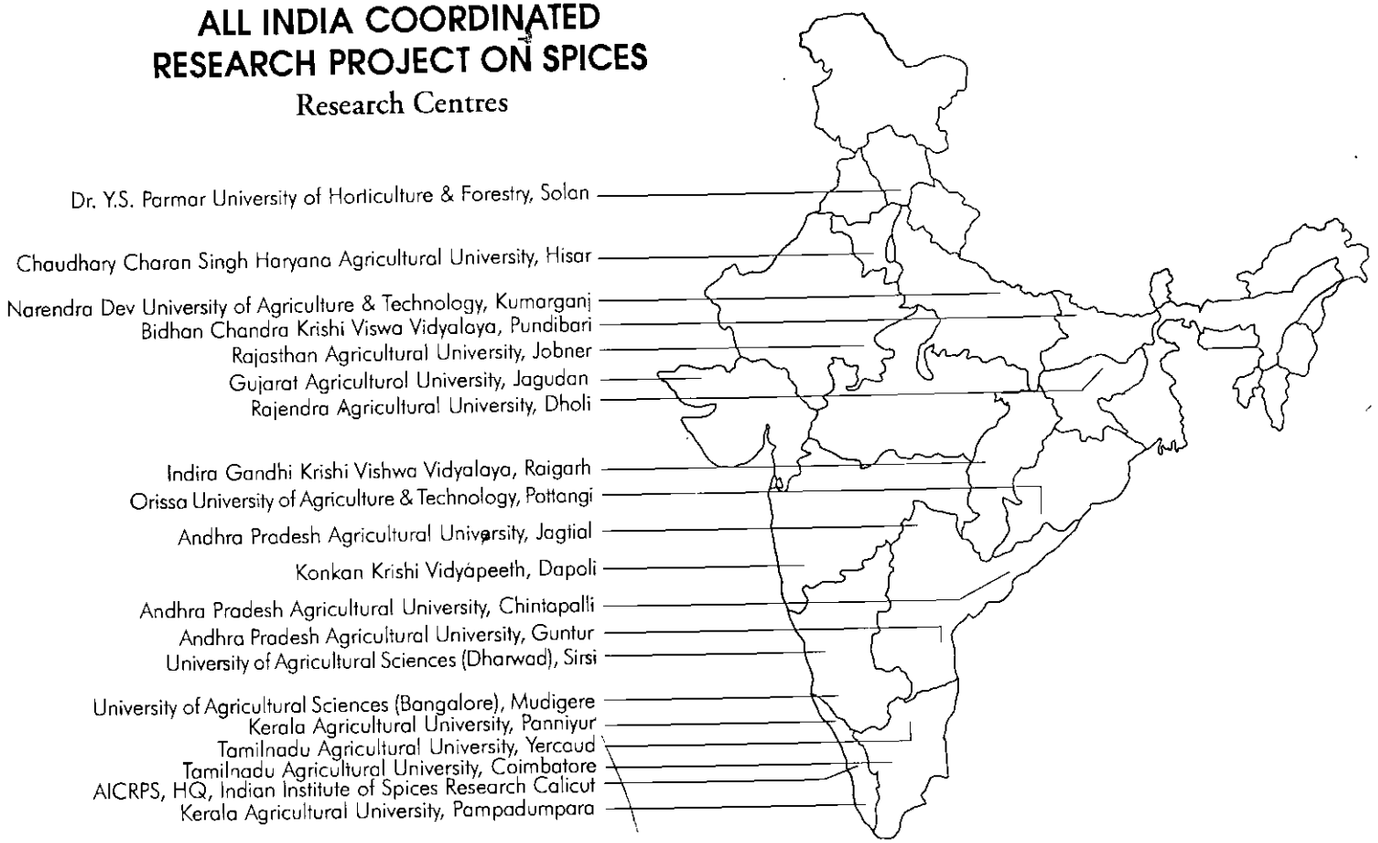
वार्षिक प्रतिवेदन

ANNUAL REPORT 2000

INDIAN INSTITUTE OF SPICES RESEARCH
(Indian Council of Agricultural Research)
Calicut - 673012, Kerala

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

Research Centres



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Front cover:
Natural 'Katte' resistant cardamom variety 'IISR Vijetha'

Back cover:
Fruits of high yielding nutmeg variety 'IISR Viswashree'

CONTENTS

PREFACE

I have extreme pleasure to present the Annual Report of this Institute for the year 2000. Indian Institute of Spices Research, which started as a Regional station of Central Plantation Crops Research Institute during 1975, has completed 25 years of its service to the Nation. The silver jubilee of the Institute is being celebrated during 8-9, October 2001. During the last 25 years the Institute has contributed substantially to increase spices production through release of high yielding varieties, development of high production technologies and eco-friendly crop protection measures. At the end of 2000 most of our spice crops are facing stiff competition at the International level, as new producing countries are able to offer a very low price. The major bottleneck in our system is the low productivity per unit area. Unless we increase our productivity we won't be able to resist the international competition. Qualitatively many of our spices hold a premium position in the international scenario. This can very well be attributed to the import of pepper from Vietnam and re-exporting along with Indian pepper.

I am glad to inform that IISR has reached a stage in the last 25 years to address the major challenges facing the farmers and industry. Programmes in spices is carried out through 43 institute projects and 24 externally aided projects funded by DBT, ICAR, NATP, Pepper Technology mission and other departments.

The gene bank collections rose to 3097 in black pepper, 299 in cardamom, 541 in ginger, 769 in turmeric, 51 in vanilla and 1267 in tree spices. Collection 1041 was found not only tolerant to *Phytophthora* but also well adopted to high ranges of Valparai. In addition HP 1411 and OP Karimunda were consistently high yielders. High curcumin Aleppey finger turmeric with a yield of 34.7t/ha and dry recovery of 20%, high yielding high quality nutmeg line A9/4 and 'Papriking' a paprika type with zero pungency and high colour are some of the new achievements during the year.

As drought is still a problem during December-May active programme is in progress to identify drought tolerant lines of black pepper. HP976, Acc 892 and Acc 933 are some pepper lines, which have shown tolerance to drought.

Decomposed coir pith enriched with DAP was found to be an excellent

substitute for FYM. Efficient dryers have been developed for drying nutmeg mace and *Piper chaba*.

Studies are regularly undertaken to identify spices with high oil, oleoresin and pungent principles.

Eco-friendly crop protection technologies IPM/IDM with importance to bio-control are the major focus. As demand for organic spices is increasing world over programmes are in progress to blend the conventional knowledge and modern technology in pest and disease management.

Under the National Network Project on *Phytophthora* diseases of Horticultural Crops (PHYTONET) about 420 isolates are maintained in the National Repository of *Phytophthora* (NARPh). PHYTONET programme is in operation at 9 centres throughout the country catering the needs of several horticultural crops.

Institute KVK at Peruvannamuzhi is doing commendable service to the farming community.

All India Coordinated Research Project on Spices with its headquarters at IISR, Calicut has 20 centres distributed in 16 states.

Institute has active collaboration with Kerala Agricultural University, Rajiv Gandhi Centre for Biotechnology, Tamil Nadu Agricultural University, Bharatiar University, NBPGR, NRC for DNA finger printing and RRL, Jammu.

I place on record the support rendered by Director General, Deputy Director General (Hort) and other officials of ICAR and Research Advisory Committee headed by Prof. V.L. Chopra, National Professor. I thank the scientists and staff of IISR for their valuable contribution and whole hearted support.

Y. R. Sarma

Director

Calicut

30 September 2001

EXECUTIVE SUMMARY

GERMPLASM

Black pepper

One hundred and forty eight accessions of black pepper and its wild relatives were collected. A total of 3097 germplasm accessions are maintained and multiplied in the black pepper germplasm conservatory.

Cardamom

Three collections viz. long panicle (175 cm) vazhukka type, compact panicle with bold capsule (short internode) and a superclone from lower altitude are added to the germplasm this year.

Ginger

Two new *Zingiber* spp. and 13 other new collections of *Zingiber officinale* Rosc. Including a putative wild type characterized by very small rhizome, persistent fleshy root with high pungency are added to the ginger gene bank. The total collection in the ginger gene bank is 637.

Turmeric

Nine collections of *Curcuma* spp. obtained from West Bengal, Tamil Nadu and Kerala are added to gene bank. Black turmeric (*C. caesia*), Kasturi turmeric(*C. aromatica*), mango ginger(*C. amada*) etc, are conserved in the turmeric gene bank. Total collections in the gene bank now stands at 786 accessions.

Vanilla

One accession, *V. vatsalana* from the KMTR region, Tamil Nadu and three collections of *Vanilla planifolia* are added to the germplasm.

Tree spices

Fourteen collections of *Garcinia* spp., 11 collections each of *Myristica* spp. and *Syzygium* spp. and five collections of *Cinnamomum* spp. are added to the gene bank.

CROP IMPROVEMENT

The foot rot tolerant black pepper line Coll.1041, continued to be tolerant to Phytophthora foot rot at Valparai and had a mean yield of 4.77 kg green/ vine. Black pepper hybrids HP-34, HP-105 and HP-813 continue to maintain their

yield superiority at Valparai, a high altitude region (3000- ft above MSL).

HP 1411, a black pepper hybrid characterized by long compact spike and bold berries with a mean yield of 3.65 kg (green/vine) and an open pollinated progeny of Karimunda (OPKm) with vigorous growth, broad leaves and long spikes with an yield of 3.4 kg green/vine, are the promising black pepper lines under advanced stages of evaluation.

Out of eight methods of grafting tried with *Piper colubrinum* as root stock and 'Subhakara' black pepper as scion, tongue method (56.75%) and double root stock method (78.24%) were significantly superior to other techniques for survival in the field even after three years. Among the pepper varieties evaluated as scions, 'Poonjaramunda' was found to be a good scion for grafting on *P. colubrinum* rootstock.

Alleppey Finger Turmeric (AFT) selection 585 recorded highest yield of fresh rhizome at Peruvannamuzhi. Its mean yield is 34.7 t/ha with a dry recovery of 20%.

A promising nutmeg line A 9/4 and its clonal progenies continued to perform well in the field. It has 7.14% and 7.13% oil, 2.48% and 13.8% oleoresin in nut and mace respectively.

Among the different wild and related species of nutmeg (*Myristica malabarica*, *M.beddomeii*, *M. attenuata* and *Gymnocranthera canaria*) used as rootstocks for grafting, *M. malabarica* was found to be the most compatible followed by *M. beddomeii*.

'Papri king' a Zimbabwean variety of paprika came up well yielding excellent fruits with good colour and zero pungency (245 ASTA units)

CYTOGENETICS & REPRODUCTIVE BIOLOGY

Cytological analysis of 9 accessions of turmeric including 6 seedling progenies (23a, 23b, 426, 417, 414 and 384) and three mother plants (23,324, 384) showed chromosomal variations such as 2n=84 (23a,23b, 426, 417), 2n=86 (414) and 2n=63 (384) among seedling progenies and normal chromosome number (2n=63) among mother plants.

BIOTECHNOLOGY

In vitro techniques for multiplication of *Vanilla andamanica* were standardised. Somatic embryogenesis was induced in cardamom with high rate of multiplication. RAPD analysis of micropropagated ginger showed some amount of variability. RAPD profiles of selfed progenies of vanilla showed high genetic variability. In *in vitro* conserved cardamom accessions, genetic stability was seen even after 6 years of conservation under minimal growth conditions.

NUTRITION AND SOIL MANAGEMENT

Decomposed coir compost enriched with DAP (0.2 kg/m^3) can replace the FYM component in the nursery mixture.

In bush pepper, application of FYM and vermicompost @ 1.25 kg/pot with 10 kg soil enhanced the yield up to 119% and 75% respectively as compared to chemical fertilizers.

Based on DRIS (Diagnosis Recommendations Integrated System) for optimum production in cardamom, the index leaf should contain 1.26 to 2.81% N, 0.1 to 0.2% P, 1.3 to 3.4% K, 0.51 to 1.38% Ca and 0.18 to 0.31 % Mg. Second and third leaf from the top can be used as an index leaf.

Studies on performance and economics of cardamom under replanting indicated that an average yield of 749 kg (dry)/ha for the five crop seasons which is 5.35 times higher than the national average yield, can be obtained.

NUCLEUS PLANTING MATERIAL

Four tonnes of turmeric seed rhizomes, 4.4 tonnes of ginger seed rhizomes, 2581 nutmeg grafts, 282 cinnamon seedlings, 496 allspice seedlings, 14000 cardamom seedlings and 108 kg cardamom seed capsules were distributed to farmers and different agencies.

DROUGHT TOLERANCE

Among 150 black pepper hybrids screened for drought tolerance, HP 976 followed by HP 1000 and among germplasm accessions, Acc. 892 followed by Acc. 933 were relatively tolerant.

QUALITY EVALUATION

Quality evaluation studies of black pepper showed that HP 1411, Coll. 4187, Coll. 1490 and OP Neelamundi gave 4% essential oil; HP 780, Sreekara, Coll.4187,

Coll.1411 gave more than 10-11% oleoresin and Coll. 4187, Sreekara, Coll. 4175 and Coll. 1411 had 3.5-4.0% piperine.

Ginger varieties viz. Bhaise, Kalimpong and Gurubathani when cultivated in plains at Tamarassery and Peruvannamuzhi (Kerala) gave 18% dry recovery compared to 10-12% in Sikkim (higher altitude). However volatile oil and oleoresin were high(2.5% and 7%) at Sikkim compared to Kerala (1.5% and 5%).

Preliminary studies on storage indicated that ginger rhizomes can be stored without much dehydration in polyethylene cover with restricted ventillation upto three months after harvest.

Fractionation studies of Phenyl alanine ammonia lyase (PAL) the key enzyme in curcumin biosynthesis in turmeric leaves indicated maximum activity in mitochondrial fraction as compared to microsomal and cytoplasmic fractions.

GC profile of volatile oils of turmeric rhizomes, roots and leaves showed that ar-turmerone is the major component in rhizomes and roots (31.5% and 46.8% respectively) while 2-phellandrene (32.6%) is the major component in leaves.

POST HARVEST STUDIES

Using agricultural waste fired dryer (60 °C), nutmeg mace could be dried in 4hrs. While in hot sand (50 °C) the same can be achieved in 3.5 hrs. However the retention of quality parameters like lycopene, the colour pigment and volatile oil were better in hot air drying compared to drying in hot sand.

Piper chaba could be dried in 8 hrs in hot air drying without change in chemical quality.

PLANT PATHOLOGY

Characterization of pathogens

Eight new isolates were added to *Ralstonia* repository and these isolates were characterized. Seven of them are positive for biovar 3 and an isolate from Peruvannamuzhi tested positive for biovar 4. Thermal death point of *Ralstonia* was found to be 46° C at 30 min. exposure.

The etiology of stunted disease of black pepper has been confirmed and is caused by a strain of cucumber mosaic virus (CMV) based on serological test

and EM studies. However involvement of more than one virus such as Badna is suspected. In cardamom, protocols were standarized for purification of vein cleaning virus causing 'Kokke Kandu'. EM studies are in progress for detailed morphology of virus particles.

Host resistance

Hundred and fifty hybrids of black pepper were screened adopting stem inoculation technique, for their reaction to *P. capsici* Of these, three hybrids, HP-423, HP-664 and HP-756 showed tolerant reaction.

Seven promising hybrids/cultivars were tested for their reaction to *P. capsici* through root dip inoculation and the hybrids HP-105 and HP-780 showed better survival.

Disease Management

Cultural practices

In the field trial to rejuvenate foot rot affected black pepper garden, the establishment of vines and the number of vines flowered were more in plots with clean cultivation compared to plots with weeds. Field experiment to test the efficacy of solarization has been initiated and the proliferation of *Trichoderma* was more in solarized plots.

A simple disinfection technique 'rhizome solarization' for producing healthy seed was developed and tested in green house condition. Solarization of ginger rhizomes for 2 to 4 hrs. from 9.00 am to 1.00 pm which raised the rhizome temperature to 55° C during summer, just before planting eliminated the seed borne *R. solanacearum* from ginger rhizomes.

Chemical control

Pot culture experiments with higher concentrations of Potassium phosphonate (6ml/l and 9ml/l) and *Trichoderma* clearly showed the efficacy of higher concentration of Potassium phosphonate in checking *P. capsici* infection and their compatibility with *Trichoderma*. At all these concentrations phytotoxicity on black pepper was not noticed.

Biocontrol

An experiment to study the effect of VAM and Phosphate solubilising bacteria on black pepper rooted cuttings indicated that the combination of VAM and phosphate solubilising bacteria promoted better growth of the cutting as shown by number of roots and root length.

Fluorescent pseudomonads (27 isolates) and *Trichoderma* spp. (25 isolates) isolated from rhizosphere of black pepper were screened *in vitro* for their antagonistic potential against *P. capsici* using dual culture technique. The inhibition ranged from 26.9-37.6% in the case of *Trichoderma spp.* and 36.3-70.0% in the case of fluorescent pseudomonads. Incidentally, fluorescent pseudomonad isolates antagonistic to *P. capsici* were also found to be good phosphate solubilizers, which is an additional advantage.

Coir compost + sorghum combination was found to be the best carrier medium for mass multiplication of *Trichoderma.*

BIOTECHNOLOGICAL APPROACH

PCR based techniques

Protocols for isolation of PCR amplifiable bacterial DNA from soil was standardized. The protocols involve extraction of bacterial cells from soil followed by lysis in SDS+CTAB based DNA extraction buffer. The DNA isolated by this method was pure enough for polymerase chain reaction. The method will be useful for developing a molecular detection kit for soil borne bacterial pathogens affecting ginger.

A crystalline compound inhibiting sporulation of *P. capsici* was isolated from *Chromolaena odorata* leaves by solvent extraction and column chromatography.

PHYTONET

Among the 424 *Phytophthora isolates* maintained at National Repository of *Phytophthora,* 115 isolates of *P. capsici* from black pepper were studied for chlamydospore formation. Of these only 60 isolates produced chlamydospores.

A new *Phytophthora* isolated from pineapple roots has been tentatively identified as *P. cinnamomi.*

Morphological characterization of 52 black pepper isolates of *Phytophthora* indicated two *P. palmivora* , two *P. parasitica* and two other atyptical isolates and the rest of the isolates were of *P. capsici.*

Isozyme analysis

- Biochemical characterization of *Phytophthora* isolates was initiated using isozyme analysis. The isolates were characterized for 4 enzymes, viz, catalase (CAT), superoxide dismutase (SOD), malic enzyme (ME) and glucose-6-phosphate dehydrogenase (G6PDH). Up to10 putative loci were resolved across the 4 enzyme systems studied. The electrophoretic patterns for the 4 enzymes in the study revealed 3 loci each for SOD and ME and 2 loci for G6PDH.

- *Phytophthora capsici* infecting black pepper was exposed to the volatiles of *Trichoderma spp. in vitro* and the virulence of the exposed isolates was studied by testing its pathogenicity on Karimunda leaves by detached leaf technique. Volatile metabolites produced by *Trichoderma* spp. were found to reduce virulence of *P. capsici*. The percent loss in virulence when compared to the parent isolate ranged from 0-100%. The loss of virulence of *P. capsici* is dependent on type of *Trichoderma* isolate used and also the duration of exposure. Out of twenty *T. harzianum* isolates studied, six of them caused more than 50% loss in virulence of *P. capsici*. Apart from the various other mechanisms like lysis, mycoparasitism,antibiosis and competition,loss of virulence of the pathogen could also be one of the mechanisms of biocontrol.

- Four *Trichoderma* spp viz, *T. harzianum* (P26), *T.virens* (P12), *T.aureoviride*(P25) and *T. pseudokoningii* alone and in combinations were studied for their effect on growth promotion of black pepper seedlings and control of foot rot. T. *aureoviride P25* in combination with *T. harzianum* P26 recorded maximum growth of plants, which showed 180% increase over the control.

Different inoculum concentrations of *T. aureoviride* P25 were applied to soil to study their effect on the control of *P. capsici* . Concentrations ranged from $62x10^1$- $62x10^{10}$ spores/g of soil and $5x10^1$ - $5x10^5$ mycelia/g of soil. After two months, the population came down from 10^{10} to 10^5 in the case of spores and 10^5 to 10^4 in the case of mycelia. But on challenge inoculation with *P. capsici* no correlation between mortality and number of cfu was found.

ENTOMOLOGY

Identification and characterization of host resistance against 'pollu'beetle

Screening of 196 cultivars, 24 hybrids and 3 somaclones of black pepper accessions available in the Germplasm Conservatory of IISR at Peruvannamuzhi against 'pollu' beetle (*Longitarsus nigripennis*), a major pest of black pepper, indicated that 6 cultivars and 2 hybrids were free of pest infestation.

Evaluation of natural products against pollu beetle

Laboratory and green house bioassays were conducted to evaluate the persistence of antifeedant activity of chilli extract containing capsaicin against *'pollu'* beetle. Chilli extract containing 1% capsaicin caused >90% and >50% feeding deterrence to *'pollu'* beetle up to 14 and 21 days respectively, after treatment indicating its potential for use in IPM schedules.

Integrated management of shoot borer

Cultural methods and spraying malathion 0.1% in various schedules were evaluated for the management of shoot borer (*Conogethes punctiferalis*), a major pest of ginger. An integrated strategy involving pruning of infested shoots (at fornightly intervals) during July-August and spraying of insecticide (at monthly intervals) during September -October resulted in lower incidence of the pest and higher rhizome yield with a cost benefit ratio of 1:4.6. By adopting this strategy, two insecticide sprays can be avoided, thus conserving natural enemies and causing less harm to the environment.

Determination of pesticide residues in ginger

Spraying 2 and 4 rounds of endosulfan 0.05% during crop season resulted in non-detectible levels of endosulfan residues in dry ginger and thus the insecticide recommendation is environmentally safe.

Management of rhizome scale

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

NEMATOLOGY

Host resistance

Twelve each of ginger and turmeric germplasm accessions were found resistant to root-knot nematode, *Meloidogyne incognita,* in the second round of screening. Turmeric accessions 31,82 and 200 showed resistance to *M. incognita* consecutively in three rounds of screening. All the 29 and 38 black pepper accessions screened against root knot and burrowing nematodes, respectively, were susceptible.

Biological Control

Plant Growth Promoting Rhizobacteria (PGPR)

PGPRs were isolated from the roots of black pepper from Kerala (160 isolates) and turmeric from Andhra Pradesh (19 isolates). Ten out of the 29 isolates caused 100% mortality of nematodes in the *in vitro* bioassay. In a greenhouse evaluation, 65 isolates were screened for their efficacy to suppress root knot nematodes. Three isolates imparted complete protection to tomato plants against nematode attack, while 11 other isolates caused > 50% suppression of nematodes.

Field evaluation of promising fungal biocontrol agents

Thirteen promising fungal biocontrol agents were evaluated on turmeric in microplots infested with root knot nematodes. *Verticillium chlamydosporium, Paecilomyces lilacinus, Fusarium* sp., *Aspergillus nidulans* and *Scopuloriopsis* sp. suppressed root knot nematode populations significantly.

In a farmer's plot at Wynad, *Trichoderma harzianum, V. chlamydosporium* and *Pasteuria penetrans* were evaluated for the management of root - knot nematodes infesting black pepper. Significant reduction in nematode population was observed in all treatments. The mean incidence of yellowing in plots treated with biocontrol agents varied from 17.3-37.3% while that in plots treated with pesticides and untreated control ranged between 32.8-50.5%. The maximum improvement in the crop stand (75.2% healthy vines) was observed in plots treated with *V. chlamydosporium* followed by *T. harzianum* (75.6% healthy vines). The highest yield (4.6 kg green/vine) was also recorded in *V. chlamydosporium* treated vines.

Variability in V. chlamydosporium isolates

Three *V. chlamydosporium* isolates and one each of *V. tenerum* and *V. lecanii* isolates varied in their ability to parasitize root-knot nematode eggs and females. All of them colonised egg masses of root-knot nematodes. To induce variability in *V. chlamydosporium,* its spores were treated with different concentrations of Ethyl Methyl Sulfonate (EMS) and the sporadic colonies produced at higher concentrations were isolated and maintained.

Ecology of biocontrol agents

The optimum temperature for growth and multiplication of *T. harzianum* (Is.33) and *P. lilacinus* (Is.36) was 30° C while that for *V. chlamydosporium* was 25° C. *T. harzianum* isolates (Is.33 and 56) varied in their optimum pH requirements, (pH4 and 5, respectively) and pH 6 was found ideal for *Fusarium* sp. (Is.11)

Potassium phosphonate and insecticides like phorate and chlorpyriphos at recommended levels had no adverse effect on biocontrol agents viz. *T. harzianum, P. lilacinus and V. chlamydosporium.* However, metalaxyl mancozeb at all concentrations reduced the growth and sporulations of all the above fungi.

Organic amendments

Incorporation of green leaves of *Strychnos nuxvomica* and *Piper colubrinum* in basins of black pepper vines reduced foliar yellowing due to nematode infection. Amendment like vermicompost had little impact on nematodes.

EXTENSION

* Three regular and five sponsored training programmes were organised. Hundred and fifteen trainees from various parts of the country were trained on spices production technologies. One day orientation programme was conducted for farmers fron. Kerala, Karnataka, Tamil Nadu and Maharashtra.

* Awareness programme on 'Spice Research & Development' was imparted to agricultural and traditional university students. A comprehensive guide on 'Spices Production Technology' was printed and is distributed through ATIC.

AICRP ON SPICES

The AICRPS centres strengthened the Genetic Resources in all the mandatory spices. Under the evaluation/screening programme, disease tolerant lines have been short listed/identified in ginger, turmeric and seed spices. Package of practices for ginger and turmeric for the high elevation regions of Eastern Ghats were standardised by the Chintapalli centre (AP). Irrigation requirement of black pepper (Kerala) as well as fertilizer and water requirement for black pepper and arecanut mixed cropping system for Karnataka were standardised. Studies at Mudigere revealed the positive influence of micronutrients (boron and molybdenum) as well as the increased dose of fertilizer application resulting in increased yield in cardamom. A new fertilizer dose of NPK @ 75:75:150 kg/ha is recommended for cardamom by Mudigere (Karnataka) centre.

The fertilizer package for clove and nutmeg (for Tamil Nadu), turmeric (for Madhya Pradesh), spacing and fertilizer for turmeric (for UP), spacing and time of sowing for fenugreek (for Tamil Nadu) were recommended.

The package of technology for the management of *Phytophthora* foot rot disease in black pepper as well as nematode disease using integrated methods was developed by Sirsi (Karnataka) and Panniyur(Kerala) centres. Control measures for nursery diseases in black pepper (Panniyur), cardamom nursery leaf spot (Mudigere) root rot of ginger in field and storage (Solan & Raigarh) leaf blotch in turmeric (Pundibari, Raigarh and Chintapalli) were recommended.

OTHER ACTIVITIES

- A Centennial Conference on Spices and Aromatic Plants was organised in collaboration with Indian Society for Spices, National Horticulture Board and National Academy of Agricultural Sciences during 20 to 23 Sept 2000, at Calicut. The conference was inaugurated by Prof. S. Kannaiyan Vice-Chancellor, TNAU. About 250 delegates participated.

