



**ALL INDIA COORDINATED  
RESEARCH PROJECT  
ON SPICES**

**ANNUAL  
REPORT**  
**1995 - 1996**



**INDIAN INSTITUTE OF SPICES RESEARCH**  
(Indian Council of Agricultural Research)  
CALICUT - 673 012, KERALA, INDIA

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**ANNUAL REPORT 1995-96**  
(April 1995 to March 31, 1996)



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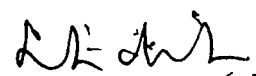


## SUMMARY

The AICRP on Spices was initiated in 1971 with the objective of evolving varieties resistant/ tolerant to pests and diseases, standardisation of agro-techniques suited to different agroclimatic regions of India, evolving control measures to manage pests and diseases with minimum residual toxicity and developing linkages between different agencies working on Spices Research & Development. The 12 mandatory spice crops of the Project are Black Pepper, Small and Large Cardamom, Ginger, Turmeric, Nutmeg, Clove, Cinnamon, Coriander, Cumin, Fenugreek and Fennel. Research achievements generated from 67 research projects during 1995-96 in spices improvement, production, protection and quality aspects conducted at 20 coordinating centres based at 15 Agricultural Universities and one ICAR Research Complex in 15 States of India (by 53 Scientists) are highlighted.

During Annual Plans 1990-91 and 1991-92 as well as the VIII Plan, six new centres have been initiated which are located at Dholi in Bihar, Hisar in Haryana, Kumarganj in Uttar Pradesh, Dapoli in Maharashtra, Raigarh in Madhya Pradesh and Pundibari in West Bengal. There has been also an increase in staff position by the addition of 12 Scientists and 8 Technical Staff for the new centres in VIII Plan. Thus the Project has a strength of 53 Scientists supported by 32 other staffs. The XIII Workshop/National Group Meeting was held at Jaipur during August 23-25, 1995 and critically evaluated the research results of the Project and formulated the new programmes. The priorities for the new centres were also identified during this Workshop. The Project Coordinator completed all formalities of opening these 4 new centres as per the ICAR norms.

Some of the highlights are the recommendations for release of 9 varieties of spices during the Jaipur Workshop viz., 2 each in turmeric, ginger and cinnamon, one each in black pepper, coriander and cardamom. The Workshop also recommended technologies on fertilizer application for ginger in Orissa, Intercropping for turmeric in Andhra Pradesh, chemical weed control for coriander, fennel and fenugreek in Rajasthan, dates of sowing for fenugreek in Bihar etc. The technical programmes for epidemiological studies of Alternaria blight of cumin, integrated management of cumin wilt, coriander wilt, fenugreek root rot besides the foot rot disease of black pepper were also refined. Greater emphasis was also laid in enlarging activities under germplasm exchange, especially between the new centres. The activities on production and distribution of quality planting material from the coordinating centres have been very much appreciated by the Govt. of India.



(DR S EDISON)  
PROJECT COORDINATOR

## INTRODUCTION

The All India Co-ordinated Research Project on Spices was the first-ever attempt made by the Indian Council of Agricultural Research to initiate an organised research set-up on Spices. It started as a combined Project on Spices and Cashewnut in 1971 with the headquarters at the Central Plantation Crops Research Institute, Kasargod. Although the research support was forthcoming through the coordinated efforts between the various State Agricultural Universities, the ICAR decided to bifurcate the combined Project into two independent Projects viz., one on Spices and the other on Cashewnut in 1986. Accordingly, the headquarters of the Spices Project is located at the National Research Centre for Spices, Calicut, which has been upgraded as the Indian Institute of Spices Research since July 1996.

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

### Mandate

- ☆ The objectives of the Coordinated Project are:
- ☆ evolving high yielding varieties resistant/tolerant to diseases and pests;
- ☆ standardisation of agro-techniques for the crops under different agro-climatic conditions.
- ☆ evolving control measures for major pests and diseases and
- ☆ working as an inter-face and feed back between SAUs, Indian Institute of Spices Research and the ICAR

### History and activities:

The first Workshop of the AICRPS was held at CPCRI, Kasargod in Dec. 1971 wherein the research problems to be tackled under AICRPS were identified, technical programmes drawn and implemented. Since then the performance of various research programmes under the Project was reviewed at the annual/biennial workshops held during the years 1972, '75, '78, '81, '85, '87, '88, '89, '91, '93 and '95. The working of AICRPS for ten years (1982-92) was reviewed by the Quinquennial Review Team and the report submitted to ICAR. The ICAR after accepting the Report of the QRT has already initiated necessary action on the various recommendations made.

Dr.M.C.Nambiar was the first Project Coordinator for the combined Project on Spices and Cashewnut since its inception in 1971 and he retired in April 1985. For a brief period, Dr.M.K.Nair, Director CPCRI, Kasargod held additional charge of the position until Dr.S.Edison took over as the regular Project Coordinator of the independent project during March 1986. He continues in this capacity till date but for 2 years' deputation to the FAO United Nations as Spices Research Expert (Jan.93-Jan.95) and he now continues as Project Coordinator.

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



## PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices (AICRPS) has been an important determinant for strengthening the research capability in spices research system in the country. This Project is vested with the mandate to conduct research on 12 spices crops and to develop location specific agrotechniques and crop production systems for sustained spice production.

Scientific research on these 12 spices crops are carried out in 20 AICRPS centres based in 15 States in the 15 State Agricultural Universities and one ICAR centre at Gangtok. In addition to 20 coordinating centres, 8 voluntary/participating centres are also functioning under the purview of this project. The headquarters of the Project Coordinator is situated at the Indian Institute of Spices Research, Calicut.

### History:

The AICRP on Spices was originally formulated as a combined project for Spices and Cashew Improvement Project during 1971 (IV Plan) with its headquarters at CPCRI, Kasargod. The Project underwent many development changes and a separate AICRP on Spices was established in 1986 with the headquarters in its present location at IISR, Calicut.

To begin with, the project had four coordinating centres (IV Plan) with just 4 Spices crops (Black Pepper, Cardamom, Ginger and Turmeric) and this was expanded to 16 centres and to cover 12 spices crops over the subsequent Plan periods of V, VI & VII Plans. However, during the Annual plan (1990-91, 1991-92) and VIII Plan period, six new centres were started in the states of Haryana, Bihar, West Bengal, Maharashtra, Uttar Pradesh and Madhya Pradesh making it to 20 coordinating centres in 15 State Agrl. Universities, besides the one for large cardamom under the ICAR RC for NEH at its Gangtok centre in Sikkim. At present there are eight centres each for black pepper (Panniyur-KAU, Sirsi-UAS-D, Chintapalli-APAU, Pampadumpara-KAU, Mudigere-UASB, Pundibari-BCKVV, Dapoli - KKV) two for cardamom (Pampadumpara, Mudigere -UASB) five for ginger (Pottangi-OUAT, Solan-Dr. YSPUHF, Raigarh-IGKVV, Kumarganj-NDUAT, Pundibari) six for turmeric (Pottangi, Jagtial-APAU, Dholi-RAU, Raigarh, Kumarganj, Pundibari), four for fennel (Jobner-RAJAU, Jagudan-GAU, Hisar-HAU, Dholi) two for cumin (Jobner, Jagudan) 8 for Coriander and 7 for fenugreek (Jobner, Jagudan, Coimbatore-TNAU, Guntur-APAU, Dholi and Hisar, Kumarganj and Raigarh) one each for tree spices (Yercaud-TNAU) and large cardamom (ICAR RC Gangtok)

The first combined Workshop was held at Kasargod in 1971 and research programmes formulated in four spices crops. Subsequent Workshops were held at Trivandrum (1972), Coimbatore (1975), Goa(1978), Trichur (1981), Calicut (1983), Trivandrum (1985), Guntur(1987), Solan (1988), Coimbatore (1989), Trivandrum (1991), Trichur (1993) and Jaipur (1995). These Workshops reviewed the progress of research and enabled the formulation of need based, new technical programmes.

### Staff and Budget:

The staff strength of the AICRP on Spices consists of 53 Scientists, supported by 26 Technical and 6 supporting/auxiliary staff, making a total of 85 staff. The VIII Plan budget was Rs.327 lakhs

with Rs.64.16 lakhs in 1995-96 and the scheme is implemented by financing at 75:25 percent share basis between the ICAR and SAUs respectively.

### **Research activities:**

The AICRP on Spices has the mandate to conduct and coordinate research on 12 Spices crops in the country. There are 73 projects under different disciplines and the crop wise distribution of projects are pepper 9, cardamom 10, large cardamom 1, ginger 10, turmeric 8, tree spices-6, coriander-7, cumin-8, fennel-6 and fenugreek-8.

The significant achievements made during the year 1995-96 are listed below.

### **1. GENETIC RESOURCES:**

The AICRP on Spices centres enriched the germplasm collections every year by way of collection by surveys, introduction from abroad, mutual exchange between the centres etc.

So, the centres of AICRP on Spices hold a good number of germplasm collection including wild and exotic accessions of the mandate crops in the respective centres. The germplasm assemblage in the 20 coordinating centres as on March 31, 1996 is given elsewhere.

#### **1.1 Black Pepper:**

The Panniyur centres collected a new cultivated type while 4 new wild black pepper accession was done by the Chintapalli. Similarly, survey work conducted by the Yercaud centre in the Shevroy hills helped in identifying 20 elite accessions. The Chintapalli centre evaluated 16 accessions of pepper and the variety Panniyur-1 recorded the highest yield (9.26Kg green berries/vine) and among the 20 wild accessions, "Maredumalli" gave the maximum yield. At Panniyur centre, Karimunda III gave the highest yield and a mean green berry yield of 4.4 Kg/vine obtained during 1995-96.

#### **1.2 Cardamom:**

Pampadumpara centre added two more cultivated types in cardamom from Vandanmettu and Kanchiyur of Idukki. Out of 72 clones evaluated at Pampadumpara, clone PS-31 gave maximum dry yield (835 g/clump) followed by PS-1 (698 g/clump), the other promising clones being PS-27, PS-29, PS-24, PS-22, Veeraputran, MBP, PS-4 and SI. The Promising Cultures identified based on the four years study at Mudigere are P-17, P-8, CL-692, CL-681, P-12, CL-730, CL-757, P-20 and EB-1277-7.

#### **1.3 Ginger:**

The Pottangi centre collected four new cultivated and one wild ginger types from Cuttack, Koraput and Malkangiri districts of Orissa and the Raigarh centre assembled 20 ginger accessions from Pottangi centre and 7 local ginger through collection. One hundred and forty six germplasms were evaluated at Pottangi. Maximum fresh rhizome yield was recorded in PFLR-1 Vi2, 1.8 Kg/3sq.m

#### **1.4 Turmeric:**

Pottangi centre added 4 new turmeric accessions and one each of C. aromatica and C. amada from Cuttack, Koraput and Malkangiri districts of Orissa and in all, 173 accessions were

evaluated. Similarly, Jagtial centre added new turmeric germplasm and were grouped according to the 'crop duration'. Raigarh centre obtained 20 germplasm from Pottangi centre and two new accessions collected locally.

#### 1.5 Tree Spices:

Thirteen elite clove lines were collected, identified and maintained at the Yercaud centre. A total of 10 cinnamom accessions and a nutmeg accession (having yellow mace) was collected by the Yercaud centre. The Pechiparai centre collected and maintained 4 elite nutmeg grafts from IISR, one high yielding type from the State Horticultural farm Courtallam and 7 types from the estates of Kanyakumari district; twelve cinnamon types were also maintained at Pechiparai.

#### 1.6 Coriander:

In collaboration with the NBPGR Regional centre at Hyderabad, the Guntur centre collected 110 coriander accessions. Similarly, extensive surveys conducted by the Coimbatore and Jobner centres collected 16 composite germplasm (Coimbatore) and 47 accessions (Jobner). Coriander entries UD-164 and UD-68 at Jobner and LU-138 at Guntur are identified as most promising high yielders. Jagudan centre evaluated 168 coriander accessions and identified 27 entries on the basis of variability.

#### 1.7. Cumin:

The survey conducted by the Jagudan centre in the State of Gujarat enabled addition of 102 new cumin accessions. All the 332 cumin accessions were evaluated at Jagudan and 53 entries were isolated on the basis of variability for different characters for further test.

#### 1.8 Fennel :

Jobner centre collected 2 new accessions from Tonk district of Rajasthan and extensive survey conducted in Gujarat collected 95 diverse genotypes with variability by the Jagudan centre. Out of the 153 entries examined at Jagudan, 9 entries were identified as high yielders.

#### 1.9 Fenugreek :

The Jobner centre collected 15 fenugreek accessions from Madhya Pradesh and Rajasthan. UM-288 and UM-295 were identified the most promising germplasm accessions. All the 46 entries were critically examined and 7 entries were identified on the basis of variability at Jagudan.

### 2. CROP IMPROVEMENT:

Several MLT's are in progress viz., 4 in black pepper 3 in cardamom 2 in ginger, one each in turmeric, clove and cinnamon. Similarly MLT's are also in seed spices viz., one each in cumin, coriander, fennel and two in fenugreek.

Similarly preliminary evaluation of the germplasm in 12 spices are conducted in the IETs and CYTs. Apart from this, crop improvement work is also carried out with OP progenies, hybridization and mutation breeding programmes.

#### 2.1 Black Pepper:

In the intervarietal hubridization trial with OP/hybrid progenies at Panniyur, Cul.5489 gave maximum green berry yield (7.14 Kg/vine) followed by Cul.5403 and Cul.7156 with 4.6 Kg and 3.89 Kg per vine respectively. Panniyur-3 ranked first (4.02 kg green berry/vine) in the MLT with

promising cultures and Kuthiravally gave the highest yield of 3.39 Kg/vine in the MLT of promising cultivars at Panniyur centre. In the MLT III (1987), Panniyur-3 was found promising in the evaluation at Sirsi. The MLT with released varieties and promising cultures is progressing at Yercaud, Panniyur and Ambalavayal centres. Panniyur-1 followed by Kottanadan and Balancotta gave higher yield in the evaluation of pepper at Chinatapalli. The CYT of pepper genotypes, Karimunda and Panniyur-5 are promising at Panniyur.

## 2.2 Cardamom :

The variety Mudigere-2, a clonal selection from Malabar type, an early maturing variety yielding 476 Kg/ha was recommended for release from Mudigere centre.

The MLT series III (1991) with Mysore and another with Malabar type (1993) have started bearing. Studies at Mudigere revealed that the yield from the clonal crop was 30-40 percent more than that raised from seedlings and that from 20 months' seedlings.

## 2.3 Ginger:

A variety Himgiri developed by Solan centre through clonal selection is suitable for both irrigated rainfed conditions and is suitable for green ginger purposes. In the IET, SNR, BDJR-1113, BDJR-1054 and SG-687 were comparatively better at Solan. Under CYT; none of the entries performed better than check at Solan. Accession no. V<sub>1</sub>E<sub>8</sub>-2 was the top yielder at Pottangi.

## 2.4 Turmeric :

Under CYT, Rajendra Sonia and RH-5 were higher yielders at Jagtial, Dholi centre. PTS-19 has been identified as the most promising at Pottangi. Under the MLT-III. PTS-43 (long duration) and PTS-59 (short duration) gave highest yield.

## 2.5 Tree Spices:

The MLT in cinnamon laid out with 5 accessions at four centres. An MLT in clove with 5 elite lines has been laid out in Yercaud, Pechiparai and Thadiyankudissai centres. Cinnamon, Acc.No.3 recorded the highest yield of 0.78 Kg dry quills/plant at Thadiyankudisai

Vegetative propagation technique for nutmeg was standardised using non-precured orthotropic and semihard wood scions grafted on to a root stock with two leaves.

## 2.6 Cumin :

At Jobner, Acc.UC-209 was identified as superior and UC-223 continued to show superiority with respect to grain yield as well as low incidence of wilt. Successful crossing of hairy cumin and white flower cumin with Gujarat Cumin-2 was carried out at Jagudan centre.

Cumin exotic entries viz., EC-232684, EC-243375 were found to be resistant against Fusarium wilt under sick plot conditions at Jagudan.

## 2.7 Coriander:

Coriander accessions UD-435 and UD-436 were identified on superior at Jobner centre. In the CYT, UD-446 out yielded other entries at Dholi and in IET, ATP-8 recorded the highest yield at Guntur. The Performance of the entries from Hisar and Jobner were poor and ATP-77 and JCO-64 were identified as high yielders at Gujarat.

The Jobner centre developed a coriander variety RCr-20, recommended for growing under unirrigated conditions and gave an yield of 1100 Kg/ha under irrigated and 500 Kg/ha under limited moisture conditions.

#### 2.8 Fennel:

RF-101 (UF-101) of fennel was identified as a high yielder at Jobner for further field testing.

#### 2.9 Fenugreek:

At Guntur, accessions UM-144 and JF-102 recorded significantly high yields in MLT-1993 and MLT-1995 respectively. At Coimbatore two lines viz., CF-390, CF-464 were "advanced" based on the yield under IET and CYT. At Jobner, the variety RMt-1 a multipodded, spontaneous mutant (UM-305) characterised by determinant habit of growth has been identified as a variety as well as for use in crossing programmes. The Bulgarian collection EC-257566 and Kasthuri Methi are free from powdery mildew at Jagudan.

### 3. CROP PRODUCTION AND MANAGEMENT

#### 3.1 Black Pepper :

The irrigation cum fertilizer trial of black pepper with two different cultures of pepper is progressing at Panniyur & Sirsi centres. At Panniyur centre, irrigation at IW/CPE ratio of 0.25 was the best for maximum spike yield but did not show any significant effect on the variety Panniyur-1. At Sirsi, the study with three levels of irrigation and four levels of fertilizers with two pepper varieties viz., Panniyur-1 and Karimalligessara planted in arecanut standard is progressing.

#### 3.2 Cardamom :

The average yield of the variety Mudigere-1 ranged from 90-150 dry capsule/ha under conditions at Mudigere. Studies on the response of different levels of NPK on the yield of cardamom at Mudigere confirmed that, higher levels of fertilizers viz., 150-150-225 Kg NPK/ha resulted in significantly higher capsule yields when grown under natural shade. Studies also revealed that growth regulators had no influence on proliferation of suckers whereas closer spacing significantly increased the sucker production in Mudigere.

#### 3.3 Ginger:

Studies at Pottangi with ginger variety Suruchi confirmed that application of  $N_{125}P_{100}K_{100}$  Kg/ha for higher yields and maximum returns (14.65 t/ha) with the maximum benefit of Rs.53,000/ha

Ginger seed rhizome size for planting standardised at Dholi (Bihar) revealed that use of larger sizes of 24 g/piece produced the highest yield (213.03 q/ha). The relative profitability of different seed rhizomes size was also worked out at Dholi and the highest net return of Rs.61,395/ha was achieved when 18 g size of seed rhizomes were sown. Hence it is recommended that a minimum of 18 gm size seed rhizomes may be followed for higher net returns per ha in ginger in Bihar.

#### 3.4 Turmeric:

Intercropping soybean in Turmeric is recommended for Pottangi which gave maximum rhizome yield of Turmeric (17.0 T/ha) and highest benefit of Rs.34,000/ha; this practice also reduced the cost of cultivation and substituted the 2nd and 3rd mulching operations.

### 3.5 Coriander :

Coriander sown on 25th October and on 4th November at 30cm row spacing produced maximum seed yield with the variety RCr-41. A seed rate of 14 kg/ha using RCr-41 and UD-20 (RCr-20) and a seed rate of 12 kg/ha with the variety RCr-436 (UD-436) produced the maximum seed yield at Jobner. Six coriander varieties evaluated at Dholi for green leaf yield were harvested 55 days after sowing. The variety Pant Dhania-1 and RD-36 produced the highest green leaf yield.

### 3.6 Turmeric :

Studeis of various spacing/plant population of turmeric were tested at Dholi using the variety Rajendra Sonia. The maximum yield (484.45 Q/ha) was obtained by adopting a spacing of 30cm x 20 cm (1,66,500 plants/ha) which also generated the highest net return of Rs.22,615/-per hectare. Studies concluded to adopt a spacing of 30 x 20 cm in turmeric in the agroclimatic condition of Dholi, Bihar.

### 3.7 Fennel :

Optimum age of fennel seedlings for transplanting was studied at Dholi. It was observed that transplating of "6-weeks-old seedlings" of fennel variety RF-17 produced the highest yield of 18.36 q/ha while older seedlings affected the yield.

## 4. CROP PROTECTION:

### 4.1 Black Pepper :

The study on Phytophthora foot rot and nematode disease management in black pepper was continued at the three pepper centres. Out of the 8 treatment combinations tried at Chintapalli, combination with the cultural practices + 1 kg neem cake + 3 gm a.i Phorate (Sol<sup>i</sup> application) + 1.0% Bordeaux mixture spray first and second round of spray with Akomin (0.4%) spray observed the least disease incidence in terms of foliar yellowing (5.6%) and defoliation (8.4%). In Phytophthora disease control studies at Sirsi, minimum disease incidence (10%) was observed in vines receiving the all applications @ 1 kg/vine phorate 3 G @ 30g/vine, Bordeaux mixture (1%) spray before onset of monsoon + application of Akomin (0.04%) Ridomil Mz-72 WP (100 ppm) as spray (@ 3 l/vine) and drench (@ 5 l/vine) seperately at 30 days interval from the first spray repeatedly. At Panniyur the Phytophthora foot rot management studies did not show any significant effect on the disease control.

The preliminary results of Biocontrol studies for the management of Phytophthora foot rot in black pepper has shown some dividends. Treatment with the biocontrol agents T. harzianum & T. viride revealed the lowest disease incidence of 8.3% compared to 33.3% in control in Chintapalli; similarly T. viride is found to be effective at Sirsi

Control measure developed for the nursery diseases in black pepper involves the spraying & drenching with Bordeaux mixture (1.0%) and Akomin (0.2%) under low and high shade conditions. At Sirsi, less mortality (26.66%) was observed in pepper cuttings sprayed and drenched with Bordeaux mixture raised under medium light intensity (3.3lux.)

### 4.2 Cardamom :

Spraying schedule for management of cardamom thrips worked out at Mudigere comprising of three insecticidal sprays, one in March (Monocrotophos 0.05%) followed by May and August

(Phosalone 0.05%) was the most effective. The crop protection studies using cultural & chemical control of thrips, shoot borer & capsule borer conducted at the Pampadumpara centre, the pooled analysis of results showed that the treatment of five application of insecticides during the months Feb/April/May/August & October appeared to be most effective as well as convenient and economical compared to more number of sprays. Similarly, application of insecticides 5,6 or 7 times along with or without selective thrashing during Feb/March adopted in controlling shoot borer (Pampadumpara). The yield loss of 8.92 kg/ha per year was observed due to shoot borer.

