

*For official use only*

**All India Coordinated Research Project on Spices**

**ANNUAL REPORT**  
(April 1, 1990 to March 31, 1991)

**Project Coordinator**  
**S. EDISON**



**NATIONAL RESEARCH CENTRE FOR SPICES**  
( Indian Council of Agricultural Research )  
**CALICUT 673 012, KERALA, INDIA**

December 1991

*Correct citation :*

All India Coordinated Research Project on Spices, 1991  
ANNUAL REPORT 1990 - 91  
National Research Centre for Spices,  
Calicut

*Compiled by :*

S. EDISON  
Project Coordinator (Spices)

JOHNY A. KALLUPURACKAL  
Technical Information Officer

## ABOUT THIS REPORT.....

It is our pleasure to place before you the SIXTH Annual Report of the All India Coordinated Research Project on Spices for the period April 1, 1990 to March 31, 1991. This forms the sixth independent report of the SPICES PROJECT and covers the research activities conducted during the 12 month period. As the VIII plan would commence from 1-4-1992 only, the intervening period 1-4-90 to 31-3-92 has been treated as "annual plans" and accordingly the "1990-91 annual plan" activities are presented in this document.

The Vellanikkara Centre (KAU) ceased to function after 31-3-90 and consequently there are 14 Centres, reporting under the Project. The research projects have been continued as approved during the VII Plan with additional experiments that were added as per decisions taken during the Coimbatore Workshop (August, 1989). The present report also includes the list of research publications from the Coordinating Centres, budget, annual meteorological data etc. We welcome your suggestions to improve the quality of presentation in future.



Dr. S. EDISON  
PROJECT COORDINATOR

## C O N T E N T S

INTRODUCTION	1
CHAPTER I : TECHNICAL	
PROJECT COORDINATOR'S REPORT	4
TECHNICAL PROGRAMME	8
EXPERIMENTAL RESULTS	
CARDAMOM	14
LARGE CARDAMOM	26
BLACK PEPPER	28
GINGER	40
TURMERIC	46
CORIANDER	53
CUMIN	65
FENNEL	72
FENUGREEK	77
GERMPLASM HOLDINGS IN CENTRES	88
CHAPTER II ORGANISATION	
RESEARCH CENTRES	89
FUNCTIONING OF THE COORDINATED PROJECT	91
ACTION TAKEN ON THE RECOMMENDATIONS OF THE X WORKSHOP ON SPICES	96
BUDGET	104
STAFF POSITION	105
PUBLICATIONS FROM CENTRES	109
METEOROLOGICAL DATA FROM CENTRES	111

## INTRODUCTION

The All India Coordinated Research Project on Spices was initiated as a combined Project on Spices and Cashewnut in 1971 with headquarters at Central Plantation Crops Research Institute, Kasaragod. In order to ensure undivided attention to the research efforts on spices, the Indian Council of Agricultural Research bifurcated the above Project to two Projects viz., one for Spices and the other for Cashewnut. The independent Coordinated Project for Spices started functioning from September 1985 and the headquarters of this Project was later shifted to the National Research Centre for Spices, Calicut. This National Research Centre for Spices has come into existence at Calicut by upgrading the erstwhile Regional Station of the CFCRI at Calicut and by merging the Cardamom Research Centre (of the CPCRI) at Appangala, Dist. Madikeri, Karnataka. The Project Coordinator's Cell functions at the NRCS, Calicut from March 1986 onwards.

This Coordinated Research Project was initiated in 1971 with 4 Coordinating Centres and expanded to 15 Centres during the VII Plan. However one Centre viz., the Vellanikkara Centre (KAU) was discontinued with effect from April 1, 1990 and the Gangtok Centre under the ICAR Research Complex for NEH Region was continued as a "Non-Plan" component under the ICAR Institute. The Gangtok Centre will however continue to be a Coordinating Centre although the funding is from the Non-Plan funds of the ICAR. Hence there are 14 Centres as on April 1, 1990. In view of the delay in implementation of the VIII Plan, a sanction was given for an Annual Plan of "1990-91" for all the Centres under the Project. The Research on these 14 Centres are being taken up Pepper and Cardamom in 3 Centres each, Turmeric, Coriander and Fenugreek in 4 Centres each, Ginger, Cumin and Fennel in 2 Centres each and Large Cardamom at 1 Centre.

In addition, the Project has two Voluntary Centres, viz., the Department of Vegetable Crops, Haryana Agricultural University, Hisar and the Indian Cardamom Research Institute (under the Spices Board), Myladumpara, Kerala. Scientists from these Voluntary Centres also participate in the Workshops of the Project held from time to time.

The main objectives of the Spice Project are :

- i) evolving high yielding varieties resistant/tolerant to diseases and pests;
- ii) standardisation of agro-techniques for the crops under different agroclimatic conditions;
- iii) evolving control measures for major pests and diseases; and
- iv) working as an inter-face and feed-back between the Agricultural Universities and the National Research Centre for Spices / Central Plantation Crops Research Institute and ICAR.

An outlay of Rs.37.33 lakhs has been provided for the Annual Plan of 1990-91 for all the 14 Centres which however did not include items of expenditure on "equipments, works" etc. because it was an Annual Plan. The needs of the different Centres are however being taken up within the allocation under Annual Plan. The work on construction of storage/propagation sheds taken up during the VII Plan at Chintapalli, Jobner, Solan and Panniyur Centres have all been completed and put under use.

The first Workshop of the All India Coordinated Research Project on Spices (& Cashewnut) was held at CPCRI, Kasaragod in December 1971 wherein the research problems to be tackled under the Project were identified and the technical programmes drawn up. Since then, the performance of the various research programmes under this Coordinated Project was reviewed at the Workshops held in 1972, 1975, 1978, 1981, 1983 and 1985; besides, group meetings were also held whenever required especially for the minor and annual spices so as to incorporate necessary modifications in the technical programmes. It has been decided by the ICAR that hereinafter, the Spices Workshop will be held independently as an annual feature, de-linking from the present practice of "combined Workshop of all the Coordinated Projects in Plantation Crops". Accordingly three independent Workshops have been conducted viz., in 1987 (Guntur, AP), 1988 (Solan, HP) and 1989 (Coimbatore, TN) so far; the last Workshop was conducted during August 1989 at Coimbatore, Tamil Nadu and the Proceedings of the Workshop already issued.

Even though there was a requirement to bring out the Annual Reports for the calendar years as per instructions in the immediate past, the policy has now been revised. Accordingly the present Annual Report is for the financial year viz., April 1, 1990 to March 31, 1991. The present report is presented as two chapters, one for the Technical and the other for the Organisational aspects.

Dr. M.C.Nambiar was the first Project Coordinator of the combined Project on Cashew and Spices right from its inception in 1971 and he retired on April 30, 1985. Dr. M.K.Nair held additional charge of this Project until Dr.S.Edison took over as Project Coordinator (Spices) during March, 1986. We would like to place on record our gratitude for the dedicated services rendered by Dr.M.C.Nambiar in establishing the various Research Centres since 1971.

We would also place on record the great vision, dynamism and the services rendered by Dr.K.V.Ahamed Bavappa, the then Director, CPCRI for having been instrumental in initiating and establishing the host Institute viz., the CPCRI and the various coordinated projects on plantation crops. His personal interest in development of the Spices Project is duly acknowledged and he was also responsible for creating the independent project for spices during the VII Plan. It is my proud privilege to acknowledge the help, guidance and support received from Dr.M.K.Nair, Director, CPCRI in the various activities of the Coordinated Project. I would also like to thank Dr.A.Ramadasan, Director, NRCS and my colleagues at NRCS for having helped me in the smooth running and other activities of the Project during the period under report.

(Dr. S EDISON)  
PROJECT COORDINATOR

## CHAPTER-I : TECHNICAL

i)	PROJECT COORDINATOR'S REPORT	4 - 7
ii)	TECHNICAL PROGRAMME	8 - 13
iii)	EXPERIMENTAL RESULTS	14 - 87
iv)	GERMPLASM HOLDINGS	88



## PROJECT COORDINATOR'S REPORT

The All India Coordinated Spices Improvement Project envisages research on Cardamom, Pepper, Ginger, Turmeric, Cumin, Coriander, Fennel, Fenugreek and Large Cardamom. The research programmes are carried out in 14 Centres spread over in the various Agricultural Universities in the country as enlisted elsewhere. The Headquarters of this Project is located at the National Research Centre for Spices, Calicut. The Research Centres under the Project are located in different agro-climatic regions in 9 States.

The first Workshop of the combined All India Coordinated Spices and Cashewnut Improvement Project was held at Kasaragod in 1971 and formulated research programmes on pepper, cardamom, ginger and turmeric and in the beginning, 5 centres were functioning on Spices. The research on condiments was initiated after the third Workshop held at Coimbatore and the subsequent Workshops held at Goa (1978), Trichur (1981), Calicut (1983), Trivandrum (1985), Guntur (1987), Solan (1988) and Coimbatore (1989) reviewed the progress of implementation of the technical programmes at various centres. The VI Plan enabled starting of two new centres on Pepper, one on Cardamom and one on Ginger and Turmeric. During the VII Plan, an additional centre for Turmeric in Andhra Pradesh and for Large Cardamom in Gangtok have started functioning. The Vellanikkara Centre which functioned during the VII Plan was discontinued with effect from April 1, 1990. There are 51 experiments which included 9 on Cardamom, 5 on Pepper, 4 on Ginger, 2 on Turmeric, 3 on Large Cardamom and 28 on Condiments. The brief report on the work carried out during 1990-91 is summarised below:

### 1. Genetic resources :

Panniyur centre improved its Black Pepper collection by addition from Karnataka, bringing to 200; Sirsi has 75 including wild accessions added during the year. Pettangi maintains the largest germplasm viz., 155 in Turmeric and 124 in Ginger and this Centre has supplied material to Jagtial, Solan and Coimbatore Centres as well as NRCS. Solan Centre added 59 new accessions

to the Ginger collections, though a NBPGR-joint survey. The Cardamom germplasm at Mudigere Centre was freely exchanged with the NRCS Appangala Centre. In Large Cardamom, additional germplasm was brought from Arunachal Pradesh and parts of Sikkim. Germplasm in seed spices remain almost static and efforts are underway to import/exchange from mediterranean countries through the NBPGR.

## 2. Crop improvement :

Varieties Fanniyur-2, Fanniyur-3 and Panniyur-4 have been released with average yield of 1954 kg/ha, 1749 kg/ha and 975 kg/ha respectively. About 5 lakh rooted cuttings of these varieties have been distributed. PV-1 cardamom selection is in advanced stages for release by KAU and in case of M-1, cardamom variety from Mudigere (UAS), 25 kg of seed capsules were distributed, each kilo seed yielding @ 70000 seedlings. The cultivar 'Pink Gelsey' in Large Cardamom has performed superior in 2 years successively; clone 4 (green cardamom) has been identified and both are being promoted for release as varieties. The Pottangi centre has released the second variety in Ginger viz., 'Suruchi' and a third variety "Surabi" is under consideration for release; the last one has less fibre (4%) content and yields better. In Coriander, varieties 'Sadhana' and 'Swathi' have been released by the APAU. These two varieties have an average yield, essential oil and fixed oil of 1025 kg/ha, 0.2% & 9.2% and 885 kg/ha, 0.2% & 9.6 % respectively. The Coimbatore Centre has released a new variety Co-3 with an yield of 644 kg/ha and had less incidence of wilt and grain mould; Co-3 had a seed oil content of 0.4%. At Guntur, coriander acc. ATP-82 recorded the highest yield of 692 kg/ha.

## 3. Crop Production :

The most economical dose of NPK for Black Pepper has been recommended as 50:50:150 kg NPK (per ha) respectively. Among the live standards for Black Pepper, those grown on Ailanthus malabaricum gave maximum yield. At Yercaud, high density planting of cardamom with a closer spacing of 1M x 1M for Malabar was found superior.

In Coriander, application of N @ 60 kg/ha in 3 equal splits, applied as basal, 30 days after as top dressing and again after 60 days - under irrigated conditions - gave higher yields at Jobner. Leaf plucking if done 75 days after sowing, up to 50% did not affect grain yield of coriander. Sowing coriander in kharif in Guntur gave 658 kg/ha when sown on 15th September. Cumin when broadcast and applied with 30 kg N/ha in single dose gave higher yields. In Fennel, application of N @ 90 kg/ha in 3 equal splits given as basal, 30 DAS and 60 DAS gave higher production in Jobner. For producing the "Chewing type", fennel can be harvested when the grains are of "half length size" and 30 days after anthesis. Fenugreek when sown in the first week of November gives profitable crop. At Jobner, it was found that when the IW/CPE ratio is kept at 1.0, the fenugreek crop gives the highest seed yield of 1400 kg/ha; along with,  $P_2O_5$  can be applied @ 60 kg/ha.

#### 4. Crop Protection :

Phytophthora foot rot disease can be controlled by spraying with 1% Bordeaux mixture done thrice and drenching the basin once, before onset of monsoon. Metalaxyl and Al-Fosetyl compounds are superior in performance at Sirsi and on par with Bordeaux mixture at Panniyur; however the cost of treatment was high. At Mudigere, the cardamom cultivar "Pink Pseudostem" was identified as tolerant to leaf spot disease. The Pestalotiopsis leaf spot of Large Cardamom is controlled by spraying Blitox 50 @ 0.3%.

In Cardamom, the azhukal disease was controlled by spraying 1% Bordeaux mixture as well as soil drenching. Nematode infestation in cardamom nurseries was controlled by application of Temik granules, whereas the root grub has been effectively checked by Carbofuran 3% G @ 8-10 g/clump, applied during June-July & November-December. Leaf diseases in cardamom nurseries have been controlled by spraying with Dithane M-45 (0.25%).

Weed control in cumin has been achieved with Terbutryn @ 0.5 kg a.i./ha. Cumin blight caused by Alternaria burnsii was controlled by spraying Dithane M45 or Cupramar @ 0.8 to 1.0 kg/ha, the first spray to be given at the time of flowering, followed by fortnightly intervals. Grain mould of coriander has been controlled by spraying Carbendazim 0.1%, applied 20 days after grain set.

## TECHNICAL PROGRAMME

The Technical Programme of the AICRP on Spices used to be finalised during the Meeting convened under the chairmanship of the Director General, ICAR and discussed in the Project Implementation Committee. The discussions normally pertain to a "Plan" period and last PIC has recommended Projects that were in operation during the VII Plan period viz., 1985-90.

Since the VIII Plan would start from April 1, 1992, the intervening period of two years will have the technical programmes as approved during the Workshops of the Project, decisions taken during the Group Meetings etc. Several new experiments were also initiated during 1990-91 especially those on multilocation trials. The list of experiments are provided below crop-wise.

### I. CARDAMOM

1. Germplasm collection, description of types & varieties and their evaluation  
(Mudigere, Yercaud and Pampadumpara)
2. Multilocation trial/comparative yield trial (MLT 1988 series-II)  
(Mudigere, Yercaud and Pampadumpara)
3. Mutagenesis in Cardamom (Mudigere and Yercaud)
4. Hybridisation and selection in Cardamom  
(Mudigere and Pampadumpara)
5. Preliminary yield evaluation of promising cultures (Mudigere)
6. Manurial experiments (Mudigere, Yercaud and Pampadumpara)
7. Studies on the effect of fertilizer levels on the yield of cardamom under natural shade  
(Mudigere)
8. Micronutrient requirements of cardamom  
(Mudigere, Yercaud and Pampadumpara)

9. Evaluation of types and varieties of cardamom for drought tolerance (Mudigere)
10. Evolving control measures against cardamom thrips & capsule borer (Mudigere and Pampadumpara)
11. Evolving katta tolerant varieties and control measures against katta disease and its management (Mudigere)
12. Screening of varieties/cultures for resistance to nursery leaf spot (Mudigere)
13. Studies on clump rot or azhukal disease (Pampadumpara)
14. Biological control of cardamom rhizome rot (Mudigere)
15. Influence of light intensity and nutrients on growth and yield of cardamom (Mudigere)

## II. LARGE CARDAMOM

1. Germplasm collection, description and evaluation (Gangtok)
2. Comparative yield trial (CYT-1) with high yielding clones (Gangtok)
3. Identifying tolerant types for two virus diseases and evolving control measures (Gangtok)
4. Fungicidal evaluation against leaf streak disease (Gangtok)

## III. BLACK PEPPER

1. Germplasm collection, description and evaluation (Panniyur, Sirsi and Chintapalli)
2. Comparative yield trial of selected cultivars (CYT / MLT 1984; Series-I) (Panniyur, Chintapalli and Sirsi)

3. Multilocation trial of promising pepper cultivars (MLT 1984 series-II)  
(Panniyur, Chintapalli and Sirsi)
4. Multilocation trial in black pepper (MLT 1987 Series-III)  
(Panniyur, Sirsi, Chintapalli and Yercaud)
5. Intervarietal hybridisation to evolve high yielding varieties  
(Panniyur)
6. Manurial requirements of black pepper (Sirsi)
7. Irrigation-cum-fertilizer requirement in black pepper  
(Panniyur and Sirsi)
8. Investigation of quick wilt and slow wilt diseases of pepper including testing of systemic fungicides  
(Panniyur, Sirsi and Chintapalli)
9. Observational trial for control of quick wilt in farmers field  
(Panniyur)
10. Field trial for the control of slow wilt disease of black pepper  
(Panniyur, Sirsi and Chintapalli)
11. Studies on the control of nursery diseases of pepper  
(Panniyur and Sirsi)

#### IV. GINGER

1. Germplasm collection and evaluation (Solan and Pottangi)
2. Initial evaluation trial (Pottangi and Solan)
3. Multilocation trials (MLT 1987 series-I, MLT 1988 series-II)  
(Pottangi and Solan)
4. Effect of intercropping in ginger (Pottangi)

5. NPK trial in ginger (Pottangi)
6. Germplasm screening for rhizome rot (Solan)
7. Evaluation of germplasm for quality characters of ginger (Solan)
8. Effect of seed treatment on rhizome rot of ginger (Solan)

## V. TURMERIC

1. Germplasm collection and evaluation (Solan, Pottangi, Jagtial and Coimbatore)
2. Initial evaluation trial (Pottangi, Coimbatore and Jagtial)
3. Comparative yield trial (Pottangi)
4. Multilocation trial on Turmeric (MLT 1987 series-II) (Solan, Pottangi, Jagtial and Coimbatore)
5. Effect of intercropping in turmeric (Pottangi and Jagtial)
6. Quality evaluation of germplasm collection/varieties (Solan)
7. Effect of storage on curcumin content (Solan)

## VI. CORIANDER

1. Germplasm collection, maintenance, evaluation and screening against diseases (Jobner, Jagudan, Guntur and Coimbatore)
2. Initial evaluation trial (Coimbatore and Guntur)
3. Comparative yield trial / Coordinated varietal trial (CYT 1989 Series-1) (Guntur, Coimbatore and Jobner)
4. Multilocation trial on Coriander (MLT 1989 Series-I) (Jobner, Guntur and Jagudan)



5. Mutation breeding to evolve varieties with earliness and resistance to disease  
(Coimbatore and Jobner)
6. Effect of different stages of harvesting on yield and quality of coriander varieties  
(Jobner and Jagudan)
7. Response of coriander to fertilizer (Jobner and Guntur)
8. Studies on the grain mould/wilt disease of coriander  
(Coimbatore)
9. Evaluation of coriander for essential oil content (Jobner)

## VII. CUMIN

1. Germplasm collection, maintenance, evaluation and screening against disease  
(Jobner and Jagudan)
2. Multilocation varietal trial (MLT 1987, MLT 1989 Series-I)  
(Jobner and Jagudan)
3. Breeding for wilt resistant variety in cumin (Jobner)
4. Effect of crop geometry and seed rate on yield of cumin  
(Jobner and Jagudan)
5. Evolving control measures against wilt disease (Jagudan)
6. Studies on seed born mycoflora of cumin (Jobner)
7. Quality evaluation studies in cumin (Jobner)
8. Adaptive trials of promising cultures of cumin at different taluka seed farms  
(Jagudan and Jobner)

### VIII. FENNEL

1. Germplasm collection, maintenance and evaluation  
(Jobner and Jagudan)
2. Multilocation trial in fennel (MLT 1989 Series-I)  
(Jobner and Jagudan)
3. Studies on intercropping in fennel (Jobner)
4. Effect of nitrogen levels and stages of umbel picking on yield  
and quality of fennel  
(Jobner and Jagudan)
5. Quality evaluation of fennel for volatile oil (Jobner).

### X. FENUGREEK

1. Germplasm collection, maintenance, evaluation and screening  
against root knot nematode & powdery mildew  
(Jobner, Jagudan, Guntur and Coimbatore)
2. Initial evaluation trial (Coimbatore)
3. Comparative yield trial (CYT 1989 Series-I)  
(Guntur and Coimbatore)
4. Multilocation trial (MLT 1989 - Series-I)  
(Jobner, Jagudan, Guntur and Coimbatore)
5. Evolving varieties resistant to powdery mildew through mutation  
breeding, (Jobner)
6. Effect of irrigation and phosphorous (Jobner and Jagudan)
7. Studies on the control of root rot disease of fenugreek by soil  
amendments and antagonistic fungi  
(Coimbatore)
8. Adaptive trials (Jobner)

.....

## I. CARDAMOM

### 1. GERMPLASM COLLECTION, DESCRIPTION OF TYPES AND VARIETIES AND THEIR EVALUATION

(Mudigere, Yercaud and Pampadumpara)

One ninety five entries were planted during 1989 and fifty entries during 1990 at Mudigere. They are being evaluated and preliminary data collected and the data as per descriptor will be collected systematically during ensuing Kharif 1991. In the 195 entries planted during June 1989, 77% of the entries produced panicles during 2nd year after planting while 23% continued to be in vegetative phase; up to 9 panicles were produced per clump. The preliminary data collected clearly indicate genotypic differences in the collection with respect to panicle initiation. In the entries planted for clonal multiplication 34.5% produced panicles during second year and data indicate genotypic differences exist among germplasm for panicle initiation. Panicle initiation during 1990 was unusually early and revealed that 91.8% of the clumps entered reproductive phase and the remaining 8.2% were late for flowering. In some collections, suckers and panicles per plant were more than 50 (Cl-692, P-20, EB 1277-7, Anamalai-1, P-10 and P-8). One hundred and thirty eight entries attained height exceeding 200 cm; 47% of the collections were found susceptible to shoot borer.

Among 533 plants of unknown identity, 16 were with erect panicles, 23 with semi erect panicles and the rest spreading type, five plants were identified as long panicle and multiple branched types.

Plants of unknown identity from the concluded "diallel experiment" were separately planted for isolating superior genotypes; 73.3% of these plants flowered during the 2nd year.

The 35 germplasm accessions maintained and evaluated at Yercaud in the new compact block, wide variability exhibited for monthly biometrical observations recorded on plant height 97.3 cm to 284.2 cm, number of suckers 4.9 to 35.2 and number of leaves per clump 33.9 to 256.1. Harvesting of capsule of the first bearing is in progress. A wild type viz., Alpinia grandiflora has been added to the germplasm.

At present 56 cultivated and 15 wild relatives are maintained as germplasm at Pampadumpara Centre.

Comments : The germplasm obtained from NRCS Cardamom Research Centre, Appangala by an exchange programme may be established early, multiplied and evaluation reports furnished. Exhaustive survey need to be conducted in the Western ghats and the descriptor for IBPGR may be finalised early for adoption in Mudigere Centre.

2. MULTILOCATION TRIAL/COMPARATIVE YIELD TRIAL  
(MLT 1988 Series II)  
(Mudigere, Yercaud and Pampadumpara)

The MLT laid out with 10 entries at Mudigere (1988) was vitiated due to Katte disease and therefore relaid during 1990. The preliminary data viz., mortality percent, percent of plants producing new suckers, number of new suckers and leaves per plant etc. are being obtained. Mortality of suckers was highest in case of SKP-14 (11.11%) and lowest in case of CL-726 and SKP-51. Percentage of plants which produced new suckers in 75 days was highest in CL-726, number of new suckers produced per plant were highest in Mudigere-1 and number of leaves produced per new suckers was highest in sel-800.

At Yercaud a MLT (Series II, 1988) with 12 entries was laid out during July 1988 and is in progress. The morphological attributes and the yield data recorded for the first time during the current harvest season 1990-91 was provided in Table-1. The selection SKP-51 excelled other entries in the morphological characters and SKP-51 recorded the highest capsule yield of 83 kg/ha which was statistically significant.