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

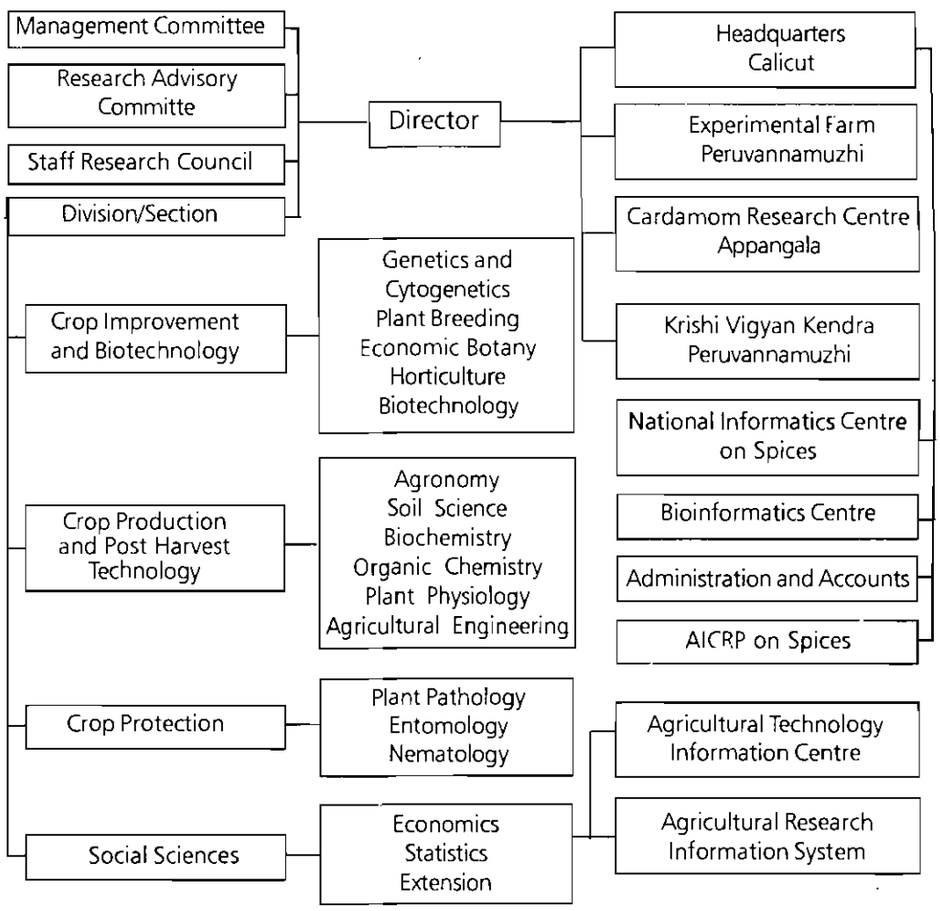
- ☆ To extend services and technologies to conserve spices genetic resources as well as soil, water and air of spices agroecosystems
- ☆ To develop high yielding and high quality spices varieties and sustainable production and protection systems using traditional and non traditional techniques and novel biotechnological 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, Staff Research Council and Research Advisory Committee assist the Director in matters relating to management, research and extension.



Organizational setup of IISR

Multidisciplinary research on different aspects of black pepper, cardamom, ginger, turmeric, nutmeg, clove, cinnamon, allspice, vanilla, garcinia 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, Sudharshana, Suguna, Prabha and Prathibha.

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 Valiyakaniakkadan 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 Prathibha. A technology to prepare salted ginger has been standardized. 'Dosi Fibre' technique for estimation of crude fibre in ginger is standardised.

Crop Protection

Among the several black pepper lines screened for their reaction to *Phytophthora capsici*, the causal agent of foot rot disease, P24, an open pollinated progeny of Perambramundi has been identified as tolerant. An integrated management strategy involving phytosanitation, cultural practices and application of Bordeaux mixture (1%) and copper oxychloride or potassium phosphonate (Akomin) is effective against foot rot disease. Field trials showed effectiveness of *Trichoderma harzianum* and *T. virens* to manage *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 2000

Month	No. of rainy days		Rainfall (mm)	
	Peruvanna-muzhi	Appangala	Peruvannamuzhi	Appangala
January	5	-	76.00	000.00
February	2	-	7.00	000.00
March	-	-	-	000.00
April	9	07	86.00	105.5
May	9	14	152.00	174.6
June	28	22	1120.00	558.6
July	21	22	581.30	808.8
August	26	20	1002.50	684.4
September	26	11	499.00	217.2
October	16	08	493.00	241.0
November	5	02	40.00	96.5
December	4	-	185.00	000.0
Total	151	106	4241.80	2 886.6

Budget (Rupees in lakhs)

Particulars	Plan	Non plan	Total
Establishment	4.00	4.00	8.00
Travelling allowance	25.00	-	25.00
Works			
Other charges including equipment	106.00	45.00	151.00
Total	135.00	242.75	375.75

Other Sources

Particulars	Amount
A.P. cess fund schemes	42.48
KVK	21.55
NATP	74.98
AICRP Spices	136.00
DBT schemes	19.34
IPDS	10.59
Pepper technology mission	4.41
Emeritus Scientist	1.36
State Govt.Scheme	2.00
Pension and gratuity	6.98
Total	319.69

Staff Position

	Sanctioned	Filled	Vacant
RMP	1	1	-
Scientific	41	34	7
Technical	44	44	-
Administrative	22*	22	-
Supportive	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, B. Sasikumar, Johnson K. George, K. Nirmal Babu & B. Chempakam)

Progress report

Collection and conservation

Surveys were conducted in different areas of Kerala, Karnataka and Tamil Nadu for collecting Piper sp. and local cultivated types. Six explorations were carried out and 148 accessions were collected. Details of the collections made are given in table 1

For taking up further planting of the germplasm collected, about 2.1 ha area was cleared and *Ailanthus* standards were planted.

Cataloguing and evaluation

150 accessions in the field (cultivars) were characterized and documented

Table 1. Piper germplasm collection

Trip No.	Places visited	District/State	No of accessions collected			Remarks
			wild types	Local cultivars	Total	
1	Chempanoda	Calicut	-	12	12	
2	Thenmala	Kollam	3	6	9	in collaboration with NBPGR, Trichur
3	KMTR	Tamil Nadu	33	—	33	in collaboration with NBPGR, TBGRI&NRCB
4	Athirapally, Sholayar, Valparai	Kerala Tamil Nadu	34	—	34	in collaboration with NBPGR, CTCRI & NRCB
5	Subramanya Bisle	Karnataka	25	1	26	
6	Silent Valley	Kerala	34		34	
		Total	129	19	148	

based on IPGRI descriptor. Important characters were listed with their range and mean values in table 2. In addition to this 150 accessions in the nursery were characterized and documented based on a few important characters.

Production of top shoots

An experiment was started for the continuous production of orthotropic shoots and harvesting of top shoots. Pepper vines were allowed to grow on 7 feet Acacia stumps and over grown top shoots having 3-4 nodes were

Table 2. Evaluation of black pepper germplasm

Character	Range	Mean
A.Vegetative characters		
1. Lateral branch length	19.5-49 cm	29.8 cm
2. No.of nodes/lateral branch	5-20	12
3. Leaf petiole length	0.8-3 cm	1.7 cm
4. Leaf length	9-18 cm	13.1cm
5. Leaf width	6-12.8 cm	8.1cm
B.Yield characters		
6. No.of berries/10 spikes	118-603	364
7. No of fully developed berries	17-110	56
8. Weight of 100 fresh berries	22.5 g	10.5 g
9. Volume of 100 fresh berries	5-18 ml	11 ml
10. Dry wt of 100 berries	1.5-7.5 g	4.5g
11. Yield/vine	0.037-2.98 kg	1.29 kg
No. of accessions evaluated	150	

harvested and rooted separately. All the promising lines and released varieties were established like this and top shoots were collected.

Multiplication and distribution of promising lines

All the germplasm accessions in the nursery were maintained and multiplied. About 1100 rooted cuttings were multiplied from the promising lines and

distributed to the farmers of Kannur, Wynad and Kasaragod districts under Pepper Technology Mission.

GEN. IX (813)

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF CARDAMOM GERMPLASM.

(D. Prasath and M.N. Venugopal)

Progress report

Three collections were added to germplasm. This includes specific genotypes viz., long panicle vazukka type (175 cm), compact panicle with bold capsule type(short internode) both from Wynad region and identified a super clone from lower altitude(400 MSL) (Sampaji area of Karnataka) which yielded 22 Kg green capsules plant in original location. The cardamom gene bank at present possess 313 accessions and are being maintained. Ten allied genera (four species in *Alpinia*, three in *Amomum* and one each in *Aframomum*, *Zingiber* and *Hedychium*) were evaluated for vegetative and reproductive characters.

Seventy two accessions planted during 1999 are being evaluated based on IPGRI descriptor for vegetative characters like plant height, total tillers, bearing tillers and number of leaves. Highest coefficient of variation (table 3) was recorded for number of leaves followed by no. of bearing tillers per plant. The plant height ranged from 78.00 to 206.00 cm and the maximum was recorded in APG 276. Maximum number of leaves per plant was recorded in APG 272(245.4) followed by APG 276(241.6).

Table 3. Evaluation of cardamom germplasm

Character	Range	CV%	Promising accessions
Plant height(cm)	78.00-206.00	18.12	APG 276 APG 313
Total tillers	5.0-24.4	32.28	APG 251 APG 299
Bearing tillers	1.0-6.3	34.17	APG 271 APG 272
No. of leaves/plant	23.8-245.4	41.01	APG 272 APG 276

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)

Progress report

Germplasm collections

Two *Zingiber* spp.and 13 other new *Z. officinale* Rosc accessions including a putative wild type *Z.officinale* from Silent Valley National Park were collected and added to the genebank

Nine new collections of *Curcuma* spp. obtained from West Bengal, Tamil Nadu and Kerala were added to the turmeric gene bank.

Yield evaluation of high curcumin turmeric lines

Eleven high curcumin lines of turmeric including six AFT (Alleppey Finger Turmeric) selections along with Prabha and Prathibha (controls) were evaluated in replicated yield trial at Peruvannamuzhi. An AFT line Acc.585 recorded highest yield of 17.38 kg(fresh)/bed of $3m^2$ (34.7 t/ha) with 20% dry recovery(table 4).

Multiplication of ginger and turmeric

Nucleus seed rhizomes of Varada (300 kg), Acc.117 (600 kg), Acc.35(650 kg), *C. aromatica* (80 kg) were produced. *C. caesia*·(black turmeric) was also multiplied.

Cataloguing of ginger germplasm

51 accessions of ginger were evaluated in $3m^2$ plot for cataloguing purposes. Data on yield and yield attributes of the accessions are given in table 5.

Variability for shelf life of ginger

Dry ginger of 27 accessions were screened against storage pest *Laisoderma serricorne*, by placing fixed quantity of dry ginger in plastic jars with perforated lids. Adults of the insect in equal numbers were introduced to the jar and the frass yield was recorded after 8 months of storage. Tolerance to the pest attack was observed in Acc 212, 215 and Acc.64 as revealed by the low yield of frass (2-4g). These accessions recorded low frass yield during previous year as well.

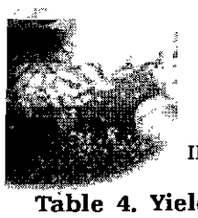


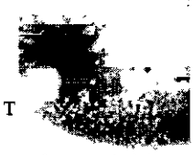
Table 4. Yield, dry recovery and curcumin content of high curcumin turmeric lines

Line	Mean yield Kg/3m² (fresh)	Dry recovery(%)	Curcumin (%)
Acc.126	16.25	20.0	5.5
Acc. 295	12.00	19.5	5.1
Acc. 584	10.63	20.5	5.5
Acc. 585	17.38	20.0	6.0
Acc. 591	14.50	19.6	5.7
Acc. 593	15.00	21.2	5.8
Acc. 656	13.25	16.1	4.9
Acc. 657	17.30	20.1	5.8
Prabha	15.00	20.0	6.5
Prathibha	15.00	18.7	5.6
CD	2.13		
CV%	10.06	- -	

Table 5. Yield and yield attributes of ginger germplasm.

Character	Range	Mean
Plant height (cm)	51.3-70.4	62.33
No. of leaves in the main shoot	18-26	21
No. of tillers	9-21	14
No. of leaves/ hill	117-315	198
Leaf length (cm)	22-27.5	23.5
Leaf width (cm)	2.9-3.6	3.1
Yield/3m²bed (fresh) kg	4.5-17.0	10.5
Dry recovery (%)	14.4-25.5	-

N=51



The new ginger varieties in pipe line viz. Acc. 117, Acc.35 had 5 g frass yield. The range in frass yield was 2-20 g.

Seedling progeny evaluation of turmeric

Twenty four seedling progenies of different mother lines were multiplied in beds of varying sizes. Wide variability was observed for the morphological and rhizome features. Curing percentage of the lines varied from 18.6 to 27.9%.

GEN.VI (813):

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

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

Progress report

The conservatory of tree spices was enriched with 14 collections of *Garcinia* spp; 11 of *Myristica* spp; 11 of *Syzygium* spp and 5 of *Cinnamomum* spp. Table 6 gives the details of collections of tree spices during the year and total number of accessions available in conservatory.

The most important *Garcinia gummi-gutta* collection is from a farmer's plot.

Table 6. Collection and conservation of tree spices germplasm

Crop	Location	No.	Remarks	Conserved (total)
Garcinia spp.	Thaliparamba	14		31
	Arikkulam		G. morella	
	Silent Valley		Elite *G. gummigutta*	
	Kidu		(fruiting round the year)	
	Sholayar	14		478
Myristica spp.	Silent Valley	11		
Syzygium spp.	Kidu	11	Wild and cultivated	227
Cinnamomum spp	Sholayar	5	Wild and cultivated	300
Pimenta spp.				180

(Mr. M. P. Hamza, Shalimar 7/492, Arikkulam - 673 322, Quilandy Taluk, Calicut District).

Salient attributes of this collection are given under:

1. Very high yielding (2500 fruits/year/tree).
2. Off season crop (yielding in October-December).
3. All season crop.
4. Weight of single fruit 150-200 g.
5. Fruit length 9.3 cm.
6. Fruit breadth 7.2 cm.
7. Shape of fruit Oblong.
8. Length of seed 4 cm.
9. Breadth of seed 1.2 cm.
10. Low astringent and more acidic.

The age of the above tree (seedling tree) is 10 years and it had started yielding from 8th year onwards.

Grafts of the above collection had been successfully made and kept ready for field planting.

Cataloguing and evaluation

Cassia

In the clonal progeny evaluation of quality cassia lines (year of planting 1998), involving Acc. A_2, C_1, D_1 and D_3, observations on morphological characters like height, number of main branches, canopy and girth were recorded. Flowering had been observed in one plant. In the germplasm plot (Peruvannamuzhi), accession D6 had lot of inflorescences and good fruit setting was observed. But the immature fruit fall was severe. In germplasm plot (Chelavoor), involving 59 plants belonging to 12 accessions, Viz. A_2, B_1, B_2, B_4, B_6, C_2, C_3, C_4, C_5, D_2, D_6 and D_7 (year of planting 1999), 16 plants were gap filled in 2000.

Garcinia

Sixty one *G. gummi-gutta* seedlings had been planted at Peruvannamuzhi farm for *in situ* grafting. Growth of plants is satisfactory. Clonal accessions T_1, T_2 and T_3 bear plenty of fruits (700-1000) per tree. Their clonal progenies also started bearing in the very first year after planting. Growth of 62 plants (19 acc.) of *Garcinia* spp planted during 1998 and 1999 at Chelavoor is satisfactory.

Clove

In progeny evaluation trial at Appangala, involving 14 elite lines, and at Peruvannamzhi, involving 4 elite lines, B-95 performed very good, with regard to quality characters.

Table 7 gives the quality parameters of clove accessions evaluated at Appangala.

Table 7. Evaluation of clove elite lines at Appangala

Accession No.	Percentage of Bud oil	
	Year 1999	Year 2000
K-4	13.3	-
K-9	11.7	-
K-10	-	15.8
K-5	17.3	18.4
B-2	13.4	16.5
B-81	16.0	17.9
K-8	18.0	-
B-95	15.0	19.0
B-74	18.3	-
Control	15.3	-
B-57	16.4	17.7
K-1	14.5	-
K-76	18.1	18.3
K-7	16.7	16.5
K-3	17.3	-

Nutmeg

Performance of clonal selection A 9/4

The pre-release variety A9/4 continues to perform very well during the year.

Table 8 gives a comparison of A 9/4 clonal selection with seedling trees. It gave an average yield of 1000 fruits/tree, in the 8th year after planting. It has good canopy of 3-4 m with a dwarf and bushy habit (height 2 m).

Table 9 gives a comparative evaluation of fruit characters of A 9/4 with its progeny (A 9/4-16) and two other high yielding selections from conservatory.

Table 10 and 11 give quality parameters of A 9/4 and of A 9/4 progenies, respectively. The butter percentage in seeds is very good in A 9/4 progenies (32.32% to 39.31%) as against <30% in others. 75% of A 9/4 progenies yielded

Table 8. Comparison of A 9/4 clonal selection with seedling trees

Parameters	A 9/4 clonal selection	Seedling trees
Flowering	2 years	5-6 years
Height at flowering	1 m	2.5 m
Fruiting	3rd year	7th year
Yield (5th year)	100	——
Yield (6th year)	600	——
Yield (7th year)	800	——
Yield (8th year)	1000	50
Yield (15th year)	*NA	1500
Height at economic yield	2m	7m
Canopy	3m	3-4 m
Spacing	5x5 m	9x9 m
No. of plants /ha	400	125
No. of female plants /ha	360	60

*Not Available

Table 9. Fruit characters of A 9/4, its progeny and two elite lines of nutmeg

Parameters	A9/4	A 9/4-16	A 9/22	A9/86
Wight of Single fruit	98.9	103.6 g	95.8 g	85.4 g
Fresh seed weight	12.4	13.6 g	11.8 g	8.9 g
Fresh mace weight	4.0	4.3 g	3.0 g	3.3 g

Table 10. Quality parameters of A 9/4

Parameter	Nut	Mace
Essential oil %	7.14	7.13
Oleoresin %	2.48	13.80
Butter %	30.9	NA

Table 11. Quality parameters of A 9/4 clonal progenies

Progeny	Oleoresin		Butter %
	Nut	Mace	
A 9/4-12	1.82	11.52	32.32
A 9/4-10	——		34.91
A 9/4-15	——		32.69
A 9/4-16			39.31
Average*			<30

*Represents other accessions in the germplasm

200 fruits/plant in the 4th year after planting. The variety is proposed for release in Kerala, due to the yield and quality attributes. Large number of A 9/4 grafts has been distributed to farmers from Tamil Nadu (Pollachi, Kolli-Hills), Kerala, Goa and Andhra Pradesh. The growth of these progenies was found to be good.

Clonal evaluation of nutmeg elite lines

At Peruvannamuzhi, growth of clonal progenies of elite lines A 9/4, A 9/20, A 9/25, A 9/69, A 9/150 and A 4/22 (planted in 1998-1999), was satisfactory

GEN. XIII (813)

COLLECTION, CONSERVATION AND IMPROVEMENT OF VANILLA

(K. Nirmal Babu, K.V. Saji and S.S. Veena)

Progress report

RAPD and AFLP polymorphism in selfed progenies and interspecific hybrids of vanilla

The RAPD profiles indicated that the progenies of vanilla are more similar to their parent *V. planifolia* and to each other. There is reasonable degree of variability within the selfed progenies of vanilla. RAPD polymorphism observed indicated that *V. planifolia* and *V. aphylla* are widely distinct. The profiles coupled with morphological characters indicated that VH1, VH4 and VH5 are true interspecific hybrids between *V. planifolia* and *V. aphylla* as they are approximately equidistant from the parents. The AFLP data also supported this (unpublished).

Interspecific hybridization

Another set of interspecific hybridization between *Vanilla planifolia* (male) x *V. aphylla*(female) was tried and three fruits developed successfully.

Selfing was also successfully done in *V. aphylla*.

HORT. IV (813)

ROOTSTOCK SCION INTERACTION IN TREE SPICES

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

Progress report

Nutmeg

a) Collection and raising of rootstocks for grafting

Seeds of *Myristica* species namely *M. beddomeii, M. malabarica* and *M.fragrans* and allied genera namely *Knema andamanica* and *Gymnocranthera canaria* were collected from different parts of Calicut and Wynad districts. The seeds were raised for use as rootstocks for nutmeg.

b) Standardization of grafting

Softwood grafting of nutmeg was carried out on *Gymnocranthera canaria*,

an allied genera of *Myristica* and a success of 70% was obtained on one year old seedling .

c) Compatibility of scions and rootstocks

Softwood grafting of nutmeg with scions from two high yielding lines namely A 9/4 and A 9/69 was carried out on three different rootstocks namely *M. fragrans, M. malabarica* and *M.beddomeii*. It was observed that success was the highest on *M.fragrans* followed by *M. malabarica* and *M. beddomeii* respectively. Between the two scions, A 9/69 was more compatible with all the rootstocks than A 9/4.

Clove

a) Field performance of clove grafts

Semi hardwood shoots were grafted on to 7 different rootstocks and soft wood grafting was found to be successful on *S. heynianum, S. cumini, S.fruiticosum*, and *S. aromaticum*. The performance of clove on *S. heynianum* and *S. aromaticum* is good in the field.

b) Screening rootstocks for drought tolerance in nutmeg

Two years old seedlings of six different rootstocks namely *M. fragrans, M. malabarica, M. beddomeii, M. attenuata, K. andamanica* and *G. canaria* were screened for drought tolerance in pots by inducing stress. Observation on soil moisture, relative water content, membrane leakage, protein, enzymes (peroxidase), chlorophyll content etc were studied at regular intervals. Among the different rootstocks, *M. malabarica* and *K. andamanica* showed relatively more tolerance to drought.

GEN.VII. 813

BREEDING BLACK PEPPER FOR HIGH YIELD, QUALITY, DROUGHT AND RESISTANCE TO PESTS

(B. Sasikumar, Johnson K. Georege K.V. Saji, T. John Zachariah, K.S. Krishnamurthy, S. Devasahayam and Santhosh J. Eapen)

Progress report

Coll. 1041, a clone of 'Thevamundi' continued to exhibit tolerance to *Phytophthora* foot rot disease at Valparai, a hot spot area of the disease. This

line had a mean fresh yield of 4.77 kg per vine at Valparai (3000 ft MSL). Coll. 1041 performed well in planes too in terms of yield and disease tolerance. HP 34, HP 105 and HP 813, the promising hybrids suited to high altitude areas (above 3000 ft MSL) continued to maintain their high yielding ability with mean yield of 3.45, 6.90 and 5.50 kg fresh berries/vine respectively.

HP 1411, a hybrid line and OPKm (an open pollinated progeny of Karimunda) are new lines identified for the plane areas. These lines are characterized by long spike and above 3 kg mean yield/vine (fresh) during the second year of yielding.

Based on a 'Material Transfer Agreement' some of these promising black pepper lines are given to selected corporate firms.

Yield trials

Black pepper yield trials are maintained and monitored both at Valparai and Peruvannamuzhi (Calicut). Mean yield of the promising lines at Valparai is given in table 12 and that of Peruvannamuzhi in table 13.

Coll. 1041, the foot rot tolerant cultivar continued to show tolerance to *Phytophthora* foot rot at Valparai.

Table 12. Yield of promising black pepper vines at Valparai

Line	Mean yield /vine (kg. Fresh)
HP-34	3.50
HP-105	6.90
HP-728	*2.69*
HP-778	6.10
HP-813	5.50
Coll.1041	8.45*
Panniyur - 1 (control)	6.60
Sreekara (control)	1.28
Subhakara (control)	2.80

Table 13. Yield and yield attributes of promising black pepper lines at Peruvannamuzhi

Line	Spike length (cm)	Dry recovery (%)	Mean yield/vine (kg .fresh)
HP-780	13.5	36.0	1.75
Coll.1041	12.0	31.2	2.12
Coll.889	-	32.4	2.20
OPKm	12.3	30.8	3.40
Coll.4133	-	32.0	1.42
HP-1	-	30.0	0.72
HP-2	-	30.2	1.97
HP-1411	16.5	29.3	3.65
Cult.1635	-	30.2	4.00
HP-813*	12.0	29.0	5.06
HP-34*	10.5	33.8	2.88
Sreekara (control)	8.0	83.2	2.27

*non replicated

Evaluation of Neelamundi collections

Seventeen clonal lines and 37 O. P. lines of 'Neelamundi" are being evaluated for yield and disease tolerance, at Peruvannamuzhi. (Two plants/line)

Among the clonal lines, yield (fresh) per vine ranged from 1.17 to 2.5 kg and dry recovery varied from 29 to 32%, during the second year of yielding. O. P. lines were low in yield 0.05 to 1.0 kg/vine (fresh).

Hybridization

A total of 36 cross combinations involving the promising lines (HP 1411, OPKm, P-24, Coll.1041, HP 2, Vadakkan (triploid), Neelamundi, Kalluvally, Kottanadan, Karimunda etc) as well as wild *P. nigrum*, *P. attenuatum* etc were attempted.

GEN. X (813)

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

(D. Prasath and M.N. Venugopal)

Progress report

Among 56 cross combinations (involving parents of mosaic resistant and high yielding selections), three combinations recorded mean yield of more than one kg green capsules per plant (NKE 9 x NKE 3- 1.01 kg/plant, NKE 9 x CCS 1- 1.02 kg/plant and NKE 34 x NKE 12 - 1.20 kg/plant).

Variances due to general and Specific Combining Abilities(SCA) were significant for all the characters. Parents NKE 9, NKE 12, NKE 34 and CCS1 were good general combiners for yield per plant. NKE 19 was found to be good general combiner for number of total tillers and bearing tillers per plant. High SCA effects were expressed by the cross combinations of NKE 34 X NKE 12, RR 1 X NKE 12 and NKE 34 X RR 1 for yield per plant. Genetic analysis revealed the influence of dominance and over dominance in the manifestation of quantitative characters viz plant height, total tillers, bearing tillers, number of capsules and yield per plant.

Initial observations in the cross combination of Rhizome Rot resistant line (RR1) and compound panicle type (MB 3) type revealed considerable improvement over parents for plant height, total tillers and bearing tillers. MB 3 X RR 1 recorded the maximum plant height and total tillers per plant. Open pollinated progenies recorded significant improvement over selfed progenies for the characters plant height, total tillers, bearing tillers, number of capsules per plant and yield per plant.

GEN. XIV (813)

CYTOGENETICS AND REPRODUCTIVE BIOLOGY OF MAJOR SPICES

(R. Ramakrishnan Nair)

Progress report

Observations on 90 OP progenies of black pepper, raised using the seeds

collected from different vines of cv. Vadakkan showed variability in morphology as well as growth rate. Cytological analysis of five progenies shown variation in chromosome numbers such as 2n=87(1), 2n=84(1), 2n=78(1), 2n =52(2).

Cytological analysis of six seedling progenies and three germplasm accessions of turmeric revealed normal chromosome number (2n=63) among germplasm accessions (Acc. 23,324, 384). Among seedling progenies four were with 2n=84 (23a, 23b, 426, 417), one with 2n=86 (414) and one with 2n=63(384).

Black pepper anthers have not responded in SH medium containing 0.1, 1.0, 2.0, 3.0, 4.0, and 5.0 mg/l of Benzyladenine (BAP).

The seed and embryo structure in *Piper mullaesua* was found to be similar to that of *P. nigrum* except for the smaller size. In *P. longum*, embryo was found to be a top shaped structure, different from that of *P. nigrum*.

