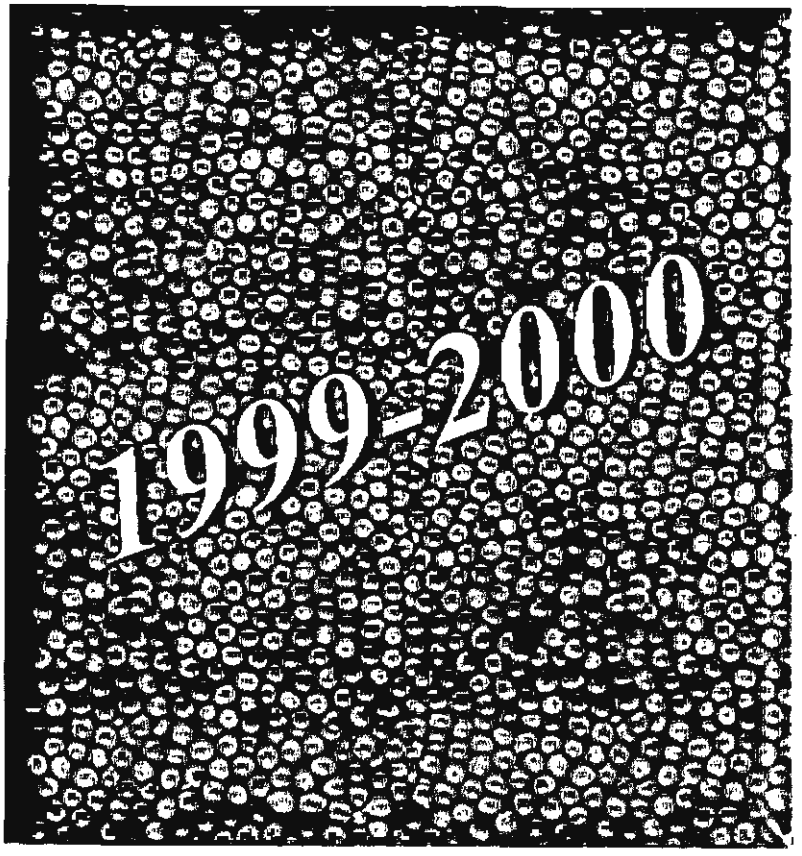
RESEARCH HIGHLIGHTS



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ICAR

INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

Calicut, Kerala, India

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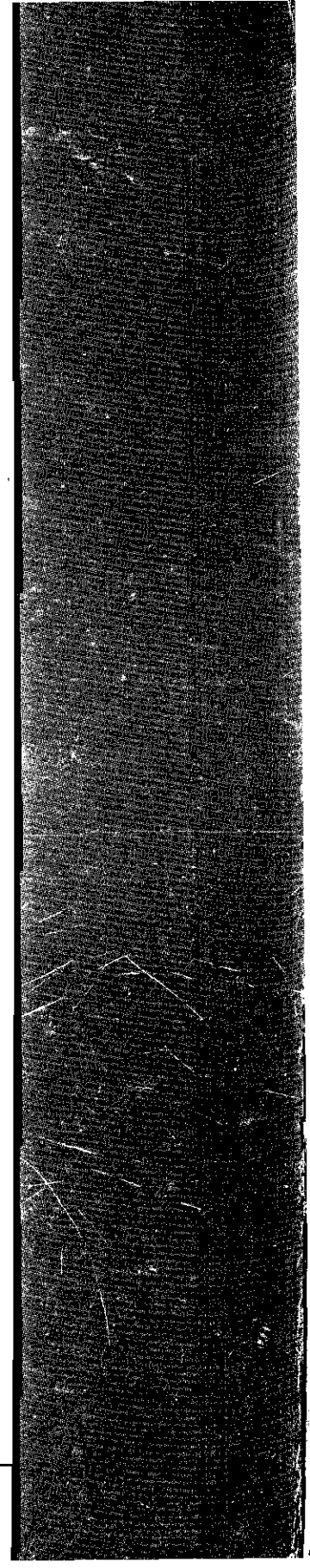

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Director's Introduction

We are now in a new century, a new millennium. As we look back we see the unbroken saga of Indian Spices from 3000 years back to the present, creating sensational history the world over, influencing the course of human civilisation. In search of Indian pepper and cardamom came the explorers who not only took our spices but also subjugated this land for centuries. In spite of all socio-political upheavals that shook the world, the saga of Indian spices remained unchanged and may remain so in the future also.