#### 4.3 Tree Spices :

The pest incidence studies in cinnamon was initiated at the Pechiparai centre. Incidence of leaf folder was observed throughout the year though the incidence was more from January-April and lesser in May-August. Incidence of the pest Papillio demoleus seems to be throughout the year except the month of April and maximum in the month of May-July. The cinnamon selection No.44 recorded the lowest infestation.

#### 4.4 Turmeric :

Taphrina leaf spot disease is of major importance in turmeric. The Jagtial centre recommended spraying of Dithane M-45 (0.25%) to control Taphrina leaf spot.

#### 4.5 Cumin :

Solarisation studies conducted in Jobner during last 2 years observed the least wilt incidence (32.85%) compared to 69.64% in control. Studies at Jagudan recommended early sowing viz., on the 5th & 15th October which was effective to save the cumin crop from blight disease.

#### 4.6 Coriander :

An ecofriendly technique of using 5 per cent onion leaf extract as foliar spray was evolved to control the powdery mildew in coriander (Coimbatore). This practice reduced the powdery mildew incidence from 88.0 to 64.75 per cent. The promising management techniques for coriander wilt developed at Coimbatore centre involves a pre-sowing seed treatment with Trichoderma harzianum @ 4g/kg of seed. The treatment reduced the disease incidence from 22.9% to 3.8%.

#### 4.7 Fenugreek :

A pre-sowing seed treatment with T. viride in combination with the application of 150 kg/ha of neem cake effectively reduced the root rot incidence (from 36.8% to 26.2%)

### 5. EVALUATION FOR QUALITY :

The quality studies in coriander using accession UC-964 observed that climate/environment conditions have its role in determining the quality. The entry UC-964 has shown maximum volatile oil content (0.5%) when grown at Tamil Nadu compared to 0.4% and 0.3% when grown in Hisar and Jobner centres respectively.

## TECHNICAL PROGRAMME

Crop/Technical programme	Research Centres	
<b>1.BLACK PEPPER</b>		
1 1	Germplasm collection, description and evaluation	Panniyur, Chitnapalli, Sirsi & Yercaud
1.2	Multilocation trials (MLTs)	
1.2.1	MLT of promising cultures' MLT 1984 - Series I	Panniyur
1.2.2.	Multilocation trial of pepper cultivars MLT 1984 -Series II	Panniyur& Chintapalli
1.2.3.	Multilocation trial of pepper genotypes MLT 1987 - Series III	Panniyur, Sirsi & Chintapalli
1.2.4	Multilocation trial MLT 1991 - Series IV	Panniyur, Yercaud, Pampadumpara, Sirsi Yercaud , Panniyur, Ambalavayal & Chintapalli
1.3	Inter varietal hybridisation to evolve high yielding varieties	Panniyur
1.4	Irrigation - cum - fertilizer requirements of pepper and arecanut in a mixed cropping system	Sirsi & Panniyur
1.5	<b>Phytophthora</b> - foot rot (quick wilt )& nematode disease management	Panniyur, Sirsi& Chintapalli
1.6	Biological control of foot rot of black pepper	Sirsi,Panniyur& Chintapalli
1.7	Management of <b>Phytophthora</b> foot rot in pepper	
1 7.1	Observational trials for the control of foot rot of black pepper in farmers field	Panniyur
1.7.2	Studies on the control of nursery diseases of black pepper (Solarisation studies for the control of plant disease)	Sirsi & Panniyur
1 8	Survey for the incidence of insect pests of black pepper in high altitudes	Mudigere
1.9,	Control of scale insects of Black pepper in the high ranges	Pampadumpara



## 2. CARDAMOM

2.1	Germplasm collection, description and evaluation	Mudigere & Pampadumpara
2.2	Comparative yield trial of promising cardamon clones/ Tissue culture clones	Mudigere
2.3	Multilocation trials (MLTs)	
2.3.1	MLT Series II - 1988	Mudigere, Pampadumpara
2.3.2	MLT Series III - 1991 with Mysore type	Mudigere, Appangala Sakleshpur & Myladumpara
2.3.3	MLT Series III - 1991 with Malabar type	Mudigere, Appangala Sakleshpur & Thadiyankudissai
2.4	Evaluation of Mudigere-1 under rainfed situation and irrigated condition	Mudigere
2.5	Effect of fertilizer levels on the yield of cardamom under natural shade	Mudigere
2.6	Manurial experiment (NPK trial) in cardamom under uniform shade	Mudigere
2.7	Intergrated Management of organic and inorganic manures in harvesting higher yields	Mudigere & Pampadumpara
2.8	Micronutrient requirement studies	Mudigere & Pampadumpara
2.9	Studies on the effect of growth regulations in plant population on proliferation of suckers in cardamom	Mudigere
2.10	Pest management in cardamom	
2.10.1	Effect of plant based insecticides on the control of thrips and borer in cardamom	Mudigere
2.10.2	Bioecology of natural enemies of major pests of cardamom	Mudigere
2.10.3	Cultural and chemical control of thrips and capsule borer	Mudigere & Pampadumpara

## 3. LARGE CARDAMOM

3.1	Comparative yield trial (CYT - 1991)	Gangtok
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#### 4. GINGER

4.1	Germplasm collection, description and evaluation	Solan, Pottangi & Dholi
4.2	Initial evaluation trial (IET)	Pottangi & Solan
4.3	Comparative yield trial (CYT)	Pottangi & Solan
4.4	Multilocation trial	
4.4.1	MLT - 1991 Series III	Pottangi & Solan
4.4.2	MLT - 1996 Series IV	Pottangi
4.5	NPK trial in ginger	Pottangi
4.6	Standardisation rhizome size in ginger for higher yield	Dholi
4.7	Survey, collection and identification of diseases of ginger	Dholi
4.8	Evolving control measures (including seed treatment) against rhizome-rot disease	Solan
4.9	Biocontrol studies on rhizome rot of ginger	Solan
4.10	Evaluation of germplasm for quality characters	Solan

#### 5. TURMERIC

5.1	Germplasm collection description and evaluation	Solan, Pottangi, Jagtial & Dholi
5.2	Initial evaluation trial (IET)	Pottangi, Jagtial & Dholi
5.3	Comparative yield trial (CYT)	Pottangi & Dholi
5.4	Multilocation trial - MLT 1991 Series III	Pottangi & Jagtial
5.5	Effect of spacing on yield of turmeric	Dholi
5.6	Survey and identification of rhizome rot disease and screening of turmeric germplasm	Dholi
5.7	Chemical control of <u>Taphrina</u> leaf spot disease of turmeric	Jagtial
5.8	Quality evaluation of germplasm collection/varieties	Solan

#### 6. TREE SPICES

6.1	Germplasm collection, conservation and cataloguing of tree spices (clove, nutmeg and cinnamon)	Yercaud, Pechipari & Thadiy-ankudissai
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6.2	Multilocation trial of elite cloves	Yercaud & Pechipari
6.3	Multilocation trials of elite cinnamon	Yercaud, Ambalavayal Thadiyankudissai & Pechiparai
6.4	Vegetative propagation in nutmeg, clove and cinnamon	Yercaud, Thadiyankudissai & Pechiparai
6.5	Drip irrigation in clove & nutmeg	Yercaud
6.6	Biofertilizer trial on clove & nutmeg	Yercaud

## 7. CORIANDER

7.1	Germplasm collection, maintenance & evaluation	Jobner, Jagudan, Guntur, Coimbatore. Hisar & Dholi
7.2	Initial evaluation trial	Jobner, Jagudan, Guntur, Hisar Coimbatore, Hisar & Dholi
7.3	Multilocation trials MLT - 1980 Series I MLT - 1993 Series II	Jagudan, Jobner, Coimbatore, Guntur, Hisar & Dholi
7.5	Mutation breeding in coriander to evolve varieties with earliness and resistance to disease	Jobner & Coimbatore
7.4	Evaluation of coriander varieties for green leaf type	Dholi
7.6	Screening for wilt resistance in Coriander	Coimbatore
7.7	Survey to study disease incidence, collection and identification of casual organism	Dholi
7.8	Studies on wilt and powdery mildew management	Coimbatore
7.9	Response of Coriander to date of sowing and row spacing	Jobner
7.10	Response of coriander varieties to seed rate	Jobner
7.11	Quality evaluation in coriander	Jobner

## 8. CUMIN

8.1	Germplasm collection, description, evaluation and screening against diseases	Jobner & Jagudan
8.2	Initial evaluation trial	Jagudan
8.3	Multilocation trial (MLT 1989 Series I)	Jobner and Jagudan

8.4	Mutation studies and hybridisation programmes	Jagudan
8.5	Evolving control measures against wilt disease including crop rotation	Jobner
8.6	Epidemiological study of <i>Alternaria</i> blight of cumin	Jagudan
8.7	Intergrated management of disease and pest of cumin	Jagudan
8.8	Quality evaluation studies	Jobner

## 9. FENNEL

9.1	Germplasm collection, description, evaluation and screening against disease	Jobner, Jagudan, Hisar and Dholi
9.2	Initial evaluation trial	Jagudan
9.3	Multilocation trial (MLT - 1994 Series II)	Jagudan, Jobner & Hisar
9.4	Mutation studies and crossing programmes in fennel	Jagudan
9.5	Response of fennel to weed management	Jobner & Hisar
9.6	Quality evaluation studies	Jobner

## 10. FENUGREEK

10.1	Germplasm collection, maintenance, evaluation and screening against disease	Jobner, Jagudan, Coimbatore, Hisar, Guntur & Dholi
10.2	Initial evaluation trial	Coimbatore & Hisar
10.3	Multilocation varietal trial	
10.3.1	MLT 1993 Series II	Guntur, Coimbatore, Jobner, Dholi, Jagudan & Hisar
10.3.2	MLT 1996 Series III	Guntur and Dholi
10.4	Standardisation of date of sowing and spacing for higher yield	Dholi, Coimbatore & Hisar
10.5	Evolving varieties resistant to powdery mildew through mutation breeding and crossing programme	Jobner & Jagudan
10.6	Biocontrol of root rot disease	Coimbatore
10.7	Response of fenugreek to weed management	Jobner
10.8	Response of fenugreek to N,P and <u>Rhizobium</u> culture	Jobner

## **LIST OF CLOSED PROJECTS 1995-96**

### **BLACK PEPPER**

1. Multilocation trial of promising Black pepper cultures (MLT 1984 Series-I) Panniyur
2. Multilocation trial of black pepper cultivators MLT - 1984 - Series - II Panniyur
3. Irrigation-cum-fertilizer requirement in two black pepper cultivars Panniyur

### **GINGER**

1. Initial evaluation trial (1992-93) Pottangi
2. Comparative yield trial (1992-93) Pottangi
3. Multilocation trial - MLT III (1992-93) Pottangi
4. NPK trial in ginger Pottangi

### **TURMERIC**

1. Initial evaluation trial (1992-93) Pottangi
2. Comparative yield trial (1992-93) Pottangi
3. Multilocation trial (1991-92) Pottangi

### **SEED SPICES**

1. Initial evaluation trial in coriander Jobner & Jobner
2. Multilocation trial 1989 (MLT-I) in Coriander Jobner
3. Evolving control measures against wilt disease including crop rotation Jobner
4. Multilocation trial in Fennel (MLT1985-Series I) Jagudan, Jobner & Hisar

## BLACK PEPPER

### 1.1 Germplasm collection, description and evaluation

(Panniyur, Sirsi, Chintapalli and Yercaud)

Survey of germplasm was done in March 1996 and one cultivated type (Mundi) was collected from Kanjirapuzha area of Palghat by the Panniyur Centre. In the germplasm collection of cultivated types, 71 accessions are maintained. Out of 56 types which produced spikes, 10 accessions recorded an average yield of 2.0 kg green berries/vine, Karimunda III with a mean yield of 4.4 kg green berries/vine stood first, followed by TMB IV (3.26kg) and Sullia (3.05kg)

The Chintapalli centre holds 27 cultivated and 25 wild accessions of pepper germplasm which includes 2 new wild collections made during the current year from the Kumkumpudi and Vengasara areas in Vishakapatnam district. In the cultivated types, 16 germplasm accessions were evaluated and Panniyur-1 recorded the highest yield (3.90 kg/vine). Among the wild accessions, Maredumilli accession has recorded maximum yield(1.2 kg green berries/vine) followed by Devarapalli (0.82 kg/vine)

Sixty two accessions including 12 wild types have been collected and are being maintained at Sirsi. During the year 1995/96 pepper accessions were collected from Sirsi and Siddapur taluks; survey was made for wild pepper germplasm in Devimaneghat area of Sirsi and Kumta taluks. Planting of germplasm in arecanut plantation for assessing its performance is in progress in Sirsi. Twenty germplasm accessions are planted in 1995 in arecanut plantation during 1995 for evaluation. A total of 106 black pepper accessions including 3 wild types are maintained at Yercaud. These collections were obtained from Calicut (37), Panniyur (50) and the rest from local collections.

**Table.1 Yield performance of promising cultures of black pepper at Panniyur (1990-1995)**

S.No	Cultures	Green Berry Yield (Kg/vine)						Mean
		1990	1991	1992	1993	1994	1995	
1.	Cul.239	1.06	2.18	2.36	3.72	1.09	3.91	2.39
2.	Cul.1199	0.38	0.20	0.21	0.63	0.47	1.88	0.63
3.	Cul.406	0.58	1.05	0.84	1.32	0.43	2.52	1.12
4.	Cul.54	1.07	1.85	1.53	2.04	1.06	2.30	1.66
5.	Cul.1171	0.53	1.07	1.20	1.48	1.14	2.69	1.35
6.	Cul.211	0.32	0.64	0.57	0.88	0.24	2.11	0.79
7.	Cul.331	1.15	1.66	1.06	2.23	0.86	4.02	1.83
8.	Panniyur 1	0.24	0.55	0.64	1.09	0.64	2.34	0.92
9.	Karimunda	0.38	1.03	1.07	1.88	1.21	2.69	1.38
CD	(0.05)	0.48	0.62	0.82	1.17	0.44	0.92	0.42

## 1.2 Multilocation trials

### 1.2.1 Multilocation trial of promising cultures (MLT 1984 Series I)

(Panniyur)

The trial was laid out in 1984, aimed to evaluate the performance of 9 promising cultures selected from the breeding programmes at Panniyur centre. Out of these cultures, Cul.331, stood first in yield (4.02 kg) followed by Cul.239 (3.91 kg) and Cul. 1171 (2.69 kg). The pooled green berry yield/vine of six years (1990-95) presented in Table I showed that Cul. 239 (Perumkodi OP) with a yield of 2.39 kg green berries/vine was significantly superior to all other cultures and the check. The green berry yield of Cul. 239 (2.39kg) was followed by Cul. 331(1.83 kg ) and Cul. 54 (1.66 kg) which were on par. It would be concluded that Cul. 239 and Cul. 331 are the best promising cultures which were already released as varieties Panniyur-5 and Panniyur-3

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

(Panniyur and Chintapalli)

The MLT with seven promising cultivars of black pepper viz., Aimpirian, Arakkulamunda, Kalluvally, Kottandan, Kuthiravally, Narayakodi and Neelamundi with two checks Panniyur - 1 and Karimunda was initiated in 1984. The yield did not show any significant difference between the cultivars and checks. However, Kuthiravally gave the highest yield of 3.39 kg/vine followed by Neelamundi (3.37kg) and Arakkulamunda (3.20 kg)

At Chintapalli, the trial was laid out in 1986 with 9 varieties trailed on silver oak standards. As per the recommendations of the XII Workshop, the trial was converted into a germplasm evaluation trial.

### 1.2.3. Multilocation trial of pepper genotypes (MLT 1987-Series III)

(Panniyur, Sirsi & Chintapalli)

To compare the performance of released pepper varieties, the trial with 8 cultures/varieties was laid out in 1990 at Panniyur with two checks. During 1995-96, culture-5128 recorded the maximum green berry yield ( 2.15 kg) followed by Cul. 239 (1.87 kg) and Cul.141 (1.57 kg)

The trial was laid out at Sirsi as an intercrop in arecanut plantation during 1992-93 with cultivars namely Panniyur - 1 Panniyur-2, Panniyur-3, Panniyur-4, Uddakara, Karimalligesara, Culture 856, Culture 812, KS-27 and KS-88. Among the cultivars under evaluation, Panniyur-3 is found to be vigorous with a mean plant height of 288.60cm with 17.20 laterals per vine followed by Panniyur-2 (169.20 cm plant height).

### 1.2.4 Multilocation trial (MLT 1991-Series IV)

(Panniyur, Sirsi, Chintapalli, Yercaud, Ambalavayal & Pampadumpara.)

With an objective to evaluate the performance of released varieties of pepper at different locations, the MLT Series IV was laid out at five centres with 14 varieties/cultures viz., Sreekara, Subhkara, Panchami, Pournami, Kottanadan (Acc. 2426), Kottanadan (Acc.2425), Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-4, Cul-1558, Cul.5128, Cul.239 along with local checks.

The MLT was laid out in 1992 ( 14 treatments) at Pampadumpara and biometrical observations and reaction to pests and diseases were recorded. Maximum vine length was noticed in Cul.239; variety Cul.5128 showed the largest leaf size, the incidence pests and diseases was lowest in Sreekara at the Pampadumpara centre. At Yercaud, Panniyur-3 recorded the highest vine length (140.3 cm) with 16.7 cm leaf length and 10 cm leaf breadth. During 1995, flowering was observed in Panniyur-1, 2, 3, 4 and 5. At Ambalavayal, Panniyur-3 recorded the maximum vine height (1.97) and 100% survival percent in the observation obtained during 1995. The trial is yet to be laid out at Chintapalli. The Sirsi centre dropped the MLT 1991 as per the XIII Workshop decision.

### 1.3. Inter-varietal hybridization to evolve high yielding varieties (Panniyur)

In the inter-varietal hybridization, 491 OP progenies/hybrids are maintained. The vines vary in age from 1-10 years. During 1995-96, yield was recorded from 113 cultures. In the evaluation, cul-5489 (Cheriyakaniakadan OP) recorded maximum green berry yield of 7.14 kg/vine followed by cul.5403 ( Karimunda OP ) and cul. 7156 ( Perumkodi OP) with 4.6 kg and 3.89 kg green berries per vine respectively.

### 1.4 Irrigation cum fertilizer requirement on pepper and arecanut in mixed cropping system. (Panniyur & Sirsi)

The Irrigation cum fertilizer trial of pepper and arecanut mixed cropping system at Sirsi centre (laid out in 1992) consisted of three levels of fertilizer with two varieties viz., Karimalligesara and Panniyur-1, grown on arecanut standards. It was laid out in split plot design with three levels of irrigation (IW/CPE ratio 1.0, 0.66, 0.33) and three levels of fertilizer (control, NPK @ 50:20:70, 100:40:140, 150:60:210g /vine). The manurial and irrigation treatments were imposed from third year onwards (May 1996) for arecanut and pepper combinations and regular plant protection measures are being followed.

The experiment was commenced in 1988 at Panniyur (Split plot design) using panniyur-1 and Karimunda varieties with three irrigation levels (No irrigation, irrigation at IW/CPE ratio of 0.125 and 0.250) and 3 levels of fertilizer (No fertilizer, NPK @ 50:50:150, 75:75:225g/vine) in sub plots. The pooled data of 4 years (1992 to 1995) presented in Table 2 showed that there was no significant effect for the irrigation or the fertilizer levels even though higher levels of irrigation resulted in more spike yield. Varieties differed significantly with respect to spike yield. Karimunda gave higher yield (3.44 kg/vine) compared to Panniyur-1 (2.62 kg/ vine). Interaction effect of "irrigation and variety" was found to be significant. The pooled data for four years showed significant impact of irrigation on yield of Cv. Karimunda. Irrigation at IW/CPE ratio of 0.25 was found to be the best for maximum green spike yield of (4.22 kg/vine) in the Cv. Karimunda. Irrigation did not show any significant effect on spike yield in variety Panniyur 1. The study recommended in basin irrigation at IW/CPE ratio of 0.25 at the rate of 100L of water once in 8-10 days during the December to May period per month found to be beneficial. It increased yield by 72.2 percent over no irrigation.



**Table - 2 Influence of irrigation and fertilizer levels on spike yield of black pepper varieties (1992-1995) at Panniyur**

Green Spike yield (Kg/Vine)												
Treatment	1992		1993		1994		1995		Mean		Grand	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	Mean	
<b>1.Irrigation</b>												
I-0=IW/CPE No Irrigation	3.05	4.86	2.28	2.06	1.75	0.43	2.82	2.89	2.48	2.56	2.52	
I-1=IW/CPE 0.125	7.61	2.72	2.86	2.54	1.63	1.26	2.21	2.85	3.58	2.34	2.96	
I-2=IW/CPE 0.250	9.11	5.23	3.74	3.29	1.97	2.30	2.25	1.03	4.27	2.96	3.61	
<b>2.Fertilizer</b>												
F0=No fertilizer	7.71	3.79	2.87	2.84	1.94	1.67	2.44	2.05	3.74	2.59	3.17	
F1=NPK@50:50:150	6.23	4.87	2.79	2.05	1.82	1.04	2.92	2.07	3.44	2.51	2.98	
F2=NPK@75:75:225	5.83	4.15	3.23	3.01	1.59	1.12	1.92	2.64	3.14	2.73	2.94	
CD (0.05)									NS		NS	

Variety V1 - Karimunda, V2 = Panniyur -1

#### 1.5. Phytophthora foot rot (quick wilt) and nematode management in black pepper (Panniyur, Sirsi and Chintapalli)

Studies conducted at Panniyur centre with newer fungicides (9 treatments) for the management of wilt disease did not show any significant effect during the year under report. However the treatment consisting of all cultural practices + 1kg neem cake plus 3g a.i. Phorate/vine/ + first spray with 1% Bordeaux mixture + 0.2% Akomin (second) recorded minimum defoliation (6.74%), foliar yellowing(5.65%), without any death of vines.

