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All India Coordinated Research Project on Spices

ANNUAL REPORT 1994-'95

(April 1, 1994 to March 31, 1995)

INDIAN INSTITUTE OF SPICES RESEARCH
(Indian Council of Agricultural Research)
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C O N T E N T S

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About this report .....

May I place before you the Annual Report of the All India Coordinated Research Project on Spices (AICRPS) for the period April 1, 1994 to March 31, 1995. This forms the Tenth independent Annual Report of the SPICES PROJECT and covers research activities of 67 projects conducted by 41 Scientists based in 16 centres located in 11 States of India. This report has special significance as it contains the detailed report on the ongoing research projects that has been continued as approved during the VIII Plan besides experiments that were added as per decisions taken during the XII Workshop (July 26-28, 1993) held at Trichur, Kerala. The present report includes the list of germplasm holdings. Cost effective strategy to manage Phytophthora foot rot in black pepper, intercropping in turmeric, weed control in coriander, quality analysis in fennel and cumin etc. Intensification of research on biocontrol in the management of diseases and pests of spices, research publications, meteorological data from the Coordinating Centres, budget, staffing pattern, etc. are also furnished.

The Coordinating Centres located at the State Agricultural Universities have taken up the assigned technical programmes seriously and provided their Reports which helped in compilation of this document. The Associate Directors, Professors and Head of Offices as well as the scientific and other staff in all the Centres deserve our appreciation for providing the necessary data which enabled us in compiling this report in time. We place on record the help and support received from the Director and staff of IISR who have rendered assistance in the functioning of the Coordinated Project. I acknowledge the services of Dr. A.K. Johny, Technical Information Officer and Mrs. P.V. Sali, Stenographer, PC's Cell in bringing out this Report in time.

(Dr.S.EDISON)
PROJECT COORDINATOR

Calicut
July 1995

SUMMARY

The AICRP on Spices was initiated in 1971 with the objectives of evolving varieties resistant/tolerant to pests and diseases, standardisation of agro-techniques suited to different agro-climatic regions of India, evolving control measures to manage pests and diseases with minimum residual toxicity and developing linkages between different agencies working on Spices Research & Development. The 12 mandatory spice crops of the Project are Black Pepper, Small and Large Cardamom, Ginger, Turmeric, Nutmeg, Clove, Cinnamon, Coriander, Cumin, Fenugreek and Fennel. Research achievements generated from 67 research projects during 1994-95 in spices improvement, production, protection and quality aspects conducted at 16 Coordinating centres based at 11 Agricultural Universities and one ICAR Research Complex in 11 States of India (by 41 Scientists) are highlighted.

The important features have been induction of two new centres - Dholi in Bihar and Hisar in Haryana. Efforts have been made to initiate new Centres in West Bengal, Uttar Pradesh, Madhya Pradesh and Maharastra states. The last AICRPS Workshop was held at Trichur during July 26-28, 1993 which critically evaluated research results of projects and formulated new programmes. The Quinquennial Review Team on the AICRP on Spices has reviewed the Project work and made recommendations.

Some of the highlights are collection of wild pepper germplasm from Shevroy Hills, identification of Co-17 for high yield in ginger, laying out of MLTs in clove and cinnamon in 4 Centres, efficacy of bio-control agents in Phytophthora foot rot disease in Black Pepper, soil application of Trichoderma in controlling rhizome rot of ginger, use of onion leaf extract to control powdery mildew in coriander etc. intercropping with Bhendi with Turmeric at Dholi and Soybean (after first mulching) at Pottangi have been found profitable. Variety releases being a regular activity, about 10-15 proposals which came up during 1994-95 will be discussed in the next Spices Workshop. The Centres also took up the work on production and distribution of planting materials very seriously and the impact is acknowledged by the clientele viz., the progressive farmers who are our apostles of extension.

(Dr.S.EDISON)
PROJECT COORDINATOR

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INTRODUCTION

The All India Coordinated Research Project on Spices was the first-ever attempt made by the Indian Council of Agricultural Research to initiate organised research set up on Spices. It started as a combined Project on Spices and Cashewnut in 1971 with the headquarters at the Central Plantation Crops Research Institute, Kasaragod. Although the research support was forthcoming through the Coordinated efforts between the various State Agricultural Universities, the ICAR decided to bifurcate the combined Project into two independent Projects viz., on Spices and on Cashewnut in 1986. Accordingly, the headquarters of the Spices Project is located at the National Research Centre for Spices, Calicut. This National Research Centre has however been upgraded as Indian Institute of Spices Research since July 1995.

The AICRP on Spices which was initiated in 1971 (IV Plan) had, to begin with, four Coordinating Centres with just four crops (Black Pepper, Cardamom, Ginger & Turmeric) and this was expanded to 16 Centres and to cover 12 Spices over the subsequent Plan periods, viz., V, VI, VII & VIII Plans. Now the Project has Centres operated in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Sikkim, Gujarat, Maharashtra, Haryana and Himachal Pradesh. These 16 Centres are located in the respective State Agricultural Universities PLUS an ICAR Institute. However, the latest addition has been the approval by the Govt. of India to initiate Coordinated research on Spices in four more Centres during the VIII Plan period itself and these will be located in the States of West Bengal, Uttar Pradesh, Maharashtra & Madhya Pradesh. The new Centres come into operation from April 1, 1995 and the overall strength of 20 Centres would cover a wide range of Spices viz., Black Pepper, Small Cardamom, Large Cardamom, Ginger, Turmeric, Cumin, Coriander, Fennel, Fenugreek, Clove, Nutmeg & Cinnamon.

Mandate

The objectives of the Coordinated Project are :

* evolving high yielding varieties resistant/tolerant to diseases and pests;

* standardisation of agro-techniques for the crops under different agro-climatic conditions;
* evolving control measures for major pests and diseases; and
* working as inter-face and feed-back between SAUs, Indian Institute of Spices Research and the ICAR

History and activities

The first Workshop of the AICRPS was held at CPCRI, Kasaragod in Dec. 1971 wherein the research problems to be tackled under AICRPS were identified and technical programmes drawn and implemented. Since then the performance of various research programmes under the Project was reviewed at the Annual/Biennial Workshops held during the years 1972, '75, '78, '81, '83, '85, '87, '88, '89, '91 and '93. The working of AICRPS for ten years (1982-92) was reviewed by the Quinquennial Review Team and the report submitted to ICAR. The ICAR after accepting the Report of the QRT has already initiated necessary action on the various recommendations made.

Dr. M.C. Nambiar was the first Project Coordinator of the combined Project on Spices and Cashewnut from its inception in 1971 till his retirement in April 1985. Dr. M.K. Nair, Director, CPCRI, Kasaragod held additional charge as Project Coordinator during 1985-86. Dr. S. Edison took over as Project Coordinator during March 1986 and is continuing in the same capacity till date but for a break for two years while he was on deputation to the FAO of the United Nations and posted as Spices Research Expert in Bangladesh. During the interregnum (Jan.92 to Jan.95), Dr.A.K.Sadanandan was functioning as In-charge Project Coordinator.

We place on record the dynamism and great vision rendered by Dr.K.V.Ahmed Bavappa, the then Director of CPCRI, Kasaragod who has helped in many ways in providing the necessary host Institute facilities to initiate the AICRP System on Spices. The guidance and support received from Dr. M.K. Nair, Director, CPCRI in the activities of the Spices Project is gratefully acknowledged. The help and assistance rendered by Dr.K.V. Peter, Director, Indian Institute of Spices Research and our colleagues at the Institute in the smooth running of the Project during the period under report is also acknowledged.

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PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project (AICRP) on Spices is vested with the mandate to carry out scientific research to develop location specific technology to augment spices productivity in the country. Problem oriented research has been envisaged in black pepper, small and large cardamom, ginger and turmeric, tree spices (clove, nutmeg and cinnamon) and seed spices (coriander, cumin, fennel and fenugreek). Scientific research of these 12 Spice crops are carried out in 16 Centres of AICRPS based in eleven Agricultural Universities and one ICAR centre at Gangtok. The research programmes are carried out under four broad heads, Genetic Resources, Crop Improvement, Crop Production including Quality and Crop Protection. The Project Coordinator is based at the Indian Institute of Spices Research, Calicut.

History

The AICRP on Spices was formulated during IV Five Year Plan (1971) as a combined AICRP on Spices and Cashewnut. The first combined Workshop was held at Kasaragod in 1971 and research programmes initiated in four spice crops (black pepper, cardamom, ginger and turmeric) at four centres (Panniyur, Pampadumpara, Mudigere and Solan). During V Plan, research on seed spices was initiated and intensified work on ginger by adding five more centres (Jobner, Jagudan, Guntur, Coimbatore and Pottangi). During VI Plan, four new centres were added (Sirsi, Vellanikkara, Chintapalli and Yercaud) to further intensify work on black pepper, ginger and turmeric. During VII Plan, two more centres were added (Gangtok and Jagtial) one for turmeric and the other for large cardamom in Gangtok. During VIII Plan, two new centres one at Hisar (Haryana) and another at Dholi (Bihar) were added to intensify work on seed spices and turmeric thus making the total to 16 Research Centres which are based in 11 Agricultural Universities and the Gangtok centre under ICAR Research Complex, in 11 States of India.

As a result of the recommendations of a Parliamentary Committee on Spices, four more new Centres have been added to the Coordinated network during 1995-96 and this will be located in the States of West Bengal, Uttar Pradesh, Maharashtra and Madhya Pradesh.

The Spices Workshops were held at Goa (1978), Trichur (1981), Calicut (1983), Trivandrum (1985), Guntur (1987), Salem (1988), Coimbatore (1989), Trivandrum (1991) and Tirupur (1993). The Workshops reviewed the progress of research and depending upon the needs of the country and enabled formulation of new technical programmes.

Staff and budget

The staff strength of AICRP on Spices consists of 53 Scientists supported by technical (21) and auxiliary (3) making the total 65 staff. The annual budget was increased from Rs.15.6 lakhs in 1985-86 to Rs.61.00 lakhs in 1994-95.

Research activities

The AICRP on Spices is vested with a mandate to develop location specific agrotechniques for sustainable spices production. A multidisciplinary approach is envisaged and research projects formulated to tackle pests and diseases. There are 6 projects and discipline wise distribution are 31 in Crop Improvement (including Genetic resources), 11 in Crop Production, 5 in Quality improvement and 14 in Crop Protection. The crop wise distribution of projects are pepper 8, small cardamom 3, large cardamom 3, ginger 7, turmeric 5, tree spices 6, seed spices 24 (coriander 7, cumin 5, fennel 6 and fenugreek 5).

The salient achievements made during the year 1994-95 are enumerated below:

GENETIC RESOURCES :

The germplasm holdings including wild and exotic accessions maintained in the 16 Coordinating Centres as on March 31, 1995 are given elsewhere.

1.1 Black pepper : The Yercaud Centre collected 20 elite lines from Shevroys Hills. The Sirsi Centre undertook a survey of the Tarchelli forests, Honnavar & Karwar areas in search of germplasm; similarly the Chintapalli Centre took up the survey in Tirtede and Partapadu areas. The work on evaluation of germplasm has been initiated at the Yercaud Centre. At Panniyur, Karimunda-III gave a mean green berry yield of 2.17 kg/vine, followed by TMB-IV and

Balercotta-1. Panniyur-1 continued to perform as the best variety in the Chintapelli zone, giving the highest yield of 4.17 kg/vine. The Panniyur, Sirsi, Chintapelli and Yercaud Centres maintained 76, 58, 46 and 106 accessions respectively.

.2 Cardamom : Among the 72 accessions evaluated at Pampadumpare in IET, accession No.57 gave the highest yield of 507 g dry capsule/plant. Among the 195 accessions from Mudigere, CL-698 was found superior in sucker and panicle production. The Pampadumpare and Mudigere Centres maintained 89 and 243 accessions respectively.

1.3 Ginger : At Pottangi, the mutant V_3S_1-8 gave the highest yield of 3.075 kg fresh rhizomes/$3M^2$ plot. The Solan and Pottangi Centres maintained 132 and 138 germplasm accessions.

1.4 Turmeric : One more new accession has been added in Pottangi centre bringing the total to 191 which includes 20 wild and related species. Accession No.6 gave the highest yield of 8.53 kg/$3M^2$ at Pottangi. Among the 164 accessions at Solan Centre, ST-616, ST-154, ST-330, ST-323, TC-4, ST-55 and ST-491 are promising. From Jagtial, entries PTS-24, PTS-383 and PTS-1 were found promising; besides, 22 accessions showed resistant reaction to Taphrina disease. The Pottangi, Jagtial and Dholi Centres maintained 191, 188 and 38 accessions respectively.

1.5 Tree Spices : The Yercaud Centre added 13 elite lines to their collections of clove.

1.6 Coriander : The Jobner, Jaguder, Coimbatore, Guntur, Hisar & Dholi centres maintained 683, 146, 372, 230, 58 and 100 accessions respectively. The promising entries identified from different Centres were TG-400 from Jobner, LCC-25 from Guntur, DH-13 from Hisar and J.Co-45 & J.Co-126 from Coimbatore.

1.7 Cumin : The Jobner and Jaguder centres maintained 224 and 467 accessions. From the Jaguder centre, 131 accessions were selected based on genetic diversity for further studies. The Jobner Centre recorded the highest yield of 4.1 Q/ha from variety RZ-19. The entry JC-147 gave 7.68% higher oil content than the control.

1.8 Fennel : The Jobner, Jeguden, Hisar & Dholi centres maintained 139, 98, 44 and 56 accessions respectively. At Hisar, the accessions HF-71, HF-102, HF-104 and HF-119 gave better performance.

1.9 Fenugreek : The germplasm collections maintained at Jobner, Jeguden, Coimbatore, Guntur, Hisar and Dholi were 270, 47, 179, 70, 82 and 58 respectively. The promising germplasms identified were : UM-124 & UM-144 from Jobner, HM-110, HM-129, HM-141 and HM-145 from Hisar and JF-10 from Coimbatore. At Guntur, 70 selections showed diversity in their performance. At Coimbatore, accession No.464 was identified as a superior line, giving an yield of 380 kg/ha in the IET. In CYT at Coimbatore, accession CF-390 gave the highest yield of 433 g/plot.

2. CROP IMPROVEMENT

Based on the decisions taken during the XI & XII Workshops held at Trivandrum (1991) & Trichur (1993) respectively, several MLTs are in progress viz., five in Black pepper, two in Cardemom and turmeric and one each in clove and ginger. In seed spices, the decisions of the Workshop were reinforced by the recommendations made during the Group Meeting (exclusively for Seed Spices) held in Nov. 1992 (Coimbatore) and accordingly, a number of MLTs are in progress in all the 6 Centres; Coriander, Fennel and Cumin in Jobner, Jeguden & Hisar and Fenugreek in Jobner, Jeguden, Guntur, Coimbatore and Hisar. In the case of fenugreek, a second MLT (1993-Series II) has also been initiated at Guntur, Coimbatore, Jobner and Jeguden Centres.

2.1 Black Pepper : At Panniyur, in the intervarietal hybridisation trial, Cultures 5308, 4700, 5198 and 4563 performed well, producing more than 1 kg green berries/vine. In the MLT, Culture 1171 gave the highest yield of 1.14 kg green berries/vine. In the CYT, Karimunda and Panniyur-5 were promising.

2.2 Small Cardemom : The MLT III Series (1991) laid out with Mysore types and Malabar types during 1993, have come to bearing this year.

2.3 Ginger : In the CYT at Pottangi, V_1E_8-2 was the top yielder with 18 t/ha at Pottangi centre. At Solan, V_1E_8-2, SG-692, SG-671 and SG-702 have given the higher yield than control viz., SG-666. In the MLT-III at Pottangi, V_2S_1-7 gave the highest yield of 15.3 t/ha.

2.4 Turmeric : PTS-19 was the top yielder with an yield of 21.6 t/ha and 5% curcumin at Pottangi; among the 13 cultivars tested. In the CYT, however, PTS-19 gave an yield of 19.5 t/ha and topped the 6 entries tested. Accession No.PTS-43 was identified as the best (yield 25.31 t/ha) in the IET, followed by PTS-8 (23.23 t), PTS-59 (17.06 t) and PTS-15 (16.03 t). At Dholi, variety Sugandham gave the best yield of 38.79 t/ha in the IET. Cultivar Duggirala gave 17.83 kg/3M^2 at Jagtial, followed by TC-2 (16.76 kg) and check Armoor (12.56 kg).

2.5 Tree Spices : As a follow up of the Group Meeting on Tree Spices (May 15, 1992), the work has been initiated at Yercaud and Ambalavayal Centres in 1992-93 and later at Pechiparai and Thadiyankudisai. A MLT with 5 elite lines of clove has been laid out in Yercaud and Pechiparai. In Cinnamon, a MLT has been laid out with 5 promising lines at 4 Centres viz., Yercaud, Ambalavayal, Pechiparai and Thadiyankudisai. In vegetative propegation of Nutmeg, root stocks selected at 2 leaved stage gave the maximum percentage of success viz., 52.50%.

2.6 Coriander : In the IET at Coimbatore, out of the 11 entries under evaluation, CC-745 and CC-748 recorded higher yields of 583 kg/ha which is 20.7% higher than the check viz., Co-3. At Guntur, the highest yield of 1050 kg/ha was obtained from ATP-147 whereas at Dholi, accession DH-38 was found most promising. Among the leafy types, Pant Dhania-1 gave the highest leaf yield followed by RCr-41. Accessions JCo-123 and CC-964 gave 6.37% and 10.34% higher yields respectively than Guj.Coriander-2 at Jagudan Centre. At Coimbatore, JCo-64 gave an yield of 683 kg/ha compared to 583 kg/ha of Co-3, a 17.2% increase. The MLT at Guntur centre revealed that CC-964 gave the highest yield of 1078 kg/ha followed by ATP-77 giving 1025 kg/ha. In the evaluation of mutants at Coimbatore, the line 16/6 gave an yield of 550 kg/ha while Co-3 gave 517 kg/ha.

2.7 **Fennel :** At Jobner, accession UF-125 was identified as superior with high yield potential, earliness and dwarfness. The Hisar accessions HF-33 and HF-39 gave a maximum of 1.5% volatile oil as s well as high yields.

2.8 **Fenugreek :** CC-464 was found to be most promising with a yield of 380 kg/ha at Coimbatore. At Dholi and Hisar centres, HM-103 performed very well and gave maximum seed yield. At Jobner, the irradiated seeds which were put under an IET indicated that "40 Gy-3-4" gave 12.6 Q/ha and had less incidence of powdery mildew.

3. CROP PRODUCTION

3.1 **Black pepper :** At Panniyur Centre, the irrigation-cum-fertiliser trial with 2 varieties indicated that irrigation at IW/CPE ratio of 0.25 was found best for maximum yield. The rooted cuttings soaked in 1% Potassium Sulphate for 12 hours gave 66% establishment at Thadiyankudisai.

3.2 **Cardamom :** Spacing of 0.3 m x 0.9 m increased the sucker production to 1.25 l suckers/ha at Mudigere. The clonal material gave 37% more yield than seedlings material. Phosphobacteria applied @ 4g/kg of soil gave highest number (3.6) of branches and in combination with Azospirillum, recorded still higher number viz., 9.0, as reported from Thadiyankudisai.

3.3 **Tree Spices :** Hard wood cuttings of Cinnamon gave high percentage of rooting (82.6%) when dipped in NAA 2500 at Thadiyankudisai. There was increase in tree girth, mean fruit yield and fruit girth (size) in nutmeg by application of Azospirillum and Phosphobacteria.

