुसेरियम एस.पी.होता है। वालपराई में वैनिला से फुसेरियम एस पी को वियुक्त किया। कारबनडाज़ीम और मानकोज़ेब संयोजन का एक नया कवगनाशी 'सफ' व्यापार नाम से विक्रय किया जिसका इन विट्रो और इन विवो में जांच किया और 100 ppm फुसेरियम की वृद्धि निरोधित करने में इसे सफल देखा गया।

## रोग प्रतिक्रिया केलिए जर्मप्लासम की छंटाई

133 जर्मप्लासम में उनके पी काप्सीसी की प्रतिक्रिया की छांट करने पर उनमें 3 जर्मप्लासम (HP 295, W3241 और W3073) प्राथमिक छांट में प्रतिक्रिया प्रतिरोधी पाया गया। पुल्पल्ली और वाल्पराई में किये गये खेत परीक्षण में फाइटोफथोरा खुर विगलन की सह्यता केलिए संगत दक्षता प्रस्तुत की।

## निवेशन तकनीक

अदरक जर्मप्लासम के जीवाणुक म्लानी सह्यता की छांट केलिए सरल निवेशन तकनीक मानकीकृत किया। यह तकनीक बहुत तीव्र और लागू करने में सरल होता है। निवेशन के 10 दिन के अन्दर प्रतिक्रिया देखा जा सकता है। अदरक जर्मप्लासम के मूल्यांकन केलिए निवेशन प्रक्रिया का उपयोग किया जाता है।

जीवाणुक म्लानी सह्यता केलिए ग्रीन हाऊस में कुल मिलाकर 21 सोमाक्लोन का मूल्यांकन किया गया। ये सोमाक्लोन हिमाचल किस्म की तरह उतना ही सुग्राह्य होता है।

## जैविक नियंत्रण

## अदरक के जीवाणुक म्लानी का जैविक नियन्त्रण:-

अदरक खेत से वियुक्त आठ बाक्टीरिया और रिज़ोस्फियर मृंदा को ग्रीन हाऊस में रालस्टोनिया पर विरोधी प्रबाव केलिए मूल्यांकन किया गया। मूल्यांकित बैक्टीरिया में कोई भी पौधों को म्लानी

से बचाया नहीं जा सकता। फिर भी कुछ वियुक्तियांपोट कल्चर परीक्षण द्वारा अदरक की उपजता बढ़ा सकती है।

काली मिर्च नर्सरी में VAM और ट्राइकोडरमा की दक्षता विगलन की योगवाही वृद्धि प्रबाव का अध्ययन किया गया। करिमुंडा किस्म पन्नियूर 1 से अधिक महत्वपूर्ण देखा गया। VAM और ट्राइकोडरमा हरीज़यानम और टी वाइरन्स का संयोजन दोनों कस्मिों में अंकुरण और मूल वृद्धि तेज बनाता है।

अनिवेशित खेत में शून्य स्तर से तुलना करने पर जैवनियन्त्रण प्लांट में ट्राइकोडरमा की संखाय $10^4$ cfu/g हो गया।

## रोग प्रबन्ध

काली मिर्च में पी.काप्सीसी के प्रति पोटैशियम फासफोनट संस्तुत मात्रा में लगाने से 4 दिन के बाद नाश होता है। पोटैशियम फॉसफानेट (4 ml/l से 10 ml/l) के उच्च संकेन्द्रण के साथ अध्ययन की कोशिश की। इस उपचार में 6-10 ml द्वारा दवा पिलाने के बाद 30 दिन तक उच्च संरक्षण दिया जा सकता है। इन्ही संकेन्द्रणों में कोई पादप आविषालुता देखा नहीं। सिर्फ जैवनियन्त्रण एजेंट के साथ पोट कल्चर परीक्षण में और पोटैशियम फॉसफानट संयोजन में मूल विगलन पर यही दिकाता है कि वर्टिसिलियम टनीरम और पोटैशियम फॉसफानट (11.1%) संयोजन के साथ उपचार करने से कम नाश दिखाया जाता है जिसके पीछे ट्राइकोडरमा वाइरन्स और टी हरज़ियानम पोटैशियम फॉसफानट संयोजन में (16.6%) नियंन्त्रण में 83.3% होता है।

