# AICRPS

# ANNUAL REPORT 1997-1998


ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

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

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(APRIL 1997 TO MARCH 1998)


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*(Indian Council of Agricultural Research)*

CALICUT, KERALA, INDIA - 673 012

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# EXECUTIVE SUMMARY

The All India Coordinated Research Project on Spices (AICRPS) is giving emphasis on 12 major spices at 20 AICRPS centres and eight voluntary centres located at 15 States of India, so as to augment production, productivity and quality upgradation of spices.

The research achievements accomplished by the centres during 1997-98 are highlighted. There are 80 projects manned by 53 scientists supported by 32 technical / auxillary staff. The annual budget was around Rs.85 lakhs and shared @ 75:25 basis between ICAR and SAUs.

The AICRPS centres strengthened the genetic resources by adding 40 new accessions of black pepper, 68 of ginger, 67 of turmeric, 16 of nutmeg, 19 of cinnamon, 89 of coriander, 22 of cumin, 60 of fennel and 76 of fenugreek.

The black pepper accession Karimunda III registered the highest yield (10.2 kg green berry vine $^{-1}$). The open pollinated progenies of pepper viz., 4879, 5089 and 5621 performed better. The cardamom entries *Veeraputhran*, M-1 and SKP-14; ginger accessions *Vengara*, BDJR-1179 and $V_1E_8$-2 and turmeric entries PTS-4, JTS-16 and PTS-43 are promising. As regards seed spices, LCC-128, LCC-15 and Acc. 745 of coriander; EC-279081 and JF-94-37 of cumin; UF-125 and JF-200 of fennel and acc.464, 504-1, CF-390 and JF-102 of fenugreek are high yielders.

Studies on the effect of fertilizers on cardamom yield at Mudigere showed that a fertilizer schedule 75:75:150 kg NPK ha$^{-1}$ recorded maximum yield (284 kg ha$^{-1}$).

For vegetative propagation of nutmeg, soft wood two leaved root stock, grafted with orthotropic scion, recorded maximum success (48.5%) at Yercaud.

Under Jobner condition, sowing of coriander during first week of November recorded higher grain yield (1198 kg ha$^{-1}$) with maximum B:C ratio of 1.96. A fertilizer schedule of 60:30:30 kg NPK ha$^{-1}$ and a spacing of 30x10 cm were optimum under Kumarganj condition. For fenugreek under Coimbatore condition, sowing at a spacing of 15x 10 cm during first week of October was optimum.

For management of pepper nursery diseases, soil solarisation (medium light intensity (3.3 K Lux)) with Bordeaux mixture (1%) as spray and drench at 15-20 days interval resulted in the production of quality rooted pepper cuttings.

For effective control of cardamom thrips and borer, application of phorate @ 10 g clump$^{-1}$ followed by two sprays of phosalone (0.05%) during May and August was effective under Mudigere.

The turmeric entries Kohinur and G.L Puram; coriander entries Rcr-41, CC-462, ATP-77, Jco -64 and *Pant Haritima*; cumin entries RZ-19, EC-232584, EC-84-1 and EC-73-1 and the fenugreek entries UM-117, UM-128, UM-140, UM-302 and UM-9 showed tolerance to major pest and diseases.

For control of cumin diseases, use of biocontrol agents (*T. harzianum*) restricted the wilt incidence. For fenugreek root rot control, seed treatment with *T. viride* was effective.

The ginger accession $V_1S_1$-8, SG-553 and SG-54; the turmeric accession *Kurtan Tanake*, PTS-10 and PCT-5 are promising for quality.

The Quinquennial Review Team (QRT) constituted by ICAR under the Chairmanship of Dr K V A Bavappa with Dr R P Sharma, Dr Rajendra Gupta, Dr R K Sharma and Dr S Chaudhuri as members and Dr A K Sadanandan as Member Secretary reviewed the work of the 20 AICRPS centres and eight voluntary centres for the period 1992-96 and gave recommendations.

## Terms of reference of the QRT

✺ To make a comprehensive review of the functioning of the Indian Institute of Spices Research and AICRPS and its coordinated centres covering the period 1.4.1992 to 31.12.1996 and suggest appropriate strategies for future research.

✺ To suggest the manner in which linkage could be developed by the user agencies.

✺ To assess the impact of new technologies developed in improving productivity and area under these crops.

Though the terms of reference of the QRT is by and large confined to the review of research and technologies developed for improving productivity and area, the team in its work has attempted to take a holistic review of the spice industry so that research is able to meet the needs of the processing industry and trade in the context of the newly emerging scenario in these crops.

The AICRPS centres contributed substantially towards the production and distribution of quality planting materials. During 1997-98, the AICRPS centres produced and distributed 99,334 numbers of rooted cuttings of pepper, 1776 of cardamom clones, 6.52 kg cardamom seeds, 619 cinnamon seedlings, 211 of nutmeg grafts, 0.73 tonnes of ginger, 8.4 tonnes of turmeric and 25.2 tonnes of seed spices.

**Dr A K Sadanandan**
Project Coordinator

# INTRODUCTION

India, rightly known as the 'Land of Spices' is the largest producer, consumer and exporter of spices. During the year 1997-98 (April - March) India exported 2,18,750 tonnes of spices valued Rs.1352.15 crores (US $ 363.62 million) as against an export of 2,25,295 tonnes valued Rs.1230.72 crores (US $ 346.97 million) in 1996-97. The export registered an increase of 10 per cent in value as compared to last year.

The export of cardamom (small), turmeric, coriander, cumin, fennel, curry powder, tamarind, asafoetida, cinnamon, cassia, kokum and saffron has increased both in terms of quantity and value during 1997-98, while the export of pepper, ginger, spice oil and oleoresins showed an increase in value only.

During the year, the pepper export was 34,250 tonnes valued Rs.479.56 crores as against an export of 47,893 tonnes worth Rs.412.31 crores during 1996-97. The per unit value of pepper was higher (Rs. 140 $kg^{-1}$) as compared to Rs. 86 $kg^{-1}$ of the last year. Pepper continued to be the leader in spices export earnings with a share of 35% followed by spice oils and oleoresins (17%) and chilli (10%).

The All India Coordinated Research Project on Spices (AICRPS) operating in 20 regular and eight voluntary centres based at 15 Agricultural Universities is focussing research on 12 spice crops which is contributing a sizeable amount of foreign exchange to our economy through production and export. The research achievements made by the AICRPS centres, staff position and budget are given in the respective chapters. The mandate of AICRPS is:

- Evolving high yielding varieties tolerant / resistant 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 interface and feed back between SAUs, Indian Institute of Spices Research and Indian Council of Agricultural Research.

# PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices (AICRPS) initiated during IV Five year plan (1971) as a combined project on spices and cashewnut was divided into two independent projects on spices and cashewnut during 1986, so as to give more attention to carry out location specific research for augmenting the spices productivity and quality. The AICRPS is concentrating research on 12 major spices (Black pepper, cardamom (large and small), turmeric, ginger, tree spices (clove, nutmeg, cinnamon) and seed spices (coriander, cumin, fennel and fenugreek) in 20 coordinating and eight voluntary centres based at 15 agricultural universities in 13 agroclimatic regions of India. The headquarter of AICRPS is at IISR, Calicut.

## History

During IV Plan (1971), the spices project was in operation in four centres (Panniyur, Pampadumpara, Mudigere and Solan) on four crops (Pepper, cardamom, ginger and turmeric). Research on ginger, turmeric, and 'seed spices' (coriander, cumin, fennel and fenugreek) started during V Plan by including additional five centres (Jobner, Jagudan, Guntur, Coimbatore and Pottangi). During VI Plan, four new centres (Sirsi, Vellanikkara, Chintapalli and Yercaud) were added to further intensify work on pepper, ginger and turmeric. Two new centres (Gangtok and Jagtial) were added during VII Plan, one each for large cardamom and turmeric respectively. Six new centres, namely Hisar, Dholi, Kumarganj, Dapoli, Raigarh and Pundibari were added during VIII Plan mainly to intensify research on seed spices, turmeric and tree spices with due emphasis to cover the northern region of the country.

The research progress of the coordinating centres are reviewed during the annual / biennial workshops. Workshops were held at Coimbatore (1975), Goa (1978), Trichur (1981), Calicut (1983), Trivandrum (1985), Guntur (1987), Solan (1988), Coimbatore (1989), Trivandrum (1991), Trichur (1993), Jaipur (1995) and Bangalore (1997). The Quinquennial Review Team (QRT) reviewed the progress of the AICRPS centres for the period 1992 to 1996 and gave new directions to meet the emerging scenario of spice industry.

## Staff and budget

The AICRP on Spices is supported by 53 scientists and 32 technical and supporting/auxillary staff and the annual budget is around Rs. 80 lakhs which is shared by ICAR (75%) and SAU's (25%).

## Research Activities

The research is focused on Crop

Improvement, Crop Production, Crop Protection and Post Harvest Technology. There are 80 projects distributed under different disciplines (38 in crop improvement, 18 in crop production, 19 in crop protection and 5 in quality upgradation).

## Genetic Resources

The AICRPS centres strengthened their genetic resources by collection, conservation, cataloguing and exchange between AICRPS centres, IISR, ICRI and NBPGR. The new collections added during the period are given below.

In black pepper, the Panniyur centre added 22 new accessions from NBPGR, R.C. Vellanikkara, Trichur. Two cultivated(*Karimalligesara* and *Uddakara*) and one wild accession from Malanad of Uttara Kannada were added at Sirsi. The Chintapalli centre added 13 new cultivated accessions. Two new collections were added by Pundibari centre.

In cardamom, the Pampadumpara centre added one new cultivated accession.

In Ginger, two accessions at Pottangi, 27 at Dholi and 11 at Pundibari were added to the existing germplasm.

In turmeric, 37 new accessions were added at Raigarh centre. The Pottangi, Pundibari and Kumarganj centres added four, 14 and 12 accessions respectively.

In tree spices, the Yercaud centre collected 15 new nutmeg accessions while, Thadiyankudisai centre collected one new accession. In cinnamon, the Yercaud centre added one new accession. Six and 12 accessions were added at Thadiyankudisai and Dapoli centres respectively.

With respect to seed spices, Jobner centre added three new germplasm accessions of coriander while, Jagudan added two accessions. Six new accessions from Guntur, Jobner and Jagudan were also added at Coimbatore centre. Eighteen and 60 accessions were included at Dholi and Kumarganj centres respectively.

At Jobner, 15 new cumin entries were added, 45 at Jagudan and seven new collections were added at Kumarganj centre.

The Jobner centre added 28 new fennel accessions and Jagudan added 94 new collections. The Dholi and Kumarganj centres added six and 26 accessions respectively.

The Coimbatore centre added eight new fenugreek accessions from Jobner and Hisar centres. Twenty new accessions at Guntur, five accessions at Dholi, 11 accessions at Raigarh and 32 accessions at Kumarganj were also added to the germplasm.

## Evaluation of germplasm

Apart from collection and cataloguing of genetic resources, evaluation of germplasm was also carried out.

At Panniyur, the accession Karimunda- III registered the highest yield (10.2 kg green berry vine$^{-1}$) followed by Kaniakadan (7.1 kg vine$^{-1}$) and Kalluvally IV (6.5 kg vine$^{-1}$). As regards

open pollinated progenies, the cultures 4879, 5089 and 5621 registered an yield of 9.52, 8.42 and 7.38 kg of green berries per vine respectively. At Chintapalli, among the cultivated accessions, Panniyur-1 recorded maximum yield (3.93 kg vine $^{-1}$). Among the wild collections Maredumalli accession registered an yield of 0.46 kg vine $^{-1}$.

At Pampadumpara, the cardamom accession *Veeraputhran* registered highest yield (1.35 kg clump$^{-1}$). At Mudigere, the accessions EB-1277-7, P 17,P8, CL-728, CL-692, P-12, CL-730, CL-757 and P-20 are promising.

In ginger, the accessions SG-700 (7.7 kg 3m $^{-2}$) at Solan, and $V_2E_4$ (7.8 kg 3m $^{-2}$) at Pottangi are high yielders. In tumeric, the *Curcuma longa* accessions Viz., Tu. No.1, PTS-13 and PTS-45 and accessions of *C. aromatica* viz., Chayapasupa-II and Bataguda and accessions of *C. amada* viz., CAM-1 and CAM-2 are the top yielders.

At Jobner, the coriander accessions UD-349, UD-16, UD-595 and UD-627 are promising. The accessions CS-64, CS-108 and CS-154 are the top yielders under Coimbatore condition. At Guntur, the accession LCC-227 recorded highest yield (1100 kg ha$^{-1}$) followed by LCC-197 and LCC-128. The entries RCS-13 and RCS-2 under Raigarh and RCr-41, *Pant Haritima* and RD-23 under Kumarganj are also promising.

Under Guntur condition, the fenugreek entry LFC-97 recorded the highest yield (1150 kg ha $^{-1}$) followed by LFC-84 and LFC-74. The accessions RFS-1 and RFS-8 are top yielders under Raigarh condition. At Kumarganj, HM-114 recorded maximum grain yield (2475 kg ha $^{-1}$) followed by RM-1, JF-58 and HM-305.

## Reaction of germplasm to pests and Diseases

Under Dholi condition, Kohinur and G.L. Puram turmeric showed tolerance to leaf spot and leaf blotch.

At Jobner, the coriander entry RCr-41 found to be tolerant to powdery mildew. And the entries UD-475, CS-4 and CS-6 showed tolerance to root knot nematode. The accessions CC-462, 496, ATP-77 and JCo. 64 showed lower wilt incidence under Coimbatore condition. Under Dholi, the entries *Pant Haritima*, UD-646 and *Rajendra Swati* are tolerant to stem gall disease of coriander.

In cumin, the entries, RZ-19 and EC-232584 showed lower wilt incidence under Jobner condition while, three entries viz., EC-84-01, EC-73-1 and EC-75-1 were tolerant to *Fusarium* wilt at Jagudan.

In fenugreek entries, UM-117 and UM-128 are tolerant to rootknot nematode. UM-140 and UM-141 are free from powdery mildew under Jobner condition. The fenugreek varieties UM-302, UM-9, RM-5, UM-29, J. Fenu-53 and UM-66 are tolerant to downey mildew under Dholi condition while, *Kasurimethi* was resistant to Powdery mildew under Jagudan.

## Crop Improvement

In pepper MLT, the culture 239 recorded the highest berry yield followed by Panniyur-1.

In cardamom, the entries M-1 (2.1 kg clump$^{-1}$) and SKP-14 (1.9 kg clump$^{-1}$) are promising at Pampadumpara.

In ginger IET at Pottangi, *Vengara* recorded highest fresh rhizome yield of 23.9 t ha$^{-1}$. At Solan, the entry BDJR 1179 (20 t ha$^{-1}$) out yielded the check (16.33 t ha$^{-1}$). In CYT at Pottangi, the entries $V_1E_8$-2 (25.7 t ha$^{-1}$) and $V_1S_1$-8 (20.9 t ha$^{-1}$) were the high yielders. Under MLT, the highest rhizome yield (21.0 t ha$^{-1}$) was registered by $V_1S_1$-8 followed by $V_1E_8$-2 (20.7 t ha$^{-1}$). The entry SG-554 recorded maximum yield (18.2 t ha$^{-1}$) at Solan.

In turmeric IET at Pottangi, higher yield was recorded by the entries PTS-4 (28.73 t ha$^{-1}$), PTS-51 (28.51 t ha$^{-1}$) and PTS-27 (28.38 t ha$^{-1}$). In CYT at Jagtial, the long duration entry JTS-6, medium duration entry JTS-313 and short duration entry JTS-602 recorded higher yields of 31.3, 29.99 and 27.44 t ha$^{-1}$ respectively. Under CYT at Pottangi, the accessions PTS-43 (long duration) and PTS-59 (short duration) recorded significantly higher yield of 25.8 t ha$^{-1}$ and 28.06 t ha$^{-1}$ respectively.

In tree spices, the cinnamon accession Sel. 189 recorded the highest mean bark yield of 892 g tree$^{-1}$ followed by Sel. 53 (880 g tree$^{-1}$) under MLT at Yercaud. At Ambalavayal, MLT with seven entries were laid out and the plants were coppiced during the year.

In IET on coriander at Dholi, the accession LCC-128 registered highest yield (1022 kg ha$^{-1}$). In MLT (1996) at Jobner, the entry UD- 684 recorded higher yield of 885 kg ha$^{-1}$ followed by UD-686 (872 kg ha$^{-1}$). The accession LCC-15 resulted in highest grain yield of 961 kg ha$^{-1}$ over check (811 kg ha$^{-1}$) at Guntur. Under Coimbatore MLT (1996) the acc. 745 recorded the maximum yield of 530 kg ha$^{-1}$ as against 453 kg ha$^{-1}$ recorded in check (CO. 3). In the comparative yield trial of leafy type coriander at Dholi, the entry *Pant Haritima* performed superior, due to its late flowering nature.

In MLT (1994) at Jobner, the cumin entry UC-233 performed better for growth and yield attributes. In cumin CVT under Jagudan the entry EC-279081 recorded higher yield than control. In IET, the entry JC-94-37 performed better.

In MLT (1994) at Jobner, the fennel entry UF-125 (RF-125) registered significantly higher grain yield (1738 kg ha$^{-1}$) and other promising entries are UF-134, JF-25 and HF-71. At Jagudan, the entries JF-200 and JF-237 are the high yielders.

In IET on fenugreek at Coimbatore, the accession 464 performed superior for yield (640 kg ha$^{-1}$) followed by acc. 390 and acc. 169. In Jobner, the entry 504-1 produced maximum yield of 2119 kg ha$^{-1}$ without powdery mildew incidence. In CYT at Coimbatore, the acc. CF-390 registered highest yield of 591 kg

ha$^{-1}$ as against 439 kg ha$^{-1}$ in check (CO.1). The entries JF-102 (1017 kg ha$^{-1}$) and UM-304 (950 kg ha$^{-1}$) gave higher yield under Guntur.

In MLT (1995) at Jobner, UM-303 (2324 kg ha$^{-1}$), UM-304 (2183 kg ha$^{-1}$) and HM-110 (2149 kg ha$^{-1}$) are the top yielders.

## Crop Production and Management

In pepper, irrigation cum fertilizer trial at Sirsi recorded economic yield of 548 g vine$^{-1}$ in the treatment receiving 150:60:210 g of NPK vine$^{-1}$ with irrigation at IW/CPE ratio of 0.33.

In cardamom, NPK @ 100:100:175 Kg ha$^{-1}$ recorded maximum yield at Pampadumpara. A fertilizer schedule of 75:75:150 kg NPK ha$^{-1}$ resulted in significantly higher capsule yield (284 kg ha$^{-1}$) under natural shade at Mudigere. In the integrated nutrient management of organic and inorganic manures, application of 100% inorganic manures recorded maximum green capsule yield (707 kg ha$^{-1}$) compared to all other combinations.

In the vegetative propagation of nutmeg, orthotropic scions grafted on soft wood two leaved root stock recorded maximum success (48.5%) at Yercaud. In the drip irrigation requirement of clove, dripping of 8.0 lit. of water per day recorded maximum plant height (136.34 cm) and number of branches per plant (41.4).

At Jobner, sowing coriander during first week of Nov. recorded higher grain yield (1198 kg ha$^{-1}$) with B:C ratio of 1.96. At a fertilizer schedule, higher yield of 1840 kg ha$^{-1}$ was obtained under Kumarganj at 60:30:30 kg N, P, K ha$^{-1}$. And a spacing of 30 x 10 cm registered significantly higher yield (1953 kg ha$^{-1}$).

At Coimbatore, sowing fenugreek during first week of October at a spacing of 15 x 10 cm registered higher yield (1304 kg ha$^{-1}$) whereas, 30x10cm spacing and a fertilizer schedule of 60:50:10 kg NPK ha$^{-1}$ was optimum under Kumarganj condition.

## Quality evaluation

At Solan, the ginger accession $V_1S_1$-8 registered maximum oleoresin (8.75%) and R-3 the maximum essential oil (2.0%). The SG-553, Maran, Kerala local and BDJR-1054 are also promising lines. The entry SG-54 produced highest dry matter content (20.57%).

In turmeric, the accessions *Kurtan Tanake* and PTS-5 registered highest curcumin content (6.34%) and oleoresin (17.38%) respectively. Maximum essential oil content (9.5%) was observed in PTS-10 and maximum dry recovery (30.6%) in PCT-5.

## Crop Protection

For the management of nursery disease (*Phytophthora*) of black pepper, use of biocontrol agent *Trichoderma viride* and *T. harzianum* were very effective at

Panniyur. Soil solarisation studies at Sirsi (for control of nursery disease) revealed that treatment with 1% Bordeaux mixture as spray and drench at 15-20 days interval resulted in the vigorous growth of vines in the nursery under medium light intensity of 3.3 K Lux.

At Mudigere, cardamom thrips and borer were effectively controlled by the application of phorate @ 10g clump $^{-1}$ followed by two sprays of phosalone (0.05%) during May and August. The economic threshold level for the shoot and capsule borer was 10% shoot damage.

The integrated management to control diseases of cumin at Jobner was progressing. Application of *T. harzianum* (seed treatment + soil application) plus spray of 0.3% Mancozeb + 0.3% neem oil + 1.0% Tepol was effective. As a cultural practice to control *Alternaria* blight, sowing during second week of Nov. gave lower blight incidence under Jobner condition.

For control of fenugreek root rot, use of biocontrol as seed treatment (*T. viride* @ 5g kg $^{-1}$ of seed) followed by application of neem cake @ 150 kg ha $^{-1}$ restricted the disease incidence to 5% under Coimbatore condition.

## Planting material production

The AICRPS centres have taken up the production of elite / nucleus planting materials/ foundation seeds of the mandate spices. They took part in the IPDS (Integrated programme for development of spices) and Spices Board sponsored programmes for quality planting material production. During 1997-98 the AICRPS centres produced 99,334 numbers of rooted cuttings of pepper, 1776 of cardamom clones, 6.52 kg cardamom seeds, 619 cinnamon seedlings, 211 of nutmeg grafts, 726 kg of ginger, 8.4 tonnes of turmeric and 25.2 tonnes of seed spices.

The Quinquennial Review Team (QRT) constituted by ICAR under the Chairmanship of Dr K V A Bavappa with Dr R P Sharma, Dr Rajendra Gupta, Dr R K Sharma and Dr S Chaudhuri as members and Dr A K Sadanandan as Member Secretary reviewed the work of the 20 AICRPS centres and eight voluntary centres for the period 1992-96 and gave recommendations.