HORT. II (813)

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

(P.A. Mathew, J. Rema, T.J. Zachariah and M. Anandaraj)

Progress report

The growth of grafts in trial -I(Grafting methods) and trial -II (varieties) were monitored. In both the trials the grafts yielded berries and harvesting was done. Since runner shoots were used for grafting, lateral formation on the entire length of the support was poor in most of the vines. Hence re-grafting of rootstock sprouts with top shoots have been done to get a better spread of laterals throughout. Rootstock sprouts also are being retained to facilitate survival of the rootstock. The graft survival in the third year indicated that tongue (56.75%) and double root stock (78.24%) methods of grafting were significantly superior to other methods. The data on survival are given in table 14. The yield of fresh berries harvested from various types of grafts are given in table 15. It is seen that the yields from tongue and double rootstock grafts were the highest owing to better growth and survival. There was no appreciable difference in driage of berries between grafted and non grafted 'Subhakara' on *P. colubrinum.*

Among the grafted varieties, Poonjaramunda indicated the highest

Table 14. Field survival of 'Subhakara' grafts on *P. colubrinum*

Sl.No.	Grafting/budding method used	No.of grafts	Survival	
			After one year (%)	After two year(%)
1.	Cleft(wedge)	18	50.82+ (45.47)	44.34+ (41.75)
2	Saddle	18	62.02 (51.96)	62.02 (51.96)
3.	Splice	18	55.64 (48.24)	50.00 (45.00)
4.	Modified splice	18	11.46 (19.76)	11.46 (19.76)
5.	Tongue	18	69.93* (56.75)	69.93* (56.75)
6.	Double rootstock	18	98.04* (81.97)	95.85* (78.24)
7.	Yemma	18	62.02 (51.96)	55.64 (48.24)
8.	Approach	18	32.54 (34.78)	15.30 (23.30)
	LSD		29.26	30.74

+ Transformed values. Figures in parenthesis are original values
. Means do not differ significantly at 5% level. Duncans Multiple range test

Table 15. Yield of grafts with various methods during third year.

Sl.No.	Type of grafted/budded plant	Av. yield of fresh berries per vine (kg)
1	Control(non graft)	0.947
2.	Cleft(Wedge)	0.303
3.	Saddle	0.701
4.	Splice	0.271
5.	Modified splice	0.392
6.	Tongue	1.188
7.	Double rootstock	1.263
8.	Yemma	0.682
9.	Approach	0.591
10.	Topshoot	0.380

yield(1.317kg) -per vine followed by Panniyur-IV (0.615 kg) and Sreekara(0.551 kg) (table 16). This shows that varieties do have some compatibility problems with *P. colubrinum*.

Table 16. Yield of grafted pepper varieties during second year

Sl.No.	Variety	Av. yield (kg/plant(fresh berries)	
		Grafted	Non grafted
1.	Panniyur-I	0.155	0.152
2.	Panniyur-II	0.098	0.190
3.	Panniyur-III	0.236	0.052
4.	Panniyur-IV	0.615	0.297
5.	Panniyur-V	0.160	0.232
6.	Pournami	0.197	0.725
7.	Poonjaran munda	1.317	0.00
8.	Udhakara	0.257	0.038
9.	Sreekara	0.551	0.098
10	Balankotta	0.0	0.165
11.	Neelamundi	0.040	0.00
12.	Kottanadan	0.040	0.00
13.	Kuthiravally	0.00	0.097
14.	Panniyur culture	0.00	0.041
15.	Malligeswara	0.00	0.040

The trial of grafted pepper in farmer's plot yielded 3.80kg fresh green pepper from one year old vines and 8.20 kg from two year old vines. No casuality was seen due to disease incidence or breakage of union.

HORT III (813)

DEVELOPMENT OF PAPRIKA FOR WARM HUMID TROPICS

(P.A. Mathew and T.J. Zachariah)

Progress report

For selfing of the surviving accessions, 41 exotic and 72 indigenous ones were field planted and the plants have come to bearing. The seed collection in 11 exotic lines and 22 indigenous lines has been done.

In addition to the above exotic accessions, 'Papri King' an internationally

Table 17. Vegetative and reproductive characters of 'Papri King'

1	Plant height(cm)	66.10
2.	No.of branches(primary)	0-1
3.	Time taken for 50% flower opening from germination(days)	64
4	Time taken for first harvest from flowering(days)	58
5.	Average number of fruits/plant	7
6.	Average fruit weight fresh(g)	18.29
7.	Driage(%)	18.4
8.	Weight of pedicel to total weight of fruit(%)	7.15
9.	Seed content(%)	17.5
10.	Pedicel length(cm)	4.62
11.	Fruit length(cm)	123.38
12.	Fruit Breadth(cm)	2.83
13.	Fruit colour	Dark red
14.	Fruit shape	Elongated, flattened
15.	Fruit skin	Smooth, thick
16.	Fruit tip	Pointed
17.	Colour value	245(ASTA units)
18.	Incidence of anthracnose	Severe on leaves, stem pedicle-fruits drop due to this.
19.	Incidence of bacterial wilt	64.5%
20.	Incidence of virus	Not noticed
21	Pungency	Nil

acclaimed variety was grown in bags as a preliminary trial. The population was very uniform consisting of 99 plants. The data on vegetative and reproductive characters are given in table 17.

From the table it may be seen that 'Papri King' is a very ideal variety for paprika production but needs breeding to incorporate disease resistance. The variety is not suitable for sundrying but needs artificial drying to retain the colour.

BIOTECH II (813)

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

(K. Nirmal Babu and A. Kumar)

Progress report

Multiplication of somaclones: A large number of somaclones are being multiplied. About 500 plantlets were planted out for hardening.

Screening of somaclones for *Pythium* and *Ralstonia* : The 12 disease escapes were subjected to guaranteed infection by inoculation with very virulent strain of *Pythium* and all these succumbed to disease.

Another set of 100 somaclones are being planted (multiplied) in polybags (3+3 each) for screening against *Pythium* and *Ralstonia*).

Field evaluation of somaclones: One trial of 1x1 M bed each of 12 *Pythium* tolerant lines was planted in Chelavoor for multiplication and in Pervannamuzhi (sick plot) for screening. Another trial of 3 beds each was planted in Wynad. The yield of most of the somaclones was good with 5 fold increase.

BIOTECH IV (813)

BIOTECHNOLOGICAL APPROACHES FOR CROP IMPROVEMENT IN BLACK PEPPER

(K.Nirmal Babu and Johnson K George)

Progress report

Molecular characterization

Molecular markers effectively augment the phenotypic characters in genetic characterization. Molecular profiles are being developed to characterize various cultivars and species of black pepper. RAPD protocols were standardised for black pepper varieties and related species and the RAPD polymorphism was used to estimate the genetic distance between them. Of the 8 primers tested, most

of them amplified the related species and good polymorphism was observed. Only 2 primers OPA 04 and OPA 14 amplified all the genotype studies, expressing polymorphism. The studies indicate that the released varieties i.e., Panniyur - 1, Sreekara, Subhakara and Panchami, genetically differ from each other to a large extent. The higher similarity index(60%) was obtained between Panniyur-1 and Subhakara. The RAPD profiles also indicated that Sreekara and Subhakara differ from each other though it is difficult to distinguish between them morphologically. Among the tolerant lines tested HP-I is nearest to Panniyur-1 with the similarity index of 85.7% followed by HP780 with 78.6%. P24 is nearest to Sreekara with 86% similarity index while P1095 is 80% similar to Panchami. However, these tolerant lines could not show any common ploymorphic bands compared to that of other varieties, which are susceptible to *Phytophthora* foot rot. More primers and more genotypes should be screened before we identify RAPD markers co-segregating with tolerance to *Phytophthora*.

Genetic transformation studies in black pepper: The osmotin and GFP constructs received from NRC for Plant Biotechnology are being revived. Asepetic cultures of black pepper embryos were established for transformation.

ICAR AD-HOC PROJECT

ESTABLISHING IN VITRO CONSERVATORY OF SPICES GERMPLASM

(K. Nirmal Babu, P.N. Ravindran, Geetha S Pillai, Minoo D and Jayakumar)

Estimation of genetic stability among in vitro conserved accessions of cardamom using RAPDs

At IISR cardamom germplasm is conserved in *in vitro* gene bank. RAPD profiles were assessed for genetic fidelity of genotypes conserved in *in vitro* repositories. Since tissue culture is an essential technology for *in vitro* conservation and variation may occur at all tissue culture levels, the genetic stability of conserved materials is at risk. High molecular weight DNA was isolated and RAPD technique was used for characterization of *in vitro* conserved plants to estimate their genetic stability. These profile differences were assessed as an index for genetic differences within genotypes conserved in *in vitro* repositories for at least three years with yearly sub culturing on minimal growth medium. It was for the first time that RAPD protocols were standardised in *in vitro* conserved cardamom varieties. Among the 19 primers tested, three primers viz., OPA 12, OPC 19 and OPE 02 gave indications of polymorphism between genotypes i.e., NKE 9,NKE27 and APG 50, during screening. Results indicated

there is considerable uniformity between the 6 replicates of *in vitro* conserved varieties of cardamom tested. This preliminary finding needs to be continued by studies on larger population size and more polymorphic primers.

Conservation of spices germplasm in vitro

Establishment of accessions under *in vitro* condition was attempted and priority was given to those with important characteristics like high quality, high yield, resistance to diseases etc. Newly established Piper species include *P. peepuloids*, a high elevation species, *P. cubeba*, a medicinally important species and *Vanilla andamanica* . Important cardamom accessions established are CCS-I, a released variety with high quality and yield and RR-I a rhizome rot tolerant variety.

Retrieval of conserved germplasm

The efficiency of any *in vitro* storage method can be assessed in terms of survival and maintenance of viability after storage ie., recovery and regrowth of cultures after storage. *In vitro* cultures of all the species, which were in minimal growth storage conditions were transferred to multiplication medium to assess their regeneration capability. Cardamom cultures after 1 year of storage could be brought back to normal conditions with 90% success and are transferred to soil. The ginger and turmeric cultures after 10 months of storage were multiplied within 30 days. The rooted plantlets were established in the soil with 80% success.

Microrhizome formation in turmeric

Microrhizome formation was noticed under slow growth storage conditions in turmeric and an experiment was conducted with the aim of enhancing the microrhizome formation. MS basal medium without growth regulators supplemented with sucrose and mannitol at different levels were tried. Observations were made on time taken for induction, number of microrhizomes per culture, fresh weight, size, percentage of establishment in soil etc. Cross sections were taken and stained in 1% saffranin and observed under microscope and compared with normal rhizome anatomy.

Cryopreservation of Vanilla Pollen

Attempts to cryopreserve vanilla pollen, primarily to design a viable method for interspecific hybridization programmes, were made. Results indicated that a pretreatment with Cryoprotectant (DMSO) was essential before plunging in liquid nitrogen, instead of direct dessication and liquid nitrogen preservation.

Cardamom pollen

Pollen germination studies were carried out in Brewbaker and Kwack's medium with sucrose at different concentrations to optimize the germination conditions. Dessication and treatment with cryoprotectants were tried before plunging directly into liquid nitrogen. The post freeze viability was assessed by staining in fluorescein diacetate and also by *in vitro* germination.

Cryopreservation of ginger shoot buds (encapsulation/dehydration)

Embryos were dehydrated with cryoprotectants like dimethyl sulfoxide(DMSO), glycerol and sugar, singly as well as in combinations ranging from 5-15% for 30-60 m and kept in dark. The pre-treated control (without Liquid nitrogen treatment) was also cultured on recovery medium. The survival rate of encapsulated shoot buds after pregrowth and desiccation varied depending on the sucrose content in the preculture medium. Preculture for 1 d with 0.5M as well as 0.75M sucrose was detrimental to survival. Shoot buds could withstand 2 and 3d preculture duration in both the sucrose concentrations with 60-70% survival. Shoot buds precultured for 3 days in 0.5M and 0.75M sucrose and desicated for 4 hrs showed a post freeze viability of 30% and 50% respectively.

Establishment of DNA Bank

A DNA bank was established as part of *in vitro* gene bank to store and conserve DNA for further studies and use in genetic engineering experiments, in making genomic libraries and in crop improvement programmes. At present, we have 17 accessions of black pepper, 50 accessions of cardamom, 40 accessions of ginger and 2 accessions of turmeric, 2 accessions of Kaempferia and 17 accessions of vanilla.

PRODUCTION OF HAPLOIDS AND DIHAPLOIDS OF CARDAMOM (*ELETTARIA CARDAMOMUM* MATON) THROUGH ANTHER CULTURE

(P.N. Ravindran, K. Nirmal Babu, J. Dominic and Minoo D)

Plantlets could be regenerated from anther derived cultures of cardamom. These need to be indexed cytologically to estimate their ploidy level. Studies are in progress to enhance the regeneration efficiency and recovery of plantlets.

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

(K. Nirmal Babu , P.N. Ravindran, M.N. Venugopal and Benny Daniel)

Over 2000 cardamom somaclones were produced during the year and transferred for screening.

Over 1000 somaclones were screened against katte and 50 lines have escaped infection after second round of screening. These are being subjected to third round of screening.

Field evaluation of somaclones indicated high variability with regard to plant height, number of clumps, fruit set, fruit shape and size indicating that somaclones are important source of variation to be exploited in cardamom.

A plant regeneration protocol was standardized to induce somatic embryogenesis in cardamom for the first time.

DBT PROJECT

FIELD EVALUATION OF TISSUE CULTURED PLANTS OF SPICES AND ASSESSMENT OF THEIR GENETIC STABILITY USING MOLECULAR MARKERS

(K. Nirmal Babu, P.N. Ravindran, Anu Augustine, Manoj P Das, Elango Mathavan, Minoo D and Sreenivasan)

A field evaluation trial consisting of 300 lines of micropropagated black pepper involving Karimunda and Aimpriyan is laid out during the year. Another trial was laid out with 100 lines of curry leaf. Over 500 each of cultures of black pepper, ginger, turmeric and cinnamon were established and are ready for transfer for field planting next year.

DNA was isolated in 15 lines of each of micropropagated black pepper, ginger and *Kaempferia* to study the genetic fidelity of micropropagated plants using molecular markers.

Estimation of genetic variability among somaclones of ginger using RAPDs

The somaclaonal variation forms an important source of genetic variability in ginger. RAPD profiles were used for estimation of genetic viability. Three varieties of ginger viz., Varada, Australia and Jamaica, collected from three distinctly different geographical regions were used. Of the 11 primers tested

8 gave good polymorphism between Varada and Australia in the initial screening and four were tested for all the genotypes viz., OPB 2, OPC 5, OPE 02 and OPF 01. The primer OPB 2 could detect polymorphism to certain extent in the tissue cultured plans from Australian variety which differed with all the rest by the presence of double bands ~ 0.7 kb while all the others had only single band at this location. The primer OPC 5 did detect polymorphism between Varada and the rest of Australia and Jamaica lines by the presence of a band at 0.70 kb. The primer OPE 2 also showed some degree of polymorphism between the genotypes in that Varada plantlets did not have the band at ~0.4 kb. The primer OPF1 did detect polymorphism between Jamaica and the rest of the genotypes in that all Jamaica collections had specific double band at ~2.5 kb. Thus the present study indicated that specific RAPD profiles could be obtained for molecular identification of Varada, Australia and Jamaica. There is possibility of somaclonal variation among the micropropagated ginger types. It is expected from a crop like ginger, which may be a genetic mosaic due to accumulated mutations. This also accounts for so many varieties irrespective of lack of sexual reproduction.

NATP PROJECT

MOLECULAR CHARACTERIZATION AND PREPARATION OF MOLECULAR MAPS IN BLACK PEPPER

(K. Nirmal Babu, P.N. Ravindran, M. Anandaraj, Johnson K. George, S. Asha and Minoo D)

RAPD Polymorphism in varieties and related species of black pepper (Piper nigrum L.):

Molecular markers effectively augment the phenotypic characters in genetic characterization. Molecular profiles are being developed to characterize various cultivars and species of black pepper. RAPD protocols were standardized for black pepper varieties and related species and the RAPD polymorphism was used to estimate the genetic distance between them.

Preparation of molecular maps: A mapping population is being developed from selfed and crossed progenies of Subhakara, Panniyur 1 and P 24. The selfed progenies were already embryo rescued to reduce time and are ready for transfer. Laterals of these 3 varieties were developed for crossing during 2002.

DNA is being isolated from these progenies.

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)

Progress report

Ground coverage and growth

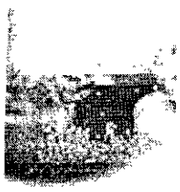
Amongst various crop combinations, cardamom + clove continued to record maximum ground coverage (9200.4 sq. m.), leaving only 799.6 sq. m. of the ground area uncovered. Least ground/canopy coverage was observed in combination of cardamom and coffee (6552.3 sq. m.). Cardamom continued to show better growth in terms of its height in combination with all spices, 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 with 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 were 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 contents (0.21%) were highest in case 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 mix 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 moles 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 moles m^{-2} sec^{-1}. Light received by cardamom in various cropping

systems ranged from 54.2 to 906.4μ moles m^{-2} sec^{-1} with a mean of 265.92 μ moles 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 moles 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.XVII (813)

VERMICOMPOSTING USING ORGANIC WASTES AVAILABLE IN CARDAMOM AREAS.

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

Progress report

Growth parameters

The observations on number of tillers per plant, number of leaves per tiller and plant height were 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) were recorded in treatments which received vermicompost alone (T_5) and treatments that received 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 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) 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}) were observed in T_9 (50% VC+50% NC), T_1 (control) and T_5 (vermicompost) respectively. Relatively higher build up of nutrients in soil was observed in combination with recommended dose of fertilizer (RDF) plus organic fertilizers than using alone.

Secondary and micro nutrients

The content of secondary and micronutrients 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) was observed in T_{11}, 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 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 18)

Table 18. Micronutrient content in soil as influenced by different treatments (6 MAIT)

Tr. No.		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	Chemical+FYM	425.00	136.33	38.003	22.00	2.60	5.37
7	100%NPK+NC	427.67	129.67	9.33	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						
12	50%FYM+50%VC +50%NPK	585.33 418.33	189.33 158.67	40.00 35.67	21.33 24.67	2.57 2.17	6.80 6.23
	CD at 5%	NS	NS	NS	24.631	NS	NS

Microbial population such as bacteria, fungi, actinomycetes and beijerinckia were recorded wide variation among the treatments(table 19). Bacterial population ranged from 140.19 x 10^5 to 274.93 x 10^5 with a mean of 195.63 x 10^5. Fungal 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 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 was studied. Light availability was 1520.78 micro moles/m^{-2}/sec^{-1} Almost 70.69% of light was intercepted by the shade trees. On an average leaf area index of shade tree was 1.4 (approximate). Cardamom crop received on an average 335.36 micro moles/ m^{-2}/sec^{-1} and intercepting 62.91%. It recorded 1.095 average leaf area index.

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)

Progress report

Various systems included in the study are-

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

Co - 1 grass was used for Bangalore method of composting. Five hundred pepper- rooted cuttings were raised for planting in the main field. Arecanut is establishing 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 by doing hand pollination.

Table 19. Microbial population in the soil after 1 year of planting

Tr. No		Bacteria	Fungi x 10^5	Actinomycetes x 10^4	Beijerinckia x 10^3
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. XX (813)

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

(C. K. Thankamani, V. S. Korikanthimath, P. A. Mathew and S.J. Anke Gowda)

Progress report

Nucleus planting materials of Turmeric seed rhizomes (4 tons), Ginger seed rhizomes (4.4 t), Nutmeg grafts (2581 Nos), Cinnamon seedlings(282 Nos),

Allspice seedlings (496 Nos), Cardamom seedlings (14000 Nos), Cardamom seed capsules (108 kg) were produced and distributed.

SSC II (813)

NUTRITIONAL REQUIREMENT OF IMPROVED VARIETIES OF *SPICES*

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

Progress report

Black pepper

There was significant increase in the levels of DTPA extractable Zn from soil in Zn applied treatments over control and foliar application and soil application levels behaved on par. Leaf Zn concentration was significantly highest in highest dose of soil application of Zn (20 kg/ha) and foliar application treatments (table 20). But this had no influence on the berry Zn concentration among the levels applied over control. Significantly highest yield (2.2 kg/vine) was recorded in foliar Zn sprayed plots and other soil application treatments have yielded on par to control. The oleoresin content was also not influenced by the levels and mode of Zn application.

Turmeric

Different levels of Zn application had no effect on the availability of major and secondary nutrients except that of potassium. The soil availability of Zn was significantly high in Zn treated beds and there exists a significant difference among the levels applied also. Coir compost application along with Zn had no influence on the availability of major, secondary and micronutrients except that of K (table 21).

Yield and Quality

Zinc levels had no significant influence on the rhizome yield of turmeric as all the treatments yielded on par. But the rhizome Zn concentration was highest in 15 kg Zn application on par with 7.5 kg Zn/ha application. Significantly highest (6.32%) level of curcumin was recorded at 7.5 kg Zn level that was on par with levels 5 and 15 kg Zn/ha. Coir compost application had no significant effect

on yield and curcumin contents but the rhizome concentration of Zn increased significantly.

Ginger

Nutrient availability

With increasing levels of Zn applied, the soil availability of P decreased considerably. The availability of other nutrients like Ca, Mg, Fe and Mn were not affected with levels of Zn applied. Soil Zn availability status increased significantly with the levels of Zn applied with highest of 7.4 ppm in 15 kg Zn applied plots. Application of coir compost along with Zn did not improve the availability of Zn, rather caused temporary arrest on its availability, there by reduction in Zn content in coir compost applied beds over non-applied. Further, the application of coir compost significantly improved the release of soil P and Mg.

Yield and Quality

The rhizome Zn concentration was significantly high in Zn applied plots over control and significantly differed among the levels of Zn applied with highest rhizome concentration in highest level of Zn application. With the application of coir compost also there was significant increase in the rhizome Zn concentration.

The Zn application ignificantly increased the yield over control. Significantly highest yield was observed in 5 kg Zn applied plots which was on par with 15 kg applied plots followed by other levels of Zn application. With coir compost application, there was significant increase in the rhizome yield upto 8.23 kg/bed (table 22.). Zinc application at different levels and application of coir compost had no effect on the quality parameter of ginger, as all the treatments were on par with control in their oleoresin content.

Investigation on the effect of magnesium nutrition in black pepper

First year yield of the black pepper plants were recorded. The soil availability of magnesium increased significantly with the application of Mg fertilizer but the levels were on par on availability. The availability of other related nutrients were not influenced much (table 23). The leaf Mg concentration increased significantly with the application of Mg and with the increasing levels in all the

three varieties studied. The application of Mg had no influence on the yield as all the treatments studied were on par in all varieties.

Investigation on nutrient requirement for targeted production of black pepper

The experiment to find the target production of black pepper was taken up in the farmers' plots at three locations namely, Kalpetta and Padichera in Wynad and Madikeri, Coorg, Karnataka. Based on the soil nutrient status, crop uptake and yield, parameters like kg, of nutrient required for berry production (NR), contribution of nutrient from soil (CS) and contribution from fertilizer (CF) were worked out. With these parameters the fertilizer requirement for getting a targeted pepper yield will be derived and tested at the locations subsequently.

Place	NR(kg/qtl)			NR/%CF			%CS/%CF		
	N	P	K	N	P	K	N	P	K
Kalpetta	1.94	0.31	1.86	0.056	0.048	0.08	0.16	1.37	0.14
Padichera	1.72	0.22	0.85	0.091	0.063	0.33	0.14	0.29	0.21
Madikeri	2.01	0.33	1.53	0.10	0.06	0.22	0.10	0.92	0.62

Table 20. Effect of different levels of zinc on soil availability, plant uptake,

	Yield and oleoresin content of black pepper				
Zn level kg/ha	Soil Zn (ppm)	Leaf Zn (ppm)	Berry Zn (ppm)	Yield kg/vine	Oleoresin %
0	1.5	22	9.9	1.3	10.3
5	10.3	23	10.3	1.9	10.6
10	11.4	26	10.6	2.0	10.5
15	11.6	24	10.1	1.9	9.9
20	11.9	26	12.5	1.8	9.8
0.25% Foliar	2.3	27	11.8	2.2	9.3
CD 5%	0.84	2.8	1.8	0.78	NS

Table 21. Effect of different levels of Zinc application on its soil availability, rhizome concentration, yield and curcumin content of turmeric

Zn Level kg/ha	Coir com. t/ha	Soil nutrient(mg/kg)							Rhiz Zn	Yield Zn (mg)	kg/3m² Cur-	cumin %
		N	P	K	Ca	Mg	Fe	Mn				
0	0	222	1.2	145	365	91	43	3.6	0.90	19	11.2	5.1
	2.5	230	2.0	104	371	111	40	6.5	0.70	19	11.3	5.6
	Mean	226	1.6	125	368	101	42	5.1	0.80	19	11.3	5.4
5	0	217	1.8	111	302	83	40	5.4	1.1	22	11.5	5.6
	2.5	213	1.4	62	358	94	42	7.6	1.7	19	12.2	5.3
	Mean	215	1.6	87	330	89	41	6.5	1.4	21	11.8	5.4
75	0	227	1.4	109	278	91	42	5.2	2.9	21	12.5	6.5
	2.5	224	1.2	132	417	80	41	7.7	1.7	26	12.7	6.2
	Mean	226	1.3	121	348	85	42	6.4	2.3	24	12.6	6.3
10	0	221	1.2	131	300	92	41	5.6	3.8	17	12.5	4.8
	2.5	222	3.7	110	338	88	42	10.6	4.1	22	11.0	6.0
	Mean	222	2.5	121	319	90	41	8.1	4.0	20	11.8	5.4
15	0	216	3.0	106	369	90	40	5.9	4.7	22	11.2	5.5
	2.5	218	2.1	89	357	96	41	5.9	5.2	34	11.0	6.4
	Mean	217	2.5	97	363	93	41	5.9	5.0	28	11.1	5.9
CD 5%		NS	NS	28	NS	NS	NS	1.6	0.51	NS	2.29	NS

Table 22. Effect of different levels of Zinc application on its soil availability, rhizome concentration, yield and oleoresin content of ginger

Zn com. kg/ha	Coir t/ha	Soil Nutrient(mg/kg)							Rhiz Zn	Yield kg/3m² (mg)	oleo-	Level resin %
		N	P	K	Ca	Mg	Fe	Mn	Zn			
0	0	201	1.4	130	402	97	36	5.2	0.91	11	4.8	5.4
	2.5	215	4.4	127	434	105	42	7.0	0.91	15	6.3	5.2
	Mean	208	2.9	129	418	101	39	6.1	0.91	13	5.5	5.3
5	0	209	2.8	138	354	90	41	9.2	2.0	13	8.5	5.5
	2.5	254	3.9	91	488	124	40	8.1	1.6	19	8.6	5.9
	Mean	232	3.3	115	421	107	40	8.7	1.8	16	8.6	5.7
75	0	215	4.1	131	423	109	39	13.8	3.3	15	6.8	5.0
	2.5	216	2.1	105	443	111	39	9.5	2.4	24	8.5	5.5
	Mean	215	3.1	118	433	110	39	11.6	2.9	20	7.7	5.3
10	0	205	1.8	122	327	95	39	10.6	5.6	20	6.2	5.1
	2.5	219	3.3	101	475	118	39	9.6	3.9	26	8.6	5.5
	Mean	212	2.5	112	401	107	39	10.1	4.7	23	7.4	5.3
15	0	209	1.3	117	424	110	39	10.5	7.8	20	7.6	5.4
	2.5	240	3.5	155	481	133	41	10.1	7.0	28	9.1	5.9
	Mean	225	2.4	136	453	122	40	10.3	7.4	24	8.3	5.6
CD 5%		18	NS	NS	NS	10	NS	NS	0.99	0.69	1.5	NS

Table 23. Effect of different levels of magnesium on soil nutrient availability, leaf concentration of Mg and yield of black pepper

Mg level kg/hg	Soil nutrient (mg/kg)			Leaf Mg (%)				Yield (kg/vine)			
	K	Ca	Mg	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
Check	319	1150	185	0.20	0.20	0.20	0.20	0.70	0.69	1.3	0.91
NPK	341	1168	235	0.21	0.21	0.22	0.21	1.4	0.63	1.8	1.3
NPK+50	396	1236	385	0.25	0.32	0.38	0.31	0.94	0.60	1.8	1.1
NPK+75	379	1323	419	0.31	0.39	0.40	0.36	0.79	0.63	2.1	1.2
NPK+ 100	389	1433	424	0.36	0.42	0.42	0.40	1.2	0.82	1.6	1.2
CD 5%	147	396	125	0.02			0.01	N.S			0.27

NPK @ 140, 55, 270 kg/ha
V1 = Subhakara, V2= Pournami, V3= Panniyur-1

PHY V (813)

CHARACTERIZATION OF DROUGHT TOLERANCE IN BLACK PEPPER

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

Progress report

In preliminary screening trial, 140 germplasm accessions and 150 hybrids were screened for drought tolerance based on moisture loss in laboratory desiccation experiments. Leaves from both the control and stressed (under open light condition) plants were subjected to desiccation and the moisture percentage after 5 and 24h was worked out(table 24). Moisture content of control leaves subjected to laboratory desiccation was positively correlated with relative water content under field stress condition.