काली मिर्च बाग में पडे खुर गलन के पुनर्युवन केलिए एकीकृत मिलना पर किये अध्ययन से टेक द्वारा सूचित पादप वृद्धि पत्तों की संख्या और पादप ऊंचाई आदि अन्तर खेती रहित उपचार की अपेक्षा घास-पात रहित कृषि युक्त उपचार उत्तम होता है।

एकीकृत रोगप्रबन्धन पलट में P 24 में सबसं कम नाश (1/40) होता है जिसके पीछे पन्नियूर-4 (4/40) आता है।

रोग प्रतिरोधी किस्मों में प्रतिरोधकता की क्रियाविधि व्यवस्था

इलायची किस्मों के रोगप्रतिरोधी RAPD प्रोफाइल विश्लेषण के उद्देश्य से 20 ओपेरॉन यादृच्छिक अनियमित की कोशिश की गयी। दोनों OPAO 8, OPA 12, ने अच्छा प्रबर्धन प्रस्तुत

किया। इलायची को तापानुशीतित करने का तापमान 40°C के रूप में मानकीकृत किया। राइज़ोम विगलन प्रतिरोधकता में इलायची के RR-1 एक सुस्पष्ट बैंड के सुग्राह्य जांच की अपेक्षा उत्तम देखा गया।

## फाइटोनट

भारत के विविध परपोषियों से कुल मिलाकर 514 फाइटोफथोरा वियुक्तियों को फाइटोफथोरा के राष्ट्रीय रपोसिटरी (NARPA) में बनाये रखा जा रहा है। काली मिर्च के 48 फाइटोफथोरा वियुक्तियों तथा बीटल वाइन के 32 फाइटोफथोरा क्युक्तियों में आकृतिक लक्षण का विस्तृत अध्ययन किया गया। 48 वियुक्तिकृत में 44 लंबे पुष्पवृंत 20-206 μm युक्त पी.काप्सीसी प्रारूपक और पुष्पछत्री व्यक्तिकृत्त होता है जहां 4 स्पोरोन्जियल स्टॉक लंबाई 23-195μm युक्त संघिताक्षी व्यक्तिकृत्त होता है। अध्ययन किये 32 बीटल वाइन वियुक्तियों में 22 वियुक्तियां विभिन्न पुष्पवृंत (0-20.7μm) युक्त पी. काप्सीसी प्रारूप और संधिताक्षी व्यक्तिवृत्त होता है जहां 10 लंबे पुष्पवृंत (20-24μm) युक्त पी. काप्सीसी प्रारूप और पुष्पछत्री व्यक्तिकृत्त होता है।

काली मिर्च में पी. काप्सीसी निवेशन पर रोगजनक संबन्धित प्रोटीन (PR-प्रोटीन) का रिपोर्ट किया गया। एन्टी रबिट प्रतिरक्षी के प्रयोग के द्वारा फाइटोफथोरा सहयता युक्त काली मिर्च किस्म पी 24 में काइटिनस और β-1,3 ग्लूकोनस के अस्तित्व का पहचान किया गया। β-1, 3 ग्लूकानस और काइटिनस इसोफॉम के रूप में पहचान किये 30 और 35 के KDa प्रोटी क्रमश: इलक्ट्रोइल्यूटड कर दिया और इस इल्यूटड प्रोटीन में कवगप्रतिरोधी क्षमता दर्शाये।

फाइटोफथोरा वियुक्तियों के चरित्रांकन केलिए सूपर आंक्साइड डिस्म्यूटाइस और कटालस के साथ इसोज़ाइम कार्य प्रारंभ किया। कई सार प्रतिरोधी की कोशिश की। पी. काप्सीसी वियुक्ति 99 101 में SOD केलिए दो लोसी और एक लोकस कटालस की पहचान की गयी।