3.4 **Ginger :** At Pottangi centre, an yield of 14.15 t/ha rhizomes was obtained at 125:100:100 kg NPK/ha. The profit was Rs.53,000/- per ha.

3.5 **Turmeric** : Intercropping bhendi with turmeric was profitable at Dholi centre; the ideal spacing for turmeric as monocrop being 30 cm between rows and 20 cm between plants. At Pottangi, soybean as intercrop after the first mulching has been recommended.

3.6 **Coriander** : Pendimethalin @ 1 kg/ha with one hand weeding gave a net profit of Rs.11250/ha in coriander, with a cost : benefit ratio of 2.93 at Jobner Centre. Guntur centre recommended CH-5 (from Haryana) for light soils in Andhra Pradesh.

3.7 **Fennel** : At Jobner, hand weeding done thrice in Fennel gave an yield of 1.02 t/ha and a net profit of Rs.15177/ha and a cost:benefit ratio of 3.35. In Hisar, application of Pendimethalin (1 kg/ha) followed by one hand weeding 45 DAS gave maximum seed yield.

3.8 **Fenugreek** : Preplanting application of Fluchloralin @ 0.75 kg/ha plus one handweeding gave maximum seed yield of 1.598 t/ha with a net profit of Rs.14,621/- and benefit : cost ratio of 2.33. At Dholi, variety Rajendra Kanti gave the highest yield when sown on 26 October and at 20 cm x 10 cm spacing; Hisar gave maximum yields when sown on 5 November.

4. CROP PROTECTION

4.1 **Black pepper** : At Panniyur, the Phytophthora foot rot incidence was low in plots receiving 1 kg neem cake + 3 g Phorate spraying + 1% Bordeaux mixture + drenching with 0.2% Copper Oxychloride. Sirsi had similar results. At Chintapalli, Akomir treatment gave better results, when followed to neem cake + Phorate + Bordeaux mixture; the treatments reduce disease incidence and defoliation. In biocontrol of this disease, Trichoderma harzianum inoculations reduced the disease incidence to 16%.

Nursery diseases at Panniyur are controlled by Bordeaux mixture with Neem cake @ 1 kg/vine. Stunted disease has been noticed in the Lower Pulneys Hills of Tamil Nadu. Defoliation due

to semilooper insect has been noticed in Chickmagalur district, Karnataka.

4.2 **Cardamom** : Selective threshing during Feb-March, combined with insecticidal application controlled borer infestation. Spraying Monocrotophos controlled thrips at Mudigere, when followed after threshing in February and May. Neem pesticides like Nemark, Nimbecidine are also useful in controlling the thrips. A fungal pathogen has been recorded to infect the grown up larvae of Conogethus punctiferalis, the capsule and shoot borer at Mudigere.

4.3 **Ginger** : Seed rhizomes dressing with Indofil M-45 + Bavistin recorded minimum disease incidence at Solan centre. Soil application with Trichoderma herzianum resulted in reducing the disease incidence.

4.4 **Turmeric** : PCT-10, PCT-13 and PCT-14 were free from rhizome rot disease in Jagtial Centre and gave 30 t seed rhizomes/ha.

4.5 **Large Cardamom** : Cultivar Golsey was found to be tolerant to both Chirkey and Foorkey diseases of large cardamom. Anthracnose has been controlled by spraying Dithane M-45 (0.2%), Kavach (0.1%) or Cuman L (0.2%).

4.6 **Cumin** : A three years' crop rotation with clusterbean-cumin-cluster bean-mustard gave the maximum yield of 257.59 kg/ha and wilt incidence of 36%, as compared to 96.27 kg/ha and 57% disease in one year rotetion.

4.7 **Coriander** : Seed treatment with Trichoderma herzianum @ 4g/kg of seed reduced wilt. Neemcake @ 150 kg/ha also reduced wilt in Coimbatore. Coriander powdery mildew was controlled by foliar spraying and onion leaf extract (5%); among fungicides, Celixin was effective.

5. **Quality evaluation** : SG-710 Ginger selection from Solan gave highest oil content. High voletile oil in cumin was from Jobner and recommended for export purposes. The Jobner centre has undertaken the analysis of seed spices received from all the Centres.

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TECHNICAL PROGRAMME

Crop/Technical programme		Research Centres
1.	**BLACK PEPPER**	
1.1	Germplasm collection, description and evaluation	Panniyur, Chintapalli Sirsi & Yercaud
1.2	Multilocation trials (MLTs)	
1.2.1	MLT of promising cultures MLT 1984 - Series I	Panniyur
1.2.2	Multilocation trial of pepper cultivars MLT 1984 - Series II	Panniyur & Chintapalli
1.2.3	Multilocation trial of pepper genotypes MLT 1987 - Series III	Panniyur, Sirsi & Chintapalli
1.2.4	Multilocation trial MLT 1991 - Series IV	Mudigere(discontinued) Panniyur, Pampadumpara Yercaud, Ambalavayal, Sirsi & Chintapalli
1.3	Inter varietal hybridisation to evolve high yielding varieties	Panniyur
1.4	Irrigation-cum-fertilizer requirements of pepper and arecanut in a mixed cropping system	Sirsi & Panniyur
1.5	Phytophthora - foot rot (quick wilt) and nematode disease management	Panniyur, Sirsi & Chintapalli
1.6	Biological control of foot rot of black pepper	Sirsi, Panniyur & Chintapalli

1.7	Management of Phytophthora foot rot in pepper	
1.7.1	Observational trial for the control of foot rot of pepper in farmers' field	Panniyur
1.7.2	Studies on the control of nursery diseases of black pepper (solarisation studies for the control of plant diseases)	Sirsi & Panniyur
1.8	Survey for insect pests of black pepper in high altitudes insect pests	Mudigere
2.	**CARDAMOM**	
2.1	Germplasm collection, description and evaluation	Mudigere Pampadumpara
2.2	Multilocation trials (MLTs)	
2.2.1	MLT Series II - 1988	Mudigere Pampadumpara
2.2.2	MLT Series III - 1991 with Malabar type	Mudigere Appangala Sakleshpur & Thadiyankudisai
2.2.3	MLT Series III - 1991 with Mysore type	Mudigere Appangala Sakleshpur & Myladumpara
2.3	Hybridisation and selection in cardamom	Mudigere

2.4	Preliminary yield trial / comperative yield trial of promising cardamom clones - Tissue cultured clones	Mudigere
2.5	Evaluation of Mudigere-1 under rainfed situation	Mudigere
2.6	Manurial experiment (NPK trial)	Mudigere & Pampadumpara
2.7	Micronutrient requirement studies	Mudigere & Pampadumpara
2.8	Integrated management of organic and inorganic manures in harvesting higher yields	Mudigere
2.9	Pest management in cardamom	
2.9.1	Screening of cardamom germplasm for shoot borer	Mudigere
2.9.2	Cultural and chemical control of thrips and capsule borer	Mudigere & Pampadumpara
2.9.3	Determination of number of sprays for thrips control	Mudigere
2.9.4	Estimation of loss due to cardamom shoot borer	Mudigere
2.9.5	Effect of plant based insecticides on the control of thrips and borer in cardamom	Mudigere
2.9.6	Bioecology of natural enemies of major pests of cardamom	Mudigere

3. LARGE CARDAMOM

3.1 Germplasm collection, description and evaluation	Gangtok
3.2 Identifying tolerant types to the two virus diseases and evolving control measures	Gangtok
3.3 Evaluation of fungi toxicants against Anthracnose disease	Gangtok

4. GINGER

4.1 Germplasm collection, description and evalution	Solan, Pottangi & Dhoni
4.2 Initial evaluation trial (IET)	Pottangi & Solan
4.3 Comparative yield trial (CYT)	Pottangi & Solan
4.4 Multilocation trial (MLT series III 1991)	Pottangi & Solan
4.5 NPK trial in ginger	Pottangi
4.6 Standardisation rhizome size in ginger for higher yield	Dhoni
4.7 Evolving control measures including seed treatment against rhizome-rot disease	Solan
4.8 Biocontrol studies on rhizome rot of ginger	Solan
4.9 Evaluation of germplasm for quality characters	Solan

5 TURMERIC

5.1	Germplasm collection, description and evaluation	Solan, Pottangi Jagtial & Dholi
5.2	Initial evaluation trial (IET)	Pottangi Jagtial & Dholi
5.3	Comparative yield trial (CYT)	Pottangi & Dholi
5.4	Multilocation trail - MLT 1991/series III	Pottangi, Jagtial
5.5	Effect of spacing on yield of turmeric	Dholi
5.6	Quality evaluation of germplasm collection/ varieties	Solan

6 TREE SPICES

6.1	Germplasm collection, conservation and cataloguing of tree spices (Clove, nutmeg and cinnamon)	Yercaud, Pechiparai & Thadiyankudisai
6.2	Multilocation trial of elite cloves	Yercaud & Pechiparai
6.3	Multilocation trial of elite cinnamon	Yercaud, Ambaleveyal Thadiyankudisai & Pechiparai
6.4	Vegetative propagation in nutmeg, clove and Cinnamon	Yercaud, Thadiyan-kudisai & Pechiparai
6.5	Drip irrigation in clove & nutmeg	Yercaud
6.6	Biofertilizer trial in clove & nutmeg	Yercaud

7 CORIANDER

7.1 Germplasm collection, maintenance and evaluation	Jobner, Jeguden, Guntur Coimbatore, Hisar& Dholi
7.2 Initial evaluation trial	Jeguden, Guntur, Hisar Coimbatore & Dholi
7.3 Multilocation trials	
MLT - 1989 series I	
MLT - 1993 series II	Jeguden, Jobner, Coimbatore, Guntur, Hisar & Dholi
7.4 Mutation breeding in coriander to evolve varieties with earliness and resistence to disease	Jobner & Coimbatore
7.5 Evaluation of coriander varieties for green leaf	\Dholi
7.6 Studies on wilt disease management of coriander	Coimbatore
7.7 Response of coriander to weed management	Jobner
7.8 Quality evaluation in coriander	Jobner

8. CUMIN

8.1 Germplasm collection, description, evaluation and screening against diseases	Jobner & Jeguden
8.2 Initial evaluation trial	Jeguden
8.3 Multilocation varietal trial (MLT 1989 series I)	Jobner,Jeguden & Hisar

8.4 Mutation studies and hybridisation programmes	Jaguden
8.5 Evolving control measures against wilt disease including crop rotation	Jobner
8.6 Quality evaluation studies	Jobner
9 **FENNEL**	
9.1 Germplasm collection, description, evaluation and screening against diseases	Jobner & Jaguden
9.2 Initial evaluation trial	Jaguden
9.3 Multilocation trial (MLT-1989 series I)	Jaguden, Jobner & Hisar
9.4 Mutation studies and crossing programmes in fennel	Jaguden
9.5 Response of fennel to weed management	Jobner & Hisar
9.6 Quality evaluation studies	Jobner
10 **FENUGREEK**	
10.1 Germplasm collection, maintenance, evaluation and screening against diseases	Jobner, Jaguden Coimbatore, Guntur & Dholi
10.2 Multilocation varietal trial MLT 1993 series II	Guntur, Coimbatore, Jobner, Jaguden & Hisar
10.3 Standardsetcpm pf date pf spwcmg and specing for higher yield	Dholi
10.4 Evolving varieties resistent to powdery mildew through mutation breeding and crossing programme	Jobner & Jaguden

10.5 Effect of time of sowing and spacing	Coimbatore
10.6 Response of fenugreek to weed management	Jobner

CLOSED PROJECTS

1	Multilocation trial in coriander (MLT 1989 Series I)	Jobner, Jaguden & Hisar
2.	Multilocation varietal trial in Fenugreek (MLT 1989 Series I)	Jobner& Hisar
3	Comperative yield trial in cumin	Jobner
4	Comperative yield trial in Fennel	Jobner
5	NPK fertilizer trial in ginger	Pottengi
6	Manurial trial in cardamom under uniform shade	Mudigere
7	Manurial experiments on black peppr arecanut	Sirsi
8	Response of fenugreek to weed management	Jobner
9	Response of fennel to weed management	Jobner
10	Field trial for the control of slow wilt disease of black pepper	Pennlyur
11	Effect of number of sprays on thrips control in cardamom	Mudigere
12	Control of nursery diseases in cardamom	Mudigere
13	Screening for katte disease resistance, evolving control measures against clump rot	Mudigere

Discipline/crop wise distribution of technical programme of AICRPS in 1994-95

Crop	Crop Improvement	Crop production	Quality evaluation	Crop protection	Total Projects
Black pepper	3	1	-	4	8
Cardamom	5	3	-	1	9
Large cardamom	2	-	-	1	3
Ginger	4	2	1	2	9
Turmeric	4	1	1	-	6
Coriander	5	1	1	1	8
Cumin	4	-	1	1	6
Fennel	4	1	1	-	6
Fenugreek	4	2	-	-	6
Tree Spices	4	2	-	-	6
Total projects	39	13	5	10	67

BLACK PEPPER

1.1 Germplasm collection, description and evaluation
(Panniyur, Sirsi, Chintapalli & Yercaud)

Seventy six cultivated types are maintained at Panniyur. Out of the 48 types which produced spikes, during 1994-95., Karimunda III, TMB IV and Balankotta I were the best performers which produced green berry yields of 2.17kg, 1.77kg, 1.29kg per vine respectively.

The Chintapalli centre holds 27 cultivated and 21 wild accessions of pepper germplasm which includes the two new wild collections from Rirtade and Pentapadu collected during the current year. In the cultivated germplasm, 9 varieties (planted in 1984) were evaluated. Among these, Panniyur-1 has recorded the highest yield of 4.170kg fresh berries/vine, followed by Kottanadan(3.87kg) and Aimpiriyan (3.67kg). In the evaluation of wild germplasm, Chapagadda accession has recorded maximum yield (2.08kg fresh berries/vine) followed by Maredumilli(2.0kg).

Totally, 58 pepper germplasm (including 12 wild types) are being maintained at Sirsi. Planting of germplasm in arecanut plantation for assessing its performance is in progress at Sirsi. The yercaud centre has 106 accessions including 3 wild entries for evaluation.

1.2 Multilocation trials (MLT's)

1.2.1 Multilocation trial of promising cultures (MLT-1984 series I)
(Panniyur)

The trial aims to evaluate the performance of 9 promising cultures selected from the breeding programmes at Panniyur viz. Cultures 54, 211, 239, 331, 406, 1171 and 1191 alongwith Panniyur-1 and Karimunda. As against the previous year, the check Karimunda recorded the maximum green berry yield of 1.21kg followed by culture 1171 (1.14kg), Culture 239 (1.09kg) and Culture 54 (1.06kg).

1.2.2 Multilocational trial of black pepper cultivars (MLT 1984-Series-II)

(Panniyur & Chintapelli)

The trial was laid out at Panniyur (in 1984) consisted of 9 cultivars viz. Neelamundi, Kalluvally, Aimpiriyan, Kottanadan, Narayakodi, Kuthiravally, Arakkulammunda with Panniyur-1 and Karimunda as controls. The yield levels were on par during the current year. The highest yield of 0.94kg/vine was recorded in Karimunda and Neelamundi, followed by Kuthiravally (0.91kg) and Kottanadan (0.63kg)

At Chintapelli, the trial was initiated in 1986 with 9 varieties trailed on Silver oak standards. The highest yield of 6.680kg/vine was recorded in Panniyur-1. Vellanamban gave green berry yield of 5.05kg/vine followed by Thombanmundi (4.59kg/vine) and Narayakodi (3.98kg).

1.2.3 Multilocational trial of pepper genotypes (MLT 1987-series III)

(Panniyur, Sirsi & Chintapelli)

A trial to compare the performance of released varieties (CYT) was laid out in 1990 at Panniyur with the cultivars 141, 239, 331, 1558, 5128 (KAU) and KS-14 KS-27 and KS-88 (NRCS) along with Karimunda and Panniyur-1. The check 'Karimunda' produced the highest green berry yield followed by culture 239, KS-27 and culture 331.

The trial was laid out in arecanut plantation during 1992 with cultivars viz. KS-27, cultures 141, 239, 331, 812, 856, Panniyur-1, Karimalligesara and Uddakara. The vines are under evaluation at Sirsi.

The new trial (CYT) was laid out at Chintapelli in 1993-94 with 10 elite accessions viz. acc. 2426, acc. 2442, Panniyur-2, Panniyur-3, Panniyur-4, Sreekara, Subhakara, Panchami, Ottaplackal alongwith Panniyur-1 as check.

1.2.4 Multilocational trial (MLT - 1991 Series IV)

(Panniyur, Pempedumpere, Yercaud, Ambaleveyel, Sirsi & Chintapelli)

The objective is to evaluate the performance of released varieties of pepper at different locations. The trial was laid out in 1992 at 4 centres (Panniyur, Yercaud, Pempedumpere, Ambaleveyel) with 14 varieties/cultivars, i.e. nine varieties viz. Panniyur-1,2,3,4 and 5 (from Panniyur), Sreekara, Subhakara, Panchami and Otteplackal four promising cultures viz. Kottanadan (Acc. 2426), Kottanadan (Acc.2445), Culture 1558 and Culture 5128 from NRCS with Karimunda and Vellanamper, as controls. The biometric observations of the growth parameters were recorded and also on pest and disease incidence; the trial is in progress at all the centres except Chintapelli & Sirsi.

1.3 Intervarietal hybridization to evolve high yielding varieties

(Panniyur)

In the intervarietal hybridization of pepper, 576 open pollinated/hybrid progenies are maintained. The age of the vines varied from 1 to 10 years. Variation in yield was observed in the cultures over the years. The yield/performance of the progenies were also poor during the current year. The cultures 5308, 4700, 5198, 5403 and 4563 yields about 1kg of green berries/vine.

1.4 Irrigation cum fertilizer requirements on pepper

(Panniyur & Sirsi)

The experiment commenced in 1988 at Panniyur (Split plot design) using Panniyur-1 and Karimunda varieties with three irrigation levels (No irrigation, irrigation at IW/CPE ratio of 0.125, 0.250 and three levels of fertilizers (No fertilizer, NPK @ 50:50:150, 75:75:225g/vine) in subplots; the studies showed that irrigation at IW/CPE ratio of 0.25 was found to be the best for giving the maximum green spike yield/vine. Eventhough the interaction is significant, no definite trend was observed.

The experiment was laid out at Sirsi (1992) with two varieties namely Panniyur 1 and Kerimelligesare using arecanut palm as standard to trail pepper (split plot design) with three levels of irrigation (IW/CPE ratio 1.0, 0.66, 0.33) and three levels of fertilizer (control, NPK @ 50:20:70, 100:40:140. 150:60:210g/vine.

The recomended dose of fertilizers i.e. 100:40:140g/arecanut/ year is applied uniformly during all the years. Manurial and irrigation treatments are imposed on the 3rd year old vines during May 1995.

1.5 **Phytophthora foot rot (Quick wilt) and nematode disease management in black pepper**
(Panniyur, Sirsi and Chirtapalli)

Studies were conducted at Panniyur centre with newer furgicides (9 treatments) for the management of wilt disease. The treatments were imposed thrice, first just before the onset of the monsoon, second during the third week of July and the thrid in the second week of September. The results presented in Table 1 showed minimum defoliation (4.06%) and foliar yellowing (3.35%) in treatments receiving "all cultural practices + 1kg neem cake/vine + 3g e i Phorate/vine + 1% Bordeaux mixture + drenching with 0.2% Copper oxychloride."

