25 YEARS OF SPICES RESEARCH
1975 - 2000
SILVER JUBILEE YEAR
2000 - 2001

ICAR

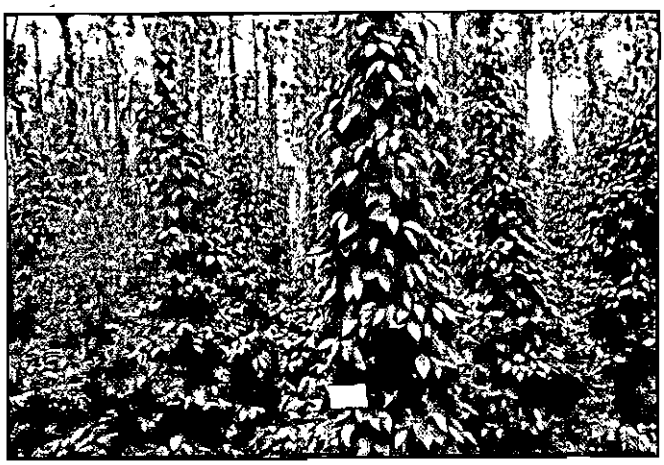
INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

Calicut, Kerala

New hybrid in black pepper with compact long spikes

Coll. 1041 at Valparai amidst infected vines.



Black pepper garden treated with *Verticillium chlamydosporium*

RESEARCH HIGHLIGHTS

2000-2001

Indian Institute of Spices Research

(Indian Council of Agricultural Research)

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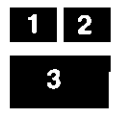
Front Cover Photo

1. Effect of root bacterization on the growth of black pepper
2. *Curcuma aromatica* rhizome
3. Nutmeg A9/4 - a very high yielding clonal selection



Back Cover

1. Black pepper grafted on *Piper colubrinum*
2. High yielding *Garcinia gummigutta* collection

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May 2001

DIRECTOR'S INTRODUCTION

The 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 Nation. We are celebrating 2000-2001 as the Silver Jubilee Year. During the last 25 years, the Institute has addressed several issues of the Spice farmer and contributed substantially to increase spices production through release of high yielding varieties, development of high production technologies and eco-friendly crop protection and efficient extension strategies. This was possible due to committed efforts of the scientists and staff members of this institute. As we are going ahead with several achievements, new challenges are *mounting in the crop front with the increasing competition at international level both in production and* marketing. It is also discouraging to note the fall in the exports from 2,36,142 tonnes to 2,33,000 tonnes during 2000-2001. Today the farmers of Plantation Crops and Spices are in great distress due to price slump on one side and due to free trade because of the inevitable WTO agreements which resulted in the import of several spices commodities, giving a challenge to the farming community. It is a reality and is imperative that spice farmer has to face this challenge with a resolute commitment and become internationally competitive through increased productivity and reduced cost of production! It is an onerous responsibility for the scientists to come to the rescue of the farmers by focussing on the removal of the production constraints to increase the productivity and thus creating confidence to farmers.

I am glad to inform all concerned that Indian Institute of Spices Research, during this period of report (2000-2001) addressed these issues and new technologies are emerging / emerged. This was possible through 43 institute projects and 23 externally aided projects funded by DBT, ICAR Cess Fund and NATP. Pepper Technology Mission sponsored by Govt. of Kerala, and DBT sponsored Network programme on "Improvement of selected spices (black pepper, cardamom, ginger and vanilla) through Biotechnological tools" are in progress. 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. In addition to the existing field tested P 24, *Phytophthora* tolerant black pepper line, the collection 1041 was found not only tolerant to *Phytophthora* but also well adopted to high ranges of Valparai (3000 ft. MSL). In addition, HP 1411 and an OP Karimunda were consistently high yielders (fresh 3.4-3.6 kg/vine) and are of great relevance. Aleppey finger turmeric with a yield of 34.7 t/ha and dry recovery of 20%, high yielding and high quality nutmeg line 9/4 and 'Papriking', a paprika type with '0' pungency and high colour are some of the varieties developed, which need popularization.

Since IPR is a major issue, molecular characterisation of germplasm is being taken on a priority.

DRIS (Diagnosis Recommendation Integration System) have been worked out for cardamom and should be utilised for yield targeting. Decomposed coirpith enriched with DAP was found to be an excellent substitute for FYM. Production and distribution of planting materials of black pepper, cardamom, ginger, turmeric and tree spices were continued.

Some of the drought tolerant lines of black pepper viz., HP 976, HP 1000, ACC 892, ACC 933 identified are of greater significance, especially for future breeding programmes to develop high yielding drought tolerant black pepper.

High recovery of volatile oil and oleoresin in 'Bhaise' and 'Gurubathani' varieties of ginger at high ranges of Sikkim and their low levels for the same in Kerala clearly indicated that the quality is again location

specific. Efficient dryers have been developed for nutmeg mace and *Piper chaba* which need popularization.