At Sirsi, the trial was conducted in farmer's field with 8 treatments for the 5th consecutive year. The treatments imposed as per the schedule i.e., before commencement of monsoon and repeated

at 30 days interval, 3 times. The results were recorded at monthly intervals for three months commencing from 30 days after the imposition of treatments. The disease incidence was the least (8.68%) in vines receiving all cultural practices, neem cake application @ 1 kg/vine, Phorate 3G @ 30g/vine, Bordeaux mixture (1%) spraying @ 3l/vine and drench (@ 5 l/vine) before the onset of monsoon. Again, application of Akomin (0.04%) and Ridomil MZ-72 WP (100ppm) as spray (3 l/vine) and drench (5 l/vine) separately at 30 days' interval as 2nd and 3rd round respectively.

Studies conducted at Chintapalli indicated that out of the 8 treatment combinations tried, (treatment application thrice, i.e., first just before the onset of the monsoon, second during the third week of July and third in the second week of September). The least % of disease incidence (5.6%) and foliar yellowing was observed in the treatment combination "all cultural practice + 1 kg neem cake + 3g a.i. Phorate (soil application), 1% Bordeaux mixture, spray first or second round of spray with Akomin (0.4%) compared to 19.8% disease index, 16.2% foliar yellowing and 20.6% defoliation in untreated control.

#### 1.6. Biocontrol of foot rot disease of black pepper

(Sirsi & Chintapalli)

Biocontrol studies against the foot rot disease caused by Phytophthora capsici was conducted in pot culture at Sirsi and Chintapalli centres. The trial had treatments with antagonistic organism, fungicides and neemcake.

In the trial laid out at Sirsi with 8 treatments, Trichoderma viride was found to be effective in controlling the foot rot of black pepper vines to 26.66%, but the disease incidence was least (10%) in vines treated with Ridomil MZ 72 WP as spray and drench.

Pot culture studies on biocontrol at Chintapalli (1995-96) observed that treatment with I. harzianum and I. viride recorded least incidence of 8.3% compared to 33.3% in control.

#### 1.7. Management of Phytophthora foot rot disease in black pepper

##### 1.7.1. Observational trial for the control of the foot rot of pepper in farmer's field

(Panniyur)

An experiment to assess the effect of chemicals and soil amendments on the foot rot disease of black pepper (consisting of 5 treatments) with Bordeaux mixture/Bordeaux paste/copper oxychloride and neem cake application was laid out at farmers' field at Iritty. Observations showed that the treatments effects are not significant in the case of leaf infection; branch infection was significantly reduced by spraying 1% Bordeaux mixture + drenching with 0.2% copper oxychloride. No stem infection was noticed in spraying with 1% Bordeaux mixture + drenching with 0.2% copper oxychloride and application of 1 kg neem cake/vine. Similarly, there was no yield increase.

##### 1.7.2 Studies on the chemical control of nursery diseases of black pepper

(Sirsi and Panniyur)

The experiment was laid out in Sirsi with three light intensities (high/medium/low) consisting of 8 treatments with different chemical treatments. Early sprouting and vigorous growth was

observed in medium light intensity (3.3 K lux) as compared to high and low light intensities. The cuttings which were raised under medium light intensity (3.3 K.lux) showed reduced mortality ( 32.22% disease incidence ) by spraying and drenching with Bordeaux mixture as evident from the pooled data presented in Table 3.

**Table 3 Chemical Control of Nursery Diseases of Black Pepper**

Sl No.	Treatments	% Disease incidence			
		1993-94	1994-95	1995-96	Mean
1	Bordeaux mixture spraying	53.33	43.33	40.00	45.55
2	Difolaton (0.2%)	46.66	46.66	50.00	47.55
3.	Bordeaux mixture (1%) spraying +Drenching	40.00	30.00	26.66	32.22
4	Difolaton (0.2%) Spraying+Drenching	33.33	33.33	40.00	35.55
5.	Chlorothalonil (0.2%) Spraying	50.00	40.00	40.00	43.33
6	Cheshunt compound drenching	43.33	40.00	46.66	43.33
7	Chlorothalonil (0.2%) spraying+drenching	43.33	30.00	33.33	35.55
8	Control	76.66	66.66	73.33	72.21
	SEM $\pm$	0.73	0.73	0.51	0.65
	CD @ 5%	2.21	2.20	1.54	1.98

A similar experiment was also conducted at Panniyur under 3 light intensities and treatments with different fungicides/chemicals (Bordeaux mixture, Aureofungin, Validacin, Akomin, Kavach, Metalaxyl etc.) consisting of 11 treatments. Studies revealed that spraying and drenching with 0.2% Akomin followed by spraying and drenching with Bordeaux mixture reduced the disease incidence.

#### 1.8 Survey for the incidence of insect pests on black pepper at high altitudes (Pampadumpara)

A survey was conducted in seven villages by the Pampadumpara centre during 1994-95. Thrips infestation ranged from 25 to 70 % of the total vines. Other pests such as mealy bug, scale insect, pollu beetle and shoot borer were seen in few vines.

1.9 Control of scale insect of black pepper in the high ranges  
(Pampadumpara)

Pampadumapara centre conducted a survey for the pests of black pepper in the Idukki district. The pest incidence was found to be very meagre to conduct the experiment.

## CARDAMOM

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

A total germplasm holding of 245 accessions are being maintained at Mudigere from 1989-90. Out of the 195 accessions evaluated during the past 4 years, promising accessions were identified. The remaining 50 accessions planted in 1990 are being maintained and are yet to be evaluated. Among the 150 germplasm collections, the mean data of 4 years (1991 to 96) were evaluated and Acc. No. 102 was better in suckers/clump, panicle/clump, panicle length and No. of nodes. The acc. 103, 99, 74, 95 and 110 were good in yield over the years.

Two more cultivated types were added from Vandanmetu and Kanchiyar areas by the Pampadumpara centre, increasing the collections to 77. Besides, 14 wild relatives are also maintained at Pampadumpara. Seventy two clones collected till 1991 were evaluated for various traits. The highest yield was recorded by PS-31 which gave 835 g of cured capsules per clump followed by PS-1 (689g/clump). Tillering was maximum in PV-1, viz., 66 tillers/clump. The other high yielding clones are PS-27, PS-29, PS-24, PS-22, Veeraputhran, MBP, PS-4, S, Cinchona selection, Clone-57, PS-10 and PS-6.

2.2 Comparative yield trial of promising cardamom clones/ tissue cultured clones  
(Mudigere)

A preliminary yield trial with 10 entries was carried out at Mudigere (1991-96). The results indicated over the years presented in Table 4 indicated that accessions, CL-683 and CL-726 were higher yielders compared to the other 8 entries. The conclusions drawn are tentative and need further confirmation.

The preliminary yield trial of tissue culture generated promising cardamom selections were evaluated at Mudigere along with the varieties Mudigere-1 and Mudigere-2. TC-5 was the most promising among the 8 tissue cultured cardamom selections evaluated for the past three years (Table 5) and TC-6 and TC-7 were next in rank. The yield and yield contributing characters in TC-5 were significantly higher than the other entries.

## 2.3 Multilocation trial on cardamom

### 2.3.1 MLT series II - 1988

(Mudigere and Pampadumpara)

The comparative yield trial (MLT series-II 1988) with 10 promising clones was taken up in 1988 and relaid out in 1990 at Mudigere. The data could not be gathered in 1992 because of the unprecedented bad weather and hence conclusions drawn from this trial are tentative; (therefore, a modified MLT was laid out in 1992 (MLT series III-1991) with Malabar types including all the three entries). The observation on yield and yield attributes were recorded upto 1996. The results so far obtained during the years 1991 to 1996 indicate that among the entries in MLT, there was no difference in yield between Sel.800, SKP-14, CL-683 and Mudigere-1. However Sel. 800 recorded numerically higher yield over the years than the other entries. (Table 6)

The trial was relaid with 10 accessions at Pampadumpara in 1994 as per the decisions of the XII Workshop: vegetatively propagated planting materials were used and the plants are coming up well and observations of biometric characters were recorded.

### 2.3.2 MLT series III (1991) with Malabar types

(Mudigere, Appangala, Sakleshpur and Thadiyankudisai)

As per the XI Workshop decisions, the comparative yield trials of promising clones (MLT-Sereies III, 1991) with malabar types consisting of 14 entries was laid out during 1992 at Mudigere, Sakleshpur and Appangala. At Mudigere the experiment was vitiated, the conclusion drawn are tentative and hence needs further confirmation. The available results indicated that SKP-14, HS-1, Mudigere-1, CLS-872 and CL-726 are high yielders. Data also indicated that SKP-14 was significantly superior compared to other in pseudostem height, bearing and total suckers/clump, panicle length, nodes/panicle etc.

Table.4 Performance of promising cardamom clones in preliminary yield trail at Mudigere (1991-92 to 1995-96)

Sl. No.	Entries	Pseudo stem height (cm)	Suckers/Clump		Panicle/ Clump	Panicle length (cm)	Nodes/ Panicle	Flowers/ node	Yield/ clump (gm)	
			Bea- ring	New						Total
1.	M-1	199	4.8	8.8	15.6	10.5	40.9	12.2	7.5	100
2.	C1-37	223	5.8	9.3	15.7	12.1	40.2	14.8	7.5	108
3.	C1.664	198	5.5	9.5	15.4	10.9	39.6	14.5	7.0	95
4.	C1-679	216	5.5	9.8	17.1	11.8	42.6	14.7	7.0	97
5.	C1-683	232	6.3	10.5	17.3	16.6	49.5	15.5	8.3	394
6.	C1-726	203	6.8	13.8	19.2	13.1	38.8	13.3	9.5	248
7.	CS-6	207	4.8	8.3	14.2	8.3	35.3	13.5	7.3	73
8.	D-751	214	4.3	8.3	11.5	7.9	41.0	14.5	7.0	63
9.	HS-1	221	5.7	9.5	14.3	12.6	45.3	15.0	7.5	113
10.	K-1	192	5.5	10.8	18.9	10.9	31.1	11.7	7.0	183
	Mean	211	5.5	9.6	15.9	11.5	40.4	14.0	7.6	148
	C D 5%	14.5	1.6	2.4	2.3	3.5	8.2	1.6	0.9	141
	C V %	8	19	16	30	20	8	10	8	93

**Table. 5 Performance of tissue cultured promising cardamon selection in preliminary yield trial (1993-94 to 1995-96)**

Entries	* Dry Capsule yield (Kg/ha)			
	1993-94	1994-95	1995-96	Average
TC 1	41	54	83	56
TC 2	40	55	71	55
TC 3	16	49	42	38
TC 4	54	115	69	79
TC 5	77	175	184	145
TC 6	93	93	110	99
TC 7	62	134	91	96
TC 8	20	89	142	84
Mudigere 1	37	87	46	57
Mudigere 2	54	98	118	90
Mean	50	94	95	79
CD 5%	45	82	124	49
CV %	66	51	76	65

\* Estimated yield

**Table.6 Mean performance of promising cardamom clones in comparative yield trial at Mudigere (1991-92 to 1995-96)**

Sl. No	Entries	Pseudostem Height	Suckers/Clump		Panicles per Clump	Panic Length(Cm)	Nodes per Panicle	Flowers per nodes	Yield per Clump(gm)		
			Bearing	New							
			Total								
1.	Cl.679	234	6.7	10.5	20.0	13.5	46.6	13.9	7.5	93	
2.	Cl-683	227	6.5	11.3	20.3	11.9	44.2	13.2	7.5	95	
3.	Cl-726	226	7.5	12.0	20.7	13.8	39.4	13.0	7.8	80	
4.	M-1	234	7.7	11.3	21.1	15.3	47.2	14.0	6.8	108	
5.	PV-1	231	5.8	12.2	21.8	12.1	37.8	15.3	8.3	108	
6.	Sel-112	246	7.0	10.8	19.5	14.1	51.6	14.1	7.3	98	
7.	Sel-262	216	7.0	10.5	19.1	9.7	34.7	9.8	8.0	53	
8.	Sel-800	217	6.7	11.5	21.1	13.7	48.6	13.0	7.7	127	
9.	SKP-14	232	8.0	13.2	23.1	14.8	49.7	15.8	7.3	91	
10	SKP-51	251	7.0	12.2	21.2	10.9	42.8	15.7	8.2	55	
	Mean	230	7.0	11.6	20.8	13.0	44.3	13.8	7.7	91	
	CD%	14.5	1.4	1.3	2.1	3.5	5.6	1.5	2.0	51	
	CV%	8.7	16.5	9.6	13.8	34.2	15.4	11.5	21.8	68	



### 2.3 3 MLT Series - III (1991) with Mysore types

(Mudigere, Appangala, Sakleshpur, Myladumpara)

The MLT Series-III (1991) with Mysore types consisting of 5 entries viz., SKP-51 (Sakleshpur), MCC - 12, MCC - 21, MCC - 85 (ICRI, Myladumpara) and control (MCC - 61) was laid out at Myladumpara, Mudigere, Sakleshpur and Appangala (1992) with an additional "Local control"

The yield and yield contributing characters were studied at Mudigere. The available data are tentative and there was no significant difference between the entries but for MCC - 81 as this was significantly yielding higher than SKP - 51.

### 2.4. Evaluation of Mudigere - 1 under rainfed situations/under irrigated condition

(Mudigere)

It is apparent that under rainfed conditions, the average yield of Mudigere - 1 varied from 90-150 kg (dry capsule) per ha, depending up on the type of planting material used. The results obtained at Mudigere exhibited significant difference in yield between seedling and clonal crops of the variety Mudigere-1. The yield data obtained during the years ( 1993-94 to 1995-96 ) presented in Table 7 confirmed that the yield from suckers (clonal crops) was found to be 30-40% more than that of the seedlings under rainfed conditions. Among the seedlings, 20 months old seedlings performed better with 19% more yield, compared to 10 months seedlings. Under irrigated conditions, it recorded a mean higher yield with 69 kg (dry capsule) per /ha/year i.e., 19% more yield was observed (over the years 1991-92 to 1995-96) in the clonal crop, compared to the "seedlings" of Mudigere-1 under irrigated conditions (Table.8)

**Table.7 Performance of Mudigere-1 under rainfed situation at Mudigere (over 3 years, 1993-94 to 1995-96)**

	Seedlings		Suckers	Expt Mean	C D. 5%	C.V %
	10 months	20months				
Pseudostem height	175 b	184 b	204 a	187	16.8	3.9
Old suckers	5.7 a	5.3 a	6.7 a	5.9	1.8	13.3
New sucker	11.3 a	11.3 a	11.7 a	11.4	1.5	5.8
Total sucker	17.3 a	16.7 a	18.3 a	17.4	3.0	7.6
Panicle/plant	9.7 a	9.3 a	11.0 a	10.0	1.8	8.2
Panicle length	27.0 a	30.7 b	33.7 a	30.4	2.6	3.7
Nodes/Panicle	12.0 b	13.0 a	13.3 a	12.8	0.7	2.6
Flowers/ nodes	5.5	6.0	6.5	-	-	-
Yield/clump	133.0 b	162.7 ab	226.7 a	174.0	64.8	16.4
Yield, kg/ha (Dry)	90.3 b	110.2 ab	153.7 a			
(Estimated)	-41%	-29%	*			
	-18%	*				

Tested results; a,b Dissimilar letters indicate significant difference. CD 5% & CV %: Obtained by analysing results treating "years" as replications

**Table.8 Performance of Mudigere-1 cardamom variety under irrigation (1991-92 to 1995-96)**

	Seedlings				Suckers				
	91-92	92-93	93-94	Mean	91-92	92-93	93-94	95-96	Mean
Pseudostem height(Cm)	234	265	232	244	-	323	243	247	271
Old suckers	-	4.6	5.9	-	-	7.5	7.5	8.0	7.7
New suckers	-	6.5	-	-	-	10.2	16.9	16.4	14.5
Total suckers	26	30	12.4	22.0	-	17.7	24.4	24.5	22.2
Panicles/plant	22	29	13.0	21.3	31	25.7	13.9	20.0	22.6
Panicle length(Cm)	-	56	35.0	45.5	49	59.6	39.7	24.5	43.3
Nodes/Panicle	-	-	11.0	-	-	18.4	14.0	17.8	16.7
Flowers/nodes	-	-	-	-	-	9.8	7.6	9.2	8.9
Yield/clump(Gm)	470	672	167	437	880	561	172	205	454
Yield, kg/ha (Dry)	319	456	113	296	597	381	117	139	365

The studies confirmed that suckers of Mudigere-1 have been found to be higher yielding, compared to "seedlings" even when the seed-source is from seed-gardens.

#### 2.5 Effect of fertiliser level on the yield of cardamom under natural shade.

(Mudigere)

The trial laid out with 6 treatments during Kharif 1992 with graded levels of fertilizer under natural shade using clonal material of Mudigere-1. The treatments included are (i) 0-0-0, (ii) 38-38-75, (iii) 75-75-100, (iv) 100-100-175, (v) 125-125-200 and (vi) 150-150-225 kg NPK/ha. The study revealed that the response to fertilizer levels on yield of Cardamom was marked. Application of 150-225 Kg. NPK/ha resulted in significantly higher yields (834 kg green capsules/ha).

#### 2.6 Manurial trials in cardamom under uniform shade

(Mudigere)

The experiment was carried out for 9 years (1986-87 to 1995-96) under uniform shade with 3 level of NPK (0-0-0, 50-50-100, 100-100-200 kg NPK/ha) using 27 treatment combinations; planting material used was the clones of "Mudigere-1". The yield data indicated that the response to NPK and their interactions were significant; the response to fertilizers was more pronounced in higher level of fertilizers. The pooled analysis of 7 years data are being processed and will be presented in the next report.

#### 2.7 Intergrated nutrient mangement of organic and inorganic manures in cardamom.

(Pampadumpara and Mudigere)

The experiment has been laid out during Kharif 1994 with 6 treatments. The treatments comprised of different percentage combinations of both organic and inorganic besides 100% organic and 100% inorganic manures. The experiment is in progress the crop stand is satisfactory and will start yielding from 1996.

The experiment to assess the response of cardamom to higher levels of fertilizers besides application of neemcake was laid out at Pampadumpara with clones of PV-1. The six treatments (viz., NPK 0-0-0, kg/ha, 75-75-100 kg/ha, 100-100-125 kg/ha, 125-125-200 kg/ha, 150-150-225 kg/ha, 150-150-225 kg/ha, 75-75-150 kg/ha + 0.5 kg neem cake/plant) were imposed for the first time in two split and the data on height and No. of tillers /clump were recorded; it showed a non-significant difference.

## 2.8 Micronutrient requirement studies

(Mudigere & Pampadumpara)

The trial was laid out at Mudigere (1992) with 7 treatments using the micronutrients boron and molybdenum. The influence of micronutrient on the yield of the cardamom Mudigere-1 under natural shade revealed that the response of micronutrients did not have any effect on the capsule yield.

The study was taken up at Pampadumpara to study the effect of different levels of boron and molybdenum on cardamom and to assess the response of cardamom to different methods of application of micronutrient. The experiments would be repeated in 1996, since the treatments could not be imposed during 1994.

## 2.9 Studies on the effect of growth regulators in plant populations on proliferation of suckers in cardamom.

(Mudigere - 1994)

The experiment was carried out under uniform shade (artificial) to study the effect of growth regulators (Ethrel 250 ppm and Cycocel 12000ppm) and plant population (3 different spacings) on proliferation of suckers. The study indicated that a closer spacing of 0.9m x 0.3 m gave significantly higher number of planting units (8.8 suckers/sq.m). In the case of growth regulators, Ethrel and Cycocel did not influence the proliferation of suckers.

## 2.10 Pest Management in Cardamom

### 2.10.1 Evaluation of plant based insecticides for the control of thrips and borer in cardamom.

(Mudigere/ 1994)

In the evaluation of plant products against thrips and borers in cardamom, application of neem cake @ 250g/clump, neemark 15G (8g/clump) and nimbicidine (2ml/1t) were compared for their efficiency in controlling thrips and borers compared with conventional insecticides like monocrotophos (1.25 ml/1t) carbofuran (10g/clump) and phosalone (5ml/1it) and with the untreated control. In the experiment with the 7 treatments, the results showed no significant differences between the treatments.

### 2.10.2 Bioecology of natural enemies of major pests of cardomom

(Mudigere)

Documentation of natural enemies of cardamom thrips and shoot-cum-capsule borer was initiated in 1992. An unidentified pathogen has been noticed to infect the larvae; mortality was also

observed in pupal stages and attempts are being made to identify the pathogen. The parasitisation of the larvae was by Xanthopimpla sp.

### 2.10.3 Cultural and chemical control of thrips and capsule borer

(Mudigere & Pampadumpara)

The objectives of the experiment was to evolve a suitable spraying schedule for the control of cardamom thrips and capsule borer and to study the effect of thrashing on the population build-up of thrips. The experiment has been concluded at both the centres.

The preliminary evaluation revealed that the time of application of insecticides appeared to be more crucial in controlling thrips than the actual number of sprays. The experiment was continued for 3 years (1992-95) at Mudigere and the promising treatment evaluated in a large scale during 1995-96. The treatment comprising of sprays in March, May and August was found to be most effective in controlling cardamom thrips (Table 9). The results recommended a control schedule for thrips and capsule borer viz., the first spray in March with Monocrotophos 36 EC (12.5 ml in 10.1 water) which effectively controlled the initial population of thrips on the panicles. The second and third sprays to be followed in May and August with Phosalone (20ml phosalone 35% EC in 10.1 of water) which checks the subsequent increase in thrips population, thus minimising the damage.

A similar trial conducted at Pampadumpara with 10 treatments with selective thrashing during February-March and insecticidal application at different intervals. Observations were taken on shoot and capsule borer as well as thrips infestation of the capsules. The pooled analysis presented in Table. 10 showed significant differences in shoot borer infestation between treatments. In the case of capsule borer, the results did not show any significant difference between the treatments as the infestation was not severe. Five insecticide applications during the months of February, April, May, August and October performed well along the other treatments with 6 or 7 insecticide applications with or without selective thrashing during Feb-March in controlling the shoot borer attack.

With regard to the thrips infestation, insecticide application during the months of Feb, March, May and October and 5, 6 or 7 spraying along with or without selective thrashing during Feb-March were found to be on par (Table 11). Accordingly, the study recommended the treatment "5 insecticide application during the month of Feb, April, May, August and October" as effective against the incidence of both thrips and shoot borer.