At Sirsi, the trial was conducted with 8 treatments for the 4th year and treatments imposed as per the schedule. The disease was reduced upto 10% (compared to 56.66% in control) by adopting all cultural practices and by application of neem cake @ 1kg/vine, Phorate 3G @ 30g/vine, spraying (3l/vine) and drenching (5l/vine) with Bordeaux mixture (1%), Akomin 0.04% spray and drench from second month and Ridomil MZ-72WP (100ppm) spray and drench from the third month, starting from first week of June (Table 2). The mean percentage of disease incidence for 4 years also revealed the lowest disease incidence (8.35%) by the same treatments (Table 2).

Table 1 : Phytophthora - foot rot disease and nematode management in black pepper (1994-95) at Panniyur (Disease incidence %)

Treatments	Mean of			
	Defoliation	Foliar yellowing	Death of vines	Fungal 'pollu'
T1 - Absolute control without cultural practices	16.69	12.45	1.0	9.46
T2 - All cultural practices + 1kg neemcake + 3g a.i. Phorate/vine	13.21	13.98	0.67	9.03
T3 - All cultural practices + Bordeaux mixture spray + 0.2% Copper oxychloride drenching + 100 ppm Metalaxyl	9.88	8.10	1.0	10.46
T4 - T2 + 100 ppm Metalaxyl + Bordeaux mixture spray	10.47	11.50	1.0	7.51
T5 - T2 + Akomin (0.2%) (Spray+drenching) + Bordeaux mixture spray	9.08	5.67	1.0	5.34
T6 - T2 + Bordeaux mixture spray + Akomin (0.2%)	4.13	3.54	0.67	7.85
T7 - T2 + Bordeaux mixture spray + 0.2% Copper oxychloride drenching	4.06	3.35	0.33	9.16
T8 - T2 + Bordeaux mixture + Akomin (0.2%) + 100 ppm Metalaxyl	10.26	5.43	1.33	5.33
T9 - Ridomil (0.2%) drenching and spraying - 3 times	10.90	10.69	1.67	10.34
C.D (0.05)	7.15	5.51	NS	NS

Table 2 : Phytophthora foot rot and nematode disease management in black pepper at Sirsi

	Treatments	% Disease incidence				
		91-92	92-93	93-94	94-95	Mean
T1	Absolute control without any cultural practices	20.00	53.33	50.00	56.66	45.99
T2	All cultural practices + 1kg of Neem cake + 3 g ... of Phorate (30g/vine) soil application	56.67	43.33	33.00	36.66	42.41
T3	All cultural practices + Bordeaux mixture (1.0% spray) + Bordeaux paste application + soil drench with copper oxychloride (0.2%) first and spray + drench Ridomil MZ-72WP(100ppm) as second round	10.00	26.77	23.33	23.33	20.85
T4	T2 + Ridomil MZ-72 WP (100ppm) spray and drench first round spray BM(%) second round	23.33	33.33	20.00	23.33	24.99
T5	T2 + Akomin spray and drench first round and spray BM (1.0%) (4ml/l) second round	6.67	26.77	20.00	20.00	18.36
T6	T2 + BM spray and drench + application of B. paste first + Akomin (4ml/l) spray + drench second round	3.33	20.00	13.33	13.33	12.49
T7	T2 + BM spray + Copper oxychloride drench two rounds + B. paste application first round	10.00	26.77	10.00	13.33	15.02
T8	T2 + First round BM (1.0%) spray and drench + 3rd round Ridomil MZ-72WP spray and drench	0.00	16.77	6.66	10.00	8.35
C.D @ 5%		0.69	1.22	2.48	1.83	1.55

The trial was initieted at Chintepelli centre (1990) with 8 treatments. Out of the treatments, the least percent disease incidence (4.4%), foliar yellowing (5.6%) and defoliation (10.3%) was observed in the treatmental combination with "ll cultural practices + 1kg neem cake + 3g a.i. Phorate (Soil application) + Bordeaux mixture treatment followed by second round spraying with Akomin as the best (Table 3).

1.6 Biological control of foot rot disease of black pepper (Sirsi, Chintepelli & Panniyur)

Biocontrol studies against the foot rot disease caused by Phytophthora capsici was conducted in pot culture at Sirsi and Chintapelli centres. The trial was laid out at Sirsi with seven treatments including antagonistic organisms, fungicides and neem cake. Trichoderma harzianum, T. viridae, Lacteserie arvalis B. subtilis were used against Phytophthora capsici. The organisms were applied @ 150g/vine to soil after mass multiplication. Among the antagonistic organisms T. harzianum controlled the foot rot incidence upto 16.65 per cent, followed by T. viridae (20%) as compared to check (56.0%) at Sirsi, during the second year of the studies. The studies at Chintapalli also recorded that the disease incidence was also lowest by T. harzianum application (16.0%) followed by T. viridae (18.0%)

1.7 Management of Phytophthora foot rot disease in black pepper

1.7.1 Observational trial for the control of the foot rot of pepper in farmer's field (Panniyur)

This experiment was laid out in two locations by the Panniyur centre (1987-1988) with an objective to evaluate the efficacy of soil amendments for the management of Phytophthora foot rot disease. The treatments are pre-monsoon pasting, spraying and drenching with bordeaux mixture and application of lime and neem cake. Second and third spraying with Bordeaux mixture was done during last week of July and September respectively. The pooled analysis of the seven years' data of this trial presented in Table 4 revealed that spraying and

Table 3 : Phytophthora foot rot and nematode disease management in black pepper at Chintapalli 1994

	Treatments	(Disease incidence %)		
		Defoliation (%)	Foliar yellowing (%)	Disease incidence (%)
T1	Absolute control without any cultural practices	24.2	14.8	22.2
T2	All cultural practices + 1kg of Neem cake + 3g a.i Phorate (Soil application)	19.8	14.2	20.2
T3	All cultural practices + Bordeaux mixture (BM) spray and soil drench with copper oxychloride (CoC 0.2%) first and Ridomil MZ-72WP (100ppm Metalaxyl) as second	12.6	8.7	12.2
T4	T2 + Fidomil MZ-72 first and BM second round	12.4	11.6	18.2
T5	T2 + Akomin first (Spray and soil drench + Bordeaux mixture (BM) second round	14.4	7.2	15.6
T6	T2 + BM treatment first + Akomin second round	10.3	5.6	4.4
T7	T2 + BM spray first + CoC (0.2%) drench second round	12.3	6.2	12.4
T8	T2 + BM first round, Akomin second round Ridomil MZ-72 third round	12.1	6.4	14.6
C.D at (0.05%)		2.85	1.85	2.66

Table 4 : Effect of soil amendments in the management of Phytopthora foot rot disease of Black pepper at Sirsi (Pooled data for 7 years from 1987 - 88 to 1993 - 94)

Treat ment No.	Treatments	Location - Pediyotchel				Location - Eramam			
		% of disease incidence			Mean yield (Kg)	% of disease incidence			Mean yield (Kg)
		Leaf	Branch	Stem		Leaf	Branch	Stem	
T1	Bordeaux mixture pasting spraying and drenching	5.57 (2.46)	2.07 (1.60)	1.45 (1.40)	8.74	6.15 (2.58)	4.14 (2.15)	2.67 (1.47)	7.74
T2	T1 + Neemcake @ 2kg/vine	5.49 (2.45)	1.94 (1.156)	1.29 (1.34)	8.20	6.39 (2.62)	3.68 (2.04)	2.50 (1.73)	8.58
T3	T1 + Lime @ 1kg/vine	4.66 (2.27)	1.83 (1.53)	1.51 (1.42)	9.54	5.21 (2.39)	2.84 (1.83)	2.50 (1.73)	10.75
T4	T2 + T3	4.75 (2.29)	1.74 (1.50)	0.81 (1.14)	10.84	5.08 (2.36)	3.06 (1.8)	0.63 (1.06)	10.89
T5	Control	10.99 (3.39)	2.71 (1.79)	3.53 (2.01)	6.60	10.45 (3.31)	7.71 (2.86)	13.75 (3.77)	7.27
CD	at 5% level	0.33	0.05	0.44	1.28	0.18	0.19	0.57	NS

Values in parentheses are square root transferred ones.

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drenching with Bordeaux mixture (1%), application of 2kg neem cake and 1kg lime/vine was effective and this treatment increased the yield to above 37 per cent over control. The trial was again laid out in 1994 by modifying the treatments avoiding the pasting of Bordeaux mixture. The results of 1994-95 indicate that combined (soil) application of Bordeaux mixture with neem cake @ 1kg/vine) and lime @ ½ kg/vine) reduced the incidence of the disease.

1.7.2 Studies on chemical control of nursery diseases of black pepper (Sirsi & Panniyur)

The experiment conducted at Panniyur under three light intensities with different fungicides/chemicals (Bordeaux mixture, Aureofungin, Veledicin, Akemin, Kavach, Metalexyl etc.) consisting of 11 treatments as per the modified technical programmes. The studies revealed that all the treatments were on par in checking the disease.

The experiment was laid out at Sirsi in three light intensities (high/medium/low) consisting of 8 treatments. The fungicides used are Bordeaux mixture, Difolatan, Chlorthalonil and Cheshnut compound. The treatments were imposed at 15 days interval. Under medium light intensity, Bordeaux mixture and chlorthalonil as sprays and drench seperately, reduced the seedling diseases to 30% as compared to 66.66% in check. But the two years' pooled data indicate that difolatan (0.2%) spray + drenching reduced the disease incidence to a minimum level.

1.8 Survey for the insect pests of black pepper at high altitude (Mudigere)

The survey was conducted by Mudigere centre at Chickmangalur Hassan, Kodagu and Shimoga districts for three consecutive years (1991,92 and 93) to study the occurrence of pests of pepper with an objective of documenting the most serious pests.

CLOSED PROJECTS

1. **Field trial for the control of slow wilt disease of pepper** (Perniyur)

The experiment to identify suitable chemicals and soil amendments for the management of slow decline (slow wilt) was conducted in farmers' field by the Perniyur Centre since 1987. The treatments were applied in two rounds, the first during June and next during the last week of September. It could be seen from analysis of six years' results (1989-90 to 1994-95) that there is no significant treatments effect between the treatments. Application of Phorate 3g a.i. + 0.3% Copper oxychloride/vine; Phorate 3g a.i. + 0.1% Carbendezim + 0.3% Copper oxychloride/vine + 2kg neem cake/vine; or application of all the above treatments checked the slow decline to some extent.

2. **Manurial experiments in black pepper and Arecanut** (Sirsi)

The manurial experiment in black pepper and arecanut was concluded at Sirsi. The three years' result indicated that application of 200:80:280 gm NPK per vine for arecanut and pepper increased the fresh yield by two- folds and four-folds respectively over the control. A net return of Rs.38,000/ha. was obtained due to increase in crop yield, over control.

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CARDAMOM

2.1 Germplasm collection, description and evaluation
(Pampadumpara & Mudigere)

A total of 245 germplasm collections are being maintained at Mudigere. Among the collections planted during 1989, C.7 and Cl.668 were superior with high values for both suckers/clump and panicle/clump. Ceylon-3, Pallivasal 6, Ncl.1, C-34, C.7 and Malayar-2 were consistently found to be high sucker producing entries during 1991-92 to 1994-95; C-7 was found to be the most consistent high panicle producing entry since 1991.

Seventy two cultivated and 15 wild types are maintained at Pampadumpara. The cultivated types were subjected to critical evaluation for yield and other important characters, the highest yield obtained by Clone 57 (507 gm dry capsules/plant). The capsule borer incidence is also comparatively low in this clone. The other high yielding lines identified during the years are Cinchona selection, PS-9, PS-4, S-1, PS-1, PS-12, PS-22, "Compound panicle" and PS-5.

2.2.1 Multilocation trials on Cardamom (MLT Series II - 1988)
(Mudigere & Pampadumpara)

The comparative yield trial (MLT series II) with 10 promising clones was taken up in 1989 and relaid in 1990. The data could not be gathered because of the unprecedented bad weather; hence another experiment was laid out in 1992. The performance of the clones were observed for yield and yield attributes. The data so far obtained during the years (1991 to 1995) indicated that Mudigere-1, CL - 679, CL-683, and SKP-14 were similar to one another in their performance. Sel. 800 from Appangala and SKP-14 from Sakalapur were on par with CL-683, CL-679 and Mudigere-1 in yield potential.

The MLT (Series II) with 10 promising entries was laid out in 1991-92 with single replication at Pampadumpara. The trial was relaid in July 1994 as per the decision of the XII Workshop and the plants are coming up well.

2.2.2 MLT Series III (1991) with Meleber types (Mudigere, Appangala, Saklespur and Thadiyankudisai)

As per the XI Workshop decision, the comparative yield trial of promising cardamom clones (MLT III-1991) with Meleber types consisting of 14 entries was laid out during 1992 at Mudigere, Saklespur and Appangala. The morphological data of 14 entries viz. CCS-872, CCS-893, CCS-800, CL-679, CL-683, CL-726, SKP 21, SKP-14, SKP-72, SKP-100, MCC-34, M-1, PV-1 and HS-1 observed at Mudigere and Saklespur did not differ from one another for most of the observations made.

At Appangala, the entries differed significantly among themselves for the total number of tillers and number of"bearing tillers" per clump, height of tallest tiller and number of leaves per plant. But entires did not differ significantly among themselves for yield in the first year of bearing.

2.2.3 MLT series III (1991) with Mysore types (Mudigere, Appangala, Saklespur and Myladumpara)

The MLT series III (1991) with Mysore types consisting of five entries viz. SKP 51 (Saklaspur) MCC-12, MCC-21, MCC-85 (ICRI, Myladumpara) and control (MCC-61) was laid out at Myladumpapra, Mudigere, Saklespur and Appangala (1992) with additional (local) control. At Mudigere, the entries did not differ from one another with respect to the six characters studied. The yield is expected during the next year(1995-96). The trial with CCS-1 and CL-37 at Appangala also did not differ significantly for morphological characters observed. The data on yield (1st year) and plant growth characters recorded at Myladumpara differ significantly only with the number of tillers per clump. The selection MCC-21 registered the highest yield/ plot (2745g) followed by MCC-12 (1657.50 g). Replanting was done again at Saklespur (1993) since the trial was damaged by animals.

2.3 **Hybridization and selection in cardamom**
(Mudigere)

The studies were initiated in 1989. The seedling progenies were evaluated.

2.4 **Preliminery yield trial/comparetive yield of promising cardamom clones/Tissue cultured cardamom clones**
(Mudigere)

A preliminery yield triel with 10 entries wes cerried out during 1991 to 1995. The accessions CL - 683, CL-726 end K1 gave higher yield. Among the tissue cultured selections from ICRI Myledumpere, TC-5, TC-7, TC-6 end TC-4 were found better then others in yield potentiel.

2.5 **Evaluetion of Mudigere-1 under reinfed situation**
(Mudigiere)

Studies indicated 41% to 83% higher yield from "suckers" es compered to "seedlings" of 10 end 20 months of Mudigere-1 veriety under reinfed situetions. This yeer's dete further confirmed the superiority of "clonel crop" in respect to yield with 33% less in "10 months old" end 17% in "20 months old" seedlings, compered to clonel planting units. Mudigere-1 clones yielded 37% more yield (132 kg/he) es compered to 10 end 20 months old seedlings under "reinfed" whereas under irrigeted conditions, the yield of clones however increased by 68% (300kg/he).

2.6 **Menurial Experiments (NPK trials)**
(Mudigere & Pempadumpere)

The experiment wes cerried out et Mudigere (1987) under uniform shede (Nylon net) with monoclonel pleanting meteriel of Mudigere-1 veriety with three levels of NPK (0-0-0, 50-50-100, 100-100-200kg NPK/he) consisting of 27 treetment combinetions of NPK. The planting wes done in Kherif 1987 end the crop sterted yielding from 1989 onwerds. The pooled dete of six yeers on yield, sucker production end penicle number/clump end green

capsule yield/ha are provided in the Table 5 indicated that the response to 'N' was significant over years. But the response was not observed for both P and K levels including their interactions. Nitrogen 100 kg/ha, recorded higher yield followed by 50kg Nitrogen. Significant response was observed with regard to panicles on N, P and K but interactions were not significant. In case of Sucker production response was observed on N and K levels but not on P levels.

Table 5 : Response of N P and K levels on capsule yield, panicles and sucker production at Nudigere (Pooled data 1989 to 1994)

Treatments	Yield(Green capsule) Kg/ha	Number of panicle/ clump	Number of suckers/ clump
N0	675.4	15.5	11.6
N1 (50 kg/ha)	804.5	17.6	12.6
N2 (100 kg/ha)	1030.2	21.2	13.6
P0	807.6	16.8	12.1
P1 (50 kg/ha)	825.5	18.4	12.5
P2 (100 kg/ha)	876.8	19.1	12.9
K0	786.9	16.5	11.9
K1 (100 kg/ha)	843.0	17.9	12.7
K2 (200 kg/ha)	880.0	18.5	13.0
C.D at 5%	99.0	1.8	1.3

As per the X Workshop recommendation, a new NPK trial with six treatments was laid out with six graded levels of fertilizers under natural shade at Nudigere and Pampadumpare in 1992-1993. The trial was laid out at Nudigere (with protective irrigation) with Nudigere-1 clone. The experiment was re laid out Pampadumpare with PV-1 suckers in 1993 to assess the response to higher levels of fertilizer application as well as the efficacy of neem cake application. The crop stand is satisfactory.

2.7 Micronutrient requirement studies
(Mudigere & Pampadumpara)

The experiment was laid out at Mudigere during 1992 using Mudigere-1 suckers with seven treatments. Micronutrients Boron and Molybdenum were applied one month before panicle initiation and the crop will be ready for harvest during 1995.

At Pampadumpara, the trial was laid out with vegetative propagules of PV-1 during 1994.

2.8 Integrated management of organic and inorganic manures in harvesting higher yields
(Mudigere)

The new experiment has been laid out during 1994 in RBD with six treatments integrating organic and inorganic manures. The crop stand is satisfactory.

2.9. Pest Management in cardamom

2.9.1 Screening of cardamom germplasm for thrips and shoot borer
(Mudigere)

Ten elite clones identified by preliminary screening of 200 germplasm accessions (viz. D-471, D-297, D-457, D-446, D-514, CL-754, CL-769, CL-679, CL-726, CL-683, PI, Pink pseudostem) having resistance to shoot borer damage. The same clones are being multiplied for field trial and for further screening during July 1995.

2.9.2 Cultural and chemical control of thrips and capsule borer
(Mudigere & Pampadumpara)

Experiments were conducted at Mudigere to study the effect of "thrashing alone" and thrashing combined with insecticidal sprays (10 treatments) for the control of thrips. Chemical control with monocrotophos (0.05%), thrashing in February and May followed by insecticidal application. In this study,

threshing followed by three sprays given in the months of March, May and August were at par with threshing followed by four or five sprays as evident from Table 6.

Table 6 Effect of threshing and insecticide sprays on thrips control in cardemom at Mudigere

Treatments	Thrips damage (%)			
	1992-93	1993-94	1994-95	Mean
1. T1 Threshing (2,5)	14.31	21.01	31.29	22.20
2. T2 Five sprays (3,5,6,8,9)	06.63	01.42	05.55	04.53
3. T3 Four sprays (3,5,8,9)	07.35	03.49	05.68	05.51
4. T4 Three sprays (3,5,8)	04.82	05.15	09.60	06.52
5. T5 Three sprays (5,6,7)	13.25	04.45	07.09	08.26
6. T1 + T2	04.43	02.67	18.12	08.41
7. T1 + T3	04.75	03.59	07.90	05.41
8. T1 + T4	09.37	03.10	08.19	06.88
9. T1 + T5	06.48	02.76	07.36	05.53
10.Control	09.10	15.89	17.50	14.16
CD @ 5%	NS	09.22	12.97	06.93

(2-Feb; 3-March; 5-May; 6-June; 7-July; 8-August; 9-Sept).