Table 1 : PERFORMANCE OF ENTRIES IN MLT-II (1988) AT YERCAUD CENTRE (1990-91)

Entry/ Acc.No.	Source	Plant height (cm)	No. of suckers	No. of leaves	No. of panicles	Yield of capsules (kg/ha)
CL.726	RRS Mudigere	152.8	7.3	52.6	6.5	36.0
CL.679	RRS Mudigere	146.5	4.6	28.9	2.0	25.0
CL.683	RRS Mudigere	147.7	4.9	32.7	3.0	26.3
P.1	RRS Mudigere	147.9	4.4	30.8	6.0	22.3
Sel.262	CRS Appangala	177.4	7.0	50.6	2.4	24.6
Sel.800	CRS Appangala	171.9	9.6	64.6	3.9	31.0
Sel.112	CRS Appangala	225.6	13.8	102.9	10.1	55.3
SKP.14	Sakleshpur	126.6	11.5	74.7	9.6	59.3
SKP.51	Sakleshpur	227.8	22.4	159.7	14.9	83.0
PV.1	Pampadumpara	209.4	12.4	96.7	4.6	38.0
Malabar	Local check	209.3	18.3	125.1	11.8	72.6
Mysore	Local check	207.7	9.7	70.1	8.2	47.3
CD (P=0.05)						8.64

The trial was not laid out at Pampadumpara Centre.

Comments : The trial is making satisfactory progress in Mudigere & Yercaud Centres. In spite of repeated requests and personal visits, the Pampadumpara Centre has not taken up trial.

### 3. MUTAGENESIS IN CARDAMOM (Mudigere and Yercaud)

The data on pseudostem height and sucker number of M-1 seedlings of cardamom planted in mainfield during 1989 at Mudigere were collected and presented in Table 2.

Table 2 : OBSERVATION ON MORTALITY AND MORPHOLOGICAL CHARACTERS  
IN M-1 GENERATION CARDAMOM PLANTS

Treat ment	No. of plants		Morta lity %	Pseudostem height cm		No. of leaves/ pseude- stem 10 months crop	Suckers No./plant	
	trans plan ted	survi ved after 10 months		10 ths crop	16 men- ths crop		10 men- ths crop	16 men- ths crop
Control	108	68	37	66.9	119.6	11.0	8.2	21.3
1 KR	96	50	48	58.7	98.9**	10.8	4.8**	14.3**
2 KR	96	34	65	48.3**	98.8**	10.3	5.2**	18.1**
3 KR	48	20	58	42.4**	98.2**	9.2**	4.4**	14.8**
4 KR	96	54	44	54.3**	106.9**	10.3	5.8**	16.1**
5 KR	156	58	37	61.0	115.9**	10.9	7.1	20.7

\*\* - t test significantly differing mean from control.

Pseudostem height was significantly lower in all treatments following gamma rays treatment which varied from 115.9 to 98.2 cm in the treatments than in the control (119.6 cm). The height decreased with dose from 1 to 3 KR but was on the higher side and significantly higher at a higher dose of 4 and 5 KR. Sucker number per plant also showed a similar trend. However 5 KR treatment was on par with control and there was significant reduction in other treatments.

Comments : During the Coimbatore Workshop (1989) it was decided to delink this experiment from the Coordinated Project and this has been communicated. However, the work is being continued by the University.

4. HYBRIDISATION AND SELECTION IN CARDAMOM  
(Mudigere and Pampadumpara)

Evaluation of OF seedling progenies of selected F-1 hybrids and promising clones (Mudigere)

The selected F-1 hybrids which recorded relatively higher yield from the "diallel experiment" were multiplied in isolated blocks along with promising clones. The seedling progenies of these selections were evaluated for yield and yield attributes and compared with the standard check, Mudigere-1. Data were collected on plant height, and sucker number per plant after 3 months and 8 months following transplanting. Out of the 62 entries, 42 were selected F1 hybrids and 20 were promising clones; and among these, significant variability with respect to height was observed, in most of the F-1 hybrids than in promising clones. Similarly variability for sucker was also more in case of hybrids than in promising clones. Among the 13 entries which showed enlarged variability for both "height and sucker number", 12 were hybrids and one was a promising clone. Thus, as compared to 8.33% of the "clones", 28.6% of the hybrids were found suitable for making a selection. Hence selection prospects appear better in seedling progenies of the hybrids than in seedling progenies of promising clones. More than 50% of the plants in case of four entries (D-18, D-496, D-516 and HS-1) were early in bearing and produced panicles by 10 months after transplanting.

Comments : Pampadumpara Centre has not conducted the experiment due to absence of Plant Breeder and however, the post has been now redeployed at Ambalavayal (RARS - KAU) to work on Black Pepper.

5. PRELIMINARY YIELD EVALUATION OF PROMISING CULTURES :  
(Mudigere)

A trial with the two promising cultures with bold capsule size viz., D-751 and HS-1 along with other seven promising cultures as well as Mudigere-1 were taken up for their evaluation. Mortality of suckers was highest in D-751. The percentage of plants which produced new suckers in 75 days was highest in case of CS-6, CL-664 and Mudigere-1 and after seven months, was highest in case of D-751 and Cl-37.

## 6. MANURIAL EXPERIMENTS

(Mudigere, Yercaud and Pampadumpara)

The experiment was laid out at Mudigere during 1987 to study the response of NPK on yield of cardamom under uniform coir mat shade and the variety used was uniform monoclonal Mudigere-1. The treatments (NPK 3x3x3 factorial - 27 treatments) were imposed during 1988. The results do not indicate any significant variation in yield in the second year also. However, the response to fertilizer was more pronounced to higher levels of fertilizers.

In the relaid out experiment at Yercaud (July 1989) the mean data indicated that the treatment 100:100:200 kg NPK/ha recorded maximum plant height (181.63 cm) and number of leaves per plant (81.66). Treatment 100:100:100 kg NPK/ha registered maximum number of suckers/plant (21.85). A new NPK trial was laid out with Malabar variety (Oct.1990) with 6 treatments based on the X Workshop (1989) recommendation.

The experiment has been conducted for three years at Pampadumpara Centre using variety FV-1 under uniform (coir mat) shade and it has been completed. Pooled analysis of yield data (from July 1986 to Dec. 1988) showed no significant difference between 27 different treatments.

Comments : The new experiment planned after the Coimbatore Workshop (1989) will have to be laid out at Pampadumpara Centre.

## 7. STUDIES ON THE EFFECT OF FERTILIZER LEVELS ON THE YIELD OF CARDAMOM UNDER NATURAL SHADE.

(Mudigere)

As per X Workshop decision, a new manurial trial was initiated (1990) with six fertilizer treatments. (NPK levels kg/ha 0-0-0, 75-75-150, 100-100-175, 125-125-200, 150-150-225 and 38-38-75). The initial observations of the growth attributes viz., plant height and number of suckers/clump were found non-significant.



8. MICRONUTRIENT REQUIREMENT OF CARDAMOM  
(Mudigere, Yercaud & Pampadumpara)

A trial on the influence of micronutrients on the yield of cardamom under natural shade with the following seven treatments has been initiated at Mudigere centre:

1. Control (NPK only)
2. NPK + Borax 10 kg/ha (Soil application)
3. NPK + Borax 20 kg/ha (Soil application)
4. NPK + Borax 0.2% solution spray
5. NPK + Molybdenum 0.25 kg/ha (Soil application)
6. NPK + Molybdenum 0.50 kg/ha (Soil application)
7. NPK + Borax 10 kg/ha + Molybdenum 0.25 kg/ha  
(Soil application)

(Borax as Sodium Metaborate, Molybdenum as Sodium Molybdate).

Pre-treatment observation on plant height and number of suckers/clump have been found non-significant. Treatments will be imposed one month before panicle initiation.

The same trial has been laid out at Yercaud and pre-treatment samples have been collected for analysis.

Comments : The new micronutrient trial based on the recommendation of Guntur Workshop (1987) has not yet started at Pampadumpara and it is a serious deficiency. The ADG (PC) & PC (Spices) during their joint visit to the Centre have expressed serious concern on non-initiation of agronomic experiments at Pampadumpara.

9. EVALUATION OF TYPES AND VARIETIES OF CARDAMOM FOR DROUGHT TOLERANCE  
(Mudigere)

In the drought tolerance studies initiated in 1986, twelve selected clones (12-subtreatments) were planted under natural shade in a split plot design with three main treatments (No irrigation, irrigation at

75% depletion and 50% depletion of field capacity). They were grown for two years with the recommended package of practices and during summer 1988-89 and 1989-90, the plants were given irrigation whenever the moisture content got reduced to 75% and 50% of field capacity. The effect of different soil moisture depletion on growth of clones was assessed by determining the percentage of leaf death and sucker death during the stress period (Dec. 1988 to April 1989). The clone P-6 recorded the lowest leaf death and lowest sucker mortality; earlier studies on dry matter accumulation and LAI also indicated P-6 as relatively drought tolerant.

The observation recorded on plant height and number of suckers recorded during May 1990 showed significant differences between levels of irrigation and between clones, Clone P-6 recorded superiority by attaining maximum height (152.73 cm) compared to many other clones and as regard to number of suckers, it was on par with Cl-670, P-8 and P-3. However, the yield differences between entries during September-December 1990 were non-significant. However, yield of P-6 (202.36 g/clump) and P-3 (165.53 g) are numerically higher to other 10 entries.

Comments : In the absence of Plant Physiologist for two years, the programme could not be attended seriously.

#### 10. EVOLVING CONTROL MEASURES AGAINST CARDAMOM THRIPS AND CAPSULE BORER

(Mudigere & Pampadumpara)

The effect of insecticidal spraying and thrashing on the pest population in cardamom and the damage due to thrips and borers were studied in each harvest at Mudigere. A set of 200 cardamom plants were thrashed off old and dried suckers, shoot peels, and dried leaves and were sprayed with 0.05% monocrotophos, followed by two sprays of 0.05% phosalone at 30 days interval, another set treated only with the above insecticides without thrashing and a third set functioned as control. Reduction in thrips damage was observed (16.42%) by spraying monocrotophos and phosalone after thrashing and 13.84% by spraying the above insecticides without thrashing as against control. A gradual decrease in thrips damage was observed in both treatments with succeeding harvest while it remained constant (around 40%) in control. The damage due to capsule borer was very low (3%).

The experiment at Pampadumpara (1988) consists 9 treatments and the chemicals were applied as follows.

- T<sub>1</sub> & T<sub>2</sub> - Endosulfan 0.07% & 0.15%  
 T<sub>3</sub> & T<sub>4</sub> - Carbaryl 0.01% & 0.15%  
 T<sub>5</sub> & T<sub>6</sub> - Monocrotophos 0.05% & 0.1%  
 T<sub>7</sub> & T<sub>8</sub> - Phosalone 0.05% & 0.1%  
 T<sub>9</sub> - Control

The percentage of thrips and capsule borer infestation and yield during the three harvests of the years 1989 and 1990 were observed. Capsule borer infestation was comparatively less in field. The observation on capsule borer infestation of the 3 harvests during the year 1990 are presented in Table-3 showed treatment T-4 is superior in all other treatments.

Table 3 : MEAN PERCENTAGE OF CAPSULE BORER INFESTATION

Treatment	I Harvest	II Harvest	III Harvest
T <sub>1</sub>	2.644 (1.626)	1.000 (1.000)	3.317 (1.821)
T <sub>2</sub>	4.000 (2.000)	4.321 (2.079)	4.966 (2.229)
T <sub>3</sub>	3.219 (1.794)	1.629 (1.276)	2.311 (1.520)
T <sub>4</sub>	1.000 (1.000)	1.000 (1.000)	1.000 (1.000)
T <sub>5</sub>	5.288 (2.300)	5.545 (2.355)	2.644 (1.626)
T <sub>6</sub>	3.547 (1.883)	1.295 (1.138)	4.321 (2.079)
T <sub>7</sub>	1.778 (1.333)	2.644 (1.626)	1.629 (1.276)
T <sub>8</sub>	3.727 (1.931)	3.000 (1.732)	6.000 (2.449)
T <sub>9</sub>	7.520 (2.742)	11.986 (3.462)	12.249 (3.500)
CD at 5%	0.7005	0.333	0.357

Figures in parenthesis are values after  $\sqrt{x}$  transformation.

The thrips infestation percent showed treatment T-2 is superior in all the three harvests and in first harvest T<sub>6</sub> also is found superior (Table-4)

Table 4 : PERCENTAGE OF THIRPS INFESTATION

Treatment	I Harvest	II Harvest	III Harvest
T <sub>1</sub>	19.967 (4.468)	22.565 (4.750)	30.984 (5.566)
T <sub>2</sub>	7.326 (2.707)	6.563 (2.562)	8.538 (2.922)
T <sub>3</sub>	13.963 (3.737)	18.293 (4.277)	22.286 (4.721)
T <sub>4</sub>	11.313 (3.363)	10.661 (3.265)	11.944 (3.456)
T <sub>5</sub>	13.211 (3.635)	13.305 (3.648)	21.293 (4.614)
T <sub>6</sub>	9.327 (3.054)	10.646 (3.263)	15.622 (3.952)
T <sub>7</sub>	13.270 (3.643)	12.611 (4.551)	20.000 (4.472)
T <sub>8</sub>	21.258 (4.611)	22.619 (4.756)	24.952 (4.995)
T <sub>9</sub>	39.328 (6.271)	48.437 (6.960)	59.930 (7.741)
CD at 5%	0.429	0.590	0.465

Figures in parenthesis are values after  $\sqrt{x}$  transformations.

#### 11. EVOLVING KATTE TOLERANT VARIETIES AND CONTROL MEASURES AGAINST KATTE DISEASE AND ITS MANAGEMENT (Mudigere)

The seedlings of the germplasm collection showed susceptible reaction in mass screening at Mudigere. The seeds of Mudigere-1 were subjected to mutagenic agent EMS and M2 seedlings are being evaluated.

Comments : Pampadumpara centre has been advised to drop this experiment as katte is not prevalent in that zone.

12. SCREENING OF VARIETIES/CULTURES FOR RESISTANCE TO NURSERY LEAF SPOT  
(Mudigere)

The available germplasm has been taken up for screening against leaf spot in nurseries. Open pollinated seedlings progenies of promising cardamom clones maintained in an isolated block have been raised in the nursery beds and are being screened for the disease.

13. STUDIES ON CLUMP ROT OR AZHUKAL DISEASE  
(Pampadumpara)

The experiment was laid out at Pampadumpara in two locations in 1988 to find out the effect on time of spraying Aliette (0.3%), Ridemil (0.2%) in combination with Bordeaux mixture (1%) consisting of 8 treatment. None of the treatments gave significant results.

Comments : As the results are non-significant, the trial may be continued.

14. BIOLOGICAL CONTROL OF CARDAMOM RHIZOME ROT  
(Mudigere)

Isolation and culturing of pathogens involved in clump rot for screening with antagonistic fungi and bacterial cultures are under progress. This is as per the decisions taken during X Workshop (Coimbatore, 1989).

Miscellaneous (UAS programme)

15. INFLUENCE OF LIGHT INTENSITY AND NUTRIENTS ON GROWTH AND YIELD OF CARDAMOM  
(Mudigere)

A trial laid out in split plot design with two main treatment (A. shade regulation in May, B. No shade regulation) and the following 6 sub treatments (Nutrient composition of F, Ca, Mg, S, Zn) in the year 1986.

- T<sub>1</sub> - Soil injection with nutrient solution 2 ml/lit
- T<sub>2</sub> - Soil injection with nutrient soil
- T<sub>3</sub> - T<sub>1</sub> + Foliar spray 2 ml/lit
- T<sub>4</sub> - T<sub>2</sub> + Foliar spray 2 ml/lit
- T<sub>5</sub> - Foliar spray 2 ml/lit
- T<sub>6</sub> - Control

No significant yield differences or plant height and number of suckers were observed due to shade management. However numerically higher yield was observed in plots where shade was regulated during May. Soil injection of nutrients at 4 ml/lit + Foliar spray 2 ml/lit resulted in significantly higher yield.

## II. LARGE CARDAMOM

### 1. GERMPLASM COLLECTION, DESCRIPTION AND EVALUATION (Gangtok)

Five promising types of large cardamom viz., Acc. No.3 (Ramnag from Singhik), Acc.No.4 (Ramla from Singhik), Acc. No.9 (Ramsey-green type), Acc. No.12 (Burlangey), Acc. No.14 (Bebo) and five relatives viz., Churumpa (Amomum dealbatum), Boklok (Amomum kingii), Belak (Amomum sp.), Tali (Amomum sp.) & Jaker (Amomum sp.) have been identified from the 34 germplasm types maintained at the experimental farm of ICAR Complex, Tadung for further use in crop improvement.

### 2. COMPARATIVE YIELD TRIAL WITH HIGH YIELDING CLONES (CYT-1) (Gangtok)

In the CYT with six cultivars at the end of third year, the maximum survival observed in Cv. 'Pink Golsy' (80%) followed by 'Ramla' (78.50%) and Sawney (77%). In most of the cultivars the mortality was directly related to the Virus disease except in cultivar 'Dzongu - Golsy'.

'Sawney' and Clone-2 were most affected due to chirkey whereas 'Sawney' and 'Ramla' were affected most due to Foorkey disease. The pooled yield recorded for two years indicated that Cv. 'Pink-Golsy' had a maximum of 1374 kg/ha fresh capsules followed by 'Ramsey' (1053 kg/ha).

Comments : The CYT-1 may be continued for one more year (3rd year) and the data to be pooled and analysed.

### 3. IDENTIFYING TOLERANT TYPES TO TWO VIRUS DISEASES AND EVOLVING CONTROL MEASURES

(Gangtok)

Five hundred seedlings, each of four commercial varieties were planted in May 1988 for screening against virus diseases 'Foorkey' and 'Chirkey' under natural conditions. Chirkey appeared in 'Ramla' & 'Sawney' but not in 'Golsey' & 'Ramsey'. The disease was recorded in 11 clumps and 25 clumps in the variety Sawney in 1989 & 1990 respectively; and in Ramla, 22 clumps were found infected with this disease in 1990 as against 16 in 1989.

Foorkey disease was later observed in three clumps in 'Golsey' and one clump in 'Ramsey' in 1990. In 'Sawney', 25 clumps were infected against 8 in 1989 and 22 clumps in variety 'Ramla' against 14 clumps in 1989.

### 4. FUNGICIDAL EVALUATION AGAINST LEAF STREAK DISEASE

(Gangtok)

The leaf streak disease caused considerable foliage damage to the variety 'Golsey' which was found tolerant to Chirkey and Foorkey. The evaluation with the 10 fungicides for two years (1989 & 1990) indicated that Copper fungicides Blitox-50 and Fytolan were found to be the best to control the disease.



### III. BLACK PEPPER

#### 1. GERMPLASM COLLECTION, DESCRIPTION AND EVALUATION (Panniyur, Sirsi and Chintapalli)

In the black pepper germplasm collection sixty three cultivars produced spikes during 1990 at Panniyur. Though vines are of variable age, a comparison was made for varieties which yielded more than 5 kg green spike/vine. The highest green spike yield of 9.700 kg by a vine was obtained in "Sullia" followed by TMB-IV (8.590 kg), Karimunda-I (8.110 kg), Karimunda-III (8.080 kg), Balankotta-II (7.820 kg), Kumbakodi (6.885 kg), Munda (5.330 kg), Valli (5.130 kg). Wild germplasm were collected from Kodagu district and Sirsi areas of Karnataka.

A total 65 germplasm accession (45 cultivated and 20 wild) were maintained at Sirsi.

At Chintapalli, 17 cultivated and 4 wild accessions are maintained. Additional (wild) germplasm collection made during 1990 from the forest areas of R.V.Nagar and Chintapalli forest division increased the wild germplasm to 19 and are established in germplasm block.

At Chintapalli, nine cultivated germplasm as well as wild germplasm were evaluated for progressive growth, spike characters and yield. The yield data were recorded in available vine in each variety and the mean values showed that among the 9 cultivated varieties evaluated, Kottanadan followed by Karimunda & Panniyur-1 have recorded maximum number of spikes/vines (63.4, 62.5 & 54.3 respectively). The spike length was however greater in Panniyur-1 (10.3 cm) followed by Kottanadan (10.1 cm) whereas berries/spike was greater in Kottanadan (56.2) followed by Panniyur-1 (52.5). Yield of berries in terms of fresh and dry weight were maximum in Panniyur-1 (0.460 kg & 0.13 kg) followed by Balankotta, Kottanadan and Karimunda.

## 2. COMPARATIVE YIELD TRIAL OF SELECTED CULTIVARS (CYT 1984 : Series-I)

(Panniyur)

The experiment was aimed to evaluate 9 cultivars at two Centres viz., Panniyur and Chintapalli. However, the experiment was started with 9 entries only at Panniyur during 1984 (CYT 1984 Series-1). The entries are Culture No.54, Culture No.211, Culture No.239, Culture No.331, Culture No.406, Culture No.1171, Culture No.1199, Panniyur-I and Karimunda bulk. Three cultures viz., No.54, No.239 and No.331 yielded high and later No.331 was released as Panniyur-3. It was decided to discontinue this experiment but to continue as a University programme as only by 1995, firm results would become available.

## 3. MULTILLOCATION TRIAL OF PEPPER CULTIVARS (1984 Series-II) (Panniyur, Chintapalli & Sirsi)

Another set of experiment also initiated in 1984 in Panniyur, Sirsi and Chintapalli locations with the promising cultures viz., Neelamundi, Kalluvally, Aimpiriyar, Kottanadan, Narayakodi, Kuthiravally, Karimunda bulk, Arakulamunda and Panniyur-1. During the last 3-4 years of stabilised yield (vines per se), there is no significant difference between the cultivars at Panniyur Centre. The trial at Chintapalli has been laid (1987) with 11 selected cultivars and the initial 3 years' data showed superiority of Panniyur-1 & Kottanadan over others. At Sirsi, the trial has been abandoned due to mortality of vines and a new MLT started in 1987.

Comments : Though there is no significant outcome from this trial, it was allowed to be continued as an University programme. The programme would give dependable results only by 1995 at Panniyur.

## 4. MULTILLOCATION TRIAL IN BLACK PEPPER (1987 Series-III) (Panniyur, Sirsi, Yercaud & Chintapalli)

The Guntur Workshop decided to initiate a new CYT with 10 promising black pepper entries at Panniyur, Sirsi, Chintapalli & Yercaud

Centres. Accordingly the trial laid out at Panniyur with standards as Karayam (Garuga pinnata); the entries included are cultures 141, 239, 331, 1558 (OP Kalluvally) and 5128 (OP Cheriyakaniakadan), KS-14, KS-27, KS-88, Karimunda and Panniyur-1. This has been laid out only during 1990. The trial has also been laid out at Sirsi with Local Controls viz., Karimalligessara & Uddakare. At the Yercaud Centre, a similar trial has been laid out (1990-91) on a voluntary basis.

Comments : The Chintapalli Centre is yet to take up the programme.

#### 5. INTERVARIETAL HYBRIDISATION TO EVOLVE HIGH YIELDING VARIETIES (Panniyur)

Out of more than 2000 hybrid and OP progeny seedlings planted, since 1983, 541 OP and hybrid seedling vines were harvested. The vines were 3-8 year old. The vines which yields more than 1 kg green spike planted in 1982/83/84 are 27 in number. The yield data of the 7 accessions along with Panniyur-1 & Karimunda were statistically analysed and that showed significant variation among the accessions.

Note : This trial involving 14 parental combinations was initiated during July-August 1987. About 8000 OP and hybrid progeny are under evaluation for yield and other attributes. The 'hybrids' constitute about 25% of the population and the rest are OP progenies. The promising cultures have been advanced to either CYT/MLT resulted in release of Panniyur-2, Panniyur-3 & Panniyur-4. An OP seedling of cultivar Cheriyakaniakadan (Cul.No.5128) also is superior in performance.

Comments : This is a continuous experiment, providing very valuable material for future use in MLT etc.

#### 6. MANURIAL REQUIREMENTS OF BLACK PEPPER (Sirsi)

The experiment laid out during June 1990 is in progress at Sirsi with 5 treatments (different dose of fertilizer application to main crop & intercrop). Yield of black pepper and arecanut have been recorded.

## 7. IRRIGATION-CUM-FERTILIZER REQUIREMENT

(Panniyur &amp; Sirsi)

As per the recommendations of Guatur Workshop (1987), an experiment has been laid out at Panniyur in 1987 to study the requirement of irrigation and fertilizer in Karimunda and Panniyur varieties with combination of varieties and 3 levels of irrigation as main treatments and 3 levels of fertilizer as subtreatments. Observation on the number of spikes and yield of spike per plant (1990-91) revealed that the two levels of irrigation had increased the number of spikes and yield of berries per plant in both the varieties producing highest number of spikes and yield of berries by Karimunda under IW/CPE ratio of 0.250 (Table 5 & 6).

Table-5 : IRRIGATION-CUM-FERTILIZER REQUIREMENT (Panniyur Centre)

Mean yield of berries/plant (g) (1990-91)

Levels of irrigation (I)	Varieties (V)		Mean
	V <sub>1</sub> (Karimunda)	V <sub>2</sub> (Panniyur-1)	
I <sub>1</sub> - No irrigation	306.29	510.37	408.58
I <sub>2</sub> - Irrigation at IW/CPE ratio 0.125	1010.27	1119.46	1064.87
I <sub>3</sub> - Irrigation at IW/CPE ratio 0.250	1342.43	1060.07	1201.25
Mean	886.33	896.80	

C.D. at 5% level

V x I	NS.
V	NS
I	422.98

Irrigation significantly increased spike yield, but irrigation at IW/CPE ratio 0.250 did not increase the yield over irrigation at IW/CPE ratio of 0.125.

