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ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

Indian Institute of Spices Research
(Indian Council of Agricultural Research)
Marikunnu P.O, Calicut - 673012, Kerala, India.

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

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कार्यकारी सारांश

मसाले का अखिल भारतीय समन्वित अनुसंधान परियोजना राज्य सबसे बडे मसाला अनुसंधान नेटवर्क है। इसके प्रयोजन के अन्तर्गत इसमें 12 मसाले फसल है जिसमें 15 राज्य कृषि विश्वविद्यालय के अधीन 19 परियोजना केन्द्र तथा 8 स्वैच्छिक केन्द्र है और उनमें एक भारतीय इलायची अनुसंधान संस्थान (स्पाइसेस बोर्ड) गांगटोक में है। इस रिपोर्ट में वर्ष 1999-2000 के दौरान विभिन्न केन्द्रों में प्राप्त अनुसंधान देन अंकित किया जाता है।

वर्ष 1999 नवेंबर 18-21 के दौरान कालिकट में मसालों पर अखिल भारतीय समन्वित अनुसंधान परियोजना की XV वीं कार्यशाला चलायी गयी। विभिन्न कार्यक्रमों के अनुसंधान की प्रगति जननिक संसाधन और फसल सुधार, फसल उत्पादन तथा फसल संरक्ष्ण दलों में कार्यशाला के पूर्ववाली बैठक में आलोचनात्मक ढंग से मूल्यांकित किया। इन्हीं बैठकों में नये अनुसंधान कार्यक्रम रूपायित किया। कार्यशाला में नौ नई किस्मों को विमोचित करने के लिए संस्तुत किया।

मसालों की अखिल भारतीय समन्वित अनुसंधान परियोजना में काली मिर्च में 4, इलायची में 7, अदरक में 33, हल्दी में 50, जायफल में 8 धनिया में 35, बडी सौफ में 17, मेथी में 22 नये वन्य अकसशन जोडकर मसालों के आनुवंशिक संसाधनों को मजबूत बनाया। अब मसालों पर अखिल भारतीय समन्वित अनुसंधान परियोजना के विभिन्न केन्द्रों के जर्मप्लासम में काली मिर्च का 386, इलायची का 320, अदरक का 42, हल्दी का 1109, वृक्ष मसालों का 112 और बीज मसालों का 3500 संग्रह होता है और उन्हें विभिन्न केन्द्रों में बनाया जाता है। इन केन्द्रों में पहचान किये आशाजनक जर्मप्लासम अक्सशनों का अतिरिक्त मूल्यांकन और जांच किया जा रहा है। मूल्यांकन परीक्षण से आशाजनक अक्सशनों (IET और CYT) को विभिन्न केन्द्रों में समन्वित किस्म परीक्षण (CVT) के लिए बढाया जाता है। इनमें अधिकांश फसालों में नये समन्वित किस्म परीक्षण (CVTs) लागू किया जाता है।

मूल्यांकन के आधार पर काली मिर्च का पांच अक्सशन [करिमुण्डा II, III, PRS-17, Cul. 5489, Cult 5308, (पन्नियूर)] इलायची का आठ अक्सशन [PS - 44 & S-1 पांपाडुमपारा), CL - 692, CL-730 (मुडिगरे), MCC-13, MCC-18, MCC-200 & MCC - 347 (आई सी आर आई मईलाडुमपारा)] अदरक के दो [V_1C_8 और V_1S_1-2 (पोट्टंगी)] और हल्दी के 11 अक्सशन [TCP -1 (पुंडिबारी) PTS-55, TU No-1, PTS-11, PTS-15, PTS-52 & PTS - 59 (पोट्टांगी) JTS-6, JTC-313 & TCP-2 (जगतियाल) RH-5 (घोली)] आदि नये समन्वित किस्म परीक्षण के लिए पहचान किया गया। मौजूदा 13 समन्वित किस्म परीक्षण के अलावा मसालो में 6 समन्वित किस्म परीक्षण का भी पहचान किया गया।