All the treatments comprising of insecticide application and combination of insecticides and threshing were superior over control and threshing alone. Analysis of the pooled data for three years also indicated the same trend. The experiment is being concluded and the bestviz., treatment with three sprays (March, May and August) is being evaluated in larger plots.

A similar trial conducted at Pampadumpara with 10 treatments with selective threshing during February-March and insecticidal application at different intervals. Observations were taken on shoot and capsule borer as well as thrips infestation on the capsules. Capsule borer infestation was not very severe and did not vary among treatments. But the percentage of shoot borer incidence showed considerable variation among treatments. All the treatments (except selective threshing alone) were found to be equally effective in controlling thrips infestation.

Determination of number of sprays for thrips control (Mudigere)

A trial conducted for three years (1992-1995) to develop

suitable spraying schedule for thrips and capsule borer of cardamom. Evaluation of number of sprays for thrips and capsule borer controls showed no significant difference between six sprays commencing from April at monthly interval and three sprays given in April, June & August. The first spray in all treatments was done with monocrotophos and the subsequent sprays with Phosalone. Analysis of pooled data for three years also indicted a similar trend as evident from Table 7 which indicated that there was no significant difference in thrips damage between the number of sprays.

Table 7 Effect of number of sprays on thrips control in cardamom at Mudigere

Treatments	Thrips damage (%)			
	1992-93	1993-94	1994-95	Mean
1. Six sprays (3,4,5,6,7,8)	10.02	6.04	11.88	9.31
2. Three sprays (3,5,7)	11.85	12.48	27.54	17.29
3. Two sprays (3,4)	18.12	20.50	19.87	19.50
4. Three sprays (4,5,7)	24.23	11.85	21.13	19.07
5. Control	25.11	33.36	43.81	34.09
CD @ 5%	5.27	14.18	10.83	10.47

(3-April, 4-May, 5-June, 6-July, 7-August, 8-September)

2.9.4 Estimation of loss due to cardamom borer (Mudigere)

Studies on the incidence of shoot borer (in all the three types of cardamom viz. Mysore, Malabar and Vazhukka) on sucker and panicle production indicated an yield reduction of 3.24 percent when 16 percent of the suckers were damaged.

2.9.5 **Effect of plant based insecticides on the control of thrips and borer in cardamom**
(Mudigere)

Evaluation of plant products against thrips and borer revealed Neemark and Nimbecidine to be on par with monocrotophos in reducing thrips damage.

2.9.6 **Bioecology of natural enemies of major pests of cardamom**
(Mudigere)

Documentation of natural enemies of cardamom thrips and shoot and capsule borer was initiated in 1992. An unidentified pathogen has been recorded to infect the grown up larvae of Conogethus punctiferalis Attempts are being made to identify the pathogen. Parasitization of the larva by Xanthopimpla was negligible.

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LARGE CARDAMOM

3.1 Germplasm collection, description and Evaluation
(Gangtok)

Four commercial cultivars identified are: Golsey, Ramsey, Ramla and Sawney; Ramsey and Sawney are grown more at places at 5000m and above MSL while Golsey is very popular at lower altitudes. 'Chirkey' and 'Foorkey' are the two virus diseases occurring in large cardamom. The survey conducted revealed that the average incidence and extent of damage due to 'Foorkey' disease was less viz. one percent. In places where Ramsey & Sawney were more (6%), however, the exact figures of incidence of 'Foorkey' is not possible because most of the farmers uproot the diseased clumps. The Chirkey is fast spreading and restricted to a few pockets and 5-40% clumps are found effected. From a survey conducted, it was observed that the cultivar 'Golsey' is tolerant to these two diseases.

3.2 Identifying tolerant types to the two virus diseases and evolving control measures
(Gangtok)

Five hundred seedlings each of the four commercial cultivars were planted at ICAR Research Complex (May, 1988) to screen against 'Chirkey and Foorkey' diseases under natural conditions. In this trial, Golsey was found tolerant to both the viral diseases. Studies showed that the two viral diseases were in increasing trend(Table 8). Systematic uprooting of diseased clumps and planting of seedlings raised from true seeds is the only way for managing these virus diseases.

3.3 Evaluation of fungi toxicants against Anthracnose disease
(Gangtok)

Anthracnose caused by Glomerella cingulate is an important foliage disease. The intensity of the disease was found more in Golsey which is otherwise tolerant to Chikey and Foorkey virus diseases. In the fungicidal evaluation, all the fungicides included

in the trial controlled the disease significantly. The control observed by the various fungicides are Cumen-L (0.2%)-1.4%. dithene M-45 (0.2%)-85.5% and Kavach (0.1%)-83.7% and at par and significantly superior in controlling the disease incidence (Table 8).

Table 8 : Status of the Chirkey & Foorkey in newly planted Large Cardamom plantation in Nov. 1994.

Variety	No. of clumps							Chirkey							Foorkey						
	1988	'89	'90	'91	'92	'93	'94	1988	'89	'90	'91	'92	'93	'94	1988	'89	'90	'91	'92	'93	'94
Golsey	357	357	357	357	351	350	350	--	--	--	2	5	7	8	--	--	3	5	7	8	8
Ramsey	107	93	93	90	87	85	85	--	--	--	2	7	10	12	--	--	1	2	4	6	9
Sawney	377	355	355	355	349	348	348	--	11	25	46	52	60	66	--	8	25	31	35	38	42
Female	400	398	398	395	391	390	390	--	16	22	30	39	46	52	--	14	22	27	30	33	37

Note: No of seedlings planted 500 in each case in May, 1988.

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4.1 Germplasm collection, description and evaluation
(Pottengi & Solan)

At Pottengi, 3 more indigenous germplasm collected from Nandapur made the total to 150, which includes 146 indigenous, 3 exotic and one wild collection. In the evaluation of 138 accessions, highest fresh rhizome yield was obtained in the mutant V_3 S_1-8 (3.075kg/3m^{2}plot).

The Solan centre maintained 140 indigenous collections which include 8 new collections added during the year. Dholi centre collected and maintained 41 ginger germplasm obtained from the Solan centre.

4.2 Initial Evaluation Trial (IET)
(Pottengi & Solan)

Sixteen promising entries were evaluated under IET at Pottengi. The pooled data for three years (1992-93 to 1994-95) gave significant differences in the yield. The highest fresh rhizome yield of 18.75 t/ha was obtained from V_1 E_8 - 2 followed by V_1S_1-8 (18.47t/ha).

On the basis of evaluation of performance of germplasm, 13 top yielding collections at Solan were put under IET. None gave significant difference for yield in the current year. However, the seven collections viz. SR SG-692, SG-700, SG-62, V_1E_8 - 2, SG-671 and SG-688 out yielded the check viz. SG-666.

4.3 Comparative Yield Trial (CYT)
(Pottengi & Solan)

Six cultures were evaluated in the CYT at Pottengi. The pooled analysis of three years' yield data (1992-93 to 94-95) gave significant differences in yield. A projected yield of 14.49 t/ha (V1E8-2) was followed by 14.23t/ha (V_1C-8)

On the basis of the performance in the IET, six collections viz. SG-670, SG-699, SG-710 were studied under CYT from 1994. Non significant differences for yield were observed between the collections this year also and none of them showed increase in yield over check SG-666. In the CYT II with six collections viz. SG-689, SG-700, SDR, SG-695, SG-696 were evaluated during 1993 and 1994 with SG-666. The results were non significant; however there were significant effect on yield over years.

4.4 Multilocation Trial (MLT series III : 1991)
(Pottengi & Solan)

The promising cultures were evaluated (in the MLT series III) for the 4th year at Pottengi. The mean projected yield is presented in Teble 9. V_2S_1-7 (15.29t/ha was the top yielder closely followed by SG-547 (14.55 t/ha).

Teble 9 Fresh rhizome yield of Ginger cultivers in MLT-III at Pottengi

Sl. No.	cultivers	1991-92	1992-93	1993-94	1994-95	Mean yield kg/3m^2	Projected yield (t/ha)
1	V_2S_1-7	1.966	6.135	9.212	7.157	6.12	15.29
2	S-547	2.235	9.382	7.638	4.027	5.82	14.55
3	Rejgarh local	2.424	7.010	7.606	5.563	6.65	14.13
4	S-666	2.305	6.244	7.752	5.957	5.56	13.91
5	V_1S_4-4	2.346	4.441	8.972	6.393	5.54	13.85
6	S-646	1.115	5.078	7.998	5.952	5.54	13.85
7	V_1S_1-2	1.735	8.054	7.282	4.242	5.53	13.32
8	Suprabha	1.638	6.430	6.456	6.033	5.14	12.85
9	Surabi	1.743	4.945	7.357	5.217	4.82	12.04
10	Maran	1.491	5.890	6.199	5.363	4.71	11.78
C.D (P=0.05)		--	--	--	1.69	1.09	3.23

The MLT started during 1991 was continued at Solan with 10 entries. During 1994, the yield per plot varied from 1.63 kg (V_1E_4-4) to 5.40kg(SG-666). The two collections viz. SG-674 and SG-666 recorded higher yields than the check viz. Maran. The pooled data (1991-94) also indicated that there was no effect of environment on the yield per plot; however, response of the variety was different between the years. The locally adapted variety outyielded the varieties from Pottengi as well as variety Maran as observed from the pooled data presented in table 10.

Table 10 Fresh rhizome yield of ginger cultivars (MLT III) at Solan

Sl. No.	Name	1991-92	1992-93	1993-94	1994-95	Mean yield kg/ha	Converted yield (t/ha)
		Kg/3m^2 Plot					
1	Rejgreh	5.33	6.42	5.00	4.87	5.40	10.96
2	SG 646	5.83	5.07	4.33	3.73	4.74	9.62
3	SG 547	4.53	5.40	4.17	4.17	4.56	9.26
4	SG 666	6.77	2.93	4.30	5.40	4.85	9.85
5	V_1K_1-3	1.77	1.42	0.97	2.60	1.64	3.33
6	Suprabha	0.90	1.03	1.03	1.00	0.99	2.01
7	V_1S_1-2	0.55	0.90	1.97	1.87	1.32	2.68
8	V E_4-4	1.13	1.08	1.73	1.63	1.39	2.82
9	$V_2^1S_1$-7	2.17	0.67	2.60	3.33	2.19	4.43
10	Maran	3.36	3.76	2.33	4.03	3.37	6.48
Mean		3.26	2.87	2.82	3.26	3.04	
CD at 5%							

4.5 **NPK trial in ginger**
(Pottengi)

The fertilizer triel was conductcd for five yeers (RBD) using cultiver Suruchi with six trcatments et Pcttengi. Thc 5 yeers' pcoled dete presentcd in Teblc 11 ccnfirmcd thet, applicetior cf N125, P100 erd K100 kg/he geve the highest prcjected yicld cf 14.15 t/he cf fresh rhizcmes with maximum bcnefit (Rs.5,300/he). Thc percentege cf leef spct infectiin was elsc lcwest in this treetment.

4.6 **Evolving control measures (including seed treatment) against rhizome rot disease of ginger**
(Sclen)

Thc triel was cenducted et Sclen tc evelueto the effect cf seed treatment with 5 different fungicides and their combinetions plus Phorete as soil epplicetion in reducing thc incidence cf rhizcme rct. Seed rhizcmes were treeted with fungicides es prc sowing seed dip treetment fcr 6C minutes Phcrete wes epplied in soil @ 1Ckg he^{-1} et thc time cf bed preperetion. Thc dete presentcd in Teblc 12 ccnfirmed thet ginger seed rhizcmes treeted with the combinetion cf Indofil - M45 + Bevistin wes the best which reduced the diseese incidence tc e minimum cf 6.C% end increesed yield.

4.7 **Biocontrol cf rhizcme rct of ginger**
(Sclen)

Studies were initiated in 1994 cn the effect cf soil epplicetion cf biocontrol egents end in combinetion with seed treetment with fungicide egeinst rhizcme rct disease. It wes cvident frcm the studies thet minimum incidence cf the disease (6.C%) was cbteined in Indofil-M45 + Bevistin seed treeted rhizcmes elcngwith soil epplicetion cf T. herzienum. This treetment elsc increesed the yield cf fresh rhizcme (6.7kg/3m^2 plot) cempered tc 4.85kg/3m^2 in centrol.

4.8 **Standardizetion cf seed rhizcme size in ginger fcr higher yield**
(Dhcli)

Studies were cenducted et Dhcli centre tc stendardise thc seed rhizcme size fcr higher yicld end prcfitebility. Seed rhizcmes cf 24 cm size produced thc highest yicld cf 22.19t/he.

Table 11 Fresh rhizome yield of ginger in the NPK trial at Pottangi (1990 - 91 to 1994 - 95)

	Treatment	Five years Mean yield (Kg/3m^2)	Projected yield (t/ha)	Cost of produce (Rs./ha)	Cost of cultivation (Rs./ha)	Benefit/ Rs./ha	Cost: % benefit ratio
T_1	Control (No FYM No NPK)	3.954	9.885	79,080.00	59,250.00	19,830.00	1.33
T_2	FYM alone 9Kg/3m^2 (i.e. 30t/ha)	3.062	7.655	61,240.00	60,600.00	640.00	1.01
T_3	N75 P50 K50 Kg/ha	5.105	12.763	1,02,104.00	60,000.00	42,104.00	1.70
T_4	N100 P75 K75 Kg/ha	5.020	12.551	1,00,408.00	60,325.00	40,083.00	1.67
T_5	N125 P100 K100Kg/ha	5.660	14.151	1,13,208.00	60,650.00	52,558.00	1.87
T_6	N150 P150 K150Kg/ha	4.353	10.883	87,064.00	61,200.00	25,864.00	1.42
CD (P=0.05)		1.250	3.125	(Cost of ginger Rs.800/q.)			

Soil PH-5.7, Organic carbon 0.37%, P - moderate, K - moderate

Table 12 Effect of seed treatment and soil application of Phorate on the control of rhizome rot of ginger in Solan

Treatment	Conc. (%)	Disease incidence (%)	Yield ($Kg/3m^2$) Fresh rhizome
Bavistin	0.1	7.8	3.630
Indofil M-45	0.25	6.3	4.400
Indofil M45+Bavistin	0.25 + 0.1	6.0	4.610
Blitox - 50	0.3	10.0	2.730
Captan	0.3	12.75	2.160
Ridomil MZ	0.4	12.5	2.300
Phorate	10kg ha^{-1}	9.6	2.960
Phorate+Indofil M45+ Bavistin	10kg/ha^{-1}+0.25+ 0.1	10.5	2.700
Control	--	12.4	2.510
CD (0.05)			1.350

4.9 **Evaluation of germplasm for quality**
(Solan)

Sixtysix germplasm collections of ginger were analysed for quality characters. Besides these, 30 collections were evaluated for crude fibre content. The maximum essential oil content of 2.5 per cent was observed in SG-700, SG-693, SG-670 and BDJR 1054, whereas the oleoresins were maximum in Kerala Local (10.18%) followed by SG 568 (9.78%) and SG-710 (9.33%). The dry recovery was maximum in SG-679 (21.5%). The minimum amount of crude fibre reported in SG-684 (5.25%), followed by SG-554 (5.40%) and SG-674 (5.70%).

TURMERIC

5.1 Germplasm collection, description and evaluation
(Pottangi, Solan, Jagtial and Dholi)

The Pottangi centre added four new accessions in turmeric making the total to 191 accessions. During the year, out of 153 Curcuma longa evaluated, the highest fresh rhizome yield of 8.5 kg / M^2 was obtained with turmeric selection No.6; among 17 Curcuma aromatica, Betagude gave 2.95 kg/M^2 and among C.amada, CAM-3 gave 2.05 kg/M^2.

As per the decisions of the XII Workshop, the Solan centre is entrusted with the maintenance of elite Turmeric germplasm. The centre at present holds 164 indigenous germplasm collections; of which ST-616, ST-154, ST-220, ST-223, TC-4, ST-55, ST-491 gave an yield of more than 6.5 kg per 3 M^2 plot.

The 188 germplasm collection maintained at Jagtial on evaluation showed wide variation for growth and yield characters; they were grouped into different maturity groups. Among the 188 germplasm lines evaluated, 20 lines showed resistant reaction to Taphrina leaf spot disease; the promising cultures being CL-1290, CL-1369 and CL-136. Another set of 19 cultures showed resistance to Colletotrichum leaf spot, the promising entries being PTS-24 and PTS-28.

Out of the 80 germplasm collected and maintained at Dholi, ten promising lines were identified for further evaluation.

In the sick plot screening technique against rhizome rot disease, cultures PTS-10, PTS-13, PTS-14, CL-136, CL-138, CLI-195, CL-1317, CLI-330, CLI-370, Kerkipadu and Ethamukula showed no incidence of rhizome rot disease compared to Armoor (80% damage). However PTS-10, PTS-13 and PTS-11 were found promising with 30.0 t/ha rhizome yield compared to 10-15 t/ha in others.

5.2 **Initial evaluation trial**
(Pottangi, Jeypore and Dhali)

Fifteen promising entries each of long duration type (maturity period more than 200 days) and short duration group (less than 200 days) were evaluated for last three years 1992-93, 1993-94 & 1994-95 at Pottangi. The three years' study indicated that PTS-43 (25.31 t/ha), PTS-8 (23.23 t/ha) and PTS-22 (22.04 t/ha) are the elite cultures in long duration turmeric and PTS-50 (17.06 t/ha) PTS-15 (16.09 t/ha) and PTS-52 (15.69 t/ha) emerg short duration turmeric.

Jeypore, seven each of long duration, short duration and intermediate types were evaluated to identify high yielding types. In the long duration group, PTS-24 (27.16 t/ha) and 218 (26.75 t/ha); CLI-317 and CLI-367 (27.22 t/ha each) under medium and PCT-14 (35.15 t/ha) and PTS-13 (34.98 t/ha) in short duration group were found superior.

Ten promising lines were tested under IET at Dhali. Rajendra Sonia cultyielded giving 400.10 Q/ha fresh rhizome yield followed by Roma (check) yields 201.67 Q/ha which is statistically in par with CF 317, PH-5, PH-2 and Lindigrem.

5.3 **Comparative yield trial**
(Pottangi and Dhali)

Six promising cultivars were evaluated (with Roma as check) for three years at Pottangi. The accession PTS-19 (19.5 t/ha) followed by PTS-62 (17.73 t/ha) gave significantly higher fresh rhizome yields in the pooled analysis of the three years' data.

In the trial with 10 lines at Dhali, the growth and yield parameters observed the highest fresh rhizome yield in Sugandham (387.95 Q/ha) followed by PCT-11 (356.21 Q/ha).

5.4 **Multilocation trial (MLT-1991 Series III)**
(Jagtial and Pottangi)

The MLT (1991) was laid out with 12 cultures at Jagtial for the third year. Out of the 12 varieties tested, Duggirala out yielded other varieties giving a significant / projected yield of 40.77 t/ha, followed by 37.62 t/ha by TC-2 compared with the local cultivar Armoor (35.55 t/ha). Among the thirteen high yielding cultivars tested, PTS-19 was the top yielder 21.63 t/ha.

5.5 **Effect of spacing on yield of turmeric**
(Dhoni)

A study conducted on the effect of inter and inter row spacing (4 spacings) on the yield of turmeric variety, Rajendra Sonia. The yield differed significantly and a spacing of 30x20 cm produced highest yield of 478.87 Q/ha.