The biotic stress is the major production constraint in the spice crops. New viral problems in black pepper and cardamom are becoming serious. The ecofriendly crop protection technologies IPM/IDM with a greater stress on biocontrol is the major focus. Identification of PGPRs particularly strains with dual mode of action viz., growth promotion and disease suppression and efficient *Trichoderma* strains which were found suppressive to *Phytophthora* and plant parasitic nematodes are the major findings. A repository of biocontrol agents with a collection of 284 isolates is being maintained. 'Rhizome solarisation' a novel technique for disinfection of ginger seed rhizome was found promising for production of disease free materials. Three accessions of turmeric were found resistant to root knot nematodes and need field evaluation in hot spot areas of the disease. The compatibility of potassium phosphonate with chlorpyriphos and phorate is an important finding for IPM/IDM in black pepper. Soil application of *Verticillium chlamydosporium* reduced root knot damage and improved the health of the vines in a farmer's field in Wynad.

Under the National Network Project on *Phytophthora* Diseases of Horticultural Crops (PHYTONET), about 420 *Phytophthora* isolates are maintained in National Repository of *Phytophthora* (NARPh). Characterisation of *Phytophthora* isolates from black pepper and betelvine is in progress. Volatiles of *Trichoderma* spp. reduced the virulance of *Phytophthora* in black pepper. The PHYTONET programme is in operation at 9 centres throughout the country catering to the needs of several horticultural crops to standardise disease management.

Training programmes on spices production technology continued to be the major focus of this Institute. Besides, Krishi Vigyan Kendra (KVK) at Peruvannamuzhy is doing a commendable service to the farming community.

The Institute also started a Counsultancy Processing Cell to cater the needs of plantation community. *Trichoderma* technology has been transferred to 10 entrepreneurs in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh.

All India Coordinated Research Project on Spices with its headquarters at IISR, Calicut caters to the needs of 20 centres distributed in 16 states.

Team work, multidisciplinary approach and collaboration are the major tenets of IISR's research strategies. The Institute has initiated / developed collaborative programmes with Kerala Agricultural University, Rajeev Gandhi Centre for Biotechnology, Tamil Nadu Agricultural University, Bharatiar University, NBPGR, NRC for DNA Finger Printing and RRL, Jammu.

I place on record the bountiful support given by Dr. R.S.Paroda, Director General and Secretary DARE, Dr. S.P.Ghosh, former DDG (Hort) and Dr. R.N.Pal, DDG (Hort.) and also the Research Advisory Committee headed by Prof. V.L.Chopra, National Professor. We are concious that there is a long way to go and we are on the right track with an excellent team of Scientists & Staff. I am glad to present the Research Highlights of Indian Institute of Spices Research for the year 2000-2001.

Calicut
May 2001

Y. R. Sarma
Director.

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 genebank. 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 continued to maintain their yield superiority at Valparai, a high altitude region (3000 ft 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* root stock

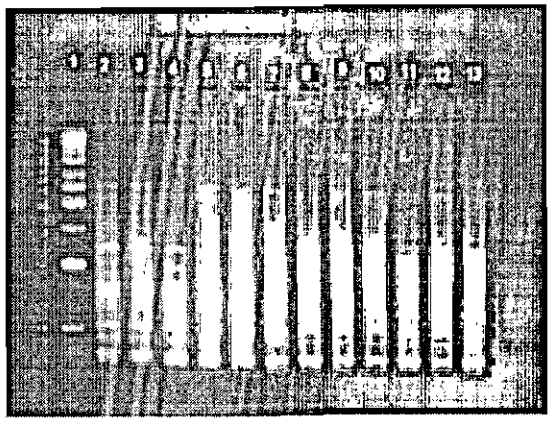
- Alleppey Finger Turmeric (AFT) selection 585 recorded highest yield of fresh rhizome at Peruvannamuzhi. Its mean yield is 34.7 t/ha with a dry recovery of 20%.

- 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)



RAPD profiles of micropropagated ginger indicating genetic variability.

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 are relatively tolerant.

QUALITY EVALUATION

- Quality evaluation studies of black pepper showed that HP1411, 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 Sikkimcompared 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.

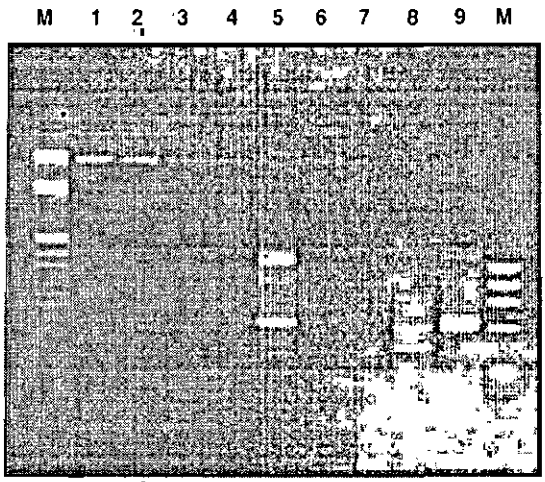
PLANT PATHOLOGY

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 standardized for purification of vein clearing virus causing 'Kokke Kandu'. EM studies are in progress for detailed morphology of virus particles.