Gas exchange parameters such as photosynthetic rate (A), stomatal conductance (g_s), leaf temperature (T_{leaf}) and transpiration rate were studied in both irrigated and water stressed pepper plants. A, g_s and E decreased drastically while T_{leaf} increased during water stress(table 25).

A summary of the results is given in the table below.

Table 24. Moisture content of leaves (%) as affected by water stress

Acc No	Control		4 days after stress induction	
	5h	24h	5h	24h
	Tolerant accessions (Visual scoring)			
828	88.8	60.3	88.4	57.9
926	91.0	65.0	90.5	62.5
892	92.0	64.5	92.1	69.8
1018	89.6	62.9	89.1	57.9
813	91.2	66.1	84.0	64.5
807	89.2	64.0	89.9	57.6
	Susceptible accessions			
885	89.4	57.6	88.6	59.6
877	91.0	67.1	93.7	72.7
981	88.5	52.1	87.9	62.6
1200	83.4	49.4	90.9	68.3
1025	86.2	49.0	89.2	64.1

Table 25. Gas exchange parameters as affected by moisture stress

Acc No	A (u mol)		g_s (mol)		T_{leaf} °C		E (mol)	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress
813	2.62		0.02		31.5		0.92	
805	1.18		0.00		33.18		0.19	
910	2.96	1.18	0.02	0.00	33.1	35.7	0.84	0.34
809	2.53		0.02		33.5		1.00	
892	2.69	0.17	0.02	0.00	33.7	36.3	0.83	0.17
1188	3.48		0.02		34.6		0.80	
803	3.82	0.39	0.02	0.00	34.3	36.0	1.08	0.21
1334	2.20		0.01		35.5		0.58	
807	3.62		0.02		35.1		0.98	
1025	3.09		0.02		35.1		0.76	
1108	2.05	1.65	0.01	0.01	35.7	36.2	0.54	0.60

Enzyme activities such as catalase and peroxidase were also monitored during water stress. Activities of both the enzymes were reduced drastically under severe stress condition.

PHY VI (813)

CHARACTERIZATION OF DROUGHT TOLERANCE IN CARDAMOM

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

Progress report

Six accessions namely NKE-12, NKE-9, RR-1, RR-2, 893 and LR-1 were screened for moisture stress tolerance in cement pots under rainout shelter. Moisture stress was imposed by withholding irrigation and data on morphology related to drought tolerance was recorded at initiation of stress, middle of stress and at the end of stress. Data revealed that accessions RR-1, CI 893 and LR-1 were relatively tolerant to moisture stress. They maintained relatively higher biomass under stress compared to NKE-12, NKE-9 and RR-2.

Fifty-eight accessions were screened for relative water content, specific leaf weight and stomatal counts. They recorded significant variation. Relative water content (per cent control over stress) ranged from 15.22 to 44.56% with a mean of 27.96%. Specific leaf weight ranged from 4.2 to 7.13 with a mean of 5.25 mg/cm^2. Number of stomata per microscopic field ranged from 6.23 to 14.4 with a mean of 10.28.

BIOCHEM.I (813)

BIOGENESIS OF PIGMENTS IN SPICE CROPS

(B. Chempakam and T. John Zachariah)

Progress report

The major objectives of the project were to assay, localize 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).

PAL activity was assayed during the early germination phase in rhizomes, roots and leaves of turmeric. The activity was maximum at 15 DAS (days after sowing) in rhizomes which declined afterwards. The activity in roots showed a steady increase.

Distribution of PAL in different cell fractions of turmeric leaves showed maximum activity in mitochondrial fraction (table 26).

Secondary metabolites

Major phenolic acids, which act as intermediate precursors in curcumin biosynthesis, were identified as caffeic, coumaric and ferulic acids. The relative distribution of components of essential oil through Gas chromatography revealed ar-turmerone as the major component in rhizomes and roots (31.5 and 46.8% respectively) while phelladrene was found to be the major component in leaves (32.6%).

Table 26. PAL distribution in various cell fractions in turmeric leaves

Speed	Time	Fraction	PAL activity($x10^{-2}$)
200 g	5'	Crude extract R	25.31
1000 g	10'	Chloroplast R	14.65
10,000 g	15'	Mitochondria R	28.35
1,05,000 g	2 hrs	Microsomes R	13.33
		Soluble protein S	Nil

R-Residue
S-Supernatant

PHT.I (813)

QUALITY EVALUATION IN SPICES

(T. John Zachariah, P. Heartwin Amala Dhas and B. Chempakam)

Progress report

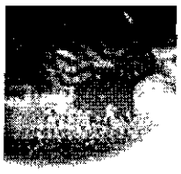
Evaluation of ginger samples from North East

Bhaise, Gurubathani and Kalimpong varieties which are traditionally grown in North-east were cultivated at Peruvannamuzhi (Calicut), Thamarassery (Calicut) and the chemical quality was compared with that of the same cultivated at Sikkim(table 27).

The data clearly indicate that ginger samples from North-east are slightly immature in nature and they acquire full maturity when they are cultivated in the plains. This is evident from the high dry recovery we obtain when it is cultivated in plains. Generally immature samples yield more oil and oleoresin. The ginger samples yield more oil and oleoresin at North-east compared to plains.

Table 27. Quality evaluation of ginger from North-east

Variety	Dry recovery (%)	Ess. Oil (%)	Oleoresin (%)	Crude fibre (%)
BHAISE-Thamarassery	18	1.6	5.1	2.8
BHAISE-Peruvannamuzhi	17.0	1.6	6.0	3.2
BHAISE-Gangtok	10.3	2.6	7.0	6.0
GURUBATHANI-Thamarassery	16. 2	1.6	5.0	2.1
GURUBATHANI -Peruvannamuzhi	15.2	1.6	6.0	3.1
GURUBATHANI -Gangtok	13.2	2.5	6.2	4.8
KALIMPONG - Peruvannamuzhi	19.0	1.6	3.9	4.0
MAHIM - Peruvannamuzhi	18.0	2.6	5.3	3.9



Storage studies in fresh ginger and turmeric

This programme was taken up with the following objectives. 1) long term storage of fresh ginger and turmeric without dehydration to use as raw ginger and 2) to develop ecofriendly storage measures for storing dry ginger and turmeric.

Hence harvested fresh ginger and turmeric were stored in ordinary gunny bag, cardboard box, newspaper bag and polyethylene bag. The samples were stored for about 3-4 months after harvest. The study indicate that the samples undergo complete dehydration and become unfit for consumption in all containers except polyethylene cover The ventilation in the polyethylene cover has to be adjusted to prevent sprouting and condensation of moisture inside.

Evaluation of black pepper sample from Valparai

At Valparai(T.N), HP-813 has about 11.7% oleoresin, P-24 has relatively very good bulk density (654gm/litre), high oil (3.2%), good oleoresin (10%) and 2.1% piperine.

Analysis of black pepper (Neelamundi) samples

Among the 22 samples analysed HP-813 gave 15% oleoresin, 5.4% volatile oil and 3.5% piperine(table 28).

Table 28. Black pepper collection - quality profile

Variety	Bulk density (gm/lit)	E. Oil (%)	Oleoresin (%)	Piperine (%)
HP-813	452	5.5	15.3	3.5
HP-1411	473	3.0	10.8	3.5
HP-34	555	3.6	8.4	2.3
HP-2	528	2.4	10.8	3.8
HP-1	488	3.6	11.7	3.8
OPKm	589	3.0	8.3	2.2
4133	518	3.2	8.6	2.3
1365	586	2.8	10.7	3.5

Refining methods to prepare white pepper

This programme was taken up to evolve a method to reduce the retting time required to prepare white pepper and also to develop a microbial culture to convert black pepper to white pepper.

1. Pectinase and cellulase enzymes @ 5 to 20% obtained from CTCRI were added to the retting medium
2. The organisms present in the retting medium were evaluated using expertise from plant pathology section.

It was found that pectinase and cellulase did not give any attractive colour or could reduce the retting time.

Quality evaluation of ginger germplasm accessions

Fifty accessions were evaluated for volatile oil, oleoresin and crude fibre. Acc. 155, 127 and 50 contained more than 2.8% oil, Acc. 248, 209, 109, 288, 50, 128, 60, 22, 127, 97, 184, 53, 58 and 167 contained more than 4.5% crude fibre. Acc 50, 127, 187 and 137 contained 6- 7% oleoresin. Acc.211, 108, 243, 171, 385, 269, 26 and 161 contained less than 3% crude fibre.

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)

Progress report

The efficacy of the volatile oils from allspice leaves and *Zanthoxylem rhesta* seeds, hexane and methanol extracts of *Annona squamosa* seeds, *Melia dubia* seeds and *Polyalthia longifolia* leaves were tested on the mycelial growth of *Phytophthora capsici*, at concentrations ranging from 0.5% to 2%. All the extracts inhibited mycelial growth to varying levels. However, the volatile oils from allspice leaves and *Zanthoxylem rhesta* seeds completely inhibited mycelial

growth of *P. capsici at* 0.5% and 2% concentration respectively.

Studies were conducted to see the nematicidal activity of these extracts on the second stage juveniles of the root-knot nematode, *Meloidogyne incognita.* The results indicated that the methanol extract of *Annona squamosa* seeds at 0.25% concentration caused 100% mortality of the test nematodes, after 24 hours of incubation.

PHT. II. (813)

HARVESTING AND PROCESSING TECHNIQUES IN SPICES

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

Progress report

Dehydration of mace and nutmeg seed

The following methods of drying were tried to dry mace and nutmeg seed.

- ☆ Hot air drying in agricultural waste fired dryer
- ☆ Hot sand drying

The dryer consists of a burning chamber and a plenum chamber. The rate of combustion can be controlled by adjusting the smoke outlet from the chimney and also the entry of fresh air into the burning chamber. In hot air drying, the temperature was maintained in the range of 55 to 65 °C. Both mace and nutmeg were spread in a single layer over the wire mesh. It was observed that drying of mace took 4 hours(table 29) while that of nutmeg seed took 16 hours. The dry recovery of nutmeg mace and seed are 33.10 and 70.6 per cent respectively.

In the hot sand drying method, a sand bed was placed over a wood fired stove and mace and nutmeg seed were spread over it. It is one of the traditional methods followed for drying of nutmeg. In this method, control over the temperature of drying is limited. The sand bed provides uniform and constant heat supply to the produce. Drying was over in 3.5 hours for mace and 14

hours for nutmeg seed. The quality of air dried and hot sand dried nutmeg mace and seed were compared. It was found that the quality was better in hot air drying(table 30).

Aerated steam treatment of ginger rhizomes

Ginger rhizomes were treated with *Ralstonia* culture and were subjected to humid hot air treatment at 46,50 and 54 °C for different time duration of 15, 30 and 60 minutes. Similarly one set of rhizomes was washed in distilled water and subjected to the same treatment and this acted as the control. The treated rhizomes were planted in pots with four replications. However, much of the

Table 29. Drying characteristics of mace

Drying method	Initial weight (g)	After 0.5 hr	After 1hr	After 1.5hrs	After 2hrs	After 2.5hrs	After 3hrs	After 3.5hrs	After 4hrs	Dry Recovery %
Air drying	200	140.6	106.2	86.2	76.8	72.6	69.6	67	66.2	33.1
Hot sand drying	200.0	132.50	101.75	89.00	81.50	75.25	71.25	68.00	68.00	34.0

Table 30. Biochemical analysis of nutmeg and mace

nutmeg Seed

Sample	Moisture (%)	Butter(%)	Oleoresin(%)	Essential oil(%)
Fresh	34.32	13.36	1.11	4.81
Air dried	6.08	34.75	2.23	6.95
Hot sand dried	7.09	32.50	1.80	6.20

mace

Sample	Moisture (%)	Lycopene (%)	Oleoresin	Essential oil(%)
Fresh	59.75	151.37	11.99	4.49
Air dried	3.36	165.99	22.01	11.32
Hot sand dried	4.42	146.37	20.03	11.03

data were lost since there was flooding in the pots kept outside. Therefore, the results are inconclusive. The experiment will be repeated this year. An aerated steam unit of 125 kg capacity per batch of ginger rhizomes is under fabrication. The unit consists of a steam generator, air blower, mixing chamber and holding chamber. The temperature of the aerated steam is to be maintained at 50 to 52^0 C.

iii) Dehydration of *Piper chaba*

Piper chaba at three maturity levels namely; mature (turning green to orange), ripe (completely turned into red) and over ripe (become soft and red) were dried in both sun and dryer. It was estimated that sun drying took 5 days while hot air drying took 8 hours for complete drying. The dry recovery was between 30 and 34 per cent in both methods of drying. Dry recovery was found to be highest in over ripe sample because of its low moisture content at the time of harvesting. Proximate analysis for quality of the dried samples is under progress.

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

Agroforestry approach in cultivation of cardamom and black pepper afforestation of vacant/open sloppy 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 micro climate 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 is 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. 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)

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 micronutrients due to organic 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 solubilizing 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 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 oleoresin in bush black pepper. Quality analysis of cardamom showed that, 1-8 cineole content was highest in FYM treatment where as alpha terpinyl acetate was highest in leaf compost treatment.

CONTRACT RESEARCH PROJECT

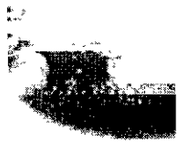
STUDIES ON EVALUATION OF TERRA CARE FOR GROWTH, NUTRITIONAL AVAILABILITY, YIELD RESPONSE AND QUALITY OF SPICES

(V. Srinivasan)

The experiment was 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 was conducted at Coorg district of Karnataka and that of ginger and turmeric at IISR farm, Peruvannamuzhi. Treatment consists of two levels of terra care in combination with N, P, K, FYM and biofertilizers.

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 + Biofertilizers, FYM + single



dose of TC + ½ NPK + biofertilizers 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 + biofertilizers 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) + biofertilizers 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 solubilizing bacterial population was recorded for the treatment where terra cares alone was applied at a rate of 1.25 tons/ha.

Nitrogen fixing bacterial population (*Beijerinckia and Azotoabactor*) was highest for the combination of Terra Care + ½ NPK + biofertilizers.

CROP PROTECTION

PATH.11.3 (813)

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

(S. S. Veena,Y. R. Sarma, M. Anandaraj, K. V. Ramana, V. Srinivasan & C. K Thankamani)

Progress report

Studies with potassium phosphonate

A pot culture experiment was conducted to study the effect of various concentrations of potassium phosphonate on *Trichoderma* population. Population was enumerated at weekly interval. *Trichoderma* was applied along with different concentrations of potassium phosphonate i.e. 3ml/l, 6ml/l, 9ml/l and COC 0.2%. No statistically significant reduction in *Trichoderma* proliferation was observed, when *Trichoderma* was applied along with different concentrations of potassium phosphonate, whereas copper oxy chloride reduced the multiplication.

The plants were challenge inoculated with *P. capsici* and the survival percentage was recorded(table 31).

Table 31. Effect of *Trichoderma* and potassium phosphonate in checking foot rot infection in black pepper

Treatment	Survival %
1. *Trichoderma* + potassium phosphonate 3ml/l	44d
2. Pot. phosphonate 3ml/l	44d
3. *Trichoderma* + pot. phos. 6ml/l	58abc
4. Pot. phos. 6ml	56bc
5. *Trichoderma* + pot. phos. 9ml/l	67a
6. Pot. phos. 9ml	64 ab
7. *Trichoderma* + COC 0.2%	33e
8. COC (0.2%)	53cd
9. *Trichoderma*	31e
10.Control	17f
LSD (P 0.05)	5.89

All the treatments were statistically significant in checking the pathogen compared to control. The highest survival % was noted with the treatment *Trichoderma* + Pot. phos. 9ml/l and it was on par with the treatments, *Trichoderma* + Pot. phos. 6ml/l and Pot. phos 9ml/l.

Effect of vermicompost on P. capsici

The initial studies with different proportions of vermicompost showed that vermicompost 25% (75% soil) could check foot rot in black pepper to certain extent. To continue with the study, a pot culture experiment was conducted and the details of the experiment is given (table 32).

Table 32. Effect of vermicompost on survival of *P. capsici*

Treatments	Survival %
Vermicompost 25%	58.3(50)abc
Vermicompost12.5%	66.6(55)ab
Vermicompost 6.25%	66.6(55)ab
Vermicompost 3.125%	50(45)bc
Trichoderma	*75.0(60)a*
Copper oxy chloride	75.0(60)a
Control	41.6(40)c

The highest survival % was noted with the treatments, *Trichoderma* and copper oxy chloride, however, these treatments were on par with vermicompost 12.5% and 6.25%.

In vitro studies with vermiwash revealed its inhibitory effect on mycelial growth, sporangial formation and zoospore liberation of *P. capsici* (table 33).

Rejuvenation of black pepper in a diseased garden

This field trial consists of 16 treatments (it includes effects of weeds, susceptible and tolerant lines, organic and inorganic nutrition, chemical and biological control). The establishment of vines, number of plants flowered and average yield was better with clean cultivation.

Table 33. Effect of vermiwash on *P. capsici*

Treatment Concentration	Mycelial growth (diameter in mm)	Sporangial production/ microscopic field (20X)	Zoospore liberation %
Fresh vermicompost			
1%	54c	72.0b	61.5ab
2%	45.5d	54.6b	51.0bc
5%	29.5e	42.40b	24.8e
4 months old			
1%	64.7b	68.8b	43.6c
2%	60bc	57.8b	30.4d
5%	45d	43.8b	16.2e
Control	90a	107.0a	70.6a
LSD	6.96	31.17	7.344

Phytophthora and *Trichoderma* population were monitored. After the imposition of treatments, the highest *Trichoderma* population noted in a plot with the combination of with weeds, tolerant line, organic fertilizer and biocontrol. The proliferation of BCA was more in plots with weeds.

Effect of coir compost on P. capsici population

Soil and coir compost mixture of different proportions (60:40, 70:30, 80:20 and 90:10) was used for the study. None of the treatments could significantly inhibit the pathogen.

A new observational trial was taken up with the objective of exploring the possibility of managing a diseased garden through soil solarization.

Hand weeding + solarization, Hand weeding alone and Routine operations are the treatments followed.

Solarisation was done for 45 days in the existing garden and 96% mortality observed in solarized block.

To study the use of fungicides alternating with *Trichoderma*, a new field experiment was started.

Copper oxy chloride twice, COC (1st round) + BCA (2nd round) and BCA twice are the treatments adopted.

The proliferation of *Trichoderma* was more in solarised block followed by block with weeds and the least multiplication was noted in block with hand weeding alone.

PATH.X (813)

INVESTIGATION ON VEIN CLEARING VIRUS OF SMALL CARDAMOM

(M.N.Venugopal)

Progress report

Purification of Kokke kandu virus

Eight modified protocols suitable for elongated, spherical, bacilliform particles were tried for purifying the virus with five different buffer systems. Satisfactory spectrophotometric peaks were observed with higher proportion of borate buffer 1:4 (W/V), 1.0 M urea, 1.5 % NaCl and 2 % PVP. The concentration of nucleo- proteins was done by PEG precipitation (4 %) and further pelleting over 20 % sucrose cushion. Further purification on sucrose density needs modifications to get higher concentration of virus.

EM observations

EM observations were carried out at IIHR, Bangalore and Dept. of Applied Botany, University of Mysore, Mysore. Scattered elongated particles resembling virions of poty viridae were observed under EM.

Screening

Screening of disease escapes was continued through viruliferous aphids carrying Hongadahalla isolate. 18 collections did not take infection after three rounds of individual screening.

Path XI (813)

STUDIES ON BACTERIAL WILT OF GINGER

(A. Kumar and Y.R. Sarma)

Progress report

Disease management

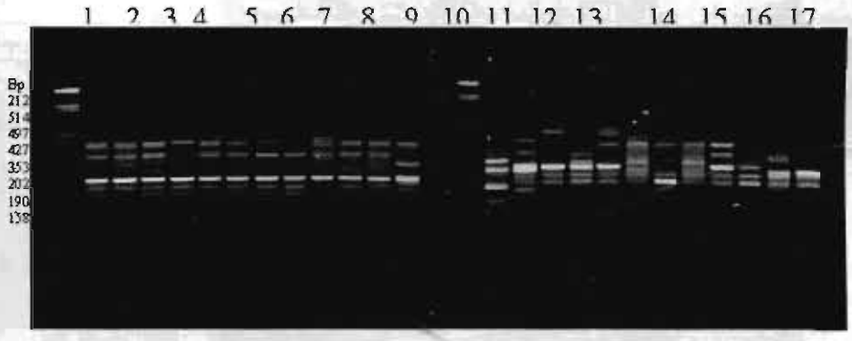
Rhizome solarization: A novel eco-friendly method for disinfecting ginger seed rhizomes from bacterial wilt pathogen, *Ralstonia solanacearum*

Bacterial wilt of ginger (*Zingiber officinale* Rosc) caused by *Ralstonia solanacearum* is one of the most serious production constraints in ginger. Most of the disease out breaks is from seed borne bacterium. There are no effective, practical methods currently available for eliminating seed borne bacterium. At IISR, Calicut a simple method for disinfecting seed rhizomes of ginger was developed. The thermal death point of *Ralstonia solanacearum* was determined as 47°C at 30 min of exposure in water suspension. Having generated this basic information, the rhizomes were heated to 47°C using solar energy. Different trials were conducted to standardize the heating process, with out affecting germination, by exposing rhizomes to sunlight after packing them in polythene bags by airtight. When the rhizomes were solarized after packing them in sealed polythene bag, the temperature of 60°C was recorded inside seed rhizome at 1.00 pm during May (summer) whereas the air temperature in polythene bag was 51°C. Solarization for 2 hours from 9.00 am to 11.00 am did not affect germination of sprouts. When artificially inoculated rhizomes were solarized for 2 and 4 hours, the developing ginger plants were free from bacterial wilt disease (table 1), indicating the effectiveness of rhizome solarization as a method of disinfecting seed rhizomes of ginger. When such rhizomes were tested for bacterium using NCM-ELISA, none of the treated rhizomes yielded positive reaction with Rs. specific antibodies. This incidentally is the first report of disinfection of ginger from bacterial wilt pathogen using solar energy. (Fig. 1).

Pathogen characterization

Eighteen isolates of *Ralstonia solanacearum* isolated from ginger, tomato, potato, chilli and chromolaena were characterized by RAPD-PCR and there was no polymorphism seen among the ginger strains indicating the presence of single phenotype of *R. solanacearum* causing bacterial wilt of ginger (Fig. 2).

Fig.1 : Rhizome solarization : an effective disinfection technique for bacterial wilt management

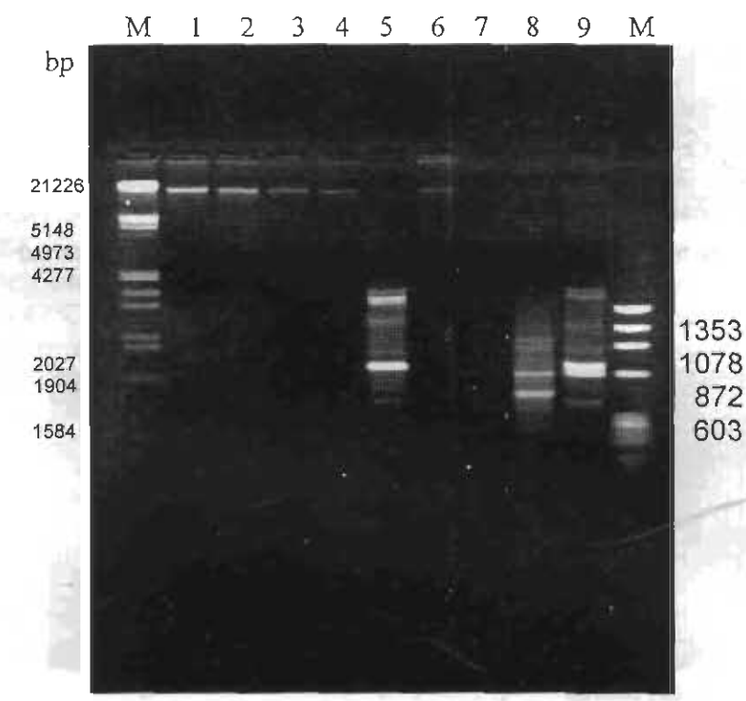


Lane1. 1DNA double digested with EcoRI and Hind IIILane2. ORS Tms
Lane3 ORS Tms Rif
Lane4 ORS Pnl
Lane5 ORS Kkri
Lane6 ORS Vy
Lane7 ORS Km
Lane8 TRS Cal
Lane9 ERS Cal
Lane10 ORS Kar
Lane11 ORS Gh
Lane12 ORS Mk
Lane13 ORS Kmp

Fig. 2. Molecular profiling of *Ralstonia solanacearum* by RAPD-PCR using OPA 2 primer

Pathogen detection in soil

Protocols have been standardized for isolation of PCR amplifiable DNA from soil for specific detection of *R. solanacearum* in soil. The protocol, standardized is highly reproducible without any need for further DNA purification for PCR amplification (Fig. 3).



M 1 DNA double digested with Hind III and EcoRI Marker
1.Sterile soil+Rs, 2.Sterile soil+Rs, 3.Sterile soil+Rs
4.Sterile soil+Rs, 5.Sterile soil+Rs, 6.Sterile soil+Rs, 7.Field soil,
8.Rhizome rind, 9.Genomic DNA from cultured *R. solanacearum*
Note : amplification of ~ 590 & 650 bp DNA
M. Phi X 174 Hae III Marker

Fig. 3. Amplification of *Ralstonia solanacearum* DNA isolated from soil using OPA 2 primer

PCR conditions were standardized for amplification of genomic DNA of *R. solanacearum* using random primers (Operon primers and Rep primers). Out of 20 primers screened positive amplification could be obtained with the following 5 operon primers

OPA 2 : (5'-TGCCGAGCTG-3')

OPA 11 : (5'-CAATCGCCGT-3')

OPA 13 : (5'-CAGCACCCAC-3')

OPA 16 : (5'-AGCCAGCGAA-3')

OPA 18 : (5'-AGGTGACCGT-3')

Crop.Prot.l.l(813)

SCREENING GERMPLASM FOR REACTION TO DISEASES

(Y. R. Sarma, S. S. Veena, M. N. Venugopal & K. V. Saji)

Progress report

During the year, 137 hybrids were screened for their reaction to *P. capsici* through stem inoculation technique. Three hybrids showed tolerant reaction.