5.6 **Quality evaluation of germplasm collections**
(Solan)

The samples of 61 collections (from Solan) of turmeric were analysed for quality attributes. The highest level of curcumin and oleoresin was obtained in BCJRK-1250 (3.65%) and 14.11% respectively. The maximum content of essential oil 7.88% obtained with VK-70 whereas the dry recovery was maximum in ST-43 (29.6%).

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TREE SPICES

6.1 Germplasm collection, conservation and cataloguing of Tree spices viz., clove, nutmeg & cinnamon

(Yercaud & Pechiparai)

At Yercaud centre, progenies of 13 elite clove lines were field-planted during 1993 and 1994. Establishment of the plants is good. Yercaud centre maintained ten cinnamon, one cassia cinnamon besides three allspice accessions.

At Pechiparai centre, in clove two progeny trials were in progress. One trial with nine elite lines (Lines - 4,5,8,9,10,11,12,13 and 14) collected from Indian Institute of Spices Research, Calicut was laid out during Sept. '91 and another trial with seeds from seven high yielding trees of Kanyakumari district (Estate names where these are collected; Castle Rock, Meremalai, Epen, Pioneer, Bethany, Thulasi and Ambadi) were planted during May '94. In the first trial, Type 5 recorded the maximum mean plant height of 123.2cm and girth of 4.5mm, while in the second trial,types collected from Castle Rock recorded the maximum mean plant height of 85.3mm.

At Pechiparai, seven seedlings in each of 7 high yielding nutmeg types collected from various estates of Kanyakumari district like Balamore, Pioneer Muthu, Pioneer Sasthe, Omanapuram, Rani Estate, Ambika Estate and Vellimalai Estate were field-planted during May 1994. Types collected from Vellimalai Estate recorded the highest mean plant height of 95.3cm and stem girth of 2.9 cm.

The trial with 4 nutmeg types (Indian Institute of Spices Research, Calicut), 8 grafts/type, along with one high yielding type collected from State Horticultural Farm, Courtallam was laid out during 1991. The type-2 recorded maximum mean plant height of 179.3cm, while type 4 recorded maximum stem girth of 7.4cm, Twelve cinnamon types which include, nine types supplied by IISR, Calicut are under field evaluation; SL 53 recorded the maximum mean plant height 324.2 cm, and stem girth (19.3mm) in 3 years' growth.

6.2 Multilocation trial in Clove
(Yercaud & Pechiparai)

The MLT with five elite lines viz. sel-1, sel-2, sel-3, sel-4, sel-5 (supplied by IISR Calicut) was laid out during 1991-92 in both Yercaud and Pechiparai centres. Growth parameters were recorded.

6.3 Multilocation trial in Cinnamon
(Yercaud, Ambaleyeyal, Thadiyankudissai & Pechiparai)

The MLT with five elite lines sel-44, sel-53, sel-63, sel-189, sel-203 (supplied by IISR Calicut) was laid out during 1992 in all the four centres with 12 seedlings per line. The selection "Sel In 189" was found to be promising in Thadiyankudissai centre. In all the centres, vegetative parameters have been recorded.

6.4 Vegetative propagation in Nutmeg Clove and Cinnamon
(Yercaud, Pechiparai & Thadiyankudissai)

Epicotyl graftings at epicotyl stage, two leaved four leaved and six leaved stages of root stock of nutmeg were carried out at Yercaud centre using non-rooted orthotropic and semi hardwood scions. The maximum success of 45.6% was observed when rootstocks of two leaved stages were used for grafting.

At Pechiparai, cutting and air layering were tried in clove and nutmeg. Grafting is tried in nutmeg (nutmeg on nutmeg)

At Thadiyankudissai, trial on vegetative propagation in Cinnamon with stem cuttings was laid out. Four growth regulators, NAA, IBA, IAA and SADH at three concentrations each (1000, 2500 and 5000 ppm) for rooting the stem cuttings were tried to stem cuttings. Hardwood cuttings recorded the highest rooting of 49%. Among hardwood cuttings, NAA 2500 ppm recorded the maximum of 82.6% followed by NAA 5000 ppm (62.5%).

6.5 Drip Irrigation in Clove and Nutmeg (Yercaud)

The trial was laid out during July '92 with clove seedlings and nutmeg grafts at 6m x 6m spacing. The drip system was installed during March '93. Following are the treatments.

Phase I (Prebearing age up to 8th year)

T1 Dripping of 2 Lt water/day/plant during dry months
T2 Dripping of 4 Lt "
T3 Dripping of 6 Lt "
T4 Dripping of 8 Lt "
T5 Providing 8 Lt of water by watering once in a week/plant during dry months (control)

The treatment for Phase II - bearing age (after 8th year) will be fixed based on the growth and response to the above drip irrigation trial.

The second year observation on vegetative growth parameters after installing drip irrigation system was recorded. The mean plant height was 169.9cm and the maximum mean number of branches as 9 in T4.

6.6 Biofertilizer trial in tree spices - Clove & Nutmeg (Yercaud)

In the biofertilizer trial in clove and nutmeg, the treatments as per the technical programme were imposed. The pre and post treatment levels of NPK were analysed in the treatment plots. Data on nutmeg yield showed that the treatment T4(ie. T2 (100kg FYM + 40C, 32C, 120Cg of NPK/tree/year) + 50g each of Azospirillum and Phosphobacteria/tree/year showed the maximum fruit number/tree (85.75), followed by T5 (ie. 50% of T2 + 50g each of Azospirillum and Phosphobacteria/tree/year (76.00). The other characters viz. fruit length, girth and tree girth were also recorded for all the treatments. The treatment (T4) recorded higher values for all these characters.

CORIANDER

7.1 Germplasm collection, maintenance and evaluation
(Jobner, Jagudan, Guntur, Coimbatore, Hisar and Dholi)

The Jobner centre maintained 683 collections (578 indigenous and 35 exotic). In the evaluation of 277 accessions, promising accessions were identified viz., ATP-29, UD-13, TG-400, UD-119, UD-321 and TG-318. Screening of 33 germplasm entries against stem gall disease caused by Protomyces macrosporus was continued at farmers' field in Danta (Sikar), but as the disease did not appear this year too, data could not be recorded. Screening of 35 accessions tested against root knot nematode (M. incognita) was done in pots and in field. None was found to be resistant in field conditions, though UD-20, UD-124 and UD-239 were found to be moderately resistant in pot culture studies.

During 1994-95 rabi season, out of 230 collections, 120 were evaluated at Guntur. There was good variation for the various yield attributes and the yield data of first 5 rankers are presented below:

LCC 25 (1583 kg/ha); LCC 20(1558 kg/ha); LCC 23 (1542 kg/ha); LCC 13 (1517 kg/ha) and LCC 16 (1500 kg/ha)

The Coimbatore centre is maintaining 372 accessions (108 accessions collected during 1994-95), among which 108 were evaluated during Rabi 1994-95. The yield per plant varied from 0.6 to 12.7 g in the different accessions tested. The most promising ones which excelled in yield are UD 228 (12.7g per plant), JCo.45 (10.9g per plant), JCo. 126 (9.1g per plant), CS. 287 (9.1 g/plant) and IC 67153 (9.1g/plant).

The Jagudan centre retained 140 collections, out of the 159 collections evaluated. Sixteen entries (15 exotic + 1 indigenous) were screened against powdery mildew and the PDI (Per cent Disease Incidence) varied from 48 to 91. None of the entries was found to be resistant or tolerant to powdery mildew.

Being the first year the Hiser centre did not make any collection, but maintained the germplasm. Out of the 58 accessions evaluated for yield, DH-13 and DH-139 gave the highest yield of 340g per plot of 2.5sq.m.

The Dholi centre collected and maintained 48 types, out of which ten collections were found to be promising for yield, quality as well as disease resistance viz. GC-85, UD-44, UD-93, GC-43,UD-55 GC-44 UD-115, UD-136, RD-22 and RD-120. In the screening of varieties against stem gall disease out of the 10 varieties, Rajendra Sonia (RD-44) shown resistance to the disease.

7.2 Initial Evaluation Trial (IET)

(Jaguden, Guntur, Hiser, Dholi and Coimbatore)

The trial with 9 entries alongwith Guj. Coriander-2 as control at Jaguden centre indicated that the yield differences were non-significant; but average performence of the 2 years' data revealed that entry J. Cc-327 gave the highest yield (12.89 q/ha) followed by J. Cc-58 (12.78 q/ha)

Out of 9 accessions evaluated along with Pant Haritima at Hiser centre, DH-13 and DH-52 gave significantly higher yield of 17q/ha and 16.6q/ha respectively, over the control. The Experiment was completely destroyed due to hail storm at Dholi.

During 1994-95 rabi, ten promising accessions selected from germplasm were evaluated with Sadhana as check at Guntur. Among the entries tested, though not significantly superior over check, ATP-147 and ATP-8 recorded higher yields with 1050 and 1022 kg/ha respectively. The check Sadhana recorded an yield of 894kg/ha.

The trial with eleven accessions, alongwith Cc-3 (control) was laid out at Coimbatore during Rabi 1994-95. Significant differences were observed among the enteries, compared to control with regard to number of umbels per plant, percentage of wilt incidence and yield per plot. Accessions 964, 745 and 1050 recorded significantly more number of umbels per plant (55.3, 54.8, 54.8) as against Cc.3 (48.6). The wilt incidence was the lowest (9.2%) in entry 466, followed by 1050 (10%). Variety Cc.3 recorded the highest (20.1) per cent of

wilt. Accessions 745 and 748 recorded the highest grain yield of 0.583 kg/plot of 10sq.m. size followed by 812 (0.567 kg/plot) and 4.62 (0.560 kg/plot). The yield trend signifies the productivity of the improved entires in the initial evaluation trials.

7.3 Multilocation trials (MLT 1993 Series II)
(Jagudan, Jobner, Coimbatore, Guntur, Hisar & Dholi)

The MLT-1993 series II was laid out at Jagudan with 11 entries. The yield and yield contributing traits were recorded. None of the entries performed superior than control, the mean yield data of two years showed that the entry from Tamil Nadu, ie. CC-964 gave maximum yield of 13.33q per hectare, which was 9.93% higher than control.

A total of 11 entries including Cc-3 as control were evaluated during Rabi 1994-95 at Coimbatore. Significant differences were observed among the entries, as compared to control for number of umbels/plant, incidence of wilt and yield. DH-447 recorded the highest number of umbels per plant (42.7) followed by DH.38 and CC-462 with 40.6 and 39.9 umbels respectively as compered to Cc.3 (35.3). ATP 77, UD 446 and JCc.123 were less effected by wilt, with incidence of 18.6, 19.5 and 19.7 per cent respectively as against the maximum incidence of 32.7 per cent in Cc.3. JCc 64 alone recorded the highest yield of 0.683 kg per plot as compared to Cc-3 (0.583kg/plot).

Among the 11 entries tried at Guntur, CC-964 recorded the highest yield of 1078 kg/ha followed by ATF-77 with 1025 kg/ha. The yields of remaining entries are on par with check, viz., Sadhana (961 kg/ha).

A trial with twelve coriander entries namely UD-435, UD446 UD-447, RCr-41 (Rajasthan); CC-964, CC-462 (Tamil Nadu); J. Cori-123, J. Cori-64 (Gujarat); ATP-77, ATP-102 (Andhra Pradesh), DH-36, DH-38 (Haryana) with the released variety RCr-41 being control was laid out at Jobner in Oct. 93 under irrigated conditions. Vegetative, reproductive and quality traits were recorded. The maximum grain yield of 20.83q/ha was recorded in DH-36, though no entry gave significantly higher yield compared to control. Early maturing

varieties like ATF-77, ATF-102, CC-462, J. Cori-64 and CC-964 produced significantly low grain yield as compared to late maturing entries.

A trial with ten entries namely CC-462, CC-964 (Tamil Nadu) ATP-77, ATP-102(Andhra Pradesh), DH-36, DH-38 (Haryana), J.Cc-123, JCc.64 (Gujarat) and UD-446, UD-447 (Rajasthan) alongwith Narnaul selection (control) was laid out at Hisar in November 93 and the vegetative as well as yield traits recorded. UD-446 recorded maximum grain yield of 2.5t/ha but the plant population among the entries during the year was not uniform and hence need to be repeated in the years 1995-96 and 1996-97.

A trial with 9 entries viz; J. Cc-64, ATP-77, ATP-102,. DH-36 DH-38, JCc. 123, UD-446, UD-447 and Rajendra Swati (check) was laid out during October 94 at Dhali. The "control" outyielded (38.33q/ha) others. Out of the two Tamil Nadu varieties, namely CC-462 and CC-464 which should have been included in the trial, as the seeds of only CC-462 was received and not included in the trial during 1994-95. The CYT for green leaf types was destroyed due to hailstorm and seed material could not be saved.

7.4 **Mutation breeding in Coriander to evolve varieties with earliness and resistance to disease**
(Jobner and Coimbatore)

Twenty progenies of coriander derived from 5, 10, 15 and 20 Kr doses of gamma radiations were evaluated at Jobner in two initial evaluation trials namely IET A and IET B with ten progenies in each trial, alongwith RCr-41 and UD-20 as check. The trial was laid out during November '93 and the vegetative and reproductive traits were recorded.

The 9 mutant lines of Coriander were evaluated at Coimbatore during 1994-95. In IET A, 5 Kr-10 recorded maximum grain yield of 6.24q/ha. In IET B, 5 Kr-14 recorded maximum grain yield of 5.20 q/ha. Other progenies identified in IET A are 20 Kr-5 (4.99q/ha) Kr-13 (4.64q/ha) and 20 Kr-6 (4.51q/ha) and in IET B, 5Kr-68 and 5Kr-6 (14q/ha) RCr-41 and UD-20 (controls) recorded 2.70 and 2.97q/ha in IET A and 3.60a and 3.19 q/ha in IET B respectively.

An experiment was conducted to evaluate mutant lines at Coimbatore during Rabi 1994-95 with nine entries. The plant height ranged from 53.6 to 60.7 cm. The mutant lines did not show any significant differences. Mutant 60/1 recorded maximum height (60.7cm). The mutants did not also exhibit any striking variability in respect of number of primary branches per plant, number of umbels per plant, number of umbellates per umbel and number of seeds per umbel. All showed powdery mildew incidence which is more or less comparable with that of Cc-3 or even higher than Cc-3. However, there is significant variation expressed by the mutants in respect of yield of grains. Mutants 16/6, 47/11 registered higher yields of 550, 533g/plot (Plot size : 10 sq M) respectively as compared to Cc-3 (516g).

7.5 **Studies on wilt disease and powdery mildew management of coriander (Coimbatore)**

The trial on biocontrol of coriander wilt was laid out during Rabi 94-95 on Cc-3. Biocontrol agents like Trichoderma viride, T. herzianum, Bacillus subtilis, Pseudomonas fluorescens were tested for their efficacy in comparision with fungicides as seed treatment and soil drenching.

Carbendezim (0.2%) controlled the disease to a maximum extent (2.1 per cent disease) when applied both as presowing seed treatment as well as soil drenching as against control (22.9 per cent disease). T. herzianum also reduced the disease to a maximum level (3.8 per cent)by the seed treatment of T. herzianum at 4 g per kg of seed. All the treatments exhibited spectacular effects in reducing the disease over control.

All treatments showed an yield improvement over control which ranged from 0.5 to 0.7 kg per plot while the untreated plots recorded a very low yield of 0.3kg only. Among treatments, seed treatment with Carbendezim, Pseudomonas fluorescens and seed and soil treatment with Carbendezim were on par in respect of yield viz. 0.7kg per plot (size 10 sq.m).

For the management of Powdery mildew disease, nine plant products were tested in Coriander Co-3 at Coimbatore. The observation on the incidence of the disease as well as yield showed significant variation due to the plant products tested on the incidence of the disease as well as yield. Ecofriendly technique of using 5% onion leaf extract as foliar spray gave effective reduction of powdery mildew in Coriander. The disease was recorded from 67.4% to 53.5% per cent.

7.6 Response of coriander to weed management
(Jobar)

The dominent weed species observed in the experimental plots included Chenopodium murale, Heliotropium ellipticum and others being Melilotus alba, Chenopodium album, Amaranthus viridis, Tribulus terrestris and Portulaca sp. Data from third year revealed that weed control measures has significant effect on plant height, umbels/plant grains/umbel, test weight and biological straw and seed yield. All control measures recorded significantly more number of umbels/per plant than "unweeded control" with the maximum value of 24.1 being recorded under weed free conditions, it was statistically at par with that recorded under the treatment Fluchloralin at 0.75kg/ha supplemented with hand weeding once , and Pendimethalin at 1.0kg/ha(22.2). Maximum yield of 22.07g/ha recorded under "weed free treatment" and was statistically at par with that observed under lower levels of Fluchloralin, Metachlor and Pendimethalin supplemented with hand weeding once and Pendimethalin at 1.0kg/ha. Maximum net profit of Rs.1150g/ha was obtained under weed free treatment.

Three years' experimental data revealed that keeping the crop weed free almost up to harvest stage gave maximum seed yield of 9.14q/ha and net profit of Rs.12073 /ha, with benefit:cost ratio of3.09 closely followed by Pendimethalin at 1.0kg/ha Oxflourfen at 0.15kg/ha and Fluchloralin at 0.75kg/ha supplementing these herbicides with hand weeding once and hand weeding twice which recorded seed yield of 8.5, 8.17, 8.05 and 7.35 q/ha and net profit of Rs.11032, Rs.10252, Rs.10408 and Rs. 9204/ha respectively.

7.7 Quality evaletion in Coriander

(Jobner)

The voletile oil of 12 entries under CYT wes determined. The voletile oil contents renged from 0.1 to 0.4%. The meximum voletile oil of 0.4% wes observed in UD-435 end ATP-77, followed by 0.35% in RCr-41, J.Cc-123, J.Cc-64, CC-964 end ATP 102 while minimum of 0.1% wes recorded in DH-38. The grain yield wes meximum in DH-36 (20.83q/he), followed by UD 435 (20.76q/he) end RCr-41 (19.04q/he). A negetive but non significent correlation between grein yield end voletile oil content (r= -0.159) wes observed. Weed control measures significently increased the yield of voletile oil over "weedy check", only due to increase in seed yield. Pendimethelin @ 1kg/he supplemented with one hend weeding resulted in higher yield in coriender.

CUMIN

8.1 Germplasm collection description, evaluation and screening against disease.

(Jobner and Jagudan)

During 1994-95, cumin growing areas in Gujarat were surveyed and 146 entries collected by Jagudan; a total of 460 indigenous and 6 exotic collections were maintained at Jagudan centre. These entries were critically examined and screened for morphological and yield diversity and based on genetic diversity, 131 were selected as promising lines.

Out of nine entries tested, only 3 exotic entries namely EC 243373, EC 232684 and EC 243375 were found to be resistant against Fusarium wilt disease in wilt sick plot in Jagudan. All eight entries studied had equal score (PDI 100% at harvest) for blight disease incidence. Eight entries were tested for screening against powdery mildew. However, the exact estimation of powdery mildew intensity could not be recorded.

A total of 224 collections, including 214 indigenous and 10 exotic were maintained at Jobner centre. The cumin variety RZ-19 maintained its superiority and produced average yield of 4.13q/he during 1990-91, 91-92 and 1993-94. JC 147 recorded 3.79 q/he, JC 11: 3.4q/he, JC-15: 3.41 q/ha and UC-216 : 3.34 q/he. The lowest yield of 2.86 q/he was recorded in UC-218.

8.2 Initial evaluation trial

(Jagudan)

This is the second year of the experiment. Ten entries (seven exotic and two indigenous) were tested, keeping Guj. Cumin-2 as a check. The trial was laid out in November 1994. Yield and yield contributing characters were recorded. The yield differences were non significant among the entries. An average performance of two years' showed that an entry EC-109635 recorded the highest yield (8.18q/he) with 6.23% increase over control.