Table 6 : IRRIGATION-CUM-FERTILIZER REQUIREMENT (Panniyur Centre)

Mean number of spikes/plant - 1990-91

Levels of irrigation**	Varieties*		Mean
	V <sub>1</sub>	V <sub>2</sub>	
I <sub>1</sub>	83.64	85.94	84.79
I <sub>2</sub>	241.83	134.96	188.40
I <sub>3</sub>	312.29	132.29	222.29
Mean	212.59	117.73	
CD at 5% level	V x I	78.12	
	V	45.12	
	I	55.26	
*V-1	- Karimunda		
V-2	- Panniyur-1		
**I <sub>1</sub>	- No irrigation		
I <sub>2</sub>	- Irrigation at IW/CPE ratio 0.125		
I <sub>3</sub>	- Irrigation at IW/CPE ratio 0.250		

Interaction between irrigation and varieties were also significant.

This trial has been planned at Sirsi Centre and the field is getting established; Karimalligessara and Panniyur-1 are the varieties tested, the other treatment details being similar to as at Panniyur. The arecanut-pepper intercropping system has been taken into account at

## 8. INVESTIGATION OF QUICK WILT AND SLOW WILT DISEASE OF PEPPER INCLUDING TESTING OF SYSTEMIC FUNGICIDES

### a) Chemical control of quick wilt (Foot rot) disease Panniyur & Sirsi)

A field control trial was started in 1985-86 at Panniyur and Sirsi (1986-87). The experiment was however again modified by including Aliette and Ridomil MZ containing 5 treatments consisting of 3 application, first just before the onset of monsoon, second and third were given during the last week of July and September respectively. The result of experiment (1989 & 1990) at Panniyur provided in Table-7 showed significant difference between treatments in leaf & branch infection. All the fungicidal treatments reduced the levels of infection in leaf & branches and all fungicides were on par in respect of leaf infection. The pooled analysis of the last three year data (1988-89, 1989-90 and 1990-91) also observed significant variation among treatments (Table-8). All fungicidal treatment except spraying and drenching with Aliette were effectively reduced stem infection.

Table 7 : FIELD TRIAL FOR THE CONTROL OF QUICK WILT DISEASE OF PEPPER AT PANNIYUR (1989 & 1990)

Treatments	1989			1990		
	Infection %			Infection %		
	Leaf	Branch	Stem	Leaf	Branch	Stem
1. Bordeaux mixture spraying, drenching and pasting	2.02	1.01	0	4.00	2.43	2.50
2. Bordeaux mixture spraying, pasting and drenching with Copper Oxychloride 0.3%	2.27	0.96	0	4.01	2.95	0
3. Ridomil MZ 72 WP 0.2% spraying and drenching	3.43	2.17	0	4.35	2.66	7.50
4. Bordeaux mixture pasting and drenching and spraying with Captafol-0.2%	2.62	2.42	0	4.40	4.05	10.00
5. Spraying and drenching with Aliette - 0.3%	2.12	2.12	0.33	5.14	4.13	11.25
6. Control	7.63	4.48	8.33	9.65	6.77	17.50
C.D. at 5% level	4.48	NS	NS	1.56	1.20	NS

Table-8 : FIELD TRIAL FOR THE CONTROL OF QUICK WILT DISEASE OF PEPPER AT PANNIYUR (Pooled data 1988-89 to 1990-91)

Treatments	Infection (%) (Pooled three years)		
	Leaf	Branch	Stem
1. Bordeaux mixture spraying, drenching and pasting	2.81	1.48	0.83
2. Bordeaux mixture spraying, pasting and drenching with Copper Oxylchloride-0.3%	3.03	1.78	0
3. Ridomil MZ 72 WP 0.2% spraying and drenching	3.01	2.00	2.50
4. Bordeaux mixture pasting and drenching and spraying with Captafol - 0.2%	3.25	2.67	3.33
5. Spraying and drenching with Aliette-0.3%	3.66	2.87	7.45
6. Control	7.57	5.11	9.53
C.D. at 5% level	1.23	0.75	6.16

The experiment with six treatments laid out at Sirsi in farmers garden at Sirsimakki during 1987 was concluded. The details of the treatment are provided in the following Table. The pooled/analysed data of three years 1987-88 to 1989-90 showed no significant difference between the treatment T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> (Table-9). But there is significant difference between treatments and between treatments and control. However incidence of disease was least in the "metalaxyl" treatment. When compared with cost-benefit ratio, treatments T<sub>1</sub> and T<sub>3</sub> seems to be equally beneficial.

The experiment was again modified as per the decision of Group Meeting of Plant Pathologists held at Bangalore during June 1990, the new experiment entitled as "Phytophthora" foot rot and nematode disease management in Black pepper.

Table-9 : POOLED ANALYSIS OF PERCENTAGE OF DISEASE INCIDENCE OF FOOT-ROT DISEASE AT SIRSI (1987-88, 1988-89, 1989-90)

Treatments	% of disease incidence (Mean of 3 years)
T <sub>1</sub> - Bordeaux mixture (1%) Spraying + Drenching + Bordeaux paste application (up to 0.5 M)	3.2
T <sub>2</sub> - Bordeaux mixture (1%) spraying + Copper Oxychloride (0.3%) drenching + Bordeaux paste (up to 0.5 M)	2.3
T <sub>3</sub> - Metalaxyl (100 ppm) spraying + drenching	2.6
T <sub>4</sub> - Captafol (0.2%) spraying + drenching + Bordeaux paste application (up to 0.5 M)	4.6
T <sub>5</sub> - Control	21.2
S.E.m ±	0.33
C.D. at 5%	0.72

b) MANAGEMENT OF Phytophthora FOOT ROT OF BLACK PEPPER  
(Chintapalli)

Management of foot rot of black pepper was taken up in the A.P. Forest Development Corporation plantations, Vangasara during 1990 with six treatments. The preliminary data indicated drenching with 1.0% Bordeaux mixture @ 5 lits. per vine and two rounds of foliar spray with 1.0% Bordeaux mixture applied during July and repeated in August are quite effective.

A plantation having 15-20% foot rot incidence was selected at Vangasara for the new coordinated trial with 8 treatments for the management of Foot rot of black pepper as per Coimbatore Workshop (1989) decisions. The treatments will be imposed during May 1991. The existing chemical control trial of foot rot of black pepper will be continued.

Note : However, the treatments were actually given as per the Bangalore Group Discussions (June 1990) and will be reported in the next year's annual report.



9. OBSERVATIONAL TRIAL FOR CONTROL OF QUICK WILT IN FARMERS' FIELD  
(Fanniyur)

An experiment to study the effect of soil amendments for the management of quick wilt disease was laid out in 1986 in two locations viz., Padiyotchal and Eramom with 4 treatments and control. Observation on the incidence of infection on leaf, branch and stem were recorded during last four years, along with the incidence of fungal pollu on yield. In the case of leaf and branch infection, treatment effects were significant at both the locations during 1990-91. In Padiyotchal, stem infection was not significant but it was significant at Eramom.

The last 4 years data were pooled, analysed and presented in Table 10. Significant reduction in disease were observed in all the treatments compared to control. In general, the vigour of the vines were improved by soil amendments and application of neem cake and lime along with Bordeaux mixture; this not only reduced the incidence of disease but also increased the yield.

Table 10 : OBSERVATIONAL TRIAL FOR THE CONTROL OF QUICK WILT DISEASE AT FANNIYUR

Pooled analysis - 1987-91 ( 4 years )

Treatment	Pooled analysis of mean infection(%) and yield at							
	(a) Padiyotchal				(b) Eramom			
	Infection %			Yield	Infection %			Yield
	Leaf	Branch	Stem	(Kg)	Leaf	Branch	Stem	(Kg)
T <sub>1</sub> - Bordeaux mixture pasting, spraying and drenching	4.82	5.02	3.33	7.99	5.16	4.26	2.50	8.63
T <sub>2</sub> - T <sub>1</sub> + Neem cake @ 12 kg/vine	4.94	4.08	2.50	8.09	6.00	3.90	4.17	11.12
T <sub>3</sub> - T <sub>1</sub> + Lime @	3.66	3.45	4.17	9.59	3.78	3.22	3.33	14.52
T <sub>4</sub> - T <sub>1</sub> + Neem cake @ 2 kg/vine + Lime 1 kg/vine	4.55	3.94	0	9.19	4.30	3.68	6.83	14.01
T <sub>5</sub> - Control	10.76	6.82	14.17	5.50	9.49	6.34	17.09	9.71
C.D. at 5% level	1.84	2.08	5.45	2.51	2.43	1.74	4.49	3.76

## 10. FIELD TRIAL FOR THE CONTROL OF SLOW WILT DISEASE OF BLACK PEPPER

(Panniyur, Chintapalli &amp; Sirsi)

An experiment to find out suitable chemicals and soil amendments for the management of slow wilt disease of pepper was laid out at Panniyur during 1986 with 6 treatments and later on, two more treatments were included during 1989 (T<sub>7</sub> & T<sub>8</sub>). The first treatments were given during the first week of June and other during the second week of September; the details of treatments and observations on the incidence of the disease are provided in Table as under.

Table 11 : FIELD TRIAL FOR THE CONTROL OF SLOW WILT

Treatments	Mean infection %	
	1989	1990
T <sub>1</sub> - Application of Thimet 3 g a.i./vine	7.22	10.89
T <sub>2</sub> - Application of Bavistin 0.1%	10.84	10.78
T <sub>3</sub> - Application of Copper oxychloride 0.3%	6.39	12.55
T <sub>4</sub> - T <sub>1</sub> + T <sub>2</sub>	11.39	12.86
T <sub>5</sub> - T <sub>1</sub> + T <sub>3</sub>	4.72	3.63
T <sub>6</sub> - T <sub>1</sub> + T <sub>2</sub> + T <sub>3</sub>	9.17	5.11
T <sub>7</sub> - Application of Neem cake 2 kg/vine	8.06	7.83
T <sub>8</sub> - T <sub>7</sub> + T <sub>1</sub> + T <sub>2</sub> + T <sub>3</sub>	8.89	6.07
T <sub>9</sub> - Control	16.39	15.47
C.D. at 5%	N.S.	N.S.

The control of slow wilt with different concentrations of Aliette (0.1 and 0.2%) by different methods of application (3 methods) was initiated at Chintapalli during March 1989. The data recorded on the slow wilt control trial with respect to length and girth of vine and mortality showed that spraying of 0.1% Aliette resulted in an increase of 0.19 M of vine length and 0.4 mm increase in girth over the control.

Similarly 0.1 & 0.2% concentration in all the methods of application resulted in a general marginal increase in the girth of the slow wilt affected vine except in 0.1% Aliette drenching treatment. A marginal increase in girth of vine was observed in 0.2% Aliette with all 3 methods of application.

The data clearly indicated that there is no appreciable effect on different concentration of Aliette and methods of application and there is no advantage of using Aliette in the control of slow wilt disease.

The observational trial for the control of slow wilt disease laid out in 1988-89 in farmers field at Sirsi was abandoned due to absence of disease.

Comments :

There were no significant difference among the treatments. However combined application of nematicide and fungicide seemed to reduce the incidence.

11. STUDIES ON THE CONTROL OF NURSERY DISEASE OF PEPPER  
(Panniyur)

A modified trial to find out effective control measures for the management of nursery diseases was started during 1987-88 with 5 treatments under three light intensity (K.Lux.). Spraying and drenching were done at fortnightly intervals. The data on the percentage of incidence of nursery disease during 1990-91 (Table 12) showed no significant difference in treatment under light intensity at 11.382 K.Lux. However there was significant difference between treatments at light intensity of 5.595 and 4.867 K.Lux. In general disease incidence was reduced with increased intensity of light and spraying and drenching with Bordeaux mixture. The two years pooled data (1989-91) also showed the same results on those of individual years.

Table 12 : PERCENTAGE OF INCIDENCE OF NURSERY DISEASE 1990-91  
(Panniyur)

Treatments	Light intensity (K.Lux)		
	Mean infection (%)		
	High 11.382	Medium 5.593	Low 4.867
T <sub>1</sub> - Spraying Bordeaux mixture 1%	15.45	16.60	18.96
T <sub>2</sub> - Spraying Difoltan 0.1%	14.73	14.38	16.38
T <sub>3</sub> - Spraying and drenching with Bordeaux mixture - 1%	2.70	5.23	8.60
T <sub>4</sub> - Spraying and drenching with Difoltan 0.1%	6.50	14.83	18.65
T <sub>5</sub> - Drenching with cheshunt compound	12.75	28.05	24.25
T <sub>6</sub> - Control	18.23	39.53	37.53
C.D.at 5% level	3.322	2.544	5.920

#### IV. GINGER

##### 1. GERMPLASM COLLECTION AND EVALUATION

(Solan & Pottangi)

At Solan a total collection of 163 germplasm are available of which observation for different horticultural characters were recorded for 104 accessions during 1989/1990. The remaining 59 accessions were planted in observational plot in 1990. In general, SR, SDR, SG-547, SG-551 and SG-568 gave consistent performance for most of the characters studied during 1990. However SG 547 being the best line during 1989, has been included in the MLT (Series III) from 1991.

One hundred and thirty four accessions were evaluated (total 140) at Pottangi. A wide range of variability was observed in all the traits. The highest data recorded for different characters viz., number of tillers/clump in Chintapalli local (18.0), number of leaves/shoot in SG 666 (21.3), plant height in S-557 (76.5 cm) length of fully opened last leaf in Kurmaput local (25.8 cm), breadth of fully opened last leaf Gandeni (1.8 cm). Highest rhizome yield was obtained by PGS-8 (12.150 kg/3 M<sup>2</sup>) and was free from soft rot.

Comments : There is need to import germplasm from Jamaica, China and Pakistan.

##### 2. MULTILLOCATION TRIALS

(Pottangi & Solan)

Two MLT were laid out at Solan, the MLT-I with 10 entries and MLT-II with 6 entries. The MLT-I is running the fourth year at Solan during 1990; the accession Maran gave maximum rhizome length and breadth while SG-646 gave maximum yield per plant and plot. The pooled performance of the entries for four years (1987-90) presented in Table 13 indicate that these did not perform consistently during the period of studies. SG-666 gave maximum yield per plot and was statistically on par with SG-646 and Rajgarh and were significantly superior in yield when compared with other entries.

Table 13 : POOLED ANALYSIS OF GINGER YIELD OVER 1987 to 1990 AT SOLAN

Sl. No.	Varieties	Plant height cm	Tiller per plant	Leaves per plant	Leaf length cm	Rhizome		Yield per	
						Length cm	Breadth cm	Plant g	Plot kg
1.	EGS-39	33.06	8.02	72.49	17.71	9.98	4.20	75.48	2.19
2.	EGS-35	29.58	8.24	63.45	16.29	9.40	3.99	83.66	1.69
3.	V <sub>2</sub> K <sub>3</sub> -2	28.85	6.84	61.86	15.55	10.17	4.24	103.14	2.31
4.	V <sub>1</sub> K <sub>1</sub> -3	29.46	7.81	74.99	16.43	10.31	4.32	80.24	2.32
5.	Wynad	36.06	7.91	80.30	19.54	12.94	5.33	118.04	4.00
6.	SG 666	40.78	7.83	78.92	20.51	14.51	5.67	174.81	7.22
7.	Rajgadh	41.73	6.96	84.63	20.82	14.08	5.53	149.92	6.94
8.	SG-046	42.35	7.76	86.46	21.92	14.93	6.00	171.83	6.88
9.	Kerala Local	34.61	8.64	79.38	19.00	13.17	5.12	153.37	3.59
10.	Maran	36.80	7.26	72.06	19.41	13.01	5.16	127.32	4.57
Range		28.85 to 42.35	6.84 to 8.64	61.86 to 86.46	15.55 to 21.92	9.40 to 14.93	3.99 to 6.00	75.48 to 174.81	1.69 to 7.22
Mean		33.32	7.73	75.45	18.76	12.25	4.96	123.78	4.17
CD 5% years		0.80	1.04	9.44	0.92	0.83	0.35	14.85	0.62
Vars		5.07	NS	14.91	1.46	1.31	0.56	27.11	0.98
Vars in years		10.14	NS	29.84	2.92	2.62	1.12	54.22	NS

The MLT (II) laid out at Pettangi and Solan during 1988 with six entries from various Coordinating Centres. The pooled analysis of 4 years data at Pettangi indicated significant differences among the varieties in rhizome yield (Table 14). The entry V<sub>1</sub>K<sub>1</sub>-3 gave the highest projected yield of 17.448 t/ha and also higher dry ginger recovery (25.0%) with 10.2% oleoresin, 2.1% essential oil and 4.0% crude fibre. This accession needs to be recommended for release.

Table 14 : FRESH RHIZOME YIELD UNDER MULTILLOCATION TRIAL AT  
POTTANGI (Pool data - 1988-91 - 4 years)

Cultivar	Rhizome yield Kg/3 m <sup>2</sup>					Projected yield (t/ha)
	1988	1989	1990	1991	Mean	
V <sub>1</sub> K <sub>1</sub> -3	8.080	5.375	6.550	7.912	6.980	17.448
Suprabha	8.610	4.550	3.865	10.044	6.767	16.917
V <sub>2</sub> E <sub>5</sub> -2	8.662	1.763	4.415	8.084	5.731	14.328
FGS-19	6.030	2.275	3.660	5.801	4.441	11.104
SG-666	6.422	1.500	4.188	6.321	4.608	11.520
Maran	2.542	3.893	4.045	6.600	4.270	10.675
C.D. at 5%	3.650	N.S	2.216	3.266	1.066	2.665

Comments : The mutant V<sub>1</sub>K<sub>1</sub>-3 is performing well and hence can be promoted as variety. The pooled analysis from Solan Centre may be reported immediately.

### 3. INITIAL EVALUATION TRIAL (Pottangi)

Eighteen cultures tested in IET during 1990 and 1991 indicated significant differences in rhizome yield (Table 15). Pooled data on yield for two years revealed superiority of V<sub>1</sub>E<sub>4</sub>-4 (14.452 t/ha) followed by V<sub>1</sub>S<sub>1</sub>-2 (13.775 t/ha)

Comments : The top performers viz., V<sub>1</sub>E<sub>4</sub>-4, V<sub>1</sub>S<sub>1</sub>-2 and V<sub>1</sub>E<sub>8</sub>-2 can be promoted for CYT and later for multilocation testing. The Solan & Pottangi Centre should clearly indicate the total accession number, actually evaluated entries during 1990-91 and the remaining entries pending evaluation. This may be speeded up.

Table 15 : INITIAL EVALUATION TRIAL IN GINGER IN POTTANGI

Cultivar	Soft rot incidence(%)	Fresh rhizome yield kg/3m <sup>2</sup>			Projected yield t/ha
		1990	1991	Mean	
V <sub>1</sub> E <sub>4</sub> -4	2.4	4.992	6.570	5.781	14.452
V <sub>1</sub> S <sub>1</sub> -2	5.0	2.949	8.072	5.510	13.775
V <sub>1</sub> E <sub>8</sub> -2	3.7	3.017	7.571	5.299	13.247
S.S.1	8.8	4.192	5.468	4.830	12.758
Gurubharan	5.8	4.394	5.610	5.020	12.550
Suprabha	0.0	3.536	6.321	4.928	12.320
V <sub>1</sub> C-8	0.0	3.433	6.051	4.742	11.835
V S <sub>1</sub> -7	0.0	3.978	5.242	4.610	11.525
V <sub>1</sub> <sup>1</sup> S <sub>1</sub> -8	5.8	2.187	6.968	4.577	11.442
Jugijan	7.0	4.035	4.708	4.380	10.950
V <sub>2</sub> E <sub>4</sub> -5	22.5	3.082	5.417	4.249	10.622
Nc.22	1.6	3.273	5.198	4.235	10.587
Nc.8	5.0	2.852	5.476	4.164	10.410
V <sub>4</sub> E <sub>4</sub> -1	9.3	2.205	5.515	3.860	9.650
Nadia	1.8	2.653	4.500	3.577	8.942
V <sub>5</sub> E <sub>5</sub> -4	29.7	1.677	5.181	3.429	8.572
V <sub>3</sub> S <sub>1</sub> -8	5.7	3.216	2.533	2.874	7.185
Nc.21	9.5	1.835	3.887	2.861	7.152
C.D. at 5%		1.446	3.692	2.010	5.025



#### 4. EFFECT OF INTERCROPPING IN GINGER

(Pottangi)

As per the decisions, a case study was recommended to be made during the Coimbatore Workshop. Studies were conducted (8 treatments) i.e., T<sub>1</sub> to T<sub>8</sub> first mulch + intercropping with the Soyabean or Arhar or Niger or French bean or Rice Bean. T<sub>6</sub> - First mulch only, T<sub>7</sub> - No mulching, T<sub>8</sub> - All the 3 mulches. There were no significant difference for ginger yield due to treatments though highest yield was obtained by pure crop with 3 mulchings (9.617 t/ha) closely followed by Soyabean (9.555 t/ha). The cost benefit analysis accounted for the highest benefit by intercropping with Soyabean.

#### 5. NPK TRIAL IN GINGER

(Pottangi)

A new NPK trial laid out (1990-91) comprising 6 treatments as per Coimbatore Workshop decisions. Higher rhizome yield of 19.90 t/ha was recorded by application of N<sub>125</sub> P<sub>100</sub> K<sub>100</sub> kg/ha closely followed by N<sub>100</sub> P<sub>75</sub> K<sub>75</sub> kg/ha (19.10 t/ha) and N<sub>150</sub> P<sub>150</sub> K<sub>150</sub> kg/ha (19.045 t/ha). The cost benefit analysis indicated highest benefit by application of N<sub>125</sub> P<sub>100</sub> K<sub>100</sub> kg/ha (Rs.1,38,380/ha).

#### 6. GERMPLASM SCREENING FOR RHIZOME ROT

(Solan)

The 85 collections of ginger were evaluated for rhizome rot pathogens viz., Pythium ultimum and Fusarium oxysporum under field conditions. Seven lines viz., SR, SDR, SGR, SG 547; Sel. Kothi-II, Maran, Awcho were found to be resistant and another 26 were moderately susceptible, 48 susceptible and 4 highly susceptible to this disease.

7. EVALUATION OF GERMPLASM FOR QUALITY CHARACTERS  
(Solan)

Thirty two collections of ginger were evaluated for essential oil and oleoresin contents during 1988-89. In the 52 collections evaluated from crops harvested during 1990 from Solan/Kandaghat, SG 666 recorded maximum essential oil. Oleoresin was maximum SG-551 (5.38%) closely followed by Rajgarh (5.36%) at Kandaghat location, near Solan.

8. EFFECT OF SEED TREATMENT ON RHIZOME ROT OF GINGER  
(University programme)  
(Solan)

A pilot trial was started with 6 treatments during 1987 to evaluate the effect of 6 different fungicides/seed treatments in reducing the incidence of rhizome rot of ginger. Fungicides Ridomil MZ (0.4%), Bavistin (0.1%), Blitox-50 (0.3%), Captan (0.25%), Dithane M-45 (0.3%) and Dithane M-45 (0.3%) + Bavistin (0.1%) were applied to the rhizome of ginger as pre-sowing dip treatment during the month of April, 1990. The observations on germination, pre-emergence and post-emergence, indicated that pre-sowing treatment in combination of Bavistin & Dithane M-45 followed by Captan increased germination and reduced pre-emergence and post-emergence rot. The pre-sowing seed treatment with fungicides for 60 minutes reduced rhizome rot of ginger.

## V. TURMERIC

### 1. GERMPLASM COLLECTION AND EVALUATION

(Solan, Pottangi, Jagtial and Coimbatore)

The turmeric germplasm collection increased to 157 at Solan by the addition of 90 new collections. In the evaluation of 57 accessions, ST-77, ST-323, ST-365, ST-42 and PGT-8 (Suvarna) gave good performance in general for most of the characters viz., plant height, tiller and leaves per plant, leaf length and breadth, rhizome length and breadth, yield per plant and plot. The highest "per plant" yield (315.0 g) and "per plot" yield (8.50 kg) was recorded by ST-77.

At Pottangi, 157 turmeric accessions which were evaluated included 137 types of C. longa, 17 of C. aromatica and 3 of C. amada. Observations on growth parameters showed good performance by PTS-15, CLD-16, PTS-7, PTS-5, PTS-62, PTS-41, Mundapadar, PTS-55 among C. longa. Highest fresh rhizome yield was obtained by CLS-7 (15 kg/3 M<sup>2</sup>) followed by PTS-9 (4.55 kg/3 M<sup>2</sup>) among C. longa, Chaya Pasupu-II (3.75 kg/3M<sup>2</sup>) among C. aromatica and GAM-I (7.50 kg/3M<sup>2</sup>) among C. amada.

Eight accessions evaluated at Jagtial had shown wide variation for height, No. of leaves, weight of mother and finger rhizomes and for fresh rhizome yield during 1989-90 and 1990-91. Disease tolerance (rhizome rot and leaf spot) was also observed in some of the entries.