As we start the new century, the Indian Institute of Spices Research is also entering a new phase of its career as this Institution is completing 25 years of its existence this year. It had a modest beginning as a Regional Station of CPCRI, Kasaragod, but soon became a NRC and later a full-fledged Institute. This rapid development is indicative of the importance of spices not only to this country but also to the world at large. The scientists of this Institute now have a greater responsibility. The spices production in the country is at cross roads. In spite of various efforts, we are unable to contain the problems facing black pepper, cardamom and ginger cultivation. Conventional research techniques have failed in these areas. What now?

The world is at the cutting edge of a Bio-technological revolution and application of such techniques may be the answer to the above maladies. For this we need to achieve a lot of sophistication in research and great expertise. Unfortunately, most scientists educated in the conventional system existing in our universities, are not fully geared to face the challenges that the modern Biotechnology poses. We need a lot of investment in this area but unless we do that we stand to lose and will be relegated to the back and that would be disadvantageous for our farming community and for our nation at large.

At the Indian Institute of Spices Research, we have tried to approach some of the major problems facing spices production and productivity in a holistic manner. Germplasm collection, conservation and documentation are occupying a priority position among the research programmes of this Institute. In spite of having the largest germplasm collection in the world in the case of black pepper, ginger and turmeric, the achievements are not so encouraging when we come to areas like molecular characterisation. However, this has been identified as a top priority item and efforts are being made in genetic finger printing of spices germplasm. Development of high production technology in cardamom and black pepper have helped in pushing up the average productivity of our farmers considerably. However, the adoption level of such technologies are still low and vigorous extension campaigns are needed in this area. The gap existing in the production between the national level and highest achievable is so wide (300kg and 10,000 Kg in the case of

black pepper, 149 kg and 5000 kg in the case of cardamom). The filling up of this gap requires tremendous effort on the part of the Scientists and extension workers. On the whole, it is not the technology that is lacking but it is the lack of adoption of the technology at the farmers' level.

Biotic constraints are among the major factors adversely affecting productivity and production. Conventional approach together with biocontrol agents are in a position to keep the diseases under reasonable control but the global market is clamouring for the so-called "organic spices", untainted by the application of agrochemicals of any sort. In spite of our achievements we still have to go a long way to reach this goal, as it becomes extremely difficult for any farmer to save his crop without the application of fungicides or pesticides. Integrated pest management and Integrated nutrient management have to be adopted on a large scale but even in this area our understanding is not sufficient.

This is a time to critically analyse what we have achieved so far, where are we standing, what are our priorities and what is that we want to achieve after ten years or twenty years from now. Clear targets and programmes to achieve those targets have to be devised in all the major problem areas. Problem areas have to be pin pointed and for tackling such areas, core groups of young, energetic, visionary Scientists drawn from multi disciplinary areas, who are willing to work with total commitment are needed. The age of miracles is over. This is the age of committed, devoted hard work. Only then can we reach the targets for saving the spices cultivation in the country and the spices exports for which India was so famous.

The research highlights contained in this publication give a glimpse of what we have done last year, and between the lines, what we could not do. I present this publication before the readers mainly to get the feedback, so vital to an agricultural Scientist, from the farming community and from the extension workers to know where we have faltered and to realise our short comings, so that the future programmes can be organised on a much better footing. Scientists are not working in isolation, they need the support of the farming community, the extension workers, the traders, processors and exporters. Success shall come out of unity, united we move, united we shall succeed.