काली मिर्च की वृद्धि और फाइटोफथोरा निरोध केलिए इन विवो में ट्राइकोडरमा वाइरन्स वियुक्तियों की छांट की। वियुक्ति GVS अधिकतम पादप वृद्धि केलिए उचित होता है। आरगनिक संशोधन जैसे रेशा पिथ FYM नी, केक और ग्लिरिसिडिया के लिफ लिटर मृदा में टी. हरीज़यानम के अस्तित्व में सहायक होता है। जब ये आरगनिक कार्य बडी मात्रा में प्राप्त होती है तब टी. रहज़ियानम के कालोनी रूपायन एकक की संख्या में स्पष्ट वृद्धि होती है। रेशा, पिथ, रेशा कम्पोस्ट के कालोनी रूपायन एकक की संख्या में स्पष्ट वृद्धि होती है। रेशा, पिथ, रेशा कम्पोस्ट और

लिगनाईट को द्रव किण्वन उपज केलिए कार्य माध्यम के रूप में प्रयोग करता है। मिश्रण के 60 दिन बाद जब स्टरिल दशा में सभी तीन मध्यम को उच्च कालेनी रूपायन एकक में अंकित किया। काली मिर्च के रिज़ोसफियर से ट्राइकोडरमा के 25 वियुक्तियां, बैक्टीरिया के 23 वियुक्तियों और कवग विरोधक के 16 वियुक्तियों को अलग किया गया। फोराइट और क्लोरपिरिफोस संस्थुत मात्रा में डालने के साथ जैवनियन्त्रण एजेंट टी. हरजियानम उचित देखा गया। ड्सिलेस हेमीसेलूलेस (hemicellulase) और सेलूलेस ओनुज़ुका (Cellulase Onuzuka) का इस्तेमाल करके ट्राइकोडरमा हरज़ियानम से प्रोटोप्लास्टस की वियुक्ति केलिए एक प्रविधि मानकीकृत की गयी।

## कीट विज्ञान

## परपोषी प्रतिरोधकता की पहचान एवं चरित्रांकन

काली मिर्च अक्सशनस, वन्य पाइपर स्पीसीस और अन्तरविशिष्ट संकरज को पोल्लू बीटल के प्रतिरोधक पाया जाता है जिसे अपनी जैवरासायनिक संघटक केलिए चरित्रांकित किया गया। सुग्राह्य नियन्त्रण की तुलना में प्रतिरोधक किस्मों में अबद अमिनों एसिड और सतह मोम का स्तर प्रधानतया ऊंचा होता है।

## प्रकृतिक उपजों का मूल्यांकन

पोल्लू बीटल के प्रति मिर्च सार के एन्टीफीडन्ट क्षमता और मेलिया कम्पोसिटा के बीज गिरी का मूल्यांकन करने केलिए प्रयोगशाला जैव आमापन (bioassay) आयोजित किया गया। मिर्च सार और एम.कम्पोसिटा बीज गिरी सार की एन्टीफीडन्स क्षमता सराहनीय होता है जिसके कारण क्रमश: 1 और 2% एकाग्रता में 90% फीडिंग डिटरन्स होता है।

## काली मिर्च में पेस्टिसाइड रसिड्यू का निर्धारण

काली मिर्च में पेस्टिसाइड रसिड्यू, जिसमें एन्डोस्लफान और नीम उपज के छिडकाव की मात्रा संस्तुत है अपनाने का निर्णय किया। दो बार एनडोसल्फान (0.05%) का छिड़काव एक बार एनडोसल्फान (0.05%) के साथ तीन बार नीमगोल्ड 0.6% और 4 बार. नीम गोल्ड 0.6% छिडकने के फलस्वरूप काली मिर्च फसलन में एनडोस्लफान रिसड्यूस का अनिगमन स्तर 0.041, 0.009ppm होता है। ये रसिड्यू स्तर आयातक राष्ट्रों द्वारा व्यवस्थित 0.1 ppm के अनुज्ञेय स्तर से कम होता है।

## मूल मीली बग का वितरण एवं काली मिर्च पर विनाश का स्वभाव

काली मिर्च पर मूल मीली बग (प्लानोकोकस स्पीसीस) के वितरण का अध्ययन करने हेतु केरल के वयनाडु जिला के 8 जगहों में सर्वेक्षण आयोजित किय। कीटबाधा का निरीक्षण 6 जगहों में किया जहां बेल के 6.7 से 42.2% तक मूल मीली बग की बाद दिखाई पडी। मूल मीली बाधित 33% बेल पर फाइटोफथोरा खुर विगलन रोग भी पड़ जाते है। मीली बग की बाधा के कारण पत्ते पीले पड़कर मुरझे जाते है, विपत्रण और बेल का नाश भी होता है। चूंकि इनमें अधिकांश बेलों पर पी.काप्सीसी और नेमटोड की बाधा होती है।