Wide variability was observed for most of the biometric characters in the 105 germplasms evaluated at Coimbatore. PTS-5 registered the maximum height (95.1 cm) and Avarigadda recorded the shortest plant (78.1 cm). Co-1 registered higher mean number of mother leaf (10.6), tiller leaf (12.6), tiller number (2.3) and secondary rhizome number (15.6). PTS-55 recorded higher values for economic characters viz., mean weight of secondary fingers (57 g) and length of finger (7.1 cm).

Comments : The Jagtial Centre needs improvement in addition to germplasm; this Centre may also intensify collection of wild germplasm from forests of Adilabad-Nizamabad districts.

## 2. INITIAL EVALUATION TRIAL

(Pottangi, Coimbatore &amp; Jagtial)

Twenty promising accessions including Roma (as standard) were put under IET at Pottangi during the year 1990 and 1991. Pooled yield data for 2 years proved the superiority of PTS-19 giving a projected yield of 24.665 t/ha.

At Coimbatore, 17 entries were tested and the yield ranged between 16.9 and 28.2 t/ha. The highest significant yield was recorded by the promising accession 5335-3-1 (TC.2) which had 19.7% curing percentage, 4.6% curcumin and 28.2 t/ha yield followed by 5331-3-1 which recorded the lowest curing percentage (15.2), 4.4% curcumin and 26.7 t/ha yield.

At Jagtial, 24 accessions were evaluated during 1990-91 and highest yield was obtained from PCT-13 (11.83 kg/3m<sup>2</sup>) followed by PCT-14 (9.33 kg/3m<sup>2</sup>).

Comments : The Solan centre is advised to undertake systematic initial evaluation of the accessions.

## 3. COMPARATIVE YIELD TRIAL

(Pottangi)

In the CYT at Pottangi with six promising cultivars (including Roma and Suvarna standards) there was significant difference among the varieties (Table 16). PTS-19 yielded the highest fresh turmeric followed by T.No.1, PTS-11, PTS-62 and Roma.

Table 16 : PERFORMANCE OF SIX TURMERIC CULTIVARS UNDER CYT 1990-91 AT POTTANGI

Cultivars	Fresh rhizome <sub>2</sub> yield in kg/3m <sup>2</sup>	Projected yield in t/ha
PTS-19	11.446	28.615
Turmeric No.1	7.764	19.410
PTS-12	7.645	19.113
PTS-62	7.175	17.863
PTS-10 (Roma)	7.045	17.613
PCT-8 (Suvarna)	3.555	8.888
CD at 5%	2.0524	5.1309

4. MULTILLOCATION TRIAL ON TURMERIC (1987 Series-II)  
(Solan, Pottangi, Jagtial and Coimbatore)

The MLT (Series-II) with improved selection obtained from different centres initiated in 1987/88 were continued at all the above centres.

The trial at Solan with 11 selections (without TNAU selection) showed significant results in yield and rhizome characters but not with the most other horticultural traits. The highest per plant (221.7 g) and per plot (6.63 kg) yield were obtained by ST-323.

The pooled mean performance studied for 4 years (1987-90) at Solan presented in Table 17 showed significant "year effects" indicating that there were variable environmental conditions whereas significant varietal and varietal x year effects indicated that varieties showed variation for all characters except for leaves per plant and leaf breadth. These characters also did not show variation during the four year period. ST-323 was the best performer for yield closely followed by PCT-2 and PTS-24 which were however statistically on par.

The MLT (Series-II) at Pottangi was laid during 1988 to 1991 and the pooled data for 4 years are presented in Table 18 revealed superiority of PTS-38 (23.785 t/ha) over the released variety Roma (23.510 t/ha). This is 17% more than the averages of other accessions. PTS-38 gave slightly higher curcumin (7.47%) than Roma (7.39%).

In the MLT (Series-II) at Jagtial with 12 accessions, (during 1988-89), Duggirala had given significantly higher yield (38.3 t/ha) followed by the local check Armcor (36.8 t/ha) and during 1989-90, Armcor had given significantly high yield (45.9 t/ha) followed by PTS-24 (39.20 t/ha). During 1990-91 again, maximum yield was obtained from Armcor (26.23 t/ha) followed by PTS-24 (23.40 t/ha). The trial is being continued for one more year before the pooled data could be analysed.

Table 17 : PERFORMANCE OF TURMERIC ACCESSIONS AT SOLAN FOR 4 YEARS

Pooled mean data 1987-90

Sl. No.	Accession No.	Plant height (cm)	Tiller Leaves		Leaf		Rhizome		Yield per	
			Nos.	Nos.	Length (cm)	Breadth (cm)	Length (cm)	Breadth (cm)	Plant (t)	Plot (kg)
1.	PCT 5	72.1	2.3	6.5	23.4	8.0	10.4	5.6	123.8	3.61
2.	PCT 8	79.5	1.7	6.2	24.0	7.5	9.3	6.4	97.5	3.16
3.	PCT 2	84.4	2.3	5.7	22.7	8.0	12.4	6.6	174.7	4.98
4.	PTS 9	76.0	1.9	6.4	22.8	7.5	11.2	6.4	121.4	4.05
5.	PTS 10	76.9	2.8	6.1	22.9	7.3	10.4	6.0	129.0	3.81
6.	PTS 38	74.4	1.8	6.5	21.0	7.5	10.3	5.4	116.0	3.92
7.	PTS 24	78.8	2.0	7.2	22.1	7.6	10.8	6.3	156.8	4.78
8.	ST 323	85.0	2.4	5.6	25.4	8.1	12.1	6.7	145.0	5.13
9.	ST 3	78.9	2.5	7.3	23.0	7.6	11.4	6.2	137.2	3.98
10.	VK 70	83.5	1.7	5.6	23.4	7.7	10.8	6.0	113.6	3.24
11.	EM 321	85.2	2.6	6.0	22.1	8.2	12.5	6.8	149.9	3.55
Range		72.1 to 85.2	1.7 to 2.8	5.6 to 7.3	21.0 to 25.4	7.3 to 8.2	9.3 to 12.5	5.4 to 6.8	97.5 to 174.7	3.16 to 5.13
Mean		79.4	2.2	6.3	23.0	7.7	11.1	6.2	133.2	4.02
CD (5%) years		2.5	0.2	0.9	2.4	0.7	1.1	0.4	14.6	0.37
CD (5%) varieties		3.2	0.3	NS	NS	NS	1.8	0.6	24.2	0.62
CD (5%) Vars X yrs		9.7	0.6	NS	7.9	NS	NS	1.2	48.4	1.25

Table 18 : PERFORMANCE OF TURMERIC ACCESSIONS AT POTTANGI  
(1988-1991)

Sl. No.	Accessions	Rhizome yield in kg/3m <sup>2</sup> plots				Mean	Projected yield t/ha	Rhizome rot %
		1988	1989	1990	1991			
1.	PTS 38	13.100	6.600	11.133	7.226	9.514	23.785	Nil
2.	KCMA	13.883	6.867	9.866	7.001	9.404	23.510	2.1
3.	PTS 9	14.167	4.863	11.700	6.299	9.257	23.142	Nil
4.	PTS 24	12.267	5.560	10.473	6.513	8.703	21.757	Nil
5.	BSR 1	9.807	8.283	9.120	6.829	8.522	21.305	Nil
6.	Cc-1	10.733	7.443	9.133	6.141	8.362	20.905	2.3
7.	FCT 2	10.317	4.447	6.383	4.910	6.489	16.222	4.5
8.	PCT 5	7.070	9.133	4.673	3.410	6.071	15.177	2.9
9.	PCT 8	7.000	8.900	4.916	2.622	5.872	14.680	Nil
10.	321 Etha- mukulam	7.017	3.927	6.233	4.036	5.053	12.632	10.7
11.	VK 70	3.687	7.783	5.266	3.474	5.052	12.630	Nil
12.	ST 323	1.700	7.083	6.400	3.149	4.584	11.460	Nil
CD at 5%		1.700	NS	3.028	NS	1.052	2.642	

At Coimbatore PTS-24 (from Pottangi) has given the maximum yield (16.70 kg/plct) during the year 1989-90 which was significantly superior. However, during the year 1990-91, the highest yield was obtained from BSR-1.

Comments : While the pooled data for 4 year has been reported by Pottangi and Solan centres, the same has been done for 3 years for Coimbatore and Jagtial Centres. The latter 2 Centres would conduct the trial for one more year so that a comparison would be possible.

## 5. EFFECT OF INTERCROPPING IN TURMERIC

(Pettanji &amp; Jagtial)

An intercropping experiment was conducted during 1989-90 and 1990-91 with 8 treatments at Pettanji to find out the most remunerative intercrop. The intercrops were sown in the middle of alternative inter-row spaces of turmeric at the time of first top dressing (mulching) of turmeric without further mulching. The number of turmeric plants were kept constant ( $50/3 M^2$ ) as in case of pure crop. Intercropping did not give any significant difference for yield of turmeric, however highest turmeric yield was obtained by intercropping with Soybean ( $8.066 \text{ kg}/3 M^2$ ) during 1989-90 and by pure crop with first mulch ( $5.911 \text{ kg}/3 M^2$ ) during 1990-91. The pooled data for two years indicated highest yield of turmeric by pure crop with 3 mulchings ( $17.010 \text{ t/ha}$ ) which was closely followed by intercropping with soybean (turmeric yield  $16.637 \text{ kg/ha}$ ). The cost-benefit of intercropping with soybean (Rs.33,928/ha) was followed by inter-cropping with French Bean (Rs.33,292/ha).

The intercropping studies were conducted at Jagtial to select a suitable and profitable intercrop. The data presented in Table-19 indicated that the turmeric rhizome yield (dry) was on par in treatments  $T_1$ ,  $T_4$ ,  $T_6$  and  $T_7$  and significantly superior over other intercrops. The additional monetary returns was more under Turmeric-Maize intercropping system.

Table-19 : INTERCROPPING TRIAL AT JAGTIAL (1990-91)

Treatments	Dried yield (t/ha)		Gross monetary returns (Rs.)*		Total
	Base crop	Inter crop	Pure crop	Inter crop	
$T_1$ - Turmeric + Maize	6.66	4.2	33.21	7.38	40.57
$T_2$ - Turmeric + Clusterbean	5.14	4.2	25.72	0.32	26.04
$T_3$ - Turmeric + Chillies	4.22	1.9	21.10	10.76	31.86
$T_4$ - Turmeric + Greengram	6.45	0.5	32.26	0.30	32.56
$T_5$ - Turmeric + Caster	4.55	2.7	22.74	13.67	36.41
$T_6$ - Turmeric + Bhendi	6.23	2.3	31.16	2.27	33.43
$T_7$ - Pure crop of Turmeric	6.10	-	30.53	-	30.53
*Rupees thousands/ha CD at 5%	1.0476				



## 6. QUALITY EVALUATION OF GERmplasm COLLECTION / VARIETIES (Solan)

Forty one selections were analysed for quality characters the curcumin, essential oil and oleoresin contents ranged from 0.03 to 3.85%, 1.88 to 6.70% and 2.58 to 10.05% respectively. The curcumin content was maximum in "ST 323 yellow" (3.85%) and minimum in ST 64 (0.03%). The content of essential oil was maximum in PCT-5 (6.70%) followed by PCT-8 (6.50%) and minimum in ST-323 (1.88%). Maximum oleoresin content was obtained in ST-510 and "ST 323 yellow" (10.05%) and minimum in ST 323 (2.58%). The samples harvested in 1991 have been cured and the analysis is in progress.

Evaluation of quality characters of 11 varieties tested under MLT, accession ST 323 was the poorest for all quality characters while accession PTS 24 for curcumin (3.82%) and oleoresin (9.58%) and PTS-5 for essential oil (6.70%) were the best.

## 7. EFFECT OF STORAGE ON CURCUMIN CONTENT IN TURMERIC (Solan)

The samples of four accessions of turmeric harvested during February 1990 were analysed for curcumin immediately after harvest and at different intervals (0 to 180 days). The results obtained are summarised below:

Sl. No.	Accession No.	% of Curcumin after harvest at different intervals (days)					
		0	15	30	60	120	180
1.	ST 323 yellow	3.85	3.86	4.04	3.30	2.82	3.30
2.	EM 321	3.10	3.20	3.17	2.80	2.45	2.46
3.	PCT 2	3.42	3.15	3.38	2.90	2.71	2.65
4.	ST 85	3.18	3.20	3.15	2.85	2.45	2.74

The loss of curcumin content was visible only two months after harvest. After six months of storage, 15-20% loss in Curcumin was observed in the cultivars studied.

Comments : The Biochemist was advised to visit NRCS, Calicut and refine the experimental techniques as per standard procedure.

## VI. CORIANDER

### 1. GERMPLASM COLLECTION, MAINTENANCE AND EVALUATION (Jobner, Jagudan, Guntur & Coimbatore)

A germplasm collection of 461 (378 indigenous and 63 exotic) has been maintained at Jobner. In the evaluation of 70 entries, none of them was better than RC-41. Five exotic selections received from NBPGR were also grown for multiplication.

At Jagudan 280 indigenous and 11 exotic germplasm were maintained and observation on their growth and yield characters were recorded.

A total number of 120 entries were evaluated at Guntur during 1989-90 and wide variability has been found for plant characters and yield. In the evaluation maximum grain yield was recorded in CS-287 (1444 kg/ha) followed by Composite Koilkunta (1389 kg/ha) and ATP-8 (1375 kg/ha). During 1990-91 due to soil moisture stress, the yields were lower in all the 120 entries evaluated. Among the entries, ATP-77 followed by ATP-82, ATP-102, Uppalapadu-2 and ATP-97 recorded higher yields.

A total of 135 accessions were evaluated at Coimbatore during Rabi season. Variability was seen for all characters studied (Table-20).

Table 20 : VARIABILITY IN CORIANDER GERMPLASM (COIMBATORE 1990-91)

Mean plant characters	Accession No.	Maximum recorded	Accession No.	Minimum recorded
Plant height (cm)	UD.215	53.2	Acc.769	21.1
No. of Primary branches	UD.184	10.8	Acc.333	2.2
No. of Secondary branches	Acc.498	27.8	Acc.400	6.2
No. of umbels/plant	Acc.445	36.6	UD 301	9.2
No. of umbellets/umbel	UD 377	5.9	UD 139	3.1
No. of seed/umbel	UD 76	30.4	Acc.141	11.4
Grain yield/plot (g)	UD 205	490	UD 293	100

The highest primary and secondary branch numbers were recorded by UD-184 and Acc. 493 respectively. The number of umbels per plant showed variation ranging from 9.2 to 36.6. Similar observation was recorded for number of umbels/umbel and seed/umbel. UD-205 recorded the highest yield of 490g/plot while UD-293 recorded the lowest seed yield of 100g/plot showing that there is scope for crop improvement.

Forty three germplasm entries were screened against stem gall at maturity stage of the crop in farmers field at Jobner. In the evaluation variety UD-41 was found to be completely free from stem gall under field conditions and the rest of the lines showed traces to heavy infection. In the screening of 32 germplasm entries at Jagudan (1990-91), none of the entries tested is tolerant or resistant against powdery mildew disease. Twenty six coriander genotype at Jobner were screened against root knot nematode Meleiodygune sp., accessions UD-1, UD-20, UD-30, UD-40, UD-358, UD-374, Co-2, CS-2, CS-4, CS-287 and CS-695 were moderately resistant.

At Coimbatore 12 accessions under IET and 13 accessions under CYT were screened against grain mould/wilt under field condition. Acc. 695, 745 and 466 showed low incidence of 3.1, 3.2 and 4.1% respectively among IET accessions. In the case of CYT, Acc.695 followed by CS-335 and CS-45 registered low incidence of around 2 percent.

## 2. INITIAL EVALUATION TRIAL

(Guntur and Coimbatore)

Ten promising selections from the coriander germplasm were evaluated at Guntur during 1989-90 and 1990-91 and due to soil moisture stress the yield were poor. During the current year entry ATP-18 recorded the highest yield of 680 kg/ha which is significantly superior.

In the new IET (1989) at Coimbatore, 11 entries were evaluated with Co-2 as check. Acc.695 which showed promise in earlier seasons out yielded others during 1990 recording 683.4 kg/ha (Table 21) which was statistically superior to the check variety Co-2 (483.2 kg/ha). The lowest yield of 343 kg/ha was recorded by Acc.806. Mean number of umbels ranged between 18.6 to 30.8 and similarly mean number of seeds per umbel ranged between 16.4 to 20.9 which were statistically significant.

Table 21 : INITIAL EVALUATION TRIAL IN CORIANDER AT COIMBATORE  
(1990)

Accession No.	Yield (kg/ha)
695	683.4
462	350.7
806	343.0
748	383.5
496	406.2
466	666.7
964	385.9
745	585.2
497	466.7
Co.2	483.2
1080	502.3
812	463.4
CD at 5%	73.8

### 3. COMPARATIVE YIELD TRIAL (CYT 1989 series-I) (Guntur and Coimbatore)

The trial initiated at Guntur and Coimbatore during rabi 1989 as proposed in Jobner Group Meeting (Oct.1989) with 13 entries from different coordinating centres. At Guntur, in rabi 1990-91 entry ATP-82 has recorded maximum yield followed by DH-5 which is furnished in Table-22.

In the CYT (CYT 1989 series-I) at Coimbatore Acc.695 recorded the significantly highest yield (666.7 kg/ha) which was on par with Acc.335 (656.3 kg/ha), compared to an yield of 455.7 kg/ha in the control Co-2 (Table-23). The mean number of secondary branches ranged between 17.8 to 27.9 and the seeds per umbel between 15.6 to 23.2 which were found to be significant to influence the yield. Based on earlier results Acc.695 was released as Co-3.

Table 22 : YIELD DATA OF CYT OF CORIANDER AT GUNTUR (1990-91)

Sl.No.	Name of the entry	Source	Yield (kg/ha)
1.	UD-435	Jobner	453
2.	UD-436	Jobner	492
3.	JCO-81	Jagudan	483
4.	JCO-126	Jagudan	567
5.	JCO-147	Jagudan	575
6.	CS-287	Coirbatore	547
7.	No.695	Coimbatore	564
8.	CS-335	Coimbatore	550
9.	CS-45	Guntur	561
10.	ATP-82	Guntur	692
11.	DH-5	Hisar	656
12.	DH-26	Hisar	536
13.	Guntur Local	Guntur	475
CD at 5%			119.2

Table-23: COMPARATIVE YIELD TRIAL IN CORIANDER(COIMBATORE 1990-91)

Accession No.	Yield (kg/ha)
CS.45	556.2
CS.335	656.3
CS.695	666.7
UD.435	336.4
JC.126	366.2
ATP-82	278.4
JC.81	445.3
CS.287	540.0
DH.5	315.7
Co-2	455.7
DH.26	326.1
JC.147	311.4
UD-436	414.8
CD at 5%	67.9

Comments : Since the trial has been in progress for two years it may be continued for one more year.

The trial conducted at Diggi (Jobner), showed (1989-90) that out of six entries UD-21 was superior in yield followed by RCr-41, UD-20, UD-374, UD-1 and UD-373. The three years mean performance of entries tested in station trial revealed superiority of RCr-41 (8.73 Q/ha) followed by UD-21 (8.22 Q/ha) and UD-373 (7.70 Q/ha) as evident from Table-24.

Table-24 : PERFORMANCE OF CORIANDER AT DIGGI (JOBNER)  
(Mean of 3 years 1987-90)

Sl.No.	Variety	Yield Q/ha			Mean
		1987-88	1988-89	1989-90	
1.	UD-20	7.69	11.28	3.78	7.58
2.	UD-21	9.20	10.98	4.48	8.22
3.	RCr-41	7.92	14.44	3.84	8.73
4.	UD-373	7.43	12.22	3.44	7.70
5.	UD-374	5.99	11.11	3.77	6.96
6.	UD-1	-	-	3.69	3.69
CD at 5%		1.85	NS	NS	-
CV%		48.55	15.62	21.03	-

4. MULTILOCATION TRIAL IN CORIANDER (MLT 1989 series-I)  
(Jobner, Guntur and Jagudan)

The new trial at Jobner consisted of 11 entries viz., RCr-41, UD-435 and UD-436 (from Rajasthan), CS-287, Acc.335 and Acc.695 (from Tamil Nadu), J.Co.81, J.Co.126 and J.Co.147 (from Gujarat), DH.5 and DH.26 (from Haryana), along with a local check. Out of 12 accessions of Coriander tested, the local check produced significantly higher yield of 10.53 Q/ha followed by RCr-41 (10.18 Q/ha), UD-435 (6.25 Q/ha), DH.5 (5.88 Q/ha) and CS-287 (5.55 Q/ha).

In the Coordinated trial at Guntur with 20 entries from different Coordinating Centres during rabi 1990-91, Co-2 recorded highest yield of 592 kg/ha followed by UD-376, CS-2, CS-4, CS-6, P-2, CS-5, UD-21 & Co-1 as shown from yield data presented in Table-25.

Table-25 : YIELD OF CORIANDER UNDER MLT AT GUNTUR (1990-91)

Sl.No.	Name of the entry	Yield (kg/ha)
1.	CS-2	578
2.	CS-4	572
3.	CS-5	533
4.	CS-6	556
5.	CS-7	506
6.	UD-1	444
7.	UD-3	425
8.	UD-20	439
9.	UD-21	533
10.	UD-41	406
11.	UD-373	586
12.	UD-374	478
13.	Co-1	530
14.	Co-2	592
15.	Pusa-360	431
16.	Seethal	464
17.	GAO-1	456
18.	P-2	550
19.	GAU-2	439
20.	Guntur Local	414
CD at 5%		102.7

Fourteen entries consisting of 4 from Andhra Pradesh, 5 from Rajasthan and 3 from Gujarat were tested under multilocation trial at Jagudan for the second year viz., 1990-91, keeping GAU Cor.1 and GAU Cor.2 as check. The results showed significant differences for yield characters. Significantly higher yield was obtained in the entry CS-695 (2150 kg/ha) followed by all other entries except J.Cor.81, UD-436, DH-26, J.Cor.147 and UD-435 as presented in Table-26.

Table-26 : PERFORMANCE OF CORIANDER ACCESSIONS AT JAGUDAN

Sl. No.	Treatments	Source	Yield kg/ha.		Average yield (kg/ha)	% increase over control
			1989-90	1990-91		
1.	CS-45	Andhra Pradesh	1117	1897	1507	1.34
2.	CS-287	Andhra Pradesh	1116	2034	1575	5.92
3.	CS-335	Andhra Pradesh	1111	1965	1538	3.43
4.	CS-695	Andhra Pradesh	1211	2150	1681	13.05
5.	UD-435	Rajasthan	923	1576	1250	-
6.	UD-436	Rajasthan	1039	1798	1419	-
7.	ATP-82	Rajasthan	1062	1897	1480	-
8.	J.Cor.81	Gujarat	818	1852	1335	-
9.	J.Cor.126	Gujarat	116	1929	1523	2.42
10.	J.Cor.147	Gujarat	738	1586	1162	-
11.	DH-5	Rajasthan	793	2011	1402	-
12.	DH-26	Rajasthan	741	1690	1216	-
13.	Guj.Cori-1 (check)		1063	1937	1500	0.87
14.	Guj.Cori-2 (check)		1069	1904	1487	-
	S.Em ±	64.81	111.11			
	CD at 5%	185.19	256.17			
	CV %	12.93	11.94			

Comments :- The trial may be continued for one more year.



## 5. MUTATION BREEDING TO EVOLVE VARIETIES WITH EARLINESS IN FRUITING AND RESISTANCE TO DISEASE

(Coimbatore and Co-2)

Effect of gamma irradiation (5, 10, 15 and 20 Kr doses) on germination percent, plant survival, pollen fertility, days to 50% flowering, plant height, primary branches/plant, umbels/plant, umbellets/plant, grains/umbel, days to maturity, umbel fertility and seed setting, 100 grain weight and yield/plant of Coriander accession UD-20 were recorded at Jobner. The study indicated that LD-50 dose lies somewhere at 15 Kr treatment. The effect of treatment dose on other characters revealed a reduction trend after 10 Kr dose with increased doses except for primary branches per plant on  $M_1$  generation. In the evaluation of 14 single plant progenies of  $M_2$  generation, significantly higher variability was observed for plant height, umbellets/umbel, grains/umbel and 100 seed weight. Based on mean and coefficient of variability, four promising  $M_2$  progenies of 20 Kr (progenies - 24, 25, 27 and 28) were identified for most of the characters.

Nine promising mutant lines were put in to IET in kharif 1989 and rabi seasons at Coimbatore with Co-2 on check. Mutant 7/7 of 5 Kr recorded the highest yield of 635.2 kg/ha which was statistically significant. Similarly 29/1 of 5 Kr and 76/10 of 20 Kr recorded statistically significant yields of 558.1 and 555.4 kg/ha respectively (Table-27). Among the yield contributing characters the mean number of branches and number of seeds per umbel showed significance.