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

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 — *No Amplification*
5 Sterile soil+Rs → *Note Amplification of ~650 bp soil DNA*
6 Sterile soil+Rs
7 Field soil
8 Rhizome rind
9 Genomic DNA from cultured *R. solanacearum*
→ *Note Amplification of ~590 & 650bp soil DNA*
M Phi X 174 Hae III Marker

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 *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* isolate, isolated from pineapple roots has been tentatively identified as *P.cinnamomi*.

Morphological characterization of 52 black pepper isolates of *Phytopthora* indicated two *P. palmivora*, two *P. parasitica* and two other atypical 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 to 10 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 and its combination with *T. harzianum* P26 recorded maximum growth of plants, which showed 180% increase over the control.

Different inoculum concentrations of *T. aureoviride* 25 were applied to soil to study their effect on the control of *P. capsici*. Concentrations ranged from 62 X 10^1-62 X 10^{10} spores/g of soil and 5 X 10^1 –5 X 10^5 mycelia/g of soil. After two months, the population has come down from 10^{10} to 10^5 in the case of spores and 10^5 to 10^4 in the case of mycelia. At the same time there was slight increase from 10^1 to 10^3 in the case of spores and 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 greenhouse 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 fortnightly 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-deductible 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* biossay. 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 populations 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 ethylmethyl 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 program was conducted for farmers from Kerala, Karnataka, Tamil Nadu and Maharashtra
- Awareness program on 'Spices 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

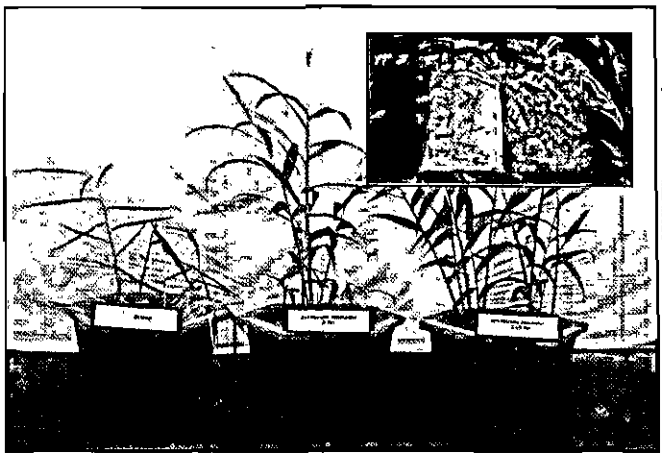
The AICRPS centres strengthened the Genetic Resources in all the mandatory spices. Under the evaluation/screening programme, disease tolerant lines have been short listed/ identified in ginger, turmeric and seed spices. Package of practices for ginger and turmeric for the high elevation regions of Eastern 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 standarised. 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)

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.

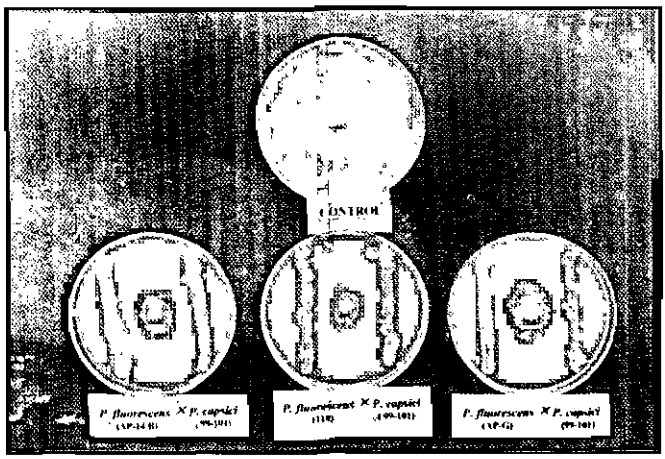
The package of technology for the management of *Phytophthora* foot rot disease in black pepper as well as nematode disease using integrated methods was developed by Sirsi (Karnataka) and Panniyur (Kerala) centres. Control measures for nursery diseases in black pepper (Panniyur), cardamom nursery leaf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

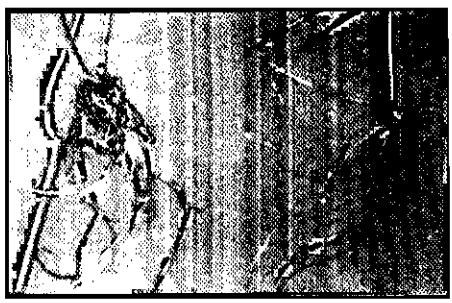


Rhizome solarisation - practical disinfection technology for management of bacterial wilt in ginger. Inset : Rhizome exposed for two hours of sunlight and rhizome unexposed.



In-vitro screening of flourescent pseudomonads for antagonistic potential against *P. capsici.*

Effect of root bacterization with flourescent pseudomonads on the root proliferation of black pepper cuttings.



Suppression of root rot of black pepper by fluorescent pseudomonads.
Left - treated Right - Untreated

RESEARCH HIGHLIGHTS 2000-01

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