**A K Sadanandan**
Project Coordinator
30th November 1998

# TECHNICAL PROGRAMME

## 1.BLACK PEPPER

| | | |
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| 2.3.1 Yield evaluation of promising cardamom selections - 1998 | Mudigere |
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| 4.2 | Initial evaluation trial (IET) | Pottangi and Solan |
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| 6.4 Vegetative propagation in nutmeg, clove and cinnamon | Yercaud, Thadiyankudisai and Pechiparai |
| 6 5 Drip irrigation in clove and nutmeg | Yercaud |
| 6.6 Biofertilizer trial in tree spices | Yercaud |
| 6.7 Studies on fruit drop of nutmeg | Dapoli |

## 7.CORIANDER

| | |
|---|---|
| 7.1 Germplasm collection, maintenance and evaluation | Jobner, Jagudan, Guntur, Kumarganj, Coimbatore, Hisar, Dholi and Raigarh |
| 7.2 Initial evaluation trial | Jagudan, Guntur, Hisar, Coimbatore and Dholi |
| 7 3 Multilocation trials | |
| 7.3.1 MLT 1993 - Series II | Jagudan, Coimbatore, Guntur, Hisar and Dholi |
| 7.3.2 MLT 1996 - Series III | Jobner, Jagudan, Guntur, Dholi, Coimbatore and Hisar |

| | | |
|---|---|---|
| 7.4 | Comparative yield trial of leafy type coriander | Dholi and Coimbatore |
| 7.5 | Mutation breeding in coriander to evolve varieties with earliness and resistance to disease | Jobner and Coimbatore |
| 7.6 | Response of coriander to date of sowing and row spacing | Jobner |
| 7.7 | Response of fertility levels and plant spacing on yield of coriander | Kumarganj |
| 7.8 | Response of coriander varieties to seed rate | Jobner |
| 7.9 | Survey to study the disease incidence, collection and identification of casual organism | Dholi |
| 7.10 | Studies on wilt and powdery mildew management in coriander/Biocontrol of wilt in coriander | Coimbatore |
| 7.11 | Quality evaluation in coriander | Jobner |

**8. CUMIN**

| | | |
|---|---|---|
| 8.1 | Germplasm collection, descripuon, evaluation and screening against diseases | Jobner and Jagudan |
| 8.2 | Initial evaluation trial | Jagudan |
| 8.3 | Comparative yield trial | Jagudan |
| 8.4 | Multilocation trial MLT 1994 - Series II | Jobner and Jagudan |
| 8.5 | Mutation studies and hybridisation programmes in cumin | Jagudan |
| 8.6 | Irrigation schedules for cumin with reference to yield and blight disease | Jagudan |
| 8.7 | Blight disease control by manipulation of Agronomic practices | Jagudan |

| | |
|---|---|
| 8.8 Integrated management of pests and diseases of cumin | Jobner and Jagudan |
| 8.9 Epidemiological studies of *Alternaria* blight of cumin | Jobner and Jagudan |
| 8.10 Quality evaluation in cumin | Jobner |

**9. FENNEL**

| | |
|---|---|
| 9.1 Germplasm collection, description, evaluation and screening against diseases | Jobner, Jagudan, Hisar and Dholi |
| 9.2 Initial evaluation trial | Jagudan |
| 9.3 Multilocation trial MLT 1994 - Series II | Jobner and Hisar |
| 9.4 Yield evaluation trial | Jagudan |
| 9.5 Mutation studies and crossing programmes in fennel | Jagudan |
| 9.6 Response of rabi fennel to irrigation, nitrogen and phosphorus | Jagudan |
| 9.7 Effect of different inter and intra row spacings on yield of rabi fennel | Jagudan |
| 9.8 Weed control studies in fennel | Hisar |
| 9.9 Quality evaluation studies in fennel | Jobner |

**10. FENUGREEK**

| | |
|---|---|
| 10.1 Germplasm collection, maintenance, evaluation and screening against diseases | Jobner, Jagudan, Coimbatore, Guntur, Hisar, Dholi and Kumarganj |
| 10.2 Initial evaluation trial (IET) | Coimbatore and Jagudan |
| 10.3 Multilocation trial | |
| 10.3.1 MLT 1993- Series II | Coimbatore, Jobner, Guntur, Hisar, Dholi and Kumarganj |
| 10.3.2 MLT 1995- Series III | Guntur, Jagudan, Coimbatore, Dholi, Hisar, Kumarganj and Jobner |

| | |
|---|---|
| 10.4 Evolving varieties resistant to powdery mildew through mutation breeding and crossing programme | Jobner and Jagudan |
| 10.5 Effect of time of sowing and spacing on the yield of fenugreek | Coimbatore, Dholi, Hisar and Kumarganj |
| 10.6 Response of fenugreek to Nitrogen, Phosphorus and Rhizobium cultures | Jobner |
| 10.7 Response of fertility levels and spacing on seed yield of fenugreek | Kumarganj |
| 10.8 Biocontrol of root rot disease | Coimbatore |

## Discipline / Crop wise distribution of technical programme of AICRPS (1997-98)

| Crop | Crop Improvement | Crop Production | Crop Protection | Quality Evaluation | Total projects |
|---|---|---|---|---|---|
| Black pepper | 3 | 1 | 5 | - | 9 |
| Cardamom | 3 | 3 | 1 | - | 7 |
| Large cardamom | 2 | - | 1 | - | 3 |
| Ginger | 4 | - | 2 | 1 | 7 |
| Turmeric | 4 | - | 4 | 1 | 9 |
| Tree Spices | 3 | 4 | - | - | 7 |
| Coriander | 5 | 3 | 2 | 1 | 11 |
| Cumin | 5 | 1 | 3 | 1 | 10 |
| Fennel | 5 | 3 | - | 1 | 9 |
| Fenugreek | 4 | 3 | 1 | - | 8 |
| Total projects | 38 | 18 | 19 | 5 | 80 |

# EXPERIMENTAL RESULTS

## BLACK PEPPER

### 1.1 Germplasm collection, description and evaluation

*Panniyur, Sirsi, Chintapalli, Yercaud and Dapoli*

At Panniyur centre, 22 new accessions of black pepper were added to the germplasm and a total of 87 accessions are maintained. Among the 65 accessions evaluated, 48 accessions flowered. And Karimunda III (PRS-22) registered highest green berry yield (10.2 kg vine$^{-1}$) followed by Kaniakadan (7.1 kg vine$^{-1}$) and Kalluvally IV (6.50 kg vine$^{-1}$). As regards open pollinated progenies the cultures 4879, 5089 and 5621 recorded an yield of 9.52, 8.42 and 7.38 kg (green berry) vine$^{-1}$.

The Sirsi centre collected two cultivated (*Karimalligesara* and *Uddakara*) and one wild accession from Malanad and Uttara Kannada areas. The centre is maintaining a total of 72 cultivated and 21 wild and related species of black pepper. Among the 20 accessions planted for assessing the performance, Kuthiravally, Karimunda, Munda, Thalakkodi, Kalluvally-3 and Nilgiris started yielding during 1997-98.

The Chintapalli centre added 13 new cultivated accessions and a total of 27 cultivated and 23 wild accessions are maintained.

At Yercaud, a total of 106 accessions which includes four wild types are maintained. Fifty one accessions flowered in 1997-98. The accessions PN-2 (Somali) recorded highest berry set. The new accession included are Killiyur-1 and 2, Mulluvi 1, 2, 3, 4 and 5. The Dapoli centre maintains seven cultivated and one wild type.

### 1.2 Inter varietal hybridization to evolve high yielding varieties

*Panniyur*

At Panniyur, 490 OP progenies / hybrids are maintained in the intervarietal hybridization trial. Almost all the cultures recorded substantially poor yield during the year due to extreme drought.

### 1.3 Multilocation trials

### 1.3.1Multilocation trial of pepper genotypes (MLT-1987- Series III)

*Panniyur and Sirsi*

At Panniyur, a trial was laid out (1990) with eight cultures / varieties along with two checks to study their comparative performance. Among the entries, Karimunda registered significant difference for yield (4.69 kg vine$^{-1}$).

At Sirsi, the trial was laid out (1993) as an intercrop in arecanut garden, consisting nine cultivars / varieties. Panniyur-5 registered maximum plant height and more laterals (45) compared

to all other entries. Flowering commenced in Malligesara, Uddakara and all the Panniyur types. Panniyur-5 registered maximum yield (220 g green vine $^{-1}$) followed by Panniyur-3 (216 g).

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

*Panniyur, Sirsi, Chintapalli, Yercaud, Ambalavayal and Pampadumpara*

The MLT series IV was laid out at five centres with 14 cultures/varieties to evaluate their performance.

At Panniyur centre, Panniyur-5 registered higher yield (1.1 kg green berry vine $^{-1}$) in the MLT laid out during 1993. At Chintapalli, the trial was laid out during 1996 and is in progress. At Ambalavayal, Panchami registered the highest berry yield followed by Panniyur-4. At Pampadumpara, highest yield was recorded by the culture 239 (214 g green vine$^{-1}$) followed by Panniyur-1 (172g). At Yercaud, Panniyur-3 performed better (1kg vine$^{-1}$).

## 1.4 Irrigation - cum - fertilizer requirements on black pepper and arecanut in a mixed cropping system

*Panniyur and Sirsi*

A trial consisting of three irrigation levels and four fertilizer levels was laid out (1992) at Sirsi to study its effect on pepper and arecanut in a mixed cropping system with irrigation.

The treatments were imposed during May 1995 on three years old vine. The results did not show any significant difference among the irrigation levels. However, for fertilizer levels there was a significant difference in yield. A fertilizer schedule of 150:60:210 g of NPK vine$^{-1}$ recorded the highest berry yield (535 g green vine$^{-1}$).

At Panniyur, a new trial on drip irrigation in black pepper was laid out during June 1996. The trial is in progress.

## 1.5 *Phytophthora* foot rot and nematode disease management in black pepper

*Panniyur, Sirsi*

At Panniyur, the trial was concluded. The most economical management developed by the centre is the timely adoption of package of practices along with 1 kg neem cake during June and application of Phorate 3G @ 30g vine$^{-1}$, Bordeaux mixture (1%) spray as first round in June and Akomin (0.2%) spray as second round in August.

A new experiment to manage *Phytophthora* was laid out at Sirsi (1996-97) at six locations in farmers field with five treatments consisting of different fungicides / bioagents. The fungicides were applied to vines as spray / drench The bioagent viz., *T. viride* (50 g vine$^{-1}$), neem cake (1 kg) and FYM (5 kg) were applied as basal. Application of bioagent will be repeated after 30-35 days.

The disease incidence was least (5.55%) in the treatment involving spraying

(3 lit vine$^{-1}$) and drenching twice (5 lit vine$^{-1}$) with Akomin (0.3%). The next best treatment combination was Bordeaux mixture (1%) spray and drench with 0.2% copper oxychloride (Table 1).

## 1.6 Biological control of *Phytophthora* foot rot of black pepper

*Sirsi and Chintapalli*

For the biocontrol of *Phytophthora* root rot, a pot culture experiment was conducted at Sirsi. The trial consisted of seven treatments including antagonistic organism, fungicide and neem cake. The antagonistic organisms were applied basaly along with neem cake (100 g pot$^{-1}$) before application of infected material. The pooled data of five years revealed that application of Bordeaux mixture as spray (1%) + copper oxychloride as drench (0.2%) registered lowest disease incidence (15.81%). The next best treatment was use of *T. viride* which recorded disease incidence of 24.18% (Table 2).

Studies at Chintapalli involving *Trichoderma* treatmental combinations showed that the vines receiving *T. viride* registered least disease incidence.

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

### 1.7.1 Control of *Phytophthora* foot rot disease of black pepper in farmers field (Observational trial)

*Panniyur*

The experiment was modified by including biocontrol agent *Trichoderma harzianum* with soil application of neem cake and Akomin a fungicide spray against *Phytophthora*. This was compared with the most effective treatment (from the previous experiments-spraying 1% Bordeaux mixture + drenching copper oxychloride and application of 1kg neem cake). The trial was laid out at two

Table 1 *Phytophthora* foot rot and Nematode disease management in black pepper at Sirsi (1997-98)

| Treatment | Per cent disease incidence | | |
|---|---|---|---|
| | 1996-97 | 1997-98 | Mean |
| Control | 33.88 | 17.77 | 25 82 |
| Bordeaux mixture (1%) spray and copper oxychloride (0 2%) drench | 8 99 | 6.11 | 7 49 |
| Akomin (0 3%) spray and drench (twice) | 6.66 | 4.44 | 5.55 |
| Bioagent (*T. viride*) @ 50 g, 1 kg neem cake and 5 kg FYM Vine-1 | 20 55 | 7.20 | 13 87 |
| Akomin (0 3%) spray + Bioagent (*T. viride*) | 17.77 | 5 00 | 11 38 |
| C D at 5% | 2 52 | 3.76 | 3 14 |

Table 2 Biological control of *Phytophthora* foot rot of Black pepper at Sirsi

| Treatment | Per cent disease incidence | | | | | |
|---|---|---|---|---|---|---|
| | 1993-94 | 1994-95 | 1995-96 | 1996-97 | 1997-98 | Mean |
| *Trichoderma viride* | 46 66 | 20.00 | 26.66 | 33.33 | 16.70 | 24.18 |
| T *harzianum* | 20.22 | 16.66 | 30 00 | 40.00 | 23.31 | 24 98 |
| *Laetisaria arvalis* | 26.66 | 23.33 | 33 33 | 53.33 | 36.63 | 35 39 |
| *Bacillus subtilis* | 33.33 | 23 33 | 33.33 | 56.66 | 40.00 | 38.33 |
| Bordeaux mixture (1%) spray+ Copper oxychloride (0.2%) drench | 20 00 | 13.33 | 16.66 | 23 33 | 13.30 | 15 81 |
| Neem cake @ 100g pot $^{-1}$ of 4 kg soil | 53.33 | 43.33 | 56.00 | 63 33 | 46.62 | 50 30 |
| Untreated control | 80.00 | 56 66 | 63.00 | 73.33 | 56 00 | 62 16 |
| C D at 5% | 1 26 | 1.34 | 2 27 | 1.86 | 1 14 | 1 38 |

locations viz., at PRS, Panniyur and at Kannoth Estate, Payam, Irritty. The disease incidence was low. The treatments were on par with respect to leaf and branch infection. As regards the yield, the treatments were significantly superior over the control.

### 1.7.2 Studies on the chemical control of nursery disease of black pepper including biocontrol

*Sirsi and Panniyur*

At Sirsi, an experiment with three light intensities viz., 7.2 K lux (high), 3.3 K lux (medium) and 0.48 K lux (low) and eight treatmental combinations were laid out (1993-94). Vigorous growth of the vines was observed in medium light intensity (3.3 K lux). The mean data of five years presented in Table-3 showed that Bordeaux mixture (1%) spray and drench at 15-20 days interval under medium light intensity registered lowest disease incidence of 23.34% as compared to control (65.72%).

At Panniyur, the experiment was relaid out by including biocontrol and soil solarisation as treatments. The results of the studies at Panniyur showed that dipping the cuttings in culture solutions of *T. harzianum* recorded least disease incidence (8.8%).

### 1.7.3 *Phytophthora* foot rot incidence in different density of black pepper in an arecanut garden

*Sirsi*

At Sirsi, an experiment involving different densities of black pepper in arecanut garden was laid out during 1996-97. The variety Malligesara was planted @ 25, 50, 75 and 100 per cent population. The experiment is in progress.

Table 3 Chemical control of nursery diseases of black pepper at Sirsi

| Treatment | Per cent disease incidence | | | | | |
|---|---|---|---|---|---|---|
| | 1992-93 | 1994-95 | 1995-96 | 1996-97 | 1997-98 | Mean |
| Bordeaux mixture (1%) spray | 53 33 | 43.33 | 40 00 | 43.00 | 19 90 | 32 40 |
| Difolatan (0.2%) spray | 46.66 | 46.00 | 50 00 | 43.00 | 33.30 | 39.85 |
| Bordeaux mixture (1%) spray + drench | 40.00 | 30.00 | 26.66 | 23 33 | 16.70 | 23 34 |
| Difolatan (0 2%) spray + drench | 33.33 | 33 33 | 40 00 | 36.66 | 30 00 | 32.91 |
| Chlorothalonil (0 2%) spray | 50.00 | 40.00 | 40.00 | 40.00 | 33.00 | 37 75 |
| Cheshnut compound drench | 43.33 | 40.00 | 46 66 | 40 00 | 36 60 | 39.54 |
| Chlorothalonil (0 2%) spray+drench | 43.33 | 40 00 | 46.66 | 40.00 | 36 60 | 39.54 |
| Control | 76.66 | 66 66 | 73 33 | 56 00 | 63 27 | 30 40 |
| C D at 5% | 2.21 | 2.20 | 1 54 | 1.60 | 1.66 | 1.77 |

## 1.8 Control of scale insect in black pepper

*Pampadumpara and Mudigere*

The experiment for control of scale insect of black pepper could not be carried out due to the poor incidence of scale insect.

## 1.9 Survey for the incidence of insect pests on black pepper at high altitudes

*Pampadumpara and Mudigere*

The survey was conducted in different taluks of Idukki district for thrips, mealy bug and gall thrips. Heavy infestation of mealy bug was noticed. The incidence of scales was very less.

**Closed Project - final report**

## *Phytophthora* foot rot and nematode disease management in black pepper

*Sirsi*

The experiment was laid out with seven treatments and a control to standardise *Phytophthora* management under Sirsi condition. Investigations during 1991-97 identified the following package of technology to control foot rot and nematode.

The package of cultural practices recommended by UAS, Dharward along with basal application of one kg neem cake, phorate 3 G @ 30g vine$^{-1}$, Bordeaux mixture (1%) spray (3 lit vine$^{-1}$) and drench (5 lit vine$^{-1}$) before onset of monsoon, followed by Akomin (0.04%) as second spray (3 lit vine$^{-1}$) and drench (5 lit vine$^{-1}$) and third spray (3 lit vine$^{-1}$) and drench (5 lit vine$^{-1}$) with Ridomil MZ-72 w p (100 ppm) at 30 days after second spray.

This technology reduced the disease incidence to 7.78% as against control (46.66%) with C:B ratio of 1:4.4 (Table 4).

Table 4. *Phytophthora* foot rot and nematode disease management in black pepper at Sirsi

| Treatment | 1991-92 | 1992-93 | 1993-94 | 1994-95 | 1995-96 | 1996-97 | Mean | C:B Ratio at Sirsi |
|---|---|---|---|---|---|---|---|---|
| T1 | 20.00 | 53.00 | 50.00 | 56.66 | 60.00 | 40.00 | 46.66 | 1:1.00 |
| T2 | 56.67 | 43.33 | 33.00 | 36.66 | 33.33 | 26.00 | 38.16 | 1:2.26 |
| T3 | 10.00 | 26.27 | 23.33 | 23.33 | 26.66 | 16.00 | 21.01 | 1:3.28 |
| T4 | 23.33 | 33.33 | 20.00 | 23.33 | 20.00 | 16.00 | 22.66 | 1:3.60 |
| T5 | 6.67 | 26.77 | 20.00 | 20.00 | 20.00 | 13.00 | 17.74 | 1:4.51 |
| T6 | 3.33 | 20.00 | 13.33 | 13.33 | 16.66 | 6.60 | 12.20 | 1:5.55 |
| T7 | 10.00 | 26.77 | 10.00 | 13.33 | 20.00 | 6.60 | 14.45 | 1:5.44 |
| T8 | 0.00 | 16.67 | 6.66 | 10.00 | 10.00 | 3.30 | 7.78 | 1:4.41 |
| CD at 5% | 0.69 | 1.22 | 2.48 | 1.83 | 1.80 | 1.33 | 1.55 | |

T1- Absolute control without any cultural practices

T2- Package of practices + 1 kg of Neem cake + 3G a.i. of Phorate (30g vine$^{-1}$) as soil application

T3- Package of practices + Bordeaux mixture (1%) spray + soil drench with Copper oxychloride (0.2%) first round and spray + drench Ridomil MZ - 72 WP (100 ppm) as second round

T4- T2 + Ridomil MZ - 72 WP (100 ppm) spray and drench as first round and spray Bordeaux mixture (1%) as second round

T5- T1 + Bordeaux mixture (1%) spray and drench as first round and Bordeaux mixture (1%) spray and drench as second round

T6- T2 + Bordeaux Mixture (1%) spray and drench as first round and Akomin (0.04%) spray and drench as second round

T7- T2 + Bordeaux mixture (1%) spray + Soil drench with Copper oxychloride (0.2%) first round and second round

T8- T2 + Bordeaux mixture (1%) spray and drench first round + second round with Akomin (0.04%) spray and drench + third round with Ridomil MZ-72 WP as spray and drench

## CARDAMOM

### 2.1 Germplasm collection, description and evaluation

*Pampadumpara and Mudigere*

At Pampadumpara centre 92 germplasm accessions including 77 cultivated and 14 wild species are maintained. Survey has been carried out in 13 taluks of Idukki district and one new collection has been made locally. Among the 77 types evaluated, the highest capsule yield of 1.4 kg vine$^{-1}$ was recorded by *Veeraputhran* followed by PS-4 (1.3 kg dry capsule).

Mudigere centre holds 245 accessions, which are being maintained and evaluated for yield and agronomic characters. Among the accessions, 55, 56, 39, 2, 19, 32 and 145 recorded more than 30 suckers. And accessions 121, 113, 55 and 122 recorded more than 30 panicles clump$^{-1}$. Pooled data over seven years revealed that FB 1277-7, P17, P8, CL 728, CL 692, P 12, CL 730, CL 757 and P20 are promising. These are being multiplied for further large scale yield testing.

## 2.2 Multilocation trials (MLTs)

### 2.2.1. MLT 1988- Series II

*Pampadumpara*

As per the decision of XII AICRPS Workshop the trial was relaid out with 10 accessions at Pampadumpara in 1994. During the second year of bearing, highest yield of 2.1 kg clump$^{-1}$ was recorded by M-1 followed by SKP-14 and Sel. 800 which have yielded 1.9 kg and 1.8 kg respectively. The height of tillers and number of panicles were also maximum in M-1.

### 2.2.2 MLT 1991-Series III with Malabar types

*Mudigere, Appangala, Sakleshpur and Thadiyankudisai*

The experiment was relaid out with 14 treatments at the centres as per the decision of XIV AICRPS Workshop. The trial is in progress.

### 2.2.3. MLT 1991 - Series III with Mysore types

*Mudigere, Appangala, Sakleshpur and Myladumpara*

The trial was relaid out with 5 treatments and observations recorded.

## 2.3 Hybridization and selection in cardamom

### 2.3.1 Yield evaluation of promising cardamom selections

*Mudigere*

Twenty three promising selections (seedling progeny) identified from the OP progenies (from poly cross nursery of promising clones) at Mudigere has been planted for further evaluation with Mudigere-1 and Mudigere-2.