**Table 9 Effect of trashing and insecticide application on thrips control at Mudigere (1992-95)**

Treatment Schedule	%Thrips damage in capsules			
	1992-93	1993-94	1994-95	Mean
T1. Trashing (Feb & May	14.31	21.01	31.29	22.0
T2. Five sprayings (Mar, May, June, Aug., Sept.)	6.63	1.42	5.55	4.53
T3. Four Sprayings (Mar, May, Aug, Sept)	7.35	3.49	5.68	5.51
T4. Three sprayings (Mar, May, Aug.)	4.82	5.15	9.60	6.52
T5. Three sprayings (May, June, July)	13.35	4.45	7.09	8.26
T6. T1+T2	4.43	2.67	18.12	8.41
T7. T1+T3	4.75	3.59	7.90	5.41
T8. T1+T4	9.37	3.10	8.19	6.88
T9. T1+T5	6.48	2.76	7.36	5.53
T.10 Control	9.10	15.89	17.50	14.6
CD	NS	9.22	12.97	6.93

**Table 10 Cultural and Chemical Control of Shoot borer in Cardamom at Pampadumpara**

Treatment	Mean Shoot borer Infection (%)
T1 - Selective thrashing during February-March	2.68
T2 - Insecticide application during Feb, March, April, May, Aug., Oct., Dec.	1.93
T3 - Insecticide application during Feb., March, April, May, Aug., Oct.	2.24
T4 - Insecticide application during Feb., April, May, Aug., Oct.	2.18
T5 - Insecticide application during March, May August, October	2.24
T6 - T1 + T2	2.08
T7 - T1 + T3	2.13
T8 - T1 + T4	2.32
T9 - T1 + T5	2.45
T10 - Control (No spraying & tharashing) (Insecticide-Monocrotophos 0.05%)	2.58
CD	0.32

Pooled analysis showed significant differences between treatments, selective thrashing during Feb - March did not affect the result when there were 6 to 7 spraying given to the crop but T4 was found superior to T8. Four spraying during March, May, August and October were not sufficient to control the shoot borer.

**Table 11 Cultural and Chemical Control of Thrips in Cardamom at Pampadumpara**

Treatment	Mean Thrips infection (%)
T1 - Selective thrashing during February-March	7.20
T2 - Insecticide application during Feb, March, April, May, Aug., Oct., Dec.	2.02
T3 - Insecticide application during Feb., March, April, May, Aug., Oct.	2.02
T4 - Insecticide application during Feb., April, May, Aug., Oct.	1.94
T5 - Insecticide application during March, May August, October	2.67
T6 - T1 + T2	2.04
T7 - T1 + T3	1.88
T8 - T1 + T4	1.81
T9 - T1 + T5	2.60
T10 - Control (No spraying & tharashing) (Insecticide-Monocrotophos. 0.05%)	6.74
CD	0.386

## LARGE CARDAMOM

### 3.1 Comparative yield trial (CYT - 1991)

(Gangtok)

The CYT was laid out at Gangtok with clones of 12 cultivars. The cumulative yield obtained during 1993 and 1994 indicated tht clone-3, Ramla, white Ramna and Bharalangéy gave better performance (Table 12). Observation of the incidence of Chirkey disease (10 to 16%) was more severe in Ramla, Ramnay and white Ramna whereas Okhre, Red Sawney and Bebo-1 were highly susceptible. Similarly, field tolerance to foorkey was noticed in Bebo-1 and Bebo-2 whereas Ramla and Ramnag were highly susceptible. The trial was however concluded due to poor establishment.

Table 12 : Comparative Yield Trial of Cardamom at Gangtok

Cultivar/ Clone	No. of plants survived /6 Plants per plot				Tillers/clump				No. of affected plot				Dry capsule Yield/clump(g)					
	1993	1994	Mean	1993	1993	1994	Mean	1993	1993	1994	Mean	1993	1993	1994	Mean	1993		
Clone-6	5.67	5.33	5.00	8.00	18.52	13.26	0.00	1.00	0.50	0.33	0.33	0.33	3.00	12.33	7.67	36.67	148.33	92.50
OKhre	5.00	3.67	4.33	7.92	14.51	11.21	1.67	2.33	2.00	0.67	0.33	0.50	2.67	10.33	6.50	28.33	126.67	77.50
Ramla	5.33	4.00	4.67	6.54	9.54	8.04	0.00	0.00	0.00	0.33	1.00	0.66	7.67	19.67	13.67	91.67	126.67	154.16
White Ramna	6.00	4.67	5.33	6.10	11.16	8.63	0.00	0.00	0.00	0.33	1.00	0.66	4.67	22.67	13.67	53.33	226.66	140.00
Red Sawney	5.67	3.67	4.67	6.07	11.38	8.72	2.00	2.33	2.16	0.33	0.33	0.33	4.67	18.00	11.33	51.67	200.00	125.83
Clone-3	6.00	6.00	6.00	7.83	15.89	11.86	0.33	1.33	0.83	0.67	0.00	0.33	7.33	29.00	18.16	83.33	288.33	185.83
Bebo-1	5.67	4.67	5.16	7.15	14.05	10.60	0.67	1.67	1.16	0.00	0.00	0.00	2.33	15.00	8.67	33.33	133.33	83.33
Bebo-2	5.67	5.00	5.33	4.25	8.72	6.48	0.67	0.67	0.66	0.00	0.00	0.00	2.33	3.67	3.00	26.67	40.00	33.33
Ramnag	5.67	4.33	5.00	4.11	4.94	4.52	0.00	0.00	0.00	0.33	0.67	0.33	0.43	5.67	5.00	50.00	55.00	52.50
Clone-1	6.00	4.00	5.00	3.88	9.48	6.68	0.33	1.33	0.83	0.33	0.67	0.33	2.33	7.67	5.00	28.33	81.66	55.500
Bharlangey	5.67	4.00	4.83	5.50	9.41	7.45	0.33	0.76	0.50	0.00	0.00	0.00	7.00	19.33	13.16	76.67	186.67	131.67
Pink Golsey	5.67	4.33	5.00	4.03	7.83	5.93	0.00	0.67	0.33	0.00	0.00	0.00	5.33	10.67	8.00	75.00	105.00	90.00
Mean	5.67	4.47	5.07	5.95	11.28	8.62	0.50	1.00	0.75	0.22	0.36	0.29	4.47	14.50	9.48	52.92	150.69	101.80
CDat 5% Var	0.87	1.86	-	3.69	8.92	-	1.21	1.71	-	NS	NS	-	4.94	16.11	-	56.20	159.93	-
Pooled Analysis																		
Var			1.12		4.60			1.00				0.68			8.72			86.92
Year			0.46		1.87			0.40				0.28			3.56			35.48
Var, XYr.Int.			1.59		6.50			1.41				0.97			12.33			122.92



## GINGER

### 4.1 Germplasm collection description and evaluation

(Pottangi, Solan & Dholi)

At Pottangi, 4 more indigenous and one wild genotype each were added from Malkangiri, Koraput and Cuttack district of Orissa. This increased the total germplasm to 155, which includes 150 indigenous, 3 exotic and two wild collections; of which, 140 accessions were evaluated and the maximum fresh rhizome yield was recorded in PFLR-1 viz., 10.8 kg/3m<sup>2</sup>.

The Solan centre maintained 134 cultivated germplasm which includes the 10 new collections made during the year.

The Dholi centre received 31 ginger germplasm from the Solan centre in addition to the local germplasm collected from Samastipur, Mazaffarpur and Darbhanga districts. The germplasm has maintained and evaluated for yield and yield attributes.

### 4.2. Initial evaluation trial (IET)

(Pottangi & Solan)

Sixteen promising entries were evaluated under IET at Pottangi for the last four years (1992-93 to 1996-97). The pooled data for 4 years (1992-93 to 1995-96) gave significant differences in the yield. The highest fresh rhizome yield of 21.32 t/ha was recorded by V<sup>1</sup>E<sup>8</sup>-2, followed by V<sup>1</sup>S<sup>1</sup>-8 (20.4 t/ha); these are grouped as low fibre types.

During the year 1995, fifteen collections along with check (Himgiri) were studied in an IET at Solan. there was no significant difference in yield per plant, but five collections viz., INFR, BDJR-1054, BDJR-1113, BDJR-1267 and SG 687 showed increasing trend in yield over the local check Himgiri.

The new IET (1996-97) with sixteen accessions viz., V<sup>3</sup>S<sup>1</sup>-8, Vengara, Singihara, V<sup>2</sup>E<sup>4</sup>-5, S-547, SS-1, Zo-17, Rajgarh, S-641, Jugijan, S-558, Nadia, Anamika, Suprabha, and SG-666 was initiated at Pottangi centre.

### 4.3. Comparative yield trial (CYT)

(Pottangi & Solan)

Six cultures were evaluated in the CYT at Pottangi and the pooled analysis of the four years' projected yield (1992-93 to 1995-96) gave significant yield differences amongst the entries. Acc. V<sup>1</sup>E<sup>8</sup>-2 (16.36 t/ha) followed by V<sup>1</sup>C<sup>1</sup>-8 (13.78 t/ha) gave significantly higher fresh rhizome yield.

The Solan centre studied five accessions along with check Himgiri in the CYT (1995). Non-significant differences for yield per plot were observed in the collections. However, SG-682 gave a slight increase in yield over the check.

#### 4.4 Multilocation trials

##### 4.4.1 MLT Series III-1991 (Pottangi & Solan)

The MLT III (1991) was continued at Solan (1991-95) with 10 entries. The mean performance for the different horticultural characters showed non-significant difference whereas significant effect was observed in yield and yield contributing characters. SG-646, gave the maximum yield/plot followed by SG-666 (Himgiri) and are statistically at par with SG-674 (Rajgarh). The pooled performance of these cultivars for the last five years (1991-95) presented in Table 13 have shown their inconsistency. Local entries SG-674 (Rajgarh) gave maximum yield and at par with SG-547 and SG-666. The local entries also performed statistically better than check (Maran) whereas the Pottangi accessions showed poor performance not only from the Solan entries but also from check Maran.

The promising cultures were evaluated (in the MLT series III) for the 5<sup>th</sup> year at Pottangi. The mean projected yields are presented in Table 14 and a significantly high fresh rhizome yield was recorded by SG-666 (17.5 t/ha) followed by SG-646 (15.53 t/ha). The Acc. SG-666 was the top yielder and was released by Solan as variety in the XIII workshop.

##### 4.4.2. MLT Series IV-1996

(Pottangi)

The MLT IV 1996 with six entries from Solan/Jagtial/IISR and Pottangi viz., V<sub>1</sub>E<sub>x</sub>-2, V<sub>3</sub>S<sub>1</sub>-8, Acc 64, SG-554 and Suprabha laid out at Pottangi during 1996.

##### 4.5. NPK trial in ginger

(Pottangi)

The fertilizer trial was conducted for over six years with six treatments at Pottangi. The six year's pooled data (1990-91 to 1995-96) are presented in Table 15 which confirmed that the application of 125:100:100 Kg NPK/ha in ginger cultivar Suruchi gave significantly high fresh yield (16.94 t/ha) with the maximum cost-benefit ratio of 1:1.23.

##### 4.6 Standardisation of seed rhizome size in ginger for higher yield and profitability.

(Dholi)

Studies were conducted at Dholi centre (1993-95) to standardise the seed rhizome size for higher yield and profitability using 12, 15, 18, 21, and 24g seed rhizome sizes. The statistical analysis of pooled data of two year's yield revealed that the yield varies directly in proportion to the weight of seed rhizomes. The yield of 24g seed size remains at par with 21g & 18g seed rhizomes weight. Considering the seed cost of ginger, 18g seed rhizome wt/size was observed to be very economical.

Table 13 : Fresh Rhizome Yield of Ginger Cultivars in MLT at Solan  
(MLT-III 1991-Mean over five years, 1991-95)

Sl.No.	Name	Yield Kg/3M <sup>2</sup> plot									Projected Yield (q/ha)
		1991	1992	1993	1994	1995	Mean				
1.	SG 674 (Rajgarh)	5.33	6.42	5.00	4.87	4.73	5.72	105.93			
2.	SG 646	5.83	5.07	4.33	3.73	3.73	4.54	91.25			
3.	SG 547	4.53	5.40	4.17	4.17	5.43	4.74	95.27			
4.	SG 666	6.77	2.93	4.30	5.40	5.17	4.91	98.69			
5.	V <sub>1</sub> S <sub>1</sub> -3	1.77	1.42	0.97	2.60	2.90	1.90	38.19			
6.	V <sub>1</sub> S <sub>1</sub> -2	0.55	0.90	1.97	1.87	2.50	2.25	45.22			
7.	V <sub>1</sub> S <sub>1</sub> -4	1.13	1.08	1.73	1.63	2.53	1.57	31.55			
8.	V <sub>1</sub> S <sub>1</sub> -7	2.17	0.67	2.60	3.33	3.13	1.74	34.97			
9.	Suprabha	0.90	1.03	1.03	1.00	1.50	1.10	22.11			
10.	Maran	3.36	3.76	2.33	4.08	3.63	3.37	68.94			
	Mean	3.23	2.87	2.82	3.26	3.53	3.14	63.11			
	SE+	CD 5%									
Years	0.210	0.411									
Varieties	0.297	0.582									
Varieties	0.665	1.303									

Table. 14: Mean Fresh Rhizome Yield of Ginger Cultivars in MLT-III at Pottangi (1991-92 to 1995-96)

Sl. No.	Cultivars	YIELD OF FRESH RHIZOME (Kg/3M <sup>2</sup> )									Projected Yield (t/ha)	Fibre type
		1991-92	1992-93	1993-94	1994-95	1995-96	Mean Yield (Kg/3m <sup>2</sup> )					
1	SG-666	2.305	6.244	7.752	5.957	12.752	7.00	17.50	High			
2.	SG-646	3.115	5.078	7.998	5.952	8.880	6.21	15.53	High			
3.	SG-547	2.235	9.382	7.638	4.027	6.070	5.87	14.08	High			
4.	V2S1-7	1.967	6.135	9.212	7.157	4.560	5.18	14.52	Mod.			
5.	Rajgarh L.	2.424	7.010	7.606	5.563	5.567	5.63	14.08	High.			
6.	Suprabha	1.638	6.430	6.456	6.033	6.953	5.50	13.76	Mod.			
7.	Maran	1.491	5.890	6.109	5.363	8.287	5.43	13.56	Mod.			
8.	V1S1-2	11.735	8.054	7.282	4.242	4.590	5.18	12.96	Low.			
9.	V1E4-4	2.346	4.441	8.972	6.393	2.967	5.03	12.56	Low.			
10.	Suravi	1.743	4.945	7.357	5.217	2.303	4.32	10.79	Mod.			
CD : (P=0.05)		NS	NS	1.690	1.090	3.064	1.95	4.87				

\*\* Low fibre(4%), Moderate fibre (4.0.to 45%) and High fibre (4.5%)

#### 4.7 Survey, collection and identification of diseases of ginger

(Dholi)

During 1995-96, survey was conducted in ginger growing areas of Samastipur, Muzaffarpur and Darbhanga districts and pathogens isolated from the diseased ginger plant parts. Out of the 44 entries screened, not a single cultivar showed resistant reaction against rhizome/soft rot disease.

#### 4.8 Evolving control measures (including seed treatment) against rhizome rot of ginger

(Solan)

In the experiment in evolving control measures of rhizomes rot, the trial conducted at Solan (consisting of seven treatments) to evaluate the effect of seed rhizomes treatment with different fungicides/and their combination plus Phorate soil application in reducing the incidence of rhizome rot, it was inferred from the data presented in Table 16 that the germination increased with the chemical treatments viz., "Pre-sowing fungicides seed treatment" with Captan or a combination of Dithane M-45 and Bavistin along with Phorate soil application in furrows at planting time reduced incidence of rhizome rot and increased the yield.

#### 4.9. Biocontrol studies on rhizome rot of ginger

(Solan)

Studies were initiated in 1994 at Solan on the effect of seed treatment/soil application of biocontrol agents and in combination with seed treatment with fungicide (six treatments ) against the rhizome rot disease. It was evident that fungicide has an additive effect with biocontrol agents like T. harzianum and T. viride and T. hamatum in controlling the disease as well as increasing the seed germination and yield of ginger .

#### 10. Evaluation of germplasm for quality characters.

(Solan)

Sixty seven collections have been analysed at Solan for quality characters viz., essential oil, oleoresin and dry matter percentage. The essential oil content ranged from 0.5% to 2.2% on dry matter basis, while the oleoresin in different collections varied from 3.22 to 6.64%. The maximum value of the dry matter was in SG-689 (23.2%), the minimum being 17.0% in SG-762.

Table. 15 Fresh Rhizome yield of ginger in the N.P.K Trial at Pottangi (1990-91 to 1995-96)  
(six years pooled-analysed data with economics)

Treat ment	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	Mean Projected Yield (Kg/3m2)	Projected Yield (t/ha)	Cost of Cultivation (000 Rs)	Cost Benefit Ratio
T-1	4.867	2.551	5.235	4.042	3.075	8.493	4.17	11.78	59.25	1:0.59
T-2	4.852	2.852	4.808	4.152	3.453	7.295	3.77	9.24	60.60	1:0.24
T-3	5.578	2.694	7.066	6.000	4.185	8.680	5.70	14.25	60.60	1:1.90
T-4	7.641	2.379	4.963	5.848	4.270	7.965	5.51	13.78	60.33	1:0.8
T-5	7.961	5.047	5.274	5.670	5.350	12.348	6.77	16.94	60.65	1:1.23
T-6	2.759	5.407	5.522	4.477	3.600	14.693	6.08	15.19	61.20	1:1.03
CD:	2.759	1.999	NS	NS	1.366	2.550	1.81	4.53		

(P=0.05)

Ti= Control (No FYM No NPK) T2= FYM alone (30t/ha), T3=75:50:50: kg NPK/ha, T4= 100: 75: 75kg NPK/ha T5=125:100: 100: kg NPK/ha, T6=150: 150:150kg NPK/ha  
Cost of ginger =Rs. 800/Q

Conclusion : Application of 125:100:100: kg NPK/ha in ginger cultivar Suruchi gave significantly high fresh rhizome yield (16.94 t) with maximum cost benefit ratio of 1:1.23 .

**Table.16 Effect of fungicides on germination and rhizome rot incidence in ginger at Solan**

Sl. No.	Treatment	Germination (%)	Disease Incidence (%)	yield (kg/3m <sup>2</sup> )
1.	Aureofungin (200\ppm)	61.6	10.2	1.11
2.	Contaf 5E(0.05%)	65.3	9.4	1.4
3.	Captan(0.25%)	84.0	2.8	2.83
4.	Antracol (0.25%)	76.5	5.0	3.66
5.	Phorate (Soil application) (10 kg ha-1) + Indofil M-45 (0.25%) + Bavistin (0.1%)	86.8	2.8	3.86
6.	Celest IDS/WS (0.25%)	56.9	9.8	1.33
7.	Control	56.9	10.0	1.96
CD (0.05%)				0.6

## TURMERIC

### 5.1. Germplasm collection, description and evaluation

(Pottangi, Jagtial, Dholi and Solan)

The Pottangi centre added six new accessions in turmeric from Malkangiri, Koraput and Cuttack districts of Orissa making a total of 197 accessions. Out of the 197 accession, 175 belong to Curcuma longa, 18 Curcuma aromatica and 4 Curcuma amada. During the year, out of 135 C. longa evaluated, the highest fresh rhizome yield of 7.7 kg/3m<sup>2</sup> was obtained in PTS-51; among 17 C. aromatica types, Uttangar gave 5.75 kg/3M<sup>2</sup> and among C. amada, CAM-2 gave 6.95 kg/3M<sup>2</sup>.

The 188 germplasm collections maintained at Jagtial, on evaluation, showed a lot of variability for yield and disease tolerance in different cultures. According to the duration, the cultures were grouped in the three maturity groups viz., long, intermediate and short duration cultures.

The sixty germplasm collections maintained at Dholi comprised of local as well as reputed varieties from different states.

The Solan centre maintained the available 184 accessions. On evaluation, the germplasm performed comparatively poor than the last year. In general, the multiplied collections of turmeric performed better over the already established collections for almost all characters evaluated. The yield per plot was maximum in BDJR 1241 followed by BDJR 1203, BDJR 1203, BDJR 1125 and BDJR 1153.

### 5.2. Initial evaluation trial (IET)

(Pottangi, Dholi & Jagtial)

The fifteen promising entries each of long duration type (maturity period more than 200 days) and short duration group (less than 200 days) were evaluated at Pottangi for four years from 1992-93 onwards. The mean yield for four years indicated significantly highest yield by PTS-43 (25.73 t/ha) with 5% curcumin and 22.4 dryage. The study indicated PTS-62, PTS-22, PTS-55 were the other promising elite cultures among the long duration types. Similarly, highest yield was obtained in the four year's pooled data by PTS-15 (16.45) t/ha, PTS-59 (16.0t/ha) PTS-52 (15.4 t/ha) and PTS-11 (14.4 t/ha), containing high curcumin and dry recovery among short duration types at Pottangi. The new IET (1996-97) with 15 accessions has been laid out at Pottangi.

Ten lines were tested under IET at Dholi. The variety Sugandham outyielded giving 36.83T fresh rhizome yield per ha and the varieties PCT-8, Manipuri and PCT-11 were on par with Sugandham in the 2 years' pooled yield average.

At Jagtial, seven each of the long/short duration and 14 intermediate types were evaluated to identify high yielding ones. The evaluation indicated significant difference for the growth, yield and yield contributing characters among a long duration types and for yield/yield attributes among the intermediate and short duration types. Among the varieties/cultures tested, higher fresh rhizome yield was recorded in PTS-24 (22.91 t/ha) followed by 21A (22.65 t/ha) among long dura-



tion. CLT-317 (22.30 t/ha) followed by CLI-330 (21.96 t/ha) among intermediate, and PCT-13 (22.80 t/ha) followed by PCT 14 (21.22 t/ha) among short duration types.

### 5.3 Comparative yield trial (CYT)

(Pottangı and Dholi)

Six promising cultures including Roma as check were evaluated for 4 years at Pottangı. Pooled analysis of the four years (1992-93 to 1995-96) fresh rhizome yield give significant differences in yield among the cultures. PTS-19 gave a projected yield of 20.85 t/ha (with a curcumin content of 5.6% and 20% dryage) followed by PTS-62 (18.04 t/ha). The new CYT with long duration (6 accessions) and 16 accessions of short duration type will be laid out at Pottangı during 1996-97.