8.3 Multilocation trial (MLT 1989 Series I)
(Jobner, Jagudan and Hisar)

Eight entries namely UC-216, UC-217, UC-218 (Rajasthan), JC-9, JC-11, JC-15 and JC-147 (Gujarat) and Guj. Cumin 1 (control) were included in the comparative yield trial on cumin at Jagudan. This was the 4th year of the experiment and the trial was laid out during November '94. Observations on yield and yield attributing characters were recorded and the differences were non-significant for yield among the entries. Mean yield of the past 2 years showed that JC 147 gave the highest yield of 6.93 q/ha which is 6.3% more over the control.

Eight entries (Seven as in Jagudan) alongwith RZ-19 (Control) were evaluated at Jobner. The trial was laid out in November '93. The maximum grain yield of 4.47q/ha was recorded in JC-11, closely followed by RZ-19 (4.13q/ha), JC-147 (3.92/ha), UC-216 (3.66q/ha) and JC-15 (3.56q/ha), while UC-217 recorded lowest yield of 3.15 q/ha. The mean performance of entries evaluated in comparative yield trial during 1990-91, 1991-92 and 1993-94 revealed that all entries were at par as far as yield potential is concerned; however, variety RZ-19 recorded maximum grain yield of 4.13q/ha, followed by JC-147 (3.79q/ha), JC-11 (3.43q/ha) JC-15 (3.41q/ha) and UC-216 (3.34q/ha) while the lowest yield of 2.86q/ha was recorded in UC-218.(Table 13)

Table 13 Mean performance of cumin entries evaluated during 1990-91, 91-92 and 1993-94 at Jagudan

Entries	Yield (q/ha)			
	1990-91	1991-92	1992-93	Mean
UC-216	4.66	1.69	3.66	3.34
UC-218	3.33	1.85	3.41	2.86
JC-9	4.38	1.69	3.37	3.15
JC-11	4.61	1.20	4.47	3.43
JC-15	4.45	2.21	3.91	3.41
JC-147	5.34	2.14	4.13	3.79
RZ-19	5.03	3.23	3.56	4.13
CD at 5%	NS	1.01	NS	NS
CV%	18.20	34.14	14.54	27.69

Hisar centre discontinued the programmes on cumin as per the XII Workshop dicision in view of high disease incidence.

8.4 **Mutation studies and hybridisation programmes in cumin**
(Jagudan)

To induce genetic variability, cumin seeds were treated with Gamma rays of different doses (ie. 5,10,15,20 and 25 KR). Seeds germinated in 5, 10 and 15 Kr treatment. Cumin seeds were also treated with different doses of EMS/ie 0.25, 0.50, 0.75 and 1.00 per cent). Seeds germinated in "0.25 per cent" treatment. Abnormal plants were isolated and harvested seperately and all other normal plants were bulked. In the hybridisation programme, GC1 was crossed with "Hairy Cumin". Seventy three F1 seeds were collected during Rabi 1994-95.

8.5 **Evolving control measures against wilt disease including crop rotation**
(Jobner)

Six treatments viz, soil solarisation, spraying captan 0.3%, bavistin 0.1% thiram 0.3%, Trichoderma 0.4% were evaluated for their effect on wilt. The trial was laid out in December 1993 and per cent infection recorded. Solarisation reduced disease incidence (42.04%) resulting in maximum grainyield of 0.925 q/ha. Trichoderma (45.43%) giving an yield of 0.538q/ha. The control resulted in maximum disease incidence (87.21%) and the lowest yield (0.050 q/ha) as compared to all other treatments.

An experiment with ten treatments was conducted to study the effect of crop rotation on yield and wilt infection of cumin at Jobner centre. The experiment was started in 1984-85 and ten years' experimental data revealed that three year crop rotation ie "cluster bean-cumin-cluster bean-wheat-cluster bean-mustard" recorded the highest yield of 257.59kg/ha and the wilt percentage of 36.46 as against 96.72 kg/ha and 57.13% respectively under the one year crop rotation with cluster bean.

8.6 Quality evaluation in cumin (Jobner)

The volatile oil content of 8 cumin entries tested under CYT ranged from 3.3 to 4.5%. The best entries with respect to volatile oils are : UC-217 (5.4%), UC-216 (4.05%) and UC-218 (4%).

Data on the mean performance of volatile oil contents over three years (1990-91, 1991-92 and 1993-94) provided in Table 14 confirmed that JC-147 gave the highest mean volatile oil of 3.83% followed by UC-218 (3.80%). The total yield of volatile oil (depending upon yield of grain and oil percentage of entry) was maximum in JC-147 (14.5 l/ha), followed by RZ-19 (12.92 l/ha) and UC-216 (11.89 l/ha).

Table 14 Mean yield performance of cumin entries during 1990-91, 1991-92 and 1993-94 in CYT at Jobner

Entry	Mean grain yield (q/ha)	Volatile oil				
		% (ml/100g)				Mean Yield Mean (l/ha)
		1990-91	1991-92(*)	1993-94		
JC-147	3.79	3.9	3.7	3.9	3.83	14.51
UC-218	2.86	3.6	3.8	4.0	3.80	10.86
JC-9	3.15	3.6	4.0	3.3	3.63	11.43
UC-216	3.34	3.1	3.6	4.0	3.56	11.89
JC-15	3.41	2.9	4.2	3.3	3.46	11.79
JC-11	3.43	2.5	3.6	3.5	3.21	11.01
RZ-19	4.13	2.6	3.4	3.4	3.13	12.92

* Crop abandoned due to unfavourable impact by weather

9.1 Germplasm collection, description, evaluation and screening against diseases

(Jobner, Jagudan & Hisar)

Jobner centre holds a total of 139 collections (131 indigenous and 8 exotic) in fennel. A total of 254 entries of fennel were collected after surveying the fennel growing areas in Gujarat by Jagudan centre. The following selections were made with a view to develop an early dwarf and high yielding variety.

Sl. No.	Details	No. of plants selected	Purpose
1.	Compact umbel with compact umbellates having more seeds	80	For improvement of yield
2.	Selection for earliness	182	For earliness
3.	Selection for dwarfness	56	For dwarfness
4.	Variant types	25	For morphological variability

Jagudan centre collected 254 cultivars of fennel during 1994-95 by a survey conducted in the fennel growing areas of Gujarat. Out of the 352 germplasm screened evaluated for yield and morphological diversity and 40 accessions selected for further evaluation.

Nineteen exotic fennel entries were field-screened at Jagudan against Ramularia blight disease, alongwith Guj. Fennel-1 as control. The trial was laid out in Nov.1994 but disease had not occurred.

Twenty four lines were maintained by sibmating under muslin cloth and self seeds of these lines have been harvested by the Hisar centre.

9.2 Initial evaluation trial (IET)

(Jagudan & Hisar)

Eight entries viz., UF-125, UF-133 (Rajasthan), JF-25 JF-29 (Gujarat), HF 134, HF-71 (Haryana), PF 35 and Guj. Fennel-1 (control) were evaluated. The trial was laid out in November 1994. Yield and yield related attributes were recorded. Though none of the entries showed significantly higher yields as compared to control, two entries gave higher yields than the control. They are JF 25, JF 29. JF-29 gave the maximum yield of 15.52 q / ha. followed by JF-25 giving 14.19 q/ha. The yield of JF-29 was 11% higher than "Control".

In the IET in fennel, at Hisar HF 71, HF-102, HF-104 and HF-119 gave good performence.

9.3 Multilocation trial (MLT 1989 Series I)

(Jagudan, Jobner & HIsar)

At Jobner centre, ten entries viz. UF(M)-1, UF-90, UF-101, UF-112, UF-131 (Rajasthan); JF-66, JF-71, JF-127, JF-132 (Gujarat), HF-33(Haryana) plus control (local) were evaluated. The trial was laid out on November 93. Morphological yield and quality perameters were recorded.

The results indicated significant differences among entries evaluated four days to flowering, umbels/plant, grains/umbel, test weight and grain yield, while it was non significant for rest of the characters studied. The maximum grain yield of 17.4 q/ha was recorded in UF-101, followed by JF-71 (16.25q/ha). The volatile oil content ranged between 1.1% (Local) and 1.6% (UF-90).

The mean performance of entries evaluated during 1990-91, 1991-92 and 1992-93 revealed that all the entries were at par as far as the yield potential is concerned, but the maximum grain yield of 19.3q/ha was recorded in UF-101, followed by UF-90 (18.76 q/ha) and local (18.13 q/ha)

The CYT with 13 entries evaluated at Hisar. On the basis of mean yield performance for 3 years (1991-92 to 1993-94), HF-33 registered the highest yield of 23.7q/he which was 37.0% increase over local followed by JF.132 (31.1%), UF-131 (27.2%) and UF (M) 1 (25.4)%)

9.4 **Mutation studies and crossing programmes in Fennel**
(Jeguden)

Besides mutation studies, crossing programmes initiated at Jeguden in Fennel. The crossed exotic cultures and bloomless type with Gujerat F.1 and sufficient F1 seeds were harvested. The exotic cultures were crossed with Guj. F.1 for dwarfness and with bloomless type for inheritence studies.

9.5 **Response of fennel to weed management**
(Jobner & Hisar)

At Jobner, the experiment comprised of 16 treatments consisting 4 herbicides viz., Fluchlorelin, Pendimethelin, Metolachlor and Oxyfluorfen (each at 2 concentretins and the lower dose supplemented with hand weeding once at 50 DAS). unweeded control, hand weeding once/25 DAS) and twice (25 and 50 DAS) and "weed free". Data revealed that weed control measures significantly controlled the weed population compared to unweeded control.

The plots "hand weeded" as and when needed to keep weed free were almost weed free, allowing only 0.70 q/he of weed dry matter accumulation up to harvest stage. Hand weeding proved to be the best treatment at 50 DAS. Among the herbicidal treatments, Pendimethelin at 1.5kg/he was most effective in reducing the weed dry matter production at 50 days' crop growth stage. The plots hand weeded twice and those treated with lower dose of herbicides used in the experimentation supplemented with hand weeding has significantly reduced the dry matter production of weed's compared with the rest.

Three years experimental data revealed that weed control measures significantly effected the plant height, branches and umbels plant, umbelletes and seeds/umbel, test weight, harvest index and biological, straw and seed yield of fennel. Weed free plots recorded maximum of 134.8cm plant height, 12.3 umbels/plant, 29.9 umbelletes/umbel, 237.2 seeds/umbel, 28.13q/ha biological yield and 13.68 q/ha seed yield which was a significant increase of 36.3, 83.6, 80.1, 17.5, 103.3 and 502.7% over unweeded control respectively.

Three years' pooled data indicated that fennel weed free plots (hand weeding thrice) produced the best mean seed yield of 10.19 q/ha with a net profit of Rs.15,177/ha and benefit : cost ratio 3.35 followed by application of Pendimethalin 1.0 kg/ha + hand weeding once(8.67q/ha) with benefit : cost ratio of 2.75 and net profit of Rs.12,255 as compared to a net loss of Rs.394 and benefit : cost ratio of -0.11 in weedy check.

At Hisar, the experiment comprised of 4 herbicides viz. Fluchloralin, Pendimethalin, Isoproturon and Oxyfluorfen each at 2 two concentrations and the lower dose of herbicide was supplemented with one hand weeding at 45 days after sowing along with one hand weeding, two hand weedings alone, weed free and weedy control. Major weed flora in the field were Chenopodium album, C. murale, Cenchrus ciliaris, Tribulus terrestris, Portulaca oleracea, Cyperus rotundus and Cynodon dactylon. All treatments significantly reduced the weed population and their dry weight compared with control. Maximum dry weight of weeds was found in plots treated with Isoproturon at 0.5kg/ha and minimum in Pendimethalin at 1.5kg/ha followed by its lower rate, Oxyfluorfen at both the rates. Oxyfluorfen at both the rates was phytotoxic to the crop. Maximum seed yield was recorded in "weed free" followed by Pendimethalin at 1Kg/ha supplemented with one hand weeding and Pendimethalin at 1.5kg/ha

3.6 **Quality evaluation studies**
(Jabner)

The volatile oil content of 11 entries of fennel tested under CYT ranged from 1.1 to 1.6%. The maximum volatile oil of 1.6% was found in UF-90, followed by 1.5% in UF-112 and UF-33. There is a positive correlation between grain yield and volatile oil contents (r= 0.416).

The mean performance of nine selected fennel entries over 1990-91, 91-92 and 93-94 was worked out. The highest volatile oil yield was reported to be 23.73 l/ha in UF 101, followed by 23.63 l/ha in UF-90 and 21.03 l/ha in control (Table 15).

Table 15 Mean yield performance of volatile oil contents of selected entries of fennel (1990-91, 91-92 and 93-94) at Jobner.

Sl. No.	Entry	Mean grain yield (q/ha)	Volatile oil % (ml/100 g)				Projected yield (L/ha)
			1990-91	1991-92(*)	1993-94	Mean	
1.	UF-90	18.76	1.30	1.1	1.40	1.26	23.63
2.	UF-101	19.30	1.30	1.0	1.40	1.23	23.73
3.	Local	18.13	1.30	1.1	1.10	1.16	21.03
4.	UF-112	17.83	1.00	1.0	1.50	1.16	20.68
5.	UF-131	17.83	1.00	1.1	1.20	1,10	19.61
6.	UF (M)-1	17.91	0.85	1.0	1.25	1.03	18.50
7.	JF-132	17.97	0.80	0.9	1.40	1.03	18.50
8.	JF-127	18.04	0.90	1.0	1.10	1.00	18.04
9.	JF-66	17.88	0.70	0.9	1.40	1.10	17.88
10	JF-71	17.90	0.80	0.9	1.2	0.96	17.18

* The crop of 1992-93 was abandened due to damage by bad weather.

The effect of weedicide application and weed control on the volatile oil content of fennel in the experiment comprising of four herbicides was estimated at Jobner. Weed control measures significantly increased the grain yield over weedy control, weed free fennel produced maximum volatile oil yield of 21.11 l/ha. However, treatment of Oxyfluorfen (0.15kg/ha) supplemented with one hand weeding or Pendimethelin (1kg/ha) supplemented with one hand weeding indirectly resulted to volatile oil yield of 17.11 l/ha or 16.11 l/ha respectively. The volatile oil yield increased due to above treatment was 6.0 times and 4.6 times, respectively more then (weedy) control

At Hisar the experiment comprised of 4 herbicides viz., Fluchlorelin, Pendimethelin, Isoproturon and Oxyfluorfen each at 2one and the lower dose of herbicide was supplemented with one hand weeding at 45 days after sowing along with one.

10.1 Germplasm collection, maintenance, evaluation and screening against diseases

(Jobner, Jagudan, Coimbatore, Guntur & Dholi)

A total of 270 accessions are maintained at Jobner centre. This includes 12 exotic types. A total of 200 accessions (127 : Rajasthan, 43 : Tamil Nadu and 30 : Gujarat) were evaluated with 4 controls viz., RMt-1, HM-46, UM-34 and local during 1993-94. Seventy one accessions were better over all the four controls.

In Jagudan centre, the area under fenugreek was surveyed and 15 entries were collected on the basis of genetic diversity. A total of 47 entries are retained (out of a total of 70 collections) not a single entry was found superior for yield over the control in CYT.

Coimbatore centre collected 98 accessions during 1994-95, making the total to 179 fenugreek accessions, out of which 98 were evaluated for their performance during Rabi 94-95. Twelve accessions recorded yields either on par or above the ruling variety Co-1; accession 243 recorded the maximum yield of 7.7 g/plant. The other promising accessions, as compared to Co-1 are JF-10, JF-8, UD-145, HM-57, 256, 243, 273 UM 120 and M 46.

Guntur centre evaluated 70 collections. L.F.C-33, 59, 58, 28 and 32 are the first five rankers yielding 1667, 1600, 1558, 1533 and 1517 kg/ha respectively. There has been diversity among the collections with regard to height of the plant, number of pods, pod length and number of seeds/pod.

Fifty eight germplasm have been collected and maintained at Dholi. Among these, eight lines have been identified as promising. The germplasm will also screened against Cercospora Leaf spot disease; HM 103 and HM 141 gave resistant reaction against this leaf spot.

Four entries were screened at Jagudan for resistance to powdery mildew. The entries are : Methi EC - 257566, Fenugreek Australian, Kasuri and Methi local. Methi EC-257566 entry was resistant against powdery mildew.

36 entries of fenugreek were screened against root knot nematode (Meloidogyne incognita) under artificial conditions in pots in Jobner; UM-35, UM-62 and UM-129 are found to be moderately resistant. In field condition, only UM-129 was found to be moderately resistant. IG

10.2 **Initial Evaluation Trial (IET)**
(Hisar & Coimbatore)

The trial with 9 accessions conducted during 1992-93 and 93-94 at Hisar, HM-103, HM-110, HM-114 and HM-129 gave significantly higher yield over the checkviz., Pusa Early Bunching during the two years of study.

In the IET at Coimbatore, 9 accessions were evaluated during Rabi 1994-95 and gave significant differences among the entries with regard to pod length and yield/plot. The yield varied significantly from 0.226 kg to 0.80 kg per plot. Highest grain yield was recorded by accession 464 (10.380kg/plot) compared to Co-1 (0.250kg/plot).

10.2 **MLT 1993 - series II**
(Guntur, Coimbatore, Jobner, Jagudan, Hisar & Dhcli)

An MLT(1993-series II) was initiated with 9 entries in all the Seed spices centres.

In the trial conducted at Coimbatore with 8 accessions with Co-1 as control (Rabi 1994-95), the grain yield per plot significantly varied among accessions; Acc. CF-390 recorded the highest yield of 0.433kg/plot of $3m^2$.

The trial was laid out in 1993-94 at Hisar with nine entries viz., CF-169 and CF-390 (Coimbatore), HM-103 & HM-141 (Hisar) J. Fenu 145 and J. Fenu 148 (Jagudan), UM - 143 and UM-144 (Jobner) alongwith Pusa Early Branching (check). The plant population among

the entries tested were not uniform, hence the trial has to be repeated. However maximum grain yield obtained with the check Puse Early Branching.

At Dhdli, the entry HM-103 outyielded the Rajendra Kanti (Check) and gave the highest yield of 1996 kg/ha.

At Jobner, RMt-1 recorded maximum grain yield of 27.9q/ha followed by HM-103 (23.13 q/ha), UM-143 (22.66 q/ha), UM-144 (21.44 q/ha) and CF-169 (19.1q/ha) while lowest yield of 17.08 q/ha was recorded by CF-390.

At Jagudan, the trial with the 9 entries was laid out in November 94 with Methi local as control (II year). The yield differences were significant among entries, though none of the entries gave higher yield than Methi local. HM-141 gave the maximum yield of 13.5 q/ha as against 14q/ha for control.

In Guntur, due to complete failure of germination of CF 390 and poor germination of CF-169, the trial could be conducted only with 7 entries. UM-144 recorded the highest yield of 717 kg/ha, but not statistically significant than that of control (Lam selection-1 : 670 kg/ha).

In a "Statich trial" of fenugreek conducted with 11 entries at Tabiji-Ajmer (Jobner) UM-34 and UM-127 recorded maximum grain yield of 20.25/ha closely followed by UM-32 (19.74q/ha), UM-116 (19.53 q/ha) while control, ie, the released variety RMt-1 recorded 14.22 q/ha.