Hybrid	Disease index	Lesion length (mm)
HP 423	**3.6**	7
HP 664	**3.8**	8
HP 756	3.6	4.6

11 hybrids were selected for further screening to confirm their reaction.

- Six promising hybrids / cultivars were screened through root dip method. There was not much difference in root rot index and all the lines had taken up infection. However, survival percentage was more in HP 105 (66.6%) and HP 780 (66.6) compared to Karimunda (0%) and other hybrids.
- 30 hybrids were screened through root dip method and the hybrids HP 413, HP 422, HP 198, HP 187 and HP 163 showed tolerant reaction.
- Twenty-seven Neelamundi collections were screened through leaf inoculation method and collection No. 8 and 14 showed tolerant reaction.
- 13043 open pollinated seedling progenies of 16 cultivated hybrids were screened and all did succumb to infection.

- 19-foot rot escapes were collected from different parts of Kerala, Karnataka & Tamil Nadu.
- Field trials at Pulpally and Idukki showed that HP 780 is performing well in Wynad and P 1534 is performing well in Idukki.

Crop Prot. 1.2(813)

SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO INSECT PESTS

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

Progress report

Screening of black pepper for reaction to *Pollu beetle* was done by counting the total number of berries and infested berries on ten spikes from each vine. Observations were recorded from 196 cultivars and 24 hybrids. Infestation by *Pollu beetle* ranged 0.3 - 24.6% in the case of cultivars and 1.1 - 14.9% in hybrids of black pepper maintained at I.I.S.R experimental farm, Peruvannamuzhi during the period under report. However seven cultivars and two hybrids were found free of infestation.

Crop Prot. 1.3 (813)

SCREENING OF BLACK PEPPER GERMPLASM FOR REACTION TO NEMATODES

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

Progress report

Multiplication & maintenance of black pepper germplasm

Eighty-seven black pepper hybrids and resistant lines obtained in the preliminary screening (against root-knot nematodes -9 lines and against *Radopholus similis* -5 lines) were multiplied using rapid multiplication methods.

Screening of germplasm

About 71 black pepper hybrids were screened against *R. similis* while another 39 accessions were screened against *M. incognita*. The results are given in table 34.

Table 34. Preliminary screening of black pepper germplasm accessions against root-knot and burrowing nematodes.

Category	No of accessions screened against	
	Radopholus similis	*Meloidogyne incognita*
Wild	36(12)	31(16)
Cultivars	24(6)	6(1)
Hybrids	11	2
Total	71(18)	39(17)

Figures in parentheses are number of accessions that showed resistance to nematodes in the preliminary screening.

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)

Progress report

Biochemical characterization of nematode tolerant line

The activities of enzymes such as PAL and peroxidase were monitored in the nematode tolerant line Pournami after inoculation with *Meloidogyne incognita*. Along with check physically injured plants were also maintained in order to study the effect of physical injury on the activity of the enzymes (Table 35). Increased activity was seen 24 h after nematode inoculation and physical injury did not have any effect on the activities of enzyme.

Table 35. PAL activity in the nematode tolerant line after inoculation with *M. incognita*

	μ moles of Cinnamic acid released / min/mg protein (x 10^3)		
Time	Inoculated	Control	Injured
24h	33.4	16.9	19.4
48h	20.9	12.5	15.3
72h	15.8	14.8	13.1

Biochemical characterization of 'Pollu' resistant lines

The surface wax content of pollu resistant lines were analysed and compared with the susceptible Panniyur - 1. In all the resistant lines it was higher and ranged from 20.8 to 80.8µg /100g of leaf tissue compared to 9.8µg/100g in susceptible check. The free amino acid concentrations were also higher in pollu resistant lines which ranged from 63.4 to 100µg/100g tissue compared to 52.5µg/100mg of tissue in susceptible line (Table 36).

Black pepper

The DNA of *Phytophthora* tolerant black pepper line P24 was amplified using Operon primers. One of the primers showed a characteristic band corresponding to 930bp. This primer was used to check other *Phytophthora* tolerant lines. This primer has shown a similar band in all *Phytophthora* tolerant lines and the same was not found in the susceptible KS 27. The seedling progenies obtained from both P 24 and KS 27 were tested for their resistance response. The

Table 36. Free amino acids and surface wax content

	Free amino acids (µg/100mg tissue)	Surface wax (µg/100g)
Tolerant lines		
816	55.07	70.7
841	133.62	20.8
1114	63.43	80.8
1084	90.38	9.78
Susceptible		
Panniyur-1	52.54	9.78
Wild accessions		
P. longum		
P. barberi	100.69	-
P. chaba	100.45	10.09
P. colubrinum	104.20	73.9
	-	200.9
Interspecific hybrids		
P. nigrum x P. barberi	47.9	-
P. nigrum x *P. attenuatum*	70.6	141.0

progenies from both populations showed varied response ranging from highly susceptible to resistant reaction. The test is extended to larger population in order to phenotype the progenies.

RAPD- analysis of cardamom

The DNA obtained from 'Katte' resistant lines and Rhizome rot resistant lines were analysed for polymorphism using operon primers. All 'katte' resistant lines showed monomorphic reaction. But, the rhizome rot resistant line showed specific bands in rhizome rot resistant line RR1 for two of the primers. The studies are continued.

Nema III (813)

INVESTIGATIONS ON NEMATODES ASSOCIATED WITH SPICES

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

Progress report

Screening of germplasm

Thirteen turmeric and 12 ginger germplasm accessions which showed resistance/tolerance in the preliminary screening were further tested for their reaction to root-knot nematodes (*Meloidogyne incognita)*. Out of these, nine turmeric and eight ginger accessions continued to be resistant to root-knot nematodes. Turmeric accessions 31,82 and 200 and ginger accession 221 were resistant even after three rounds of inoculation.

Studies on organic amendments

The microplot study to evaluate the effect of mulching black pepper basins with leaves of *Piper colubrinum* or *Strychnos nuxvomica* or with vermicompost was continued for the second consecutive year. All the three organic materials improved the growth and yield of vines, *P. colubrinum* being the maximum (Table 37). However, none of them were able to provide complete protection against nematodes. Nematode populations, foliar yellowing and root rot were comparatively low in plants mulched with *S.nuxvomica* and *P. colubrinum leaves.*

Table 37. Effect of organic amendments on growth and yield of nematode-free and nematode-infested black pepper vines

Treatment	Canopy size	Foliar Yellowing	Root rot index	Yield (kg)
Check	2.62[d]	1.33	0.86	0.99
Nematode(N) alone	1.97	1.02	1.77	1.08
P. colubrinum(Pc)	2.90	0.47	1.12	1.70
S. nuxvomica(Sn)	2.96	1.08	0.72	1.28
Vermicompost(Vc)	2.75	1.49	2.52	1.15
Pc+N	1.22	1.02	0.98	1.22
Sn+N	1.45	0.71	1.09	0.98
Vc+N	1.58	1.87	2.14	0.94
LSD 0.05	1.12	N.S.	N.S.	N.S.

Biocontrol 1.1. (813)

BIOLOGICAL CONTROL OF DISEASES OF SPICE CROPS

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

Progress report

Field trial with VAM & BCA

The field trial undertaken with inoculation of VAM in the nursery and application of biocontrol in the field was continued. The treatments were imposed and the population of applied biocontrol agents (BCAs) was mentioned along with the population of *P. capsici*. In all the treatments the pathogen was active and the BCA population ranged from 5.5 x 10^3 to 70.1 x 10^3 (Table 38)

Two experiments were conducted to test the effect of decomposed coir pith for both using as carrier media and *T. harzianum* and to use the same as a

Table 38. *Trichoderma* population (cfu x 10^3)

Treatment	M1 *T. h*	M2 *T. v*	M3 *C. o*
T1	56.8**	32.7**	5.53**
T2	43.8**	28.3*	4.2**
T3	51.2*	46.1	13.6
T4	49.2*	14.9*	23.1**
T5	8.5	12.6**	10.92*
T6	23.1	29.6	28.8*
T7	70.1*	30.7	23.3**

● Positive baiting for *P. capsici*

constituent of potting mixture. The population was higher in the 1:3 proportion than other combinations (table 39&40).

The population of *T. harzianum* varied from 3.5 x 10^3 in various proportions.

When coir pith amended potting mixture was fortified with organic fertilizers (NPK), the growth of black pepper cuttings recorded enhanced growth (Fig. 4). However, when challenge inoculated with *P.capsici* the mortality of cuttings ranged from 80-100% (table 41).

Fig. 4. Percent increase

Table 39. Population dynamics of *T. harzianum* in different media mixes (cfu x 10^6)

Treatment	Days after inoculation				Mean
	0 DAY	10 DAY	20TH DAY	30TH DAY	
NPM	1.700 (6.032)	5.525 (6.738)	5.375 (6.730)	1.405 (6.186)	3.501 (6.421)
DCCP+NPM (1:1)	5.460 (6.736)	13.38 (7.125)	3.110 (6.491)	6.825 (6.849)	7.191 (6.800)
DCCP+NPM (1:2)	7.730 (6.887)	11.45 (7.032)	2.275 (6.357)	4.15 (6.622)	6.410 (6.722)
DCCP+NPM (1:3)	15.75 (7.197)	8.005 (6.903)	4.420 (6.645)	7.100 (6.851)	8.820 (6.894)
DCCP+NPM (1:4)	4.815 (4.815)	7.540 (6.877)	4.720 (6.672)	5.770 (6.761)	5.711 (6.744)
Mean	7.09 (6.704)	9.180 (6.933)	3.978 (6.579)	5.116 (6.654)	-

Figures given in Parenthesis are log transformed values
NPM - Nursery Potting Mix DCCP Decomposed Coconut Coir Pith

Table 40. Population dynamics of *T. harzianum* in NPM media mix(cfu x 10^6)

Treatment	Days after inoculation				Mean
	0 DAY	10 DAY	20TH DAY	30TH DAY	
NPM	0.245 (5.376)	3.655 (6.563)	4.530 (6.656)	3.115 (6.498)	2.896 (6.273)
DCCP+NPM (1:1)	1.040 (6.017)	7.200 (6.856)	4.755 (6.675)	6.370 (6.804)	4.841 (6.588)
DCCP+NPM (1:2)	8.465 (6.927)	5.155 (6.711)	2.580 (6.400)	6.245 (6.795)	5.611 (6.708)
DCCP+NPM (1:3)	9.825 (6.992)	16.32 (7.210)	6.315 (6.799)	3.325 (6.52)	8.946 (6.880)
DCCP+NPM (1:4)	5.505 (6.725)	11.39 (7.057)	8.320 (6.917)	3.265 (6.513)	7.120 (6.803)
Mean	5.016 (6.407)	8.744 (6.879)	5.300 (6.689)	4.472 (6.626)	-

Figures given in the Parenthesis are log transformed values
NPM - Nursery Potting Mix
DCCP - Decomposed Coconut Coir Pith

Table 41. Population of *P. capsici* and mortality of black pepper cuttings

Treatment	*P. capsici*		NPM + *P. capsici*	
	DPI	Mortality	DPI	Mortality
NPM	32	100	32	100
DCCP + NPM (1:1)	32	80	32	80
DCCP + NPM (1:2)	32	80	32	80
DCCP + NPM (1:3)	16	80	16	80
DCCP + NPM (1:4)	16	80	16	80

NPM: Normal Potting Mixture
DCCP:Decomposed Coconut Coir Pith

A combination of VAM and phosphobacteria were inoculated in black pepper nursery to test their effect on black pepper cuttings. The combination has shown better growth of cuttings.

The isolates of *Trichoderma* maintained in repository were characterized using RAPD-PCR (Fig. 5). The 22 isolates resolved in to 14 clusters. *T.harzianum*, *T.viride* and *T.psudokoningi* resolved in to separate clusters although there were differences with the isolates for several characters (Fig. 6). A *Trichoderma* isolate from ginger although identified as *T.harzianum* found a separate cluster suggesting that it belonged to another taxonomical group.

Biocontrol 1.2(813)

BIOLOGICAL CONTROL OF INSECT PESTS OF SPICES

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

Progress report

Evaluation of plant products against Pollu beetle

The persistence of antifeedant activity of *Capsicum* extract containing various concentrations (0.05-1.0%) of capsaicin against pollu beetle was studied in laboratory and greenhouse bioassays. The tests indicated that *Capsicum* extract containing 1% capsaicin caused >90% and >50% feeding deterrence up to 14 and 21 days respectively, after treatment.

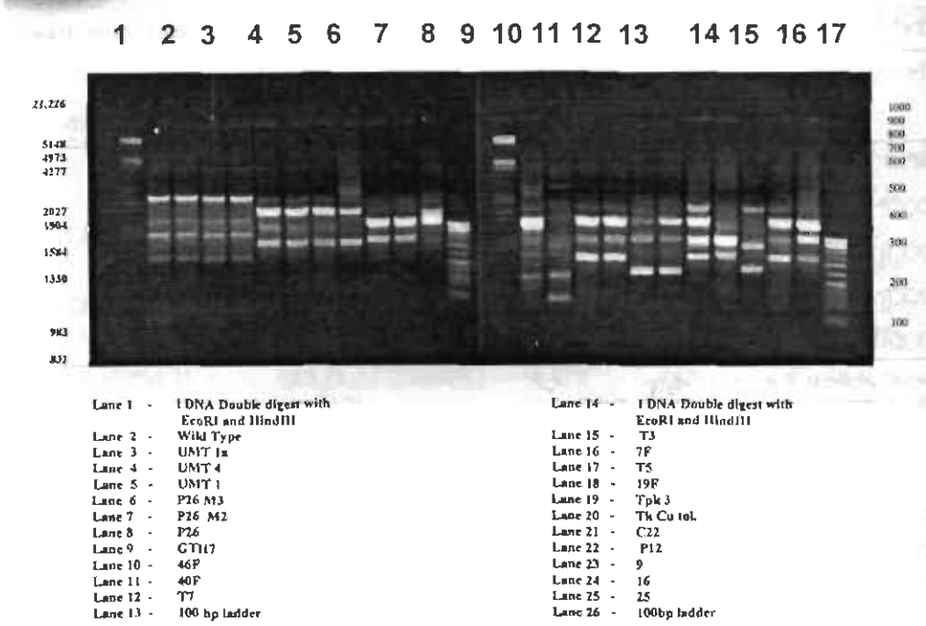


Fig. 5. Molecular typing of *Trichoderma* strains by OPA - 17 primer by RAPD-PCR

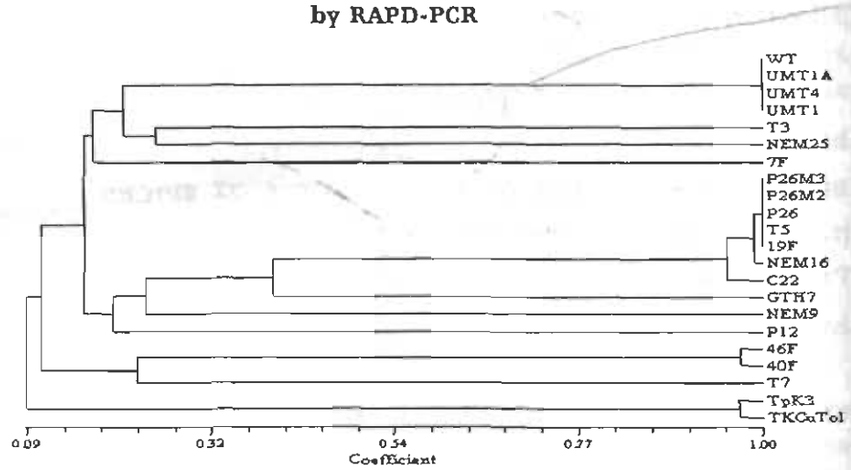
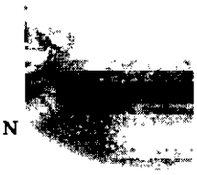


Fig. 6. Phenogram showing the Phylogenetic relationship between the 22 isolates used in this study



Management of shoot borer

Cultural methods such as pruning of infested shoots and spraying of insecticides and spraying of insecticides alone were evaluated in the field for the management of shoot borer in ginger. The trials indicated that pruning of infested shoot during July-August (at fortnightly intervals) and spraying of insecticide (malathion 0.1%) during September-October (at monthly intervals) resulted in significantly lower incidence of shoot borer and higher yields. The economics of various management schedules were also calculated and the adoption of pruning and spraying resulted in a Cost:Benefit ratio of 1:4.6 which was higher than pruning alone and spraying alone. By adopting this integrated strategy two insecticide sprays could be avoided, thus causing less harm to the ecosystem.

Pesticide residues in ginger

The recommended package of practices for the management of shoot borer on ginger involving spraying of malathion 0.1%, monocrotophos 0.05% and endosulfan 0.05% at monthly intervals during July-October (4 sprays) and September-October (2 sprays) was adopted. The residues of endosulfan was below 0.001 ppm in dried ginger rhizomes at harvest under both the schedules of spraying which is well below the limiting values fixed by the importing countries. The residues of monocrotophos and malathion was being analysed.

Evaluation of repellent plants

Plants of saw-toothed coriander (*Eryngeum foetidum)* and galangai (*Kaempferia glanaga)* were raised along with ginger to study the repellent action of these plants against oviposition by the shoot borer. However these plants were not effective in preventing oviposition by the shoot borer and the percentage of infested shoots were not significantly reduced in plots where these crops were grown.

Management of rhizome scale

Various insecticides (malathion, methyl parathion, quinalphos, phosphamidon, dimethoate and monocrotophos- 0.075% each), plant and organic products (Neemgold 0.5%, Nimbicidine 0.5%, neem oil 15 and fish oil rosin 3%) were evaluated for the management of rhizome scale (*Aspidiella hartii)* on ginger

during storage. The trials indicated that among the various products, dipping of seed rhizomes in quinalphos 0.075% was the most effective for obtaining a higher recovery of rhizomes, higher number of sprouts and lower population of the pest.

The trials also indicated that discarding of severely infested rhizomes was also important since none of the insecticide treatments was effective in obtaining a high recovery of rhizomes that were severely infested with rhizome scales.

Biocontrol 1.3 (813)

BIOLOGICAL CONTROL OF NEMATODES OF SPICES

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

Progress report

Variability in V. chlamydosporium isolates

Three isolates of *V. chlamydosporium* (Vc1, Vc2 and Vc3) and one each of *V. lecanii(Vl)* and *V. tenerum I(Vt)* were studied for their parasitic ability on different stages of root-knot nematodes. All the fungi, though colonized the egg masses, varied in colonizing eggs and juveniles of root-knot nematodes (Fig.7). None of them was able to colonize on second -stage larvae. However, higher degree of nematode suppression was observed with all the isolates, indicating the involvement of mechanisms other than direct parasiticsm.

Induction of variability in Verticillium

Mutagenic effects of ethyl methyl sulfonate (EMS) at six concentrations (0,10,20,30,40 and 50 ppm) were studied on *V. chlamydosporium* and *V. tenerum* isolates. Suppression of colony formation in *V. tenerum* was directly proportional to increasing levels of EMS but concentrations beyond 10 ppm totally inhibited *V. chlamydosporium.* The colonies produced at higher levels of EMS were saved but none of them had any remarkable difference in their growth rate or in any other features.

Studies on Pasteuria penetrans

The mode of action and life cycle of *P. penetrans* was studied under *in vitro* conditions. Root-knot nematode larvae were suspended in a spore suspension of *P. penetrans* for 24-48 h. They were then inoculated on 1month old black

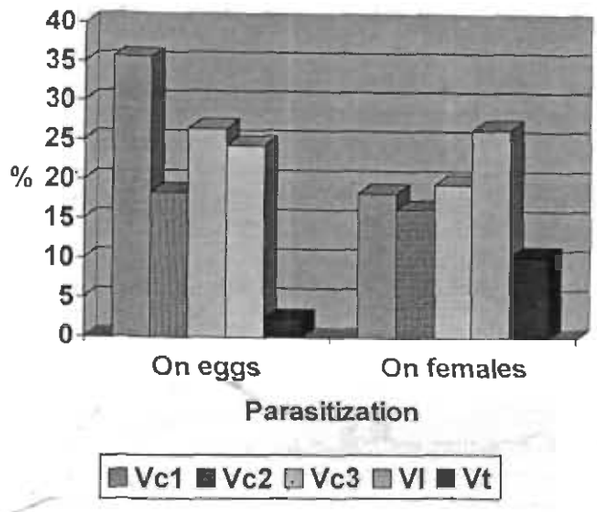


Fig. 7. Variability of *Verticillium* isolates in parasitizing root-knot nematodes.

pepper seedlings, planted in steam-sterilised soil. Different stages of the bacterium were observed in the inner contents of the nematodes by sampling the inoculated plants, extracting and crushing the nematodes. Stages like vegetative growth, differentiation, sporulation and maturation were observed.

Field evaluation

The field trial at Pulpally, Wyanad, to evaluate *Trichoderma harzianum, V. chlamydosporium* and *P. penetrans* was continued. Yield and health status of vines was generally superior in plots treated with biocontrol agents. The highest yield was obtained in *V. chlamydosporium* treated plots, which was significantly higher than that of control plots (Table 42,). The root-knot nematode population decreased in all treatments compared to the initial population (Fig.8). The lowest population of root-knot nematodes in black pepper roots was observed in plants treated with phorate followed by *P. penetrans.*

Screening of fungicides for nematicidal activity

Two -fungicide viz. Potassium phosphonate (10,100,1000 and 10,000 ppm) and metalaxyl-mancozeb (10, 100 and 1000 ppm) were screened for nematicidal

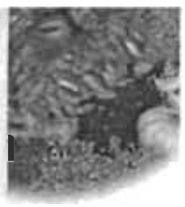


Table 42. Crop stand and yield of black pepper in a biocontrol field trial at Pulapally, Kerala

(Mean of three replications)

Treatment	No.of vines		Yield (kg-green)
	Yellowing(%)	Healthy(%)	
T. harzianum	17.3a	72.6a	3.46ab
V.chlamydosporium	24.8a	75.2	4.66ab
P. penetrans	37.3a	59.5a	3.43ab
Phorate+potassium phosphonate	50.5a	44.9a	3.04ab
Phorate	32.9a	67.2a	2.81ab
Control	41.0a	54.9a	2.09ab

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

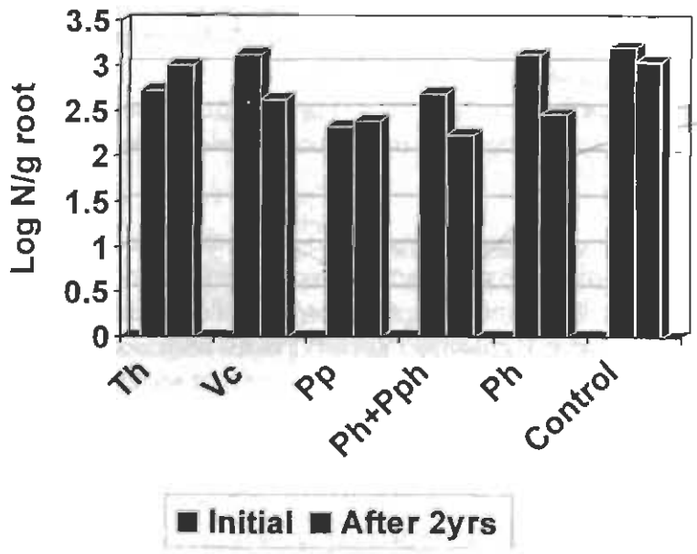


Fig. 8. Mean root-knot nematode population in roots of black pepper plants of the field trial at Pulpally, Kerala.

activity, if any, using root-knot nematode as the test nematode. Both did not suppress the fungicide nematodes at the recommended dosages but were toxic to nematodes at higher concentrations.

Ent. XI (813)

BIOECOLOGY AND MANAGEMENT OF MEALY BUGS INFESTING BLACK PEPPER

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

Progress report

The interaction studies using mealy bugs with *Radopholus similis* and *Phytophthora capsici* were conducted by inoculating nematodes, mealy bugs and the fungus in pepper laterals raised in earthen pots and kept under green house conditions. These were inoculated singly and in combinations at various intervals. Since no symptoms were exhibited, the potted laterals are kept for further observations.

The field trial conducted at Kalpetta (Wyanad district) using insecticides such as quinalphos, malathion, chlorpyriphos and profenphos all used at 0.075 % concentration, singly and in combination with wetting agent showed that all insecticides used were effective in suppressing mealy bugs. However wetting agent alone was found to be equal to the untreated control.

Surveys conducted in certain areas of Calicut District showed that mealy bugs infestation was not much in these areas. However, a few gardens in Chakkittappara area showed the presence of mealy bugs.

ICAR AD-HOC PROJECT

BIOLOGICAL CONTROL OF PLANT PARASITIC NEMATODES OF MAJOR SPICES

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

Plant Growth Promoting Rhizobacteria (PGPR)

PGPRs were isolated from the roots of black pepper from Kerala (160 isolates) and turmeric from Andhra Pradesh (19 isolates). Ten out of the 29 isolates caused 100% mortality of nematodes in the *in vitro* bioassay. In a green house evaluation, 65 isolates were screened for their efficacy to suppress root knot

nematodes. Three isolates imparted complete protection to tomato plants against nematode attack, while 11 other isolates caused >50% suppression of nematodes.

Field evaluation of promising fungal biocontrol agents

Thirteen promising fungal biocontrol agents were evaluated on turmeric in microplots infested with root knot nematodes. *Verticillium chlamydosporium, Paecilomyces lilacinus, Fusarium* sp., *Aspergillus nidulans* and *Scopuloriopsis* sp. suppressed root knot nematode populations significantly.

Ecology of biocontrol agents

The optimum temperature for growth and multiplication of *T. harzianum* (Is. 33) and *P. lilacinus* (Is. 36) was 30°C while that for *V. chlamydosporium* was 25°C. *T. harzianum* isolates (Is. 33 and 56) varied in their optimum pH requirements, pH 4 and 5, respectively and pH 6 was found ideal for *Fusarium* sp. (Is. 11).

Potassium phosphonate and insecticides like phorate and chlorpyriphos at recommended levels had no adverse effect on biocontrol agents viz. *T. harzianum, P. lilacinus* and *V. chlamydosporium*. However, metalaxyl mancozeb at all concentrations reduced the growth and sporulation of all the above fungi.

SOCIAL SCIENCE

EXT. IV(813):

TRAINING OF RESEARCH AND EXTENSION WORKERS

(M.S. Madan and P. Rajeev)

Progress report

Regular training programmes on 'Spices Production Technology', 'Nursery Management' and 'On-farm Processing of Spices' were conducted. On request, training to farmers from various parts of the country was also arranged. On behalf of Spices Board, sponsored training programme on 'Spices Production Technology' to spices growers and extension officers from Northeastern states were conducted.

Activities

- More than 250 farmers in groups from States of Kerala, Karnataka, Tamil Nadu and Maharashtra were given one day orientation programme in spices production.
- Individual farmers/planters from Kerala, Tamil Nadu and Karnataka were helped in clearing their doubts regarding spices production and procuring right kind of planting materials.
- Batches of students from Agricultural Universities of Kerala, Tamil Nadu and Maharashtra were given brief one-day awareness programme about new developments in spices research and development.
- Students from other traditional universities and schools were also given awareness programme on 'recent developments in spices research, development and production.
- Extension bulletins on production technology for various spice crops are being revised and published.
- A book on 'Spices Production Technology' published to provide overall information on spices production to development workers and farmers.