Table-27 : EVALUATION OF SELECTED CORIANDER MUTANTS (COIMBATORE)

Sl.No.	Accession No.	Yield (kg/ha)
1.	20 KR 67/10	555.4
2.	15 KR 16/6	375.2
3.	Co.2 Control	460.2
4.	5 KR 29/1	558.1
5.	5 KR 7/7	635.2
6.	25 KR 48/1	356.9
7.	20 KR 26/7	396.1
8.	5 KR 10/7	453.2
9.	10 KR 15/1	316.8
10.	10 KR 7/7	451.1
	CD at 5%	72.4

6. EFFECT OF DIFFERENT STAGES OF HARVESTING ON YIELD AND QUALITY OF CORIANDER  
(Jobner and Jagudan)

Three years' study at Jobner revealed that harvesting of Coriander at different stages and crop varieties (three varieties - Long, Medium & Short duration) differed significantly in respect to coriander seed yield and essential oil content. Highest seed yield was recorded when harvesting was done at 100% grains turned yellow in colour (7.03 Q/ha) closely followed by 50% grains turning yellow (6.88 Q/ha) and both were superior to harvesting full size grain with green colour stage (4.81 Q/ha). Coriander variety RCr-41 and GAU-1 recorded significantly higher yield. GAU-1 recorded the highest average essential oil content (0.350%) followed by Co-2 (0.342%).

The experiment conducted for the fourth year at Jagudan consisted of 12 treatment combinations of 3 coriander varieties, GAU.1, RCr-41 and Co.2, which were medium, long and short duration types respectively and four stages of harvest (SOH). The data on growth and yield contributing characters were recorded. During the current year the yield difference due to various treatments were found to be non-significant, however the highest yield (1999 kg/ha) was recorded by the "medium duration variety GAU-1, grain harvested 100% grain in main umbel showing yellow colour" (GIMUYC). Pooled analysis of 4 years showed that the yield differences due to various treatments were found to be significant (Table-28). The highest yield (1355 kg/ha) was recorded with the Co-2 variety harvested at the stage when 100% fruit turn to yellow colour (100% FTYC) in whole plant. It was significantly superior over variety UD-41 which has full size grain with green colour and UD-41 and 50% fruits turning to yellow colour. However it was at par with GAU-1 and 50% fruits turn to yellow colour.

The single effect of the variety and stage of harvest was found to be significant. Variety GAU-1 gave significantly higher yield over remaining varieties whereas among stages of harvest, 100% fruit turn to yellow colour in whole plant (100% GTYC) was found to be significant so far yield level is concerned (Table-29).

Table-28 : YIELD PERFORMANCE IN CORIANDER AS AFFECTED BY SOH AT JAGUDAN  
(Pooled analysis 1987-88 to 1990-91 -- 4 years)

Varieties	Treatments Stages of harvest (SOH)	Year-wise yield kg/ha				Pooled mean yield (kg/ha)	% incre- ase over control
		1987-88	1988-89	1989-90	1990-91		
GAU-1	FSGWGC	1180	1244	1572	1569	1134	-
GAU-1	GIMUYC	1185	1377	1479	1999	1260	-
GAU-1	50% FTYC	1458	1324	1460	1890	1283	-
GAU-1	100% FTYC	1474	1564	1512	1748	1325	-
UD-41	FSGWGC	706	1286	398	1465	964	-
UD-41	GIMUYC	711	1247	539	1737	1059	-
UD-41	50% FTYC	781	1111	561	1465	980	-
UD-41	100% FTYC	842	1172	654	1721	1097	-
Co-2	FSGWGC	1234	1106	501	1416	1064	-
Co-2	GIMUYC	1353	1172	583	1792	1225	-
Co-2	50% FTYC	1582	980	550	1541	1163	-
Co-2	100% FTYC	1598	1653	534	1634	1355	2.26
S.Em ±		95.530	38.894	93.860	230.888	135.121	-
CD at 5%		280.154	114.070	N.S.	N.S.	379.256	
CV %		14.22	5.32	30.96	24.02	20.20	

Table-29 : SINGLE EFFECT OF VARIETY AND STAGE OF HARVEST (SOH) ON YIELD OF CORIANDER AT JAGUDAN

Effect of variety	Yield (kg/ha)	Effect of SOH	Yield (kg/ha)
GAU-1	1250.170	FSGWGC	1053.695
UD-41	1024.646	GIMUYC	1181.236
CO-2	1199.959	50% GTYC	1141.975
		100% GTYC	1256.128
S.Em ±	33.776		39.008
CD at 5%	109.476		94.804
CV %	20.20		20.20

## 7. RESPONSE OF CORIANDER TO FERTILIZER

(Jobner and Guntur)

At Jobner, results of 3 years' study on irrigated Coriander revealed that time of Nitrogen application had significant effect on seed yield and yield attributes except number of umbellets per plant and test weight, on the Coriander variety RCr-41. A split application of 60 kg N/ha viz., 1/3 at sowing time, 1/3 at 30 DAS and remaining 1/3 at 75 DAS registered on average seed yield of 10.44 Q/ha as compared to 5.57 Q/ha with no Nitrogen application (Table-30). Maximum mean net profit of Rs.4792/ha was obtained when 60 kg N/ha was applied in 3 equal splits at sowing, 30 and 75 DAS.

## 8. STUDIES ON THE GRAIN MOULD/WILT DISEASE OF CORIANDER

(Coimbatore)

The fungicidal trial to control grain mould in Coriander with 10 treatments laid out at Coimbatore during rabi 1988 and rabi & kharif 1989 and 1990. During this season also spraying with 0.1 % Carbendazim, 20 days after grain set was found to be very effective in controlling grain mould incidence (7.9%) followed by spraying of 0.25% Copper Oxychloride 20 days after grain set (10.1%). The above treatments had recorded maximum yield of 840.4 and 780 kg/ha respectively.

## 9. EVALUATION OF CORIANDER FOR ESSENTIAL OIL

(Jobner)

Thirty two entries of Coriander germplasm and 16 Coriander entries under CYT were evaluated for volatile oil contents. The volatile oil ranged from 0.2 to 0.4% in CYT entries and 0.1 to 0.5% in germplasm entries. The promising entries of coriander with respect to volatile oil content are UD-111, UD-263 and UD-323 (0.5% each) and UD-124, UD-239, UD-172, UD-285, UD-77, UD-174 and UD-204 (0.4% each).

Table 30 : EFFECT OF TIME OF NITROGEN APPLICATION ON YIELD OF CORIANDER AT JOBNER

(Pooled yield data for 3 years - 1987-88 to 1989-90)

Treatments	Grain yield ( $\bar{Q}$ /ha)			
	1987-88	1988-89	1989-90	Mean
T <sub>1</sub> 0 kg N/ha (Control)	5.75	5.89	5.07	5.57
T <sub>2</sub> 60 kg N/ha at sowing	7.52	6.68	7.50	7.23
T <sub>3</sub> 60 kg N/ha at 30 DAS	7.49	7.69	4.38	6.52
T <sub>4</sub> 60 kg N/ha at 45 DAS	7.14	6.99	7.29	7.14
T <sub>5</sub> 60 kg N/ha at 60 DAS	6.03	7.05	5.63	6.24
T <sub>6</sub> 60 kg N/ha at 75 DAS	5.52	6.09	7.01	6.21
T <sub>7</sub> 60 kg N/ha $\frac{1}{2}$ at sowing & $\frac{1}{2}$ at 30 DAS	6.15	5.58	4.38	5.37
T <sub>8</sub> 60 kg N/ha $\frac{1}{2}$ at sowing & $\frac{1}{2}$ at 60 DAS	9.59	10.00	8.40	9.33
T <sub>9</sub> 60 kg N/ha $\frac{1}{2}$ at sowing & $\frac{1}{2}$ at 75 DAS	7.03	6.52	5.35	6.30
T <sub>10</sub> 60 kg N/ha $\frac{1}{2}$ at 30 DAS & $\frac{1}{2}$ at 60 DAS	9.30	10.72	8.75	9.59
T <sub>11</sub> 60 kg N/ha $\frac{1}{2}$ at 45 DAS & $\frac{1}{2}$ at 75 DAS	7.21	7.87	8.19	7.76
T <sub>12</sub> 60 kg N/ha $\frac{1}{2}$ at 60 DAS & $\frac{1}{2}$ at 75 DAS	6.29	7.96	5.69	6.65
T <sub>13</sub> 60 kg N/ha $\frac{1}{3}$ at sowing, $\frac{1}{3}$ at 30 DAS & $\frac{1}{3}$ at 75 DAS	9.84	11.48	10.00	10.44
T <sub>14</sub> 60 kg N/ha $\frac{1}{3}$ at 30 DAS, $\frac{1}{3}$ at 45 DAS & $\frac{1}{3}$ at 60 DAS	8.32	11.92	9.17	9.80
S.Em $\pm$	0.59	0.45	0.67	0.50
CD at 5%	1.72	1.30	1.94	1.46
CD at 1%	2.32	-	2.63	1.98
CV %	13.81	9.68	17.32	11.70

## VII. CUMIN

### 1. GERMPLASM COLLECTION, MAINTENANCE AND EVALUATION (Jobner and Jagudan)

At Jobner, 219 (211 indigenous and 8 exotic) germplasms are being maintained. 220 single plant progenies of UC-216 and 82 single plant progenies of UC-217 were maintained by sibrating under muslin cloth. In the evaluation during 1989-90, 42 progenies of UC-216 and 37 of UC-217 outyielded RZ-19 (check). The most promising progenies of UC-216 are UC-216-202, UC-216-327, UC-216-441 and UC-216-444. Four progenies of UC-217 viz., UC-217-20-8 (68g/plot), UC-217-14-1 (50g), UC-217-14-5 (42g) and UC-217-21-7 (35g) and are found very promising, which outyielded RZ-19 (check).

One hundred and seventy two germplasm (166 indigenous and 6 exotic) were maintained as well as observations on their growth and yield characters were recorded at Jagudan.

Seven lines of cumin were screened under artificial condition against wilt disease at Jobner. The percent mortality due to disease incidence was lowest in line UC-19 (15.62%) followed with UC-198 (24.07%) and the highest plant mortality of 70.37% observed in line RS-1 (check). During the year 1990-91, forty one entries were tested for their reaction against Fusarium wilt disease under wilt sick plot at Jagudan conditions. None of the entries was found to be tolerant or resistant against wilt disease.

### 2. MULTILLOCATION TRIAL (MLT 1987 and MLT 1989 Series-I) (Jobner and Jagudan)

The trial was started in Rabi 1987 at three locations viz., Jobner, Mandore and Jalore under Jobner Centre. At Jobner, the trial consisted of 11 entries viz., 7 from Rajasthan, 4 from Gujarat with 2 local checks sown under irrigated conditions. Out of the 13 entries tested at Jobner, the variety RZ-19 (UC-19) produced maximum yield of 2.48 Q/ha followed by UC-208 (2.30 Q/ha), UC-209 (2.23 Q/ha), Hardi-local (2.20 Q/ha), UC-199 (1.65 Q/ha) during 1989-90. Wide range and significant values were obtained for other characters recorded. The

mean performance of entries at Jobner for four years (1986-87 to 1989-90) revealed no significant difference among the varieties and all entries at par as far as yield potential is concerned (Table-31).

Table-31 : PERFORMANCE OF CUMIN VARIETIES IN COORDINATED TRIALS AT JOBNER CENTRE (1987-90)

Sl. No.	Varieties	Yield Q/ha				Mean
		1986-87	1987-88	1988-89	1989-90	
1.	UC-19 (RZ-19)	0.40	0.96	5.60	2.48	2.36
2.	UC-209	0.82	1.84	7.50	2.23	3.10
3.	GC-1	1.54	2.27	6.33	1.00	2.79
4.	VC-24	0.62	1.27	6.33	0.93	2.29
5.	UC-208	0.76	1.84	5.57	2.30	2.59
6.	UC-198	2.67	2.62	5.03	1.10	2.86
7.	VC-11	0.70	1.74	5.43	0.85	2.18
8.	UC-89	1.09	1.40	7.23	0.73	2.61
9.	RS-1	0.36	1.37	7.27	1.63	2.66
10.	UC-199	2.34	2.08	5.26	1.65	2.83
11.	Local	0.68	2.00	4.73	1.40	2.20
CD at 5%		0.766	0.761	1.21	0.72	NS
CV%		50.94	30.69	11.27	33.78	29.96

The performance of cumin varieties in the trial at different locations during 1989-90 is presented in Table-32. The entries at other two locations (Diggi & Mandore) revealed the superiority of RZ-19 at Diggi (3.60 Q/ha) while at Mandore, UC-89 recorded maximum yield of 5.05 Q/ha which is at significant level.

The new MLT (1989 Series-I) laid out (1990-91) with 8 entries under different agroclimatic conditions at Jagudan, consisted of 3 entries from Rajasthan (RS-1, UC-198 & UC-199) and JC-9, JC-11, JC-15 and JC-147 from Gujarat keeping Gujarat Cumin-1 as check. In the observation,

the yield and ancillary characters varied to a great extent; the yield difference were found to be highly significant giving the highest yield (843 kg/ha) by the entry JC-147 followed by RS-1 (763 kg/ha) and Guj.Cumin-1 (check) (741 kg/ha).

Table-32 : PERFORMANCE OF CUMIN VARIETIES IN THE MLT AT DIFFERENT LOCATIONS (1989-90)

Sl. No.	Varieties	Jobner	Diggi	Mendore
		Yield (Q/ha)		
1.	UC-19	2.48	3.60	4.55
2.	UC-208	2.30	2.79	4.86
3.	UC-209	2.23	2.58	4.92
4.	UC-199	1.65	3.25	3.49
5.	UC-198	1.63	3.25	3.12
6.	UC-89	0.73	3.54	5.05

Comments : UC-199, UC-198 & UC-209 need to be promoted to MLT.

### 3. BREEDING FOR WILT RESISTANT VARIETY IN CUMIN (Jobner)

Out of seven single plant progenies of Cumin derived from mutation breeding programme (from RZ-19) and hybridisation (chance crosses) between UC-19 and UC-198, none of the progeny produced seeds due to heavy incidence of Cumin blight. In the selection of natural population, out of twenty four single plant progenies derived from UC-218, the most promising progenies were UC-218-157, UC-218-57, UC-218-18, UC-218-13 and UC-218-173.

### 4. EFFECT OF CROP GEOMETRY AND SEED RATE ON YIELD OF CUMIN ( Jagudan and Jobner )

This was the fourth year of experiment at Jagudan. The experiment consisted of 20 treatment combination of five seed rates and four spacing methods, viz., row spacing at 15, 22.5 and 30 cm and broadcasting. The yield and ancillary observations as influenced by different geometry and seed rate recorded showed non-significant



differences for yield in the pooled analysis. However broadcasting with 14 kg seed rate/ha gave highest yields. In the single effect of geometry and seed rate also the yield differences were found to be non-significant. However 15.0 cm spacing and 12 kg/ha seed rate were found to be better.

The net realization (incremental cost benefit ratio) is found to be highest in 15 cm spacing and 8 kg seed rate/ha followed by 10 kg seed rate/ha with broadcasting and 15 cm spacing with 10 kg seed rate/ha having ICBR 1:6.2, 1:5.9 and 1:5.6 respectively.

At Jobner, the second year's (1989-90) experimental findings repeatedly revealed that crop geometry significantly affected the number of branches/plant, umbels/plant, test weight and seed yield. Seed rate significantly affected yield. In the four sowing methods, the crop sown at 15 and 22.5 cm row spacing recorded significantly higher seed yield over broadcast-sown method. However, seed yield recorded under 15 x 22.5 cm and 30 cm row spacing was statistically at par. Seed rate of 12 kg/ha recorded significantly higher seed yield (2.91 Q/ha) over 8 kg/ha seed rate (2.56 Q/ha). Although, the seed yield obtained under seed rates of 10, 12, 14 and 10 kg/ha was statistically at par.

## 5. EVOLVING CONTROL MEASURES AGAINST WILT DISEASE

(Jagudan and Jobner)

An experiment conducted at Jagudan (1990-91) to find out the effective and economical fungicide for the management of wilt disease. The data pertaining to wilt percent incidence presented in Table-33 revealed Rabbing treatment significantly reduced the wilt in different stages of the cumin crop under wilt sick plot condition.

Another experiment to control cumin wilt by seed treatment with 7 different fungicides initiated at Jobner under irrigated condition. The fungicides used are provided in Table-34. The seeds were treated with fungicides before 24 hours of sowing. The data presented in Table-34 revealed Topsin-M significantly reduced the disease incidence resulted into maximum grain yield followed with Bavistin.

Table-33 : WILT PERCENT INCIDENCE AT DIFFERENT STAGES OF THE CROP, JAGUDAN CENTRE 1990-91)

Sl. No.	Treatments	Mean		
		Before flowering	After flowering	At harvest
1.	Captan @ 3 g/kg seed	49.62 (58.0)	62.52 (78.80)	90.00 (100.00)
2.	Bavistin granules @ 2 g/kg seed	46.14 (52.0)	62.73 (79.0)	90.00 (100.00)
3.	Rabbing (soil sterilization)	31.72 (27.6)	52.94 (63.70)	69.19 (87.40)
4.	Emisan @ 3 g/kg seed	45.99 (51.70)	59.34 (74.00)	90.00 (100.00)
5.	Bavistin 25 5D @ 2 g/kg seed	48.76 (56.50)	62.14 (78.10)	90.00 (100.00)
6.	Thiram @ 3 g/kg seed	47.90 (55.00)	63.46 (80.00)	90.00 (100.00)
7.	Control	50.61 (59.70)	63.93 (87.10)	90.00 (100.00)
	S.Em ±	3.06	1.93	0.38
	CD at 5%	9.40	5.95	1.17
	CV %	11.57	5.42	0.77

(Retransformed value given in parenthesis).

Table-34 : CONTROL OF CUMIN WILT BY SEED TREATMENTS AT JOBNER

Sl.No.	Treatment	Percent disease	Yield (Q/ha)
1.	Apran SD-35 (0.2%)	24.40	1.55
2.	Bavistin (0.2%)	17.89	2.15
3.	Emisan-6 (0.2%)	23.45	1.63
4.	Topsin-M (0.2%)	17.55	2.30
5.	Thiram (0.3%)	26.80	1.83
6.	Saprol EC-15 (0.1%)	26.88	1.65
7.	Vitavax-200 (0.2%)	19.63	2.08
8.	Control	39.57	1.30
	S.Em ±	1.9707	9.089
	CD at 5%	5.7969	26.811

6. STUDIES ON SEED BORN MYCOFLORA OF CUMIN  
(Jobner)

At Jobner, seed analysis studies revealed that Alternaria alternata was found to be associated predominantly with seeds whereas Fusarium sp. was not predominantly associated with the seeds indicating the perpetuation of A. alternata through seeds, while Fusarium sp. through soil or seeds. Besides these, several other fungi were also found associated with the seeds.

Investigation were carried out to study the effect of these seed borne fungi mortality and vigour of seedlings. In the pathogenicity test conducted by blotter and pot method. Seven fungi viz., Alternaria alternata, Aspergillus flavus, A. niger, A. ochraceus, Bipolaris hawicnsis and Fusarium sp. were found to be pathogenic, while Curvularia spp., Chactomium sp. and Rhizopus oryzae were not pathogenic to cumin seed/seedlings caused both pre and post emergence mortality. Root and shoot length were also reduced by the fungi.

7. QUALITY EVALUATION  
(Jobner)

The volatile oil content were estimated from 14 promising entries of cumin. In cumin seeds, the volatile oil contents ranged from 3.0 to 4.6% (1990-91). The mean value of volatile oil content of two years (1989-9) & 1990-91) are provided in Table-35. The highest oil content obtained with UC-198 followed by VC-11, UC-218, MC-4373, UC-199, UC-89.

8. ADAPTIVE TRIALS OF PROMISING CULTURES OF CUMIN AT DIFFERENT TALUKA SEED FARM  
(Jagudan and Jobner)

At Jagudan, the adaptive trial conducted with promising culture MC-43-73 at four Taluka seed farms and one Research Station. The trials failed due to cumin-blight except in Umarala Seed Farm, where MC-43-73 gave an yield of 700 kg/ha which was 16% yield increase over the control.

In the adaptive trial and demonstrations conducted during 1989-90 (Jobner) maximum grain yield of 7.33 Q/ha was recorded in UC-19 (RZ-19) at adaptive testing centre-Tonk as well as in demonstrations conducted at Jaipur and Dausa area (Table-36).

Table-35 : VOLATILE OIL CONTENTS OF SELECTED ENTRIES OF CUMIN

Sl. No.	Entry	Volatile oil %		
		1989-90	1990-91	Mean
1.	UC-19	2.9	3.7	3.3
2.	UC-198	4.8	4.6	4.7
3.	UC-199	3.4	4.0	3.7
4.	RS-1	3.0	3.8	3.4
5.	UC-89	3.3	4.05	3.05
6.	UC-218	3.5	4.05	3.75
7.	VC-11	4.3	4.25	4.25
8.	VC-24	2.8	3.00	2.9
9.	UC-208	2.6	3.10	2.85
10.	UC-209	2.3	3.3	2.8
11.	MC-43-73	3.3	4.05	3.65
12.	GC-1	2.8	3.2	3.2
13.	Local	2.9	3.85	3.4
14.	UC-19 (mnt)	4.4	-	-

Table-36 : PERFORMANCE OF CUMIN VARIETIES AT ADAPTIVE CENTRE AND FARMERS FIELD (1989-90)

Sl. No.	Varieties	Yield (Q/ha)		
		Tonk	Jaipur	Dausa
1.	UC-19	7.33	3.75	2.00
2.	RS-1	7.00	-	-
3.	UC-198	4.50	3.25	1.80
4.	UC-199	5.00	-	-
5.	Local	7.00	2.50	1.50

## VIII. FENNEL

### 1. GERMPLASM COLLECTION, MAINTENANCE AND EVALUATION (Jobner and Jagudan)

At Jobner, 131 (124 indigenous and 7 exotic) entries and 183 (171 indigenous and 12 exotic) at Jagudan were maintained and observed for growth and yield characters. In Jagudan, 12 accessions were evaluated, 4 new collections made and one local check maintained by sibmating under muslin cloth. They were evaluated for yield stability and yield associated characters.

### 2. MULTILOCATION TRIAL IN FENNEL (MLT 1989 Series-I) (Jobner and Jagudan)

The MLT at Jobner consisted of 8 entries of fennel including 4 from Rajasthan viz., UF-90, UF-112, UF-101 and UF(M)-1 and three from Gujarat viz., PF-35, S-7-9 and GF-1 along with local check. The observations were recorded on days to 50% flowering, plant height (cm) branches/plant, umbels/plant, umbellets/umbel, grain/umbel, harvest index (%), volatile oil content (%) and yield/plot. Significant differences were recorded only for days to 50% flowering and grains/umbel. Out of the eight entries none of the entry was superior over local check. The maximum grain yield was recorded in Local collection (14.13 Q/ha) followed by PF-35 (12.73 Q/ha).

The MLT (1989 Series-I) with 9 culture laid out during rabi season 1990 at Jagudan. The observation viz., Plant stand, days to flowering, plant height (cm) number of branches/plant, number of umbels/plant, number of umbellets/umbel, number of seeds/umbellate, days to maturity, 1000 seed weight (gm) yield (kg/ha) and volatile oil (%) were recorded showed wide variation in the characters. The yield differences were highly significant and the maximum yield of 1198 kg/ha was recorded by the entry JF-132 (Table-37).

Table-37 : MULTILLOCATION TRIAL AT JAGUDAN (1990)

Sl. No.	Accession No.	Source	Yield (Kg/ha)	% of increase over control
1.	UM(N)-1	Rajasthan	710	-
2.	UF-131	Rajasthan	772	-
3.	JF-66	Gujarat	955	-
4.	JF-71	Gujarat	1099	0.92
5.	JF-127	Gujarat	926	-
6.	JF-132	Gujarat	1198	9.09
7.	HF-33	Hisar	815	-
8.	HF-39	Hisar	455	-
9.	G.Fennl (Check)	Gujarat	1089	-
S.Em ±			58.198	
CD at 5%			170.55	
CV %			13.07	

### 3. STUDIES ON INTERCROPPING IN FENNEL (Jobner)

Studies on intercropping comprising 10 treatments showed that intercrops had significant effects on yield equivalent to fennel. Three years experiment on intercropping in fennel revealed (Table-38) that maximum average yield of fennel equivalent (13.72 Q/ha) was observed under sole crop of cauliflower followed by paired planting of fennel at 30 : 60 cm + 1 row of cauliflower (11.79 Q/ha).