मसालों पर अखिल भारतीय समन्वित अनुसंधान परियोजना की XV वीं कार्यशाला में केन्द्रीय/राज्य किस्म विमोचन समिति के सामने प्रस्तुत करने हेतु मसालों के नौ नई किस्मों को संस्तुत किया गया। ये है काली मिर्च में पन्नियूर - 6 और पन्नियूर - 7 इलायची में RR-1, धनिया में RCr-435, RCr-436, RCr-684 मेथी में RMt-303 & गुजरात मेथी - 1 और बडी सौंफ में RF-101, जीरा में गुजरात जीरा - 3 आदि। वृक्ष मसालों में अन्य दो किस्मों अर्थात् धनिया में RCr-20 और मेथी में Co-2 को माननीय राज्य किस्म विमोचन समिति द्वारा संस्तुत किया गया।

छानबीन कार्यक्रम के अधीन जर्मप्लासम से पहचान किये गये कुछ रोग/कीट सह्यातायुक्त अक्सशनों का

मुल्यांकन किया गया। हल्दी की गुणवत्ता अध्ययन में सोलन केन्द्र में हल्दी के तीन अक्सशनों (TCT-1GL पुरम, PTS -16) की तथा कोयंबत्तूर में 6.4% कुरकुमिन युक्त अक्सशन CL-67 की सूची बनायी। अक्सशन BDJ-105 और अक्सशन 360 में अधिक सूखे प्राप्ति होता है और ST1M और ST-7M में क्रमशः अधिक सुगन्धित तेल और ओलिओरसिन प्राप्त होता है। सोलन केन्द्र में SG - 685 को अधिक सुखे उपजवाले तथा कुछ अन्य अक्सशनों को अधिक सुगन्धित तेल युक्त भी पहचान किया। धनिया के JCO-331 में अधिक तेल (0.45%) प्राप्त होता है। जीरा के EC-232684 (2.4%) और UC-220 (2.3%) में अधिक बाष्पशील तेल होता है।

सिरसी केन्द्र ने काली मिर्च - सुपारी मिश्रित तरीके के लिए अपेक्षित उर्वरक एवं सिंचाई देने को मानकीकृत किया। मुडिगरे के अध्ययन से इलायची में हरी संपुटिका (Green Capsule) उपजता में सूक्ष्म पोषीय, बोरोन एवं मोलिब्डिनम का प्रभाव स्पष्ट हुआ। इलायची में उर्वरक लगाने से अच्छा फल मिला और अधिक मात्रा में उर्वरक लगाने से अधिक उपजता भी प्राप्त हुई। येरकाड केन्द्र में लौंग और जायफल के लिए जैव उर्वरक युक्त एक उर्वरक पैकेज मानकीकृत किया। धनिया और बडी सौंफ में Zn, Fe, Mn और Cu लगाने से उपजता और गुणवत्ता में वृद्धि दिखाई पड़ी।

चितापल्ली केन्द्र में अदरक एवं हल्दी के लिए पैकेज पद्धति मानकीकृत किया। येरकाड में जायफल में कलम बांधने की तरीके द्वारा कायिक प्रवर्धन मानकीकृत करने पर 50.5% सफलता प्राप्त हुई।

गुजरात में अक्तूबर 15 को जीरा बोने से अधिक उपजता होने के साथ ब्लाइट प्रभाव कम करने में ज्यादा फल देखा गया और यह भी सूचित किया कि तापमान में वृद्धि आने से रोग आपतन कम होता है। कोयंब्तूर में 15 × 10 से. मीटर अन्तराल में अक्तूबर के प्रथम हफते में तथा जोबनर में अक्तूबर 31 को मेथी बोने से अधिकतम उपजता प्राप्त होती है।

कालीमिर्च के फाइटोफथोरा खुर विगलन तथा नेमटोड रोग नियन्त्रण के लिए सिरसी (कर्नाटक) और पन्नियूर (केरल कृषि विश्वविद्यालय) केन्द्रों में एकीकृत तरीकों द्वारा एक तकनोलजी पद्धति को विकसित किया गया। काली मिर्च के मूल लगाई कतरन (पन्नियूर) नर्सरी रोग तथा इलायची नर्सरी के पर्ण चित्ती के लिए नियन्त्रण उपाय प्रस्तुत किया गया। खेत तथा भंडार में अदरक का राइजोम गलन के लिए सोलन और राइगढ़ केन्द्रों में प्रबन्धन उपायों के संस्तुत किया गया। हल्दी के पर्ण दाग के नियन्त्रण उपायों को पुंडिबारी और चिंतापल्ली केन्द्रों में प्रस्तुत किया। पांपाडुमपारा केन्द्र में किये सर्वेक्षण से यह स्पष्ट होता है कि काली मिर्च का सबसे प्रबल कीट सीमांत पिटिका कीट होता है।