Econ. I (813)

ECONOMICS OF SPICES PRODUCTION AND MARKETING

(M.S. Madan and Jose Abraham)

Progress report

I. Spice Database

A software package "Spice Data-base" created and put into use for storage of primary and secondary data on spices. Packages created earlier for Spices Information System and Spices Economics System were also put into use.

II. Spice Economics

Data from the 'Spice database' was tabulated and analysed to bring out useful interpretations on spice economy to help the policy makers and other developmental agencies.

Black pepper

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%).

Cardamom

Demand and supply estimates for cardamom

Status of world cardamom industry in general and Indian cardamom industry in particular was analysed in terms of year-wise production, price trend, change in consumption pattern and finally the forecasted demand and supply position for the crop.

The Forecast

The forecast based on historic data helped us to understand the overall direction in which the supply (area and production) will move and price fluctuates. Forecast is produced with upper and lower confidence limits. The upper confidence limit is calculated for 97.5 per cent and the lower for 2.5% i.e. the actual should fall inside the confidence band 95% of the time.

Demand

The major markets for cardamom are Saudi Arabia, Kuwait, Jordan, Qatar, UAE, USSR and Western Europe. Other important importers include West Germany, Pakistan, UK, Japan and Iran. The highest consumption of cardamom (80% of the total world consumption) takes place in the Middle East where it is used in the preparation of their traditional drink 'gahwa' Demand potential in the world was at an average growth rate of 2% per annum, which is proportionate to the growth rate of population. Demand was accordingly estimated for 2000-2001 as 12000 tonnes. Recent domestic consumption trends in India indicate a sharp increase in off-take. As against 1500 tonnes in 1985-86, domestic consumption has gone up to more than 6850 tonnes during 1997-98. If this level is maintained, the world demand (including India's) at the turn of the century may be more than 15000 tonnes. When actual data is not available, deducting the quantity exported from total production gives an approximate consumption in the domestic market. The growth equation fitted for the consumption trend in the country is:

$$\ln Dt = 6.7110 + 0.0725T \qquad R2 = .815$$

Accordingly, the estimated growth rate is 7.3% per annum. Thus, the growth rate in demand is much more than the growth rates in production. Under the circumstances, it is unlikely that India can reclaim its position as the world's largest producer and exporter because an increasing percentage of production will be consumed domestically leaving nothing much for export. The global import demand for cardamom is expected to be 18,000mt by 2000 AD and 20,000mt in 2005.

Supply

In order to make projections for Indian cardamom, a model was developed for area and production. Both area and production are expected to grow slowly in the immediate future. The growth in production is expected to be more pronounced than in area indicating the improvement in yield per unit area. As per the cyclical movement discussed earlier, after the peak so achieved in 1995-96, three year period of decline is already over, it is the turn of increasing trend to reach the next peak in the cycle. As per the forecasted value, by the year 2000-2001 the expected production level will be between 8000 to 10000 tons; and the area expansion is expected to touch 90000 ha during the same period. The improvement in internal and international price will catalyze the supply to

jump in the usual fashion discussed earlier.

Since the forecasted production is not sufficient to create enough export surplus and the reports of declining production in Guatemala is already reflected in the form of less supply to the world market by that country during the 1998-99 crop year, the repercussions will be favourable to Indian farmers in the form of increased price. The prevailing higher market price is expected to continue in the near future and there is also a possibility for the price to cross the Rs. 1000/kg mark before falling down as per the usual cyclical fluctuations. Availability of less exportable surplus will have direct effect on the export.

III. Export performance of Indian spice industry

The estimated growth rate for export of various spices during the past two decades showed that, during eighties, except black pepper all other commodities have registered a negative growth rate in volume exported. Among the value added spice products, oils and oleoresin achieved the maximum growth rate of 42.93% in volume and 25.91% in value terms. Overall, there was a negative growth rate of 3.6 was recorded for total spices during the period 1978-79 to 1987-88 (Table 43).

However, during the period from 1988-89 to 1997-98, except in cardamom (small) exports of all other commodities achieved a positive growth rate both in volume and value terms. Chilli and ginger have performed well. Unit price rise was more for pepper than for all other commodities exported. During this decade almost all the crops have recorded a positive growth rate in terms of value because of the continued rising trend in prices.

Impact of QRs free trade on Indian export

Export performance of major spices after removal of quantitative restriction on trade i.e. during the first half of the current financial year (April-June 2001) is not encouraging. Export during the period is estimated as 59840 tonnes valued Rs. 406.08 crores (87.03 million US$) as against 67668 tonnes valued Rs. 460.02 crores (104.23 million US$) in the corresponding period of last year. Compared to last year, the export has shown a decline of 12%, both in terms of quantity and rupee value. In dollar terms, the decline is 17%. In order to arialyse the impact of QRs free trade on prices, three years average (1997-2000) was compared with April-June 2001 (table 44). As it can be seen from the table the price fall varied from 0.88% in oils and oleoresin to 39.4% in black pepper. The estimated loss due to price fall is around Rs. 2257.84 million.

Table 43. Compound growth rate in spices export during 1978-79 to 1997-

Spice	1978-79 to 1987-88			1988-89 to 1997-98			1978-79 to 1997-98		
	Qty	Value	U.Value	Qty	Value	U.Value	Qty	Value	U.Value
Total spices	-3.6	10.81	14.95	9.71	21.81	11.05	5.77	13.27	7.56
Black pepper	9.64	28.69	17.38	2.33	15.87	13.22	10.27	3.22	13.82
Cardamom(s)	-14.13	-16.17	-2.31	-4.19	4.19	8.79	-12.73	-8.27	4.68
LargeCardamom	-3.67	9.3	13.44	13.63	21.75	7.15	14.11	23.22	7.98
Chillies	-14.67	-7.9	7.86	18.77	28.33	8.36	10.09	20.89	9.79
Ginger	-11.39	-.34	12.47	18.35	23.4	4.26	6.73	11.43	4.4
Turmeric	-4.2	2.33	6.82	6.37	18.39	11.3	4.45	12.49	7.7
Oil &Oleoresins	42.93	25.91	10.33	16.66	30.15	11.57	25.49	27.39	8.63
Seed spices	-11.79	-5.87	9.29	13.62	28.07	9.36	5.31	13.27	7.57

Table 44. Impact of QRs free trade on prices of Indian spices

Crop	Average Price		Price	Apr-June Price		%change	Average	Value of
	1997-00	2000-01	difference	2001	difference		Export Qty	loss
(1)	(2)	(3)	(3-2	(5)	(5-2)	(7)	(8)	(7X8)
Pepper	176.59	169.52	-7.07	107.01	-69.58	-39.40	37306.7	-2595.77
Cardamom (small)	456.54	514.06	57.53	574.34	117.80	25.80	460.3	54.23
Cardamom (large)	98.40	168.31	69.92	163.64	65.24	66.30	1361.7	88.84
Chillies	35.44	32.01	-3.43	32.18	-3.26	-9.19	56493.0	-184.00
Ginger	34.98	34.88	-0.10	44	9.02	25.79	15367.0	138.61
Turmeric	32.83	26.39	-6.43	20.71	- 12.12	-36.92	32326.0	-391.76
Coriander	24.76	23.44	-1.32	29.92	5.16	20.84	18252.7	94.18
Cumin	53.99	85.10	31.11	89.13	35.14	65.09	9672.7	339.92
Celery	25.86	32.39	6.53	32.5	6.64	25.68	3496.0	23.21
Fennel	35.70	44.45	8.75	42.86	7.16	20.06	6410.7	45.90
Fenugreek	18.04	19.75	1.71	29	10.96	60.77	8661.0	94.94
Other seeds(1)	33.89	36.96	3.07	35	1.11	3.29	2840.0	3.17
Garlic	17.58	9.46	-8.13	18	0.42	2.36	5536.7	2.30
Other spices(2)	37.98	41.40	3.42	34.74	-3.24	-8.54	19179.7	-62.22
Curry powder	57.33	64.47	7.14	65	7.67	13.38	5383.0	41.30
Mint oil	334.97	326.32	-8.64	358.33	23.36	6.97	3184.0	74.39
Spice Oleroe-sins and other oils	1017.12	1004.28	-12.85	1008.16	-8.96	-0.88	2796.0	-25.06
Total							155843.7	-2257.84

Note: *FOB prices

TECHNOLOGY ASSESSED AND TRANSFERRED

Package of practices for foot rot management in pepper

For the adoption of biological control to manage foot rot following recommendations have to be adopted.

- Maintenance of optimum moisture level and organic matter build up to support the biocontrol agents in the field.
- Assurance of quality of BCA and supply of sufficient quantity for covering the target.
- Need for technical education to selected members of Kurumulaku Samrakshana Samithi/farmers for multiplying the stock material for field application.
- Need for specifying the quantity to be applied in terms of g/plant instead of cfu.

Based on the above suggestions an adhoc recommendation has been formulated

Pre-and post application of Bordeaux mixture spray and copper oxycholoride drenching.

OR

Potassium phosphonate @ 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.

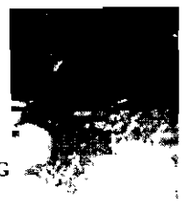
EDUCATION AND TRAINING

Krishi Vigyan Kendra

Krishi Vigyan Kendra , Calicut was established in 1992 under the Indian Institute of Spices Research at Peruvannamuzhi, 60 km away from the district head quarters.

Activities

A. Training programmes



The KVK is providing regular vocational training in agriculture and allied fields. The duration of training extends from 1 day to 5 days. Applications for each training are invited by adequate publicity through various dailies and also by broadcasting through All India Radio. The number of trainees for a batch is limited to 25. A training schedule is followed incorporating modifications considering the demand of farming community every year. Training achievements during the year are given in table 45

Table 45. Training Achievements

Sl.No.	Discipline	No.of courses	No.of participants
1.	Crop Science	32	971
2.	Horticulture	13	244
3.	Fisheries	11	539
4.	Animal Science	27	600
	Total	83	2354

B. FLD programmes

This is a new concept of field demonstration and the main objective is to demonstrate newly released crop production and protection technologies and its management practices in farmer's fields under different agro-climatic regions and farming situations. In this programme, technologies are demonstrated for the first time by the scientists themselves, before being fed into the main extension system of State Department of Agriculture. These programmes are carried out with the co-operation and complete participation of progressive farmers under the direct supervision of KVK scientists. A part of the expenditure of this demonstration will be met by KVK.

i) Inter-cropping ginger and turmeric in coconut garden

No. of demonstrations :4 Area: .0.08 acre each

Variety - Ginger -Himachal

Tumeric- Aleppey

In this programme, four demonstrations were conducted in coconut garden with ginger and turmeric. The main objective of the demonstrations was to prove the profitability of inter-cropping coconut garden with ginger and turmeric

thereby increasing the income of farmer. The average yield obtained in the case of demonstrations plots were 5 .7 t/acre and 8.2 t/acre respectively for ginger and turmeric and 3.6 t/acre and 7.10 t/acre for local varieties.

ii) Fish cum duck culture

No. of demonstrations:2 Area: 1 ha

Variety : Fish: Cutla, rohu, Mrigal

Duck: Kakhi Camp Bell

In this programme, the main objective was to demonstrate the integrated farming practice involving both fish and duck thereby optimising inputs and also to maximise production from unit area. The critical inputs were supplied during October, 2000 and the growth performance is satisfactory. The detailed results of the programme are awaited.

iii) Broiler goat production

No. of demonstrations : One

Name of breed : Tellicherry Cross Bred

In this programme, it was envisaged to demonstrate stall feeding of goat with concentrates so that it will have better growth rate, higher weight and attains early maturity. Kins reared under this programme had higher growth performance during early periods of life compared to traditional system.

C. OFT programmes

. This programmes aims at testing the new technologies developed at research stations in the field of crop husbandry, horticulture, animal husbandry, fisheries, etc, to ensure their suitability and sustainability to the specific locations and to suggest or modify or refine the technology accordingly. This is done by testing a released technology on the real farm situation with the participation of farmer. The real problems faced by the farmer in the adoption of new technologies can also be fed back to the research stations by this programme. KVK will bear the cost of critical inputs in this programme. The major OFT programmes carried out during the period are listed below.

i) Integrated management of *Phytophthora* foot rot of black pepper through the use of cultural practices and bio-control agents

No. of trials : 5

Area : 0.5 acre each

Varieties : Different local varieties

In this programme, five pepper farmers were selected from Chakkittapara and Changaroth panchayat of Quilandy taluk. Biocontrol agents viz. *Trich oderma* spp. was given as critical input to cover 200 vines for each farmer. Treatments were effective in three out of five plots and mortality was found to be less than one percent in these plots. In the other two plots mortality ranged from 26-37%.

ii) Management of YLD of arecanut

No. of trials : 1

Area : 0.5 acres

Varieties : South Kanara

In this programme *Trichoderma* alone (with organics) and in combination with Ridomil were applied in 150 YLD affected palms in June, 1999. Other treatments include neem cake, chlorpyriphos and their combinations. In the palms where *Trichoderma+neem cake+ridomil* combination was tried, most of the palms show initial remission of symptoms have produced green leaves and bunches. Intensity of yellowing within the palms was also found to be steadily decreasing. In palms where *Trichoderma+neem* cake combination was tried, remission of yellowing was found to be very slow and incomplete. In other treatments and in control, yellowing intensity increased gradually.

iii) Performance of deep water rice varieties

No. of trials : 4

Area : 0.10 acre each

Season : 1st crop 2000

Varieties : Sabitha, Jitendra, Purnendu and Neeraja

This programme was aimed at testing the performance of 4 deep water rice varieties in Thiruvallor which is affected with heavy water logging during 1st crop season. Since the south west monsoon was abnormally week during

the period of trial, the expected high water table(deep water situation) was not experienced in the field and hence the performance of the deep water varieties were inferior compared to local variety(Mundon).

iv) Vermi-compost as an effective substitute for fertilizers in fish ponds

No.of trials	:	2
Area	:	1 ha.
Varieties	:	Earth worm: *Eudrilus eugenia*
Fish	:	Cutla, Rohu, Mrigal, Common carp

In this programme, vermicompost was tried instead of inorganic fertilizers to enhance natural production in fish ponds. Critical inputs were supplied during October 2000 and the experiment is being monitored closely.

v) Study on growth performance of goat kids as influenced by source of food

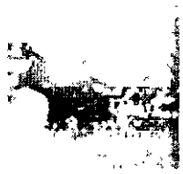
No. of trials	:	2
Breed	:	Tellicherry Cross Bred

Here an attempt is made to study the growth performance of goat kids by feeding with neem leaves with an aim to improve feeding efficiency and to produce more meat at an early age. The results of the study showed that feeding with neem leaves along with feed enhanced growth rate, hastened physiological maturity etc, without the use of growth promoters and de-worming compared to traditional method.

Revolving Fund Programme

The kendra has a strong revolving fund programme to generate income for productive uses. Under this programme, quality planting materials of various crops such as plantation crops, spices, fruit crops, vegetables, ornamental plants etc, are produced and made available to public at moderate rates. The veterinary wing of the kendra also contributes substantially to the revolving fund by way of consultation and other services.

During the period, an amount of Rs. 3,14,188/- was contributed to the revolving fund by sale of planting materials and as consultation and registration fees.



The details of income generated in revolving fund through various activities are furnished below:

a) Planting material production : Rs. 2,51,225.00

b) Plant and Animal Health Centre activities : Rs.29,665.00

c) Miscellaneous(farm produce, rent of hostel etc) : Rs: 33,298.00

Total income generated: Rs:3,14,188/-

Details of planting materials sold during the period under revolving fund are also furnished below (table 46).

Table 46. Planting materials sold during the year

Sl.No	Crop	Qty.sold(nos)
1.	Allspice seedlings	506
2.	Mango graft	138
3	Anthurium plants	408
4.	Vanilla rooted cuttings	434
5.	Bush pepper plants	5085
6.	P. colubrinum rooted cuttings	4147
7.	Arecanut seedlings	6083
8	Garcinia graft	2310
9	Nutmeg graft	2581

F. Plant and Animal Health Centre

The kendra operates a plant and animal clinic to cater various services to the farmers. An artificial insemination facility is also provided under the centre to upgrade the genetic stock of livestock. The centre offers consultation, treatment and door services with a nominal fee. In addition to the various treatments, the centre also provides vaccination facility and organises animal health camps in association with the state animal husbandry department.

KVK Farm

The kendra has 20 ha of land comprising of coconut, arecanut, cashew and an orchard comprising of miscellaneous fruit plants. A small area is maintained as forest for ecological stability.

Demonstration units maintained

i) Seed garden of arecanut: A model seed garden of arecanut variety Mohitnagar comprising of two acres was established in 1997 as intercrop in clove garden. This garden is expected to meet the seed nut requirement of a large group of farmers and may contribute significantly to the revolving fund in the future.

ii) Model homestead garden: About 0.3 ha area was protected by compound wall and a model homestead garden was established by planting fruit plants (mango, pineapple, papaya, banana, jack, rambutan, roseapple, West Indian cherry, guava etc,), spices (nutmeg, clove, garcinia graft, pepper, ginger, turmeric, allspice, vanilla etc.), tubers(diascorea, amorphophallus, colocasia, coleus, sweet potato etc.), fodder (guinea grass, hybrid napier, paragrass etc.) and perennial vegetables(chekkurmanis, drumstick, jack bean etc.) in a coconut and arecanut mixed cropped garden. This garden explains how a homestead should be planned to cater to the multifarious needs of a marginal farmer in a scientific manner.

iii) Medicinal plant collection: In order to highlight the medicinal value of herbs and trees, the kendra has maintained about 100 medicinal plants collected from Kottakal Arya Vaidya Sala and other places. The plants are labeled systematically so that each visitor can identify the plant, parts used as medicine and the diseases curable by it.

iv) Demonstration unit of anthurium: KVK is maintaining a collection of 20 rare and exotic varieties of anthurium. Some of these varieties are available for sale at moderate rate.

v) Cashew scion bank: KVK is maintaining a cashew scion bank of hybrids and high yielding varieties in about 0.2 ha area. The scion bank will be utilized for the production of grafts and also for supply of scion material under revolving fund.

Feed back

Feed back of technologies generated at research stations on adoption at farm situation are collected for improving/modifying a technology to suit the varying farming situation.

Other activities

i) Collaborative activities

One of the major achievements of KVK is the formation of a Vikas Volunteer Vahini club(VVV) by name *Karshakasadhusr*ee at Kallanode in association with NABARD and South Malabar Gramin Bank. This club started functioning on 22.11.1997 at Koorachundu panchayat in Calicut district. This was the first KVK sponsored club in the state. KVK is organising need based vocational training programmes which aims at bringing about lasting improvement in various enterprises carried out by the club members. The kendra conducted nine training programmes to the club members during the period. Club members also started income generating activities like bush pepper production, vermi compost production, mushroom cultivation, back yard poultry rearing and vegetable seed production.

ii) Self help group activities

There are 33 self help women groups sponsored by NABARD functioning in Koorachund panchayat of Quilandy taluk. Each group is having an average membership of 20. The activities of the VVV club, Kallanode has been effectively linked with this self help groups. Members of the group are regularly attending training and extension activities organised by KVK for the club members. These groups have taken up various income generating activities such as tailoring unit, cultivation of crops like vegetables, banana and ginger in leased land, piggery unit, backyard poultry rearing, vegetable seed production unit etc.

iii) Linkages with other organisations

KVK has established functional linkages with various ICAR institutes, NABARD, KAU, Agril.Dept, Fisheries Dept, Animal husbandry Dept, AIR, FIB and several NGO's.

Major achievements

i) Establishment of a commercial nursery - a success story

A school drop out Sri. Jojo residing in Chakkittapara panchayat attended a training programme on nursery technique of horticultural crops conducted by the kendra in 1998. He was then motivated to establish a plant nursery in his own farm. The scientists from KVK assisted him to procure nuclear planting material of crops like arecanut, coconut, pepper, nutmeg and bush pepper. With an investment of Rs. 30,000/-, he could make a gross income of Rs. 70,000/- in 1999. During last year, from an investment of Rs. 75,000/, a gross income of Rs. 1,60,000/- could be realised

ii) Participating NGO's for promoting employment of rural youth

A voluntary organisation called Centre for Overall Development (COD) Thamarassery sponsored a few trainees on horticultural nursery management. Mobilizing the trainees, the organisation established a nursery unit at Maruthonkara. KVK assisted in preparing action plan and layout for the nursery. As a beginning, 30,000 seedlings of Mohitnagar and South Kanara varieties of arecanut were raised for sales this year.

iii) Vermi nursery as a profitable enterprise for rural house wives

KVK trained women have established a vermi nursery of African Earthworms at Chembanoda village in 1999 and sold about 6 kg worms worth Rs. 3000/- in 2000-'01

iv) Promoting organic farming through SHGs

A Self help group sponsored by the local service co-operative bank started 10 units of vermiculture as a follow up of training on vermicompost production. The kendra aims to spread the message of organic farming by promoting vermiculture through SHGs.

v) Pickling unit as a profitable enterprise for fisher women

A group comprising of 10 fisher women started a fish processing unit at Vakakara in 1998 after attending KVK training. They are marketing their product in the trade name 'Samudra'. At present each of them earn an average income of Rs. 800/- per month.

vi) Revolving Fund Programme

The kendra operates a revolving fund programme for production of quality planting materials of various crops. Under this programme, planting materials worth about Rs. 2 lakhs is sold every year. This has helped the farmers of the district to get quality planting materials at reasonable rates. The animal clinic functioning under the kendra using the revolving fund also caters to various needs of farmers around the centre.

Radio talks (All India Radio, Calicut)

Femeena Hassan	Employment opportunities in fish farming sector
K.M. Prakash	Control of pollu beetle in pepper
K.M. Prakash	Establishment and management of pepper garden
Femeena Hassan	Problems of fisherwomen
P.S. Manoj	Harvesting and processing of pepper
K.M. Prakash	Harvesting of spices
Santhosh J. Eapen	'Information technology in spices and plantation crops'
T. John Zachariah	Value added products of spices and their commercial importance
B. Sasikumar	Propagation of spices. Interview & Cultivation of vanilla
P.A. Mathew	Interview on storage of ginger and turmeric seed rhizome

Lectures delivered

M.N.Venugopal

Management of viral diseases of cardamom and black pepper at Hethur, Sakleshpur (TK), Hassan (DT) and at Somwarpet, Kodagu (Dt)

S.S. Veena

Integrated Disease Management - Ambalavayal (in connection with the inauguration of state level distribution of *Trichoderma*)

Foot rot management - KVK, Peruvannamuzhi

Biocontrol in pest management, Calicut organized by SMGB.

Disease management in black pepper, Kambalakkad (Wynad)

P.A. Mathew

'Tree spices propagation' training sponsored by Spices Board.

'Tree spices' M.Sc . students of Calicut University.

'Tree spices' students from Allahabad Agricultural Institute.

Training on vegetative propagation of tree spices to officials of various Agriculture Departments.

Lecture on spices research to students from Tamil Nadu Agril. University, Coimbatore.

Lecture on tree spices cultivation for officials from N.E.Region.

T. John Zachariah

'Good and bad of alcoholism' - Talk delivered in the Study Circle.

'Post harvest processing and value addition in spices' lecture delivered to M.Sc Plantation Development course students of Calicut University.

Post harvest processing of spices to horticultural officers of Maharashtra at CPCRI, Kasaragod.

K.V. Ramana

'An introduction to nematodes infesting plantation crops and spices', M.Sc. (Plantation Science) students, Dept. of Botany, University of Calicut.

B. Sasikumar

'Seed production and preservation of ginger and turmeric' training on Nursery Management in Spices IISR, Calicut.

'Varieties and varietal improvement in black pepper' training on Spices Production Technology, IISR, Calicut.

Role of Spices in National Economy. National Dialogue on Developmental Reforms in India.

Familiarization of some of the Medicinal Spice Plants -'Medicinal Plants-Nursery Practices and Peoples Participation' Division of Social Forestry Department. Government of Kerala.

Propagation , improvement and breeding of ginger and turmeric M.Sc. Plantation Development students, University of Calicut.

AWARDS AND RECOGNITIONS

1. Dr. Puttarudraiah Endowment National Award for outstanding contribution to plant protection in India to Dr. Y.R. Sarma.

2. Vasvik Industrial Research award for outstanding contribution in plant protection to Dr. Y.R. Sarma.

3. Dr. C.S. Venkatram memorial award for distinguished scientist for the year 2000 for life time achievement in plantation crops research to Dr. Y.R. Sarma.

4. Award for best research paper published in Journal of Spices and Aromatic Crops vol.8 (1999) for the paper "National disease escapes as sources of resistance against cardamom mosaic virus causing 'Katte' disease of cardamom "(*Elettaria Cardamomum* Maton) to Dr. M.N. Venugopal.

5. Mr. Alapati Prasada Rao award for the best poster presentation for the paper "Distribution of curcuminoids during rhizome development in turmeric (*Curcuma longa* L) presented at the Centennial Conference on Spices and Aromatic Plants, Calicut, September 20-23, 2000 to B. Chempakam, N.K. Leela and Sinu. P. John.

6. Best Poster presentation award for the paper "Evaluation of organic substrates for the mass multiplication of *Paecilomyces lilacinus* presented in the National Nematology Symposium on Integrated Nematode Management, November 23-24, 2000 at Orissa University of Agriculture and Technology, Bhubaneswar, Orissa to Santhosh J. Eapen, Beena B and Ramana K.V.

7. Best Poster award to the research paper "DNA finger printing of triploid cultivars of banana RAPD and SCAR marker development" in the National Seminar on Hi-tech Horticulture at Bangalore 26-28 June 2000 to Johnson K. George.

8. K.V. Ramana -Fellow of the Nematological Society of India.

LINKAGES AND COLLABORATION

Agency	Linkage
Spices Board, Kochi	Director, IISR, is a member of the Board.
Directorate of Arecanut and Spices Development, Calicut	Collaboration for planning and monitoring of developmental schemes implemented by DOAC, MOA, Govt. of India.
Department of Agriculture/Horticulture of States	Transfer of technology, Technology assessment and refinement(TAR)
Kerala Agricultural University	PG. Centre for Post Graduate Research, TAR
Calicut University	PG Centre for Post Graduate Research, MOU for teaching M.Sc. Biotechnology 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, Investigatorship in adhoc schemes
Centre for Electronic Design and Technology, Calicut.	Technical collaboration, Computer database.
Farm Information Bureau, Govt. of Kerala	Transfer of technology
S.V. University, Tirupathi	Research collaboration for viral diseases
Regional Research Laboratory, Jammu	Technical collaboration for biofermenter technology
Bureau of Indian Standards	Technical and scientific collaboration to chalk out specification
NABARD, Canara Bank, State Bank of India	Interface with KVK, Peruvannamuzhi for funding

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

The AICRPS has 19 Coordinating Centres and 8 voluntary centres located in 15 states of India with a mandate to conduct research on 12 spices.

Crop Improvement

Twelve varieties were proposed/recommended in the XV AICRPS workshop for state/central release. They 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 variety Guj. Cumin-3 is the first wilt resistant variety developed from an exotic collection. The AICRPS Centres strengthened the genetic resources in all the mandatory spices. Some disease/tolerant accessions and high quality lines have been shortlisted/identified from germplasm evaluated under screening programme.