### 2.3.2 Evaluation of synthetics

*Mudigere*

The clones Cl-691 and Cl- 692 were found to be good general combiners. The other promising clones are Sel.800, SKP-14 and HS-1.

The promising clones planted in August 1996 started flowering. The sucker production ranged from 13 to 18 among the clones.

## 2.4 Effect of fertilizer on the yield of cardamom

*Pampadumpara and Mudigere*

An experiment to assess the response of cardamom to different levels of fertilizers was laid out at Pampadumpara

(1994) with clones of PV-1 consisting of six treatments. Application of NPK @ 100:100:175 kg $ha^{-1}$ gave encouraging results.

At Mudigere, the trial was laid out during 1992 using Mudigere-1 with six levels of fertilizer under natural shade. The study confined that under natural shade, fertilizer levels up to the recommended dose of 75:75:150 kg NPK $ha^{-1}$ gave significantly higher yield (284 kg $ha^{-1}$ green), but further increase in fertilizer levels did not cause much variation in capsule yield.

## 2.5 Micro nutrient requirement studies - Influence of micro nutrients on the yield of cardamom

*Mudigere and Pampadumpara*

At Mudigere, the trial was laid out with seven treatments to study the influence of micro nutrients (boron and Molybdenum) on the yield of Mudigere-1. The results did not show any significant difference for yield.

Under Pampadumpara, the study was taken up with nine treatments involving different levels of boron, zinc and molybdenum to assess the response of cardamom to different methods of application. The trial is in progress.

## 2.6 Integrated nutrient management in cardamom

*Mudigere and Pampadumpara*

At Mudigere, the experiment was laid out during *kharif* 1994 with eight treatments involving different combinations of both organics and inorganics. Significant variation in capsule yield was observed. Application of 100 % inorganics gave maximum yield (707 kg $ha^{-1}$ green) compared to control and other combinations.

## 2.7 Pest management in cardamom

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

*Mudigere*

Plant based insecticides viz., neem cake (500 g $clump^{-1}$) Nimbicidine (0.3%), Multineem (0.3%), NSKE (5%) and Nimbex (0.3%) were compared for their efficacy to control thrips, and shoot and capsule borer of cardamom with endosulfan (0.05%) and phosalone (0.05%) in combination with monocrotophos (0.05%) and phorate (10 g $clump^{-1}$). Each treatment received three spays. The first spray was either with monocrotophos or phorate application or application of neem cake in March and subsequent two sprays were with neem based insecticides or phosalone or endosulfan in the month of May and August.

The treatment combinations were compared with the recommended schedule of monocrotophos - phosalone - phosalone and an untreated check. Among the plant based insecticides all treatment combinations with neem based insecticides were at par with each other and with the recommended schedule of monocrotophos -phosalone - phosalone.

The phorate-phosalone - phosalone combination recorded the least thrips damage (12.76%) and less borer attack (0.78%).

### 2.7.2 Estimation of quantitative and qualitative loss due to thrips damage in cardamom

*Mudigere*

The thrips damage was assessed based on the per cent scabbed surface areas of the capsule. The harvested and dried capsules were graded into four groups as 0= no damage, 1= up to 10% scabbed area, 2= 11% to 33% scabbed area, and 3 = >33% scabbed area. Observations recorded showed significant reduction in the number of seeds with the increase in scabbed areas by thrips.

### 2.7.3 Bio-ecology of natural enemies of major pests of cardamom

*Mudigere*

Under Mudigere, the natural enemies of the major pests of cardamom were studied. The larvae of *Congethus punctiferalis* was infected by a bacterium. The identification of the bacteria is under study.

## CLOSED PROJECT

### 2.7.4 Estimation of loss and determination of economic threshold for cardamom shoot borer

*Mudigere*

The results of studies on the estimation of loss due to cardamom shoot borer were taken for the determination of economic threshold for shoot borer. The yield loss was computed using the formula:

$$\% \text{ yield loss} \quad \frac{\text{Actual loss}}{\text{Expected yield}} \times 100$$

Where, Expected yield = Total suckers x capsule yield / healthy sucker

Actual Loss = Number of damaged sucker x difference in yield / damaged sucker.

The study revealed that the economic threshold level was 10% shoot damage.

## LARGE CARDAMOM

### 3.1 Germplasm collection, description and evaluation

*Gangtok*

A total of 40 accessions (34 cultivated and 6 wild) have been maintained at Gangtok.

### 3.2 Comparative yield trial (1991)

*Gangtok*

Pink glossy, clone-3, White Ramna, Ramla, Red Sawaney and Bharlange were identified as promising yielders. Dzongu glossy was found immune to the viral *'Chirkey'* disease and Bebo - 1 (a collection from Arunachal Pradesh) to *'Foorkey'* virus disease.

Clone-4 was evolved through selection from the segregating progeny of 'Seto glossy'. The capsule are lemongreen with higher volatile oil content (3.5%).

Eight high yielding clones viz. RCLC-1 (Sawney) HYV, RCLC (Sawney) Clone-2, RCLC-3 (Bebo), *Foorkey* tolerant

RCLC-4 (Dzongu golsey), *Chirkey* tolerant RCLC-5, RCLC-6, ISH triploid, RCLC-7 (ISHC) and RCLC-8 (Dzongu golsey) suitable for higher altitude were identified for multuplication and further testing. Another lower altitude promising type 'Sharmaney' (Lephrakey) was identified for further evaluation and multiplication.

# GINGER

## 4.1 Germplasm collection, description and evaluation

*Pottangi, Solan, Dholi, Raigarh, Kumarganj and Pundibari*

At Solan 176 germplasm accessions are maintained and yield and yield attribtutes were observed. Maximum yield was recorded in SG 700 (7.7 kg 3m $^{2}$) followed by SG-705, SG 227, China and Ernad.

Two new collections were made by the Pottangi centre from Kendrupara and Koraput districts of Orissa. Out of 160 germplasm accession,150 were evaluated and the genotype $V_2E_4$ gave highest yield of 7.8 kg 3m $^{2}$.

The Dholi centre collected 27 ginger germplasm from YSPUHF, Solan and were evaluated. The Pundibari centre added 11 new accessions from Calicut, Chintapalli , Solan and West Bengal. Ten new entries were added at Kumarganj centre. The Raigarh centre added 18 new accessions of pepper out of which 15 entries were evaluated during *kharif* 1997-98. The accessions RGS-13, RGS-3 and RGS-1 performed better for yield.

## 4.2 Initial Evaluation Trial (IET)

*Pottangi and Solan*

At Solan, an IET (1997) laid out with 31 collections including check (*Himgiri*). Significant differences were observed for yield. The accessions BDJR 1179 significantly out yielded the check, while few collections viz., BDJR 1230, BDJR 1149, SG 680 and BDJR 1053 were at par.

At Pottangi in the IET, sixteen promising entries were evaluated. Vengara (23.87 t ha$^{-1}$), Singhjhara (23.26 t ha$^{-1}$) and $V_2E_4$-5 (22.35 t ha$^{-1}$) were the top yielders and produced significantly higher yield than *Suprabha.*

## 4.3 Comparative Yield Trial (CYT)

*Solan and Pottangi*

At Solan, the CYT (1995) with six collections along with check (SG-666) was laid out for the second year. No significant difference for yield observed. None of the collection out yielded the check except SG-62. In another CYT at Solan with six collections, no significant difference was observed.

In the CYT at Pottangi six cultivars were evaluated. $V_1E_8$-2 (25.71 t ha$^{-1}$) and $V_1S_1$-8 (20.93 t ha$^{-1}$) produced significantly higher rhizome yield.

## 4.4 Multilocation Trial (MLT)

MLT 1996 - Series IV

*Solan, Pottangi, Kumarganj, Chintapalli, Pundibari and Raigarh*

In Solan and Pottangi, the MLT (1996 series IV) was laid out with six entries *viz*., $V_1S_8$-2 and $V_3S_1$-8 from Pottangi, $V_1S_1$-8 from Jagtial, SG 554 from Solan and Acc. 64 from IISR. At Solan the observation on different characters observed were non significant. Highest yield was recorded in SG 554 (5.45 kg 3 $m^2$) and was at par with Acc. 64 while all other yield difference was non significant.

Among the six ginger cultivars, significantly higher rhizome yield was recorded by $V_3S_1$-8 (21.01 t $ha^{-1}$) followed by $V_1E_8$-2 in the evaluation of two years yield under Pottangi.

## 4.5 Studies on control of rhizome rot of ginger

*Solan and Dholi*

At Solan, an experiment on integrated management of rhizome rot of ginger was laid out with eight treatments and observation were recorded on germination per cent, incidence of rhizome rot, yield and recovery of mother rhizomes. The results (Table 5) showed that rhizome emergence was high (97.13%) when the rhizomes were treated with Dithane M-45 (0.25%) + Bavistin (0.1%) for 60 minutes followed by soil application of Thimet 10.G (12 kg $ha^{-1}$). And the disease incidence was also less (5.6%) with high yield (10.8 kg $ha^{-1}$) and high recovery (1.58 kg $3m^{-2}$). The next best treatment with high yield (10.1 kg $3m^{-2}$ and recovery (1.23 kg $3m^{-2}$) was treatment with Chlorphyriphos (0.2%) + Chlorphyriphos (0.1%) spray after two months of planting.

Studies on the effect of seed treatment on soft rot of ginger at Dholi revealed that seed treatment with Ridomil MZ @ 3g $litre^{-1}$ for one hour recorded the lowest disease incidence (11.60%) as against control (60.50%).

Table 5. Integrated management of rhizome rot of ginger at Solan

| Treatment | Emergence (%) | Disease incidence (%) | Yield (kg/$3m^2$) | Recovery (kg/$3m^2$) |
|---|---|---|---|---|
| T1 | 83 1 | 19.1 | 7 283 | 0 93 |
| T2 | 97.13a | 5 6a | 10.750b | 1 58a |
| T3 | 90.48b | 9 3c | 10.050c | 1 23b |
| T4 | 83.1 | 17.6 | 9.916c | 0.93 |
| T5 | 82 17 | 18.5 | 11 750a | 0.90 |
| T6 | 73 86 | 28 4 | 8.083 | 0.73 |
| T7 | 83 1 | 18 4 | 9 416 | 1.0b |
| T8 | 94.27a | 6 5b | 9.750c | 0 8 |
| CD(at 5%) | 3 71 | 0.35 | 0.48 | 0 29 |

T1= Farmer's practice (control but rhizome selection)

T2= T1 + Rhizome treatment in combination of Dithane M-45 (0.25%) + Bavistin (0.1%) + Thimet 10G Soil Application (12 kg/ha)

T3= T1 + Rhizome treatment in Chlorphyriphos (0.2%) + Chlorphyriphos (0.1%) spray after two months of planting

T4 = T1 + Rhizome treatment in Dithane M-45 (0.25%) + Bavistin (0.1%) + Chlorphyriphos (0.2%) + Chlorphyriphos spray (0.1%) two months after planting

T5 = T4 + 50% N (50 kg/ha)

T6 = T4 + 100% N (100 kg/ha)

T7 = T4 + 50% NPK (50:25:25 kg/ha; ½ N, full P & K as basal, ½ N as top dressing in 2 splits)

### 4.6 Evaluation of germplasm for quality

*Solan*

Sixty two samples were analysed for quality attributes viz., oleoresin, essential oil and dry matter. The maximum oleoresin (8.75%) was recorded in $V_1S_1$-8. The essential oil was maximum of 2.0% in R-3, SG-553, Maran, Kerala Local, BDJR-1054. The dry matter percentage was highest in SG-54 (20.57%).

### 4.7 Biocontrol studies on rhizome rot of ginger

*Solan*

The trial will be taken up in the ensuing season.

## TURMERIC

### 5.1 Germplasm collection, description and evaluation

*Pottangi, Solan, Jagtial, Dholi, Pundibari, Kumarganj and Raigarh*

At Solan, 185 accessions are maintained and evaluated. The yield ranged from 3.10 kg to 8.10 kg per plot of $3m^2$. The top yielders are BDJR 1210 (8.10 kg), ST 365 (7.90 kg), BDJR 1254 (7.40 kg) and CLS-24 (7.30 kg). The Dholi centre maintains a total of 56 germplasm accessions.

At Jagtial, 188 accessions collected from different places are being maintained for further evaluation. Germplasm has been collected from Adilabad, Kovvur, Chintapalli and Anantharajpeta of A.P. Based on duration, cultures were grouped into long duration (8-9 months), medium duration (7-8 months) and short duration (6-7 months). A lot of variability was observed for growth and yield characters.

The Pottangi centre holds a total of 204 accessions consisting of 182 cultivated and 22 wild related species. Four new collections were made during this year. Out of 204 accessions, 175 were evaluated. Among the 155 accessions of *C. longa*, Tu. No.1, PTS-13, PTS-45 (7.69 to 9.74 kg $3m^{-2}$) among 17 accessions of *C. aromatica*, Chayapasupa II and Bataguda (7,02 to 7.79 kg $3m^{-2}$) and among the three accessions of *C. amada*, CAM-1, CAM-2, and CAM-3 (5.75 to 6.61 kg $3m^{-2}$) were promising.

The Pundibari centre collected 14 new accessions from Pottangi, Dholi, Kahikuchi, IISR and Kalimpong areas and making a total of 50. Kumarganj centre added 12 new collections and maintaining a total of 27. All the entries were evaluated for their agronomic

traits and yield. The accessions NDH-2 produced high yield of 5.2 t ha $^{1}$ followed by NDH-2 and Rajendra Sonia. At Raigarh, 37 new entries were added and the total was made up to 43. Out of this, 34 entries were evaluated. The accessions RTS-19, RTS-21, RTS-22 and RTS-30 performed better for yield and growth parameters.

## 5.2 Initial evaluation trial

*Pottangi, Dholi and Jagtial*

At Pottangi, the IET with 15 cultivars viz. PTS-34, PTS-46, PTS-16, PTS-6, PTS-13, PTS-29, PTS-4, PTS-47, PTS-27, T.No.3, PTS-51, PTS-50, PTS-37, Alleppey (Check), *Roma* (Check) was laid out and evaluated. Significantly higher yield was recorded by PTS-4 (28.73 t ha$^{-1}$), PTS-51 (28.5 t ha$^{-1}$) and PTS-27 (28.38 t ha $^{1}$).

In the IET at Dholi, out of seven varieties, *Rajendra Sonia* (check) yielded maximum of 31.5 t ha $^{1}$.

## 5.3 Comparative yield trial

*Pottangi, Dholi and Jagtial*

At Pottangi, a new CYT with six accessions in each of long and short duration types was laid out. Among the long duration types, significantly higher yield was obtained by PTS-43 (25.80 t ha $^{1}$) followed by PTS-62 (24.61 t ha $^{1}$). Among the six short duration cultivars, PTS-59 (28.06 t ha $^{1}$) registered significantly higher yield.

In the CYT at Dholi, out of seven entries, *Rajendra Sonia* gave maximum yield of 31 t ha $^{1}$. At Jagtial, a CYT with short, long and medium duration turmeric varities were evaluated. Out of seven long duration entries, JTS-6 registered significantly higher yield (31.3 t ha $^{1}$) followed by JTS 8 (30.21 t ha $^{1}$). Out of the 12 medium duration types significantly higher yield was recorded in JTS - 313 (29.99 t ha$^{-1}$) followed by JTS-302 (24.99 t ha $^{1}$). Among the seven entries tested under short duration types, JTS 602 recorded significantly higher yield (27.44 t ha $^{1}$) as against check (PCT-13 with 22.32 t ha $^{1}$).

## 5.4 Multilocation trial

MLT 1996-Series IV

*Pottangi, Dholi, Pundibari, Kumarganj, Jagtial and Raigarh*

An MLT (1996 Series IV) was laid out at Pottangi, Dholi and Jagtial with ten cultivars viz., RS-5, *Rajendra Sonia* (Bihar) PTS-12, PTS-62, Roma (Pottangi), Acc. 360 and 361 (IISR), JTS-1, JTS-2 (Jagtial).

In the MLT at Dholi, RH-5 gave the highest yield (47 t ha$^{-1}$).

In Jagtial MLT, out of 10 cultures, significantly higher yield was recorded with JTS-2 (30.66 t ha $^{1}$) followed by JTS-1 (29.22 t ha$^{-1}$) as against the check (Duggirala with 28.33 t ha $^{1}$).

Among the 10 cultivars evaluated for two years at Pottangi, significantly higher

rhizome yield was recorded by JTS-2 (26.95 t ha$^{-1}$), Rajendra Sonia (24.15 t ha$^{-1}$) and JTS-1 (23.94 t ha$^{-1}$). However, the dry recovery was high in Acc. 361(5.70 t ha$^{-1}$) followed by PTS-43 (5.33 t ha$^{-1}$).

## 5.5 Survey and identification of the disease causing organism in turmeric and screening of turmeric germplasm against diseases

*Dhoh and Jagtial*

Leaf blotch disease was found to be most serious in North Bihar areas as per the survey conducted by Dholi centre. And 56 accessions were screened against leaf spot and leaf blotch. Kohinur and G.L. Puram were graded as resistant to leaf spot and leaf blotch diseases.

At Jagtial, out of 48 accessions tested against rhizome rot (*Colletotrichum*) and *Taphrina* leaf spot diseases, only 18 cultures were found free from rhizome rot.

## 5.6. Effect of seed treatment on leaf blotch disease of turmeric/Effect of fungicides on leaf spot disease

*Dhoh*

Seed rhizome pre-treatment studies against leaf blotch initiated at Dholi (1997-98) with six different fungicides. viz. Ridomil MZ (3g lit$^{-1}$.), Indofil M-45 (2g lit$^{-1}$), Bavistin (1g lit$^{-1}$), Indofil M-45 + Bavistin (2g + 1g lit$^{-1}$), Blitox 50 (2.5g lit$^{-1}$), Emisan-6 (1g lit$^{-1}$). Minimum disease incidence of 12.5% was observed in rhizomes treated with Emisan-6 followed by Bavistin with 18.5%. In another experiment to study the effect of fungicide on the control of leaf spot disease with respect to mode of action and spray method, the trial was laid out (1996-97) with six different fungicides. The minimum disease incidence of 19.5% was recorded by Indofil M-45 (2g lit$^{-1}$) followed by Ridomil 3g lit$^{-1}$ with 20.0%.

## 5.7 Chemical control of *Taphrina* blotch spot disease of turmeric

*Jagtial*

An experiment was laid out at Jagtial with seven fungicides viz., Difenconozole (0.1%), Propiconozole (0.1%), Ketazine (0.1%), Mancozeb (0.2%), Carbendazim (0.1%), Copper oxychloride (0.3%) and Bordeaux mixture (1%). Five sprays of each fungicides were given at fortnight intervals starting from initial appearance of the disease. The results indicated that all the fungicides tested, sprayed at 10 days interval during Nov. - Dec. reduced the incidence. Lowest disease incidence (48.36%) was recorded by Difenconozole, followed by Propiconozole with incidence of 58.9%. However, higher cost benefit ratio (1:6.17) was obtained by Carbendazim spray.

## 5.8 Investigation of the casual organism of rhizome rot disease of Turmeric and screening of biocontrol agents for the management

*Jagtial*

At Jagtial, an investigation was carried out to study the etiology of turmeric rhizome rot. The fungus *Pythium* sp. and *Fusarium* sp. was consistently isolated from roots and rhizomes of diseased plants. A new fungus with coenocytic mycilium associated with the disease was also identified.

For the management of rhizome rot of turmeric, an experiment consisting of six treatments with biocontrol agents, *Trichoderma viride* and *Pseudomonas fluroscence* was initiated. The biocontrol agents reduced the disease incidence.

## 5.9 Quality evaluation of turmeric

*Solan*

Sixty two turmeric accessions were analysed for quality attributes at Solan. The highest curcumin content (6.34 %) was observed in *Kurtan Tanake*. PTS-10 recorded maximum essential oil (9.5%). Maximum dry recovery of 30.6% was recorded in PCT-5. The accessions PTS-53 registered high oleoresin content (17.39%).

# TREE SPICES

## 6.1 Germplasm collection, conservation and cataloguing of tree spices viz. Clove, Nutmeg and Cinnamon

*Yercaud, Thadiyankudisai, Pechiparai and Dapoli*

In clove, 13 germplasm accessions are being maintained at Yercaud. And in Cinnamon, 11 accessions were assembled which includes cassia cinnamon collected from Valparai. Fifteen new nutmeg accessions were also added in the germplasm.

At Dapoli, four promising types of nutmeg from Vengurla (V-26), Bhatya (B-72), Dapoli (DPL-16, DPL-50) have been included in the nutmeg germplasm and maintaining a total of 14. Nine elite cinnamon accessions viz., No.5, 44, 53, 63, 65, 189, 203, 310 and 312 have been procured from IISR Calicut and planted in the germplasm block. Now the germplasm of cinnamon consists of 12 types. And in clove, 50 seedlings from IISR, Calicut and 10 seedlings of Kallar types from State Hort. Farm, Kallar (Tamil Nadu) have been procured and planted.

At Pechiparai, in clove, 14 high yielding selections from IISR, Calicut and seven local collections are under evaluation. The growth characters of the trees were recorded. Among the collections S.A. 12 (Pioneer) and S.A. 14 (Bethany) have started flowering. In

nutmeg, four grafts of IISR along with a selection from State Hort. Farm, Courtalam were procured and planted. The centre now maintains a total of 12 germplasm accessions. Few accessions started bearing and growth observations are continued in all the 12 types. In cinnamon 12 selections which included nine elite lines from IISR and three local collection are mantained. Among these types, Sel. 63 recorded maximum plant height (569 cm), stem girth (38 cm) and number of branches (32). All the types have flowered and the trial is in progress.

At Thadiyankudisai, in cinnamon, 10 lines were identified and selected based on the mean performance over several years. Acc. No.3 recorded highest yield of 0.58 kg dry quills plant $^{-1}$.

## 6.2 Multilocation trial in clove

*Yercaud, Pechiparai and Dapoli*

At Yercaud, six clove entries are under evaluation (MLT 1992). The growth parameters were recorded periodically. The accession Sel.1 registered highest plant height (165 cm) and more number of branches (31).

## 6.3 Multilocation trial in Cinnamon

*Yercaud, Ambalavayal, Thadiyankudisai and Pechiparai*

During 1992, the MLT with six elite lines viz. Sel.44, Sel.53, Sel. 64, Sel 189 and Sel 203 (from IISR, Calicut) was laid out in the centres. The data showed that the highest mean leaf yield of 3.7 kg tree $^{-1}$ was recorded in Sel. 44 followed by Sel. 203. The accession Sel. 189 recorded the highest mean bark yield (892 g) followed by Sel. 53 (880 g).