In the CYT with 10 lines at Dholi, the analysis of two years' pooled data (1992-93 and 1994-95), Rajendra Sonia outyielded all the others with 79.49 Q/ha dry rhizome per ha, while the varieties Rajapur and Dindigram are found to be at par.

### 5.4 Multilocation trial (MLT 1991 Series III)

(Pottangı & Jagtial)

The MLT 1991 Series III with 13 high yielding cultures from different coordinating centres was continued for the fifth year at Pottangı. The pooled data of five years (1991-92 to 1995-96) presented in Table.17 gave significantly higher yields; PTS-19 outyielded other varieties giving a significant/projected yield of 20.14 t/ha in the pooled analysis. This entry was proposed for release in the name of SONALI with 5.6% curcumin.

The MLT laid out with 12 cultures at Jagtial indicate significant difference for morphological, yield and yield attributing characters. Among the varieties tested, significantly higher yield was recorded in Duggirala (4.68 t cured rhizomes/ha) followed by PTS-10 (3.44 t/ha). The MLT IV-1996-97 with 10 entries will be laid out at the Turmeric centres.

### 5.5 Effect of spacing on yield of turmeric

(Dholi)

A Study was conducted at Dholi during 1993-94 and 1994-95 on the effect of intra and inter row spacing (4 spacings) on yield of turmeric in variety Rajendra Sonia. On statistical analysis of the two years' pooled yield data, the yield differed significantly under different spacing. the spacing of 30x20cm produced the highest rhizome yield of 484.5 Q/ha.

### 5.6 Survey and identification of rhizome rot disease and screening turmeric germplasm against diseases.

(Dholi)

A survey was conducted by Dholi centre in the turmeric growing areas of North Bihar and disease samples collected and pathogens identified. It was observed that leaf blotch disease is more serious compared to leaf spot disease.

Thirty six turmeric germplasm accessions were screened against leaf spot and out of which

Table -17 Fresh rhizome yield of turmeric under MLT-III at Pottangi (1991-1992 to 1995-96)

Sl. No.	Cultivars	91-92	92-93	93-94	94-95	95-96	Mean yield	Projected yield (t/ha)
		(Yield Kg/3m <sup>2</sup> )						
1.	PTS-19	8.285	9.874	9.774	6.667	5.677	8.055	20.14
2.	Ranga	8.152	9.486	9.226	6.340	4.380	7.516	18.79
3.	Rasmi	6.801	9.386	10.817	5.393	4.767	7.433	18.58
4.	TC-2	7.456	8.613	8.397	6.287	6.587	7.469	18.67
5.	BSR-1	7.288	8.194	9.974	6.413	3.617	7.099	17.75
6.	Surama	6.576	6.570	9.658	6.113	4.987	6.821	17.05
7.	TC-4	6.170	9.881	7.720	5.543	3.673	6.607	16.52
8.	Armoor	7.626	8.471	5.105	5.363	4.677	6.247	15.62
9.	Roma	6.580	8.313	7.320	3.990	3.757	5.991	14.98
10.	ST-510	3.345	5.050	9.609	4.163	7.103	5.852	14.63
11.	VK-70	2.320	3.996	7.931	3.007	5.897	4.627	11.57
12.	Duggirala	-	3.905	8.558	4.940	5.457	4.571	11.43
13.	ST-365	2.149	4.032	7.638	2.677	2.757	3.847	9.62
CD:(P=0.05)		1.680	3.480	2.457	0.817	NS	2.070	5.18

Kohinur and G.L.Puram were graded as resistant; Cv Kodur is found to be highly resistant against leaf blotch disease.

#### 5.7 Chemical control of Taphrina leaf spot disease of turmeric

(Jagtial)

An experiment to control leaf spot using the 5 different fungicides viz., Kavach 0.25%, Blitox 0.2%, Kitazin 0.1%, Indofil M-45 (0.2%) and Bavistin 0.1% conducted at Jagtial centre with the variety CLI-195. Spraying was done at 15 days' interval from the appearance of the disease. Spraying Indofil M-45 significantly controlled the disease; however, the yield difference between the treatments were non-significant.

#### 5.8 Quality evaluation of germplasm collection/varieties

(Solan)

Sixty one turmeric collections were evaluated for curcumin, essential oil and oleoresin and dry matter recovery. The quality analysis of germplasm showed that the highest curcumin content (4.9%) and essential oil (6.%) in BDJR 1250 and oleoresin (13.3%) in BDJR 1092 while dry matter content was maximum in BDJR 1209 (28.7%):

## TREE SPICES

#### 6.1 Germplasm collection, conservation and cataloguing of tree spices viz., clove, nutmeg and cinnamon

(Yercaud, Thadiyankudissai & Pechiparai)

A total of thirteen elite clove lines were identified by the Yercaud centre from the traditionally clove growing areas viz., Courtallam, Nagercoil and Kallar, based on the age, precocity in bearing, regularity in bearing, yield etc. The progenies of those lines were planted in the field during 1993/94 and have been established well and are in their vegetative phase. In cinnamon, a total of 10 accessions of C. verum (9 from IISR) are being maintained for evaluation.

At Pechiparai Centre, in clove, two progeny trials are in progress. One trial with nine high yielding selections viz., No.4, 5, 8, 9, 10, 11, 12,13, and 14 collected from IISR, Calicut was laid out in September 1991. Another with 7 high yielding types from Kanyakumari district (the seedlings collected from Castle Rock, Maramalai, Epen, Pioneer, Bethany, Thulasi and Ambadi Estates) were planted in May 1994; as such 16 types are under evaluation. They are in pre-bearing stage, growth observations are progressing. Under the nutmeg germplasm collection, 4 grafts of elite types collected from IISR were planted at Pechiparai during January 1991. In addition one high yielding type was also collected from state Horticultural Farm, Courtallam and planted in 1991. Seven other high yielding types collected from Kanyakumari district (from estates like Balamore, Poineer Muthu, Pioneer Sastha, Omanapuram, Rani, Ambika and Vellimalai were planted

in May 1994. They are at pre-bearing stage and growth observations were continued in all the 12 types. The germplasm collection of cinnamon consisted of 12 types which include 9 selections (5, 44, 53, 63, 65, 189, 203, 310, 312,) collected from IISR and three types viz., Konkan Tej, Bavani Estate and Zero point Farm were planted at Pechiparai during September 1991 and 1994 respectively and are under observation

#### 6.2 Multilocation trial in clove

(Yercaud & Pechiparai)

The MLT with five elite lines viz., Sel. 1, Sel.2, Sel.3, Sel.4 and Sel.5 (from IISR, Calicut) along with control was laid out during 1992/1991 in both Yercaud and Pechiparai centres. The observation on growth parameters were continued. In the initial observation at Yercaud, Sel. 1 gave early vigorous growth.

#### 6.3 Multilocation trial in Cinnamon

(Yercaud, Ambalavayal, Thadiyankudissai and Pechiparai)

The MLT with five elite lines Sel.44, Sel. 53, Sel. 63, Sel.189, Sel.203 (from IISR, Calicut) along with local accessions was laid out during 1992, in all the four centres with 12 seedlings per line. The plants are under active growth phase and the vegetative growth, parameters are recorded. Among the entries, Sel. 203, showed maximum plant height of 221.6cm with 55.1 branches/plant at Yercaud. At Ambalavayal, Sel. 189 recorded the highest value for plant height and branching. Sel. No 63 has recorded the highest plant height (525.3 cm), stem girth (31.0cm) and maximum number of primary as well as secondary branches (26 & 96.4 respectively) at Pechiparai.

#### 6.4 Vegetative propagation in Nutmeg, Clove and Cinnamon

( Yercaud, Pechiparai and Thadiyankudissai)

Epicotyl grafting technique at different stages of root stock viz., epicotyl stage, two leaved, four leaved and six leaved stages of root stocks of nutmeg were carried out at Yercaud centre using non-processed, orthotropic and semi hard wood scion. The percentage of success in grafting was recorded and the data gave significant difference. The maximum success of 48.48% and 45.63% was recorded in two leaved stage root stock in both orthotropic and semi hard wood scions respectively.

At Pechiparai, air layering was tried in 30 clove sticks and 30 nutmeg plants. The success rate was only 20% and 25% respectively. Epicotyl grafting was also tried in nutmeg at Pechiparai, with limited success (20%).

#### 6.5 Drip irrigation in clove and nutmeg

(Yercaud)

The trial was laid out during July 1992 using clove seedlings and nutmeg grafts at 6m x 6m spacing, consisting of 5 irrigation treatments identified for the pre-bearing age (up to the 7th year). The drip irrigation system was installed during March 1993 and the following treatments were

imposed during the dry months.

Phase-1 : (Pre bearing age upto 7th year)

T1 - Dripping of 2 l of water/day/plant

T2 - Dripping of 4 l of water/day/plant

T3 - Dripping of 6 l of water/day/plant

T4 - Dripping of 8 l of water/day/plant

T5 - Dripping of 8 l water per plant by watering once a week  
(control)

The third year observation was recorded on vegetative growth parameters, after installing the drip system.

#### 6.6 Biofertilizer trial in tree spices - clove and nutmeg (Yercaud)

In the biofertilizer trial in nutmeg and clove, the treatments were imposed as per the technical programme given below :

Sl. No.	CLOVE	NUTMEG
1	T <sub>1</sub> -Control (50 kg FYM+5kg bone meal)	Control (50kg FYM + 5kg bone meal)
2	T <sub>2</sub> -100 kg FYM + 400gN, 350g P <sub>2</sub> O <sub>5</sub> and 1200g K <sub>2</sub> O/tree/year	100 kg FYM +400:320 and 1200 g NPK/tree/year
3	T <sub>3</sub> -T <sub>2</sub> + 50g each of <u>Azospirillum</u> and <u>Phosphobacteria</u> /tree/year	50% of T <sub>2</sub>
4	T <sub>4</sub> -75% of T <sub>2</sub> + 50g each of <u>Azospirillum</u> and <u>Phosphobacteria</u> /tree/year	T <sub>2</sub> + 50g <u>Azospirillum</u> and 50g Phosphobacteria
5	T <sub>5</sub> 50% of T <sub>2</sub> + 50g each of <u>Azospirillum</u> and <u>Phosphobacteria</u> per tree/year	T <sub>3</sub> +50g <u>Azospirillum</u> and 50g Phosphobacteria

The entire dose of fertilizer was split into two halves and applied first in June and another in

November.

The population dynamics of soil microflora was enumerated at 45th and 50th day after the second split application of fertilizer which revealed an increase in the microbial population especially of Azospirillum and Phosphobacteria in plots which received the biofertilizer treatments. The growth and yield parameters were also recorded in clove and nutmeg. The treatments consisting of 50g FYM + 50 g bone meal + 50g each of Azospirillum and Phosphobacteria/tree/year recorded the highest tree growth (33.25cm), annual increase in tree girth (4.94cm), mean number of buds/cluster (7.6) and mean green buds yield per clove tree (3.51kg). In nutmeg, the plants which received a treatment of 100kg FYM and NPK 400:320 and 1200g/tree/year + 50g Azospirillum and 50g Phosphobacterium recorded the highest mean tree girth (45.26cm), annual increase in tree girth (10.64 cm), mean fruit wt (74.13g) and mean fruit yield (528 fruits) per tree.

## CORIANDER

### 7.1 Germplasm collection, maintenance and evaluation

(Jobner, Jagudan, Guntur, Coimbatore, Hisar and Dholi)

The survey for germplasm collection and assessing the disease intensity in coriander was conducted by the Jobner centre in the districts of Tonk, Kota, Baramur and Jhalawar (in Rajasthan) and Mandsour of Madhya Pradesh. As a result, the centre collected 47 new accessions from the standing crop and the harvested materials were added to the total germplasm raising it to 733; at present, the germplasm consisted of 581 indigenous, 105 exotic plus 47 new collections. In the evaluation of 192 accessions, 35 are better in yield performance than all the 4 checks Rcr-41, Rcr-20, UD-435 and UD-436. The promising accessions identified at Jobner in the evaluation are UD-164, UD-88, UD-145, UD-165, UD-70, UD-293 and UD-75. The disease incidence in the survey conducted revealed 20 to 80% infestation of stem gall disease (Protomyces macrosporus) and 10 to 30% powdery mildew (Erysiphe polygoni).

The stem gall disease in coriander appears in a severe form at Danta (Sikar) as well as Baramur, Jhalawar and Kota districts of Rajasthan. Screening of 33 germplasm of coriander against stem gall was continuously undertaken at farmer's field in Danta; only variety RCr-41 was found to be resistant, others are moderately resistant to susceptible and the local type found to be highly susceptible. Fifty entries of coriander were also screened against root knot nematode (M. incognita) under artificial conditions in pots as well as in field. The accession UD-241 and UD-296 were found resistant under field conditions whereas UD-176, UD-241 and UD-296 were found resistant under artificial condition in pots.

The Jagudan centre has retained 140 from 166 collections evaluated. The centre screened 9 entries against powdery mildew as well as root knot nematode. The observation of PDI (Percent Disease Incidence) showed that none seems to be resistant to powdery mildew disease. However, its incidence was lower in released varieties viz., Guj. Coriander-1 and Guj. Coriander-2. On screening of coriander entries against root knot, all the entries exhibited moderately susceptible to highly susceptible reactions against both the species of Meloidogyne.

The Guntur centre holds 230 cultivated germplasm accessions. During 1995-96 rabi season,

110 new collections were made in collaboration with NBPGR, Hyderabad of which 50 collections have been evaluated for yield and yield attributes. Accession LCC-135 recorded highest yield of 817 kg/ha followed by LCC-156, LCC-137, LCC-133 and LCC-128 with 783, 767, 733, and 700 kg/ha respectively

Local surveys were conducted by Coimbatore centre during 1996 in the major coriander growing district of South Arcot, Trichy, Salem and Kamarajar of Tamil Nadu and this resulted in the collection of 16 composite types for further testing. The centre maintained a total of 182 accessions and they are evaluated during the period under report.

The Hisar centre maintained 158 accessions in coriander and they were evaluated using RCr-41 and Narnaul selection as checks. The seed yield of the germplasm accessions ranged from 325g/plot (DH-13) to 55g/plot. Out of the 58 accessions evaluated, 32 lines gave higher seed yield than Narnaul selection and 26 of them yielded higher than RCr-41.

Altogether, 95 germplasm accessions have been collected and maintained at Dholi, out of which 10 entries were found promising with respect to growth and yield characters. 21 coriander entries were screened at Dholi against *Cercospora* leaf spot disease, but none showed resistance against the disease. But Rajendra Swathi and UD-686 showed some resistance to stem gall and the rest of the varieties showed moderate resistance to stem gall

## 7.2 Initial Evaluation Trial (IET)

(Jobner, Jagudan, Guntur, Hisar, Coimbatore, and Dholi)

In the IET, 10 entries were tested at Jagudan and the yield differences were not significant among the entries, and also none of the entries gave higher yield than control. However, entries JCo-327 and JCo-331 gave 10.5 & 5.7 per cent higher yields respectively than control. The pooled analysis of 3 year's data showed significant yield difference; entries JCo-331, JCo-327 and JCo-58 gave higher yields but they were on par with control.

The trial was carried out during 1992-93 at Hisar with 9 accessions viz, DH-7, DH-132 and DH-22, DH-48, DH-52, DH-54, DH-84 and DH-138 along with the "Pant Haritima" as check. DH-52 gave the highest yield of 17.03 Q/ha followed by DH-13 (16.8Q/ha) and DH-48 (15.90 Q/ha).

Ten promising accessions selected from germplasm were evaluated at Guntur centre with "Sadhana" as check. Statistically significant difference was observed among the entries with regard to plant height, no. of primary branches, secondary branches, no. of umbels per plant, no. of umbellets per umbel and grain yield of 556 kg/ha which is superior over the check Sadhana (472 kg/ha), the other entries which are on par are ATP-77 (517 kg/ha), ATP-147 (494 kg/ha), ATP-102 (478 kg/ha) and "Composite" (472 kg/ha).

The trial was carried out during Rabi 1995-96 with 10 accessions along with check Co-3 at Coimbatore. Acc-1080 and Co3 (Check) recorded the highest grain yield of 0.883 kg/plot

In the trial laid out at Dholi with 10 entries, the maximum yield of 15.23 Q/ha was obtained in Accession No. UD-684, followed by UD-685, UD-686, DH-13, DH-48 and UD-20.

### 7.3 Multilocation trial (MLT-1993 Series II)

(Jobner, Jagudan, Coimbatore, Guntur, Hisar and Dholi)

The trial with eleven entries viz., UD-446, UD-447 and RCr-41 (Rajasthan), DH-36 & DH-38 (Haryana), J. Cori-64, J. Cori-123 (Gujarat), CC-402 & CC-964 (Tamil Nadu), ATP-77 & ATP-102 (Andhra Pradesh) was conducted from rabi 1993-94 onwards at Jobner centre. The maximum grain yield of 9.64 Q/ha was obtained from accession UD-446 closely followed by UD-447 (8.39 Q/ha), DH-36 (8.0 Q/ha) and -41 (7.97 Q/ha) while the lowest yield of 4.85 Q/ha was recorded in ATP-71; however in the mean of yield performance of the entries over 1993-94 & 1994-97, the maximum yield of 14.42 Q/ha was recorded by DH-36, closely followed by RCr-41 (13.50 Q/ha), J. Cori-123 (12.60 Q/ha), UD-447 (12.48 Q/ha), UD-446 (11.40 Q/ha) and DH-38 (10.54 Q/ha) while the lowest yield of 4.36 Q/ha was recorded from ATP-102.

The entries were tested at Hisar along with Narnaul selection (check) during 1993-94 and 1994-95. The maximum seed yield was obtained in DH-36 (22.6 Q/ha) which was on par with CC-964, DH-38, JCo-123 and UD-446.

The MLT-1993 with 11 entries was conducted at Jagudan. Even though there is significant difference in yield, none of the entries were superior over control. However, entries CC-964 & ATP-77 gave higher yield than the control. The pooled yield data of 3 years (Table 18) indicated significant yield differences and entries CC-964 and ATP-77 gave 11.88 and 9.90 percent higher yield over control respectively.

At Guntur the performance of the coriander entries especially from Hisar and Jobner were poor due to the non-receipt of rain after sowing. Among the remaining 7 entries and ATP-77 recorded highest yield of 567 Kg/ha which significantly superior over the check Sadhana (478kg/ha).

A total of 11 entries including Co-3 as control were evaluated during Rabi 95-96 at Coimbatore. The data on plant and yield characters were recorded. The yield among the entries differed from 0.216 to 0.733 kg/plot followed JCo-123 (0.700 kg/plot). Among these lines, CC-964 recorded the highest yield of 0.73 kg/plot as compared to Co-3 (0.267 kg/plot).

The trial with 9 entries viz., DH-36, DH-38, DH052, UD-446, UD-447, JCo-123, JCo-462, ATP-77, ATP-102 and Rajendra Swathi (check) was laid out at Dholi. The check Rajendra Swathi outyielded others with an yield of 14.17 Q/ha.

### 7.4 Comparative yield trial of leafy types of coriander (Dholi)

For identification of a green leaf type, a CYT was laid out with 11 entries to study the green leaf yield harvested after 40, 55 and 70 days of sowing at Dholi with entries GCo-64, GCo-123, GCo-43, LCC-15, LCC-32, UD-446, UD-447, ATP-77, Composite-4, Pant Haritima and Rajendra Swathi. The variety Pant Haritima was significantly superior for green leaves yield due to its lateness in



**Table 18: Yield performance of Coriander in MLT at Jagudan (1993-94 to 1995-96)**

Sl.No	Entry	Yield (Q/ha)			Average Yield (Q/ha)	Increase over control(%)
		1993-94	1994-95	1995-96		
1.	CC-462	16.35	9.56	9.17	11.21	3.03
2.	CC-964	16.53	10.14	11.11	12.09	11.12
3.	ATP-77	14.96	8.78	10.83	11.08	1.83
4.	ATP-102	14.76	7.68	9.93	10.41	-
5.	DH-36	11.99	7.06	6.66	8.22	-
6.	DH-38	9.82	6.35	6.39	7.20	-
7.	J.Co-64	15.42	9.76	8.82	10.85	-
8.	J.Co-123	16.53	9.26	8.75	11.05	1.56
9.	UD-446	13.06	8.17	7.15	9.05	-
10.	UD-447	9.49	7.75	6.73	7.60	-
11.	Guj.Cori-2	13.94	10.32	9.93	10.88	-
S.Emt . +		0.63	0.80	0.70	0.63	
C.D at 5% 1.85		2.38	2.05	1.87		
C.V %		7.75	16.21	13.93	11.59	

flowering; the highest yield of green leaves at 50 days was obtained in this and was on par with UD-446, UD-447. The rest of the entries are unsuitable for this purpose and hence Pant Haritima has been rated as the best green leaf yielder at later stages of the crop.

#### 7.5 Mutation breeding in coriander to evolve varieties with earliness and resistance to diseases.

(Jobner and Coimbatore)

Twenty progenies of coriander derived from 5, 10, 15 and 20 Kr doses of Gamma irradiation were evaluated at Jobner in two Initial Evaluation Trials with RCr-41 and UD-20 as checks. The trial was initiated in November 1993 and the vegetative and reproductive characters were recorded. The progeny 5 Kr-14 of IET- B produced maximum grain yield of 7.76 Q/ha followed by 20 Kr-5 of IET-A (7.71 Q/ha), 5 Kr-68 of IET-B (7.40 Q/ha) while checks RCr-41 and UD-20 gave 7.60 Q/ha 7.49 Q/ha respectively in IET-A and 7.19 Q/ha and 6.23Q/ha respectively in IET-B

## 7 6 Screening for wilt resistance in coriander

(Coimbatore)

One hundred and fifty three coriander germplasm accessions were screened at Coimbatore under natural condition for wilt resistance. Among the 120 accessions, none was free from wilt and the remaining 33 accessions showed wilt incidence.

Among the twelve accessions screened under IET, 3 accessions viz., 462, 496 and 806 recorded very low incidence of wilt viz., 3.5%, 2.8% and 3.8% respectively.

Of the eleven entries tested under CYT, only four entries recorded lower incidence of wilt viz., DH-36, DH-38, Co-3 and JCo-64 with 5.7%, 6.8%, 6.4% and 8.3% disease incidence respectively.