Crop Production

Package of practices for ginger and turmeric for the high elevation regions of Eastern Ghats were standaridized by the Chintapalli (A.P) centre. The vegetative propagation standardized in nutmeg through grafting technique gave 50.5% success at Yercaud(Tamil Nadu). In black pepper irrigation at IW/CPE ratio of 0.25(100 litres of water once in 8-10 days) during December - March followed by a stress period is recommended by Panniyur (Kerala). Sirsi centre standardized the fertilizer and irrigation requirements for black pepper-arecanut mixed cropping system that is prevalent in Karnataka. A fertilizer level of 150-60-210g of NPK/ vine with irrigation at IW/CPE ratio of 0.33 is recommended for high yield in pepper in Karnataka. Studies at Mudigere (Karnataka) revealed the positive influence of micronutrients, boron and molybdenum, on green capsule yield in cardamom, Cardamom responded positively for the fertilizer application and increased dose of fertilizer resulted in increased yield. A new fertilizer dose of 75:75:150 kg/ha was recommended by Mudigere for the cardamom growing areas in Karnataka. A fertilizer package, including the application of biofertilizers was standardized for clove and nutmeg by the Yercaud centre. Yield and quality of coriander and fenel increased by the application of Zn, Fe, Mn & Cu. Raigarh centre recommended 150:125:125 kg NPK/ha for higher yield in Turmeric (Madhya

Pradesh). A spacing of 30x20 cm and an increased level of nitrogen @ 150 kg/ha is perferred for turmeric at Kumarganj (UP). In Gujarat sowing of cumin on 15th October is most appropriate for avoiding blight incidence. A closer spacing of 15x 10 cm and sowing in first week of October gave highest yield at Coimbatore and 31st October in Jobner for fenugreek.

Crop Protection

A package of technology for the management of *Phytophthora* foot rot disease in black pepper as well as nematode disease management using integrated methods were developed by Sirsi (Karnataka) and at Panniyur (Kerala) centres. Control measures for nursery disease in black pepper rooted cuttings (Panniyur) and cardamom nursery leaf spot were evolved. Management measures for rhizome rot of ginger in field and storage were recommended by Solan and Raigarh centres. The Pundibari, Raigarh and Chintapalli centres evolved measures for management of leaf blotch of turmeric. The survey conducted by Pampadumpara (Kerala) centre revealed that the most predominant insect pest in pepper was marginal gall thrips at higher altitudes.

The coordinating centres also produced and distributed high quality elite planting material/seeds of newly released high yielding spices varieties.

The AICRPS has intensified the studies on biocontrol and biofertilizers in spice production through the formulation of new research programmes.

General/Miscellaneous

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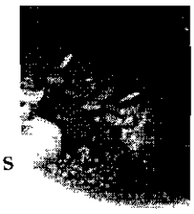

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LIST OF APPROVED ON-GOING PROJECTS

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. Gen. VII.1 (813)	Breeding black pepper for high yield, quality, drought and resistance to pests.
7. Gen. X (813)	Breeding of cardamom for high yield and resistance to 'Katte' disease.
8. Gen. XIV (813)	Cytogenetics and reproductive biology of major spices

9. Hort. II (813)	Utilisation of *Piper colubrinum* Link and *P. arboreum* as root stocks in the management of foot rot disease of black pepper.
10. Hort. III (813)	Development of paprika for warm humid tropics
11. Hort. IV (813)	Root stock scion interactions in tree spices
12. Biotech II (813)	*In vitro* selection for resistance to soft rot and bacterial wilt in ginger.
13. Biotech IV (813)	Biotechnological approaches for crop improvement in black pepper.

Crop Production & Post Harvest Technology

1. Agr. XIV (813)	Investigation 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. Agr. XXI (813)	Efficacy of biofertilizers on nutritional management of black pepper
7. SSc. II (813)	Nutritional requirement of improved varieties of spices
8. Phy. V (813)	Characterisation of drought tolerance in black pepper
9. Phy. V (813)	Characterisation of drought tolerance in cardamom
10. Biochem. (813)	Biogenesis of pigments in spice crops.
11. PHT. I (813)	Quality evaluation in spices

12. Org. Chem.I (813)	Isolation and identification of naturally occurring compounds against major pests and pathogens of black pepper
13. 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. I.1 (813)	Screening germplasm for reaction to diseases
6. Crop Prot. I.2 (813)	Screening black pepper germplasm for reaction to insect pests.
7. Crop Prot. I.3 (813)	Screening black pepper germplasm for reaction to nematodes.
8.Crop Prot. II (813):	Mechanisms of resistance to pests and pathogens in spice crops.
9. Nema. III (813)	Investigations on nematodes associated with spices.
10. Biocontrol. I. 1 (813)	Biological control of diseases of spice crops.
11. Biocontrol. I. 2(813)	Biological control of insect pests of spices
12. Biocontrol. I.3 (813)	Biological control of nematodes of spices.
13. Ent. XI (813)	Bio ecology and management of mealy bugs infesting black pepper

Social Sciences

1. Ext. IV (813)	Training of research and extension workers
2. Econ. I (813)	Economics of spices production and marketing

CONSULTANCY, PATENTS AND COMMERCIALISATION OF TECHNOLOGY

Consultancy Processing Cell

The consultancy processing cell takes up various activities such as providing consultancy services based on the request, taking up contract services such as analysis of samples for oil, oleoresin, nutrients, etc, accepting contract research projects, conducting special training programmes based on request etc. The consultancy-processing cell has commercialised the technology for large-scale multiplication of *Trichoderma harzianum* and the technology has been sold to seven enterpreneurs this year (including renewal of the technology). Various contract services such as analysis of plants for nutrients, amino acids, essential oil and oleoresin and plant samples for microbial population and nutrients has been taken up. Consultancy services were rendered to M/s Haileyburia estates Ltd, Elappara, M/s Udevar Estate Company, Arehalli and a few farmers in Pollachi.

Dr. Y.R. Sarma, the Director of the institute continues to be the concultant for Indo-Swiss Project, Sikkim. During the year the Institute collected a sum of Rs. 1,39,000/- through consultancy processing cell.

RAC, MANAGEMENT COMMITTEE, SRC, QRT etc.

Research Advisory Committee (RAC)

The RAC meeting was held during 2-3 March 2000. 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

Crop improvement

1) Characterisation of secondary and tertiary gene pools is important for locating tolerance to biotic and abiotic stress.
2) Conventional crop improvement approaches should be fully exploited before taking up biotechnological tools.
3) Disease tolerant lines currently available should be incorporated into a breeding programme to enhance the tolerance character and transferring the character to agronomically superior line.
4) A separate area may be identified for establishing the national spice gene bank.

Crop production

1) All efforts should be taken up for intensive survey and collection of natural drought escapes.
2) Based on data base available a model system for spices based cropping system may be worked out.

Post harvest technology

1) Appropriate tools and equipments for agronomic practices pertaining to spice crops may be developed and adapted.
2) Technical bulletins/visual aids starting from harvesting onwards till the finished product should be prepared.

Social science

1) Model technology transfer units for quality planting material production may be established.
2) State farms may be utilised for quality planting material production under IISR guidance and supervision.
3) IISR should establish model transfer of technology centres in selected areas for adoption by Agricultural Department.

Crop protection

1) Mutagens should be exploited for creating variations in somaclones.

echnologies developed at IISR should be made available in print and visual media.

3) Insect traps must be exploited for the management of pests of ginger and turmeric.

Staff Research Council

The XIV Staff Research Council meeting was held during 26-28, April 2000 at IISR Calicut. Dr. P.N. Ravindran, Officiating Director, IISR was the General Chairman. Heads of Divisions functioned as co-chairmen. The progress, salient achievements and technical programme pertaining to 41 institute projects were discussed in four technical sessions. The plenary session was held on 28 April 2000 under the chairmanship of Dr. R.N. Pal, Assistant Director General (PC), Indian Council of Agricultural Research, New Delhi. Dr. R.N. Pal addressed the scientists and released Research Highlights 1999-2000. The technologies developed during current year were transferred to extension agencies. Dr. T. John Zachariah, Senior Scientist (Biochemistry) functioned as the secretary.

Management Committee

Institute Management Committee (IMC) consists of following members:

Dr.Y.R. Sarma	:	Chairman
Dr. R.N. Pal	:	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

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

Name of Workshop/Seminar/Training	Name of officer(s) attended
Brain storming session on Biotechnology at IISR, Calicut, 17-18 January 2000.	Y. R. Sarma, P.A. Mathew, P.N. Ravindran, M. Anandaraj, T. John Zachariah, S.S. Veena, B. Chempakam, N.K. Leela, Y.R. Sarma, B. Sasikumar, K.S. Krishnamurthy, B. Krishnamoorthy, J.Rema
Centennial Conference on Spices, Medicinal and Aromatic Plants. Hotel Taj Residency, Calicut. 20-23 September 2000.	All Scientists of IISR
National Nematology Symposium on Integrated Management. Orissa University of Agriculture & Technology, Bhubaneswar, Orissa. 23-24 November 2000	K.V. Ramana
Fourth Management Development Programme in Agricultural Research. National Academy of Agricultural Research Management, Hyderabad. November 30- December 6, 2000.	K.V. Ramana
Phytonet- Review meeting IIHR, Bangalore 24-26 August 2000	Y.R. Sarma, M. Anandaraj, S.S. Veena, A. Kumar

Training on PCR amplification and gene cloning, CAS, Division of Biochemistry, IARI, New Delhi. March 29 to April 18, 2000.	B. Sasikumar
Review meeting on Pepper Technology Mission, KAU, Thrissur 2 October, 2000.	B. Sasikumar, M. Anandaraj, V. Srinivasan, S.S. Veena
National Biodiversity Strategy and Action Plan. One day Regional Workshop at KFRI, Thrissur. 4, November 2000.	B. Sasikumar, K.V. Saji
Fifth meeting of Kerala Biodiversity Committee. Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram. 1, December 2000.	B. Sasikumar
Training on plant propagation and nursery management of fruits and ornamental crops at TTC, IIHR, Bangalore. 20-29 July 2000.	P.S. Manoj
Tenth Swadeshi Science Congress at Cochin 7-9 November 2000.	Femeena Hassan
National symposium on recent trends in plant science research at Department of Botany, University of Kerala, Kariavattom, Thiruvananthapuram. 17-19 April 2000.	M. Anandaraj
Workshop training on molecular approaches for pest and disease resistance in crop plants at Centre of plant molecular biology, Tamil Nadu Agricultural University, Coimbatore. 15-30 May 2000.	M. Anandaraj
Farmers seminar at Gonikoppal, Karnataka 15 July 2000.	M. Anandaraj

Third annual review meeting of National network project on *Phytophthora* diseases of horticultural crops at Indian Institute of Horticultural Research, Bangalore. 24-26 August 2000	M. Anandaraj
Package of practices meeting at Kerala Agricultural University, Vellanikkara, Thrissur. 29 August2000.	M. Anandaraj, S.S. Veena, C.K. Thankamani, V. Srinivasan, P. Rajeev
Package of practices meeting at Kerala Agricultural University, Vellanikkara, Thrissur. 10th October 2000.	V. Srinivasan, S.S. Veena, Santhosh J. Eapen
Annual meeting and symposium on emerging trends in plant disease management at Indian Institute of Horticultural Research, Bangalore 7-8 December 2000.	M .Anandaraj, Y.R. Sarma, M.N. Venugopal
International Symposium on Plantation Crops, Hyderabad. 14-17 December 2000.	S. Devasahayam, S.J Anke Gowda, C.K.Thankamani
V National Conference of AZRA, Chennai 27-29 December 2000.	S. Devasahayam
ENTOMOCONGRESS 2000, Thiruvananthapuram. 5-8 November 2000.	S. Devasahayam
Annual meeting of Indian Phytopathological society and National symposium on Role of Resistance in Intensive Agriculture, at Directorate of Wheat Research, Karnal. 15 -17 Feb 2000	M. Anandaraj
Seminar on Biological control and plant growth promoting rhizobacteria (PGPR) for sustainable	Y.R. Sarma

agriculture, Department of biosciences, School of Life Sciences, University of Hyderabad .3-4, April 2000	
5th International PGPR workshop, Cordoba, Argentina. 30th Oct.-3rd November 2000.	Y.R. Sarma
Seminar on biotechnological interventions in medicinal plants of Kerala, Kerala Agricultural University, Trivandrum, Kerala- 7th Nov.2000:	K. Nirmal Babu
National Seminar on Recent advances in plant biology, at CPCRI, Kasargod.3-5 February 2000.	T. John Zachariah, B. Chempakam, K.S. Krishnamurthy, S.J. Ankegowda, D. Prasath
National Seminar on Frontiers of Research and Development in Medicinal Plants, CIMAP, CSIR, Lucknow. 16-18, September 2000.	B. Krishnamoorthy, V.S. Korikanthimath
International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st century, New Delhi 14-18 February, 2000.	B. Krishnamoorthy
Harmonisation of Agmark standards of spices with that of ISO, Agmark New Delhi. 21st November 2000.	T. John Zachariah
Town official language implementation committee meeting, Calicut. 4 September 2000.	B. Krishnamoorthy
National symposium on agronomy -	C.K. Thankamani

challenges and strategies for the new millenium, Gujarat 15-18 November 2000.	
Training on Diagnosis and correction of nutritional and physiological disorders in crops at TNAU, Coimbatore 12 - 21 June 2000	C.K.Thankamani
Training on isotope techniques for water management, CWRDM,Calicut 12- 16 February, 2000	C.K. Thankamani
National seminar on Hi- Tech Horticulture, IIHR, Bangalore, 26 - 28 June 2000	K.Johnson George, S.J Anke Gowda
Interaction workshop on development and evaluation of soil and water conservation measures and land use system for sustainable crop production in Western Ghats of coastal region.	S.J Anke Gowda
29 th Institute scientific advisory committee meeting of Krishi Vigyan kendra, Gonikoppal 11 May 2000	S.J Anke Gowda

WORKSHOPS, SEMINARS, SUMMER INSTITUTES ORGANIZED BY THE INSTITUTE

In association with Indian Society for Spices, Calicut and ICAR, New Delhi the Institute has organized Centennial Conference on Spices and Aromatic Plants at Hotel Taj Residency, Calicut during 20-23 September 2000. Theme areas of the conference were

1) Production/Productivity enhancement
2) Management of biotic and abiotic stress
3) Biotechnology application

4) Post harvest industrial processing & quality upgradation

5) Economics, marketing, trade and extension and

6) Information technology and visions for future.

The conference was inaugurated by Prof. S. Kannaiyan, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore and was presided by Prof. K.K.N. Kurup, Vice Chancellor, University of Calicut. Over 250 delegates representing Industry, Farming community, Research and Development organisations attended the conference. A salient feature of the conference was an interface between farmers, industry and scientists. Many leading personalities from various organisations gave the lead talk in different sessions.

DISTINGUISHED VISITORS

Name	Designation
Dr. Manju Sharma	Secretary, Dept. of Biotechnology, New Delhi
Dr. S.P. Ghosh	Deputy Director General (Hort), ICAR, New Delhi
Prof. V.C. Chopra	National Professor and Chairman RAC
Prof. A.M. Michael	Retd. Vice Chancellor (KAU) and member RAC
Dr. Mansingh Manohar	Retd. Director of Research, RAU and member RAC.
Dr. K.R. Maurya	Dean, Rajendra Agricultural University, Bihar and member RAC
Dr. R.N. Pal	Asst. Director General (PC), ICAR, New Delhi
Dr. K.V. Peter	Director of Research, Kerala Agricultural University, Thrissur.
Prof. Anupam Varma	Principal Scientist, IARI, New Delhi.

PERSONNEL

INDIAN INSTITUTE OF SPICES RESEARCH, CALICUT

Managerial

P.N. Ravindran Ph.D., Director upto 30.8.2000

Y.R. Sarma Ph.D., Director from 31.8.2000.

Scientific

Division of Crop Improvement & Biotechnology

B. Krishnamoorthy M.Sc. (Ag.), Principal 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 Ph.D., 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., Principal Scientist (Biochemistry)

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

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

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

C.K. Thankamani Ph.D., Scientist (Agronomy)

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

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

Division of Crop Protection

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

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

S. Devasahayam M.Sc., Principal 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. Principal Scientist (Statistics)

M.S. Madan Ph.D., Senior Scientist (Agril. Economics)

P. Rajeev Ph.D. Scientist Sr. Scale (Agri. Extension)

Technical

P. Azgar Sheriff M.LIS, Technical Officer T6 (Lib.)

Hamza Srambikkal M.Sc., Technical Officer T6 (Lab)

V. Balakrishnan, Technical Officer (T5)

M.M. Augusthy, Technical Officer (T5)

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

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

K. Jayarajan, Stat. Assistant (T4)

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, P.S. to Director

P.V. Sali, Personal Assistant

Alice Thomas, Personal Assistant

C.K. Beena, Stenographer - Grade III

P.K. Janardhanan, U. D. C

C.Venugopalan, U. D. C

R.N. Subramanian, U. D. C

K. Padminikutty, U. D. C

V.C. Sunil, U. D. C

P. Sundaran, L. D. C

S. Sunitha, Stenographer Grade III (KVK)

V.V. Sayed Muhammed, L. D. C

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES, CALICUT

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

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

IISR EXPERIMENTAL FARM, PERUVANNAMUZHI

Scientific

P.A. Mathew, M.Sc. (Ag.), Principal Scientist (Horticulture) 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. Bhaskaran, Jr. Tech. Assistant (T-II)

A.K. Balan, Jr. Tech. Assistant (T-II)

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

K. Chandran, Jr. Tech. Assistant (T-II)

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

E.V. Ravindran, Jr. Tech. Assistant (T-II)

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., Principal Scientist (Agronomy) and Head

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

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

D. Prasath M.Sc. (Ag.) Scientist (Horticulture)

ADMINISTRATIVE

Enid Savitha, Assistant Administrative Officer

K. Vasudevan, Assistant

Ramesh Babu, Stenographer Grade III

Technical

L. Balakrishna, Jr. Tech. Assistant (T1)

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

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

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

M.C. Rathish, Driver (T1)

KRISHI VIGYAN KENDRA, PERUVANNAMUZHI

Scientific

P.A. Mathew M. Sc (Ag.) Principal Scientist & CTO in charge

Technical

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

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

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

S. Ravi, B. V Sc., Trg. Asst-cum-Tech. Asst. (T-II-3)

सारांश

जर्मप्लासम

कालीमिर्च : काली मिर्च और उसकी वल्य जातियों के 148 अक्सशनों का संग्रह किया गया। कालीमिर्च के जर्मप्लासम रक्षागृह में कुल मिलाकर 3097 जर्मप्लासम अक्सशनों का अनुरक्षण करके बहुगुणित किया।

इलायची : इस वर्ष तीन संग्रह जैसे लंबे पुष्प गुच्छवाले (long panicle) (175 से. मीटर) वाषुका प्रकार, स्थूल बीजकोष (छोटे पर्व) युक्त संहत गुच्छ(compact panicle) और निम्न तुंगता से एक सूपरक्लोन (superclone)जर्मप्लासम में जोड दिया।

अदरक: अदरक जीन बैंक में दो नये *जिंजिबार* स्पीसीस और *जिंजिबार ओफिशिनेल* रोस्क के 13 अन्य नये संग्रह जिसमें बहुत छोटे राइजोम, अधिक तीक्ष्णतायुक्त और अटल मोटे मूलवाले एक प्युटेटीव (putative) वन्य प्रकार भी शामिल होता है। अदरक जीन बैंक में कुल 637 संग्रह होता है।

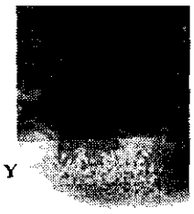
हल्दी : पश्चिम बंगाल, तमिलनाडु और केरल से पाप्त *कुरकुमा* स्पीसीस के नौ संग्रह जीन बैंक में जोड दिया। काली हल्दी (*सी. केसिया*), कस्तूरी हल्दी (*सी. अरोमटिका*) आम हल्दी (*सी आमेडा)* आदि हल्दी जीन बैंक में परिरक्षित किया जाता है। अब जीन बैंक में कुल 786 अक्सशन होता है।

वैनिला : तमिलनाडु के KMTR क्षेत्र से लिये एक अक्सशन *वी. वटसलाना* और वानिला *प्लानि फोलिया* के तीन अक्सशनों को जर्मप्लासम में जोड दिया।

वृक्ष मसाले : *गार्सीनिया* स्पीसीस के 14 संग्रह, *मिरिस्टिका* स्पीसीस और *सिसिजियम* स्पीसीस दोनों का 11 संग्रह और *सिनमोमम* स्पीसीस का 5 संग्रह जीन बैंक में जोड दिया।

फसल सुधार

1. खुर विगलन के सह्यतायुक्त काली मिर्च लाइन संग्रह 1041, वालपराई में खुर विगलन के सह्य होते रहते है और उसकी औसत उपजता 4.77 कि. ग्राम हरे/बेल होते है। काली मिर्च संकरज एच पी - 34, एच पी - 105 और एच पी - 813 वालपराई के उच्च तुंगता क्षेत्र (समुद्र तट से 3000 फीट ऊपर) में उच्चतम बनाई रखती है।
2. काली मिर्च के संकरज एच पी 1411 जो लंबे संहत स्पाइक (long compact spike) और मोटे बीजवाले औसत उपजता 3-65 कि. ग्राम (हरे/बेल) के, और करिमुंडा



(OPKm) के एक खुले परागित संतति जो हरे भरे वृद्धिवाले चौडे पत्तों युक्त और लंबे स्पाइक के तथा 3.4 कि. ग्राम हरे/बेल की उपजता होनेवाले है, मूल्यांकन की प्राथमिक दशा में आशाजनक काली मिर्च लाइन देखे गये।

3. काली मिर्च को तीन साल बाद भी खेत में बनाये रखने केलिए *पाइपर कोलुब्रिनम* को मूल कांड (root stock) के रूप में लेकर तथा शुभकरा काली मिर्च को कलम (scion) के रूप लेकर प्रयास किये आठ तरह के कलम बाँधने की तरीकों में जीभी तरीके (tongue method) (56.75%) और द्विमूल काँड तरीका (78.24%)अन्य प्रविधियों की अपेक्षा अत्यन्त महत्वपूर्ण होता है और 3 साल के बाद भी खेत में अच्छी तरह खडे होते हैं। कलम के रूप में मूल्यांकन किये काली मिर्च किस्मों में पूँचारमुंडा (Poonjaramunda) को *पाइपर कोलुब्रिनम* मूल कांड पर उत्तम कलम के रूप में देखा जाता है।

4. आलप्पी फिंगर टरमरिक (ए एफ टी) चयन 585 ने पेरुवन्नामुषि में साफ राइजोम के उच्चतम उपजाता अंकित की। उसकी औसत उपज्ता प्रति हेक्टर 34.7 टन है जिसमें 20% सुखे उपज प्राप्त होते है।

5. जायफल का एक आशाजनक लाइन ए 9/4 और उसकी क्लोन संततियां खेत में बहुत अच्छा देख रहा है। इसकी गिरी और जावित्री में क्रमशः 7.14% और 7.13% तेल, 2.48% और 13.8% ओलिओरसिन होता है।

6. कलम बाँधने केलिए जायफल के विभिन्न वन्य और संबन्धित स्पीसीस (*मिरिस्टिका मलबारिका,* एम. बडोमी, एम. अट्टेन्युवैटम और जिम्नोक्रान्तीस कनारिया) लेने पर *एम. मलबारिका* अधिक उचित देखा जाता है जिसके पीछे आता है *एस. बडोमि*।

7. "पाप्री किंग" पाप्रिका के एक सिम्बाबियन किस्म है अच्छे रंग के और तीखापन (245 ASTA एकक) रहित है और उसका उपज बहुत अधिक है।

कोशिका जननिकी & पुनरुत्पादक जीवविज्ञान

हल्दी के 9 अक्सशनों में 6 बीजपौधे संततियां (23a, 23b, 426, 417, 414 और 384) और मातृ पौधे (23, 324, 384) होते है। कोशिकापरक विश्लेषण (cytological analysis) करने पर क्रोमसोमल (chromosomal) भिन्नताएं जैसे बीजपौधे संततियों के बीच 2n = 84 (23a, 23b, 426 417), 2n = 86 (414) और 2n = 63(384) तथा मातृपौधों के बीच साधारण क्रोमसोम की संख्या (2n = 63) देख लिया।

जैवप्रौद्योगिकी

वैनिला अन्टामानिका बहुगुणिस करने हेतु *इन बिट्रो* प्रविधियाँ मानकीकृत की गयी। इलायची में उच्चदर बहुगुणनवाले सोमाटिक एम्बयोजनसिस को उत्प्रेरित किया। सूक्ष्म प्रवर्धित अदरक के RAPD विश्लेषण कुछ विभिन्नताएं दिखा दी। वैनिला के स्व संततियों के RAPD प्रोफाइल में अधिक जननिक दिभिन्नताएँ होती है। *इन बिट्रो* परिरक्षित इलायची अक्सशनों में न्यूनतम हालत में परिरक्षण के 6 साल बाद भी जननिक स्थायित्व देखा गया।

पोषण एवं मृदा प्रबन्धन

1. अपघटित नारियल जटा कम्पोस्ट DAP (0.2 कि ग्राम/मीढर) के साथ संवर्धित करके नर्सरी मिश्रण में FYM संघटक के स्थान पर प्रयोग कर सकते हैं।
2. बुश पेप्पर में 10 कि. ग्राम मृदा के साथ प्रति बरतन 1.25 कि. ग्राम के दर में FYM और वर्मी-कम्पोस्ट लगाने से रासायनिक उर्वरक लगाने की अपेक्षा उपजता में क्रमानुसार 119% और 75% वृद्धि देख ली।
3. डी आर आइ एस (डयग्नोस्टिक रेकमेंटेशन्स इन्टग्रेटड सिस्टम) के आधार पर इलायची में सर्वश्रेष्ट उत्पादन प्राप्त होने के लिए इन्डक्स (index) पत्तों में 1.26 से 2.81% नाइट्रोजन, 0.1 से 0.2% फासफारस, 1.3 से 3.4% पोटैशियम, 0.51 से 1.38% कैल्शियम और 0.18 से 0.31% मैगनीशियम आदि होना चाहिए। ऊपर से दूसरे और तीसरे पत्तों को इन्डक्स पत्ते के रूप में प्रयोग किया जा सकता है।
4. पुनरोपण करने पर इलायची की निष्पत्ती और आर्थिकी पर किये अध्ययन से यह सूचित होता है कि पाँचों फसल काल में औसत उपजता 749 कि. ग्राम (सूखे/हेक्टर है, जो राष्ट्रीय औसत उपजता से भी 5.35 गुना अधिक होता है।

केन्द्रक रोपण सामग्रियाँ

हल्दी के 4 टन बीज राइजोम, अदरक के 4.4 टन बीज राइजोम, 2581 जायफल का ग्राफ्ट्स 285 दालचीनी बीजपौधे, 496 आलस्पाइस बीजपौधे, 14000 इलायची बीजपौधे और 108 कि. ग्राम इलायची बीज संपुट (capsule) किसान एवं अन्य एजेंसियों को वितरित किया।

सुखा सह्यता

सुखा सह्यता केलिए छानबीन कीये 150 काली मिर्च संकरजों में एच पी 976 और एच पी -

1000 तथा जर्मप्लासम अक्सशनों में अक्सशन 892 और अक्सशन 933 अपेक्षाकृत सह्यता युक्त देखे गये।

गुणमूल्यांकन

1. काली मिर्च में किये गये गुणमूल्यांकन से एच पी 1411, संग्रह 4187, संग्रह 1490 और ओ. पी नीलमुंडी में 4% सुगन्धित तेल तथा एच पी 780, श्रीकरा, संग्रह 4187, संग्रह 1411 में 10-11% से अधिक ओलिओरसिन और संग्रह 4187 श्रीकरा, संग्रह 4175 और संग्रह 1411 मे 3.5-4.0% पाइपरिन होता है।