## मीली बग का जैविक नियंन्त्रणन

पेरुक्नामुषि के खेत में मृत मीली बग दल से कवग के एक अनभिज्ञ स्पीसीस का संग्रह किया। मूल मीली बग के प्रति एनटोमोपाथोजनिक कवग जैसे ब्यूवरिया बसियाना, पासिलो माइसस लिलासिनस, वर्टिसिलियम क्लामिडो स्पोरियम और मेटारबिज़ियम अनिसपलिये की रोगजनकता का मूल्यांकन करने केलिए प्रयोगशाला जैव आमापन (bioassay) का आयोजन किया गया। बयोऐसे यह सूचित करता है कि विभिन्न कवगों में एम. अनिसोपलिये सबसे अधिक आशाजनक है, जिसके कारण मीली बग कालोनी में नियन्त्रण की 175% वृद्धि की अपेक्षा 80% घटाव होता है।

## राइज़ोम शल्क का प्रबन्धन

संचयन के दौरान अदरक पर राइजोम शल्क अस्पिडियल्ला बारटी के प्रबन्धन केलिए विभिन्न कीटनाशियों, पादप और ओरगानिक उपयों का मूल्यांकन किया। राइजोम की अधिक प्रप्ति, बडी मात्रा में अंकुरण और राइजोम शल्क का न्यूनतम आपतन आदि प्राप्त करने केलिए विभिन्न उपचारों के बीच बीज राइज़ोम को क्विनालफोस 0.07% में डुबोना या मीथाइल पारातियोन 0.075% या डायमेतोयट 0.075% लगाना आदि उपचार करने केलिए परीक्षण के आधार पर सूचित किया जाता है।

## प्ररोह बेधक का प्रबन्धन

अदरक खेत में प्ररोह बेधक (कोनोगटब्स पंक्टिफरालिस)के प्रबन्धन केलिए कर्षण रीतियां और विभिन्न मात्राओं में कीटनाशियों के छिड़काव का मूल्यांकन किया। इस परीक्षण से सूचित होता है कि जुलई-अगस्त में कीटबाधित प्ररोहों की काट - छांट करना और सितम्बर-अक्तूबर में

कीटनाशी छिडकने के फलस्वरूप कीट बाधा कम होता है और उपजता बढती है। इस कर्षण रीति को अपनाते हुए दो बार कीटनाशी छिड़कने की रीति छोड़ दिया जा सकता है। ऐसे प्राकृतिक शत्रुओं को परिरक्षित करके पर्यावरण की हानी कम कर सकता है।

## गोलकृमि विज्ञान ( नेमटोलजी )

अनुरूपी खेत के अधीन मूल्यांकन करने पर हल्दी के चार अवसशन (ACC84, 142, 182 और 198) और अदरक के दो जर्मप्लास अक्सशन में मूल-गांछ गोलकृमि के प्रति प्रतिरोधकता की पुष्टी की। दूसरे काट छांट में हल्दी के अन्य चार अक्सशन (Acc31, 82, 178 और 200) और अदरक के एक अक्सशन मेलोयिडोगाइन इनकोग्निटा के प्रति प्रतिरोधक हो गये।

पाइपर नाइग्रम के पांच बन्य अक्सशन (W-3141, 3200, 3282, 3291 और 3299) और काली मिर्च के एक संकरज (HP 309) राडोफोलस सिमिलिस के प्रति प्रतिरोधक हो गये। प्रतिरक्षा संबन्धित एनजाइम जैसे सूपर आंकसाइड डिस्म्यूटाइस (SOD) पेरोकिसडेस (PO) और कटालेस (Cat) में मूल गांठ गोलकृमि सह्य (पौर्णमी) और काली मिर्च के सुग्राह्य किस्म (पन्नियूर 1) में SDS-PAGE द्वारा कीटबाधा के बादवाली बदलाव का गुणात्मक दृष्टि से अनुवीक्षण किया। ''पौर्णमी'' में निवेशन के 24 और 48 घटे बाद पेरोकिसडेस के इसोफाम और कटालेस एनजाइम का निरीक्षण किया गया।