## 7 7 Survey to study disease incidence, collection and identification of causal organism

(Dholi)

A survey conducted by Dholi centre during 1995-96 in different coriander growing areas in five districts viz., Muzaffarpur, Siwan, Gopalganj, Darbhanga and Samastipur in North Bihar, revealed that the stem gall disease was very serious.

## 7 8 Studies on wilt and powdery mildew management in coriander

(Coimbatore)

The trial on biocontrol of coriander wilt was laid out at Coimbatore during rabi 1994-95 & 1995-96 with the variety Co-3. Presowing seed treatment with biocontrol agent Trichoderma viride, T. harzianum, Bacillus subtilis and Pseudomonas fluorescens was tested for their efficiency as compared to the fungicide Carbendazim. The wilt incidence in various treatments ranged considerably from 6.0 to 36.6 per cent. Among the treatments, seed treatment with T. viride followed by seed treatment of Carbendazim and T. harzianum recorded low level of incidence of 6.0, 6.5 and 8.5% respectively while maximum incidence of 36.6% was observed in control. The studies at Coimbatore has brought out a management technique involving a seed treatment with Trichoderma harzianum @ 4g/kg of seeds

A management technique studied using 9 different plant products/leaf extracts from six plants besides neem seed kernel extract, was conducted in coriander variety Co-3 at Coimbatore. The observation on the incidence of the disease as well as yield showed significant variation due to the plant products tested on the incidence of disease as well as yield. An eco-friendly technique of using 5% onion leaf extract as foliar spray was evolved at Coimbatore to control the powdery mildew. This technique reduced the incidence of disease from 88.0 to 64.75%.

## 7 9 Response of coriander to date of sowing and row spacing

(Jobner)

The experiment consisted of 15 treatment combinations including 5 dates of sowing (15 and 25

October, 4, 14 and 24 Nov) and a row spacing of 20, 30 and 40 cm. The interaction effect of date of sowing and row spacing on number of grains/umbel and seed yield was found to be significant. The first year's experimental finding revealed that maximum coriander seed yield of 8.34 Q/ha was obtained with "4th November sowing" 14th November at 20cm row spacing (7.55 Q/ha) and sowing on 25th October and 30 and 40cm spacing (8.16 and 7.55 Q/ha respectively).

#### 7.10 Response of coriander varieties to seed rate

(Jobner)

The experiment comprising of 3 varieties (RCr-41, UD-20 and UD-436) and five seed rates (12,14,16,18 and 20 kg/ha) comprising 15 treatment combinations was conducted during rabi 1994-95 at Jobner. The first year's experimental finding revealed that the coriander variety RCr-41 and UD-20 recorded maximum seed yield of 20.41 and 19.80 Q/ha, respectively with 14 kg/ha seed rate whereas variety UD-436 gave maximum seed yield of 14.07 Q/ha with a seed rate of 12 kg/ha.

#### 7.11 Quality evaluation in coriander

(Jobner)

The volatile oil content of 11 coriander entries tested under CYT were determined during 1993-94 & 1994-95; the volatile oil content ranged from 0.2 to 0.4 % in coriander seeds. The best entries are JCo-64 (0.375%) followed by ATP-77 (0.35%) in mean performance of over two years. The total yield of volatile oil depends upon the grain yield which was found to be the highest in UD-446 (2.89 l/ha) followed by J. Cori-64 (2.728 l/ha), UD-447 (2.517 l/ha). These entries (CYT) were given to Coimbatore, Hisar and Dholi centers and the volatile oil contents determined. The results indicated that environmental conditions play an important role in determining the quality of the produce; it was observed that entry CC-964 has shown maximum volatile oil content of 0.5% when grown at Tamil Nadu compared to the same variety grown at Hisar and Jobner with 0.4% at 0.3% respectively. About 14 mutant lines of coriander variety UD-20 were evaluated for volatile oil content at Jobner and these lines have shown higher volatile oil content as compared to control

## CUMIN

### 1. Germplasm collection, description, evaluation and screening against diseases

(Jobner and Jagudan)

A total of 266 including 258 indigenous and 8 exotic accessions were maintained at Jobner centre. In the screening for wilt, seven entries viz., UC-220, UC-223, JC-124, JC-136, JC-150, Local and RZ-19 were evaluated at Jobner. Out of these seven evaluated, the percent mortality due to disease incidence was the lowest in UC-223 (6.25%) followed by JC-136 (15.61%), producing a grain yield of 2.71 Q/ha and 2.32Q/ha respectively.

During 1995-96, cumin growing areas in Gujarat were surveyed and 86 entries were collected by Jagudan; a total of 323 indigenous and 7 exotic collections were maintained at Jagudan centre. Three entries were critically examined and screened for morphological and yield diversity and based on genetic diversity, 200 accessions were selected and retained.

In the disease resistance screening programme during the year, out of the 8 entries screened at Jagudan, three exotic entries viz., EC-232684, EC-243373 and EC-243375 were found to be resistant against *Fusarium* wilt under wilt sick plot condition, whereas out of the nineteen entries screened against blight and powdery mildew diseases, none of the entries were found resistant either against blight or powdery mildew. In the screening against root knot nematodes in the 7 entries, an exotic culture EC-109635 and culture JC-105 were found moderately resistant against *M. incognita* and *M. javanica* respectively.

## 8.2 Initial evaluation trial

(Jagudan)

Ten entries, seven exotic and two indigenous were tested, with Guj. Cumin-2 as check. The trial was laid out in November 1994 and the yield and yield contributing characters recorded; the yield differences were nonsignificant among the entries. However, the entries EC-279081, JC-105 and EC-279054 were found to be superior than the control. The pooled data three years (Table 19) showed significant yield differences and the entry EC-278081 gave 14.73% higher yield over the control.

## 8.3 Multilocation trial (MLT - 1994 - Series II)

(Jagudan and Jobner)

In the MLT-II 1994, seven entries were evaluated at Jagudan. The yield differences were significant among the entries, but none of the entries was found to be significantly superior over the control viz., Guj. Cumin-2. However, entries EC-279081 and EC-232684 gave 26.87 and 6.57 per cent higher yield over the control respectively.

Eight entries viz., UC-217, UC-220 and UC-223 (Rajasthan) JC-124, JC-136 and JC-150 (Gujarat) including two checks were evaluated at Jobner (1994-95). The yield and yield attributing characters were recorded and analysed; this gave significant difference for days to 50% flowering, branches per plant, umbels per plant and grain yield. The accession UC-223 continued to show superiority with respect to grain yield as well as low incidence of wilt; it recorded an yield of 2.71 Q/ha closely followed by JC-136, (2.32 Q/ha), JC-124 (2.11 Q/ha), UC-217 (2.01 Q/ha) and UC-220 (1.85 Q/ha) while the lowest yield of 1.21 Q/ha was recorded in the "Local check."

**Table 19: Yield performance of cum in Initial Evaluation Trial at Jagudan (1993 - 94 to 1995 - 96)**

Sl.No.	Entry	Yield (Q/ha)			Average Yield (Q/ha)	% increase over control
		1993-94	1994-95	1995-96		
1.	EC-232684	6.95	6.67	6.68	6.77	---
2.	EC-243373	4.21	7.38	6.40	6.00	---
3.	EC-233375	5.48	7.38	5.82	6.23	---
4.	EC-279053	6.64	7.78	7.22	7.15	---
5.	EC-279081	6.49	7.89	7.99	7.46	---
6.	EC-279081	6.84	9.39	9.49	8.57	14.73
7.	EC-109635	7.53	8.83	6.98	7.78	4.15
8.	JC-59	7.57	6.61	7.01	7.06	1.56
9.	JC-105	6.56	7.22	8.03	7.27	---
10.	G.C-2(control)	7.63	7.89	6.89	7.47	---
S.Emt.±		0.45	1.35	0.66	0.51	
C.D at 5%			1.35	NS	NS	1.43
C.V%		11.98	30.26	15.67	21.81	

#### 8.4 Mutation studies and hybridisation programme (Jagudan)

To induce genetic variability, cum in seeds were treated with different doses of EMS (0.0625, 0.125, 0.25, 0.50, 0.75 and 1.00 per cent) and the mutant plants were harvested separately.

In the hybridization programme, successful crossing of "hairy cum in" and for further evaluation, "white flower cum in" with Gujarat Cum in-2 was done and sufficient seeds were collected.

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

An experiment with 10 treatments was conducted to assess the effect of crop rotation on yield and wilt infection of cum in at Jobner centre. The experiment was started in 1984-85 and the eleven years experincental date revealed that a three years croprotation ie, cluster bean-cum in-

cluster bean wheat-culster bean mustard recorded the highest yield of 257.6 kg and a wilt percentage of 36.5% as against 88.85 kg of yield and 63.32% wilt percentage respectively under one year crop rotation with cluster bean (Table 20)

In another experiment to control cumin wilt disease, six treatments viz., soil solarisation, spraying of Captan (0.3%) Bavistin 0.1%, Thiram 0.3%, Trichoderma (0.4%) were evaluated for their effect on wilt. The trial was laid out under irrigated conditions and the per cent disease incidence and yield showed significant differences. Solarisation reduced the disease incidence (22.87%) resulting in maximum grain yield of 2.475 Q/ha. The "control" resulted in maximum disease incidence (87.21%) and the lowest yield viz., 0.05 Q/ha as compared to all other treatments.

**Table 20: Effect of crop rotation on cumin yield (kg/ha) and wilt (%) at Jobner**

Year	Treatments									
	CR-1	CR-2	CR-3	CR-4	CR-5	CR-6	CR-7	CR-8	CR-9	CR-10
1984-85										
Wilt	44.9	33.5	34.5	39.8	33.9	44.1	46.8	30.9	39.1	31.5
Yield	199.6	185.2	179.1	179.1	222.2	148.1	118.5	307.3	144.4	151.2
1985-86										
Wilt	49.8	55.9	--	--	--	--	--	--	--	--
Yield	148.1	59.2	--	--	--	--	--	--	--	--
1986-87										
Wilt	62.2	49.6	50.0	58.4	57.4	50.0	--	--	--	--
Yield	62.9	92.5	74.1	48.1	48.1	74.6	--	--	--	--
1987-88										
Wilt	48.9	55.5	--	--	--	--	40.2	32.1	--	--
Yield	103.7	125.9	--	--	--	--	130.6	177.7	--	--
1988-89										
Wilt	50.8	44.2	40.1	50.5	41.2	37.8	--	--	42.6	30.2
Yield	177.7	174.0	203.7	229.6	181.5	229.6	--	--	299.9	277.7
1989-90										
Wilt	58.7	68.3	--	--	--	--	--	--	--	--
Yield	3.7	3.7	--	--	--	--	--	--	--	--

1990-91										
Wilt	59.3	44.7	45.2	41.2	53.7	51.1	48.6	33.0	--	--
Yield	48.1	70.9	125.9	174.0	170.4	177.7	340.7	414.7	--	--
1991-92										
Wilt	74.7	70.4	--	--	--	--	--	--	--	--
Yield	74.1	236.3	--	--	--	--	--	--	--	--
1992-93										
Wilt	81.6	64.8	53.8	38.2	41.1	35.7	--	--	39.1	32.6
Yield	6.5	12.0	63.8	134.2	94.4	114.3	--	--	186.1	214.8
1993-94										
Wilt	88.8	84.4	--	--	--	--	54.4	49.8	--	--
Yield	4.7	7.4	--	--	--	--	112.0	130.6	--	--
1994-95										
Wilt	79.51	69.52	51.54	48.95	45.41	44.21	--	--	--	--
Yield	6.48	10.19		79.63	89.81	96.76	102.31	--	--	--
Average										
Wilt	63.54	63.32	45.86	46.15	43.82	43.81	47.3	36.5	40.3	31.4
Yield	75.99	88.9	121.0	142.48	135.56	141.1	175.4	257.6	210.1	247.9
Year Average										
Wilt	63.4			44.8			41.9			38.8
Yield	82.4			135.0			216.5			229.0

## 8.6 Epidemiological study of *Alternaria* blight of cumin

(Jagudan)

Experiments were conducted at Jagudan to study the epidemiological parameters, which accounts for the quantitative relationship of weather factors, crop factors and pathogen/disease development during the epidemic under natural conditions. The data pertaining to disease characters revealed that lower intensity of *Alternaria* blight of cumin was observed in "early sown crop" and also gave a higher yield. Moreover, crop age, mean relative humidity and sunshine hours exhibited a significantly positive correlation whereas significantly negative correlation was found with minimum mean and morning temperature in relation to development of blight disease

## 8.7 Integrated management of diseases and pests of cumin

(Jagudan)

The experiment on integrated management of diseases and pests was started in 1995-96 at

Jagudan with 3 main treatments and 11 subtreatments to find out an economically integrated management schedule. The main treatment consists of seed treatment and soil application of Trichoderma harzianum and seed treatment of Carbendazim @ 0.1% + soil application of T. harzianum with sub-treatments of spraying with different combinations of pesticides. Spraying of Mancozeb was found to be superior to manage the blight disease in comparison to other fungicidal sprays.

## 8.8 Quality evaluation in cumin

(Jobner)

The volatile oil content of 7 cumin entries tested under CYT ranged from 3.3 to 4.5%. The highest volatile oil of 4.5% was recorded in JC-124 followed by 4.4% in JC-150, 4.2% in UC-220, and 4% in "local check" and the minimum of 3.3% in RZ-19. The total yield of volatile oil depends upon the grain yield and the percentage of oil present in the seed. The varieties having higher volatile oil yield are important for value-added purposes and export. The volatile oil yield was found to be the highest in UD-223 (10.02 t/ha) followed by JC-124 (9.495 t/ha) and JC-136 (9.048 t/ha).

The volatile oil constituents and correlation with wilt resistance in cumin were determined at Jobner. Earlier studies reported that the growth of wilt pathogens (Fusarium oxysporum) was inhibited in the presence of volatile oil of cumin and the infection varied from variety to variety. The main components of volatile oil in cumin varieties were determined at molecular level using GLC. The ratio of oxygenated components, and hydrocarbons were determined and this was correlated with wilt resistance. Higher oxygenated components were responsible for wilt resistance.

## FENNEL

### 1. Germplasm collection, description, evaluation and screening against diseases

(Jobner, Jagudan, Hisar and Dholi)

The Jobner centre holds a total of 144 accessions (134 indigenous and 8 exotic) which includes two new accessions collected from Tonk area during 1995-96.

Jagudan has a total of 319 collections (299 indigenous and 20 exotic), out of which 134 accessions were retained. Survey for enrichment of fennel collections carried out during 1995-96 which gave 125 accessions. The centre has made new selections in fennel crop. The following selections were made from germplasm material with a view to develop an early, dwarf and high yielding variety.

Details	No. of Plants Selected	Objective
Compact umbel with compact umbellates having more seeds	9	Improvement of yield



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Selection for earliness	7	For earliness
Selection for dwarfness	7	For dwarfness
Less leafy types	4	For morphological variability
More branches	8	For morphological variability
Variant types	6	For morphological variability

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Exotic fennel entries were field-screened at Jagudan against Ramularia blight disease along with Guj. Fennel-1. Most of the entries (Rabi planted) were found to be resistant to Ramularia blight under natural conditions, except EC-243376-1, EC24199-2 and EC-24199-3 and Guj. Fennel-1.

Twenty nine fennel accessions were evaluated at Hisar during the last 4 years. The seed yield ranged from 245.0g (HF-123) to 371.3g per plot (HF-102); fourteen lines gave higher seed yield than check PF-35. The most promising lines identified are HF-104, HF-106, HF-110, HF-199 and HF-122. These lines were maintained by sibmating under muslin cloth and the selfed seeds of all the lines have been harvested.

Twenty four germplasm have been collected and maintained at Dholi; among them, RF-17 produced significantly higher yield.

## 9.2 Initial evaluation trial (Jagudan)

Seven entries were tested in the IET at Jagudan. The yield differences were non-significant; however, an entry viz., JF-200 gave 25.70 per cent higher yield than the check.

## 9.3 Multilocation trial (MLT-1994 Series II) (Jagudan, Jobner & Hisar )

The MLT 1994 Series-II with 8 entries consisting of UF-125, UF-133, UF-134 (from Rajasthan), JF-25, JF-29 (from Gujarat), HF-71 and HF-102, HF-104 (from Haryana) along with local check were evaluated at Jobner, Jagudan and Hisar centres.

At Jobner, significant differences were observed among the entries evaluated for all the characters. The entry UF-125 recorded maximum grain yield of 15.75 Q/ha followed by JF-25 (13.50 Q/ha), local check (13.13 Q/ha) HF-102 (12.75 Q/ha) & JF-29 (12.13 Q/ha) while the lowest yield of 10.75 Q/ha was recorded by UF-133. The mean performance of the entries observed in 1993-94 and 1994-95 recorded a maximum grain yield of 13.37 Q/ha by UF-(M)-1 followed by UF-112 (11.14 Q/ha) and UF-101 (10.93 Q/ha) while the lowest yield of 9.39 Q/ha was observed from

UF-133.

In the evaluation of CYT entries, the yield differences were significant among the entries at Jagudan. An entry JF-29 gave the highest yield of 13.33 Q/ha which was 10.6% higher than control and the pooled data over two years (1994-95 and 1995-96) presented in Table 21 showed significant yield differences. But none of the entry was found to be significantly superior over the check. However entry JF-29 gave the maximum yield of (14.43 Q/ha) which was 10.80 % higher than "control".

In the CYT at Hisar, observations were recorded and significant differences were noticed for all the parameters. The maximum seed yield (20.9 Q/ha) was recorded in the entry JF-25 which

**Table. 21 Yield performance of Fennel in MLT at Jagudan (1994-95 to 1995-96)**

Entry	Yield (Q/ha)		Average yield (Q/ha)	% yield increase over control
	1994-95	1995-96		
JF -25	14.17	11.11	12.64	-
JF-29	15.52	13.33	14.43	10.80
UF-125	13.42	9.70	11,56	-
UF-133	8.11	6.41	7.26	-
UF-134	8.98	6.89	7.94	-
HF-71	11.77	7.66	8.72	-
HF-102	10.68	7.78	9.23	-
HF-104	-	8.04	8.04	-
G.F.1 (ch)	13.99	12.05	13.02	-
M.+-	1.35	0.28	0.66	
0.5%	3.93	0.83	1.87	
%	21.99	5.84	17.72	

was however at par with HF-104 and UF-125.

#### 9.4 Mutation studies and crossing programmes in fennel (Jagudan)

To create genetic variability in fennel, the seeds were treated with different doses of EMS (0.0625, 0.125, 0.50 and 0.75 and 1.00%) and the maximum germination per cent was obtained

with 0.062% doses of EMS and no germination was noticed in doses of 0.50% and above. The mutant plants were selected and seeds harvested.

Besides mutation studies, crossing programmes were also initiated in fennel at Jagudan. Crosses were made with exotic cultures and bloomless cultures with Guj. Fennel and the F1 seeds were harvested for inheritance studies.

#### 9.5 Response of fennel to weed management

(Jobner and Hisar)

The weed management experiment at Hisar comprised of 4 herbicide treatments viz., Fluchloralin, Pendimethalin, Isoproturon and Oxyfluorfen each at two higher concentrations and one lower dose of herbicide, given 45 days after sowing; along with one hand weeding, two hand weedings alone, "weed free" and "weedy control" comprising of 16 combinations. The major weed flora noticed in the experimental field were Chenopodium album, C. murale, Coronopus, Tribulus terrestris, Portulaca oleracea, Cyperus rotundus and Cynodon dactylon. The weed control studies conducted during 1992-94, 1993-94 and 1994-95 indicated that all the treatments significantly reduced the weed populations and the weed dry weight compared with weedy check. In the studies, the maximum seed yield was recorded in "weed free", closely followed by Pendimethalin at 1.0 Kg/ha plus one hand weeding at 45 DAS and Pendimethalin at 1.5 Kg/ha without hand weeding. It is evident that data regarding the comparative economics of different treatments, Pendimethalin at 1.0 Kg/ha supplemented with one hand weeding resulted in the highest net return (Rs. 16,066/ha) followed by "weed free" (Rs. 15,800/- per ha) over "weedy check".

In the weed management trials concluded at Jobner during 1994-95, the three years, pooled data indicated that weed free plot (hand weeding thrice) produced the best mean seed yield of 10.19 Q/ha with a net profit of Rs. 15177/ha and with a "Benefit: Cost ratio" of 1:3.35 followed by application of Pendimethalin 1.0 Kg/ha + hand weeding once (8.67 Q/ha) with a Benefit : Cost ratio of 1:2.75 and a net profit of Rs. 12,225/- as compared to a net profit of Rs. 394/-

#### 9.6 Quality evaluation studies.

(Jobner)

The volatile oil contents of 8 entries of fennel (tested under CYT at Jobner) ranged from 1.5 to 2.0 per cent. The best entries in fennel with respect to volatile oil content are HF-138, HF-71 (2%) Local (1.9%) UF-134, UF-133 and JF-25 (1.8%)

## FENUGREEK

### 1. Germplasm collection, maintenance, evaluation and screening against diseases

(Jobner, Jagudan, Coimbatore, Guntur, Hisar and Dholi)

The Jobner centre holds a total of 320 accessions in fenugreek which includes 293 indigenous 12 exotic type plus the 15 new collections made during 1995-96 from Mandasour district of Madhya Pradesh. The 30 accessions collected from Pratapgrah tehsil of Chittorgrah were also evaluated. The accessions namely UM-288 and UM-295 were identified with better yielding ability than RMT-1, while five accessions viz., UM-272, UM-286, UM-278 and UM-299 showed low incidence of powdery mildew.

With a view to collect diverse genotypes of fenugreek, the Jagudan centre surveyed the major areas and 23 new entries were collected, A total of 71 entries are retrieved (out of a total of 146 collections) which included 69 indigenous and 2 exotic collections.

The Guntur centre evaluated 73 collections, LFC-53 recorded highest yield of 633 kg/ha followed by LFC-59, LFC-33, LFC-9 and LFC-39 with an yield of 600, 600, 567 and 517 kg/ha respectively.

Out of the eighty two accessions of fenugreek evaluated at Hisar, 69 accessions gave higher seed yield. The seed yield of the germplasm material ranged from 9.8 Q/ha (HM-224) to 22.9 Q/ha (HM-269). The most promising lines were HM-204, HM-206, HM-214, HM-226, HM-233, HM-238, HM-269, HM-293, HM-299 and HM-315.