At Ambalavayal, the MLT consists of seven cinnamon types, which includes five from IISR, (SL-44, SL-53, SL-63, SL-189 and SL-203) and two (Acc. No. 1 and No.22) from RARS, Ambalavayal. The trees were coppiced during May 1996 and biometric observations were recorded. The accessions Sel.63 and Sel.53 recorded higher bark yield.

## 6.4 Vegetative propagation in nutmeg, clove and cinnamon

*Yercaud, Pechiparai and Thadiyankudisai*

At Yercaud, epicotyl grafting techniques in nutmeg at different stages of scion and root stock were carried out. Orthotrophic and semi hard wood scions and root stocks from four different stages *viz.*, epicotyl, 2, 4 and 5 leaved stages were selected for the study. The results indicated that the orthotrophic scions with soft wood two leaved root stock recorded the maximum success (48.5%).

## 6.5 Drip irrigation in clove

*Yercaud*

A drip irrigation experiment was laid out at Yercaud (July 1993) with five irrigation treatments (identified for pre-bearing age up to the seventh year). The drip system was in operation during dry months. The treatments include dripping of 2, 4, 6 and 8 litres of water per day per plant as against control (8.0 lit of water

per week). Among the treatments, dripping of 8.0 litres of water per day recorded the highest plant height (136.34 cm) and number of branches per plant (41.41)

## 6.6 Biofertilizer trial in tree spices (Clove and nutmeg)

*Yercaud*

### Clove

The Yercaud centre conducted an experiment with biofertilizers (*Azospirillum and Phosphobacteria*) and organics in 15 years old clove trees. Inorganics and biofertilizers were applied in two split doses during June and September. The result showed that application of recommended dose of fertilizer *viz.*, 100 kg FYM, and 400:350:1200 g $K_2O$ tree$^{-1}$ year$^{-1}$ in combination with the biofertilizers (50 g in each of *Azospirillum* and *Phosphobacteria*) recorded more bud yield 3.5 kg (fresh) tree $^{-1}$.

### Nutmeg

The experimental details were similar to clove. Application of 100 kg FYM, 400:300:1200 g NPK tree$^{-1}$ year$^{-1}$ along with 50g each of *Azospirillium* and *Phosphobacterium* recorded more yield (528 fruits tree $^{-1}$).

## 6.7 Studies on fruit drop of nutmeg

*Dapoli*

A detailed survey on fruit drop of nutmeg was undertaken by the Dapoli centre. Out of 342 trees observed under 18 to 20 years age group only nine trees showed fruit drop. The trees showing premature fruit drop was 2.53%. In general, the fruit drop of this region was very meagre (less than 5%). No fungus was found to be associated with this disorder.

# CORIANDER

## 7.1 Germplasm collection, maintenance and evaluation

*Jobner, Jagudan, Coimbatore, Guntur, Dholi, Hisar, Raigarh and Kumarganj*

At Jobner centre, a total of 733 coriander accessions which includes 105 exotic and 628 indigenous collections are maintained. In the evaluation of 348 accessions, eight accessions gave better yield than check varieties (RCr - 41, RCr-20, RCr-435 and RCr- 436). The accessions viz., UD-349, UD-16, UD-595 and UD-627 were identified promising for different characters. The stem gall disease of coriander (caused by *Protomyces macrosporus*) is a serious problem in Basan, Jahalawar, Danta and Kota districts of Rajasthan. A total of 33 germplasm entries were screened for stem gall disease at Jobner (in farmers' field of Danta district). The entry RCr-41 was found immune. In the screening of coriander entries for root knot nematode (*M. incognita*) at Durgapura, the varieties UD-475, CS-4 and CS-6 were found tolerant and UD-373 was highly susceptible.

One hundred and eighty two accessions are maintained at Coimbatore centre. The centre added six new accessions from Guntur, Jobner and Jagudan.The accessions CS 64, CS 108, CS 154, CS 177, CS 745 and UD 684 are promising. In the evaluation of germplasm for wilt resistance, among 123 accessions, 75 were free from wilt incidence. The wilt incidence ranged from 3.5 (Acc. 115) to 35.0 per cent (Acc. 114). Among the 10 accessions evaluated for wilt incidence under IET, only two accessions (CC. 462 and 496) recorded low incidence (6.0 and 6.5 respectively). In the CYT for wilt, ATP 77 and JCo.64 recorded lower wilt incidence (5.8%).

The Guntur centre is maintaining a total of 230 coriander accessions. During the reported period, out of 110 collections evaluated, the collection LCC-227 recorded highest yield (1100 kg ha$^{-1}$) followed by LCC-197 (1083 kg ha$^{-1}$) and LCC-128 (1033 kg ha$^{-1}$), as against the check (883 kg ha$^{-1}$).

The Jagudan centre is maintaining a total of 68 accessions which included 17 exotic and 51 indigenous accessions. Among the 68 accessions evaluated 21 performed better for yield.

One hundred and ten coriander accessions are maintained at Dholi centre, 10 entries performed better for growth and yield. Out of 100 entries evaluated for stem gall disease, *Pant Haritima*, UD-646 and *Rajendra Swati* showed resistance.

The Raigarh centre collected 13 germplasm accessions from different spice growing areas and evaluated for yield and yield attributes.The accessions RCS-13 and RCS-2 recorded higher yield during reported period.

Kumarganj centre is maintaining a total of 60 accessions, out of 60 accessions evaluated, RCr-41 produced highest seed yield (2180 kg ha$^{-1}$) followed by *Pant Haritima* (2060 kg ha$^{-1}$), RD-23 (2000 kg ha$^{-1}$) and CO.2 (1940 kg ha$^{-1}$).

## 7.2 Initial Evaluation Trial (IET)

*Coimbatore, Dholi, Guntur, Hisar and Jagudan*

At Coimbatore, IET was carried out during 1997 (*kharif*) with nine accessions along with the check (CO.3). Significant differences were noticed for umbellets / umbel and grain yield. The accessions 466 and 1080 recorded higher yield.

At Dholi, nine varieties with *Rajendra Swati* (Check) were tested in an IET. The variety ATP-77 retained maximum plant height (115.50 cm) followed by UD-20 (110.33 cm). *Rajendra Swati*, DH-8 and DH-48 gave better yield in comparison to other varieties.

Ten promising coriander collections along with *Sadhana* (check) were tested under IET at Dholi. LCC-128 recorded highest yield (1022 kg ha$^{-1}$) followed by LCC-133 (983 kg ha$^{-1}$) as compared to check (834 kg ha$^{-1}$).

At Guntur, 10 entries along with *Sadhana* (check) were tested. The accessions LCC-128 registered highest

yield (1150 kg ha $^{-1}$) followed by LFC-84, LFC-74 and LFC-82. Under Jagudan, among the 10 entries the entry JCo -372 registered higher yield (1252 kg ha $^{-1}$) which was 6.92% higher than control (1171 kg ha $^{-1}$).

## 7.3 Multilocation trials

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

*Jagudan, Coimbatore, Hisar and Dholi*

At Dholi, 10 cultivars along with *Rajendra Swati* (check) were tested under MLT (1996). The entry UD-446 recorded highest yield (2000 kg ha $^{-1}$) as compared to check (1450 kg ha $^{-1}$). The number of umbels per plant was higher (35) in UD-446.

### 7.3.2 Multilocation Trial - 1996 Series III

*Jobner, Guntur, Dholi, Coimbatore, Jagudan and Hisar*

At Jobner, the trial was laid out with 14 entries, which includes five (UD-684, UD-685, UD-686, RCr-41 and local check) from Jobner, three (DH-13, DH-48, and DH-52) from Hisar, two each (JCo-327, JCo-331) from Jagudan, (LCC-15, LCC-32) Guntur and (CC-745, CC-748) Coimbatore. The data revealed wide variations for growth and yield attributes. The entry UD-684 recorded maximum grain yield (885 kg ha $^{-1}$) followed by UD-686 (872 kg ha$^{-1}$) and DH-13 (743 kg ha $^{-1}$) as compared to local check (274 kg ha $^{-1}$) and released check (RCr-41 @ 599 kg ha $^{-1}$).

In Guntur 11 entries from different centres were tested. The entry LCC-15 recorded highest yield of 961 kg ha $^{-1}$ followed by LCC-32 (922 kg ha $^{-1}$) over check (Sadhana @ 811 kg ha $^{-1}$).

At Dholi, 10 entries along with a check (*Rajendra Swati*) were evaluated for yield performances under MLT (1996) for the second year. The best yield (2412 kg ha $^{-1}$) was recorded by the entry UD-686 which was significantly superior over other varieties and check (1800 kg ha $^{-1}$).

At Jagudan among the 13 entries evaluated for yield performance under CVT, the pooled data of two years showed significant differences among the entries for yield. The check (GC-2) out yielded (1527 kg ha$^{-1}$) the entries. However, the entry JCo.331 (1429 kg ha ) was on par with check (Table 6).

The MLT with nine entries along with CO.3 as check was tested under Coimbatore condition. The result showed significant variation for yield among the entries tested. The ACC. 745 registered higher yield of 530 kg ha $^{-1}$ as against 453 kg ha $^{-1}$ recorded by the check (CO.3).

## 7.4 Comparative yield trial of leafy type coriander

*Dholi and Coimbatore*

In the evaluation of CYT for leafy type coriander, 10 entries along

with *Rajendra Swati* (Check) were tested for the second year at Dholi. *Pant Haritima* was found to be significantly superior for green leaf yield (1568.9, 1655.0 and 2000.0 kg ha$^{-1}$ on 40, 55 an 70 DAS respectively) due to its late flowering.

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

*Jobner and Coimbatore*

At Jobner, on the basis of three years yield performance the progenies viz., 5 Kr-14 (UD-684), 5 Kr-68 (UD-685) and 20 Kr-5 (UD-685) were identified and included in the MLT.

## 7.6 Response of coriander varieties to date of sowing and row spacing

*Jobner*

At Jobner centre, a trial consisting of 15 treatmental combinations involving five dates of sowing (15 and 25th Oct., 4, 14 and 24th Nov.) and three row spacing (20, 30 and 40 cm) was conducted during rabi 1994-95 to 1996-97 (Table 7). The experimental findings of three consecutive years revealed that maximum seed yield of 1198 kg ha$^{-1}$ obtained under 4, Nov. sowing closely followed by 25, Oct. sowing (1180 kg ha$^{-1}$) was significantly higher compared to 15, Oct., 14, and 24, Nov. sown crops. The maximum mean net return of Rs.1 16, 367 ha$^{-1}$ and B:C ratio of 1.96 were obtained under 4, Nov. sown crop.

As regards spacing, 30 cm row spacing produced maximum mean seed yield of 1024 kg ha$^{-1}$ which was significantly higher over 20 and 40 cm row spacing. Maximum mean net return of Rs. 12902 ha$^{-1}$ with B:C ratio of 1:1.57 was obtained with 30 cm row spacing.

The date of sowing and row spacing interaction on seed yield was significant. Sowing coriander on 25, Oct. at 30 cm row spacing produced maximum mean seed yield of 1273 kg ha$^{-1}$ closely followed by 4, Nov.. sowing at 30 cm row spacing (1269 kg ha$^{-1}$) and 20 cm spacing (1193 kg ha$^{-1}$).

Table 6. Yield performance of coriander in CVT at Jagudan

| Entry | Yield (kg ha$^{-1}$) | | Average yield (kg ha$^{-1}$) |
|---|---|---|---|
| | 1996-97 | 1997-98 | |
| UD-684 | 1470 | 925 | 1198 |
| UD-685 | 1307 | 953 | 1130 |
| UD-686 | 1388 | 1062 | 1225 |
| DH-13 | 1742 | 1062 | 1402 |
| DH-48 | 1361 | 1171 | 1266 |
| DH-52 | 1236 | 969 | 1102 |
| LCC-15 | 1105 | 1307 | 1206 |
| CC-745 | 1290 | 1443 | 1367 |
| CC-748 | 1176 | 1252 | 1214 |
| JCO-327 | 1334 | 1203 | 1269 |
| JCO-331 | 1465 | 1307 | 1386 |
| G.CO-2 | 1552 | 1307 | 1429 |
| (Check) | 1666 | 1388 | 1527 |
| CD at 5% | 324 | 3 01 | 3.05 |

Table 7. Effect of date of sowing and row spacing on yield and economics of coriander at Jobner (pooled data)

| Treatment | Grain yield (kg ha$^{-1}$) | | | | Net return (Rs./ha) | | | |
|---|---|---|---|---|---|---|---|---|
| | 94-95 | 95-96 | 96-97 | Mean | 94-95 | 95-96 | 96-97 | Mean |
| Date of sowing | | | | | | | | |
| 15 October | 507 | 1718 | 569 | 931 | 2393 | 25918 | 4076 | 10796 |
| 25 October | 704 | 1959 | 882 | 1182 | 6333 | 30738 | 10962 | 16011 |
| 4 November | 744 | 1924 | 926 | 1198 | 7133 | 30038 | 11930 | 16367 |
| 14 November | 452 | 1331 | 771 | 851 | 1293 | 18178 | 8520 | 9330 |
| 24 November | 287 | 949 | 546 | 594 | (-) 2007 | 10538 | 3570 | 4034 |
| CD at 5% | 078 | 106 | 074 | 051 | — | — | — | — |
| Row spacing (cm) | | | | | | | | |
| 10 | 4.71 | 16.01 | 7.44 | 9.39 | 1259 | 23029 | 7377 | 10555 |
| 20 | 6.13 | 16.53 | 8.06 | 10.24 | 4591 | 24721 | 9393 | 12902 |
| 40 | 5.32 | 14.74 | 6.67 | 8.91 | 3228 | 21485 | 6679 | 10464 |
| CD at 5% | 0.60 | 0.82 | 0.57 | 0.41 | — | — | — | — |
| Interaction | | | | | | | | |
| 95 | — | — | — | 5.39 | | | | |
| 95-96 | — | — | — | 15.76 | | | | |
| 96-97 | — | — | — | 7.39 | | | | |
| CD at 5% | — | — | — | 0.41 | | | | |

## 7.7 Response of fertility levels and plant spacing on yield of coriander

*Kumarganj*

At Kumarganj centre, an experiment was laid out to study the effect of fertility levels and spacing on yield of coriander. Maximum seed yield of 1840 kg ha$^{-1}$ was recorded at a fertilizer dose of 60:30:30 kg NPK ha$^{-1}$. With respect to spacing, 30 x 10 cm produced significantly higher yield (1953 kg ha$^{-1}$).

## 7.8 Response of coriander varieties to seed rate

*Jobner*

At Jobner centre, three varieties (RCr-41, UD-20 and UD-436) and five seed rates (12, 14, 16, 18 and 20 kg ha$^{-1}$) were chosen for the experiment, conducted for three consecutive years (from 1994 to 97 *Rabi*). The experimental findings revealed that coriander variety RCr-41 recorded maximum seed yield of 1445 kg ha$^{-1}$ which was significantly higher than UD-20 (1315 kg ha$^{-1}$) and UD-436 (884 kg ha$^{-1}$). The variety RCr-41 also gave maximum net return of Rs. 18,890 ha$^{-1}$ with B:C ratio of 1.75.

The seed rate of 14 kg ha$^{-1}$ produced maximum seed yield of 1312 kg ha$^{-1}$ with maximum mean net return of Rs.20,785 ha$^{-1}$ with B:C ratio of 1.52.

The interaction effect of varieties and seed rate was significant. The variety RCr-41 recorded maximum mean seed

yield of 1608 kg ha$^{-1}$ at 16 kg ha$^{-1}$ seed rate closely followed by 14 kg ha$^{-1}$ (1586 kg ha$^{-1}$). The Variety UD-20 gave maximum yield of 1417 kg ha$^{-1}$ at 16 kg$^{-1}$ seed rate followed by 14 and 18 kg ha$^{-1}$ seed rate (1388, 1337 kg ha$^{-1}$ respectively). Whereas, UD-436 produced maximum mean seed yield of 1117 kg ha$^{-1}$ at 12 kg ha$^{-1}$ seed rate.

### 7.9 Survey to study the disease incidence, collection and identification of casual organism

*Dholi*

As per the survey conducted by the Dholi centre, the stem gall disease is severe in the areas of Bihar.

### 7.10 Studies on wilt and powdery mildew management in coriander / biocontrol of wilt in coriander

*Coimbatore*

Seed treatment with *T. viride* along with foliar spray of Hexaconazole on 25, 40 and 55 DAS recorded lowest disease incidence (3.5%) with an yield of 315 kg ha$^{-1}$ as against control (27.5% incidence with 228 kg ha$^{-1}$).

### 7.11 Quality evaluation in coriander

*Jobner*

At Jobner centre, among the 15 entries tested for volatile oil content under CYT, the maximum of 0.45% was observed in CC-748 followed by 0.40% in CC-745, and a minimum of 0.2% in DH-13. The total yield of volatile oil ha$^{-1}$ depend upon the grain yield, which was highest in UD-684 (2.65 l ha$^{-1}$) followed by UD-686 (2.61 l ha$^{-1}$).

The volatile oil content of coriander entries of out station CYT from Hisar were compared with Jobner entries. The Hisar entries showed a range of 0.25 to 0.4%. The maximum of 0.4% was recorded in CC-784, CC-745 and JCo- 331 and minimum in UD-686 (0.25%) and DH-13 (0.25%). The Jobner and Hisar entries did not show any difference in oil content.

## CUMIN

### 8.1 Germplasm collection, description, evaluation and screening against diseases

*Jobner, Jagudan and Kumarganj*

The Jobner centre conducted survey in the areas of Kishangarh, Ajmer, Kekari, Jahajpur, Bhilwara and Chitoregarh areas and maintains a total of 266 accessions which includes 258 indigenous and eight exotic collections. In the screening of wilt resistance programme at Jobner, out of eight entries evaluated, the per cent mortality due to wilt was lowest (12.25) in RZ-19 and EC-232684 with grain yield of 265 and 286 kg ha$^{-1}$ respectively. The entry UC-220 gave lowest seed yield of 147 kg ha$^{-1}$ with 26.25 per cent mortality.

At Jagudan, 45 new accessions were added to the germplasm and a total of

157 accessions are maintained. In the germplasm, three entries viz; EC-84-1, EC-73-1 and EC-75-1 were tolerant to *Fusarium* wilt disease.

At Kumarganj, seven new accessions were collected and raised but they could not survive due to adverse weather condition.

## 8.2 Initial Evaluation Trial

IET-II (1996-97)

*Jagudan*

In the IET at Jagudan, out of 12 entries tested, the yield difference was not significant. However, the entry, JC-94-37 registered higher yield (797 kg ha$^{-1}$) than control (GC-2 with 780 kg ha$^{-1}$).

## 8.3 Comparative yield trial

*Jagudan*

At Jagudan, eight entries were tested under CVT. The pooled analysis of two years data showed that the entry EC-279081 registered higher yield (749 kg ha$^{-1}$) than control (GC-2 with 650 kg ha$^{-1}$).

## 8.4 Multilocation trial

MLT 1994 - Series II

*Jobner and Jagudan*

At Jobner, a trial consisted of eight entries which includes five from Jobner (UC-217, UD-220, UD-223, RZ-19 and local check) and three from Jagudan (JC-147, EC-279081 and EC-232684) was laid out during *rabi* 1995-96 and 1996-97. Significant variation was observed for days to flowering, umbels per plant, test weight and grain yield. The mean performance of entries revealed superiority of entry UC-223 (333 kg ha$^{-1}$) followed by JC-147 (270 kg ha$^{-1}$) and local check (266 kg ha$^{-1}$). The mean wilt incidence was lowest in UC-223 (9.38%), followed by EC-232684 (13.63%) and maximum of 25.63% recorded in EC-279081 (Table 8).

Table 8 Performance of cumin entries in CVT during (1995-96 and 1996-97) at Jobner

| Entry | Grain yield (kg ha$^{-1}$) | | | Wilt incidence (%) | | |
|---|---|---|---|---|---|---|
| | 1995-96 | 1996-97 | Mean | 1995-96 | 1996-97 | Mean |
| UC 217 | 260 | 195 | 228 | 28 75 | 21.25 | 25.00 |
| UC-220 | 296 | 143 | 219 | 12 50 | 26 25 | 19 38 |
| UC-223 | 313 | 352 | 333 | 5.00 | 13 75 | 9.38 |
| JC-147 | 284 | 255 | 270 | 27 50 | 18 75 | 23 13 |
| EC-279081 | 281 | 202 | 242 | 20 00 | 31 25 | 25.63 |
| EC-232684 | 180 | 286 | 233 | 15 00 | 12.25 | 13.63 |
| RZ-19 | 243 | 286 | 265 | 25 50 | 12 25 | 18.63 |
| Local check | 272 | 260 | 266 | 27.50 | 22 50 | 25 00 |
| CD at 5% | 0.70 | 0.88 | 0 79 | - | - | - |

## 8.5 Mutation studies and hybridization programme in cumin

*Jagudan*

In the hybridization programme, crosses were made between GC-2 x Hairy cumin and EC-232684 x GC-2. The seeds collected during 1996-97 did not germinate due to unfavourable weather condition. In the F2 study, out of 13 progenies raised, 10 were hairy and three were intermediate.

## 8.6 Irrigation schedules for cumin with reference to yield and blight diseases

*Jagudan*

At Jagudan, a trial with five treatments was laid out to work out the ideal irrigation schedule. The treatments showed significant difference for yield. The highest yield (555 kg $ha^{-1}$) was recorded with five irrigation (at sowing 8, 30, 50 and 70 DAS) and was at par with four irrigations (Table 9). The blight incidence was low (10.85%) with two irrigations whereas, the incidence was high (20.89%) in five irrigations.

## 8.7 Blight disease control by manipulation of agronomic practices

*Jagudan*

At Jagudan, a trial with six treatments [Control, straw mulch, interculturing a day after irrigation, removal of dew by cloth or rope, gram cultivation and application Ca $Cl_2$] was laid out to find out the factors influencing the blight disease. The treatment effects were not significant. However, higher seed yield (416 kg $ha^{-1}$) was obtained with the treatment involving intercultivation a day after irrigation.