## गोलकृमि विविधता

सजीव गोलकृमि संग्रह में और भी मूल गांठ पांच गोल कृमि को जोड दिया। पेरुवन्नामुषि में एक मूल गांठ गोल कृमि स्पीसीस, एम. केरालनासिस का पहचान किया।

## जैविक नियंत्रण

इन विट्रो जैव आमापन द्वारा वेरटिसिलियम स्पीसीस, पासिलोमाइसस लिलासिनस, ट्राइकोडरमा स्पीसीस, फुसेरियम स्पीसीस अस्पराजीस स्पीसीस और अनिवार्य बाकटीरियल हाइपर परासाइट पास्टरिया स्पीसीस आदि के अंडे परजीवि कवग वियुक्तियों का पहचान किया गया। ग्रीन हाउस अध्ययन में पी क्लामिडो स्पोरियम (आंशिक रुप से) काली मिर्च के मूल लगाए कतरन में और सिमिलिस संख्या को बंद किया। आशाजनक जैवनियन्त्रण एजेंट के मूल्यांकन केलिए क्यनाडु में किसानों के गोल कृमि बाधित काली मिर्च बाग में एक नया खेत परीक्षण किया गया। सोरगम और

अपघटित काफी भूसी डालने से अधिकतम वृद्धि और वी. कलामिडोस्पोरियम की बीजाणुक जनन होता है जबकि FYM और वर्मीकम्पोस्ट सबसे छोटे जीवाधार होता है। मगर पी ल्लिासिनस की अधिकतम वृद्धि और गुणन चावल और अदरक के पर्ण चूर्ण में निरीक्षण किया गया।

पी. कोलुब्रिनम पत्तों में नेमटोड नाशक संघटक को 5'' 4' डैहाइड्रोविस - 7 मिथोविस फलेवन और 5, 3', 4' डैहाइड्रोविस-7- मिथोक्सि फलेवन के रूप में चरित्रांकित किया।

## समाज विज्ञाम

## प्रशिक्षण कार्यक्रम

'मसाले उत्पादन प्रौद्योगिकी', 'नर्सरी प्रबन्धन' और 'मसालों का खतीगत संसाधन' पर प्रशिक्षण कार्यक्रम आयोजित किया। सात राज्यों से आये लगभग 53 अधिकारियों ने इस प्रशिक्षण कार्यक्रम में बाग लिया। अनुरोध के अनुसार स्पाइसस बोर्ड के उत्तर दायित्व पर उत्तर पश्चिम और अन्य राज्यों से आये 50 से अधिक किसानों को प्रशिक्षण आयोजित किया।

## मसाले उत्पादन और विपणन की अर्थव्यवस्था

काली मिर्च केलिए विकेन्द्रीकृत विपणन चैनल जिसमें 11% मूल्य व्याप्ति और कुछ मध्यस्थ है, अदरक केलिए होने से अधिक कुशल होता है।

वर्ष 1998-99 में काली मिर्च का उत्पादन मूल्य प्रति किलों ग्राम 33 रूपए होता है जो आकलित पूर्ति मूल्य 43.50 रुपए के स्थान पर होता है।

केरल में काली मिर्च के फाइटोफतोरा खुर विगलन रोग के प्रति एकीकृत उपायों पर केन्द्रीय सरकार के उत्तरदायी कार्यक्रम के एक कार्योत्तर मूल्यांकन किया गया।

इस क्षेत्र के अधिकांश किसान लगभग 97% इस कार्यक्रम के प्रति अवगत होता है और इस के घटक भी होते है।

लगभग 73% किसानों ने इस संस्तुत कर्षण और फाइटोसानिटेशन उपायों को अपना लिया। (घटक-1)

रासयनिक नियन्त्रण उपयों केलिए भागफल अंगीकरण (मनसून के पहले और बाद दोनों बार ठिकना) जैसे घटक -II केवल 41.4% हैं।