Table-38 : EFFECT OF INTERCROPPING IN FENNEL

Treatments	Yield equivalent to fennel (Q/ha)			
	1987-88	1988-89	1989-90	Mean
T <sub>1</sub> Normal sowing of fennel at 45 cm row spacing	10.34	9.10	4.60	8.01
T <sub>2</sub> Normal sowing of coriander for leaf purpose at 15 cm row spacing	7.22	10.41	9.80	9.14
T <sub>3</sub> Normal sowing of garlic at 15 cm row spacing	14.53	5.75	5.38	8.55
T <sub>4</sub> Normal sowing of fenugreek for grain purpose at 30 cm row spacing	3.96	4.95	1.95	3.62
T <sub>5</sub> Normal sowing of Cauliflower at 45 cm row spacing	13.99	16.55	10.63	13.72
T <sub>6</sub> Paired planting of fennel at 30:60 cm spacing	10.19	9.16	4.11	7.82
T <sub>7</sub> Paired planting of fennel at 30:60 cm + 3 rows of coriander for leaf purpose	12.46	11.49	6.74	10.23
T <sub>8</sub> Paired planting of fennel at 30:60 cm + 3 rows of garlic	13.57	9.28	7.69	10.18
T <sub>9</sub> Paired planting of fennel at 30:60cm + 2 rows of fenugreek for seed purpose	2.82	8.22	4.26	7.43
T <sub>10</sub> Paired planting of fennel at 30:60 cm + 1 row of cauliflower	12.37	13.42	9.58	11.79
S.Em. ±	0.73	0.64	0.39	1.20
CD at 5%	2.16	1.91	1.16	3.57
CV %	11.59	11.37	10.33	22.99

4. EFFECT OF NITROGEN LEVELS AND STAGES OF UMBEL PICKING ON YIELD AND QUALITY OF FENNEL  
(Jobner and Jagudan)

The experiment laid out in 1985-88 at Jobner was closed. The experiment at Jagudan started during 1987-88 consisted of 12 combinations having four levels of Nitrogen viz., 0, 30, 60 and 90 kg/ha and 3 stages of umbel picking (half length of fruits, full length of fruit and fruits turns to yellow colour). The different observations relating to morphological, yield and yield contributing (including plant stand) and volatile oil showed non-significant differences for yield due to various treatments. However the highest yield 4030 kg/ha was recorded in the treatment T<sub>12</sub> i.e., application of 90 kg N<sub>2</sub> and 45 kg P<sub>2</sub>O<sub>5</sub>/ha combined with picking of umbels when fruit turns to yellow colour. The pooled analysis (4 years) presented in Table-39 showed significant differences among the treatments. The highest yield (3372 kg/ha) was recorded in the above treatment (90 kg N<sub>2</sub> and 45 kg P<sub>2</sub>O<sub>5</sub>/ha combined with picking of umbel when turns to yellow colour) which was 36.5% higher than the control (Table-39). This treatment was at par with T<sub>11</sub>, T<sub>10</sub>, T<sub>9</sub>, T<sub>8</sub>, T<sub>6</sub>. The single effect of the fertilizer level and stage of umbel picking was found to be significant giving significantly higher yield by a fertilizer level of N<sub>2</sub> @ 90 kg/ha combined with 45 kg/ha P<sub>2</sub>O<sub>5</sub> whereas in stage of umbel picking, the fruits turns to yellow colour (post physiological) was significantly superior for yield.

Comments : It is concluded for the study that fennel fertilized with 90 kg N<sub>2</sub>/ha combined with 45 kg P<sub>2</sub>O<sub>5</sub>/ha and picking of umbel when fruit turns yellow colour gave higher yield in fennel with highest net ICBR 1:23.6.

5. QUALITY EVALUATION OF FENNEL  
(Jobner)

The volatile oil contents of different promising entries of fennel were determined. The total volatile oil in fennel seeds ranged from 1.0 to 1.5%. The highest volatile oil was observed in PF-35 (1.5%) followed by local check (1.45%).



Table-39 : EFFECT OF N<sub>2</sub> AND STAGES OF UMBEL PICKING ON YIELD  
(Pooled data 1987-88 to 1990-91)

Treatments (Fertilizers) N <sub>2</sub> -P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O (Kg/ha)	Stages of umbel picking	Yield kg/ha				Pooled % increase		
		1987-88	1988-89	1989-90	1990-91	mean yield	over control	
T <sub>1</sub>	0-45-0	HLF	2691	2015	1585	2451	2186	-
T <sub>2</sub>	0-45-0	FLFG	2696	2206	1601	3649	2538	2.8
	(Control)							
T <sub>3</sub>	0-45-0	FTYC	3191	2288	1812	2587	2470	-
T <sub>4</sub>	30-45-0	HLF	2815	2342	1737	2914	2452	-
T <sub>5</sub>	30-45-0	FLFG	2928	2397	1891	3377	2648	7.2
T <sub>6</sub>	30-45-0	FTYC	3194	2505	1949	3540	2797	13.2
T <sub>7</sub>	60-45-0	HLF	3224	2369	1868	2941	2601	5.3
T <sub>8</sub>	60-45-0	FLFG	3443	2479	1895	3595	2853	15.5
T <sub>9</sub>	60-45-0	FTYC	3484	2587	2125	3704	2975	20.4
T <sub>10</sub>	90-45-0	HLF	3529	2913	2129	3186	2939	18.9
T <sub>11</sub>	90-45-0	FLFG	3551	3077	2129	3286	2986	20.8
T <sub>12</sub>	90-45-0	FTYC	3779	3459	2217	4031	3372	36.5
S.Em ±			96.291	176.471	165.033	209.465	272.440	
CD at 5%			282.386	517.524	N.S.	N.S.	764.682	
CV %			5.20	11.97	25.78	22.24	17.26	

HLF - Half Length of Fruits  
 FLFG - Full Length of Fruits  
 FTYC - Fruit Turns to Yellow Colour

.....

## IX. FENUGREEK

### 1. GERMPLASM COLLECTION, MAINTENANCE AND EVALUATION (Jobner, Jagudan, Guntur and Coimbatore)

At present Jobner holds 123 indigenous and 11 exotic collection; out of eighteen  $F_4$  and 5 single plant progenies evaluated, none was better than RMT-1 (Local, check). However out of 3 new local collections, UM-133 and UM-131 outyielded check RMT-1.

At Jagudan, 178 entries including one exotic germplasm were maintained and observations on their growth and yield characters were recorded.

Eighty four accessions were evaluated during "rabi" at Coimbatore; variability was observed for all the seven characters studied including yield. The variation for yield ranged between 40g to 200g/plot indicating a scope for selection of improved types (Table-40).

Table-40 : VARIABILITY RANGE IN GERMPLASM OF FENUGREEK  
(COIMBATORE)

Sl. No.	Characters	Accession No.	Maximum	Accession No.	Minimum
1.	Plant height (cm)	Acc.2314	55.3	Acc.235	21.9
2.	No. of primary branch	Acc.197	8.4	Acc.211	3.2
3.	No. of secondary branch	UM-114	3.0	UM-5	0.4
4.	No. of pods	GF.1	25.8	UM.32	11.8
5.	Length of pod (cm)	Acc.267	15.6	Acc.272	7.7
6.	No. of seed/pod	Acc.247	21.6	Acc.258	10.4
7.	Yield per plot (g)	Acc.221	220.0	UM.5	40.0

Seventy entries were evaluated during 1989-90 at Guntur. TG-1084 has recorded highest yield (1889 kg/ha) followed by M-24 (1667 kg/ha) and TF-4 (1556 kg/ha).

In the screening of 41 entries of fenugreek against root knot nematode under artificial conditions at Jobner, Accessions UM-34, UM-35, UM-70, UM-75, UM-84, UM-105, UM-113 and UM-144 showed resistance against root knot nematode. None of the entries was found to be tolerant or resistant against powdery mildew in the evaluation of 17 entries during 1990-91 at Jagudan.

## 2. INITIAL EVALUATION TRIAL

(Coimbatore)

In the IET with 10 entries at Coimbatore Acc. 169 and Acc.213 recorded high yields of 642.3 and 639.9 kg/ha as against 432.5 kg/ha in control. The yields were on par and were statistically significant. The lowest yield of 318.7 kg/ha recorded by Acc.390. Among the yield contributing characters studied, the mean number of primary branches per plant and mean length of pod were significant. The primary branches per plant ranged between 4.7 to 6.9 in Acc.2310 and Acc.213 respectively. Length of pod varied between 8.7 cm (Acc.1113) to 10.7 cm (Acc.169 & Acc.424).

## 3. COMPARATIVE YIELD TRIAL (CYT - 1989)

(Guntur)

The Coordinated CYT with 9 entries could not be laid out during 1989-90 at Guntur. In 1990-91 rabi, even though the crop was damaged due to heavy attack of wilt and rust, the vegetative and yield data were recorded. However the maximum yield was recorded in Lam Sel.1 (639 kg/ha) which is significantly superior over check and other entries except TG-1084 (572 kg/ha) (Table-41).

## 4. MULTILLOCATION TRIAL (MLT 1989 Series-I)

(Jobner, Jagudan, Guntur and Coimbatore)

The trial consisted of 14 entries (4 from Rajasthan, and 3 each from Gujarat, Tamil Nadu and Haryana along with local check) laid out at Jobner, Jagudan, Guntur and Coimbatore Centres. At Jobner significant differences were recorded for "days to 50% flowering", plant height, pod per plant, test weight and yield per plot. The fenugreek variety RMt-1 recorded maximum yield of 10 Q/ha followed by HM-46 (9.7 Q/ha) and HM-57 (9.7 Q/ha), J.Fenu.53 (9.38 Q/ha), J.Fenu-8 (9.03 Q/ha) and 8.83 Q/ha in the local check (Table-42).

Table-41 : MULTILOCATION TRIAL AT GUNTUR (1990-91)

Sl.No.	Name of the entry	Source	Yield (kg/ha)
1.	UM-32	Jobner	489
2.	UM-112	Jobner	494
3.	NLM (Prabha)	Jobner	525
4.	Lam Sel.1	APAU	639
5.	GF-1	Jagudan	506
6.	TG-1084	Coimbatore	572
7.	Co-1	Coimbatore	500
8.	Methi-3	Jagudan	461
9.	Guntur Local	Local	456
CD at 5%			68.66

Table-42 : MULTILOCATION TRIAL AT JOBNER (1990-91)

Sl.No.	Variety	Source	Yield (Q/ha)
1.	RMt-1	Rajasthan	10.00
2.	HM-46	Haryana	9.70
3.	HM-57	Haryana	9.70
4.	J.Fenu.53	Gujarat	9.38
5.	J.Fenu.8	Gujarat	9.03
6.	UM.129	Rajasthan	8.70
7.	TG.947	Tamil Nadu	8.65
8.	PRT-4	Haryana	8.53
9.	J.Fenu.10	Gujarat	8.00
10.	UM.128	Rajasthan	7.45
11.	UM.127	Rajasthan	7.10
12.	TG-194	Tamil Nadu	6.15
13.	TG-638	Tamil Nadu	5.58
14.	Local check	Tamil Nadu	8.83
CD at 5%			2.9
CV %			19.18

The MLT with 14 entries was conducted for the second year at Jagudan. The various observations for yield contributing & other growth characters, days to flowering, maturity etc. were recorded. The yield performance of the accessions during the last two years are presented in Table-43. The yield difference were highly significant during 1990-91 and maximum yield was recorded in the entry UM-127 (2210 kg/ha). The mean of two years also showed the highest yield of 1648 kg/ha by UM-127.

Table-43 : MULTILLOCATION TRIAL AT JAGUDAN

Sl. Treatments No.	Source	Yield (kg/ha)		Average yield kg/ha	% increase over control
		1989-90	1990-91		
1. PRT-4	Rajasthan	907	1974	1441	--
2. J.Fenu-8	Gujarat	1036	2007	1522	0.66
3. J.Fenu-10	Gujarat	1108	2132	1620	7.14
4. J.Fenu-53	Gujarat	1077	2124	601	5.89
5. HM-46	Rajasthan	980	2002	1491	-
6. HM-57	Rajasthan	917	2116	1517	0.33
7. UM-127	Rajasthan	1085	2210	1648	8.99
8. UM-128	Rajasthan	891	1961	1426	-
9. UM-129	Rajasthan	768	1324	1046	-
10. TG-194	Tamil Nadu	908	2116	1512	-
11. TG-268	Tamil Nadu	1013	2128	1571	3.90
12. TG-947	Tamil Nadu	1007	2173	1590	5.16
13. Methi-3	Gujarat	1034	1985	1510	-
14. Methi local (check)	Gujarat	977	2047	1512	-
S.Em ±		99.673	84.97		
CD at 5%		N.S.	243.05		
CV %		20.45	8.48		

The trial laid out with 11 entries was continued at Guntur during 1990-91 by the addition of three more entries HM-46, HM-57 and PRT-4. The crop was irrigated but again got damaged by pests resulted in poor yields. The yield as observed are furnished below; showed that TG-268, followed by JF-8, UM-130, HM-57, TG-194 are high yielders.

Table-44 : MULTILLOCATION TRIAL AT GUNTUR (1990-91)

Sl.No.	Name of the entry	Source	Yield (kg/ha)
1.	UM-127	Jobner	439
2.	UM-128	Jobner	394
3.	UM-129	Jobner	445
4.	UM-130	Jobner	589
5.	J.F-8	Jagudan	628
6.	J.F-10	Jagudan	400
7.	J.F-53	Jagudan	414
8.	TG-194	Coimbatore	581
9.	TG-268	Coimbatore	647
10.	TG-947	Coimbatore	447
11.	HM-46	Hisar	517
12.	HM-57	Hisar	586
13.	PRT-4	Hisar	442
14.	Guntur Local	Guntur	428
CD at 5%			69.0

The trial initiated in Rabi 1989 at Coimbatore comprising accessions from Tamil Nadu, Gujarat, Rajasthan, Haryana along with check Co-1. The data presented in Table-45 revealed that among the yield contributing factors studied, significance was noticed in number of secondary branches per plant which ranged between 1.2 to 2.3. The highest yield of 683.7 kg/ha was obtained in TG-947 closely followed by TG-268 (623.2 kg/ha) which were statistically significant.

Table-45 : MULTILOCATION TRIAL AT COIMBATORE (1990-91)

Sl. No.	Accession No.	Mean plant height (cm)	Mean No. of branches		Mean No. of pod	Mean length of pod (cm)	Mean No. of seed/ pod	Yield (kg/ha)
			Primary	Secondary				
1.	UM.127	51.5	7.4	1.4	21.5	9.3	13.8	290.2
2.	UM.128	39.2	5.6	1.2	18.2	9.5	13.0	273.5
3.	UM.129	40.7	5.2	2.4	21.9	9.0	14.2	318.9
4.	JF.8	38.3	5.4	2.0	20.5	7.2	11.6	323.3
5.	JF.10	37.0	5.3	1.5	19.5	9.4	12.8	450.1
6.	JF.53	37.8	5.9	1.9	14.8	8.6	12.8	233.6
7.	TG.194	36.4	6.1	2.8	19.4	9.3	15.6	533.8
8.	TG.268	39.7	6.0	1.7	26.2	8.8	15.6	623.2
9.	TG.947	42.2	6.8	2.3	20.1	9.5	16.3	683.7
10.	HM.16	39.2	5.2	2.1	22.4	8.1	16.2	423.0
11.	HM.57	38.4	5.9	1.9	19.4	9.2	14.2	420.2
12.	PRT.4	26.5	5.0	1.7	18.3	8.6	14.2	436.0
13.	Co.1	37.8	5.4	1.5	19.3	9.2	15.0	533.4

Comments : The Guntur Centre would lay out the trial seriously and add 14 entries. The trials will be continued for two more seasons and then the pooled data would be analysed.

#### 5. EVOLVING VARIETIES RESISTANT TO POWDERY MILDEW THROUGH MUTATION BREEDING

(Jobner)

Gamma radiation with 20, 30, 40 and 50 KR doses to Fenugreek variety RMT-1 resulted in a plant survival of 52.10% and 51.89% in 20 KR and 30 KR doses respectively. In 40 KR, the survival was 15.16% and it revealed that LD-50 lies between 40 & 50 KR doses. The treatment effect on other characters indicated a trend in reduction with increase in doses in all characters excepting "days to maturity" and 100 grains weight in M-1 generation.

Evaluation of 50 single plant progenies each of 20 and 40 KR treatment in the M-2 generation indicated significantly higher variability for all the characters excepting 100 grains weight and grains/pod based on mean and co-efficient of variability. Three M-2 progenies (54, 59 and 75) of 40 KR and two M-2 progenies of 20 KR were identified for further evaluation.

#### 6. EFFECT OF IRRIGATION AND PHOSPHORUS ON FENUGREEK (Jagudan and Jobner)

This experiment consisted of 20 treatment combinations having 4 levels of irrigation (I) ( $I_1 = 0.4$ ,  $I_2 = 0.6$ ,  $I_3 = 0.8$  and  $I_4 = 1.0$  IW/CPE ratio) and 5 levels of Phosphorus (P) (0, 20, 40, 60 and 80 kg P/ha) and was in the 3rd year at Jagudan. The observations like plant stand, height, number of branches/plant, number of pods/plant, length of pod, number of seeds/pod, 1000 seed weight and yield were recorded. The yield differences due to main plot (Irrigation levels) were found to be highly significant. The treatment  $T_{17}$  (1.0 IW/CPE ratio) and Phosphorus (20 kg/ha) gave highest yield of 2028 kg/ha during 1990-91 (Table-46). It was significantly at par with  $T_{20}$ ,  $T_{19}$ ,  $T_{18}$ ,  $T_{16}$ ,  $T_{15}$ ,  $T_{13}$  but there was no significant effect due to phosphatic fertilizers. The pooled analysis presented in Table-46 also indicated significant differences due to various treatments. The highest yield of 1246 kg/ha was recorded in treatment  $T_{20}$  ( $I_4$ ,  $P_{80}$ ).

The single effect of  $P_2O_5$  fertilizer levels and irrigation levels were also found to be significant (Table-47). In the case of irrigation levels,  $I_4$ , i.e., seven irrigations gave significantly higher yield over remaining irrigation levels, with increase in  $P_2O_5$  levels, 80 kg  $P_2O_5$ /ha was found to give significantly superior yields.

The three years field study at Jobner revealed that maximum seed yield of 12.75 Q and 10.55 Q/ha under IW/CPE ratio of 1.0 and 40 kg  $P_2O_5$ /ha is obtained respectively; this is followed by 0.8 IW/CPE ratio (11.45 Q/ha) and 20 and 60 kg  $P_2O_5$ /ha (10.22 and 10.11 Q/ha respectively) (Table-48).



Table-46 : EFFECT OF IRRIGATION LEVELS AND PHOSPHORUS ON YIELD (JAGUDAN)

Treatments			Year-wise yield (kg/ha)			Pooled Mean yield	% increase over control
Irrigation (IW/CPE)		P <sub>2</sub> O <sub>5</sub> (Kg/ha)	1988-89	1989-90	1990-91		
T <sub>1</sub>	I <sub>1</sub>	P <sub>0</sub> (cont)	147.06	425.505	946.970	506.512	146.10
T <sub>2</sub>	I <sub>1</sub>	P <sub>20</sub>	153.74	373.788	928.030	486.853	156.03
T <sub>3</sub>	I <sub>1</sub>	P <sub>40</sub>	147.06	500.842	667.087	438.330	184.38
T <sub>4</sub>	I <sub>1</sub>	P <sub>60</sub>	144.38	307.239	631.313	360.977	245.32
T <sub>5</sub>	I <sub>1</sub>	P <sub>80</sub>	169.79	252.525	968.013	463.443	168.97
T <sub>6</sub>	I <sub>2</sub>	P <sub>0</sub>	258.02	862.794	1060.606	727.140	71.43
T <sub>7</sub>	I <sub>2</sub>	P <sub>20</sub>	223.26	845.959	1174.242	747.820	66.69
T <sub>8</sub>	I <sub>2</sub>	P <sub>40</sub>	200.53	795.454	875.421	623.802	99.83
T <sub>9</sub>	I <sub>2</sub>	P <sub>60</sub>	227.27	669.192	1005.892	634.118	96.58
T <sub>10</sub>	I <sub>2</sub>	P <sub>80</sub>	196.52	765.993	980.639	647.717	92.45
T <sub>11</sub>	I <sub>3</sub>	P <sub>0</sub>	370.32	631.313	1283.670	751.768	63.64
T <sub>12</sub>	I <sub>3</sub>	P <sub>20</sub>	351.60	664.983	1388.889	801.824	55.46
T <sub>13</sub>	I <sub>3</sub>	P <sub>40</sub>	303.48	723.905	1658.249	895.212	39.24
T <sub>14</sub>	I <sub>3</sub>	P <sub>60</sub>	351.60	965.131	1519.360	945.364	31.86
T <sub>15</sub>	I <sub>3</sub>	P <sub>80</sub>	405.08	778.619	1700.337	961.345	29.67
T <sub>16</sub>	I <sub>4</sub>	P <sub>0</sub>	374.33	1279.461	1860.269	1171.353	6.42
T <sub>17</sub>	I <sub>4</sub>	P <sub>20</sub>	374.33	1069.023	2028.619	1157.324	7.71
T <sub>18</sub>	I <sub>4</sub>	P <sub>40</sub>	356.95	930.134	1738.215	1008.433	23.61
T <sub>19</sub>	I <sub>4</sub>	P <sub>60</sub>	383.69	1144.781	1784.511	1104.327	12.88
T <sub>20</sub>	I <sub>4</sub>	P <sub>80</sub>	494.65	1292.087	1952.861	1246.533	-
S.Em ±			22.170	86.253	137.736	103.350	
CD at 5%			63.640	247.582	476.575	289.350	
CV %			27.22	19.82	18.27	23.0	

Table-47 : SINGLE EFFECT OF IRRIGATION AND P<sub>2</sub>O<sub>5</sub> ON YIELD  
(JAGUDAN)

Irrigation levels	Yield (Kg/ha)	P <sub>2</sub> O <sub>5</sub> levels/ha	Yield (kg/ha)
I <sub>1</sub>	445.707	P <sub>0</sub>	781.250
I <sub>2</sub>	668.097	P <sub>20</sub>	788.510
I <sub>3</sub>	862.766	P <sub>40</sub>	732.323
I <sub>4</sub>	1123.232	P <sub>80</sub>	818.287
S.Em ±	42.212		29.834
CD at 5%	124.509		83.526
CV %	36.74		23.23

Table-48 : EFFECT OF IRRIGATION LEVELS AND PHOSPHORUS (JOBNER)

Treatments	Seed yield			
	1987-88	1988-89	1989-90	Mean
<b>A. Irrigation levels (IW:CPE ratio)</b>				
T <sub>1</sub> 0.4	7.56	5.81	7.31	6.90
T <sub>2</sub> 0.5	9.82	7.72	8.42	8.65
T <sub>3</sub> 0.8	14.00	9.68	10.68	11.45
T <sub>4</sub> 1.0	15.53	10.19	12.76	12.75
S.Em ±	0.20	0.29	0.44	0.54
CD at 5%	0.69	0.99	7.52	1.87
CD at 1%	1.04	-	2.29	2.83
CV %	5.83	11.86	15.49	18.79
<b>B. Phosphorous (kg/ha)</b>				
T <sub>1</sub> 0	10.21	7.44	9.17	8.87
T <sub>2</sub> 20	11.99	8.35	10.35	10.22
T <sub>3</sub> 40	12.71	8.84	10.10	10.55
T <sub>4</sub> 60	12.02	8.76	9.55	10.11
S.Em ±	0.11	0.25	0.42	0.22
CD at 5%	0.31	0.72	N.S	0.64
CD at 1%	0.42	-	-	0.92
CV %	3.10	10.26	14.74	7.55

It is observed that the levels of irrigation and P caused significant variation in seed yield and yield attributes in the fenugreek (RMT-1). Interaction effect of irrigation and P was also found to be significant. The maximum seed yield of 14.03 Q/ha was recorded at IW/CPE ratio of 1.0 and 60 kg P<sub>2</sub>O<sub>5</sub>/ha; this was statistically at par with seed yield of 13.38 Q/ha obtained under the same levels of irrigation with P<sub>2</sub>O<sub>5</sub> @ 40 kg/ha. Maximum net profit of Rs.10308/ha obtained at IW/CPE ratio of 1.0 with 60 kg P<sub>2</sub>O<sub>5</sub>/ha followed by IW/CPE ratio of 1.0 with 40 kg P<sub>2</sub>O<sub>5</sub>/ha (Rs.9963/ha).

Comments : The irrigation experiments were conducted for 3 years in Jobner & Jagudan centres and the analysis of pooled data show firm indications. On farm trials may be taken up to demonstrate the recommended technology to farmers.

7. STUDIES ON THE CONTROL OF ROOT ROT OF FENUGREEK WITH SOIL AMENDMENTS AND ANTAGONISTIC FUNGI IN ADDITION TO DRENCHING OF FUNGICIDES  
(Coimbatore)

Experiments were conducted at Coimbatore to evolve suitable bioagents/organic amendments/fungicides to control root rot disease of fenugreek. The data from Rabi 1990 experiment on disease incidence and yield are presented in Table-49.

Application of neem cake @ 10 Q/ha combined with seed pelleting with Trichoderma viride recorded the minimum root rot incidence of 3.5% followed by 4.3% with soil application of T.viride, 20 days before sowing; this was on par with soil drenching with Carbendazim (6.6%) compared to 24.5% in control. As regards yield, combined application of neem cake and T. viride followed by soil application of T. viride, 20 days before sowing gave higher yields viz., 303.3 and 263.0 kg/ha respectively.