## 8.8 Integrated management of pests and diseases of cumin

*Jobner and Jagudan*

An experiment consisting of four main treatments and 13 sub-treatments for the management of pests and diseases was laid out at Jobner during Dec. 1996. The wilt incidence was recorded in each treatment as the percentage of plants wilted till maturity of the crop. Observations were made for blight and powdery mildew incidence and for number of aphids

Table 9. Yield and yield attributes as affected by different irrigation treatments at Jagudan

| Treatment | Yield (kg $ha^{-1}$) | Disease incidence (%) |
|---|---|---|
| Two irrigation (at sowing time, 8 to 10 DAS) | 308 | 10.85 |
| Three irrigation (at sowing time, 8 to 10 DAS, 30 DAS) | 448 | 11.54 |
| Three irrigation (at sowing time, 8 to 10 DAS, 40 DAS) | 463 | 13.02 |
| Four irrigation (at sowing time, 8 to 10 DAS, 30 & 50 DAS) | 549 | 19.26 |
| Five irrigation (at sowing time, 8 to 10 DAS, 30, 50 & 70 DAS) | 555 | 20.89 |

and thrips before and after 72 hours of each spray. Basal application of *T. harzianum* with and without carbendazim, and neem cake as soil application reduced the wilt incidence as compared to control. Minimum incidence of 19.71 per cent with maximum grain yield of 425 kg ha$^{-1}$ was recorded in the treatment involving *T. harzianum* as both seed treatment and soil application along with spraying of 0.3%. Mancozeb + 0.3% neem oil + 1.0% Tepol. The control plot recorded maximum wilt incidence (28.66%) and lowest grain yield (229 kg ha$^{-1}$) (Table 10). The overall efficiency of foliar fungicides, insecticides, neem oil and tepol either alone or in combination with basal applications could not be worked out due to poor incidence of foliar diseases and insects which were observed only in control.

At Jagudan, the cumin crop failed due to very high incidence of blight disease. Thrips and aphids were not noticed.

Table 10 Integrated management of cumin diseases at Jobner

| Sub treatment | Main treatment | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ST + SA of TH | | STC + SA TH | | SA of OC | | Control | |
| | PWI | Y(kg ha$^{-1}$) | PWI | Y(kg ha$^{-1}$) | PWI | Y(kg ha$^{-1}$) | PWI | Y (kg ha$^{-1}$) |
| Mb @ 0 3% | 22 5 | 333 25 | 22 0 | 333 25 | 30 0 | 325 00 | 37 0 | 212 75 |
| Mb @ 0 3%+ No @ 1%+TP @ 1% | 19 7 | 425 00 | 20 0 | 325 00 | 27.0 | 316 50 | 35 3 | 237 50 |
| Mb @ 0 3% + MOP @ 0 4% | 24 0 | 425 00 | 22 0 | 300 00 | 24 0 | 458 25 | 25 0 | 233 25 |
| Mb @ 0 3% + ACEP @ 0 075% | 24 0 | 308 25 | 21 0 | 366 50 | 29 0 | 400 00 | 40 0 | 187 50 |
| Hex (Contaf) @ 0.05% | 24 3 | 370 75 | 20 2 | 308 25 | 31 0 | 350 00 | 35 0 | 170 75 |
| Hex @ 0 05% NO @ 1% + Tp @ 1% | 27 5 | 267 50 | 19 0 | 300 00 | 33 0 | 375 00 | 40 0 | 112 50 |
| Hex @ 0 05% + MOP @ 0 04% | 27 7 | 229 00 | 21 5 | 345 80 | 34 0 | 341 50 | 43 3 | 212 75 |
| Hex @ 0 05% + Acep @ 0 075% | 23 0 | 357.50 | 23 0 | 304 00 | 31 0 | 400.00 | 42.0 | 187 50 |
| Penc (Topas) @ 0 05% | 21 5 | 412.50 | 22 0 | 300 00 | 30 0 | 325 00 | 39 0 | 135 75 |
| Penc (Topas) @ 0 05% + MOP @ 0 04% | 25 0 | 320 80 | 20 5 | 400 00 | 32 0 | 400 00 | 40.0 | 237 50 |
| Thp Mc (Top M) @ 0 07% | 24 2 | 241 50 | 20 5 | 300 00 | 32 0 | 356 50 | 41 0 | 162 50 |
| + MOP @ 0 04% | 26 0 | 263.25 | 23 3 | 320 00 | 30 0 | 325 00 | 42 7 | 200 00 |
| Control (No spray) | 28 7 | 229 00 | 25 0 | 225 00 | 35 0 | 265 00 | 46 7 | 142 50 |

PWI = Per cent wilt incidence, Y= yield (kg ha$^{-1}$)

| Treatment | SEM | | CD | | CV(%) | | Com CV(%) | |
|---|---|---|---|---|---|---|---|---|
| | Yield kg ha$^{-1}$ | Wilt | Yield kg ha$^{-1}$ | Wilt | Yield kg ha$^{-1}$ | Wilt | Yield kg ha$^{-1}$ | Wilt |
| Main treatment | 400 | 0 96 | 1384 | 3 32 | 2123 | 24 70 | — | — |
| Sub treatment | 540 | 1 46 | 1532 | 3 21 | 1609 | 13 68 | 1640 | 14 19 |
| Interaction | 1094 | 2 29 | 3064 | 6 41 | — | — | — | — |

ST = Seed treatment, SA = Soil Application, ST with SA = ST with Carbendazim + SA, OC = Oil cake, TH = *Trichoderma harzianum*, Mb=Mancozeb, NO = Neem Oil, Acept = Acepitate,/ Hex = Hexaconazole, Tp = Tepol, Penc = Penaconzole, Thp Mc = Thophanate Methyl, Com CV = Combined CV, MOP = Monocrotophos

## 8.9 Epidemiological studies of *Alternaria* blight of cumin

**Jobner and Jagudan**

An experiment with five dates of sowing (10, 20, 30 Nov.. and 10, 20, Dec.) was conducted at Jobner to study the blight incidence. The wilt incidence was recorded in each treatment, as the percentage of plants wilted till maturity of the crop. Though blight incidence did not appear during 1996, the minimum wilt incidence was observed in 10th Nov. sown crop (12.5% with 298 kg $ha^{-1}$) followed by 20 Nov. (13.75% with 278 kg $ha^{-1}$). Maximum wilt incidence (14.71% with 103 kg $ha^{-1}$) was recorded in 20, Dec. sown crop.

At Jagudan, an experiment was laid out with five dates of sowing namely 5, 15, 25 Oct. and 5, 15, Nov. in order to quantify the epidemiological parameters that account for the disease. The results showed that the disease incidence was less in 5, 15 Oct. sown crop (6 to 8%). Delayed sowing enhanced the disease development. The powdery mildew incidence was also less in early Oct. sown crop.

## 8.10 Quality evaluation in cumin

**Jobner**

At Jobner, out of eight entries tested for volatile oil content (under CYT) the highest oil content of 3.2% was recorded in JC-147 followed by 3.0% in UC-233, UC-220, and local. The entry EC 232684 had the lowest oil content (2.6%). Volatile oil yield depends upon the grain yield and the percentage of volatile oil present in the seed. The volatile oil yield was high in UC 223 (9.75 l $ha^{-1}$) followed by JC 147 (8.16 l $ha^{-1}$) and RZ-19 (8.00 l $ha^{-1}$).

# FENNEL

## 9.1 Germplasm collection, description and screening against diseases

*Jobner, Jagudan, Hisar and Dholi*

A total of 198 fennel accessions which includes 162 indigenous and 28 exotic collections are maintained at Jobner. They were collected from Kishangarh, Ajmer, Kekari, Jahajpur, Bhilwara and Chitoregarh areas.

The Jagudan centre collected 94 new fennel accessions and now maintaining a total of 193 accessions which includes 20 exotic and 173 indigenous. The entries were evaluated for yield and growth attributes.

The Dholi centre cllected six more accessions of fennel from different areas and maintains a total of 40 accessions. The Kumarganj centre added 26 accessions and were evaluated for yield and agronomic traits. The accessions HF-126 recorded maximum yield (1553 kg $ha^{-1}$) followed by HF-102, HF-104, and NDF-8.

## 9.2 Initial evaluation trial

*Jagudan*

In the IET (1996-97) with 12 entries, the pooled data over two years showed

significant differences for yield. The entry JF-237 recorded significantly higher yield (3115 kg ha$^{-1}$) than control (GF-1 with 2447 kg ha$^{-1}$) which was 27.30% higher than control.

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

*Jobner, Hisar and Jagudan*

At Jobner centre, 10 entries including five from Jobner (UF-125, UF-133, UF-134, RF-101 and local check), three from Hisar (HF-71, HF-102 and HM-104) and two from Jagudan (JF-25 and JF-29) were evaluated in a CVT consecutively for three years (1994-95 to 96-97). The mean performance of entries revealed that the entry UF-125 (RF-125) recorded significantly higher grain yield of 1738 kg ha$^{-1}$ over local check (1279 kg ha$^{-1}$). The other promising entries identified are UF-134 (1388 kg ha$^{-1}$), JF-25 (1363 kg ha$^{-1}$) and HF-71 (1317 kg ha$^{-1}$). The entry UF-133 recorded the lowest grain yield of 1234 kg ha$^{-1}$. In the MLT (1997) at Jagudan, among the eight entries evaluated, the entry JF-200 gave higher yield (2833 kg ha$^{-1}$) than GF-2 (check) (Table-11).

## 9.4 Yield evaluation trial

*Jagudan*

The performance of several entries are being tested under Jagudan.

## 9.5 Mutation studies and crossing programmes in fennel

*Jagudan*

In the crossing programme at Jagudan,

Table 11 Mean performance of fennel entries evaluated under CVT at Jobner (1994-95 to 1996-97)

| Entry | Yield (kg ha$^{-1}$) | | | |
|---|---|---|---|---|
| | 1994-94 | 1995-96 | 1996-97 | Mean |
| UF-125 | 1575 | 1400 | 2238 | 1738 |
| UF-133 | 1075 | 1413 | 1213 | 1234 |
| UF-134 | 1188 | 1425 | 1550 | 1388 |
| JF-25 | 1350 | 1200 | 1538 | 1363 |
| JF-29 | 1213 | 1388 | 1300 | 1300 |
| HF-71 | 1113 | 1113 | 1725 | 1317 |
| HF-102 | 1275 | 1050 | 1675 | 1313 |
| Local check | 1313 | 1100 | 1425 | 1279 |
| CD at 5% | 1.32 | 3.87 | 3.83 | 3.01 |

in the $F_2$ study, the hybrids GF-1 x EC-386375 and GF-1 x Bloomless were sown. In the cross, GF-1 x EC-386375, 11 plants germinated among them one appeared as GF-1 with late maturity and bitter taste. In the cross GF-1 x Bloomless, all the 22 plants were observed as bloomless type.

## 9.6 Response of *Rabi* fennel to irrigation, nitrogen and phosphorus

*Jagudan*

An irrigation cum fertilizer trial with three levels of irrigation, nitrogen and phosphorus was laid out at Jagudan. The trial is in progress.

## 9.7 Effect of different inter and intra row spacings on yield of *rabi* fennel

*Jagudan*

An experiment with six spacings (30x15, 30x22.5, 40x15, 40x22.5, 60x15

and 60x22.5 cm) was laid out (*Rabi* 1997-98) at Jagudan to study the effect of spacing on yield. Significant difference in yield was observed. A spacing of 30 x 15 cm registered higher yield (1962 kg ha $^{-1}$) which was on par with other spacings, except 45 x 22.5 cm.

### 9.8 Weed control studies in fennel

*Hisar*

An experiment on weed control with four herbicide treatments was laid out at Hisar. The trial is in progress.

### 9.9 Quality evaluation studies

*Jobner*

At Jobner, nine entries of fennel tested under CVT were analysed for volatile oil content from 1994 to 1997 (Table 12). The mean performance of entries indicated that highest mean volatile oil of 1.86% was recorded in UF-125 followed by both UF-134 and HF-71 (1.73%). The entry JF-25 recorded the lowest oil content (1.56%). Comparison of volatile oil content of these entries grown at Jobner and Hisar did not show any difference.

## FENUGREEK

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

*Jobner, Coimbatore, Guntur, Dholi, Kumargan, Ratgarh, Jagudan and Hisar*

The Jobner centre conducted survey in the areas of Jahajpur, Bhilwara, Chittoregarh, Pratapgarh and collected new accessions. The centre maintains 320 accessions which includes 308 indigenous and 12 exotic collections. In the screening of fenugreek genotypes for root knot nematodes, out of five entries evaluated, UM-117 and UM-128 were graded as re-

Table 12. Performance of fennel entries under CVT at Jobner

| Entry | Mean grain yield (kg ha $^{-1}$) | Volatile oil (%) | | | | Mean volatile oil yield (t ha $^{-1}$) |
|---|---|---|---|---|---|---|
| | | 1994-95 | 1995-96 | 1996-97 | Mean | |
| UF-125 | 1737 | 1 7 | 1.9 | 2.0 | 1 86 | 32 30 |
| UF-134 | 1386 | 1.8 | 1 8 | 1.6 | 1 73 | 23 97 |
| HF-71 | 1317 | 2 0 | 1.6 | 1 6 | 1.73 | 22.78 |
| Local | 1279 | 1.9 | 1.7 | 1 4 | 1 66 | 21 23 |
| JF-29 | 1300 | 1 5 | 1 8 | 1.5 | 1.60 | 20 80 |
| UF-133 | 1233 | 1 8 | 1 5 | 1 5 | 1 60 | 19 72 |
| JF-25 | 1362 | 1.8 | 1.4 | 1.5 | 1.56 | 21.24 |
| HF-104 | 1381 | | 1.5 | 1 6 | 1.55 | 21 40 |
| HF-102 | 1362 | - | 1.6 | 1.4 | 1 50 | 20 43 |

sistant and UM-34 as moderately resistant. For yield performance, out of 281 accessions evaluated, 54 were better yielding than check (RMt-1). The acc. UM-140 and UM-141 were free from powdery mildew.

The Coimbatore centre collected eight new accessions of fenugreek, four each from Jobner (40kr-3-4, 40kr-1-5, 40kr-2-11 and 40kr-15-4) and Hisar (HM-110, HM-114, HM-291 and HM-305). The centre maintains a total of 179 accessions, and 146 accessions were evaluated during *kharif* 1997. Of the accessions tested, 104 accessions recorded more yield over the present ruling variety CO. 1. About 52 accessions are on the top order with respect to yield.

At Guntur, a total of 90 accessions are maintained by adding 20 new accessions this year. Among the new collections evaluated, the accession LFC-97 recorded the highest yield of 1150 kg ha $^{1}$ followed by LFC-84, LFC-74 and LFC-82 (1117, 1067 and 1017 kg ha$^{-1}$ respectively). The check (Lam selection-1) recorded an yield of 867 kg ha $^{1}$.

The Dholi centre added five new accessions of fenugreek and maintains a total of 105. In the screening of germplasm against downey mildew, out of 43 varieties, UM-302, UM-9, RM-5, UM-29, J. Fenu-53, UM-66, RM-1, HM-291, J. Fenu - 115, *Rajendra Kanti*, CF-290, Sel.9, Sel.6, UM-30, UM-61, UM-304 and UM-109 showed resistance to downy mildew. The entries RM-251 and HM-305 were susceptible.

The Raigarh centre collected 11 new accessions and evaluated for growth and yield performance. The accession RFS-1 recorded highest seed yield (2g plant $^{1}$) followed by RFS-8 (1.9g) with more number of seeds per pod, long pods, more number of branches and more plant height.

At Kumarganj, 32 new collections were made and making a total of 58 accessions. Out of 58 entries evaluated, HM-114 produced maximum seed yield (2475 kg ha $^{1}$) followed by RM-1 (2220 kg ha $^{1}$), JF-58 (2200 kg ha-1), HM-305 (2198 kg ha $^{1}$) and UM-301 (2125 kg ha $^{1}$).

The Jagudan centre is maintaining a total of 66 accessions including two exotic collections. Among the accessions evaluated, three entries performed better for yield.

## 10.2 Initial evaluation trial (IET)

*Coimbatore, Jobner and Jagudan*

At Coimbatore, a total of 10 accessions were evaluated during *kharif* 97 in IET. The observations on yield showed that the entry 464 recorded highest yield (640 kg ha $^{1}$) followed by 390 (591 kg ha $^{1}$) and 169 (578 kg ha $^{1}$) as against check (CO.1 @ 439 kg ha $^{1}$).

An IET with 28 entries and two checks (RMt-1 and local check) was laid out at Jobner during 1996-97. The result indicated that the entry 504-1 recorded

maximum grain yield of 2119 kg ha$^{-1}$ without powdery mildew incidence (P.M.I). The other promising progenies are 549-2 (2048 kg ha$^{-1}$ with P.M.I score of 0.67) and 293-4 (1806 kg ha$^{-1}$ with P.M.I score 8.0). The check variety RMt-1 produced a grain yield of 1631 kg ha$^{-1}$ with P.M.I score of 3.33.

## 10.3 Multilocation trials

### 10.3.1 Multilocation trial 1993 Series - II

*Coimbatore, Guntur and Hisar*

A CYT with eight entries along with CO. 1 as check was laid out at Coimbatore and evaluated during *kharif* 97. The accession CF-390 registered the highest yield of 591 kg ha$^{-1}$ followed by the accession CF-169, (578 kg ha$^{-1}$ as compared to CO. 1 (439 kg ha$^{-1}$).

At Guntur, 11 entries were tested under CVT. Among them JF-102 recorded highest yield of 1017 kg ha-1 followed by UM-304 (950 kg ha$^{-1}$). They are found to be significantly superior over check (Lam selection - 1 @ 817 kg ha$^{-1}$).

### 10.3.2 Multilocation trial 1995 - Series III

*Jobner, Dholi, Kumarganj and Jagudan*

A trial consisting of 14 entries including six from Jobner (UM-301, 302, 303, 304, RM t-1 and local check), four from Hisar (HM-110, HM-114, HM-291 and HM-305), two from Jagudan (J. Fenu-58 and J. Fenu - 102) two from Coimbatore (CO. 1 and 464) was laid out during *rabi* 1995 at Jobner (Table 13). The mean performance of entries over 1995-96 to 1996-97 revealed that UM-303 recorded maximum grain yield of 2324 kg ha$^{-1}$ followed by UM-304 (2183 kg ha$^{-1}$) and HM-110 (2149 kg ha$^{-1}$). Lowest powdery mildew incidence score of 0.54 was observed in UM-304 and minimum powdery mildew score of 5.75 was recorded in HM-110.

At Jagudan, the MLT (1995-96) was laid out with 12 entries including Methi local as check. The result showed that the yield difference was non significant. However, the entry J. Fenu-102 registered higher yield (1927 kg ha$^{-1}$) than control (1611 kg ha$^{-1}$).

Nine entries were evaluated under CYT at Dholi. The check variety (*Rajendra kanti*) recorded higher yield of 1650 kg ha$^{-1}$ followed by 1610 kg ha$^{-1}$ in UM-143 and 1600 kg ha$^{-1}$ in HM-141 and UM-144.

At Kumarganj, 14 entries were tested under CVT during *Rabi*, 1997-98. The entry HM-114 produced maximum seed yield of 2465 kg ha$^{-1}$ followed by J. Fenu-58 (2395 kg ha$^{-1}$), *Rajendra Kanti* (2395 kg ha$^{-1}$) and UM-304 (2361 kg ha$^{-1}$).

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

*Jobner and Jagudan*

At Jagudan, crosses were made between Methi local x Kasuri methi and

Table 13. Performance of fenugreek in CVT at Jobner (1995-96 to 1996-97)

| Entry | Grain yield (kg ha⁻¹) | | | Powdery mildew incidence score (0-9) | | |
|---|---|---|---|---|---|---|
| | 1995 96 | 1996-97 | Mean | 1995-96 | 1996-97 | Mean |
| UM-301 | 1979 | 1979 | 1979 | 4.33 | 4 00 | 4 17 |
| UM-302 | 2534 | 1458 | 1996 | 1.66 | 2 00 | 1 83 |
| UM-303 | 2500 | 2148 | 2324 | 4.33 | 4.00 | 4 00 |
| UM-304 | 2153 | 2213 | 2183 | 0 33 | 0 75 | 0 54 |
| HM-110 | 2344 | 1953 | 2149 | 5 00 | 6 50 | 5 75 |
| HM-114 | 2083 | 1953 | 2018 | 4 33 | 5 25 | 4 79 |
| HM-291 | 2188 | 1967 | 2078 | 1.66 | 1.25 | 1 4 |
| HM-305 | 2118 | 1941 | 2030 | 5.00 | 2.25 | 3.63 |
| 464 | 1476 | 1589 | 1533 | 1 66 | 2.00 | 1.83 |
| Local Check | - | 1693 | - | - | 2 50 | 2 50 |

seeds harvested and sown. Seven plants were of normal type and only one plant had short and thick pods. Seeds were harvested for $F_2$ study.

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

*Coimbatore, Dholi, Hisar, Kumarganj*

An experiment was conducted at Coimbatore to find out the optimum time of sowing and spacing with three spacings (15 x 10, 22.5 x 10, 30 x 10 cm) and six dates of sowing (5, 20 Sep., 5, 20 Oct., 5, 20 Nov). The result indicated that the number of days for flowering was greater in November sown crops to compared September sown crops. With respect to date of sowing, October sown crops recorded higher yield with a significant difference. Closer spacing gave more yield than wider spacing in 5, Oct. sown crops (1304 kg ha$^{-1}$) and 20 Oct. sown crop (1270 kg ha$^{-1}$).

## 10.6 Response of fertility levels and spacing on seed yield of fenugreek

*Kumarganj*

An experiment involving three fertility levels (20:30:10, 40:40:10 and 60:50:10) and three spacings (30 x 5, 30 x 10 and 30 x 15 cm) was laid out at Kumarganj to study its effect on the yield of fenugreek. A fertilizer level of 60:50:10 kg NPK ha$^{-1}$ recorded higher yield of 2370 kg ha$^{-1}$. Medium spacing recorded more yield (2357 kg ha$^{-1}$) than wider and closer spacing.

## 10.7 Biocontrol of root rot disease in fenugreek

Coimbatore

An experiment consisting of eight treatments (Seed treatment (ST) with

carbendazim + soil drenching, ST with *T. viride* alone, soil application (SA) of *T. viride* 20 DAS, SA of neem cake, ST with *T. viride* + SA neem cake, SA of *T. viride* + SA of neem cake, ST with Carbendazim + soil drenching + SA of neem cake and control) was laid out at Coimbatore to study the root rot incidence of fenugreek. Among the biological agents tested, the disease incidence was very low (5.0%) in seed treatment with *T. viride* (5 g kg $^{1}$ along with soil application of neem cake (150 kg ha $^{1}$), followed by seed treatment with *T. viride* (3.5%). The combined application of neem cake (150 kg ha $^{1}$) along with seed treatment (*T. viride*) recorded maximum yield of 375 kg ha $^{1}$, this was followed by seed treatment with *T. viride* alone (365 kg ha $^{1}$) and soil application of *T. viride* combined with soil application of neem cake (360 kg ha $^{1}$).