P. N. Ravindran
Director

NEW GERMPLASM

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

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

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

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

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

CROP IMPROVEMENT AND MAINTENANCE

♦ Black pepper hybrids HP 105 maintained superiority in yield at Valparai (6.025 kg/vine) followed by HP 728 (5.67 kg/vine) in the fifth year of yielding. Coll. 1041 continued to show tolerance to *Phytophthora* foot rot and yellowing with a mean yield of 4.7 kg/vine. HP 1411 (Aimpiriyan x Panniyur-1) and an open pollinated line of Karimunda (OPKM) also performed excellent at Peruvannamuzhi.

♦ Bold rhizome selections of ginger viz., Acc.35 and 117 were evaluated in farmers' plot along with Varada. A multiplication ratio of 1:20 was obtained in these varieties at farmers' plot as against 1:18 of Varada. Acc.35 had a dry recovery of 21% and Acc.117 - 19%.

♦ Alleppey Finger Turmeric (AFT) Acc. 584 and 585 recorded 24.5 and 30.3 t/ha (fresh rhizome yield) respectively with a driage of 17 and 16 per cent. They had more than 6% curcumin.

♦ Paprika types consisting of 64 exotic and 77 indigenous (Bydagi Dabba) collections were field tested. Exotic collections were more prone to bacterial wilt (59.2%) compared to indigenous material (39.9%). Though Bydagi Dabba types were pungent, colour values were higher (131-349 ASTA units) compared to exotic types (34-246 ASTA) indicating possibility of getting high colour lines from Bydagi Dabba which is more adapted to local conditions.

♦ In the trial in cardamom to evaluate

hybrids of crosses between mosaic resistant lines and high yielding pre-released selection, CCS-1 x NKE-12 and NKE-19 x NKE-27 cross combination recorded maximum heterosis for plant height and number of tillers.

♦ Survival of black pepper graft on *P. colubrinum* stock after three years of planting indicated double root stock method as the best (88.9%) followed by tongue and saddle grafting (61.1%). Colubrinum root stock has been found to be susceptible to mealy bugs that affects the collar region and root system resulting in death of grafts.

♦ A 9/4 in nutmeg and A_2, C, D and D_3 in Cassia are the promising lines in tree spices.

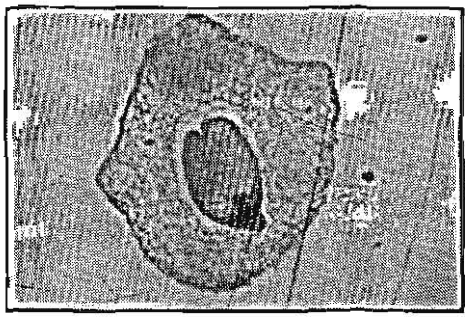
♦ *Myristica beddomeii* and *M. malabarica* were found to be compatible root stocks for approach grafting of *M. fragrans*, the cultivated nutmeg. Grafting of clove on *Syzigium heynianum* root stock is successful.

CYTOGENETICS & EMBRYOLOGY

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

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

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



Embryo of black pepper with endosperm, at the time of seed shedding.

Biotechnology

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

Nucleus Planting Material

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

Drought Tolerance In Black Pepper

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

NUTRITION AND MANAGEMENT

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

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

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

QUALITY EVALUATION

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

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

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

PLANT PATHOLOGY

Disease etiology and pa characterisation

A simple biovar characterisation techni microtiter plate and small quantity of re standardised for rapid identification c *Ralstonia solanacearum* was also isol tomato, potato, chilli, *Eupatorium* and in order to know their role in the epi bacterial wilt of ginger in India. Differen the isolates in colony character, carb utilisation pattern, pathogenic p antibiotic resistance etc. could b Characterisation based on m protein pattern revealed the presence Kda protein in all the isolates of *R solanacearum*. This protein may be u species specific antigen for producing a for developing an immuno-kit.

Serological detection of *Ra solanacearum*

♦ Dot-Immuno-binding Ass (NCMELISA) developed at Internation Centre (CIP, Lima, Peru) was evaluated the adaptability of the kit for ginger. T indicates that the kit is suitable for det bacterium in ginger sample.