खाद और उर्वरक लगाना संस्तुत सस्यीय क्रिया के अन्दर नहीं आते।

इडुक्की और वयनाडु के मसाले जिलाओं में प्राप्त अनुकूल वृद्धि दर क्रमशः 6.54% और 3.37% तकनोलजी के विजय में प्राप्त होता है।

सर्वेक्षण से सूचित होता है कि नाश की कमी (बेल की नश्वरता) 7-41% से 3.7% तक होता है।

वर्ष 1994 की उत्पादकता 268 किलो ग्राम/हेक्टर से बढकर वर्ष 1999 में 315 किलो ग्राम/हेक्टर हो गया।

## कृषि विज्ञान केन्द्र

वर्ष के दौरान कृषि विज्ञान केन्द्र में 60 प्रशिक्षण कार्यक्रम आयोजित किये जिसमे व्यवहारित किसानों केलिए 45 प्रशिण, ग्रामीण यूवाओं केलिए 14 प्रशिक्षण, सस्यविज्ञान, बागवानी, मत्स्य उद्योग और पशु विज्ञान आदि विभिन्न शाखाओं में विस्तार कार्यकारी केलिए एक प्रशिक्षण आदि शामिल होता है। कुल मिलाकर 2180 प्रशिक्षार्थी इसमें बाग लिया। कृषि विज्ञान केन्द्र ने 5 प्रदर्शनी में भाग लिया और आकाशवाणी कालिकट के माध्यम से विभिन्न विषयों पर 13 रेडियो भाषण भी दी। परिक्रमी निधि कार्यक्रम (Revolving Fund Scheme) के अधीन 1.97 लाख रुपए की रोपण सामग्रियां बेच ली।

पादप और स्वास्थ्य केन्द्र में कुल 923 मामलों की जांच की और 368 कृत्रिम वीर्यसेचन भी किया गया। इस केन्द्र ने तीन पशु स्वास्थ्य संगठित कार्यक्रम आयोजित किया और अन्य एजेंसियों द्वारा आयोजित कैंप में बाग बी लिया।

## मसालों पर अखिल भारतीय समन्वित अनुसंधान परियोजना

काली मिर्च की दो नयी किस्में (पन्नियूर 6 और पन्नियूर 7) इलायची की एक क्सिम (RRD) धनिया की तीन किस्में (Rcr-684, Rcr-436 और Rcr-435) मेथी की दो किस्में गुज मेथी-1 और (Rmt 303), जीरी की एक किस्म (गुज जीरा-3), बडी सोंफ की एक किस्म RF-101 आदि को नवेंबर 18-21, 1999 के दौरान चलनेवाले कार्यशाला में विमाचित करने का प्रस्ताव रख दिया।

कर्नाटक में काली मिर्च की आर्थिक उपजता केलिए उर्वरक के रूप में प्रति बेल 150:60:210 ग्राम के दर में NPK और साथ ही 0.33 अनुपात में IW/CPE सिंचाई करने की सिफारिश की।

अक्तूबर 15 के दौरान जीरा बोने से जीरा की मुरझाई कम कर सकती है जबकि नवेंबर 4 को धनिया बोने से उत्तम उपज प्राप्त होता है।

कुमारगंज (यू.पी) में 30 × 20 से.मी. अन्तराल में हल्दी की खेती करना और उसके लिए प्रति हेक्टर 150 किलो ग्राम के दर में नाइट्रोजन उर्वरक डालना अच्छा होता है।

काली मिर्च के फाइटोफथोरा खुर विगलन के नियन्त्रण केलिए तकनोलजी पैकेज संस्तुत किया जिसमें प्रतिबेल 1 किलो ग्राम के दर में नीम केक लगाना, मनसून के पूर्व बोर्डियोक्स मिश्रण डालना जिसके बाद कोपर औकिसक्लौराइड दवा पिलाना और दूसरी बार अकोमिन छिड्कना जिसके बाद मनसून के बाद अकोमिन दवा पिलाना जैसे उपचार केरल की दशा में साधारण फाइटोसानिटरी उपाय के उपचार करने केलिए सिफारिश किया गया।

नेमटोड आपतन केलिए 3 ग्राम सक्रिय संघटक के दर में फोराइट दिया जा सकता है।

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