# GENETIC RESOURCES OF SPICES AT AICRPS CENTRES (As on 31.3.1998)

| Crop/Centre | Indigenous | | Exotic | Total |
|---|---|---|---|---|
| | Cultivated | Wild and related sp | | |
| **Black pepper** | | | | |
| Panniyur | 87 | | | 87 |
| Sirsi | 72 | 21 | | 93 |
| Chintapalli | 27 | 23 | | 50 |
| Yercaud | 106 | | | 106 |
| Pundibari | 2 | | | 2 |
| Dapoli | 7 | | | 7 |
| Dholi | 7 | 1 | | 8 |
| **Small Cardamom** | | | | |
| Pampadumpara | 77 | 15 | | 92 |
| Mudigere | 238 | 7 | | 245 |
| **Large Cardamom** | | | | |
| Gangtok | 12 | 18 | | 30 |
| **Ginger** | | | | |
| Pottangi | 155 | 2 | 3 | 160 |
| Solan | 176 | | | 176 |
| Dholi | 27 | | | 27 |
| Raigarh | 18 | | | 18 |
| Kumarganj | 10 | | | 10 |
| Pundibari | 11 | | | 11 |
| **Turmeric** | | | | |
| Pottangi | 182 | 22 | | 204 |
| Jagtial | 188 | | | 188 |
| Dholi | 56 | | | 56 |
| Bhavanisagar | 124 | | | 124 |
| Raigarh | 43 | | | 43 |
| Kumarganj | 27 | | | 27 |
| Pundibari | 50 | | | 50 |
| Solan | 185 | | | 185 |
| **Clove** | | | | |
| Yercaud | 13 | | | 13 |
| Thadiyankudisai | 1 | | | 1 |
| Pechiparai | 16 | | | 16 |

| Crop/Centre | Indigenous | | Exotic | Total |
|---|---|---|---|---|
| | Cultivated | Wild and related sp | | |
| **Nutmeg** | | | | |
| Yercaud | 15 | | | 15 |
| Thadiyankudisai | 1 | | | 1 |
| Pechiparai | 12 | | | 12 |
| Dapoli | 14 | | | 14 |
| **Cinnamon** | | | | |
| Yercaud | 11 | | | 11 |
| Thadiyankudisai | 6 | | | 6 |
| Pechiparai | 12 | | | 12 |
| Dapoli | 12 | | | 12 |
| **Coriander** | | | | |
| Jobner | 628 | | 105 | 733 |
| Jagudan | 51 | | 17 | 68 |
| Coimbatore | 182 | | | 182 |
| Guntur | 230 | | | 230 |
| Hisar | 98 | | | 98 |
| Dholi | 110 | | | 110 |
| Raigarh | 13 | | | 13 |
| Kumarganj | 60 | | | 60 |
| **Cumin** | | | | |
| Jobner | 258 | | 8 | 266 |
| Jagudan | 150 | | 7 | 157 |
| Kumarganj | 7 | | | 7 |
| **Fennel** | | | | |
| Jobner | 170 | | 28 | 198 |
| Jagudan | 173 | | 20 | 193 |
| Hisar | 44 | | | 44 |
| Dholi | 40 | | | 40 |
| Kumarganj | 26 | | | 26 |
| **Fenugreek** | | | | |
| Jobner | 308 | | 12 | 320 |
| Jagudan | 64 | | 2 | 66 |
| Coimbatore | 179 | | | 179 |
| Guntur | 90 | | | 90 |
| Hisar | 82 | | | 82 |
| Dholi | 105 | | | 105 |
| Raigarh | 11 | | | 11 |
| Kumarganj | 58 | | | 58 |

# LIST OF COORDINATING CENTRES UNDER AICRP ON SPICES

HEADQUARTERS: **Project Coordinator (Spices)**
All India Coordianted Research Project on Spices
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| Sl.No | AICRPS CENTRES | Telephone | Fax/Telex/ Email/Grams |
|---|---|---|---|
| 1. | Cardamom Research Station (Kerala Agrl. University) PAMPADUMPARA - 685 553 Dist. Idukki, Kerala | Nedumkandam 63 | |
| 2. | Regional Research Station (Univ. of Agrl. Sciences) MUDIGERE - 577 132 Dist. Chickmagalur, Karnataka | Chickmagalur (08263) 20246 (08263)21030 (R) | FAX: 08263: 20704 Email: hmc@uasmudkar.nic.in |
| 3. | Horticultural Research Station (Tamil Nadu Agrl. University) YERCAUD - 636 602 Dit. Salem, Tamil Nadu | Yercaud (04281) 22456 | |
| 4. | Regional Agril. Research Station (Andhra Pradesh Agrl. University) CHINTAPALLI - 531 111 Dist. Visakha, Andhra Pradesh | Chintapalli 38244 (O) 38258 (R) | |
| 5. | Pepper Research Station (Kerala Agrl. University) PANNIYUR, P.B. No.113 Taliparamba - 670 141 Dist. Cannanore, Kerala | Taliparamba (0498) 203287 | |
| 6. | Agricultural Research Station (Pepper) (Univ. of Agrl. Sciences) SIRSI - 581 401 Dist. Uttara Kannada, Karnataka | Sirsi 6797 | |
| 7. | Dept. of Vegetable Crops (Dr. Y S Parmar Univ. of Horticulture & Forestry) SOLAN -173 230, Himachal Pradesh | Oachghat 329 (Nauni/Solan)52329 | FAX: 01792 : 52242 GRAM:VANUDYAN, SOLAN |

| Sl.No AICRPS CENTRES | Telephone | Fax/Telex/ Email/Grams |
|---|---|---|
| 8. High Altitude Research Station (Orissa Univ. of Agrl. & Technology) POTTANGI - 764 039 Dist. Koraput, Orissa | | |
| 9 Dept. of Genetics & Plant Breeding SKN College of Agriculture (Rajasthan Agrl. University JOBNER - 303 329 Dist. Jaipur, Rajasthan | Jobner (01425) 4741 | AGRICOL, JOBNER |
| 10. Main Spices Research Station (Gujarat Agrl. University) JAGUDAN - 382 710 Dist. Mehsana, Gujarat | Jagudan (02762) 85337 | |
| 11. Dept. of Spices & Plantation Crops Faculty of Horticulture (Tamil Nadu Agrl. University) COIMBATORE - 641 003 Tamil Nadu | Coimbatore 431222 | FARMVAR, COIMBATORE 085558360 TNAU IN Email: tnau, coimbatore. cdot. dartnet.com |
| 12. Regional Agricultural Research Station (Andhra Pradesh Agrl. University) GUNTUR - 522 034 Andhra Pradesh | Guntur 30517, 31297, 31767 | |
| 13. ICAR Research Complex for NEH Region, Tadung GANGTOK - 737 102 Sikkim | Gangtok (03592) 22547 | AGRICOMPLEX, GANGTOK |
| 14. Regional Agrl. Research Station (Andhra Pradesh Agrl. University) JAGTIAL - 505 327 Dist. Karimnagar, Andhra Pradesh | Jagtial 21381 (O) 21380 (R) | |
| 15. Department of Vegetable Crops (Chaudhary Charan Singh Haryana Agrl University) HISAR - 125 004, Haryana | Hisar 73721-29 Ext.4486 | FAX:0091 01662 73552 AGRIVARSITY, HISAR Telex: 0345 216 HALL IN |

| Sl No AICRPS CENTRES | Telephone | Fax/Telex/ Email/Grams |
|---|---|---|
| 16. Department of Horticulture<br>Tirhut College of Agriculture<br>(Rajendra Agrl. University)<br>DHOLI - 843 121<br>Muzaffarpur, Bihar | (06212) 873227 (pp) | GRAM: COLAGRI, DHOLI |
| 17. Department of Horticulture<br>(Konkan Krishi Vidyapeeth)<br>DAPOLI - 415 712<br>Dist. Ratnagiri, Maharashtra | (02358) 82025, 82026 | FAX; 02358:82074<br>GRAM KONKANAGRI,<br>DAPOLI |
| 18. Department of Vegetable Science<br>(Narendra Dev University of Agrl.<br>& Technology)<br>Narendra Nagar P.O<br>KUMARGANJ, Faizabad -224 229<br>Uttar Pradesh | | GRAM: AGRIVARSITY |
| 19. Department of Horticulture<br>(Bidhan Chandra Krishi Vishwa<br>Vidyalaya)<br>North Bengal Campus<br>PUNDIBARI PO<br>Dist Cooch Behar<br>West Bengal - 736 165 | (ADR) (03582)<br>70249 (O) 22172 (R) | FAX: 03582-70246 (Camp.Dir)<br>FAX: 03582-22172 (ADR) |
| 20. Regional Agricultural Research<br>Station<br>(Indira Gandhi Krishi Vishwa<br>Vidyalaya), Biordadar Farm<br>RAIGARH - 496 001<br>Dist. Raigarh, Madhya Pradesh | | |

# FUNCTIONING OF THE COORDINATED PROJECT

The All India Coordinated Research Project on Spices (AICRPS) with its 20 regular centres and 8 voluntary centres based at 15 Agricultural Universities located in 15 States of India have contributed much towards spices production and quality upgradation. The sanctioned budget of the Coordinated project for the year 1997-98 was Rs.80 Lakhs and was shared by 75:25 per cent basis between ICAR and SAU's and the funds are disbursed by the Project Coordinator from IISR, Calicut.

It is pertinent to note that the XIV Workshop / National group meeting was held at Bangalore during July 1997. The work shop marked the Silver Jubilee of AICRP on Spices. A significant activity of the workshop was the recommendation of the release of three new spices varieties one each in cardamom (ICRI-4), Mango ginger (*Amba*) and Cumin (Gujarat cum.2). The performance of the centre were evaluated at the spices workshop that were attended by scientists from all the coordinating centres. The various recommendations made by the workshop have been followed / persuaded with the coordinating centres. The recommendations made during the workshop are being implemented by the different coordinating centres.

## Performance of the centres

### Black pepper centres

The black pepper research under AICRPS is mainly being conducted at Panniyur, Sirsi, Chintapalli as well as in new centres at Pundibari and Dapoli. The Mudigere, Pampadumpara and Yercaud centres also doing evaluation trials in black pepper. The progress of Yercaud centre is good. The RARS, Ambalavayal (a participating centre) is conducting the MLT in black pepper. The wild and related species of black pepper germplasm were collected by the Sirsi, Chintapalli, Panniyur and Yercaud centres. All the assigned technical programme in black pepper have been laid out systematically at Panniyur centre. At present nine research projects are in operation at Panniyur. The new centres at Dapoli and Pundibari laid out all the trials. Two irrigation experiments are in progress at Panniyur and Sirsi. Drought tolerant lines were identified in black pepper at Panniyur. Black pepper culture-54 has shown tolerance to *Phytophthora* foot rot. The work done at Panniyur is good. Seven research programmes are now in operation at Sirsi. The performance of the centre is satisfactory, but needs further progress and require very close monitoring by the Director of Research, UAS

Dharwad with the Project Coordinator. Five research programmes are in operation at Chintapalli. The progress of work should be reviewed critically and need close scrutiny. The performance of the centre is by and large satisfactory. The work at new centres is steadily progressing and needs close monitoring.

The breeder post remains vacant at Pundibari. It is necessary that the new scientist joining in black pepper centres needs to be trained on techniques of isolation of soil borne pathogens like *Phytophthora*, VAM, biocontrol agents etc. Due to the price hike of black pepper there is very high demand for the planting materials of released varieties. The Panniyur centre is doing good work in the production and distribution of rooted pepper cuttings. Promising lines in the pipe lines need to be multiplied in large numbers before varietal release in order to meet the demand of the farmers.

## Cardamom centres

Mudigere centre is doing work on various aspects of cardamom under 12 research projects. One project in black pepper is also in operation. Limitation of fund and manpower for basic studies, lack of resistance source for katte diseases and effective economical IPDM strategy are some of the constraints identified for the centre. The performance of the centre is good and has made steady progress in cardamom research. The centre developed several production technologies in cardamom including package of technology for rapid multiplication of planting material.

The Pampadumpara centre has been identified to work on black pepper also as the centre falls in the major pepper growing tracts. The centre has improved its performance subsequent to the filling of all sanctioned scientific position. Four research projects in cardamom and three in black pepper are in operation at this centre. All the experiments identified to be taken up during the past years have been laid out. The performance of the centre has thus improved. A close monitoring jointly by Director of Research and Project Coordinator is called for.

At Mudigere, the post of Pathologist though vacant for a long, but was filled and was again vacant since 7-6-1997. The post of Assoc. Professor (Agronomy) is also vacant since May 1997 at Pampadumpara.

The ICAR, Research Complex for NEH region at Gangtok, the lone centre, have the mandate of work on large cardamom did not participate in the last four workshops (XI, XII, XIII, XIV). And the last three years annual report have not been received from the centre. This may perhaps be due to the fact that the centre is functioning under the non-plan budget of ICAR. The QRT (1992-96) recommended to close the centre and deployment of the two scientific position to the ICRI (Spices Board) Research Centre for large cardamom at Gangtok.

## Ginger and turmeric centres

Research on turmeric is centred at Pottangi, Jagtial, Dholi, Raigarh, Kumarganj and Pundibari centres. And ginger at Pottangi, Solan, Raigarh, Kumarganj and Pundibari centres. Coimbatore centre has recently started work on turmeric. Substantial progress has been made in ginger and turmeric research by the Pottangi and Solan centres. The new centres also laid out the trials which are in progress.

## Tree spices centres

The tree spices research centres Yercaud and Dapoli are carrying out the assigned technical programme satisfactorily. All the ongoing trials including that of black pepper are systematically laid out. The Pechiparai, Thadiyankudisai (TNAU) and Ambalavayal (KAU) centres are functioning as participating centres. The tree spices germplasm has been exchanged between IISR, Calicut and Dapoli, Pechiparai and Yercaud centres. Two research projects in black pepper and five projects on tree spices are under progress at Yercaud. The technology developed need to be taken to the farmers field expeditiously. The work done at the centres are good.

## Seed spices centres

The seed spices centres viz., Jobner, Jagudan, Guntur, Hisar, Coimbatore and Dholi have laid out the trials as per the technical programme. The new centres initiated during 1995-96 viz., Kumarganj, Raigarh and Pundibari were also linked into the systems. Substantial contribution has been done by the Jobner and Jagudan centers towards the development of seed spices including quality upgradation.

Crop rotation cycle to manage cumin wilt, biocontrol for foot rot in fenugreek and coriander wilt, fertilizer recommendation for fenugreek in Rajasthan, irrigation and fertilizer schedule for fennel in Gujarat were perfected. The quality evaluation studies in seed spices with respect to volatile oil, helped in short listing the high quality lines in seed spices. The new centres have widen their activity in the germplasm collection and survey of the mandatory crops.

The Jobner centre has sought assistance to strengthen the laboratory to work on quality and residual toxicity. The post of the Horticulturist is vacant at Guntur continuously. Expeditious action is warranted to fill the vacancy.

At Kumarganj, the Pathologist and technical assistant posts are lying vacant. And at Pundibari, the Jr. Breeder and two technical assistant posts are to be filled.

In short the seed spices centres are carrying out good work. The ongoing trials are systematically laid out and progressing well.

# ACTION TAKEN REPORT ON THE RECOMMENDATIONS OF THE XIV WORKSHOP ON SPICES HELD AT BANGALORE DURING JULY 1997 AND ACTION TAKEN ON THE EARLIER DECISIONS

| DECISION | 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 descriptor has to be prepared for every spice. | As a result of regular survey and collections by the different centres around 5000 germplasm are available. Descriptors for pepper and cardamom have been supplied to the centres. |
| 2. In all the manurial experiments, the soil and plants analysis should be taken up immediately. | Soil analysis for background information in respect of the experimental fields are being carried out. Plant analysis are not being taken up for want of infrastructure facilities. |
| 3. In view of the growing awareness to environmental pollution and eco-friendly produce, more emphasis on reaction to pests and diseases have to be laid during varietal screening. | Adequate care is being bestowed in varietal screening for identifying varieties with tolerance to pest and diseases. |
| 4. The IISR may organise short term training on isolation, mass multiplication and application of biocontrol agents used in management of soil borne pathogens of spices. | The pathologist at Pundibari centre was already trained at IISR. Scientists joining at AICRPS are invariably trained at IISR in the respective field in which they are working. |
| 5. Need to create plant quarantine units in centres in view of the threat for interstate transmission of diseases and pests. | During the IX Plan, adequate provision has been made to create this facility. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| 6. Provision of passport data and minimum descriptor for each spice. | Prescribed proforma have already been provided to all Coordinating centres and in fact duplicate sets have been sent to them again. The centres may be advised to undertake this item urgently. |
| 7. Frequent transfer of scheme scientists affect the work and long term vacancies like Horticulturist at Guntur, Breeder at Pampadumpara etc. need to be pursued. | Vacant positions are being brought to the notice of SAUs to expedite action. |
| 8. The passport data and characterisation of all available germplasm entries in all centres have to be completed and updated. | Centres started characterisation of germplasm entries and is in progress. |
| 9. Crop cafetaria of all released varieties to be established in all centres. | Work initiated at the centres and are in progress. |
| 10. All centres should follow the uniform technical programme as decided in the workshop, if necessary 1 or 2 treatments as per local requirements may be included without altering the original treatment schedule. | The guidelines are being scruplessly followed. |
| 11. The new four AICRPS centres namely Dapoli, Raigarh, Kumarganj and Pundibari must collect local germplasm of mandate spice crops. | Initiated action for collecting germplasm materials in a systematic manner. |
| 12. The local germplasm collected (one set) must be passed on to the NBPGR along with the passport data for assessing LC number. | The guidelines are now being followed. |
| 13. Integrated strategy should be evolved using different bio-control agents to achieve desired level of pathogen suppression, priority should be given for collecting local promising isolates. Inoculum | The centres have been advised to follow this decision. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| potential may be quantified for different media. | |
| 14. Variability in pathogen and biocontrol agents, fixation of dosage using uniform carrier media, applicable to different agroecological zones should be given due priority in formulating new programmes. | Directions are being followed by the centres while formulating the technical programmes. |
| 15. Efforts may be made to collect the germplasm in collaboration with NBPGR using the infrastructure facilities available with the NBPGR. | All centres have been reminded to follow this action. |
| 16. For release of varieties, the CYT's must be conducted with adequate comparison from national check, local check besides a latest released variety from the centre. | Trials are being laid out including local, national and released varieties as treatments in the trial. |
| 17. For proposal or release or identification of varieties those not tested under the coordinated programme may not be presented in the Workshop / Group meeting. | Guidelines are being followed by the centre. |
| 18. In future, the proposals for identification / release of varieties may be submitted 15 days before the dates of the workshop to PC for screening of the proposal. | Instructions are issued to the centres to scruplessly follow the guidelines. |
| 19. Three major diseases viz., foot rot of pepper, rhizome rot of ginger and wilt of cumin should be considered as disease of national importance. A standing committee should be formed to review the work formulation of technical programme and to fix locations where work has to be carried out. Committee | SAUs and centres have been informed suitably. Apex body will be formed before the cropping season to chalk out the technical programme. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| also reviews the implementation of recommendations at farmers level. | |
| 20. All the centres should compile results of various disease and pest management trials of the last 5-6 years and submit the same to PC (Spices) for finalising the treatment schedule. | Centres have been instructed suitably and the reports are awaited for finalising the technical programme. |
| 21. Biocontrol agents from different coordinating centres may be isolated and maintained at IISR, Calicut for future use and reference. | Centres are instructed to send the local isolates to IISR |
| **BLACK PEPPER** | |
| 1. New experiment on disease management of black pepper consisting of chemical and biocontrol measures may be laid out at Panniyur, Sirsi and Chintapalli. | Revised technical programmes have been communicated to all the centres for initiation of the trials. |
| 2. An *Ad-hoc* scheme proposal on feasibility of pepper cultivation in tribal areas in Orissa to be prepared by Pottangi centre. | The centre has been further instructed to immediately take up the study. |
| 3. The Pottangi centre will also take up an MLT on black pepper with released varieties. | The centre has been instructed to follow the guidelines. |
| 4. The nursery management results may be compiled and new schedule of treatment may be finalised. | The Panniyur centre has already initiated action towards the management of *Phytophthora* in the nursery |
| 5. Solarisation of nursery mixture and incorporation of antagonists can form part of nursery management technology in black pepper by all centres. | The pepper centres are following the research leads. |
| 6. The experiment on irrigation cum fertilizer level at Panniyur may be concluded and one new experiment on drip | The Panniyur centre has initiated action in laying out trial on drip irrigation studies. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| irrigation cum fertilizer may be laid out with latest, released varieties (one each in OP and hybrid). | |
| 7. New disease management strategy may be formulated using the leads from concluded experiments and tested at Panniyur, Sirsi and Chintapalli. | The centres have been instructed to suitably formulate programmes and send to PC for approval. |
| 8. Treatment schedule in new programmes for the management of nursery disease of pepper will be provided by IISR, Calicut. | The research lead at IISR in the management of nursery disease have been included in the nursery management and communicated to centres |
| 9. Survey work on pests of pepper at RRS, Mudigere should be continued and monitoring extended up to March. | The guidelines are being following by the centres. |
| 10. At Pampadumpara, management trial on pests of pepper should be undertaken in pest-prone areas. | A survey has been conducted to assess the pest load in different locations. The incidence of scales and thrips were far less to conduct a trial during the year. |
| 11. Experiments on irrigation concluded at Panniyur, findings are ready for transfer. | The Panniyur centre conducted the trial and recommendations passed on to the developmental agencies. |
| 13. The experiment at Sirsi may be continued. The stand of Karimalligesara is poor and therefore gap filling is necessary whenever revival of the previously planted vine is not possible. | The guidelines are being followed. |
| **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 micropropagation laboratory recently and work has been initiated at Mudigere itself. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| 2. All the centres working on cardamom will collect data on the tiller, no. of bearing tillers, no. of panicles, no. of capsules per panicle, no. of capsules per node and yield per clump. | The guidelines are followed. |
| 3. The voluntary centre at Thadiyankudisai will have to relay the MLT in cardamom. | The centre has been instructed suitably. |
| 4. All the data pertaining to the ecology and management of thrips in cardamom may be compiled by Mudigere and Pampadumpara. Residue analysis may be carried out in all the chemical control trials. | The centres have been advised to follow the decision. |
| 5. The MLT III (1993) with Mysore and Malabar types to be relaid out in all cardamom centres. | Mudigere centre was not able to generate sufficient material for relaying out the trial. Adequate material will be available by the ensuing season. |
| 6. Ongoing chemical control trials on thrips and capsule borers at Mudigere may be concluded and new programmes may be started in consultation with PC and IISR, Calicut. | The directions will be implemented in the ensuing season |
| 7. Research efforts on large cardamom are inadequate and hence we may initiate some programmes through the ICAR Research Complex. | Inspite of repeated reminders the Gangtok centre is not actively involved in the execution of research activities. The XIV Workshop was not represented by the Centre |
| **GINGER** | |
| 1. A greater attention for developing low fibre varieties will have to be done. | Solan, Pundibari and Pottangi centres will initiate action to identify low fibre varieties. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| 2. In all the future fertilizer and irrigation trials in ginger, percentage of dryage and fibre content should also be estimated. | The Solan centre is instructed suitably. |
| 3. In the proposed two plant pathology experiments in ginger at Solan centre the treatment schedule should be finalised in consultation with PC and IISR, Calicut. | The new technical programme by incorporating the existing leads has been drawn out for implementation at the Solan centre. |
| 4. At Pundibari, the associated pathogens of soft rot of ginger should be isolated and their pathogenicity confirmed. Required training and expertise will be provided at IISR. | Adequate training has been given to pathologist to isolate the pathogens. |
| **TURMERIC** | |
| 1. An *ad hoc* scheme on rhizome rot and leaf spot diseases of turmeric will be prepared by PC and the Project will be located in three selected centres. | The Jagtial centre will prepare the project and send to PC for finalisation of the technical programme before forwarding to the Council for approval. |
| 2. To confirm etiology of disease and associated pathogens / pathogenicity of *Pythium* sp. and *Fusarium* sp. singly and in combination, studies may be undertaken by Jagtial centre. | The studies have already been taken up by the Jagtial Centre. |
| 3. In quality analysis, guidelines formulated by IISR are to be followed. IISR, Solan, Pottangi, Kumarganj, Coimbatore and Dholi centres will take up a new promising varieties and send the material to IISR, Spices Board and Solan for quality analysis. | New experiment on quality at Pottangi will be conducted during Kharif, 1998. The other centres have been instructed to take up the work in the ensuing season. |
| 4. Soft rot management trial at Jagtial may be modified in consultation with IISR, Calicut. | The centre has been instructed suitably. |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| **TREE SPICES** | |
| 1. All experiments on tree spices at Yercaud will continue. Seeds of wild nutmeg available in the Kolli hills region may be used for grafting. | Survey has been made in the Kolli hills. The grafting studies are in progress. |
| **SEED SPICES** | |
| 1. The available fenugreek germplasm may be evaluated for 'green purpose' and simultaneously, the germplam from Jobner may be collected and evaluated at Guntur. | The Guntur centre has been instructed to take up the studies. |
| 2. The Coimbatore centre has been asked to collect germplasm materials in coriander and fenugreek at least four different districts in Tamil Nadu viz., Madurai, Ramanad, Kamarajar and Kattabomman during 1995-96. | The germplasm collection is in progress. |
| 3. Hisar centre has been advised to take up quality analysis of leafy type in coriander. | The work has been initiated and the studies are in progress. |
| 4. The quality analysis facilities available at Jobner has to be availed by all seed spices centres. It is suggested that an exploration for exotic types for oil content could be taken up on priority; the role of variety and agroclimatic situations on the quality of oil has to be established. | The seed spices centres are availing the facilities at Jobner. ICAR is being approached for exploratory survey of exotic types. Sufficient fund is to be made available. |
| 5. In each centre, there is a need to restrict the number of trials handled by each centre looking at the fact that each centre is handling two to four crops. | Guidelines are being followed. |
| 6. There will be only one MLT along with the year of start of experiment hence | Guidelines are being followed and the centres have been instructed to follow the decision |