The Coimbatore centre maintained a total of 146 accessions; during the period, new accessions were added, viz., four each from Hisar and Jobner. The accessions were evaluated for their performance during rabi 95-96; 104 accessions recorded higher yield than the ruling variety Co-1.

Fenugreek germplasm (100) was collected and maintained at Dholi; among these, 8 lines performed better. Among the nine accessions screened against the Cercospora leaf spot disease, HM-103 was resistant to the disease.

Nineteen fenugreek entries were screened against powdery mildew disease at Jagudan. An exotic entry EC-257566 and Kasurimethi were found completely free this disease.

In the screening against root knot nematode, out of 36 varieties tested at Jobner (in pots as well as in field), only UM-32 was found resistant against M. incognita and M. javanica.

### 10.2 Initial evaluation trial (IET)

(Coimbatore & Hisar)

In fenugreek, two IETs were conducted simultaneously. The trial with 9 accessions along with "Pusa Early Bunching" (as check) was conducted at Hisar (1992 to 1996); the results indicated that HM-103, HM-110, HM-114, HM-291 and HM-305 gave higher seed yield than that of the check.

In the IET at Coimbatore, 9 promising accessions were evaluated (Rabi 95-96). The observation recorded on plant characters and yield gave significant yield differences among the accessions. High grain yield was recorded in Accession No.390 compared to variety Co-1. In the evaluation of CF-390 and CF-464, the percentage of increase in yield over Co-1 was 73.2 in respect of CF-390 and 52.0 in respect of CF-464. The yield obtained was 433 kg/ha and 380 kg/ha in CF-390 and CF-464 as against 250kg in Co-1.

### 10.3 Multilocation trials

#### 10.3.1 Multilocation trial (Series II, 1993)

(Guntur, Coimbatore, Jobner, Jagudan, Hisar and Dholi)

The MLT (1993 Series II) was conducted with 9 entries in all the seed spices centres.

The trial was laid out at Hisar, with entries viz., CF-169 and CF-390 (Coimbatore), HM-103 and (Hisar), J. Fenu. 145 and J. Fenu. 148 (Jagudan), UM-143 and UM-144 (Jobner) along with local check. The study resulted in significant differences for all the parameters except length of pod. Maximum seed yield was recorded in HM-57 (check) which was on par with HM-103, J. Fenu. 145 and J. Fenu 148 and UM-143.

At Guntur, among the eight entries tested, UM-44 recorded the highest yield of 522 kg/ha which is significantly superior over check Lam Sel.1 (433 kg/ha). In the evaluation, significant differences among the entries were observed with regard to yield attributes like plant height, no. of branches, no. of pods per plant and no. of seeds/pod.

The trial conducted at Jagudan with 9 entries gave significant yield differences among the entries; the entry JF-145 gave an yield of 23.09 Q/ha followed by HM-103 (22.10 Q/ha) which were 15.45 and 10.45 per cent higher than the check respectively. However, the three years' pooled data did not show any significant differences among the entries.

In the MLT of fenugreek at Jobner, of the 10 entries evaluated, RMT-1 recorded the maximum grain yield of 23.57 Q/ha followed by UM-143 (22.27 Q/ha), HM-103 (22.0 Q/ha), UM-144 and HM-141 (21.22 Q/ha) and JF-145 (20.83 Q/ha) while the lowest yield of 14.19 Q/ha was recorded in local check. The mean yield of two years also revealed the superiority of RMT-1 (25.74 Q/ha) followed by HM-103 (22.57 Q/ha), UM-143 (22.47 Q/ha,) UM-144 (21.33 Q/ha) and J. Fenu. (19.81 Q/ha) while lowest yield 17.49 Q/ha was recorded in CF-169.

At Dholi, out of the 8 entries tested, the check variety Rajendra Kanti produced the maximum grain yield of 13.54 Q/ha. In the trial conducted at Coimbatore with 8 accessions with Co-1 as control, the grain yield per plot significantly varied to 0.343 kg/plot followed by the accessions HM-41 and CF-390 with yields of 0.318 and 0.310 kg/plot respectively as compared to Co-1 (0.264 kg/plot); the plot size was 2.5m x 4.0m.

In a 'Station trial' of fenugreek conducted with 11 entries at Banswara (Jobner), in the mean performance of entries evaluated during 1993-94 and 1994-95, the entry UM-143 recorded the maximum grain yield of 16.88 Q/ha followed by UM-144 (16.68 Q/ha), UM-127 (12.91 Q/ha), UM-128 (10.52 Q/ha) and UM-117 (9.83 Q/ha) as against 8.67 Q/ha for RMT-1,(check)

### 10.3.2 MLT 1996 Series III

(Guntur, Dholi)

A new MLT (1996-95 - Series III) with 11 entries from different centres initiated/will be started during the period under report. In this trial, at Guntur centre, significant differences were observed with regard to plant height, number of branches, no. of pods/plant, length of pods etc. With regards to the yield, JF-102 recorded the highest yield of 544 kg/ha followed by JF-58 with 511 kg/ha which are significantly superior over check Lam Sel.1 (493 kg/ha).

### 10.4 Evolving varieties resistant to powdery mildew through mutation breeding and crossing programmes

(Jobner and Jagudan)

Mutation studies were initiated in 1988-89 in fenugreek (RMt-1) at Jobner with gamma rays. Forty four progenies including 31 of M6 and 13 of M7 generations derived from RMt-1 treated with 20, 30 and 40 Kr) dose of gamma radiation were evaluated. Of the 44 progenies of fenugreek evaluated in IET during 1992-93, 93-94 and 94-95, data indicated that progeny 40 Kr 3-4 yielded maximum grain yield of 15.06 Q/ha combined with low incidence of powdery mildew, followed by the entry 40 Kr 1-15 (13.75 Q/ha).

To create genetic variability, fenugreek seeds were treated with different doses of EMS (0.125, 0.25, 0.50, 0.75 and 1.0 per cent) at Jagudan. The highest germination was obtained in 0.125 dose and the percentage of germination reduced in higher doses of EMS. The mutant plants were selected and seeds harvested for further evaluations.

Under crossing programme in fenugreek at Jagudan, the Kasuri and Australian cultures were crossed with local Methi and the F1 seeds were collected.

### 10.5 Effect of time of sowing and spacing in the yield of fenugreek

(Coimbatore, Dholi and Hisar)

An experiment was conducted at the three centres to find out the optimum time of sowing and suitable spacing for higher seed yields in fenugreek. The trial was laid out in 1995 with six dates of sowing and three levels of spacing at Coimbatore.

In the study at Hisar, significant differences were observed for all the parameters except length of pods, seeds per pod. During the two years (1994-95 and 1995-96), maximum seed yield was obtained when the sowing was done on 5th November, followed by 20th October adopting a spacing of 30cm x 10cm.

A similar trial with three spacings and five dates of sowing in fenugreek conducted at Dholi with Rajendra Kanti viz., 30cm x 10cm, 30 x 15cm, 30 x 20cm and date of sowing viz., 1st October, 1st November, 15 October, 15 November and 1st December. The study recommended the most optimum spacing as 30cm x 10cm and optimum date of sowing as 15th October for cultivation of fenugreek in Bihar.

## 10.6 Response of fenugreek to weed management

(Jobner)

The experiment consisted of 4 herbicides viz., preemergent application of Oxyfluorfen, Metalocholor and Pendimethalin and pre-planting dose of Fluchloralin each at 2 levels and the lower dose was supplemented with hand weeding once at 50 DAS, unweeded control, hand weeding once (25 DAS) and twice (25 and 50 DAS) and "weed free" was conducted for three years at Jobner. To obtain higher yield, one application of pre plant Fluchloralin@ 0.75 kg/ha and/or pre-emergent application of Oxyfluorfen @ 0.15 kg/ha, both supplemented with a hand weeding, once to keep the crop weed free and this packages being recommended for adoption.

## 10.7 Response of fenugreek to nitrogen, phosphorous and Rhizobium cultures

(Jobner)

An experiment consisting of 12 treatment combinations included nitrogen (20 and 40 kg/ha) phosphorus C20 and 40 kg/ha) and with and without Rhizobium culture with the variety RMT-1 sown on 12 November 1994, using a seed rate of 20 kg/ha. The N&P were applied on yield and yield attributes. A harvest index was also worked out. The first year experimental finding revealed that fenugreek did not respond to applied nitrogen, phosphorous and rhizomes culture. This might be due to application of 15T of FYM/ha during each preceding kharif season (1994) and rabi 1994-95.

## 10.8 Biocontrol of root rot disease

(Coimbatore)

The trial on biocontrol of root rot in fenugreek was carried out at Coimbatore for the management of root rot in fenugreek. A presowing seed treatment with Trichoderma viride combined with the application of 150 Kg/ha neem cake effectively reduced root rot disease incidence and gave maximum grain yield of 350 Kg/ha. (Table- 22) This treatment was closely followed by the combined application of neem cake @ 150 kg/ha plus seed treatment with Carbendazim plus soil application of T.viride 20 days before sowing.

Table. 22 Biological control of root rot of fenugreek in Coimbatore

Sl. No	Treatment	Root rot (%)	Yield (Kg/ha)
1	Seed Treatment with Carbendazim + soil drenching	16.0	325
2	Seed Treatment with <u>T. viride</u>	9.2	300
3	Soil application of neem cake @150 Kg/ha	12.7	275
4	Soil application of <u>T. viride</u> 20 DBS	5.5	275
5	Application of neem cake 150 Kg/ha with T. viride + Seed treatment.	4.8	350
6	Seed Treatment with <u>T. viride</u> + Soil application of <u>T.viride</u> 20 DBS	5.0	275
7	Application of Neem cake + seed treatment with Carbendazim and soil drenching	8.7	290
8	Control	30.6	220
CD (P = )		6.28	16.5

**GERMPLASM HOLDINGS OF DIFFERENT SPICES  
AT THE COORDINATING CENTRES(as on 31-03-1996)**

**BLACK PEPPER**

Panniyur	77
Sirsi	62
Chintapalli	52
Yercaud	106

**CARDAMOM**

Pampadumpara	91
Mudigere	245

**LARGE CARDAMOM**

Gangtok	34
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**GINGER**

Pottangi	155
Solan	134
Dholi	30

**TURMERIC**

Pottangi	197
Solan	184
Jagtial	188
Dholi	60

**CLOVE**

Yercaud	13
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**NUTMEG**

Yercaud	15
---------	----

**CINNAMON**

Yercaud	11
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**CORIANDER**

Jobner	733
Jagudan	140
Guntur	230
Coimbatore	182
Hisar	58
Dholi	95

**CUMIN**

Jobner	226
Jagudan	200

**FENNEL**

Jobner	144
Jagudan	134
Dholi	34
Hisar	29

**FENUGREEK**

Jobner	320
Jagudan	71
Guntur	73
Coimbatore	146
Hisar	82
Dholi	100



## LIST OF COORDINATING CENTRES UNDER AICRP ON SPICES

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(Andhra Pradesh Agrl. Univ.)  
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(Dist. Visakhe)
6. Agricultural Res. Station (Pepper)  
(Univ. of Agrl. Sciences)  
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## FUNCTIONING OF THE COORDINATED PROJECT

India continues to hold the pre-eminent position in production and export of spices in the world. Rightly called as the "Home of Spices", over 50 different spices are grown in this country which are very popular and in demand throughout the world. Spices like black pepper, small cardamom, chillies, ginger, turmeric, large cardamom, cumin, coriander, fennel, fenugreek, clove, Nutmeg, cinnamon, garlic, saffron and perhaps onion are the important ones. We grow spices in about 2.3 Million ha and the production is approximately 2.6 MT per annum, valued at about Rs. 65,000 Million. About 90% of the Spices produced are domestically consumed by us, leaving only about 5-10% for export. During 1995-96, we exported 1,79,000 tonnes, worth Rs.835 crores and the major importing countries have been the USA, UK, Russia, Japan, Canada, Saudi Arabia, Bangladesh, Germany, France, Australia, Sri Lanka, etc. The major states growing these Spices are Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Gujrat, Maharashtra, Orissa, West Bengal, Uttar Pradesh, Madhya Pradesh, and the North Eastern Region. Of late, the non-traditional areas in Andhra Pradesh and the North Eastern Region are gaining importance in introduction and expansion of area grown to Spices.

Over the years, there has been a steady increase in the value of export of spices, even though the real increase in volume has not been proportionate to the increase in demand the world over. There is hence immense scope to expand/increase the exportable surplus, especially in chillies, black pepper, cardamom, ginger, cumin, fennel and turmeric. Recently, turmeric and cumin have made greater impact in the export front. The Centrally Sponsored Scheme of the Govt. of India for Integrated Programme for Development of Spices with a sizeable outlay of Rs.125 crores for the entire VIII Plan has yielded dividends. Nevertheless, the investment on spices research has not been very encouraging, but has been an important catalyst to improve the productivity of these group of crops. The consciousness towards quality and our march towards ISO 9002 as well as the emerging markets of the European Union, the Unified Germany, etc. are to be recognised.

It is in this context, the progress in the performance of the network of Research Centres under the AICRP on Spices gain special significance. Over the years, the number of Centres has risen - from 4 in 1971 to 20 during 1995-96. During the period under report (1995-96), 4 new Centres have been initiated in the States of West Bengal, Uttar Pradesh, Madhya Pradesh and Maharashtra. The recommendation of the Parliamentary Committee have been implemented and the new centres were started at viz., (i) Pundibari (West Bengal - Bidhan Chandra Krishi Vishwa vidyalaya), (ii) Dapoli (Maharashtra - Konkan Krishi Vidyapeeth), (iii) Raigarh (Madhya Pradesh - Indira Gandhi Krishi Vishwa Vidyalaya), and (iv) Kumarganj (Uttar Pradesh - Narendra Dev University of Agriculture & Technology), the crops to be researched upon have been selected and the experiments located at the right place in consultation with the University authorities. The seed material for the various experiments for the new Centres have already been mobilised and the crops are in the field. This marks a new era in the network of the AICRP on Spices because almost all the major states in the country are covered under the Spices Project, except Punjab and Jammu & Kashmir. In fact the Project has now become rather unwieldy, with the 20 Centres spread out in 15 States and under the purview of 15 State Agricultural Universities besides an ICAR Institute. In addition, we also have & voluntary Centres, reporting to us based on the technical programmes

assigned to them during the various Workshop/Group Meetings. Hence the mandatory crops of the Spices Project, as updated are:

- |                   |                 |
|-------------------|-----------------|
| 1. Black Pepper   | 7. Coriander    |
| 2. Small Cardamom | 8. Fennel       |
| 3. Large Cardamom | 9. Fenugreek    |
| 4. Ginger         | 10. Clove       |
| 5. Turmeric       | 11. Nutmeg, and |
| 6. Cumin          | 12. Cinnamon    |

It is also proposed to include if possible crops like Ajowan, Celery, etc. during the upcoming years.

The sanctioned budget of the Coordinated Project for the year 1995-96 was Rs.85.00 lakhs and the funds were disbursed by the ICAR headquarters through the different SAUs. The performance of the various Centres were regulated by the discussion held in the consecutive Spices Workshops that have been attended by the Scientist from all the coordinating Centres. It is pertinent to mention here that during the period under report, the XIII Workshop/National Group Meeting was held at Jaipur during August 1995. The various recommendations made during the Workshop have been aptly followed/pursued by/with the different Coordinating Centres. The four new Centres also were represented in the workshop for the first time with their representative nominated by the University. The various recommendations made by the QRT have also been discussed in the Jaipur Workshop. A significant activity during the Jaipur Workshop has been the recommendation for release of nine varieties of Spices viz., two each in turmeric, ginger & cinnamon and one each in coriander, cardamom & black pepper.

## PERFORMANCE OF THE CENTRES

### **Black Pepper Centres :**

The work at Sirsi, Panniyur and Chintapalli Centres have been satisfactory; the work has also been initiated at the three Cardamom Centres viz., Yercaud, Pampadumpara and Mudigere, but the progress has been satisfactory only in Yercaud. The Mudigere Centre could not take up the programme due to lack of financial support. The multilocation trial laid out at the Voluntary Centre at Ambalavayal (KAU) could not be pursued properly due to want of the Horticulturist at that Centre. A few lakhs of rooted pepper cutting have been produced and distributed from the Panniyur Centre and there has been a heavy demand for the planting material. The Plant Pathologist at Panniyur and Sirsi centres have been active in laying out field control trials against the Phytophthora foot rot disease by including the biocontrol agents. The post of Plant Pathologist at Chintapalli has been vacant and this has affected the programmes.

### **Cardomom Centres :**

The work at Mudigere and Pampadumpara centres have been progressing quite satisfactory. The Yercaud centre which was discontinued from cardamom work has been entrusted with the black pepper and tree spices. The Mudigere Centre has made substantial progress and successfully got recommended the variety Mudigere-2 at the Jaipur workshop, August 1995. The results from the "coir mat shade experiment" has yielded significant results at Mudigere centre as well as the experiment to standardise the optimum production of suckers. The Pampadumpara Centre has been maintaining its progress and requires some more input on black pepper research, in view of this crop becoming more popular in the zone. The post of plant pathologist has been vacant for a long time at Mudigere and it has affected the progress. The equipments proposed by the Mudigere and it has affected the progress. The equipments proposed by the Mudigere Centre have been since procured; the micro propagation facility has also been created at Mudigere Centre and this experiment is making a good progress. The Gangtok centre working on large cardamom did not participate in the Jaipur workshop and the reports are also not received in time and this is perhaps due to the fact that this centre is no more under "plan funds" and has become a part of the ICAR Institute.

### **Ginger & Turmeric Centres**

Ginger work is being conducted at Solan, Pottangi as well as the new centres at Pundibari; Chintapalli centre has also taken up programmes on ginger on a voluntary basis. The turmeric work is concentrated at Jagtial, Pottangi and Dholi centres; the new Centres at Kumarganj, Raigarh and Pundibari have also been added. The germplasm accessions as well as the seed material for the newly started multilocation trials have been exchanged between all the ginger and turmeric centres. Two sets of new multilocation trials have been planned during the year under report. Efforts have also been initiated to add biological control of rhizome rot of ginger/turmeric and the biocontrol agents have been arranged for the centres. The Solan centre has made significant progress in the biological control activities and recommendations are being finalised at this Centre. Variety Himgiri (SG-666) has been released by the Solan Centre and this is good as vegetable ginger.

### **Tree spices centres:**

The Yercaud centre has made satisfactory progress in the experiments with the spices, besides black pepper. The trials have also been repeated at the Voluntary Centres viz., Ambalavayal (KAU), Thadiyankudissai (TNAU) and Pechiparai (TNAU). The new Centre viz., Dapoli in Maharashtra has also been assigned with the research programmes on tree spices and the Scientists have visited IISR, Calicut and discussed regarding the availability of planting material etc. This Centre also taken up activities on collection of germplasm of tree spices.

### **Seed Spices centres :**

The multilocation trial laid out at Jobner, Jugudan, Guntur, Coimbatore, Hisar and Dholi Centres have been progressing quite satisfactorily. The new centres initiated during 1995-96 viz., Kumarganj, Raigarh and Pundibari were also linked in the system and the germplasm material as well as the entries for the multilocation trials have been sent to them. In all, nine centres work on seed spices and the progress in all the Centres has been quite satisfactory. The Jobner centre has recommended crop rotation for the control of cumin wilt disease, besides seed treatment with

fungicides. The immune/resistant lines to cumin wilt, identified at the Jagudan centre have been used in the breeding programmes. The Jobner centre has notified one variety in coriander (UD-20) for release in the Jaipur Workshop. The post of Horticulturist at the Guntur centre and Plant Pathologist at the Mudigere centre are vacant and Universities have been requested to fill up the posts on a priority basis. The Centrally Sponsored Scheme on production and distribution of seeds of improved varieties of seed spices has been progressing quite satisfactorily in Jagudan, Jobner and Guntur centres. On the whole, the performance of the seed spices centres has been satisfactory.

**ACTION TAKEN ON THE RECOMMENDATIONS OF THE XIII WORK SHOPS ON SPICES HELD AT JAIPUR  
DURING JULY 1995 AND ACTION TAKEN ON THE EARLIER DECISIONS**

**D e c i s i o n s**

**Action taken/Remarks**

**GENERAL:**

1. Emphasis should be given for collecting germplasm from local areas of coordinating centres. Passport data should be maintained for all the germplasm collected and separate minimum descriptor has to be prepared for every spices.

2. Any variety for release has to be considered based upon the yield increase of 10-15% over the standard check varieties or they should possess desirable characters like better quality, adaptability or resistance to biotic and abiotic stresses

3. Crop cafeteria of all released varieties to be established to serve as a demonstration block

4. The MLT experiments have to be initiated and laid out only sufficient planting material in all the entries are made available; only the best released/pre-released varieties should be entered in the MLTs.

5. Promising cultures under MLT should be evaluated in farmer's field besides being evaluated at the Research station.

As per the suggestions, surveys are being taken up and collection being made.

The release proposals of coriander variety UD-40 was submitted by Jobner and black pepper Panniyur-5 by the Panniyur centre by the respective State varietal evaluation committee; similar proposal for release of turmeric PTS-19 in the name of Sonali and mango ginger Cv. CAM-3 in the name of "Amba" sent to State variety Release Committee by Pottangi centre.

The plot will be established by procuring the released varieties from the respective centres. being followed by all centres

Being followed by all centres.

Has been taken up by centre which have varieties.



6. In all manual experiments, the soil and plants analyses should be taken up immediately.
7. In all the experiments Cost :Benefit ratio are to be worked out  
This has been initiated .  
The C:B ratio have been worked out in the concluded trials.
8. In view of the growing awareness to environmental pollution and ecofriendly produce, more emphasis or reaction to pests and disease have to be laid during varietal screening.  
Being attended to by all centres.
9. The Pathologist of the scheme at Solan will find out the suitable data for obtaining training on the VAM technology toxin insolation and tissue culture techniques from IISR  
Training has already been given at IISR to the Pathologist from Solan centre.
10. The IISR may organise short time training on isolation mass multiplication and application of biocontrol agents used in management of soil borne pathogens of spices.  
Being organised in consultatoin with the centres.