Table-49 : CONTROL OF ROOT ROT DISEASE OF FENUGREEK (COIMBATORE)

Treatments		Root rot incidence(%)	Yield (kg/ha)
T <sub>1</sub>	Seed treatment with Carbendazim 0.1%	16.0 (23.55)	207.6
T <sub>2</sub>	Seed pelleting with <u>Trichoderma viride</u>	9.2 (17.66)	232.6
T <sub>3</sub>	Application of <u>T. viride</u> , 20 days before sowing	4.3 (12.01)	263.0
T <sub>4</sub>	Neem cake @ 1 Q/ha	12.7 (20.83)	200.00
T <sub>5</sub>	Neem cake @ 10 Q/ha	10.1 (18.48)	214.6
T <sub>6</sub>	T <sub>4</sub> + T <sub>2</sub>	13.8 (21.81)	235.2
T <sub>7</sub>	T <sub>5</sub> + T <sub>2</sub>	3.5 (10.76)	308.3
T <sub>8</sub>	Soil drenching with Carbendazim 0.1%	6.6 (14.9)	252.0
T <sub>9</sub>	Control	24.5 (29.7)	139.6
CD at 5%		4.23	30.89

(Figures in parentheses denote transformed values)

## 8. ADAPTIVE TRIALS

(Jobner)

RMt-1 showed superior performance from 5 demonstration in Jaipur and one in Dausa in the farmers' field. In Dausa, RMt-1 gave almost double the yield than the local check (Table-50).

Table-50 : PERFORMANCE OF FENUGREEK IN DEMONSTRATION TRIALS AT JOBNER CENTRE (1989-90)

Variety	Yield (Q/ha)	
	Jaipur*	Dausa
1. NLM (RMt-1)	4.50	13.0
2. Local-1	3.25	6.5

\*Testing in 5 locations.

\*\*\*\*\*

pvs/

**GERMPLASM HOLDINGS OF DIFFERENT SPICES  
IN COORDINATING CENTRES**

(As on Dec. 1, 1991)

<b>A. CARDAMOM</b>		<b>F. CORIANDER</b>	
1. Pampadumpara	71	1. Jobner	441
2. Mudigere	245	2. Jagudan	291
3. Yercaud	36	3. Guntur	120
		4. Coimbatore	145
<b>B. LARGE CARDAMOM</b>		<b>G. CUMIN</b>	
1. Gangtok	34	1. Jobner	219
		2. Jagudan	172
<b>C. BLACK PEPPER</b>		<b>H. FENNEL</b>	
1. Panniyur	200	1. Jobner	131
2. Sirsi	75	2. Jagudan	183
3. Chintapalli	36		
<b>D. GINGER</b>		<b>I. FENUGREEK</b>	
1. Pottangi	144	1. Jobner	134
2. Solan	163	2. Jagudan	178
		3. Guntur	70
<b>E. TURMERIC</b>		4. Coimbatore	84
1. Pottangi	185		
2. Solan	157		
3. Jagtial	80		
4. Coimbatore	110		

## CHAPTER II : ORGANISATION

i)	RESEARCH CENTRES	89	-	90
ii)	FUNCTIONING OF THE COORDINATED PROJECT	91	-	95
iii)	ACTION TAKEN ON THE RECOMMENDATIONS OF THE X WORKSHOP ON SPICES	96	-	103
iv)	BUDGET	104		
v)	STAFF STRENGTH AND PERSONNEL	105	-	108
vi)	PUBLICATION FROM CENTRES	109	-	110
vii)	METEOROLOGICAL DATA FROM CENTRES	111	-	123

## LIST OF COORDINATING CENTRES UNDER AICRP ON SPICES

\*\*\*\*\*

Headquarters : Project Coordinator (Spices)  
All India Coordinated Research Project on Spices  
NRCS, Calicut - 673 012, Kerala  
Phone: Off.56794 Res.50794 Telex: 0804 250 NRCS IN  
Grams: RESEARCH FAX: 0091-495-53900

\*\*\*\*\*

1. Cardamom Research Station  
(Kerala Agrl. University)  
PAMPADUMPARA - 685 553  
Dist. Idukki, Kerala  
Telephone : NEDUMKANDAM 63  
(Dist. Idukki)
2. Regional Research Station  
(Univ. of Agrl. Sciences)  
MUDIGERE - 577 132  
Dist. Chickmagalur  
Karnataka  
Telephone : MUDIGERE 246  
(Dist.Chikmagalur)
3. Horticultural Research Station  
(Tamil Nadu Agrl.University)  
YERCAUD - 636 602  
Dist. Salem, Tamil Nadu  
Telephone : YERCAUD 256  
(Dist. Salem)
4. Pepper Research Station  
(Kerala Agrl. University)  
PANNIYUR, P.B.No.113  
Taliparamba - 670 141  
Dist. Cannanore, Kerala  
Telephone : TALIPARAMBA 2687  
(Dist. Cannanore)
5. Regional Agril. Res. Station  
(Andhra Pradesh Agrl.Univ.)  
CHINTAPALLI - 531 111  
Dist. Visakha, A.P.  
Telephone : CHINTAPALLI 44 & 58  
(Dist. Visakha)
6. Agricultural Research Station  
(Pepper)  
(Univ. of Agrl. Sciences)  
SIRSI - 581 401  
Dist. Uttara Kannada  
Karnataka  
Telephone : SIRSI 6797
7. Dept. of Vegetable Crops  
(Dr.Y.S.Parmar Univ. of  
Horticulture & Forestry)  
SOLAN - 173 230  
Himachal Pradesh  
Telegram : VANUDYAN, SOLAN  
Telephone : OACHGHAT 29  
(NAUNI/SOLAN)

8. High Altitude Research Station  
(Orissa Univ. of Agr. & Tech.)  
POTTANGI - 764 039  
Dist. Koraput, Orissa
9. Dept. of Genetics & Plant  
Breeding  
SKN College of Agriculture  
(Rajasthan Agrl. University)  
JOBNER - 303 329  
Dist. Jaipur, Rajasthan  
Telegram : AGRICOL-JOBNER  
Telephone : JOBNER 46  
(Dist. Jaipur)
10. Main Spices Research Station  
(Gujarat Agricultural Univ.)  
JAGUDAN - 382 710  
Dist. Mehsana, Gujarat  
Telephone : JAGUDAN  
(Dist. Mehsana)
11. Dept. of Spices & Pl.Crops  
Faculty of Horticulture  
(Tamil Nadu Agrl.Univ.)  
COIMBATORE - 641 003  
Tamil Nadu  
Telegram : FARMVAR, COIMBATORE  
Telephone : COIMBATORE 41222  
Telex : 0855 360 TNAU IN
12. Regional Agrl. Res. Station  
(Andhra Pradesh Agrl.Univ.)  
GUNTUR - 522 034  
Andhra Pradesh  
Telephone : GUNTUR 30517, 31297  
& 31767
13. ICAR Research Complex for  
NEH Region  
Tadung, GANGTOK - 737 102  
Sikkim  
Telegram : AGRICOMPLEX, GANGTOK  
Telephone : GANGTOK 2249 & 2497
14. Regional Agrl. Res. Station  
(Andhra Pradesh Agrl.Univ.)  
JAGTIAL - 505 327  
Dist. Karimnagar  
Andhra Pradesh  
Telephone : JAGTIAL 381 & 380  
(Dist. Karimnagar)

Voluntary Centre, :

1. Department of Vegetable Crops  
(Haryana Agricultural Univ.)  
HISAR - 125 004  
Haryana  
Telegram : AGRIVARSITY  
Telephone : 73721/207

\*\*\*\*\*



## FUNCTIONING OF THE COORDINATED PROJECT

It has been estimated that the total area under cultivation and production of various spices (pepper, cardamom, ginger, turmeric, chillies, cumin, coriander, fennel, fenugreek, clove, nutmeg, cinnamon, saffron, garlic etc.) is about 2.0 M ha and 1.8 M tonnes respectively. The value of the spices produced in the country is about Rs.45,000 M. We export a quantity of about 0.09 M tonnes valued at Rs.2,500 M per annum. The important states accounting for the major area under Spices are Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Rajasthan, Gujarat, Orissa and to a limited extent, the States of Maharashtra, West Bengal, Uttar Pradesh and the N.E. Region.

During 1990-91, about 97000 tonnes of spices were exported from India which resulted in an earning of Rs.238 crores in foreign exchange. Although there has been an increase of nearly 5 thousand tonnes in the volume of export, the actual earning of foreign exchange has dropped due to reduction in international prices of some of the spices. Nevertheless, there is further scope to increase the export earnings through increasing the exports of seed spices as well as black pepper. Realising the importance of the spices in our foreign trade, the Government of India has initiated actions for improving the production of spices from the current level of 1600 thousand tonnes to about 2100 thousand tonnes during the VIII Plan period. The expenditure on research on spices has so far been only minimal and efforts have been made by the Government of India to increase this expenditure and provide more encouragement to spices research.

The research and development on spices has not been very encouraging until the ICAR commenced concerted research activities through the All India Coordinated Spices Improvement Project about two decades ago. This Coordinated Project was initiated in 1971 with just four Coordinating Centres in the IV Plan, this was also a part of the combined project on spices and cashewnut. The network of Centres under the Project increased to 15 during the VII Plan and currently we have mandate to serve the following crops :

- |                   |              |
|-------------------|--------------|
| 1. Pepper         | 6. Cumin     |
| 2. Cardamom       | 7. Coriander |
| 3. Large Cardamom | 8. Fennel &  |
| 4. Ginger         | 9. Fenugreek |
| 5. Turmeric       |              |

However, during the year 1990-91, one Centre viz., Vellanikkara under KAU ceased to exist. There are two Voluntary Centres reporting to the Project viz., the Department of Vegetable Crops at Hisar under Haryana Agricultural University as well as the Indian Cardamom Research Institute at Myladumpara under Spices Board. Thus there are 16 Centres currently reporting under the AICWP on Spices. It has also been proposed to initiate two new Centres during VIII Plan viz., at Hisar (Haryana) and at Dholi (Bihar). Ultimately there will be 16 Coordinating Centres and one Voluntary Centre.

In order to provide adequate and undivided attention to conduct coordinated research on the spices, an independent Spices Project has been in operation during the VII Plan and accordingly, the erstwhile Project on Spices and Cashewnut was bifurcated. The headquarters of the Project has also been shifted from Central Plantation Crops Research Institute, Kasaragod to the National Research Centre for Spices, Calicut with the joining of the new Project Coordinator during March, 1986. The Project had an allocation of Rs.37.3 lakhs during 1990-91 and the funds are allotted to the various Agricultural Universities who look after the Project Centres at the State level.

The technical programmes for the Spices Project were drawn up initially in the I Workshop held at CPCRI, Kasaragod in December 1971. The progress in research under this Project has been regularly reviewed in the Workshops held in 1972, 1975, 1978, 1981, 1983 and 1985; these were followed by Group Meetings on annual crops. Since 1986-87, independent Spices Workshops have been organised and accordingly the VIII, IX & X Workshops of the Project were held at Guntur (Andhra Pradesh) during January-February 1987, at Sclan (Himachal Pradesh) during September 1988 and at Coimbatore (Tamil Nadu) during August 1989 respectively. The technical programmes were modified wherever necessary in the light of detailed discussions during the Workshops and keeping in view the specific recommendations made in such meetings.

An important activity during the year under report has been initiation of new series of multilocation trials for turmeric and ginger.

The Coimbatore centre was also added to the turmeric network on a voluntary basis. It has also been envisaged to include Guntur centre during the VIII Plan. Necessary advance action has been initiated during the year under report.

An important feature of the Workshops of the AICRP on Spices especially from 1985 has been to promote release of varieties on Spices. The Workshops were also used as the platform to take stock of the earlier work and enable appropriate release of varieties through the State or Central Committees. We have so far 42 varieties under the various spices viz., black pepper, cardamom, ginger, turmeric, cumin, coriander, fennel and fenugreek. During the discussions the Project Coordinator had during the year under report, 11 more varieties would come up for discussion for release as varieties. This has been recommended to be done during the next Workshop (XI) of the Project.

#### PERFORMANCE OF THE CENTRES

##### Black Pepper Centres

The Panniyur Centre improved its germplasm collection by addition from surveys conducted in Kodagu district, Karnataka. The Chintapalli Centre also increased its wild germplasm collection by adding four accessions. The work on biological control of Phytophthora foot rot disease was initiated and the Scientists were given training. The work on multilocation trial to identify a suitable cultivar/variety for the Wynad zone was initiated at the Regional Agricultural Research Station, Ambalavayal. There has been heavy demand for the planting material of all the three released varieties viz., Panniyur-2, Panniyur-3 & Panniyur-4. The propagation sheds at Chintapalli and Panniyur have been put under use. The staffing pattern has been generally satisfactory excepting Panniyur where either the Agronomist or the Breeder post was vacant from time to time.

### Cardamom Centres

The Pampadumpara Centre continued to have its problem of non-filling up of scientific positions and inadequate turn over on the Project work. The Asst. Director General (Plantation Crops) has visited the Centre along with the Project Coordinator and has made efforts to improve the performance of the Centre in consultation with the University authorities. Some of the important experiments like the multiplication trial, the manual experiment and field control trial for azhukal disease have either been not laid out or not suitably followed. The Yercaud Centre has taken up the new trials allotted systematically and also helped in the exploratory survey for tree spices. In view of the consistent demand by the farmers in the Shevroy hills for diversification of crops as well as the declining trend for cardamom, it was decided to include black pepper into the mandate of Yercaud Centre. The Centre has taken advance action to procure adequate planting material of various cultivars and accessions. The Gangtok Centre will continue under the Project as a "non-plan" component under the ICAR Research Complex, Shillong. Except the posts of Plant Pathologist & Plant Physiologist at Mudigere Centre, (besides the chronic problem at Pampadumpara) there was satisfactory filling up of positions.

### Ginger and Turmeric Centres

The Pottangi Centre continued to maintain its distinct performance in production and distribution of large quantities of seed rhizomes of ginger and turmeric varieties. This Centre has also supplied germplasm to NRCS, Calicut, Solan, Coimbatore, Jagtial and Jagudan centres. The Solan centre has initiated activities on quality evaluation of ginger and also on the storage studies with turmeric. The recommendations for control of rhizome rot disease in Himachal Pradesh has been well received by the Department of Agriculture. Some of the agro-techniques like intercropping at Pottangi has also become very popular. The release of Suguna & Sudarshana has led to a large scale demand of seed rhizomes in Andhra Pradesh and the Jagtial Centre has been doing a commendable job by identifying progressive growers for multiplication of foundation seed. Coimbatore centre has associated

itself as a Voluntary Centre under the Project and has laid out multilocation trials besides maintaining a good germplasm collection. The post of Plant Pathologist is vacant at Jagtial and has affected the progress of work on rhizome rot disease; otherwise all other Scientific positions are filled in ginger and turmeric centres.

#### Seed spices Centres

The four Centres viz., Jagudan, Guntur, Jobner & Coimbatore have been progressing quite satisfactorily. The new CYT initiated during 1989 after the National Seminar on Seed Spices (Jaipur) is progressing quite well for all the crops viz., cumin, coriander, fennel & fenugreek. The Centres have taken up large scale production of improved varieties of seed spices under the Centrally sponsored scheme as well as the seed multiplication programme by the Spices Board. Specific control measures for grain mould of coriander, root rot of fenugreek and powdery mildew of the seed spices have been field tested and recommended.

As in the past, there has been the requirement for increasing the variability in germplasm and it is highly necessary to enable import of the germplasm from the Mediterranean region and widen the genetic base. The Haryana Agricultural University has offered a Voluntary Centre of the Project at Hisar and the Rajendra Agricultural University at Dholi. These two Centres will be considered for inclusion as regular Centres under the Project during the VIII Plan.

\*\*\*\*\*

**ACTION TAKEN ON THE RECOMMENDATIONS OF THE X WORKSHOP ON SPICES HELD AT COIMBATORE  
DURING AUGUST 22-24, 1989**

Decision	Action taken/remarks
<p><b>I. GENERAL</b></p>	
<p>1. Four varieties in black pepper viz., two from NRCs, Calicut and two from Pepper Research Station, Panniyur, two varieties of turmeric (both from NRCs) and two varieties of coriander (both from Regional Agricultural Research Station, Guntur) were recommended for release.</p>	<p>Cut of the eight varieties recommended for release, seven have been released by the duly constituted State/Central Varieties Release Committees. Panniyur-2, Panniyur-3 and Subhakara in black pepper, Suguna and Sudarshana in turmeric and Sadhana &amp; Swathi in Coriander have been released. The variety Sreeekara in black pepper is under consideration of the Variety Release Committee.</p>
<p>2. A team of scientists from NRCs, ICRI, KAU, TNAU, CAS(A) will work out a strategy for survey and collection of wild types of cardamom &amp; pepper from the forest areas in Kerala, Tamil Nadu, Karnataka and North Eastern States.</p>	<p>This item needs a fresh discussion in the light of the decisions taken during the Fourth Annual Staff Research Council Meeting of NRCs held during May 1991. The Director of Research, KAU has been entrusted with the responsibility.</p>
<p>3. The survey and collection of germplasm in Cardamom and black pepper from the evergreen forests of Western Ghats will be a collaborative programme among NRCs and KAU. A group meeting may be organised by KAU and NRCs to work out the strategies.</p>	<p>Same as in item No."2" above.</p>
<p>4. New promising accessions from Jobner Centre should be exchanged immediately to Jagudan Centre for screening against <u>Fusarium</u> wilt.</p>	<p>The exchange between Jobner and Jagudan centres is under progress.</p>

5. The Project Coordinator would discuss the issue of overlapping of research programmes of the Spices Board with the Director, CPCRI shortly
6. Project Coordinator may ensure that exchange of planting material is completed and sufficiently so that the multiplication trials will not suffer due to non-availability of planting material.
7. The continuance of Pampadumpara centre under the AICRP on Spices will be discussed with the authorities of KAU at a later date.
8. A Committee under the Chairmanship of Dr. A. Kanadasan will study the details of evaluation of quality parameters in turmeric and finalise necessary guidelines for future quality analysis.
9. Cost : benefit ratio should be worked out while concluding the experiments. The results should be tested in "on farm trials" if farmers holding before it is recommended for adoption. The funds allotted for the respective centre will have to be utilised for this.

This aspect has been discussed under a combined meeting of officials from the Spices Board, CPCRI and NRCS during September, 1989. The Director, CPCRI, the Chairman, Spices Board and other officials participated and decisions communicated with the Council by the Director, NRCS.

This has been ensured by the Project Coordinator. However in the case of Pampadumpara centre, the Centre has not lifted the planting material for three years from the participating centres.

The issue has been discussed several times with the KAU authorities including the Vice Chancellor and Director of Research. The ADG (PC) made joint visit to the Centre along with the Project Coordinator for an in-depth review. Recently the ICAK has issued a relevant letter to the KAU cautioning about the status/performance of the Pampadumpara Centre.

The information has been compiled and communicated to all the Coordinating Centres well in time.

All the Centres have been advised about this requirement and requested to provide necessary data especially for the technologies which are recommended for transfer to the farmers.

10. The need for taking up research programmes in Biofertilizers in spice crops was emphasized. The interested centres may consult the Professor & Head, Department of Microbiology for taking up observational trials. The cultures required will be supplied by the Department of Microbiology, Tamil Nadu Agricultural University. The Project Coordinator (Spices) will interact with TNAU in formulating suitable programmes in seed spices and pepper.

11. Biological control of Phytophthora foot rot disease of Jack pepper by use of antagonists as well as rhizome rot of cardamom may be taken up.

12. It was decided to have a thorough discussion about the Entomology Projects and formulate new technical programmes.

13. The Biochemists at Jobner will analyse the coriander samples of Jagudan & Guntur Centres also.

14. The Chairman of the Plenary Session expressed the necessity for initiating seed technology research on seed spices especially on the aspects like seed storage, seed health and viability.

A training programme was conducted at the Departments of Plant Pathology and Microbiology at TNAU, Coimbatore with participation from Coimbatore, Panniyur and Sirsi Centres. Necessary stock cultures of biofertilizers and biocontrol agents were supplied to the participants. Post culture studies have already been initiated in all these Centres.

The work has been initiated at Chintapalli, Panniyur and Sirsi Centres; the Mudigere Centre has also started similar work with rhizome rot of cardamom.

There has been transfer or absence of Entomologists under the Scheme even though there are only two positions. During the Trivandrum Workshop (July 1991), the Sub-Group will discuss the matter and finalise.

This has been taken up.

This may be discussed in detail during the Trivandrum Workshop in the Session on "Biochemistry, Physiology and Quality analysis" and recommendations discussed with the ICAR headquarters for further necessary action. The services of Head, Department of Seed Technology, TNAU may be requisitioned for this purpose.



15. The new multilocation trial on cardamom initiated during 1987 has been laid out in all the Coordinating Centres excepting Pampadumpara.
- II. SPECIFIC ITEMS, CRCP-WISE
  - A. Black Pepper
    16. The Scientists from Sirsi Centre may visit CPCRI Regional Station, Vittal along with the Project Coordinator and Agronomist/ Soil Scientist from CPCRI/NRCS and finalise the technical programme for the newly laid out irrigation-cum-fertilizer trial for pepper.
    17. The methodology for the use of systemic fungicides in plant disease control may be communicated to all pepper centres for adoption
    18. An altogether new programme for the control of Phytophthora disease has been advised to be developed under the Chairmanship of Dr.P.Jayarajan, Professor & Head, Plant Pathology, MAU; the same will be presented in the concerned Technical Session.

The matter has been taken up at the highest level and a letter issued by the ICAR to the Vice Chancellor, KAU. In addition, a few more experiments are still pending to be laid out at the Pampadumpara Centre. The ADG made a joint visit to the Centre with Project Coordinator during March, 1991 and reviewed the progress.

The joint meeting was held at CPCRI Regional Station, Vittal and the technical programme finalised and communicated to the Sirsi Centre.

This aspect was further discussed at the "Group discussion of Plant Pathologists working in the Coordinated Projects of Horticultural Crops" held at Bangalore during June 1990 and the relevant suggestions communicated for adoption.

The programme was discussed in detail by an expert group during the "Group discussion of Plant Pathologists Working in the Coordinated Projects of Horticultural Crops" at Bangalore and the technical programme implemented the Coordinating Centres.

19. The survey for wild germplasm at Andhra Pradesh and Kerala centres for turmeric and black pepper respectively may be speeded up.
20. Ambalavayal Centre of KAU will be a Co-operative Centre of AICRP on Spices and a Breeder from Pampadumpara centre may be redisplayed to look after the MLT of pepper at Ambalavayal.
21. The MLT involving promising cultures of black pepper from Panniyur may be laid out at NRCS, Sirsi and Yercaud also.
22. The Chintapalli Centre is identified as a non-performing Centre. The Project Coordinator (Spices) will critically review the progress of research project at Chintapalli centre and submit a report to the ICAR.
- E. Cardamom
23. The screening for 'Katte' resistance should be restandardised and the testing conducted as a sick-plot.

The Chintapalli centre has initiated activity on wild germplasm of black pepper and added five entries. The Panniyur centre has taken up intensive survey for wild germplasm of black pepper in Karnataka and Kerala and added about 12 new entries.

The KAU has deployed an Associate Breeder at the Ambalavayal Centre to take up multilocation trials on black pepper. This requires consideration and approval from the ICAR.

The list of promising cultures from Pepper Research Station, Panniyur and NRCS, Calicut have been identified and communicated to the Panniyur and Sirsi centres; the Yercaud centre may take up programme on black pepper during the next planting season and also add black pepper to their mandate.

The Project Coordinator visited the Chintapalli Centre and provided a critical review on the performance of the Centre to the ICAR headquarters. The Centre has progressed in its performance and has also started programmes on ginger and turmeric on a voluntary basis.

This has been taken up at Mudigere centre.

24. A new combining ability study proposed for the Mudigere centre may be shelved.
25. The mutation breeding programme on cardamom may be taken up by NRCS.
26. The experiment on drip irrigation, weed control and mulching planned to be initiated during 1988-90 in consultation with Director, W.T.C., TNFU.
27. Efforts will be made to collect the reported high yielding clones from plantations of Manjusree Estates, AVT and Hindustan Levers.
28. Experiments on effect of irradiation, mutagenesis and combining ability in cardamom may be de-linked from the Coordinated Project and may be taken as a University Project.
29. Observational trials with natural products like Ligetelin and Aitin which induce resistance may be tried in cardamom.
30. Studies to induce somaclonal variants through tissue culture to obtain 'Katte' resistant types may be intensified at NRCS and ICRI.
- The Centre has since been informed and has complied with the decision.
- The Director, NRCS has been reminded about this activity; the work is under progress.
- The necessary physical facilities for drip irrigation will have to be provided under the Project funds in the VIII Plan. The three agronomic experiments will be initiated during 1991 in consultation with the ADG(PC).
- The Scientist-in-charge, NRCS Cardamom Research Centre, Appangala has collected the information.
- All the cardamom centres have been informed about this development and they have since complied with the decisions.
- The Mudigere Centre has taken up this programme under glass house conditions.
- The programme has been taken up at NRCS, Calicut/Appangala and at ICRI, Myladumpara.