♦ *P. colubrinum* with multiple resistance for *Phytophthora capsici, Radopholus similis* and *M. incognita* was found susceptible to CMV. This was based on graft transmission and subsequently checked by ELISA.

♦ A severe incidence of leaf rot and wilt in vanilla was noticed in the IISR farm, Peruvannamuzhi. *Fusarium* sp. was found to cause both leaf rot and wilt. *Fusarium* sp. was also isolated from Vanilla from Valparai. A new fungicide formulation of carbendazim and mancozeb marketed under the trade name 'Saff' was tested both *in vitro* and *in vivo* and was found effective in inhibiting the growth of *Fusarium* at 100 ppm.

Screening germplasm for reaction to diseases

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

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

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

Biological control

Biocontrol of bacterial wilt of ginger: Eight bacteria isolated from ginger field and rhizosphere soil were evaluated for antagonistic effect on *Ralstonia* in green house. None of the bacteria evaluated could protect the plants from wilting. However, a few of the isolates could increase the yield of ginger under pot culture experiment.

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

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

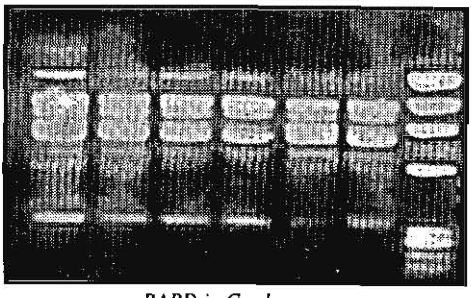
Disease Management

The activity of potassium phosphonate against *P. capsici* in black pepper at the recommended dose of 3 ml/l declines after 4 days. Studies with higher concentrations of

potassium phosphonate (4 ml/l to 10 ml/l) were tried. The treatments, 6-10 ml could give greater protection upto 30 days after drenching. At these concentrations, no phytotoxicity was noticed. In a pot culture experiment with biocontrol agents alone and in combination with potassium phosphonate on root rot showed least mortality in treatment with a combination of *Verticillium tenerum* and potassium phosphonate (11.1%) followed by *Trichoderma virens* and *T. harzianum* in combination with potassium phosphonate (16.6%) compared to 83.3% in control.

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

In Integrated Disease Management plot, the mortality was least in P-24 (1/40) followed by Panniyur-4 (4/40).



RAPD in Cardamom

Mechanism of resistance in disease resistant lines

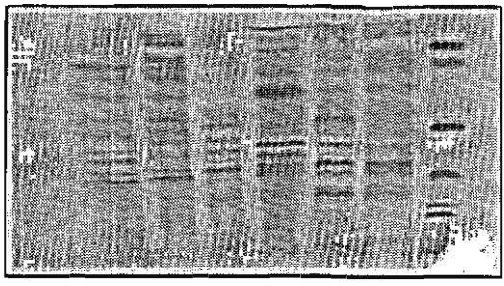
In order to analyse RAPD profiles of disease resistant cardamom lines, 20 operon random primers were tried. Two of them OPA 08, OPA 12 gave good amplification. The annealing temperature for cardamom was standardised as 40°C. In rhizome rot resistant cardamom RR1, a distinct band was seen in rhizome rot resistant RR1 compared to the susceptible check

PHYTONET

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

long pedicels (20-246 µm) and umbellate ontogeny.

Induction of pathogenesis related proteins (PR-protiens) were reported in black pepper on inoculation with *P. capsici*. Occurrence of chitinases and β-1,3 glucanases in the



Induction of PR-proteins in black pepper

Phytophthora tolerant black pepper line, P 24 have been recognised using anti-rabbit antibodies. The 30 and 35 kDa proteins recognised as β-1,3 glucanase and chitinase isoforms respectively were electroeluted and these eluted proteins showed antifungal activity.