#### CARDAMOM:

1. The promising, short listed cardamom lines of Mudigere need to be mass multiplied through tissue culture. The ICRI Myladumpara will take up the multiplication programme.  
Mudigere centre has been equipped with a micropropogation laboratory recently and work has been initiated at Mudigere itself.
2. All the centres working on cardamom will collect data on the tillers, no.of bearing tillers,no.of panicles, no.of capsules per panicle,no.of capsule per node, yeild per clump etc.  
This is being done.
3. The voluntary centre Thaidyankudisai will have to relay the MLT in cardamom.  
The matter was discussed with Director, ICRI and Scientist i/c Thaidyankudisai recently; they will take up fresh planting soon.
4. All the data pertaining to the ecologu and management of thrips in cardamom may be compiled by Mudigere & Pampadumpara. Residue analyses may be carried out in all chemical control trials.  
Centres have been reminded to attend to this.

## BLACK PEPPER :

1. The MLT-IV 1991 will be laid out in all the pepper and cardamom centres. The MLT on black pepper 1991 Series IV is to be discontinued at Chintapalli.

As per the Jaipur workshop decision, the MLT-1991 is dropped at Sirsi and a new MLT to be initiated soon.
2. Experiment on Phytophthora foot rot and nematode disease management to be continued.

Being continued.
3. The incidence of pests on black pepper in irrigation cum fertilizer trial experiment to be recorded at Sirsi. It was suggested to replace the necessary loss due to disease.

About 20% of the vines were destroyed due to foot rot disease; replanting work and necessary measures adopted. The accessions are being replaced at Sirsi.
4. New experiment on disease management of black pepper consisting of chemical and biocontrol.

Will be initiated during 1996-97.
5. An Adhoc Scheme proposal on feasibility of pepper cultivation in tribal areas in Orissa to be prepared by Pottangi centre.

Centre has been reminded to give the proposal
6. The Pottangi centre will also take up an MLT on black pepper with released varieties.

Centre has been reminded.
7. The nursery management results may be compiled and a new scheme of treatment may be finalised.

Panniyur centre has been reminded to finalise the matter soon.
8. Solarisation of nursery mixture and incorporation of antagonists can form part of nursery management technology in black pepper by all centres.

Centres advised to follow this decision.
9. An observation trial on impact of basin management with marigold may be assessed in relation to population of pathogenic nematodes of pepper. The required seed materials of marigold seed will be supplied by M/s Synthite.

The matter will be discussed by the PC with M/s Synthite and centres to be identified in due course.
10. Plantation of pepper may be monitored periodically in March, June-July- October by Mudigere to assess the pest incidence in hilly regions.

Centre did not take up the programme due to want of manpower and finance.

1. The experiment on irrigation cum fertilizer level at Panniyur may be concluded and one new experiment on drip irrigation-cum-fertilizer may be laidout with latest released varieties. (one each in OP & Hybrid)

New trial has been initiated

### GINGER

1. The trial on maximization of ginger will be taken up at Solan
2. A greater attention for developing low fibre varieties in ginger will have to be done in ginger centres.
3. The experimental results on ginger at Chintapalli centre are to be compiled and sent to PC.

Being done at Solan

Solan and Pottangi centres advised.

Details have been received

### TURMERIC

1. An Adhoc Scheme on rhizome rot and leaf spot disease of turmeric will be prepared by PC.
2. To confirm etiology of disease and associated pathogens pathogenicity of Pythium sp. and Fusarium sp. singly and in combination may be undertaken to confirm the etiology by Jagtial centre.

Jagtial centre has been advised to take up the programme

Work has been initiated

### TREE SPICES :

1. It was suggested to try multiplication of Cassia Cinnamon through air layering in month of June at Yercaud.
2. The Yercaud centre will study the quality aspects of cinna-

Vegetative propagation programme in Cassia cinnamon been initiated at Yercaud in December 1995; unrooted cuttings treated with Seradix gave 76% success in 45 days; further trials with air layering is under evaluation.

As per PC's suggestion, the coppicing of cinnamon during September 1995 was postponed as the plants have not attained the proper height and growth; coppicing will now be done in late 1996.

mon bark on harvest during september 1995.

3. All experiments on tree spices at Yercaud will continue, seeds of wild nutmeg available in the Kolli hills region may be used for grafting.
4. In the biofertilizer trial on tree spices at Yercaud, the methods of application may be standardised. the soil microflora may be monitored continuously all round the year

5. Periodical monitoring may be undertaken in identifying the pest & disease problems in tree spices in all centres.

#### **SEED SPICES :**

1. The available Fenugreek germplasm may be evaluated for greens purpose and simultaneously, the germplasm from Jobner may be collected and evaluated at guntur.
2. The Coimbatore centre has been asked to collect germplasm materials in coriander and fenugreek from at least 4 different districts in Tamil Nadu viz., Madurai, Ramnad, Kamarajar and Kattabomman during 1995-95
3. Hisar centre asked to do quality analysis of leafy type in coriander.
4. Germplasm materials of Ajowan in Guntur, Dholi and Hisar centres may be exchanged.
5. The quality analysis facilities available at Jobner has to be availed by all the seed spices centres. It is suggested that an exploration for exotic types for oil content could be taken

Arrangements made to procure the wild nutmeg from the Kolli hills.

Adequate care has been taken in the year for application of biofertilizers. A time gap of 15 days has been given after application of Azospirillum & Phosphobacteria . The soil population dynamics is being monitored periodically.

Being done in all centres.

Being done.

Material has been collected.

Work has been initiated.

Correspondance initiated between the centres in this regard.

Jobner centre is already extending this facility. Exploration work yet to be initiated out side Rajasthan.

up .

6. The new MLT in coriander and fenugreek with the identified entries to be taken up
7. Promising culture from screening programmes since 1972 may be short listed and made use in future MLT by all centres

Since initiated in all centres.

Centres have been requested to provide this information.

ALL INDIA COORDINATED PROJECT ON SPICES  
CENTRE-WISE AND HEAD-WISE ANNUAL PLAN ALLOCATION AND EXPENDITURE FOR 1995-96

Sl. No.	Centres	Salary		TA		RC		NRC		Total	
		Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.
1.	Pampadumpara	41.18	3.39	0.25	0.18	0.60	0.38	-	-	5.03	3.95
2.	Mudigere	5.55	4.78	0.33	0.21	1.00	1.00	-	-	6.88	5.95
3.	Yercuad	2.27	1.47	0.13	0.06	0.04	0.39	-	-	2.80	2.19
4.	Panniyur	5.47	4.25	0.26	0.26	1.00	1.12	1.07	0.42	8.07	6.05
5.	Chintapalli	2.39	2.02	0.16	0.16	0.40	0.40	1.00	0.94	3.95	3.25
6.	Sirsi	1.80	1.77	0.14	0.14	0.40	0.40	-	-	2.34	2.31
7.	Solan	3.15	3.80	0.24	0.08	0.60	0.60	-	-	3.93	4.48
8.	Pottangi	2.36	2.33	0.18	0.18	0.40	0.40	-	-1.10	2.97	3.92
9.	Jobner	6.38	8.42	0.40	0.35	1.00	1.00	3.00	3.00	10.78	12.77
10.	Guntur	2.39	1.85	0.08	0.60	0.40	0.39	-	-	2.87	2.57
11.	Jagudan	2.80	2.34	0.15	0.09	0.40	0.40	-	-	3.35	2.83
12.	Coimbatore	2.66	1.85	0.04	0.17	0.40	0.15	-	-	3.10	1.90
13.	Jagital	1.45	2.28	0.04	0.04	0.40	0.40	-	-	1.89	2.72
14.	Hisar	2.43	2.06	0.06	0.06	0.75	0.53	-	-	3.24	2.65
15.	Dholi	2.39	1.50	0.11	0.02	0.40	0.40	-	-	2.90	1.92
Total		47.97	43.84	2.57	2.60	8.55	7.96	5.07	5.37	64.16	59.77
ICAR Share (75%)		35.98	32.88	1.93	1.95	6.41	5.97	3.80	4.03	48.12	44.83
Gangtok (100%ICAR)				Not communicated							
Grand Total		35.98	32.88	1.93	1.95	6.41	5.97	3.80	4.03	48.12	44.83

## STAFF STRENGTH

(as on 31-03-96)

PROJECT CO-ORDINATOR'S CELL  
Indian Institute of Spices Research  
Calicut - 673 012, Kerala

Project Coordinator	:	S. Edison
Technical Officer	:	Johny A. Kallapurackal
Stenographer	:	P.V. Sali
Peon	:	K. Keeran

### CO-ORDINATING CENTRES

#### 1. CARDAMOM RESEARCH STATION, KAU, PAMPADUMPARA

Asst. Professor (Ento.)	:	Arthur Jacob J.
Asst. Professor (Agron.)	:	C. George Thomas
Breeder	:	Vacant
Lab. Assistant Gr. I	:	P.V. Joseph
Farm Assistant	:	V.P. Prasad
Peon	:	Aleykutty

#### 2. REGIONAL RESEARCH STATION, USA (B), MUDIGERE

Breeder	:	H.M. Chandrappa
Agronomist (Hort.)	:	S.M Shanthaveerabhadriah
Pathologist	:	Vacant
Jr. Entomologist	:	C. Parvathi
Jr. Technical Assistant	:	Narayanan
Jr. Technical Assistant	:	Mruthyanjaya
Messenger	:	Venkatesh

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Jr. Breeder (Hort.)	:	K. Nagesswari
Lab. Assistant	:	M. Ramaiah

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Assoc. Professor (Pl. Path.)	:	K.P. Mammotty
Ass. Professor (Pl. Path.)	:	Premanathan
Asst. Professor (Breeding)	:	Gregory Zachariah
Asst. Professor (Agron.)	:	A. Rajagoplan
Farm Assistant Gr.II	:	K. Lakshmanan
Farm Assistant Gr.I	:	T. Muhammed Haneefa.
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Peon	:	M.P. Narayanan

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Asst. Horticulturist	:	M. Padma
Technical Assistant	:	Vacant

6. AGRICULTURAL RESEARCH STATION, UAS(D), SIRSI

Jr. Horticulturist	:	H.G. Hegde
Jr. Pathologist	:	M.S. Lokesh
Research Assistant	:	Vacant

7. DEPARTMENT OF VEGETABLE CROPS, DR. YSPUHF, SOLAN

Breeder (Olericulturist)	:	B.N. Korla
Jr. Plant Pathologist	:	N.P. Dohroo
Jr. Biochemist	:	R.K. Goyal
Jr. Tech. Assistant	:	Shankar Lal

8. HIGH ALTITUDE RESEARCH STATION, OUAT, POTTANGI

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Jr. Breeder	:	D.K. Dash
Sr. Technical Assistant	:	B.C. Dash
Jr. Technical Assistant	:	Vacant



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

Sr. Breeder (Prof.)	:	R.K. Sharma
Breeder	:	S.L. Dashora
Agronomist (Hort.)	:	G.R. Chaudhary
Jr. Plant Pathologist	:	M.P. Jain
Asst. Biochemist	:	S. Agarwal
Sr. Technical Assistant	:	Dhinendra Singh
Jr. Technical Assistant	:	S.R. Kumawat

10. REGIONAL AGRICULTURAL RESEARCH STATION, APAU, GUNTUR

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Sub-Assistant	:	K. Sivakumar

11. SPICES RESEARCH STATION, GAU, JAGUDAN

Sr. Plant Pathologist	:	V.A. Solanki
Jr. Breeder (Hort.)	:	G.M. Patel
Jr. Technical Assistant	:	R.N. Patel

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Jr. Pathologist	:	Muthukrishnan

13. REGIONAL AGRICULTURAL RESEARCH STATION, APAU, JAGTIAL

Jr. Pathologist	:	M.A. Rahman
Asst. Horticulturist	:	A. Manohar Rao
Tech. Asst/Sub-Asst.	:	Vacant

14. ICAR RESEARCH COMPLEX FOR NEH REGION, GANGA TOK

Scientist S2 (Pl. Path.)	:	L.S. Srivastva
Scientist S1 (Hort.)	:	G.S. Karibasappa

15. DEPARTMENT OF VEGETABLE CROPS (CCS-HAU), HISAR

Olericulturist / Horticulturist : K.K. Thakral  
Assistant Scientist (VC) : Suresh Tehlan

16. TIRHUT COLLEGE OF AGRICULTURE (RAU), DHOLI

Horticulturist : T.Singh  
Jr. Pathologist : Bimla Rai  
Technical Assistant : Vacant

17. KONKAN KRISHI VIDYAPEETH, DAPOLI

Horticulturist : Vacant  
Jr. Breeder : Vacant  
Jr. Pathologist : Vacant  
Tech. Assistant (2 Posts) : Vacant

18. NARENDRA DEV UNIVERSITY OF AGRICULTURE & TECHNOLOGY,  
KUMARGANJ

Horticulturist : Vacant  
Jr. Breeder : Vacant  
Jr. Pathologist : Vacant  
Tech. Assistants (2 Posts) : Vacant

19. INDIRA GANDHI KRISHI VISHWA VIDYALAYA, RAIGARH

Horticulturist : Vacant  
Jr. Breeder : Vacant  
Jr. Pathologist : Vacant  
Tech. Assistants (2 Posts) : Vacant

20. BIDHAN CHANDRA KRISHI VISHWA VIDYALAYA, PUNDIBHARI

Horticulturist : Vacant  
Jr. Breeder : Vacant  
Jr. Pathologist : Vacant  
Tech. Assistants (2 Posts) : Vacant

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## WEATHER DATA 1995

Centre : Mudigere

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	1.2	-	27.5	13.7	88
February	-	-	30.8	18.6	90
March	-	-	30.8	18.6	90
April	56.8	3	31.8	19.1	92
May	144.2	10	29.0	19.3	93
June	236.0	12	26.2	19.4	97
July	1013.4	25	24.0	18.7	95
August	397.4	25	24.6	18.9	95
September	270.0	12	24.7	18.7	95
October	170.0	9	26.0	18.6	94
November	45.0	3	27.5	16.2	91
December	-	-	27.6	14.0	87
<b>Total</b>	<b>2334.6</b>	<b>99</b>			

## WEATHER DATA 1995

Centre : Jobner

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C)		Mean RH (%)
			Max	Min	
January	-	-	24.0	5.4	80
February	-	-	21.6	6.3	78
March	-	-	28.7	8.1	72
April	2.1	1	34.4	15.0	54
May	5.8	1	41.5	25.0	53
June	289.2	20	42.0	24.5	45
July	289.2	20	34.2	23.2	80
August	19.7	4	31.4	20.5	72
September	19.7	4	31.4	20.5	72
October	-	-	31.8	16.6	66
November	-	-	28.8	11.2	61
December	-	-	22.2	4.7	72
<b>Total</b>	<b>556.9</b>	<b>36</b>			



## WEATHER DATA 1995

Centre : Guntur

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C)		Mean RH (%)
			Max	Min	
January	48.7	3	28.68	17.36	92.25
February	-	--	32.26	19.10	92.21
March	-	-	36.50	21.69	93.19
April	-	-	39.40	35.00	84.33
May	129.4	7	38.02	25.87	84.97
June	96.8	4	40.16	27.52	78.30
July	148.6	13	38.84	24.84	85.45
August	283.0	13	34.68	24.91	86.35
September	49.6	5	34.47	24.63	84.63
October	317.6	10	31.38	23.99	93.52
November	6.4	1	32.38	21.32	85.87
December	-	-	30.45	16.92	88.81
Total	1080.1	56			

## WEATHER DATA 1995

Centre : Sirsi

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	-	-	27.9	22.20	-
February	-	-	33.8	24.00	-
March	-	-	33.8	24.00	-
April	12.25	3	-	-	-
May	50.00	5	-	-	-
June	167.20	14	26.54	24.58	-
July	994.15	25	24.05	20.05	-
August	373.90	19	25.80	24.86	-
September	195.25	7	32.00	27.32	-
October	129.00	7	32.00	27.32	-
November	24.25	2	-	-	-
December	-	-	-	-	-
Total	1964	82			

## WEATHER DATA 1995

Centre : Panniyur

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C)		Mean RH (%)
			Max	Min	
January	8.4	2	33.0	19.0	84.7
February	-	-	36.0	20.9	87.8
March	-	-	36.9	21.0	87.7
April	58.0	4	36.9	22.0	85.8
May	291.3	9	35.9	21.6	85.0
June	683.3	19	32.0	23.0	90.3
July	1302.0	31	26.8	22.0	95.5
August	486.2	20	22.8	24.9	88.5
September	212.0	10	30.5	22.2	83.4
October	145.4	13	32.4	22.5	86.1
November	133.4	5	32.4	21.8	90.1
December	-	-	34.6	18.6	72.9
Total	3320.2	113			

## WEATHER DATA 1995

Centre : Pottangi

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	65.0	2	20.19	15.22	72.74
February	-	-	24.11	18.42	69.49
March	18.7	5	26.12	21.74	71.06
April	97.9	11	28.50	26.00	68.50
May	275.8	12	26.70	25.50	72.30
June	48.6	4	28.40	26.50	73.70
July	464.1	22	26.90	24.50	82.00
August	377.4	19	26.00	24.50	86.30
September	205.1	13	27.50	25.50	86.30
October	243.5	21	28.50	24.70	76.50
November	45.0	4	25.00	23.70	75.00
December			22.00	20.00	70.00
<b>Total</b>	<b>1841.1</b>	<b>113</b>			

## WEATHER DATA 1995

Centre : Solan

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C)		Mean RH (%)
			Max	Min	
January	77.0	-	15.4	2.6	63.3
February	92.7	-	17.1	5.1	60.3
March	60.7	-	5	2.1	9.0
April	38.8	-	26.3	12.3	53.8
May	4.0	-	32.3	19.9	45.0
June	95.4	-	33.5	22.9	60.0
July	380.1	-	27.6	21.1	83.0
August	465.4	-	25.9	20.5	88.0
September	235.4	-	27.2	18.1	78.0
October	0.0	-	24.4	12.4	61.0
November	0.0	-	23.0	8.0	55.0
December	8.8	-	18.8	5.0	65.0
<b>Total</b>	<b>1458.1</b>	<b>NA</b>			

## WEATHER DATA.1995

Centre : Jagtial

Latitude : 18° 59' N  
Longitude : 78° 56' E  
Altitude : 243.4m MSL  
Soil type : Red sandy loam

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C)		Mean RH (%)
			Max	Min	
January	102	2	N.A	12.6	83.9
February	2.8	-	N.A	17.4	82.3
March	24.2	2	N.A	21.2	68.5
April	-	-	-	-	-
May	-	-	-	-	-
June	95.6	6	38.2	27.3	59.0
July	184.5	14	32.1	24.4	82.0
August	185.1	10	32.4	24.5	83.0
September	-	-	-	-	-
October	472.3	12	30.7	20.7	83.3
November	-	-	30.4	17.0	83.3
December	-	-	30.0	15.5	87.0
<b>Total</b>	<b>1275.1</b>	<b>52</b>			

## WEATHER DATA 1995

Centre : Coimbatore

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	3.8	-	29.6	19.1	87
February	-	-	32.6	20.4	84
March	-	-	34.8	20.9	73
April	111.0	3	35.7	23.8	80
May	126.2	6	32.6	23.8	82
June	8.0	2	32.5	23.3	78
July	36.7	3	31.0	22.7	79
August	48.8	4	31.7	22.6	82
September	29.0	4	32.0	22.0	82
October	100.0	9	31.8	22.1	86
November	109.8	7	30.5	19.4	86
December	-	-	29.7	17.6	86
Total	573.3	38			

## WEATHER DATA 1995

Centre : Chintapalli

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	24.2	4	22.9	11.0	88.0
February	1.0	-	27.2	12.9	88.9
March	29.1	3	31.7	14.4	89.0
April	83.4	7	31.7	17.5	85.9
May	284.1	15	30.5	19.6	87.0
June	125.4	9	31.2	22.0	87.6
July	256.5	18	26.8	20.8	87.7
August	208.9	12	28.0	20.7	88.8
September	122.0	10	27.4	20.2	90.0
October	244.5	15	27.0	19.6	89.7
November	22.4	3	27.8	14.6	90.0
December	-	-	26.3	10.6	90.0
Total	1401.5	96			



## WEATHER DATA 1995

Centre : Pampadumpara

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C)		Mean RH (%)
			Max	Min	
January	26.3	5	25	14.8	-
February	9.3	2	28	15.0	-
March	48.8	6	29	15.5	-
April	92.5	8	30	15.5	-
May	258.3	17	28	18.5	-
June	222.3	22	28	17.0	-
July	310.2	26	25	17.0	-
August	323.3	27	25	17.8	-
September	242.2	18	27	17.8	-
October	162.0	15	28	17.8	-
November	137.2	15	26	16.5	-
December	-	-	25	14.4	-
<b>Total</b>	<b>2091.40</b>	<b>161</b>			

## WEATHER DATA 1995

Centre : Yercaud

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	14.8	2	21.5	12.5	63.5102
February	-	-	24	14	56.8
March	39.2	2	27	13.5	53.5
April	94.4	5	27	16	63.7
May	221.0	9	25.5	17.5	69
June	214.6	10	27.5	15	69
July	348.9	16	24.61	16.48	68
August	281.6	17	24.5	16.4	67
September	138.6	8	24.5	16.5	70
October	135.0	16	24.5	15.5	68
November	104.5	6	23.5	15.5	70
December	5.2	1	21	12	60
<b>Total</b>	<b>1597.8</b>	<b>92</b>			

## WEATHER DATA 1995

Centre : Dholi

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	6.6	2	20.6	7.7	100
February	19.2	2	24.4	10.2	95
March	3.2	1	30.7	15.4	85
April	0.0	0	37.9	18.0	72
May	0.0	0	39.9	25.6	80
June	153.0	7	35.4	26.8	88
July	119.4	8	33.6	26.4	88
August	549.0	16	31.8	26.0	91
September	141.0	14	32.6	26.5	93
October	9.0	1	31.4	22.1	84
November	46.0	2	28.4	15.7	89
December	20.0	2	25.0	10.2	100
<b>Total</b>	<b>1066.4</b>	<b>55</b>			

## WEATHER DATA 1995

Centre : Jagudan

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

Month	Monthly rainfall (MM)	Rainy days (No)	Mean Temp (°C )		Mean RH (%)
			Max	Min	
January	-	-	26.7	8.6	-
February	-	-	30.7	11.2	-
March	-	-	33.7	14.8	-
April	-	-	38.8	20.5	-
May	3	-	42.2	23.3	-
June	-	-	43.8	26.8	-
July	317	12	35.8	25.7	-
August	51	4	34.6	25.2	-
September	4	-	36.7	23.8	-
October	-	-	36.0	21.9	-
November	-	-	32.7	14.9	-
December	-	-	31.1	11.9	-
Total	375	16			