With regard to grain yield, 7 accessions showed low incidence of (less than 10%) powdery milcew. Some of the promising accessions identified are TG-1080, TG-2314, TG-400, UM-144 and TG-1086 for grain yield, while UM-88, UM-87, UM-118 and TG-400 are for powdery mildew resistance. The accessions UM-46, UM-87, UM-84 and UM-100 recorded high protein content in seeds than control. Based on observation on different characters, the germplasm was classified for nine important parameters.

10.3 **Evolving varieties resistant to powdery mildew through mutation breeding and crossing programmes**
(Jagudan & Jobner)

Mutation studies were intitiated in 1988-89 in fenugreek (RMt-1) at Jobner with gamma rays. Of the 44 progenies of fenugreek evaluated in initial evaluation trial during 1992-93 and 1993-94, data indicated that progeny 40-KR-3-4, 30 KR-1-10 and 30 KR 2-15 showed low incidence of powdery mildew as well as high yield potential, as compared to control, RMt-1. Other promising progenies identified for high yield were 40 KR-3-12, 20 KR 15-4 and 40 KR-3-11.

To create genetic variability, fenugreek seeds were treated with different doses (i.e.5,10,15, 20 and 25 KR) of gamma rays at Jagudan. Seeds were germinated in 5,10 and 15 KR treatments. In the hybridisation programme, F1 seeds of local X Kasuri were grown, The F1 was intermediate for morphological traits. New crosses of local and Kasuri, local and Australian cultures were made and a total of 30 and 4 seeds were collected respectively for further study.

10.4 **Biocontrol of root rot disease**
(Coimbatore)

Among the biological agents tested, the root rot incidence was minimum (20.2%) and maximum yield obtained in plots applied with neem cake at 150kg/ha along with pre sowing seed treatment with T. viride.

10.5 **Effect of time of sowing and spacing in the yield of fenugreek**
(Coimbatore, Hisar & Dholi)

An experiment was conducted at three centres to find out the optimum time of sowing and suitable spacing for higher yields in fenugreek. The trial was vitiated due to cyclonic storm and severe flood during South West Monsoon season (Rabi 94-95) in Coimbatore. Similarly the trial sown on the evaluation of leafy types of Rabi 94-95 was damaged by floods experienced throughout the State.

In the study at Hisar, significant differences were observed for all the parameters except length of pods and grains per pod. Late sowing resulted in significant reduction in plant height and other characters. Maximum seed yield obtained when sowing was done on 5th of November at a spacing of 15 x 10 cm.

A similar trial was laid out at Dholi with Rajendra Kanti with three levels of spacing, sown at five different periods. A maximum yield of 16.67q/ha was obtained when the crop was sown on 15th of October at a spacing of 30cm X 10cm.

10.6 Response of fenugreek to weed management (Jobner)

The experiment consisted of 4 herbicides viz., pre emergent oxyfluorfen, metolachlor and pendimethalin and pre plant: fluchloralin each at 2 levels and the lower level was supplemented with hand weeding once at 50 DAS, unweeded control, hand weeding once (25 DAS) and twice (25 and 50 DAS)and "weed free". The dominent weed species observed in the plots included Chenopodium murale, Heliotropium ellipticum and others being Melilotus alba, Chenopodium album, Amaranthus viridis, Tribulus terrestris and Portulaca sp. Third year data revealed that all the weed control measures significantly reduced the weed dry matter production recorded at 25, 50 and 75 DAS and at harvest when compared with unweeded control. Pendimethalin at 1.5kg/ha or at 1.0kg/ha supplemented with handweeding once at 50 DAS was most effective in controlling the weed whereas application of metolachlor at 0.5 and 1,.0 kg/ha controlled the weeds significantly better than unweeded control but proved inferior to rest of the herbicidal treatments.

Three years' pooled data showed almost similar effect of weed control treatments on weed dry matter production in fenugreek.

Third year data revealed that weed control treatments caused significant variation in number of branches and pods/plant and 36.7 pods/plant which was a significant increase of 37.5 and 96.3 per cent over control. Application of fluchloralin at 0.75 kg/ha suplemented with hand weeding once, recorded maximum harvest index of 38.1 per cent which was a significant increase of 48.3 per cent over unweeded control. This treatment gave maximum biological yield of 53.9q/ha and seed yield of 20.5q/he. This treatment gave maximum net profit of Rs.20,001/ha with benefit : cost ratio of 5.24.

The pooled data, by and large, indicated the similar effect of weed control treatments in growth, yield attributes, yield and economics.

GERMPLASM HOLDINGS OF DIFFERENT SPICES AT THE COORDINATING CENTRES

A.	BLACK PEPPER	
	Pemmiyur	76
	Sirsi	58
	Chintapalli	48
	Yercaud	106
B.	CARDAMOM	
	Pampadumpare	87
	Mudigere	245
C.	LARGE CARDAMOM	
	Gangtok	34
D.	GINGER	
	Pottangi	150
	Solan	130
	Dholi	41
E.	TURMERIC	
	Pottangi	191
	Solan	164
	Jagtial	188
	Dholi	80
F.	CLOVE	
	Yercaud	13
G.	NUTMEG	
	Yercaud	15
H.	CINNAMON	
	Yercaud	11
I.	CORIANDER	
	Jobner	683
	Jagudan	140
	Guntur	230
	Coimbatore	480
	Hisar	30
	Dholi	48
J.	CUMIN	
	Jobner	224
	Jagudan	131
K.	FENNEL	
	Jobner	139
	Jagudan	40
	Dholi	56
	Hisar	13
L.	FENUGREEK	
	Jobner	270
	Jagudan	47
	Guntur	70
	Coimbatore	277
	Hisar	80
	Dholi	58

LIST OF COORDINATING CENTRES UNDER AICRP ON SPICES

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FUNCTIONING OF THE COORDINATED PROJECT

India being the "Land of Spices" has a pre-eminent position in production of Spices in the World. We grow almost everyone of the 52-odd Spices which are popular around the globe. The most important Spices cultivated in India are Black Pepper, Small Cardamom, Large Cardamom, Ginger, Turmeric, Chillies, Cumin, Coriander, Fennel, Fenugreek, Clove, Nutmeg, Cinnamon, Garlic, Saffron and perhaps Onion, etc. The area grown to Spices is about 2.30 M ha with the production of about 2.20 M tonnes per annum. The value of these Spices produced is around Rs.55000 M, of which more than 90% is consumed domestically. The major States growing the Spices are Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Gujarat, Maharashtra, Orissa, West Bengal, Uttar Pradesh, Madhya Pradesh and North Eastern Region.

The year 1994-95 saw an upswing in the export in Spices trade and Rs.6073 lakhs Million was earned as foreign exchange by the export of 154112 tonnes of Spices. Still there is further scope to expand/ increase the exportable surplus, especially in Black Pepper, Cardamom, Ginger, Turmeric, Chillies and Seed Spices. Of late, cumin and the value added spices have been in the forefront. The Govt. of India has also launched ambitious spices development programmes through Centrally Sponsored Schemes during the VIII Plan; with a total outlay of Rs.125 crores for the entire Plan period. Nevertheless, the expenditure on Spices research has so far been only marginal and efforts are still made by the ICAR/Govt. of India to increase the budgetary provisions and provide more to this catalytic sector. An important requirement for the future will be quality consciousness and meeting the ISO standards 9000 and the demands from the emerging markets of the European Union, ASTA etc.

The network of Centres under the Coordinated Project rose to 20 during the VIII Plan, with the addition of four new Centres that would come into being from April 1995 in West Bengal, Uttar Pradesh, Madhya Pradesh and Maharashtra. We also have seven Voluntary/ Participating Centres in addition to the above.

The mandatory crops of the spices Project are :

1.	Black pepper	7.	Nutmeg
2.	Cardamom (small)	8.	Cinnamon
3.	Large Cardamom	9.	Cumin
4.	Ginger	10.	Coriander
5.	Turmeric	11.	Fennel
6.	Clove	12.	Fenugreek

The sanctioned budget of the Coordinated Project for the year 1994-95 was Rs.55 lakhs and the funds were disbursed through the different SAUs. The activities of the Centres are regulated by the discussions made during the consecutive Spices Workshops including the latest one viz., the XII Workshop held at Trichur during July 1993. Another important activity has been evaluation of the Project work by the QRT which worked through the details of the Project for the period 1982-91 and made several recommendations.

PERFORMANCE OF THE CENTRES

Black pepper centres :

The work at Panniyur, Sirsi and Chintapalli Centres have been satisfactory; work on black pepper has also been initiated at the three Cardamom Centres viz., Mudigere, Pampadumpara and Yercaud. A review meeting on the Phytophthora foot rot disease was held at Calicut during September 1994 and the decisions have been incorporated in the programmes at the relevant Centres. A new Multilocation Trial (MLT-IV) has been laid out including the Voluntary Centre at Ambalavayal. Panniyur centre has been satisfactorily meeting the demands of production and distribution of nucleus planting material of the improved varieties. The post of Asst. Professor (Plant Pathology) at Panniyur as well as Chintapalli are vacant and barring this deficiency, the Centres have performed satisfactorily.

Cardamom Centres :

The performance of the Cardamom Centres viz., Pampadumpara and Mudigere have been satisfactory. These Centres have also initiated work on black pepper as per the decisions of the Workshop. Survey for the insect pests of cardamom as well as black pepper has been initiated at Mudigere. The post of Associate Professor (Plant Breeding) at Pampadumpara Centre has been shifted to Ambalavayal, under the same University to look after the experiments on black pepper and tree

spices. The post of Plant Pathologist has been vacant at Mudigere for a long time; some of the equipments sanctioned for the Mudigere centre are yet to be procured.

The Yercaud centre has been requested to reduce their work-load on Cardamom and instead concentrate on black pepper and tree spices. The lone large cardamom centre at Gangtok has been progressing smoothly except that the post of Junior Horticulturist is still vacant.

Ginger and Turmeric centres :

The Pottangi, Solan, Jagtial and Dhali centres have been progressing satisfactorily. The Pottangi centre has been leading in production and distribution of seed material of improved varieties of ginger and turmeric; the Jagtial centre has done well in turmeric. The Solan Centre has made significant progress in the biological control of rhizome rot of ginger as well as screening of germplasm against this disease. The intercropping trials as well as cost benefit analysis have been successful with Soybean in ginger for Orissa. The Solan Centre has been asked to discontinue the work on turmeric. The NBPGR has been collaborated for survey and collection of germplasm at Solan, Pottangi & Jagtial centres.

Tree Spices centres :

Yercaud is the lone tree spices Centre with Ambaleyaval, Thadiyankudisai and Pachiparai as other Participating/Voluntary Centres. All the allotted trials have been laid out at these locations and are making satisfactory progress.

Seed Spices centres :

Several multilocation trials are proceeding smoothly at Jobner, Jagudan, Guntur, Coimbatore, Hisar and Dhali centres. All these Centres (except Dhali) have also been participating in the Centrally Sponsored Scheme on production and distribution of improved varieties of seed spices. The Jobner Centre has come out with a viable recommendation to control the cumin wilt disease. The post of Horticulturist and Plant Pathologist at the Guntur and Jagudan centres respectively are vacant for a long time and the University authorities have been reminded about the seriousness. On the whole, the performance of the seed spices centres has been satisfactory.

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ACTION TAKEN ON THE RECOMMENDATIONS OF THE XII WORKSHOP ON SPICES HELD AT TRICHUR DURING JULY 1993 AND ACTION TAKEN ON THE EARLIER DECISIONS

	Decisions	Action taken/remarks
GENERAL		
1	One each of improved varieties of black pepper from Panniyur (KAU) Cardamom from ICRI, Sakleshpur Coriander & Fenugreek were recommended for release	The concerned centres have taken up action for release of varieties by central variety release committee
2	Promising cultures under MLT should be evaluated in farmers' field besides being evaluated at the Research Station	The directions will be followed by all centres
3	In all the experiments the cost benefit(C/B) ratios are to be invariably worked out to assess the economic implication of adoption of the various technologies	The C/B ratio are being worked out to assess the economic implications
4	This also necessary to review all the present experimental programmes to decide upon the future experiments strategy for various centres	The CRT has reviewed all programmes of the centres. Recommendations are being implemented

5	Experiments on fertilizer use efficiency and slow release fertilizers are suggested for important spice crops and organic farming trial on important spices have been suggested under AICRPS. Integrated nutrient management trial including biofertilizers have been suggested under AICRPS. Cropping system trial including pepper, tree spices & other crops are suggested under AICRPS.	This will be taken in to consideration while formulating new technical programmes.
6	In view of the great concern for reducing the pesticide residues in spices, a coordinating centre of the AICRP on Pesticide Residue may be established at NRCS, Kozhikode	This will be taken up with the concerned Project Coordinator Project and Proposal submitted to ICAR
7	Infrastructure for pesticide residue assay may be established at least in selected centres and facilities for microbioassay may be developed.	The above project will cover this aspect
8	Collaboration programmes on the post harvest technology with reference to storage pests and diseases may be reported	CPT recommended to initiate the work at Coimbatore centre; the programmes will be worked out in the next seed spices group meeting.
9	The Chairman of the Plenary Session (XI AICRPS Workshop) underlined the necessity for initiating seed technology research on seed spices especially on the aspects like seed storage, seed health and viability	The PC(Spices) has already taken up the matter with the Head, Depaprtment of Seed Technology, TNAU and work out further details in the light of group discussion on seed spices.
10	The NRCS will establish a National gene bank for pepper ginger, turmeric and tree spices. Pennivur, Appangala, Ambalavayal will be alternative centres for black pepper, cardamom and wild pepper respectively and Pottangi for Turmeric and Ginger.	NRCS has already initiated action for maintenance of gene bank for the important spices. Ambalavayal and Pennivur have initiated work.

11	The Project Coordinator may ensure that exchange of planting material is completed sufficiently early so that the multilocation trials will not suffer due to non-availability of planting material.	Coordinating centres have been asked to expedite action
12	For all concluding experiments cost benefit ratio should be worked out and results should be tested in "On farm trials" in farmers-holdings before it is recommended for adoption. The funds allotted for the respective centres will have to be utilised for this.	The centres have been advised accordingly. For pepper, Panniyur is conducting "on farm trials"
13	The use of biofertilizers in spice crops was emphasised. The centres may consult the Professor & Head, Dept. of Microbiology(TNAU) for taking up observational trials. The cultures required will be supplied by the Department of Microbiology, Tamil Nadu AGricultural University (TNAU), PC(Spices) will interact with TNAU, on formulating suitable programmes in seed spices and pepper.	At TNAU, Coimbatore a training programme was conducted at the Departments of Plant Pathology & Microbiology with participation from Coimbatore, Panniyur & Sirsi centres. Necessary stock cultures of biofertilizers and biocontrol agents were supplied to the participants. Rate culture studies have already been initiated. Yercaud started trial in 1993.
14	The Jagudan and Guntur centres has been requested to supply the coriander, cumin & Fennel to Jagudan centre for quality evaluation.	The decisions are being followed

SPECIFIC ITEMS, CROP-WISE

A. BLACK PEPPER

1	Work on Post harvest technology may be taken up at Panniyur	An Adhoc Scheme on PHT has been submitted to ICAR

2	Production of Nucleus seedlings and TCT for adaptive trials to be strengthened at Panniyur	The programmes were strengthened. Two adaptive trials for the control of Foot rot disease have been laid out at Panniyur Centre
3	The intervarietal hybridization in pepper may be treated as a University programme	Since the breeder is in position at Panniyur, the programme may be continued as AICRP project.
4	Wild germplasm collection should be strengthened at Panniyur in collaboration with UAS, NRCS, NBPGR and KAU	Not conducted for want of sufficient man-power. Survey is initiated to collect wild germplasm.
5	Promising cultures under MLT/in farmers field besides being evaluated in Research stations	The direction are/will be followed
6	The trial for the control of slow wilt disease will be concluded at Panniyur	The trial has been concluded at Panniyur
7	The soil and leaf analysis is to be done in pepper in fertilizer experiments at Panniyur	The work is in progress
8	The MLT IV (1991) will be laid out in all the pepper centres and cardamom centres	The trial is in progress at all the centres. The Sirsi centre is yet to take up the MLT.
9	Biocontrol of foot rot using <u>Trichoderma</u> spp. is to be intensified.	The work is being pursuedactively at Pepper centres using biocontrol agents.
10	Approved nomenculturetc describe the diseases will have to be used while reporting the result.	This is being followed

11	In fungicide/insecticide evaluation trials, yield data is to be provided wherever necessary and C/B ratios are to be worked out	At Sirsi the C/B ratio has been worked out. Pennivur centre expressed the difficulty in recording the yield data in cut station trials.
12	Experiment on Phytophthora foot rot and nematode management will be continued for two more years and the C/B ratio are to be worked out.	The experiment has been continued as per the decisions taken up in the workshop. The C/B ratio is worked out.
13	Sirsi Centre should start the experiment on nursery disease in coming season.	The experiment was started from 1993-94 onwards
14	In the irrigation cum fertilizer experiment involving arecanut and pepper at Sirsi centre, incidence of pests & disease should be recorded.	31% and 46% of Phytophthora foot rot incidence in Pennivur-1 and Kerimelli-gesare respectively.
15	Wild pepper collection would be strengthened to identify the source of resistence to Phytophthora and burrowing nematode Radopholus similis).	Wild pepper collection is in progress at Sirsi.
16	MLT-IV (1991) will be laid out at all the centres	MLT-IV (1991) was not laid out by Chintapelli. However MLT series (1993) was initiated at Chintapelli. The trial will be laid out at Sirsi after collecting planting material from IISR
17	The MLT of promising cultures of black pepper from Perriyur and NRCS may be used in laying trial at Sirsi and Yercaud also	The promising cultures from Pepper Research Station, Pennivur and NRCS, Calicut have been identified and the trial laid out

18	The PC (Spices) will suggest new MLT for Pennivur. / new MLT with the released varieties from NRCS and Pennivur may be laid out at Ambalavayal and also in all Cardamom centres viz., Mudigere, Yercaud Pampadumpara and Appangala Farm	New MLT's have been made out at Pennivur, Ambalavayal and other Coordinated centres
19	MLT1993 should be started at Chintapalli and Thadiyankudisai Centre	Chintapalli has started MLT IV series Thadiyankudisai has been asked to send the proposal for required numbers of planting material.