2. भैसे, कलिंपोंग और गुरुबतानी जैसे अदरक किस्में जब तामरशेरी और पेरुवन्नामुषि (केरल) के समतल प्रदेशों में उगाई जाती है तो सिक्किम (उच्च तुंगता) के 10-12% की अपेक्षा 18% सुखे अदरक प्राप्त होते है। मगर बाष्पशिल तेल और ओलिओरसिन केरल (1.5 और 5%) की अपेक्षा सिक्किम मे अधिक (2.5 और 7%) होते हैं।

3. संचयन पर किये प्राथमिक अध्ययन से यह सूचित करता है कि खुदाई के बाद तीनमहीने तक संवातन प्रतिबन्धित करके अदरक राइजोम को अधिक निर्जलीकरण के बिना पोली एथिलीन कवर मे संचयन किया जा सकता है।

4. हल्दी के पत्तों के कुरकुमिन जैवसंश्लेषण का प्रधान एन्जाइम फिनाइल एलानिन अमोनिया लाइस (phenyl alanine ammonia lyase (PAL) के अंशिक अध्ययन से यह सूचित करता है कि अणुकाय (माइक्रोसोमल) और कोशिकाद्रव्य अंश (साइटोप्लास्मिक फ्राक्शन) की अपेक्षा माइटोकोन्ड्रियल अंश (mitochondrial fraction) अधिकतम सक्रिय देखा गया।

5. हल्दी के राइजोम, मूल एवं पत्तों के बाष्पशील तेल के जी सी (GC) प्रोफाइल से यह स्पष्ट होता है कि राइजोम और मूल का प्रमुख संघटक अर टरमरोन (ar-turmerone) (क्रमानुसार 31.5% और 46.8%) है जबकि पत्तो का प्रमुख संघटक 2 - फिलान्ड्रेने (phellandrene) (32.6%) होता है।

फसलोत्तर अध्ययन

कार्षिक कूडा करकट जलानेवाले शुष्क मशीन (60°C) में जायफल की जावित्री सुखाने केलिए 4 घंटे आवश्यक होता है जबकि गरम रेत (50°C) में इसके लिए 3.5 घंटे काफी होता है। फिर भी गुण पैरामीटर जैसे लिकोपेने (Lycopene), रंग द्रव्य और वाष्पशील तेल का अवधारण गरम रेत में सुखाने की अपेक्षा गरम हवा में सुखाने पर उत्तम फल मिलता है।

पाइपर छाबा रासायनिक गुण में कोई बदलाव न रखकर 8 घंटे गरम हवा में सुखाया जा सकता है।

पादप रोगविज्ञान

रोगजनन(pathogen) का चरित्रांकन : *रालस्टोनिया* संग्रह (repository) में 8 नये विभुक्तियों को जोड दिया और इनका चरित्रांकन भी किया गया। इनमें सात वयोवर (biovar) 3 केलिए अनुकूल होता है और पेरुवन्नामुषि में जांच किये एक विभुक्ति वयोवर (biovar) 4 केलिए अनुकूल होता है। रालस्टोनिया का तापीय नाश दर 30 मिनिट प्रदर्शन में 46°C देखा गया।

सिरमीय परीक्षण (serological test) एवं EM अध्ययन के आधार पर काली मिर्च के अवरुद्ध रोग के हेतुविज्ञान की पुष्टी की गयी और यह कुकुम्बर मोसेक वाइरस (CMV) के कारण होता है। फिर भी एक से अधिक वाइरस जैसे बदना (Badna) का प्रभाव भी देख जाता है। इलायची में कोक्के कन्दु के कारण आनेवाले नस (vein) साफ करनेवाले वाइरस के निर्मलीकरण केलिए प्रोटोकॉल को मानकीकृत किया गया। वाइरस कण के विस्तृत आकृति-विज्ञान केलिए EM अध्ययन प्रगति पर हो रहा है।

परपोषी प्रतिरोधकता

काली मिर्च के 150 संकरजों में उनके *पी. कापसीसी* प्रतिक्रिया के लिए तना निवेशन प्रविधियों द्वारा छान-बीन किया। इनमें तीन संकरज एच पी 423, एच पी 664 और एच पी 756 सह्यता युक्त देख गया।

सात आशाजनक संकरजों/कल्टिवर्स में उनके मूल डुबोकर निवेशन द्वारा उनके *पी. कापसीसी* की जाँच की गयी और उनमें एच पी 105 और एच पी 780 अधिक जीवित रहते देख ली।

रोग प्रबन्धन

कर्षण प्रक्रियाएँ : खुर विगलन रोग बाधित काली मिर्च बाग को नया कर देने केलिए खेत परीक्षण में कवग बाधित प्लाट की अपेक्षा साफ खेती युक्त प्लाट में बने रहे बेल और पुष्पित बेल की संख्या अधिक होती है। आतपन (सोलाराइसेशन) की प्रभावोत्पादकता की जांच के लिए खेत परीक्षण प्रारंभ किया और सोलाराइस्ड प्लाट में ट्राइकोडरमा का प्रसरण अधिक होता है।

स्वस्थ बीज उत्पादन के लिए एक सरल रोगाणुनाशन प्रविधि "राइजोम सोलाराइसेशन" विकसित किया और उसका ग्रीन हाउस में जाँच किया। अदरक राइजोम का पूर्वाह्न 9 बजे से अपराह्न 1 बजे तक

2 से 4 घंटे आतपन किया जो गरमी की दशा में 55°C राइजोम तापमान उठाया गया, रोपण के कुछ समय पूर्व अदरक के राइजोम से आर सोलानसीरम (*R. solanacearum*) बीज द्वारा निकालकर दिया गया।

रासायनिक नियन्त्रण

उच्च गाढापन के पौटैशियम फॉसफानट (6 मि. लि/लि और 9 मि. लि/लि) और ट्राइकोडरमा का बरतन संवर्धन परीक्षण से स्पष्ट होता है कि उच्च गाढापन के पोटैशियम फॉसफानट *फइटोफथोरा काप्सीसी* को रोकने में अच्छा होता है और दोनों को मिलाकर भी प्रयोग कर सकते हैं। इन सभी गाढापन में काली मिर्च पर आविषलुता नहीं देखा गया।

जैवनियन्त्रण

काली मिर्च के मूल लगाए कतरन पर VAM और फॉस्फट सोलुबिलाइसिंग में बाक्टीरिया के प्रभाव के अध्ययन केलिए किये परीक्षण से सूचित होता है कि VAM और फॉस्फट सोलुबिनाइसिंग वाक्टीरिया कई मूल और उसकी लंबाई द्वारा कतरन की अच्छी वृद्धी दिखाते है।

काली मिर्च के रिसोस्फियर से वियुक्त *फ्लोरसन्ट प्स्यूडोमोनाड्स* (21 वियुक्तियाँ) और ट्राइको डरमा स्पीसीस (25 वियुक्तियाँ) को द्वि कर्षण प्रविधियों के सहारे *पी. काप्सीसी* के प्रति उनके प्रतिरोधी शक्ति के लिए इन विट्रो में छानबीन किया गया। *ट्राइकोडरमा स्पीसीस* के बारे में प्रतिरोध 26.9. - 37.6% होता है और यह फलूरसन्ट प्स्यूडोमोनाड्स के बारे में 36.3-70.0% होता है। प्रासंगिकतया, *पी काप्सीसी* के प्रति प्रतिरोधी प्लूरसन्ट प्स्यूडोमोनाड्स वियुक्ति याँ भी फॉस्फट विलेयन केलिए अच्छा देख लिया, जो एक अतिरिक्त देन होता है।

ट्राइकोडरमा के बडी मात्रा में बहुगुणन के लिए नारियल जटा कम्पोस्ट और शोरगुम का संयोजन (sorghum combination) अच्छा वाहक देखा जाता है।

जैवप्रौद्योगिकीय आगमन

PCR आधरित प्रविधियाँ : मिट्टी से PCR प्रवर्धन करनेलायक बैक्टीरियल DNA की वियुक्तियों केलिए प्रोटोकॉल मानकीकृत किया। मिट्टी से बैक्टीरियल कोशिका को निकालकर DNA, एक्स्ट्राक्शन बफर आधारित SDS + CTAB में लैसिस करने का तरीका भी इस प्रोटोकॉल में शामिल होता है। इस तरीके द्वारा वियुक्त किये DNA पॉलिमरेस बन्धित प्रतिक्रिया (PCR) के लिए काफी होता है। अदरक पर बाधित मृदा से उत्पन्न रोगजनक बैक्टीरिया के लिए विकसित मोलीकुलार पता लगानेवाले औजार (detection kit) बहुत उपयोगी हो जाएगा।

क्रोमोलैना ओडोरोटा *Chromolaena odorata* पत्तों से समर्थ सार और column chromatography द्वारा *पी. कापसीसी* का एक क्रिस्टलीय संयुक्त निरोधी बीजाणुकजनन (sporulation) वियुक्त किया।

फाइटोनट

राष्ट्रीय *फाइटोफ्थोरा* रेपोसिटरी में अनुरक्षण किये *फाइटोफ्थोरा* की 424 वियुक्तियों में काली मिर्च से *पी. कापसीसी* के 115 वियुक्तियों को क्लामिडोबीजाणु निर्माण केलिए अध्ययन किया। इनमें केवल 60 वियुक्तियाँ क्लामिडोबीजाणु उत्पादित करते है।

अनन्नारा के मूल से वियुक्त किये एक नये *फाइटोफथोरा* वियुक्ति को प्राथमिकतया *पी सिन्नमोमी* के रूप में पहचान किया।

फाइटोफथोरा के 52 काली मिर्च वियुक्तियों के आकारिकीय चरित्रांकन से सूचित करता है कि दो *पी. पालमिवोरा,* दो *पी. पेरासिटिका* और दो अन्य अटिपिकल (atypical) वियुक्तियाँ है और बाकी वियुक्तियाँ *पी. कापसीसी* होता है।

आइसोजाइम विश्लेषण

1. आइसोजाइम विश्लेषण के द्वारा *फाइटोफ्थोरा* वियुक्तियाँ के रासायनिक चरित्रांकन प्रारंभ किया। ये वियुक्तियाँ 4 एनजाइस जैसे कैटालेस (CAT), सूपरऑक्साइड डिस्म्यूटाइस (SOD), मालिक एनजाइम (ME) और ग्लूकोस - 6 - फॉस्फेट डिहाइड्रोजनेस (G6PDH) केलिए चरित्रांकित किया। अध्ययन किये 4 एनजाइम के बीच 10 तक अनुमानित स्थान (putative loci) नियोजित किया। 4 एनजाइस केलिए किये गये इलक्ट्रोफॉरटिक तरीकों के अध्ययन में 3 स्थान (loci) हर एक SOD और ME के लिए तथा 2 स्थान (loci)G6PDH केलिए प्रकट हुआ।

2. इन विट्रो में *फाइटोफ्थोरा कापसीसी* बाधित काली मिर्च को *ट्राइकोडरमा स्पीसीस* की अस्थिरता (volatile) पर एक्सपोस (expose) किया और एक्सपोस किये वियुक्तियों की विषाक्तता डिटाच्ड पर्ण प्रविधियों द्वारा करिमुंडा पत्तों पर उसकी रोगजनकता की जांच करके अध्ययन किया। ट्राइकोडरमा स्पीसीस द्वारा उत्पादित अस्थिर उपापचयी (volatile metabolites) को *पी. कापसीसी* की विषाक्तता कम करते देखा गया। पूर्वज वियुक्तियों की तुलना में विषाक्तता के नाश 0-100% होता है। *पी. कापसीसी* की विषाक्तता का नष्ट काम में लाये *ट्राइकोडरमा* वियुक्तियों के प्रकार और परित्यक्त काल पर आश्रित है। अध्ययन किये बीस टी. हरजियानम वियुक्तियों में छः वियुक्तियाँ *पी कापसीसी* विषाक्तता को 50% से अधिक नाश करते है। विभिन्न अन्य मेकानिजम जैसे

अपघटन (lysis), कवग परजीविता (mycoparasitism), प्रतिजीवित और कांपेटीशन के अलावा, पाथोजन की विषाक्तता भी जैवनियंत्रण का एक अन्य मेकानिजम होता है।

3. चार *ट्राइकोडरमा* स्पीसीस जैसे *टी. हर्जियानम* (पी 26), टी. *वाइरन्स* (पी 12), *टी. ऑरियोविरिडे* (पी 25) और *टी. प्स्यूडोकोनिंगी* अकेले या संयुक्त रूप में काली मिर्च बीज पौधों की वृद्धि और खुर विगलन के नियन्त्रण पर इनके प्रभाव के बारे में अध्ययन किया गया। *टी. ऑरियोविरिडे* पी 25 और *टी. हर्जियानम* पी 26 के साथ उसके संयोजन पौधों की अधिकतम वृद्धि अंकित की जो अनुपचारित पौधों की तुलना में 180% अधिक होता है।

टी ऑरियोविरिडे 25 के विभिन्न संरोपण गाढता (concentration) को *पी. कप्सीसी* के नियंत्रण में उनका प्रभाव समझने केलिए मिट्टी में लगाया गया। गाढता concentration 62x10 -62x10 बीजाणु/ग्राम मृदा और 5x10 - 5x10 माइसीलिया mycelia/ग्राम मृदा होता है। दो महीने के बाद बीजाणु के संबन्ध में संख्या 10 से 10 तक तथा माइसीलिया के संबन्ध में 10 से 10 तक घट गयी। उसी समय बीजाणु और साइसीलिया के संबन्ध में 10 से 10 तक की हल्की वृद्धि भी दिखायी पडी। लेकिन वैधानिकता पर *पी. कप्सीसी* के साथ संरोपण में मृत्यु संख्या और cfu संख्या के बीच कोई सह संबन्ध दिखाई नहीं पडा।

कीटविज्ञान (Entomology)

पोल्लु बीटल के प्रति परपोषी प्रतिरोधकता की पहचान और चरित्रांकन:

भारतीय मसाला कसल अनुसंधान संस्थान, पेरुवन्नामुषि के जर्मप्लासम रक्षागृह में उपलब्ध काली मिर्च अक्सशन जैसे 196 कल्टिवर्स, 24 संकरज और 3 सोमाक्लोन में "पोल्लु बीटल" (*लोंगिटार्सस निग्रीपन्नीस*) काली मिर्च का एक प्रमुख कीट के प्रति छानबीन करने पर 6 कल्टिवर्स और 2 संकरज कीट बाधा मुक्त दिखाई पडी।

पोल्लु बीटल के प्रति प्राकृतिक उपजों का मूल्यांकन

पोल्लु बीटल के प्रति कैप्सेइसिन होनेवाले मिर्च सार के आन्टीफीडन्ट सक्रियता (antifeedent activity) के स्थायित्व का मूल्यांकन करने हेतु प्रयोगशाला एवं ग्रीन हाउस बयोऐसे का आयोजन किया। एक प्रतिशत कैप्साइसिन होनेवाले लाल मिर्च सार उपचार के बाद क्रमशः 14-21 दिन तक पोल्लु बीटल के प्रति >90% और >50% के अधिक फीडिंग डिटरन्स (feeding detterence) का कारण होता है और IPM योजना में उपयोग केलिए इसकी संभाख्यता सूचित करता है।

प्ररोह बेधक का एकीकृत प्रबन्धन

अदरक के एक प्रमुख कीट प्ररोह बेधक (*कोनोगीतस पंक्टिफेरालीस*) के प्रबन्धन के लिए कर्षण रीतियाँ एवं मालीतियोन 0.1% विभिन्न योजना में छिडकने का मूल्याँकन किया। एक एकीकृत योजना जैसे कीटवाधित प्ररोहों को जुलाई - अगस्त के समय (पाक्षिक अन्तराल में) काट-छांट करने और सितम्बर - अक्तूबर के समयकीटनाशी छिडकने (मासिक अन्तराल में) के फलस्वरूप कीटोंके आपतन में कमी और राइजोम उपजता में वृद्धि होकर 1:4.6 अनुपात के मूल्य प्राप्त होते है। इस योजना को अपनाकर दो तरह की कीट नाशियों का छिडकाव छोड सकते है ऐसे स्वाभाविक रात्रुओं का परिरक्षण करके पर्यावरण क्षति कम कर सकते हैं।

अदरक में कीटनाशी अवशेष का निर्धारण

फसल काल में 0.05% एन्डोसल्फान 2 या 4 बार छिडकने के फलस्वरूप सोंठ में एन्डोसल्फान रसिड्यूस का अनिकाली स्तर होता है और ऐसे संस्तुत कीटनाशी का प्रयोग पर्यावरण तौर पर सुरक्षित होता है।

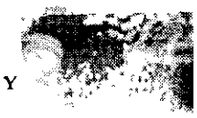
राइजोम शल्क का प्रबन्धन

अदरक एवं हल्दी संचयन में देखनेवाले एक प्रमुख कीट राइजोम शल्क (*अस्पिडियल्ला हारटी*) के प्रबन्धन केलिए विभिन्न कीटनाशियाँ जैसे पादप और ऑरगानिक उपज का मूल्याँकन किया गया। इस परीक्षण से यह सूचित होता है कि विभिन्न उपचारों में बीज राइजोम को क्विनालफोस (0.075%) में डुबोकर रखने से बडी मात्रा में राइजोम प्राप्त होने के साथ अधिक अंकुर होने एवं राइजोम शल्क का आपतन कम करने के लिए बहुत सहायक होता है।

गोलकृमि विज्ञान (Nematology)

परपोषी प्रतिरोधकता

अदरक एवं हल्दी दोनो के बारह अक्सशनों का दूसरे बार छान बीन करने पर रूट नॉट नेमटोड, *मेलोयिडोगैन इनकाग्निटा* के प्रतिरोधक देखा गया। हल्दी के अक्सशन 31, 82 और 200 जैसे तीनों छान बीन (screening) में *एम इनकोग्निटा* के प्रति प्रतिरोधक देखा गया। रूट नॉट और खोदनेवाले नेमटोड के प्रति छान बीन किये काली मिर्च के सभी 29 और 38 अक्सशनों को क्रमानुसार सुग्राह्य पाया गया।



जैविक नियंत्रण

पादप वृद्धि दायक रैजोबैक्टीरिया Plant Growth Promoting Rhizobacteria (PGPR)

केरल में काली मिर्च मूल से (160 वियुक्तियाँ) तथा आँध्रप्रदेश में हल्दी (19 वियुक्तियाँ) से PGPR वियुक्त किया गया। 29 वियुक्तियों में 10 वियुक्तियाँ *इन विट्रो* बयोऐसे में नेमटोड के 100% मृत्यु दर का कारण होता है। ग्रीन हाउस मूल्याँकन में, रुट नॉट नेमटोड को दबाने केलिए 65 वियुक्तियों को उनके प्रभावोत्पादकता के लिए छान बीन किया गया। तीन वियुक्तियां टमाटर पौधों में नेमटोड के आक्रमण के प्रति पूर्ण सुरक्षित हुई जबकि 11 अन्य वियुक्तियाँ नेमटोड के 50% से अधिक दमन का कारण होता है।

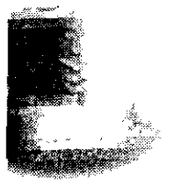
आशाजनक कवग जैवनियंत्रण एजेंट का खेत मूल्यांकन

रूट नॉट नेमटोड बाधित माइक्रोप्लाट में अदरक पर तेरह आशाजनक कवग जैवनियंत्रण एजेंट का मूल्यांकन किया गया। *वर्टिसिलियम क्लामिडोस्पोरियम, पसिलोमाइसस लिलासिनस फुसेरियम* स्पीसीस, *अस्परगिल्लस निडुलन्स* और स्कोपुलोरियोरिसस स्पीसीस रूट नॉट नेमटोड की वृद्धि को सार्थक रूप से रोक लिया।

वयनाडू के एक किसान के प्लॉट में काली मिर्च पर बाधित रूट नॉट नेमटोड प्रबन्धन केलिए *ट्राइकोडरमा हर्जियानम, वी. क्लामिडोस्पोरियम* और *पास्टुरिया पेनिट्रान्स* का मूल्यांकन किया। समी उपचारों में नेमटोड संख्या में महत्वपूर्ण कमी देखा ली। जैवनियंत्रण एजेंट के साथ उपचारित प्लॉटों में पीलापन के प्रमुख आपतन में 17.3-37.3% होता है जबकि वह कीटनाशी द्वारा उपचारित प्लॉट तथा अनुपचारित नियंत्रण में ये 32.8-50.5% होता है। खडे फसलों (75.2% स्वस्थ बेल) में अधिकतम सुधार *वि. क्लामिडोस्पोरियम* उपचारित प्लॉट मं देखा गया और जिसके पीछे *टी. हर्जियानम* (75.6% स्वस्थ बेल) आता है। अधिकतम उपजता (4.6 कि. ग्राम हरे/बेल) *वी. क्लामिडोस्पोरियम* उपचारित बेलों में अंकित की।

वी. क्लामिडोस्पोरियम वियुक्तियों में परिवर्तिता

वी. क्लामिडोस्पोरियम की तीन वियुक्तियाँ और *वी. टेनेरम* और *वी. लेकानी* की एक एक वियुक्ति उनके रूट नॉट नेमटोड अंडे एवं मादा के परजीवी क्षमता में अन्तर दिखाता है। सब रूट नॉट नमटोड के बहुत अंडे colonise करते हैं। *वी. क्लामिडोस्पोरियम* में परिवर्तिता उत्प्रोरित करने के लिए उसके बीजाणुओं को विभिन्न ई एम एस गाढता (concentration EMS) के साथ उपचारित किया गया और उच्च गाढता में उत्पादित स्पोराडिक कोलनीस (sporadic colonies) को



वियुक्त एवं अनुरक्षण किया।

जैवनियंत्रण एजेंटों की पारिस्थितिकी

टी. हर्जियानम (आइ एस. 33) और *पी. लिलासिनस* (आइ एस 36) की वृद्धि एवं बहुगुणन के लिए पर्याप्त तापमान 30°C होता है जबकि वी. क्लामिडोस्पोरियम के लिए 25°C होता है। *टी. हर्जियानम वियुक्तियों* में (आई एस. 33 और 56) उनके अनुकूल पी एच आवश्यकताएँ क्रमानुसार पी एच 4 और 5, होता है और पी एच 6 को *फूसोरियम स्पीसीस* (आइ एस. 11) केलिए आदर्श देखा गया। पौटैशियम फॉस्फानट और कीटनाशी जैसे फोराइट और क्लोरफिरिफोस संस्तुत मात्रा में लगाने से जैवनियंत्रण एजेंट जैसे *टी. हर्जियानम, पी लिलासिनस* और *वी क्लामिडोस्पोरियम* पर कोई प्रतिकूल प्रभाव नहीं पडता है। फिर भी मेटालक्सिल मानकोजेब समी गाढताओं में उपरोक्त समी कवगों की वृद्धि और बीजाणुक जनन को कम करता है।

जैवीक संशोधन (Organic amendments)

काली मिर्च बेलों के बैसिन में स्ट्रिक्नोस्नु एक्सवोमिका (*Strychnos nuxvomica*) और *पाइपर कोलुब्रिनम* के हरे पत्तों का निगमन (समावेशन) करने से नेमटोड बाधा के कारण पत्तों का पीलापन कम होता है। वर्मीकम्पोस्ट जैसे सुधार द्वारा नेमटोड पर छोटा प्रभाव होता है।

विस्तार

1. इस वर्ष तीन स्थायी और पाँच प्रवर्तित (sponsored) प्रशिक्षण कार्यक्रम आयोजित किये। देश के विभिन्न भागों से आये एक सौ पन्द्रह प्रशिक्षर्थियों ने स्पाइसस प्रोडक्शन तकनोलजी पर प्रशिक्षित हुए। केरल, कर्नाटक, तमिनलाडु और महाराष्ट्र से आये कृषकों केलिए एक दिवसीय अनुस्थापन (orientation) कार्यक्रम आयोजित किये।

2. कार्षिक एवं परंपरागत विश्व विद्यालयीन छात्रों को "मसाला अनुसंधान विकास पर अवगत करानेवाला कार्यक्रम प्रदान किया। मसाला उत्पादन तकनोलजी पर एक व्यापक मार्गदर्शक मुद्रित करके कृषि तकनोलजी सूचना केंद्र (ATIC) द्वारा वितरित किया।

अखिल भारतीय समन्वित अनुसंधान परियोजना

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना केंद्र ने सभी अधिदेश मसालों में जननिक संसाधन को मजबूत बनाया। मूल्यांकन/छानबीन कार्यक्रम के अधीन अदरक, हल्दी और बीज मसालों के रोग सह्य लाइनों की सूची बनायी और पहचान की। पश्चिम घाट के उच्च उन्नयन क्षेत्रों के लिए अदरक एवं हल्दी केलिए चिंतापल्ली केंद्रों (आंध्रप्रदेश) द्वारा पैकेज ऑफ प्राक्टीसस मानकीकृत किया।

काली मिर्च (केरल) के लिए सिंचाई अपेक्षाएँ तथा उसी प्रकार कर्नाटक में काली मिर्च और सुपारी मिश्रित फसल तरीकों के लिए उर्वरक एवं पानी की अपेक्षाएँ मानकीकृत की गयी। मुडिगरे के अध्ययन से प्रकट होता है कि सूक्ष्म पोषण (बोरोन और मोलिब्डिनम) का स्पष्ट प्रभाव तथा उसी प्रकार अधिक मात्रा में उर्वरक लगासे से इलायची में अधिक उपजता प्राप्त हुई। मुडिगरे (कर्नाटक) में इलायची के लिए एक नये उर्वरक मात्रा NPK 75:75:150 कि ग्राम/हेक्टर की मात्रा में लगाने केलिए संस्तुत किये।

लौंग, जायफल (तमिलनाडु) और हल्दी (मध्यप्रदेश) केलिए उर्वरक का पैकेज, तथा हल्दी (उत्तर प्रदेश) केलिए अन्तराल और उर्वरक एवं मेथी (तमिलनाडु) केलिए अन्तराल और बुआई का समय आदि संस्तुत किये।

काली मिर्च में *फाईटोफथोरा* खुर विगलन रोग के प्रबन्धन के लिए तथा एकीकृत रीतियों द्वारा नेमटोड रोग नियंत्रण केलिए सिरसी (कर्नाटक) और पन्नियूर केंद्रों (केरल) में एक पैकेज तकनोलजी विकसित की। कालीमिर्च (पन्नियूर) का नर्सरी रोग, इलायची नर्सरी में पर्ण चित्ती (leaf spot) (मुगरे) खेत एवं संचयन (सोलन & राइगढ) में अदरक का मूल विगलन, हल्दी (पुंडिबारी, राइगढ और चिन्तापल्ली) में पर्ण दाग (leaf blotch) आदि संस्तुत किये।

अन्य क्रियायें

मसाला और अरोमटिक पौधों पर एक शताब्दी सम्मेलन (centennial conference), इंडियन सोसाइटी फॉर स्पाइसस, राष्ट्रीय बागवानी बोर्ड और राष्ट्रीय कृषि विज्ञान अकादमी, कालिकट के सहयोग से सितंबर 20 से 23 तक आयोजित किया। इस सम्मेलन का उद्घाटन तमिलनाडु कृषि विश्वविद्यालय के उपकुलपति प्रोफ. एस कन्नैयन द्वारा हुआ। लगभग 250 प्रतिनिधियों ने भाग लिय।

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