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

Trichoderma virens isolates were screened *in vivo* for growth promotion of black pepper and suppression of *Phytophthora*. Isolate GV5 favoured maximum plant growth. Organic amendments such as coir pith, FYM, neem cake and leaf litter of *Glyricidia* supported the survival of *T. harzianum* in soil. There was clear increase in the number of colony forming units of *T. harzianum* when there was higher amount of these organic matter. Coir pith, Coir Compost and lignite were studied as carrier media for liquid fermentation products. All the three media recorded high colony forming units even after 60 days of mixing when used in the sterile condition. Twenty five isolates of *Trichoderma* spp., 23 isolates of bacteria and 16 other fungal antagonists were isolated from the rhizosphere of the black pepper. Biocontrol agent, *T. harzianum* was found to be compatible with phorate and chlorpyriphos at the recommended doses. A technique has been standardised for the isolation of protoplasts from *Trichoderma harzianum* using driselase, hemicellulase and cellulase (Onuzuka).

ENTOMOLOGY

♦ **Identification and characterisation of host resistance**

The black pepper accessions, wild *Piper* species and interspecific hybrids identified to be resistant to *Pollu* beetle were characterised for their biochemical constituents. The levels of free amino acids and surface wax were significantly

higher in the resistant lines when compared to the susceptible check.

♦ **Evaluation of natural products**

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

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

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

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

Surveys were conducted at 8 locations in Wynad district, Kerala to study the distribution of root mealy bugs (*Planococcus sp.*) on black pepper. The pest infestation was observed in 6 locations where 6.7 to 42.2% of the vines were infested with root mealy bugs. Thirty three percent of the vines infested with root mealy bugs were also affected with *Phytophthora* foot rot disease. Infestation by mealy bugs caused yellowing and wilting of leaves, defoliation and mortality of vines. However, most of these vines were also affected by *P. capsici* and nematodes.

♦ **Biological control of mealy bugs**

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

♦ **Management of Rhizome scale**

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

obtaining a higher recovery of rhizomes, higher number of sprouts and lesser incidence of rhizome scale.

♦ **Management of shoot borer**

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

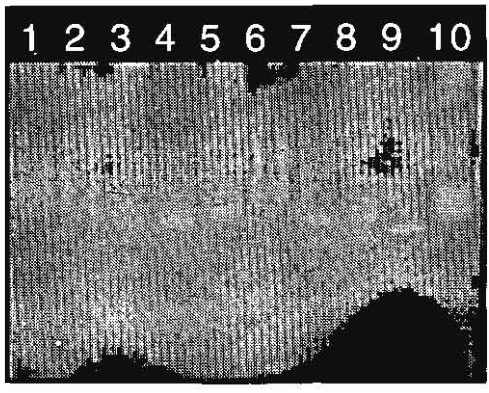
NEMATOLOGY

♦ **Host resistance**

Evaluation under simulated field conditions confirmed the resistance of four turmeric (Acc. 84, 142, 182 and 198) and two ginger (Acc. 36 and 59) germplasm accessions to root-knot nematodes. In the second round of screening, another four turmeric (Acc.31, 82, 178 and 200) and one ginger (Acc. 221) accessions were resistant to *Meloidogyne incognita*.

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

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



Induction of catalase isozyme bands in roots of 'Pournami', a nematode tolerant black pepper line on inoculation with M. incognita.
(1-5: Panniyur, 6-10 Pornami uninoculated, inoculated after 24 h,48 h, 72 h and 1 week.)

♦ **Nematode diversity**

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

♦ **Biological control**

Egg parasitic fungal isolates of *Verticillium* spp., *Paecilomyces lilacinus*, *Trichoderma* spp., *Fusarium* spp., *Aspergillus* spp., and the obligate bacterial hyper parasite *Pasteuria* spp., were identified through *in vitro* bioassays. In greenhouse studies, *V. chlamydosporium* partly suppressed *R. similis* population in black pepper rooted cuttings. A new field trial has been laid out in a farmer's nematode infested black pepper garden in Wyanad for evaluating promising biocontrol agents.