| DECISION | ACTION TAKEN/REMARKS |
|---|---|
| forth to avoid confusing nomenclature. Each centre will take up only one coordinated varietal trial (CVT) for each crop for period of three years / seasons. | |
| 7. The present CVT on coriander, fenugreek and cumin will continue for two more years with the same entries. | Being continued. |
| 8. A new CYT in fennel recommended (CVT-1998) will be laid out Hisar, Jagudan and Jobnercuher with eight accessions. | Will be laid out in the ensuing season. |
| 9. Effect of stage of maturity on oil content of coriander varieties may be studied. | The Jobner centre will take up the studies. |
| 10. Integrated nutrient management with components like biofertilizer organic manures etc. on seed spices need to be experimented. | The Jobner centre has initiated studies. |
| 11. Though there is a need to test the entries under CVT for three years, the centres can propose any entry for adaptive/ on farm research if it performs well consistently for two years by approval of the varietal release committee. The third year trial and field testing can be done concurrently to save time. For this activity infrastructure facility and funds for vehicle etc. has to be provided. | The centres have been instructed to follow the guidelines in the release of varieties in future. |
| 12. The NBPGR will be pursued to strengthen the programme for systematic introduction of germplasm from other countries particularly from centres of origin/diversity. | The workshop decision has been communicated to NBPGR. The action is pending with NBPGR. |

# RECOMMENDATIONS OF QRT ON AICRPS

The Indian Council of Agricultural Research, New Delhi as per F.No. 12-7/97-IA-V dated 12 July 1997, constituted the Quinquennial Review Team (QRT) for the review of work of AICRPS under the Chairmanship of Dr K V Ahammed Bavappa with Dr R P Sharma, Dr S Chaudhuri, Dr R K Sharma and Dr Rajendra Gupta as members and Dr A K Sadanandan as Member Secretary. The recommendations of the QRT are as follows:

## Genetic resources

1 The varieties released by the AICRPS centres, may be characterised through DNA finger printing along with their parents in the case of hybrids, and deposited at the respective SAUs as well as NBPGR, New Delhi. A national number may be obtained for each variety registered with NBPGR.

2 Though some progress has been made in germplasm collection of major spices, there is an urgent need to complete the work on time targeted basis. The Project Coordinator may prepare two projects, one for plantation spices and other for seed spices in consultation with SAUs and submit to the ICAR for funding. The duration of the project may be five years.

3 The following centres may be mandated to evaluate, characterise and catalogue the germplasm of crops noted against each Centre.

**Black pepper** : Panniyur and IISR

**Cardamom (s)**: Mudigere and ICRI

**Cardamom (l)** : ICRI Regional Centre, Gangtok

**Ginger and Turmeric** : Pottangi and IISR

**Coriander** : Jobner ( RAJU ) - North Indian collection, Coimbatore (TNAU) -South Indian collection

**Cumin** : Jobner

**Fennel** : Jagudan

**Fenugreek** : Jobner

4 Each centre collecting the germplasm will divide the material into three sub samples- one sample of each collection will go to NBPGR for cryo-preservation, other to the centres identified for cataloguing and third retained at the collecting centre. Nomenclature assigned by the collecting agency should not be changed at any stage/ centre.

5 NBPGR should enhance their efforts to collect the exotic germplasm from countries growing them/centres of diversity. Samples of germplasm so

obtained should be made available to the centres identified for cataloguing, which will multiply and make the material available to other centres. Since lack of genetic variability for economically important characters has been felt as the biggest constraint in crop improvement programme of seed spices, it is strongly suggested that an exploration team be constituted and assigned the job of collecting the germplasm.

6 Germplasm accessions collected should be described using the descriptor and also screened for biochemical characteristics. This information along with material may be passed on to IISR which will arrange for the DNA finger printing through the NRC DNA printing network facilities being established in IBPGR and registration of the materials. The concerned centres should maintain each of the registered varieties / accessions along with their numbers.

7 For every registered spice variety released as well as those in the germplasm, quality attribute profiles of the essential oils should be studied and incorporated in the descriptors.

## Varietal Improvement

8 In order to exploit the locked up variability in black pepper, a large scale hybridization programme involving lines with diverse desired characters may be undertaken. A project involving SAUs of Kerala, Karnataka and Tamil Nadu and IISR may be prepared as envisaged in the IISR QRT reports.

9 Twelve improved varieties of different spices were released during the period under report, while several lines are in the pipe line for release. Different agencies (Agriculture / Horticulture Depts., NGOs and farmers) who have the ability to produce quality planting materials may be identified by the centre which has evolved the variety and breeders stock of the varieties released made available to these agencies on a certification programme. They may be given training in the technique of planting material production and should be subjected to periodic inspection to ensure quality.

10 Hybridization (combination breeding) or heterosis exploitation must be enlarged to develop better varieties. In crops like cumin and coriander where hybridization is extremely difficult, sound population improvement programmes must be immediately started to make best use of existing variability. The breeding strategy should be for high yield, better quality and disease resistance (wilt, powdery mildew etc in seed spices). The existing facility for oil profile analysis at Jobner Centre may be strengthened.

## Crop Production

11 Black pepper is cultivated extensively in homesteads and under diverse farming systems. However, on-farm trials to evolve agro-techniques for

mixed cropping of black pepper under such systems has not been undertaken so far. Trials need to be laid out to generate information in this area. Since large scale planting of black pepper is being undertaken in coffee, this system may be studied on a priority basis.

12. For crops like ginger, turmeric and seed spices location specific package of practices for targetted yields may be developed for the major agroclimatic regions.

13 For sustainable production, it is essential that a balance between off-farm and on-farm inputs are maintained. Research on on-farm biomass generation for recycling as source of nutrients as part of IPNM should receive attention at all centres of the Coordinated Projects.

14 In tree spices, nutrient and water requirements including fertigation needs special emphasis and trials should be laid in these directions.

## Crop Protection

15 Among the different diseases that affect the spices, *Phytophthora* foot rot of black pepper, *katte* of cardamom, *Chirkey* and *Foorkey* of large cardamom and rhizome rot of ginger and turmeric still continue to be the most devastating in most of the areas. However, the team during its field trips observed that certain tracts (eg. Shevroy hills with little incidence of quick wilt) are almost free from some of these maladies. It is suggested that the AICRPS centres may study the problem from the angle of location specificity so that these tracts are maintained free of the pathogen in future as well.

16 As at present, IPM approach in pest and disease management has not received serious attention in the Coordinated programmes. It is strongly recommended that this technology is developed to the maximum extent possible for major pests and diseases.

## Post harvest processing and quality upgradation

17 A study of the existing practices adopted in the post harvest processing of each spice may be undertaken by every AICRPS centre to identify factors that affect the quality of finished products and undertake field studies to prevent un-hygienic practices. While prepa-ring package of practices for each crops, a section on post harvest processing should invariably be included to bring awareness among farmers about the importance of quality.

## General

18 Though Tamil Nadu has over 60,000 ha under turmeric, this crop has not been included under the AICRPS for research. The crop has both production and post harvest processing problems which need urgent attention. It is recommended that turmeric may be included as a mandate crop for research at Coimbatore centre with no additional staff (the existing Horticulturist and Pathologist would be attending this work).

19 The Spices Board research establishment at Gangtok be recognized as the nodal R and D centre for large cardamom with mandates for germplasm collection, evaluation and improvement, production of elite planting materials of improved varieties (Breeders foundation seeds) and formulation of package of practices. The scientific position of the ICAR NEH Research Complex may be shifted to ICRI (Spices Board), Tadung, Gangtok together with budget allotment as a regular AICRPS centre to work on large cardamom.

20 The IARI sub-station at Kalimpong in linkage with the Division of Mycology and Pathology of IARI be entrusted to work on characterisation and early detection of viruses in large cardamom. The substation may be included as a co-operating centre.

21 BCKV, Pundibari mandated to work on ginger, turmeric and black pepper should give greater emphasis for ginger for its germplasm collection, conservation and cataloguing since the NE has considerable genetic diversity for this crop. In terms of soft rot management of ginger, this centre should undertake front line demonstration and training jointly with KVK at Kalimpong.

22 AICRPS should strengthen the R & D work on black pepper in the NEH through CPCRI sub station at Mohitnagar and Kahikuchi, Guwahati in link with IISR.

23 The Centres of the AICRP on Spices are located in remote locations with little access to literature. The library of IISR is doing an excellent job in bringing out bibliographies on spices periodically as well as other publications to bring out awareness about R & D in spices. Copies of such publication should regularly be supplied to each of the centres. This would substantially improve the awareness of the scientists working in the projects.

**Scientific manpower development**

24 The cultivation of black pepper in the higher elevations of Shevroy and Kodaikanal hills of Tamil Nadu is considerable. The area is also relatively free of *Phytophthora* foot rot disease. Varietal evaluation is an urgent need of this tract. The existing staff at Yercaud centre consist of only one Agronomist and one Horticulturist. It is recommended that one post of Breeder be created at Yercaud to take up the varietal improvement work.

**Project formulation**

25 During the workshop new research programmes are being formulated in a hurry and much attention is not given. It is therefore suggested that a day prior to workshop may be allotted for group discussion and formulation of research programmes. The services of the Heads of Departments of the IISR may be made use of for the formulation of the programmes along with scientists of

the concerned disciplines from the coordinating centres. The group leader and few eminent scientists of the concerned field and a statistician so formulated research programmes are then presented in the workshop for approval.

### Monitoring and evaluation

26 Since the co-ordinated projects on spices are being implemented through 15 SAUs, it is necessary that the scheme should be closely monitored by both the Director of Research of the respective Univer-sities and Project Coordinator who are responsible for close monitoring and evaluation. It is suggested that the Director of Research may make at least one inspection in a year and the detailed report sent to the Vice Chancellor with a copy to Project Coordinator. Similarly, the Project Coordinator may visit the centres at least twice in a year and copies of his inspection report sent to the Director of Research/Vice Chan-cellor concerned.

### Manpower and Infrastructural facilities

27 The Committee strongly felt the need for one Clerk-cum-Typist to PC's Cell. The existing Jr. Stenographer is unable to meet the mounting work load consequent to the entrusting of PC to directly attending to the monitoring and budgetary preparation and release of funds to the centres. It is understood that as per the recommendations of the previous QRT, provision has been made in the VIII Plan of IISR but this has not materialised.

### R & D on spices in the North Eastern Hill Region

28 Among the spices, ginger, large cardamom, black pepper and turmeric are the more important crops of significance for the area. While ginger and large cardamom are more suitable and extensively cultivated in relatively high altitudes (100-1500 m) black pepper is grown primarily in foot hills (up to 1000 m). Turmeric grows well in the plains or foot hills. Continuous R and D and policy support for promotion of production, value addition, marketing of the identified spice crops is very important for economic development of at least some of the states of the region.

29 Immediate attention may be paid to production of disease free planting materials in large cardamom. The programme has to be supported with quick diagnosis of viruses in symptomless materials, the method for which is being standardized by the IARI centre at Kalimpong. The Government has already taken steps for distribution of tissue cultured disease free plants and the same technique may be promoted. The ICRI Regional Station, Gangtok may be entrusted with this work.

# ICAR *AD-HOC* RESEARCH SCHEMES

The ICAR is funding *Ad-hoc* research schemes on spices aims at filling the critical gaps in spices field. Right now 28 AP cess fund schemes operating on spices. The cropwise distribution of projects are three in pepper four in cardamom, one in large cardamom eight in ginger and turmeric, five in seed spices, two in tree spices, one on vanilla and four projects on general aspects of spices. The total outlay of these projects is around Rs. 215 lakhs. The list of AP Cess fund schemes are as follows:

Table 14. List of AP Cess Fund Schemes* (1994 onwards)

| Title of the schemes | Location | Total outlay | Date of start |
|---|---|---|---|
| Effect of organic fertilizer on soil quality, productivity and quality of black pepper and cardamom. | IISR, Calicut (Kerala). | 767100 | 01.08.97 |
| Characterization, early detection and management of *Kokke kandu* disease of cardamom. | " " | 551760 | 24.07.95 |
| Development of resistant variety/lines of cumin to wilt diseases caused by *Fusarium Oxysporum* using *in vitro* techniques. | SKN College of Agriculture, Jobner (Rajasthan). | 926440 | 26.12.98 |
| Investigations on crop response in large cardamom (*Amomum sublatum* Roxoura) to major nutrients. | ICRI, Idukki (Kerala). | 1203400 | 01.12.95 |
| Integrated management of rhizome rot of ginger. | Dr. YSPUH&F, Solan (Himachal Pradesh) | 668500 | 01.03.96 |
| Species relationship in the genus Piperand the scope of related taxa in the improvement of *Piper nigrum* L. | KAU, Thrissur (Kerala) | 609000 | 01.06.94 |
| Developmental morphology of ginger and turmeric . | IISR, Calicut (Kerala) | 1010800 | 07.07.95 |
| Clonal propagation of tamarind (*Tamarindus indica* L.) through *in vitro* culture. | TNAU, Coimbatore (Tamil Nadu) | 577800 | 01.10.95 |
| Biochemical characterization of ginger and turmeric. | IISR, Calicut (Kerala) | 739880 | 19.07.95 |
| Hybridization in ginger (*Zingiber officinale* Rosca.) through *in vitro* pollination. | KAU, Thrissur (Kerala) | 622400 | |
| Collection maintenance, evaluation and standardisation of agro-techniques of seed spices germplasm. | AAU, Johrat (Assam) | 516170 | 01.12.97 |

| Title of the schemes | Location | Total outlay | Date of start |
|---|---|---|---|
| Establishing *in vitro* conservatory of spices germplasm. | IISR, Calicut (Kerala) | 1050720 | 01.10.97 |
| Production of somaclones and somatic hybrids of cardamom (*Elettaria cardamom* Maton) for high yield and resistance to disease. | IISR, Calicut (Kerala) | 1543000 | 30.3.96 |
| Biological control of scale insects infesting black pepper | " " | 578000 | 29.07.94 |
| Etiology of rhizome rot of turmeric | Sri. P. Mahila Vishwa-vidhyalayam, Triputi (Andhra Pradesh) | 541000 | 01.11.96 |
| Creation of variation for improvement of yield of coriander through mutation | RAU, Bikaner (Rajasthan) | 385850 | 01.06.94 |
| Management of seed borne pathogens and wilt disease of coriander by using bio-technological approaches | TNAU, Coimbatore (Tamil Nadu) | 437300 | 01.07.96 |
| Phenol metabolism during host pathogen interaction in *Fusarium* wilt of cumin | GAU, Ahemadabad (Gujarat) | 601500 | 01.11.96 |
| Scheme for intensification of research on vanilla (*Vanilla planifolia* Andrews) | TNAU, Coimbatore (Tamil Nadu) | 378400 | 01.04.96 |
| Investigations of cardamom based cropping system | IISR, Calicut (Kerala) | 1480647 | 22.07.96 |
| Developing hardening protocols for tissue culture plants of spices | " " | 2077446 | 30.03.96 |
| Integrated management of rhizome rot of ginger | " " | 2251200 | 09.05.96 |
| Exploring the possibility of spices under humid sub temperate conditions of Himachal Pradesh | HPKVV, Palampur (Himachal Pradesh) | 550460 | 01.01.98 |
| Production of haploids and dihaploids of cardamom (*Elettaria cardamomum* Maton) through anther culture/ microspore culture | IISR, Calicut (Kerala) | 575210 | 01.10.97 |
| Biological control of plant parasitic nematodes of major spice crops | " " | 891860 | |
| Studies on the compatability of *Azospirillum* and biocontrol agents in turmeric | TNAU, Coimbatore (Tamil Nadu) | | Approved during the scientific panel meeting held at Bangalore during 7 and 8 August 1998 |
| Characterisation of nutmeg germplasm for quality | IISR, Calicut (Kerala) | | |
| Elucidation of biosynthetic pathways of curcumin in turmeric (*curcuma longa*) | " " | | |

* Three to five year duration

# STAFF

## PROJECT COORDINTOR'S CELL

*Indian Institute of Spices Research*

*Calicut - 673 012, Kerala*

| | | |
|---|---|---|
| Project Coordinator | : | Dr. A K Sadanandan |
| Scientist | : | Ms. C Vasugi |
| Technical Information Officer | : | Dr. Johny A Kallupurackal |
| Jr. Stenographer | : | Ms. C K Beena |
| Lab Attender | : | Sh. K Keeran |

## COORDINATING CENTRES

### 1. Cardamom Research Station, KAU, Pampadumpara

| | | |
|---|---|---|
| Asst. Professor (Ento.) | : | Ms. Hebsy Bai (Since June 97) |
| Asst. Professor (Agron) | : | Vacant |
| Breeder | : | Posted at Ambalavayal |
| Farm Assistant | : | Sh. C G Pradeep |
| Lab Assistant Gr.I | : | Sh. P V Joseph |
| Peon | : | Sh. K Aleykutty |

### 2. Regional Research Station, UAS (Bangalore), Mudigere

| | | |
|---|---|---|
| Breeder | : | Sh. H M Chandrappa |
| Agronomist (Hort.) | : | Sh. Shanthaveerabhadraiah |
| Pathologist | : | Sh. K V Shivakumar (since 13.10.1997) |
| Jr. Entomologist | : | Ms. C Parvathi |
| Jr. Technical Assistant | : | Sh. Narayanan |
| Jr. Technical Assistant | : | Sh. Mruthyunjaya |
| Messenger | : | Ms. Savithri |

### 3. Horticultural Research Station, TNAU, Yercaud

| | | |
|---|---|---|
| Agronomist (Hort.) | : | Sh. R Richard Kennedy |
| Jr. Breeder (Hort.) | : | Selvi K Nageswari |
| Lab Assistant | : | Sh. M Ramaiah |

## 4. Pepper Research Station, KAU, Panniyur

| | | |
|---|---|---|
| Assoc. Professor (Pl. Path.) | : | Sh. P K Unnikrishnan Nair |
| Asst. Professor (Pl. Path.) | : | Vacant |
| Asst. Professor (Breeding) | : | Vacant |
| Asst. Professor (Agro.) | : | Sh. A Rajagopalan |
| Farm Assistant Gr. II | : | Sh. K Lakshmanan |
| Farm Assistant Gr. I | : | Sh T Muhammed Haneefa |
| Lab Assistant | : | Vacant |
| Peon | : | Sh. M P Narayanan |

## 5. Regional Agricultural Research Station, APAU, Chintapalli

| | | |
|---|---|---|
| Asst. Pathologist | : | Sh. V Mohan Rai |
| Asst. Horticulturist | : | Ms. M Padma |
| Technical Assistant | : | Vacant |

## 6. Agricultural Research Station, UAS (Dharward), Sirsi

| | | |
|---|---|---|
| Assoc. Professor (Pl. Path) | : | Sh. H G Hegde |
| Asst. Professor (Hort.) | : | Sh. M S Lokesh |
| Asst. Professor | : | Sh N K Hegde |

## 7. Department of Vegetable Crops, Dr. YSPUHF, Solan

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

## 8. High Altitude Research Station, OUAT, Pottangi

| | | |
|---|---|---|
| Breeder (Olericulturist) | : | Dr. D C Mohanty |
| Jr. Breeder | : | Dr. D K Dash |
| Sr. Technical Assistant | : | Sh. R C Dash |
| Jr. Technical Assistant | : | Sh K K Patra |