3. CARDAMOM

1	Elite selections in cardamom at Mudigere centre is to be spared to NRCS for evaluation	The selections are being multiplied for supply during the current year.
2	Cardamom germplasm is to be screened for 'Kette' escapes at Mudigere	'Kette' escapes are being multiplied for evaluation.
3	The trial "Effect of fertilizer levels on the yield of cardamom under natural shade should be laid out with vegetatively propagated FV-1 plants.	The trial laid out at Pampadumpara accordingly.
4	Cardamom germplasm would be further enriched by natural kette escapes	Attempts have been made to spot out the escapes and multiply them by Mudigere.
5	The screening of cardamom for kette resistance should be tested in sick-plots	The Mudigere centre has taken up the study
6	The NRCS may take up mutation breeding programme on cardamom	The work will again be initiated at NRCS

LARGE CARDAMOM

1	A group meeting will be conducted preferably at Gangtok during 1994 to chalk out the detailed technical programme	Department of Agriculture, Gangtok has already been contacted for hosting the meeting.
2	ICRI, Myladumpara may also establish a gene bank on large cardamom	ICRI centre has initiated action in these lines

D GINGER

1	The conversion data of yield in all experiments in ginger has to be checked	The conversion results of the yield in are checked
2	Evaluation of ginger varieities are facing problems in traditional areas due to soft rot disease and therefore must be evaluated in non-traditional areas. Ten promising lines with low fibre content at IISR may be sent to Pottangi	Action is being initiated
3	(10-15) Promising accessions may be evaluated having low fibre and high oleoresin content. Promising lines from IISR may be tested at Pottangi and the centre may be a lead centre for ginger germplasm	Hundred and fifty accessions of ginger were collected and are under evaluation. Solan centre is unable to get accessions with low fibre content.
4	The NPK experiment on ginger at Pottangi will be continued for one man year	The decision followed
5	The soil and plant analysis data are to be presented in the next Workshop (Jagtial & Pottangi)	The decisions will be followed

6	Inter cropping trial at Pottengi and Jeptiel will be concluded and the report to be submitted	The decisions will be followed
7	Bicentral work in cancer against rhizome rot to be taken up at Solan	The work initiated at Solan
C	TURMERIC	
1	Turmeric samples from IET experiments at Pottengi will be sent to Solan, for Curcumin estimation	The samples were sent and curcumin content estimated. The high curcumin content lines identified are PTS-43, TN-1 in long duration types and PTS-11 among short duration type.
2	The dry recovery in turmeric will be recorded at Pottengi.	The recovery of turmeric was recorded at Pottengi, Meevattupuzha (32%) PTS-3 (28.6%) in short duration type and PTS-2 (25%) dry recovery in long duration type.
3	High curcumin varities will be tested at Pottengi & Jeptiel	The decisions followed and samples sent to IISR for analysis. Cultures PT-43, TN-1, PTS-11, PTS-52, PTS-19 & CLS-20 are identified with more than curcumin.
4	All centre has to send samples to IISR for quality evaluation	Action is being followed by the respective centres (Solan, Jeptiel & Pottengi). The Solan centre followed the procedure accepted by IISR for quality evaluation.

5	In view of large number of high yielding verieties released in turmeric, there is a need to concentrate on developing verieties in turmeric preferred by importers	High curcumin lines were selected from IET at Pottengi they were PTC-43, PTS-11 PTS-19, TN-1, PTS-52 and CL-S-20. The seed materials of these varieties supplied to developmental for large scale multiplication.
6	No experiments is being conducted at Solan in turmeric except for existing germplasm maintenance.	The recommendation followed
F	**TREE SPICES**	
1	Research on tree spices may be included in the AICRPS Yercaud & Pempecumpere may be a voluntary centre for black pepper and tree spices	Work on tree spices and pepper has been initiated at Yercaud as regular centre and Pempecumpere on voluntary basis
2	Discussion may be held with the tree spices breeder at NRCS, Calicut regarding elite tree identification	Discussion made regarding the identification procedures for elite tree spices.
3	The required scion and root stock materials of mother trees available at State Horticulture Farms, Keller-Burlar and Courtallam may be used for vegetative propagation	Necessary arrangement have been made for collection of scions of nutmeg for elite mother trees fore establishing scion bank.
4	For the trials on drip irrigation and use of biofertilizers at Yercaud nutmeg grafts only has to be used	This is being adopted
G	**CORIANDER**	
1	A new MLT (MLT-1993) with entries UD-446 & UD-447 from Jobner, JCo-64 & JCo-123 from Jagudan, DH-3-6 & DH-38 from Hissari, ATF-77 & ATF-102 from Andhra Pradesh, CC-462 and CC-964 from Tamil Nadu finalised at XII AICRPS Workshop	The MLT is being conducted in the current season at Jobner and in all the coriander centres

2	CYT for green (leaf) type will be laid out at Coimbatore, Dholi & Guntur centres with 12 entries	The CYT for green leafy type of coriander will be laid out in the current season.
3	Samples of IET & MLT (1989) will be sent to TNAU Coimbatore for evaluation of varieties for oil content.	The directions will be followed
4	Oil content may be estimated from germplasm accessions for identifying quality accessions. The centres will send samples to Coimbatore	The oil content of germplasm will be estimated after harvest of crop in rabi 1993-94 at Jobner
5	The experimental procedure for screening coriander varieties against Meloidogyne incognite has to be adopted in the Jobner, Jagudan and Coimbatore centres uniformly.	The proper experimental procedure for screening of coriander varieties against Meloidogyne incognita is being adopted at Jobner
6	The treatment in weed control, experiment may be modified	The treatment in weed control experiment were modified and data regarding weed flora are being recorded at Jobner.
7	Mutation breeding in coriander will be undertaken at Coimbatore & JObner centres	The work has already been initiated
8	The weed control experiments at Jobner will continue for one more year	The weed control trial at Jobner was taken up and the details regarding weed flora/dry matter etc are being recorded

H **CUMIN**

1	The MLT-1 (1989) will be continued for one more year and performance evaluated (Jobner & Jagudan centres)	The MLT 1989 with the entries continued in 1993-1994.

2	The wilt resistent lines (four Nos.) identified at Jeguden may be tested at Jobner. The materials will be supplied by Jeguden centre.	Resistent lines received from Jeguden are being tested in sick plot in the year 1993-94 at Jobner
3	The promising accessions of cumin from the Jobner is to be supplied to Jeguden centre for screening against Fuserium wilt	The decision followed and the seed material supplied to Jeguden
I	**FENNEL**	
1	The MLT 1991 will be continued for one more year and performance evaluated (Jobner, Jeguden & Hiser)	The directions are followed
2	Weed control experiment in fennel at Jobner & Hiser may be modified	Modifications were made in the experiment
J	**FENUGREEK**	
1	From the four years yield data of MLT-1 1989 at Jobner, yield during the poor season should be deleted and reanalysed to see if any worthwhile information can be derived	The yield data of MLT 1989 were reanalysed by Jobner after deleting 1990-91 data
2	New MLT with entries viz., UM-143, UM-144 (Jobner) J.Fenu. 149, J.Fenu. 145 (Jeguden), HM-103 & HM-141 (Hisser), CF-169 & CF-390 (Tamil Nadu) was finalised and will be laid out at all Fenugreek centres	The new MLT is being conducted in the current season
3	The CTY for green leafy type of fenugreek will be laid out at Coimbatore	The CYT for green leafy type of Fenugreek laid out
4	The IET will be continued for one more year at Coimbatore	The directions are followed

5	Mutation breeding should be initiated at Jobner and Coimbatore centres	The studies will be intensified
6	In fenugreek Guntur and Coimbatore centres will work on vegetable type of fenugreek	The trial on the evaluation of leafy types laid out in Kharif 1995 at Coimbatore was damaged by floods
7	The spacing cum time of sowing to be laid out at Coimbatore to standardise the optimum spacing/sowing time	The trial was vitiated due to cyclonic storm and severe flood during Kharif 1995

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

CENTRE-WISE AND HEAD-WISE ANNUAL PLAN ALLOCATION AND EXPENDITURES FOR 1994-95

(Rs. in lakhs)

Sl. No.	Centre	Salary		TA		RC		NRC		Total	
		Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.
1.	Pampadumpara	Not available									
2.	Madigere	4.37	4.06	0.14	0.07	0.60	0.60	2.00	2.00	7.31	6.93
3.	Yercaud	2.07	1.76	0.06	0.05	0.40	0.40	-	-	2.53	2.15
4.	Pannyur	5.22	3.84	0.12	0.12	0.80	0.73	1.38	0.26	7.52	4.95
5.	Chintapalli	2.18	1.65	0.08	0.08	0.40	0.40	1.00	-	3.66	2.13
6.	Sirsi	2.79	1.60	0.10	0.07	0.40	0.40	2.20	2.20	5.49	4.27
7.	Salem	2.88	3.52	0.12	0.04	0.60	0.60	-	-	3.60	4.16
8.	Pottangi	2.18	2.00	0.10	0.08	0.40	0.40	-	-	2.68	2.48
9.	Jobner	5.80	6.70	0.20	0.19	1.00	1.10	-	-	7.00	7.99
10.	Guntur	2.18	1.33	0.04	0.02	0.40	0.33	-	-	2.62	1.68
11.	Jagudan	2.18	1.21	0.08	0.03	0.40	0.40	0.60	0.26	3.26	1.90
12.	Coimbatore	2.18	2.91	0.04	0.02	0.40	0.40	-	-	2.62	3.33
13.	Jagtial	1.76	1.84	0.02	0.02	0.40	0.40	-	-	2.18	2.26
14.	Pusa	1.53	1.55	0.06	0.06	0.40	0.38	0.81	0.81	2.80	2.80
15.	Dholi	Not available									
TOTAL		37.32	33.91	1.16	0.85	6.80	6.74	7.99	5.53	53.27	47.02
ICAR Share (75%)		27.99	25.43	0.87	0.64	5.10	5.06	5.99	4.15	39.95	35.28
Gangtok (100% ICAR)		Not communicated									
Grand Total		27.99	25.43	0.87	0.64	5.10	5.06	5.99	4.15	39.95	35.28

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(as on 31-03-95)

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Scientist S1 (Hort.)	:	G.S. Karibasappa

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Jr. Pathologist	:	Bimla Rai
Technical Assistant	:	Vacant

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WEATHER DATA 1994

Centre : Coimbatore

Latitude :11°N
Longitude :77°E
Altitude :426.72m MSL
Soil type :Black clay loam

Month	Monthly rainfall (mm)	Rainy days (No)	Mean temp. (°C) (max)	Mean temp. (°C) (Min)	Mean RH (%)
January	72.7	2	29.2	18.6	89
February	29.0	3	31.8	20.5	87
March	6.0	1	35.1	20.4	81
April	10.0	1	36.3	23.1	82
May	55.0	4	35.8	23.8	82
June	28.0	3	31.1	22.3	70
July	125.8	5	30.1	22.3	74
August	2.0	Nil	31.1	22.3	81
September	48.9	15	32.1	22.0	82
October	256.9	15	30.6	22.1	87
November	171.9	10	28.1	20.5	88
December	1.8	Nil	28.8	16.1	86
Total	808.6	59			

Centre : Mudigere

Latitude :13°50'N
Longitude :75°39'E
Altitude :1175MSL
Soil type :Black clay loam

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temp (°C) (Max.)	Mean temp (°C) (Min.)	Mean RH(%)
January	8.0	1	28.3	15.2	91
February	2.4	Nil	29.2	15.4	93
March	0.8	Nil	32.8	17.1	93
April	70.2	7	31.6	18.8	95
May	63.2	6	30.5	19.2	93
June	933.8	26	23.5	18.8	95
July	1470.8	29	22.7	18.5	96
August	315.0	23	23.6	18.3	97
September	273.6	12	25.5	17.7	96
October	340.4	17	26.8	18.4	95
November	13.6	2	26.3	16.8	89
December	Nil	Nil	27.4	13.5	86
Total	3491.8	123			

Centre : Yercaud

Latitude : 11.4°N
Longitude : 78.5°E
Altitude : 1450m MSL
Soil type : Clay loam

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature(°c) Max.	Min.	Mean RH(%)
January	Nil	Nil	22.9	12.5	63
February	Nil	Nil	24.0	14.6	56
March	Nil	Nil	27.6	16.5	50
April	114.2	9	26.4	16.9	56
May	206.5	9	28.4	18.4	61
June	76.1	7	24.5	15.2	67
July	285.0	13	24.8	16.5	69
August	210.6	10	24.9	17.0	65
September	73.4	7	25.2	14.8	62
October	372.5	18	22.0	15.5	62
November	207.8	9	21.1	14.5	68
December	23.7	3	23.8	11.0	62
Total	1569.8	85			

Centre : Pennlyur

Latitude : 12.5°N
Longitude : 74.55°E
Altitude : 95m MSL
Soil type : Lateritic

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature(°C) Max.	Min.	Mean RH(%)
January	8.4	2	33.0	19.0	84.7
February	Nil	Nil	36.0	20.9	87.8
March	Nil	Nil	35.9	21.8	87.7
April	131.0	9	35.2	23.8	88.7
May	45.2	4	35.3	24.0	86.2
June	1364.6	30	29.0	22.7	94.7
July	1838.2	31	27.5	21.7	94.5
August	810.4	25	28.9	22.0	93.7
September	216.0	14	30.0	27.7	87.0
October	490.4	22	31.9	22.0	92.9
November	84.2	6	33.0	21.0	84.8
December	Nil	Nil	34.9	18.7	86.0
Total	4988.4	143			

Centre : **Sirsi**

Latitude : 14°36'N
Longitude : 74°50'E
Altitude : 619m MSL
Soil type : Laterite

Months	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Min.
January	Nil	Nil	25.4	22.1
February	Nil	Nil	26.8	21.3
March	7.5	1	32.3	24.0
April	20.0	2	31.9	24.1
May	10.5	2	32.1	22.2
June	573.6	22	30.1	21.9
July	1347.5	31	25.3	23.2
August	547.25	27	24.7	22.7
September	208.6	11	26.6	25.3
October	59.8	13	25.4	22.3
November	7.5	2	24.4	21.0
December	Nil	--	25.6	20.7
Total	2782.25	111		

Centre : **Chintapelli**

Latitude : 17°52'N
Longitude : 82°14'E
Altitude : 818m MSL
Soil type : Clay Loam

Months	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Min.	Mean RH(%)
January	Nil	Nil	26.4	10.2	88
February	31.5	3	27.2	13.8	90
March	Nil	Nil	32.5	15.4	91
April	81.2	6	31.6	18.9	84
May	88.6	9	33.0	20.7	84
June	138.7	15	27.6	22.2	90
July	378.2	23	26.8	22.6	89
August	259.9	19	24.2	21.2	91
September	154.6	11	26.7	26.4	88
October	241.3	12	26.3	19.2	83
November	51.0	4	24.4	15.2	90
December	Nil	Nil	24.4	9.4	88
Total	1425.0	102			

Centre : **Solan**

Latitude : 30.5°N
Longitude : 77.8°E
Altitude : 1000m MSL
Soil type : Loam

Months	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Mean temperature (°C) Min.	Mean RH (%)
January	43.6	2	17.8	4.0	59
February	106.2	3	17.5	4.3	65
March	4.6	Nil	24.9	11.1	51
April	85.8	4	24.6	12.5	57
May	23.8	3	31.1	18.3	50
June	121.6	6	32.1	20.9	58
July	307.8	14	27.5	21.3	86
August	210.2	12	26.9	21.1	90
September	57.6	4	27.1	18.2	78
October	3.4	Nil	25.9	11.5	59
November	Nil	Nil	22.7	8.5	58
December	19.1	4	18.6	5.0	61
Total	983.7	52			

Centre : **Pottangi**

Latitude : 18°34'N
Longitude : 82°52'E
Altitude : 917m MSL
Soil type : Sandy loam

Months	monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Mean temperature (°C) Min.	Mean RH(%)
January	Nil	Nil	24.3	20.4	77
February	Nil	Nil	25.3	22.4	77
March	Nil	Nil	23.0	21.0	61
April	750.0	11	28.9	23.5	76
May	533.5	18	25.6	23.1	75
June	780.0	19	23.0	19.0	75
July	800.0	23	21.0	18.0	85
August	168.7	22	24.2	22.8	85
September	174.0	13	27.8	25.5	75
October	15.2	15	26.0	21.0	78
November	18.7	3	21.0	18.0	74
December	Nil	Nil	27.9	16.9	65
Total	3240.1	124			

Centre : **Pempadumpere**

Latitude : 9°45'N
Longitude : 77°10'E
Altitude : 1100m MSL
Soil type : Forest Loam

Months	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max	Min.
January	18.6	2	26.0	13.5
February	10.4	3	27.0	14.0
March	5.2	3	32.0	17.0
April	252.7	10	31.0	17.5
May	73.3	9	28.0	18.0
June	373.0	27	24.0	17.0
July	394.0	29	25.0	14.0
August	297.6	23	27.0	17.0
September	180.0	15	28.0	16.0
October	453.8	24	27.0	17.0
November	166.8	13	27.0	16.0
December	0.6	1	29.0	13.0
Total	2226.0	159		

Centre : **Jagtial**

Latitude :18°49'46"N
Longitude :78°56'48"E
Altitude :243.4m MSL
Soil type :Red sandy loam

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Min.	Mean RH(%)
January	2.4	Nil	30.2	14.9	NA
February	Nil	Nil	32.1	17.2	NA
March	Nil	Nil	38.3	20.1	NA
April	3.4	Nil	38.3	23.0	51
May	Nil	Nil	44.6	27.8	39
June	198.2	11	35.6	25.1	69
July	362.6	16	30.2	20.7	84
August	214.6	13	NA	19.6	90
September	40.8	5	NA	20.3	91
October	182.3	4	NA	21.1	92
November	33.5	2	NA	15.1	74
December	Nil	Nil	NA	10.1	81
Total	1037.0	51			

Centre : Jobner

Lettitude : 26°5'N
Longitude : 75°20'E
Altitude : 427m MSL
Soil type : Sandy Loam

Months	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C)		
			Max.	Min.	
January	28.8	2	26.3	7.6	45
February	2.4	1	25.8	7.0	27
March	2.0	1	33.8	14.3	21
April	1.2	1	44.6	22.4	58
May	6.4	1	42.4	25.9	45
June	29.1	6	38.7	27.9	60
July	123.5	10	33.0	24.8	88
August	101.4	11	31.2	24.4	89
September	85.1	4	31.8	20.4	85
October	Nil	Nil	32.5	12.7	65
November	Nil	Nil	29.2	8.3	71
December	Nil	Nil	24.3	3.7	78
Total	379.9	37			

Centre : Jaguden

Latitude : 23.52°N
Longitude : 72.43°E
Altitude : 90.6m MSL
Soil type : Sandy to sandyloam

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C)	
			Max.	Min.
January	Nil	Nil	31.3	22.4
February	Nil	Nil	24.0	14.4
March	Nil	Nil	34.1	26.3
April	Nil	Nil	36.4	25.3
May	Nil	Nil	NA	NA
June	232	6	40.6	26.6
July	268	15	32.9	26.3
August	437	13	31.3	25.0
September	369	10	33.0	25.3
October	Nil	Nil	37.1	10.6
November	Nil	Nil	23.4	16.3
December	Nil	Nil	31.0	10.9
Total	1306	44		

Centre : **Guntur**

Latitude : 16.18°N
Longitude : 80.29°E
Altitude : 32m MSL
Soil type : Black clayey

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Mean temperature (°C) Min.	Mean RH(%)
January	Nil	Nil	31.1	16.7	92
February	27.4	2	33.6	20.6	93
March	Nil	Nil	37.9	22.8	88
April	17.4	1	39.7	24.2	87
May	21.6	2	45.2	27.3	84
June	44.6	5	40.2	24.1	77
July	181.4	14	35.4	26.7	82
August	194.4	7	32.0	26.2	83
September	49.6	3	34.5	25.5	82
October	489.0	13	30.5	23.9	93
November	316.3	5	29.6	20.0	91
December	Nil	Nil	29.8	16.2	88
Total	1341.7	52			

Centre : **Dholi**

Latitude : 25.41°N
Longitude : 34.6°E
Altitude : 52.8m MSL
Soil type : Sandy Loam

Month	Monthly rainfall (mm)	Rainy days (No.)	Mean temperature (°C) Max.	Mean temperature (°C) Min.	Mean RH(%)
January	43.8	NA	23.2	10.1	98
February	37.2	"	24.7	11.5	96
March	81.0	"	31.1	15.2	83
April	43.8	"	35.4	20.5	76
May	33.2	"	38.8	24.3	78
June	76.6	"	36.5	27.2	87
July	188.0	"	33.5	26.8	87
August	277.0	"	32.5	26.1	88
September	197.0	"	32.5	24.7	84
October	Nil	"	32.5	20.3	86
November	34.2	"	28.5	14.7	93
December	Nil	"	24.4	9.3	100
Total	1011.8				

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