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

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

SOCIAL SCIENCE

♦ **Training programmes**

Training programmes were conducted on 'Spices Production Technology', 'Nursery Management' and 'On-farm Processing of Spices'. About 53 officers from seven states attended the training programmes. On request training to over 50 farmers from North-East and other States sponsored by Spices Board was also arranged.

♦ **Economics of spices production and marketing**

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

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

An ex-post evaluation of the central government sponsored programme on Integrated measures against *Phytophthora* foot rot disease of black pepper in Kerala was done.

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

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

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

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

The survey indicated reduction in loss of vine mortality from 7.41% to 3.7%.

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

KRISHI VIGYAN KENDRA

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

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

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

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

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES

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

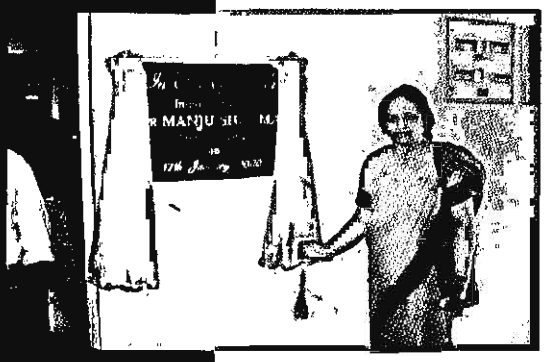
A fertilizer level of 150:60:210 g of NPK/vine with irrigation at IW/CPE ratio of 0.33 is recommended for economic yield in black pepper in Karnataka.

Sowing cumin during 15th October reduced the cumin wilt while in coriander November 4th sowing gave best yield.

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

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

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

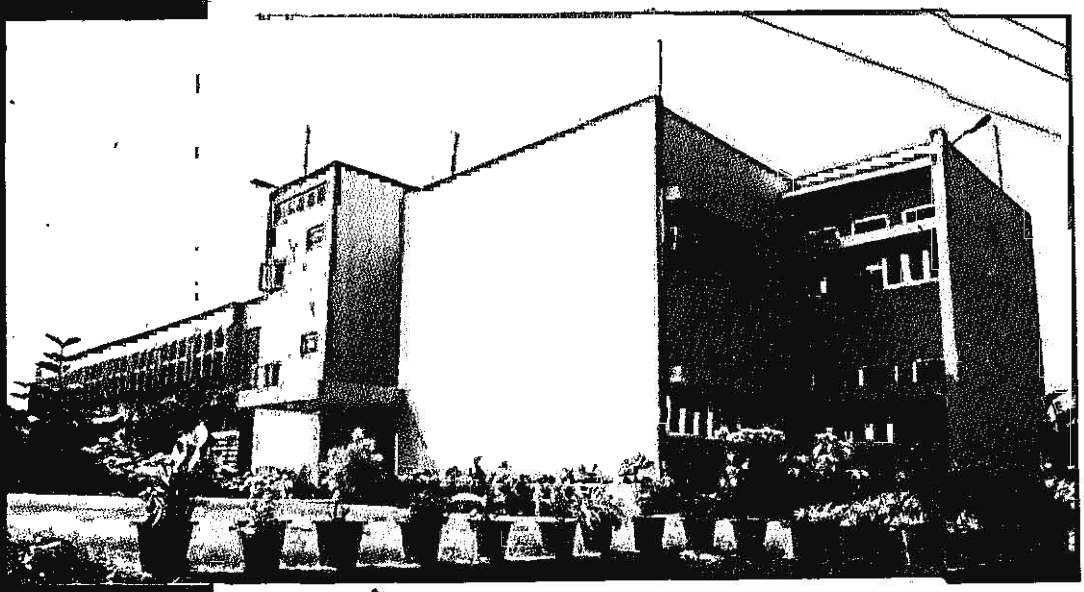


Inauguration of in vitro Gene Bank by Dr. Manju Sharma, Secretary, DBT

Black Pepper Hybrid: Panniyur-1 x Karimunda

A bisexual wild *P. nigrum* from Munnar

Root knot nematode egg parasitized by a local isolate of *Paecilomyces lilacinus*



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