## 9. Department of Plant Breeding, SKN College of Agriculture, RAJAU, Jobner

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

## 10. Regional Agricultural Research Station, APAU, Guntur

| | | |
|---|---|---|
| Horticulturist | : | Vacant |
| Jr. Breeder (Hort.) | : | Sh. N Hariprasad Rao |
| Sub Assistant | : | Sh. K Sivakumar |

## 11. Spices Research Station, GAU, Jagudan

| | | |
|---|---|---|
| Sr. Plant Pathologist | : | Sh A J Patel |
| Jr. Breeder (Hort.) | : | Sh G M Patel |
| Jr. Technical Assistant | : | Sh R N Patel |

## 12. Department of Spices & Plantation Crops, TNAU, Coimbatore

| | | |
|---|---|---|
| Breeder (Assoc. Prof.) | : | Dr. T Thangaraj |
| Jr. Pathologist | : | Sh. K Muthukrishnan |
| Agricultural Assistant | : | Sh. D Elumalai |

## 13. Regional Agricultural Research Station, APAU, Jagtial

| | | |
|---|---|---|
| Jr. Pathologist | : | Sh C L Narasimha Chary |
| Asst. Horticulturist | : | Sh. A Manohar Rao |
| Technical Asst./Sub Asst. | : | Vacant |

## 14. ICAR Research Complex for NEH Region, Gangtok

| | | |
|---|---|---|
| Scientist Sz (Pl. Path.) | : | Sh L S Srivastava |
| Scientist S1 (Hort.)1 | : | Sh G S Karibasappa |

## 15. Department of Vegetable Crops CCS-HAU, Hisar

| | | |
|---|---|---|
| Olericulturist / Horticulturist | : | Dr. K K Thakral |
| Assistant Scientist (VC) | : | Dr. S K Tehlan |

## 16. Tirhut College of Agriculture, RAU, Dholi

| | | |
|---|---|---|
| Horticulturist | : | Sh. S P Singh |
| Jr. Pathologist | : | Sh. Bimla Rai |
| Technical Assistant | : | Vacant |

## 17. Konkan Krishi Vidya Peeth, Dapoli

| | | |
|---|---|---|
| Horticulturist | : | Dr. A S Desai (since 20.8.1997) |
| Jr. Breeder | : | Sh. D S Bagade |
| Jr. Pathologist | : | Sh. N R Padeldar |
| Tech. Assistant | : | Sh. S D Tambe |
| Tech. Assistant | : | Sh. S G Thore |

## 18. Narendra Dev University of Agriculture and Technology, Kumarganj

| | | |
|---|---|---|
| Horticulturist | : | Sh. T Singh |
| Jr. Breeder | : | Sh. V P Pandey |
| Jr. Pathologist | : | Vacant |
| Tech. Assistant | : | Sh. R K Gupta |
| Tech. Assistant | : | Vacant |

## 19. Indira Gandhi Krishi Vishwa Vidyalaya, Raigarh

| | | |
|---|---|---|
| Horticulturist | : | Sh. Shankar Singh |
| Jr. Breeder | : | Sh. R K Yadav |
| Jr. Pathologist | : | Dr. A K Singh |
| Tech. Assistant | : | Sh. G P Kashyap |
| Tech. Assistant | : | Sh. D S Kshatri |

## 20. Bidhan Chandra Krishi Viswa Vidyalaya, Pundibari

| | | |
|---|---|---|
| Horticulturist | : | Vacant |
| Jr. Breeder | : | Vacant |
| Jr. Pathologist | : | Sh. B N Panja |
| Tech. Assistant (2 posts) | : | Vacant |

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# METEOROLOGICAL DATA 1997

**Pampadumpara**

Latitude : 9° 45 N
Longitude : 77° 10 E
Altitude : 1100m MSL
Soil Type : Clay loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | |
|---|---|---|---|---|
| | | | Max | Min |
| January | 0.4 | 1 | 26.0 | 12.5 |
| February | — | — | 29.0 | 13.0 |
| March | 24.8 | 3 | 31.5 | 15.0 |
| April | 93.0 | 9 | 30.0 | 17.0 |
| May | 133.6 | 12 | 29.0 | 18.0 |
| June | 187.5 | 15 | 29.0 | 17.0 |
| July | 493.3 | 30 | 23 | 17.0 |
| August | 290.0 | 25 | 25 | 15.5 |
| September | 98.8 | 14 | 27 | 17.0 |
| October | 264.7 | 23 | 27 | 17.0 |
| November | 387.0 | 21 | 26 | 17.0 |
| December | 92.0 | 15 | 25 | 16.0 |
| **Total/Mean** | **2065.4** | **168** | **27.3** | **16.0** |

**Chintapalli**

Latitude : 17° 52 N
Longitude : 82°14 E
Altitude : 818m MSL
Soil Type : Clay loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 12.1 | 2 | 26.4 | 7.4 | 88.6 |
| February | — | — | 30.4 | 11.2 | 89.2 |
| March | 34.0 | 3 | 35.5 | 18.8 | 87.5 |
| April | 57.6 | 7 | 35.1 | 18.9 | 91.5 |
| May | 52.8 | 6 | 34.4 | 20.5 | 90.1 |
| June | 41.0 | 4 | 29.5 | 18.1 | 87.1 |
| July | 80.4 | 13 | 26.4 | 20.8 | 85.8 |
| August | 58.9 | 9 | 25.3 | 21.8 | 85.8 |
| September | 146.0 | 12 | 26.4 | 20.6 | 88.4 |
| October | 90.2 | 12 | 26.1 | 18.3 | 89.5 |
| November | — | — | 22.9 | 10.8 | 89.6 |
| Devember | 14.8 | 2 | 20.9 | 7.7 | 90.8 |
| **Total/Mean** | **588.9** | **70** | **28.28** | **16.24** | |

**Guntur**

Latitude : 16.18 N Longitude : 80.29 E

Altitude : 32m MSL Soil Type : Black clay

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 35.0 | 3 | 29.78 | 16.30 | 76.39 |
| February | | 0 | 33.35 | 17.64 | 67.57 |
| March | 4.2 | 1 | 37.20 | 21.20 | 79.29 |
| April | 74.4 | 5 | 36.73 | 23.17 | 85.50 |
| May | 3.4 | 1 | 41.81 | 27.04 | 75.05 |
| June | 50.7 | 5 | 40.72 | 28.09 | 69.30 |
| July | 118.7 | 8 | 37.38 | 26.13 | 78.11 |
| August | 77.8 | 6 | 37.05 | 25.51 | 74.84 |
| September | 278.4 | 12 | 34.63 | 24.87 | 87.63 |
| October | 80.5 | 4 | 33.11 | 23.53 | 86.13 |
| November | 44.0 | 4 | 32.16 | 22.82 | 84.90 |
| Devember | 59.4 | 4 | 30.83 | 20.82 | 80.61 |
| **Total/Mean** | **826.5** | **53** | **35.39** | **20.09** | |

**Kumarganj**

| Month | Rainfall (MM) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|
| | | Max | Min | |
| January | 2.8 | 22.0 | 6.5 | 68.0 |
| February | - | 25.1 | 8.2 | 58.0 |
| March | 6.1 | 30.8 | 13.6 | 56.5 |
| April | 9.3 | 35.2 | 19.1 | 49.2 |
| May | 18.0 | 39.3 | 22.9 | 37.1 |
| June | 120.4 | 38.2 | 26.6 | 53.9 |
| July | 482.2 | 32.9 | 26.7 | 80.6 |
| August | 269.6 | 31.7 | 26.0 | 80.3 |
| September | 266.7 | 30.3 | 24.9 | 82.2 |
| October | 43.2 | 29.5 | 13.9 | 73.8 |
| November | 8.8 | 26.1 | 14.6 | 66.5 |
| Devember | 58.6 | 18.6 | 10.0 | 79.6 |
| **Total/Mean** | **1285.7** | **29.98** | **17.75** | |

**Yercaud**

Latitude : 11.4' N Longitude : 78.5' E

Altitude : 1450m MSL Soil Type : Clay loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | — | — | 22.4 | 12 | 57.1 |
| February | — | — | 25.0 | 12.9 | 58 |
| March | — | — | 28.7 | 16 | 53 |
| April | 193.2 | 12 | 27.84 | 16.6 | 62.9 |
| May | 41.7 | 2 | 30.83 | 17.8 | 64.3 |
| June | 272.4 | 10 | 24.80 | 17.08 | 68 |
| July | 34.8 | 3 | 24.0 | 16.63 | 67.13 |
| August | 317.6 | 11 | 24.34 | 16.50 | 67.90 |
| September | 476.5 | 19 | 23.8 | 16.50 | 68 |
| October | 187.9 | 8 | 22.45 | 16.63 | 66.61 |
| November | 76.5 | 5 | 21.59 | 14.12 | 65.63 |
| Devember | 356.7 | 12 | 20.7 | 13.05 | 67.16 |
| **Total/Mean** | **1957.3** | **82** | **24.70** | **15.48** | |

**Solan**

Latitude : 30.5°N Longitude : 77.8°E

Altitude : 1000m MSL Soil type : Loam

| Month | Rainfall (MM) | Temperature (°C) | | RH(%) |
|---|---|---|---|---|
| | | Max | Min | |
| January | 54.0 | 17.3 | 1.8 | 54.0 |
| February | 15.0 | 18.2 | 3.5 | 15.0 |
| March | 36.8 | 22.6 | 9.5 | 36.8 |
| April | 128.6 | 24.5 | 12.3 | 128.6 |
| May | 52.6 | 29.0 | 16.1 | 52.6 |
| June | 104.2 | 29.4 | 19.0 | 104.2 |
| July | 69.4 | 26.7 | 20.2 | 69.4 |
| August | 425.0 | 26.7 | 20.2 | 425.0 |
| September | 43.6 | 27.3 | 18.1 | 43.6 |
| October | 36.8 | 26.8 | 17.7 | 36.8 |
| November | 9.2 | 21.7 | 6.0 | 9.2 |
| December | 13.1 | 16.2 | 3.0 | 13.1 |
| **Total/Mean** | **988.3** | **23.86** | **12.28** | |

**Jobner**

Latitude : 23.52 N Longitude : 72.43 E

Altitude : 90 6 m MSL Soil type : Sandy loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | - | 2 | 21.3 | 2 4 | 58.4 |
| February | - | - | 22 4 | 4.3 | 56.3 |
| March | - | 8 | 28.3 | 9.4 | 52 9 |
| April | 51.9 | 4 | 33.1 | 14.7 | 53.0 |
| May | 51 0 | 5 | 37 9 | 21.6 | 45.6 |
| June | 14 2 | 2 | 37 8 | 21.3 | 48 8 |
| July | 203 1 | 8 | 34.8 | 25 3 | 63 1 |
| August | 107.5 | 7 | 31.8 | 23.5 | 74.9 |
| September | 17 5 | 3 | 33.2 | 22.1 | 65.6 |
| October | 152.8 | 8 | 31 1 | 14 9 | 59 7 |
| November | - | - | 29.5 | 8.0 | 56.3 |
| December | - | - | 24.3 | 4.5 | 47.6 |
| **Total/Mean** | **598** | **47** | **30.38** | **14.33** | |

**Panniyur**

Latitude . 12 5" N Longitude : 74 55"E

Altitude . 95m MSL Soil type : Laterite

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | - | - | 33.9 | 19.4 | 87.0 |
| February | - | - | 34 5 | 19 6 | 86.6 |
| March | 3 0 | 1 | 37 4 | 22 5 | 79 3 |
| April | 2.8 | 1 | 38.8 | 22 1 | 71 2 |
| May | 64.2 | 7 | 37 3 | 24.2 | 84.5 |
| June | 1153 6 | 21 | 31.5 | 22 4 | 89 2 |
| July | 1613 6 | 31 | 28 7 | 23 0 | 94 6 |
| August | 781 7 | 22 | 28.2 | 22.6 | 94.5 |
| September | 142 2 | 11 | 32.1 | 23 7 | 90 2 |
| October | 113 5 | 11 | 33.3 | 23 5 | 87 3 |
| November | 293 4 | 13 | 30 0 | 23 6 | 86 5 |
| December | 91 2 | 6 | 34 1 | 23 0 | 90 0 |
| **Total/Mean** | **4259.2** | **124** | **33.23** | **22.47** | |

**Sirsi**

Latitude : 14°36 N Longitude : 74°50 E

Altitude : 619m MSL Soil type : Laterite

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | |
|---|---|---|---|---|
| | | | Max | Min |
| January | - | - | 29.5 | 16.8 |
| February | - | - | 31.5 | 17.0 |
| March | 10.0 | 2 | 33.0 | 18.0 |
| April | 26.05 | 4 | 35.2 | 20.8 |
| May | 57.50 | 3 | 32.2 | 20.6 |
| June | 534.50 | 20 | 27.1 | 22.3 |
| July | 1110.75 | 28 | 23.1 | 20.1 |
| August | 846.50 | 30 | 26.8 | 18.5 |
| September | 59.25 | 8 | 24.6 | 18.0 |
| October | 84.50 | 5 | 25.8 | 19.5 |
| November | 86.75 | 4 | 26.4 | 16.3 |
| December | 28.75 | 1 | 26.1 | 15.8 |
| **Total/Mean** | **2844.55** | **105** | **28.45** | **18.64** |

**Jagudan**

Latitude : 23.52° N Longitude : 74.43° E

Altitude : 90.6m MSL Soil type : Sandy loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | |
|---|---|---|---|---|
| | | | Max | Min |
| January | - | - | 40.5 | 17.3 |
| February | - | - | 42.1 | 23.5 |
| March | 50 | 3 | 41.5 | 27.0 |
| April | 178 | 8 | 36.3 | 26.1 |
| May | 122 | 7 | 34.5 | 24.4 |
| June | 100 | 5 | 35.6 | 22.2 |
| July | 13 | 1 | 36.8 | 18.5 |
| August | - | - | 33.9 | 13.3 |
| September | - | - | 30.6 | 10.5 |
| October | - | - | 26.1 | 8.4 |
| November | - | - | 31.5 | 10.3 |
| December | 24 | 2 | 37.6 | 24.3 |
| **Total/Mean** | **487** | **26** | **35.58** | **18.82** |

**Dapoli**

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 2.9 | 1 | 29.50 | 11.74 | 65.59 |
| February | - | - | 30.98 | 10.05 | 66.92 |
| March | - | - | 32.78 | 16.20 | 71.70 |
| April | - | - | 32.05 | 18.41 | 74.10 |
| May | 1.0 | 1 | 32.60 | 21.87 | 70.42 |
| June | 992.5 | 24 | 30.26 | 23.50 | 86.88 |
| July | 1039.9 | 28 | 28.40 | 23.12 | 89.32 |
| August | 1069.7 | 31 | 27.46 | 22.24 | 92.62 |
| September | 394.6 | 17 | 28.72 | 22.74 | 87.37 |
| October | - | - | 32.05 | 19.47 | 63.48 |
| November | 55.7 | 3 | 32.20 | 18.60 | 77.34 |
| December | 68.4 | 2 | 29.05 | 13.90 | 74.25 |
| **Total/Mean** | **3624.7** | **107** | **28.08** | **18.50** | |

**Dholi**

Latitude : 25.41"N Longitude : 34.6"E

Altitude : 52.8m MSL Soil type : Sandy loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 12.2 | 1 | 22.0 | 7.5 | 99 |
| February | - | - | 24.6 | 9.6 | 91 |
| March | 0.5 | 1 | 31.0 | 14.9 | 74 |
| April | 48.9 | 4 | 32.4 | 18.9 | 77 |
| May | 46.4 | 5 | 35.8 | 22.7 | 75 |
| June | 284.8 | 22 | 36.5 | 26.2 | 79 |
| July | 554.2 | 30 | 30.6 | 25.6 | 85 |
| August | 209.4 | 20 | 32.1 | 26.8 | 87 |
| September | 206.8 | 21 | 31.2 | 25.3 | 89 |
| October | 9.4 | 1 | 30.8 | 20.8 | 83 |
| November | - | - | 28.5 | 16.4 | 85 |
| December | 45.0 | 5 | 20.8 | 11.8 | 95 |
| **Total/Mean** | **1417.6** | **110** | **29.69** | **18.88** | |

**Pottangi**

Latitude : 18°34 'N | Longitude : 82.52 'E

Altitude : 917m MSL | Soil type : Sandy loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 5.80 | 3 | 22.0 | 14.0 | 62 |
| February | - | - | 25.0 | 20.0 | 62 |
| March | 0.73 | 2 | 29.0 | 16.0 | 54 |
| April | 2.71 | 7 | 27.0 | 23.0 | 64 |
| May | 2.30 | 5 | 29.0 | 25.0 | 62 |
| June | 8.83 | 11 | 24.0 | 23.0 | 75 |
| July | 4.77 | 13 | 22.0 | 20.0 | 85 |
| August | 3.24 | 14 | 25.0 | 23.0 | 85 |
| September | 7.26 | 13 | 24.0 | 22.0 | 85 |
| October | 1.12 | 7 | 23.5 | 21.0 | 75 |
| November | 1.06 | 4 | 23.0 | 20.0 | 74 |
| December | 0.38 | 4 | 22.0 | 14.0 | 72 |
| **Total/Mean** | **38.2** | **83** | **24.63** | **20.08** | |

**Coimbatore**

Latitude : 11° N | Longitude : 77° E

Altitude : 426.72m MSL | Soil type : Clay loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 2.0 | - | 29.3 | 18.9 | 85 |
| February | - | - | 32.4 | 18.3 | 79 |
| March | 10.5 | 2 | 34.9 | 21.9 | 82 |
| April | 29.5 | 2 | 34.4 | 22.2 | 80 |
| May | 54.0 | 3 | 34.7 | 23.5 | 81 |
| June | 17.0 | 2 | 33.8 | 23.4 | 77 |
| July | 121.5 | 11 | 29.4 | 22.8 | 80 |
| August | 24.5 | 5 | 30.7 | 22.6 | 78 |
| September | 16.5 | 3 | 32.9 | 22.5 | 80 |
| October | 259.0 | 15 | 31.3 | 22.4 | 85 |
| November | 299.1 | 19 | 29.4 | 22.7 | 91 |
| December | 37.3 | 6 | 28.9 | 21.8 | 90 |
| **Total/Mean** | **870.90** | **67** | **31.84** | **20.04** | |

**Jagtial**

Latitude : 18"59 N Longitude : 78"56 'E

Altitude : 243.4m MSL Soil type : Red sandy loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 9.0 | 1 | 28.3 | 14.8 | 84.0 |
| February | -- | -- | 32.7 | 14.4 | 74.0 |
| March | 11.6 | 1 | 36.9 | 19.0 | 72.0 |
| April | 18.4 | -- | 36.1 | 23.6 | 69.0 |
| May | 14.6 | -- | 42.2 | 24.7 | 55.0 |
| June | 55.6 | 7 | 38.3 | 24.8 | 79.0 |
| July | 229.5 | 16 | 33.0 | 22.9 | 85.0 |
| August | 103.0 | 7 | 33.0 | 22.6 | 79.0 |
| September | 176.1 | 8 | 32.0 | 21.9 | 87.0 |
| October | 67.2 | 5 | 33.0 | 19.6 | 83.0 |
| November | - | - | 31.2 | 18.4 | 88.0 |
| December | 1.5 | - | 29.7 | 18.2 | 91.0 |
| **Total/Mean** | 686.5 | 45 | 33.87 | 20.41 | |

**Mudigere**

Latitude : 13"50 'N Longitude : 75"39 'E

Altitude : 1175m MSL Soil type : Black clay loam

| Month | Rainfall (MM) | Rainy Days (No) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|---|
| | | | Max | Min | |
| January | 32.6 | 1 | 14.2 | 26.9 | 88 |
| February | - | - | 12.1 | 29.3 | 86 |
| March | 45.4 | 1 | 15.1 | 31.6 | 88 |
| April | 54.4 | 3 | 16.2 | 30.6 | 89 |
| May | 139.6 | 8 | 18.2 | 30.1 | 89 |
| June | 379.8 | 20 | 17.8 | 26.3 | 92 |
| July | 978.2 | 25 | 17.6 | 23.4 | 94 |
| August | 633.9 | 22 | 17.6 | 23.2 | 94 |
| September | 77.8 | 10 | 17.4 | 26.3 | 93 |
| October | 180.8 | 8 | 17.8 | 28.2 | 91 |
| November | 119.0 | 8 | 17.6 | 27.5 | 90 |
| December | 73.2 | 5 | 16.6 | 27.2 | 91 |
| **Total/Mean** | **2714.7** | **110** | **15.05** | **27.55** | |

**Raigarh**

Latitude : 21°15 to 23°15 'N Longitude : 82°95 to 84°20 'E

Altitude : 237m MSL

| Month | Rainfall (MM) | Temperature (°C) | RH (%) | |
|---|---|---|---|---|
| | | | Max | Min |
| January | 5.08 | 26.50 | 8.7 | 76.28 |
| February | -- | 32.25 | 14.05 | 76.80 |
| March | 24.13 | 40.90 | 17.16 | 78.56 |
| April | 50.8 | 42.25 | 23.65 | 69.65 |
| May | 8.89 | 43.15 | 25.00 | 66.05 |
| June | 141.9 | 38.60 | 26.88 | 68.25 |
| July | 418.50 | 31.60 | 24.96 | 93.16 |
| August | 358.02 | 32.05 | 24.80 | 93.43 |
| September | 303.50 | 31.88 | 24.34 | 93.25 |
| October | -- | 32.50 | 21.53 | 91.28 |
| November | 48.46 | 31.00 | 18.78 | 87.50 |
| December | 131.30 | 25.02 | 14.98 | 90.09 |
| **Total/Mean** | **1490.58** | **33.97** | **20.40** | |

**Gangtok**

Soil Type : Silty clay loam

| Month | Rainfall (MM) | Temperature (°C) | | RH (%) |
|---|---|---|---|---|
| | | Max | Min | |
| January | 24.0 | 6.5 | 16.5 | 83.0 |
| February | 62.9 | 7.7 | 17.8 | 83.7 |
| March | 99.5 | 10.7 | 21.8 | 79.4 |
| April | 250.0 | 13.3 | 24.7 | 79.8 |
| May | 504.3 | 15.8 | 25.9 | 86.1 |
| June | 506.2 | 18.5 | 24.1 | 88.2 |
| July | 532.6 | 19.2 | 26.6 | 90.8 |
| August | 491.4 | 19.1 | 27.1 | 90.1 |
| September | 423.7 | 17.1 | 26.1 | 90.5 |
| October | 140.1 | 14.2 | 24.7 | 83.9 |
| November | 31.4 | 10.3 | 21.9 | 82.2 |
| December | 23.3 | 7.6 | 18.4 | 83.8 |
| **Total/Mean** | **3089.4** | **22.97** | **13.33** | |