31. Treatments and methodology of drought screening experiment in Cardamom will be finalised after the meeting of the Plant Physiologist, CPCRI, Kasaragod will be utilised while formulating the programme on drought. Shri Gurumurthy, Jr. Plant Physiologist should visit NRCS, Calicut during September, 1989 for finalising the programme.
- C. Large Cardamom
32. Yield loss studies in large cardamom due to leaf streak disease, severity of the disease as well as response of Topsin and Carbendazim may be taken up at Gangtok.
- D. Ginger
33. It is necessary to introduce low fibre ginger varieties to the Coordinating Centres for evaluation. The Solan Centre will supply the low fibre varieties to all the Coordinating Centres. Import of exotic germplasm from Indonesia may be arranged through NBPGR.
34. The Project Coordinator will convene a Meeting of Expert Committee to finalise an altogether new management trial to control rhizome rot of ginger.
- The Physiologist from Mudigere Centre had visited NRCS for detailed discussion; he also discussed the programme with Dr. V. Rajagopal at CPCRI, Kasaragod and finalised. The revised technical programme was again discussed at Calicut and the same is being implemented by the Centres.
- Yield loss studies have been done in a compact block in the Research Station; the reported fungicidal response is yet to be checked.
- The NBPGR has been requested again to obtain the material from exotic sources; a comprehensive list has been provided to the Project Coordinator by the NBPGR.
- In the "Group Discussion of Plant Pathologists Working in the Coordinated Projects of Horticultural Crops" held at Bangalore during June 1990, detailed discussions were conducted and the revised technical programme communicated to all the Centres under the programme.

E. Turmeric

- 35. The samples of turmeric from the Coordinating Centres may be sent to the Joint Director, NRCS with adequate basic information through the Project Coordinator.
- 36. It was decided to standardise the sampling procedures for curcumin analysis in turmeric as well as loss of curcumin during storage

Uniform procedure for sending of turmeric samples have been communicated to all the Centres. Analysis has been done by the Scientists at NRCS.

The detailed procedure has been sent to all the five centres under Turmeric. The studies on loss of curcumin during storage has already been taken up at Solan Centre.

F. Seed Spices

- 37. There is a need to enhance the activity of import of germplasm of seed spices from Mediterranean countries and West Europe. The NBPGC will be further pursued to help import of exotic germplasm in seed spices.

The Project Coordinator held discussions with Director and Senior Scientists at NBPGR and has provided the details required for enabling this activity.

- 38. The Project Coordinator (Spices) will send a detailed report on the possibility of obtaining the available exotic germplasm at CIMPC to ICAR for further action. A team under the Chairmanship of Dr.S.Edison, Project Coordinator (Spices) will prepare a proposal for "Advanced Centre for Genetic Resources in Grain Spices" and submit to ICAR.

The proposal has been sent to the ICAR headquarters by the Project Coordinator. This was also discussed with the Director, NBPGR. During the VIII Plan a "lead Centre" will be created on seed spices at Jobner.

- 39. The Project Coordinator will critically review the progress of work on grain spices at Jagudan centre.

The critical review was made about the performance of the Jagudan Centre; the Centre is making satisfactory progress.

\*\*\*\*\*

\*\*\*\*\*

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

Centre wise and Head wise Annual Plan allocation & Expenditure for 1990-91

(Rs. in lakhs)

Sl. No.	CENTRE	SALARY		T.A.		R.C.		N.R.C.		Total	
		Alloc.	Expndr.	Alloc.	Expndr.	Alloc.	Expndr.	Alloc.	Expndr.		
1.	Pampadumpara	3.00	2.01	0.08	0.08	0.48	0.48	0.37	0.22	3.56	2.57
2.	Mudigere	4.17	2.92	0.07	0.05	0.60	0.93	0.37	0.22	5.21	4.12
3.	Yercaud	1.34	1.27	0.04	0.04	0.24	0.30			1.62	1.61
4.	Panniyur	3.00	2.81	0.08	0.08	0.48	0.48			3.56	3.37
5.	Chintapalli	1.50	1.35	0.04	0.04	0.24	0.24			1.78	1.63
6.	Sirsi	1.50	1.41	0.04	0.03	0.24	0.24			1.78	1.68
7.	Solan	2.17	1.86	0.06	0.05	0.36	0.48			2.59	2.39
8.	Pottangi	2.45	2.06	0.06	0.06	0.24	0.24			2.75	2.36
9.	Jobner	3.67	4.46	0.10	0.10	0.60	0.60			4.45	5.16
10.	Guntur	2.33	0.75	0.06	0.01	0.36	0.20			2.75	0.96
11.	Jagudan	2.17	1.14	0.06	0.02	0.36	0.36			2.59	1.52
12.	Coimbatore	2.45	1.92	0.06	0.01	0.24	0.36			2.75	2.29
13.	Jagtial	1.78	0.18	0.04	0.03	0.12	0.20			1.94	0.41
	Total	31.53	24.14	0.79	0.60	4.56	5.11	0.37	0.22	37.33	30.07
	ICAR share (75%)	23.55	18.10	0.59	0.45	3.42	3.83	0.28	0.16	28.00	22.55
14.	Gangtok-100% ICAR	0.53	NA	0.07	NA	0.24	NA	-	-	0.84	NA
	GRAND TOTAL, ICAR	24.18	18.10	0.66	0.45	3.66	3.83	0.28	0.16	28.84	22.55

**STAFF STRENGTH**  
(As on March 31, 1991)

**PROJECT COORDINATOR'S CELL**  
**NATIONAL RESEARCH CENTRE FOR SPICES**  
**CALICUT - KERALA**

Project Coordinator	:	S.Edison
Technical Information Officer	:	Johny A. Kallapurackal
Stenographer	:	P.V.Sali
Supporting Staff (Part time)	:	K.Keeran

**COORDINATING CENTRES**

**I. CARDAMOM RESEARCH STATION, KAU, PAMPADUMPARA**

Plant Pathologist	:	A.Sukumara Varma
Agronomist	:	Vacant
Breeder (Botany)	:	Maya Devi
Jr. Entomologist	:	Suma Paulose
Lab. Assitant	:	P.V.Joseph
Farm Assistant	:	C.V.Kuttappan
Farm Assistant	:	C.G.Pradeep
Peon.	:	M.K.Sivaraman

**II. REGIONAL RESEARCH STATION, UAS(B), MUDIGERE**

Breeder	:	H.M.Chandrappa
Agronomist (Hort.)	:	S.M.Shanthaveerabhadraiah
Pathologist	:	Vacant
Jr. Entomologist	:	C.Parvathi
Jr. Technical Assistant	:	Narayana
Jr. Technical Assistant	:	Mruthunjaya
Lab.Attender	:	K.B.Jayappa
Messenger	:	G.Venkatesh

III. HORTICULTURAL RESEARCH STATION, TNAU, YERCAUD

Agronomist (Hort.) : N.Kumar  
Jr. Breeder (Hort.) : L.Pugalendhi

IV. PEPPER RESEARCH STATION, KAU, PANNIYUR

Pathologist (Nematology) : S.Sasikumaran  
Jr. Pathologist : K.P.Mammooty  
Agronomist : T.N.Jagadish Kumar  
Breeder (Botany) : V.P.Neema  
Farm Assistant : T.Mohammed Haneefa  
Farm Assistant : K.Lakshmanan  
Lab. Assistant : V.Achuthan  
Peon : M.P.Narayanan

V. REGIONAL AGRICULTURAL RESEARCH STATION, APAU, CHINTAPALLI

Horticulturist : E.Nagabhusanam Reddy  
Plant Pathologist : V.Chiranjeevi  
Technical Assistant : Vacant

VI. AGRICULTURAL RESEARCH STATION (PEPPER), UAS(D), SIRSI

Jr. Horticulturist : H.G.Hegde  
Jr. Pathologist : N.S.Malebennur  
Research Assistant : P.M.Gangadharappa

VII. DEPARTMENT OF VEGETABLE CROPS, Dr.YSPUHF, SOLAN

Breeder (Olericulturist) : B.N.Korla  
Jr. Plant Pathologist : N.P.Dohroo  
Jr. Biochemist : Ravinder K. Goyal  
Jr. Technical Assistant : S.L.Shankar Lal



VIII. HIGH ALTITUDE RESEARCH STATION, OUAT, POTTANGI

Breeder	:	D.C.Mohanty
Jr. Breeder	:	B.S.Naik
Sr. Technical Assistant	:	P.Berik
Jr. Technical Assistant	:	R.C.Dash

IX. DEPARTMENT OF PLANT BREEDING, SKN COLLEGE OF AGRICULTURE, RAJAU, JOBNER

Sr. Breeder	:	R.K.Sharma
Breeder	:	S.L.Dashora
Jr. Agronomist	:	G.R.Choudhary
Jr. Pathologist	:	M.P.Jain
Jr. Biochemist	:	S.Agarwal
Sr. Technical Assistant	:	Dhirendra Singh
Jr. Technical Assistant	:	S.R.Kumawat

X. REGIONAL AGRICULTURAL RESEARCH STATION, APAU, GUNTUR

Horticulturist	:	Vacant
Jr. Breeder (Hort.)	:	N.Hariprasad Rao
Jr. Agronomist	:	Vacant
Sub-Assistant	:	K.Venkateswarlu

XI. SPICES RESEARCH STATION, GAU, JAGUDAN

Sr. Plant Pathologist	:	V.A.Solanki (as Asst.Path.)
Jr. Breeder	:	G.M.Patel
Jr. Technical Assistant	:	H.S.Thakor

XII. DEPARTMENT OF SPICES AND PLANTATION CROPS, TNAU, COIMBATORE

Breeder	:	Peter G.B.Vedamuthu
Jr. Pathologist	:	F.Salal Rajan
Agricultural Assistant	:	V.Marimuthu

XIII. REGIONAL AGRICULTURAL RESEARCH STATION, APAU, JAGTIAL

Jr. Horticulturist : Vacant  
Technical Assistant : Vacant

XIV. ICAR RESEARCH COMPLEX FOR NEH REGION, GANGTOK

Scientist S-1 (Hort.) : G.S.Karibasappa  
Scientist S-2 (Pl.Path.) : L.S.Srivastava

\*\*\*\*\*

LIST OF PUBLICATIONS

A. COIMBATORE

1. Khader Mohideen, M., Abdul Khader, Md., Neelakantan, S and Peter G.B.Vedamuthu (1990). Note on curing turmeric rhizomes in cowdung slurry vs Sodium Bicarbonate solution. South Indian Hort. 38 (1) 49-52.
2. Rajan, F.S., Peter G.B.Vedamuthu, Abdul Khader, Md. and Jayarajan, R. (1990). Screening coriander lines against grain mould disease. South Indian Hort. 38(3) : 168-169.
3. Peter G.B.Vedamuthu, Abdul Khader, Md. and Rajan, F.S. (1990). Fenugreek cultivation. Spice India 3(8) : 5-6.
4. Prakasam, V, Vinayagamoorthy, A, Abdul Khader, Md, and Jayarajan, R. (1990). Control of root rot disease of fenugreek. Indian Cocoa, Arecanut and Spices Journal, 14(2) : 75-77.

B. POTTANGI

5. Mohanty, D.C., Naik, B.S. and Panda, B.S., (1990). Ginger Research in Orissa with special reference to its varietal and cultural improvement. Indian Cocoa, Arecanut and Spices Journal, 14(2) : 61-63.

C. SOLAN

6. Dohroo, N.P. and Sharma, S.K. (1990). Cultivar resistance and comparative effectiveness of Carbendazim products against yellows of ginger. Pl. Dis. Res. 5 (Special) 129-132.
7. Goyal, R.K. (1990). Adrak ek swadist padarth. Udayaniki and Vaniki, 4 : 54-55.

8. Korla, B.N., R.S.Rattan and N.P.Dohroo (1990). Effect of mulches on growth and yield of ginger. South Indian Hort., 38 (3) : 163-164.
9. Sharma, S.K. and N.P.Dohroo (1990). Occurrence and distribution of fungi causing ginger yellows in Himachal Pradesh. Pl. Dis. Res., 5(2) : 200-202.
10. Thapa, C.D., N.P.Dohroo, R.S.Rattan and O.P.Sharma. Himachal Pradesh mein adrak ki khadi (Directorate of Extension Education) Bulletin. pp.6

#### D. MUDIGERE

11. Krishnappa, M. and Shanthaveerabhadraiah, S.M. (1990). Fertility evaluation of soils under cardamom in Karnataka. Curr. Res. 19(4) : 58-60.

#### E. JOBNER

12. Sharma, O.P., D.L.Singhania, M.P.Jain and R.K.Sharma (1990). Powdery mildew resistance in Methi, Indian Cocoa, Arecanut and Spices Journal 14(1) : 28-30.
13. Chaudhary, G.R. and Gupta, O.P. (1989). Removal of nutrients by weeds and its effect on grain yield of cumin (Cuminum cyminum L.) grown under different weed management practices. Indian J. Agron. 34(4) : 396-398.
14. Agrawal, S. and Sharma, R.K. and Bhatt, B.N. (1990). Quality evaluation in Coriander, Indian Cocoa, Arecanut and Spices Journal 13 : 137-138.
15. Agrawal, S. and Sharma, R.K. (1990). Variability in quality aspects of seed spices and future strategy. Indian Cocoa, Arecanut and Spices Journal, 13 : 127-29.

\*\*\*\*\*

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## PAMPADUMPARA CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	114.7	4	25	13	NA
February 1990	5.2	2	29	15	"
March 1990	126.4	6	30	16	"
April 1990	33.0	3	31.5	19	"
May 1990	227.6	20	29	18	"
June 1990	310.2	26	23	17	"
July 1990	257.1	29	24	17	"
August 1990	256.9	25	24	17	"
September 1990	29.2	8	25	17	"
October 1990	263.2	17	28	17	"
November 1990	299.2	13	27	15	"
December 1990	77.8	6	26	14	"
Total for 1990	2000.5	159	-	-	-
January 1991	43.0	4	24	17	"
February 1991	35.0	2	27	14	"
March 1991	54.0	2	28	19	"

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## MUDIGERE CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	19.2	2	29.0	13.0	89 31
February 1990	-	-	30.2	13.6	93 33
March 1990	-	-	31.7	15.4	93 37
April 1990	4.6	1	33.2	18.3	93 41
May 1990	165.4	13	28.9	18.7	94 64
June 1990	326.0	24	24.7	18.7	96 79
July 1990	596.2	26	22.9	17.7	98 87
August 1990	665.0	29	23.1	17.9	98 90
September 1990	115.6	11	25.7	17.1	98 73
October 1990	251.0	17	27.2	17.7	96 68
November 1990	27.2	4	26.8	16.2	92 58
December 1990	0.6	-	27.8	14.5	89 42
Total for 1990	2170.8	127	-	-	- -
January 1991	-	-	29.5	14.3	89 36
February 1991	-	-	31.0	14.0	85 24
March 1991	14.4	3	32.8	16.9	91 35

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## YERCAUD CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	108.6	1	23.4	16.3	82.5
February 1990	14.0	-	21.5	14.9	94.0
March 1990	95.2	1	20.6	12.1	79.0
April 1990	52.8	4	27.7	20.4	-
May 1990	176.4	8	25.6	18.9	-
June 1990	78.6	5	24.1	20.1	-
July 1990	58.8	9	22.2	19.5	-
August 1990	194.0	13	22.7	18.3	-
September 1990	306.2	11	21.3	17.9	82.0
October 1990	244.3	13	26.3	17.3	83.0
November 1990	83.6	7	22.8	14.4	64.7
December 1990	29.0	2	20.1	14.4	67.6
Total for 1990	1441.5	74	-	-	-
January 1991	7.2	1	22.2	13.5	64.15
February 1991	-	-	21.2	14.0	61.8
March 1991	-	-	22.0	13.0	55.0

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## PANNIYUR CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	-	-	35.70	19.52	74.84
February 1990	-	-	36.28	19.59	66.67
March 1990	-	-	37.11	21.75	73.45
April 1990	-	-	36.24	25.35	72.87
May 1990	603.6	16	33.51	23.94	84.32
June 1990	742.0	30	30.13	23.03	92.67
July 1990	1058.0	28	27.23	22.87	94.55
August 1990	678.4	27	28.20	22.90	93.14
September 1990	168.6	8	31.00	22.7	84.90
October 1990	383.4	16	32.00	22.9	87.23
November 1990	78.4	4	32.88	22.28	82.54
December 1990	-	-	35.51	20.72	76.10
Total for 1990	3712.4	129	-	-	-
January 1991	-	-	35.29	20.65	80.53
February 1991	-	-	36.23	20.28	76.21
March 1991	-	-	37.20	23.51	76.81



## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

SIRSI CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	-	-			
February 1990	-	-			
March 1990	-	-			
April 1990	9.50	1			
May 1990	106.20	9	Not Available		
June 1990	587.85	24			
July 1990	686.80	27			
August 1990	592.00	24			
September 1990	129.50	8			
October 1990	59.00	5			
November 1990	13.75	1			
December 1990	-	-			
<b>Total for 1990</b>	<b>2184.6</b>	<b>99</b>			
January 1991	-	-	Not Available		
February 1991	-	-			
March 1991	-	-			

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## CHINTAPALLI CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	27.2	1	29.2	6.7	NA
February 1990	72.0	5	31.2	11.6	NA
March 1990	93.0	8	30.5	15.3	NA
April 1990	55.0	4	36.2	17.3	45.8
May 1990	815.6	14	32.9	17.9	61.8
June 1990	119.2	13	30.3	17.4	82.3
July 1990	183.1	17	29.0	15.1	82.1
August 1990	431.5	18	28.5	20.0	86.3
September 1990	95.5	7	29.4	21.5	86.0
October 1990	274.8	15	28.9	18.4	85.3
November 1990	2.2	1	26.3	14.6	77.4
December 1990	-	-	25.4	9.8	73.2
Total for 1990	2169.1	103	-	-	-
January 1991	24.4	1	26.6	11.8	60.71
February 1991	-	-	29.7	10.1	67.31
March 1991	29.6	4	32.3	14.6	62.71

## METEOROLOGICAL DATA FOR 1990-91

(January 1990.- March 1991)

## SOLAN CENTRE

Month & Year	Rainfall (mm)	N. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	5.2	NA	22.2	5.0	45.0
February 1990	146.4	NA	16.1	5.1	66.9
March 1990	129.2	NA	18.6	6.1	62.5
April 1990	20.9	1	26.2	11.5	36.8
May 1990	109.8	12	29.0	16.5	54.5
June 1990	115.3	8	30.7	19.6	56.6
July 1990	315.0	15	26.5	19.8	81.2
August 1990	346.8	9	27.2	20.1	80.7
September 1990	166.2	30	26.5	17.6	80.4
October 1990	19.2	2	24.4	10.2	61.4
November 1990	12.8	2	23.1	6.3	52.9
December 1990	176.2	3	18.5	3.5	56.5
Total for 1990	1563.00	82	-	-	-
January 1991	8.4	2	15.9	1.5	58.3
February 1991	84.6	6	17.5	4.8	59.9
March 1991	85.4	8	21.5	6.1	56.0

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## POTTANGI CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	-	-	23.1	20.8	61.6
February 1990	3.37	3	25.8	22.9	69.3
March 1990	41.2	4	27.8	24.6	72.3
April 1990	82.0	6	29.3	26.9	71.5
May 1990	749.2	14	29.6	25.7	77.7
June 1990	175.2	11	28.0	26.0	77.0
July 1990	211.7	14	26.0	24.0	85.0
August 1990	259.5	15	27.0	25.0	85.0
September 1990	280.0	14	27.5	25.1	85.3
October 1990	307.2	13	26.0	23.0	86.0
November 1990	102.5	9	24.3	21.9	83.5
December 1990	20.2	1	22.0	19.5	74.0
<b>Total for 1990</b>	<b>2232.57</b>	<b>104</b>	-	-	-
January 1991	-	-	24.0	22.0	65.0
February 1991	-	-	27.0	25.0	53.0
March 1991	39.2	4	32.0	25.0	58.8

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## JAGTIAL CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%	
			Max. (°C)	Min. (°C)		
January 1990	-	-	30.5	14.2	74	28
February 1990	-	-	32.2	17.7	68	30
March 1990	5.2	1	35.3	20.3	63	27
April 1990						
May 1990						
June 1990	384.8	13	31.4	23.6	78	55
July 1990	131.6	9	31.4	23.8	76	62
August 1990	516.2	13	30.6	23.0	84	69
September 1990	52.6	7	32.3	29.9	79	60
October 1990	97.8	7	32.0	21.4	79	59
November 1990	00.0	-	30.9	19.0	75	41
December 1990	00.0	-	29.3	15.5	83	42
<b>Total for 1990</b>	<b>1188.2</b>	<b>50</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
January 1991	2.8	1	29.1	15.9	80	46
February 1991	00.0	-	33.5	17.1	73	28
March 1991	20.6	1	35.9	21.2	69	34

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## JOBNER CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	-	-	24.8	5.3	82
February 1990	69.5	8	22.0	9.8	86
March 1990	-	-	27.4	11.9	72
April 1990	8.2	1	36.2	18.2	51
May 1990	17.0	1	39.5	27.2	52
June 1990	103.1	7	38.3	26.9	68
July 1990	193.6	14	32.2	25.0	84
August 1990	119.2	7	31.8	24.4	91
September 1990	75.3	7	31.8	23.0	88
October 1990	-	-	33.1	14.8	71
November 1990	1.2	1	28.5	9.4	74
December 1990	-	-	23.7	5.8	78
Total for 1990	587.1	46	-	-	-
January 1991	-	-	22.2	3.6	86
February 1991	-	-	25.9	9.5	81
March 1991	1.1	1	31.3	14.0	71

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## JAGULAN CENTRE

Month & Year	Rainfall	N. of rainy days	Temperature		RH%
			Max. (°C)	Min. (°C)	
January 1990	-	-	29.3	11.6	79
February 1990	9.0	1	28.6	13.5	78
March 1990	3.0	1	32.4	15.9	71
April 1990	-	-	38.8	22.0	78.8
May 1990	-	-	40.3	26.2	79.3
June 1990	9.5	1	38.7	26.1	82.8
July 1990	88.0	5	32.9	23.7	89.4
August 1990	602.0	17	31.3	22.4	92.4
September 1990	1196.5	7	31.9	21.8	91.1
October 1990	8.0	1	35.5	22.2	74.8
November 1990	-	-	31.7	18.2	72.4
December 1990	15.0	1	27.3	14.3	76.1
Total for 1990	931.0	34	-	-	-
January 1991	-	-	25.2	11.5	70.8
February 1991	-	-	28.7	14.3	71.7
March 1991	30.0	1	35.1	19.2	69.2

## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

## GUNTUR CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%	
			Max. (°C)	Min. At I (°C) hr.	At I hr.	At II hrs.
January 1990	18.0	1	17.6	31.5	91.8	61.1
February 1990	6.4	1	20.3	32.9	93.3	49.1
March 1990	91.7	4	23.9	35.5	91.7	56.5
April 1990	36.6	1	38.5	26.3	85.4	51.5
May 1990	380.2	6	36.2	26.1	81.7	65.8
June 1990	125.8	7	34.8	25.4	80.9	60.5
July 1990	65.8	6	34.1	23.8	84.2	59.9
August 1990	124.7	9	32.8	21.6	85.8	65.8
September 1990	132.3	7	33.6	20.9	89.7	67.7
October 1990	221.8	11	30.8	15.9	90.8	74.6
November 1990	31.6	4	31.3	17.0	87.9	60.9
December 1990	0.0	-	30.5	16.9	85.4	60.7
Total for 1990	1234.9	57	-	-	-	-
January 1991	5.0	1	30.4	16.2	85.4	53.8
February 1991	0.0	-	34.0	16.5	83.4	42.7
March 1991	-	-	-	-	-	-



## METEOROLOGICAL DATA FOR 1990-91

(January 1990 - March 1991)

COIMBATORE CENTRE

Month & Year	Rainfall (mm)	No. of rainy days	Temperature		RH%	
			Max. (°C)	Min. (°C)	FN	AN
January 1990	28.7	3	30.5	16.6	85	33
February 1990	-	-	32.2	18.0	75	32
March 1990	41.9	2	35.2	22.0	80	34
April 1990	52.6	4	35.6	23.7	82	40
May 1990	82.0	6	33.2	23.4	81	50
June 1990	2.0	-	32.2	23.7	69	48
July 1990	10.6	1	31.3	22.8	74	47
August 1990	49.7	4	31.6	22.2	67	50
September 1990	63.2	2	30.4	22.7	75	47
October 1990	136.9	7	31.9	22.2	81	50
November 1990	93.7	5	29.6	20.8	88	57
December 1990	7.0	1	29.1	20.0	86	50
Total for 1990	568.3	35	-	-	-	-
January 1991	27.4	2	30.5	19.2	87	44
February 1991	-	-	33.1	18.8	77	29
March 1991	7.5	2	35.9	22.8	77	33