जगुदान में जीरा के अल्टर्नेरिया अंगमारी पर तथा वृक्ष मसालों के महामारी का अध्ययन आयोजित किया। अक्तूबर 15 को जीरा बोंने पर उच्च उपजता के साथ अंगमारी रोग का आपतन कम होते देखा गया। जगुदान में गुजरात जीरा - 3 किस्म को फुसेरियम म्लानी का प्रतिरोधक देखा गया और जगुदान केन्द्र में म्लानी का एकीकृत प्रबन्धन संस्तुत किया गया। उच्च बीज उपजता और लघुतर म्लानी आपतन के लिए दिसंबर 20 को जीरा बोने को संस्तुत किया। धनिया की म्लानी के प्रबन्धन के लिए ट्राइकोडरमा के साथा बीज उपचार तथा कोयंबत्तूर में मेथी के मूल विगलन के नियन्त्रण के लिए ट्राईकोडरमा के साथ नीम केक लगाने का बीज उपचार संस्तुत किया। मसालों पर अखिल भारतीय समिन्वत अनुसंधान परियोजना केन्द्रों में विभिन्न मसालों की केन्द्रक रोपण सामग्रियां कतरन/ अन्तर्भूस्तरी (sucker) बीज बडी मात्रा में बनाकर वितरण करता है। इस रिपोर्ट में विभिन्न केन्द्रों के मौजूदा मसालों पर आई सी ए आर तदर्थ अनुसंधान परियोनाओं की देन भी शामिल होती है।

EXECUTIVE SUMMARY

The AICRPS is the largest spices research network in the country. It has 12 spice crops under its preview, with 19 Coordinating centres and eight voluntary centres based at 15 SAUs and one at ICRI (Spices Board), Gangtok. The research achievements accomplished by the centres during 1999-2000 are highlighted in this report.

The XV AICRPS workshop was held at Calicut during November 18-21, 1999. The progresses of research under various programmes were critically evaluated in the pre-workshop meetings on genetic resources & crop improvement, crop production and crop protection groups. New research programmes were formulated in these meetings. The workshop also recommended nine new varieties for release from the AICRPS centres

The AICRPS centres strengthened the genetic resources in spices by adding 23 cultivated/indigenous and four new wild accessions in pepper, seven in cardamom, 35 in ginger, 55 in turmeric, 8 in nutmeg, 35 in coriander, 22 in cumin, 133 in fennel and 22 in fenugreek. At present germplasm holdings of AICRPS centres consisted of 386 black pepper, 320 cardamom, 421 ginger, 1109 turmeric, 112 tree spices and 3500 seed spices and are maintained at different centres. The promising germplasm accessions identified in centres are under further evaluation and testing. From the evaluation trials, (IET and CYT) promising accessions are promoted to CVT at different centres. New Coordinated Varietal Trials (CVTs) were formulated in most of the crops.

Based on the evaluation, five accessions of black pepper [Karimunda-II, III, PRS-17, Cul.5489, Cult.5308 (Panniyur)], eight of cardamom [PS-44 & S-1 (Pampadumpara), CL-692, CL-730 (Mudigere), MCC-13, MCC-18, MCC-200 & MCC-347 (ICRI, Myladumpara)]; two of ginger [V_1C_8 and V_1S_1-2 (Pottangi)] and 11 of turmeric [TCP-1 (Punidbari) PTS-55, TU.No-1, PTS-11, PTS-15, PTS-52 & PTS-59 (Pottangi) JTS-6, JTC-313 & TCP-2 (Jagtial) RH-5 (Dholi)] were identified for the new CVTs. Six CVTs were identified in spices in addition to 13 existing CVTs.

Ten new varieties were recommended by the XV AICRPS workshop for presentation before central/state variety release committees. These are Panniyur-6 and Panniyur-7 in black pepper, RR-1 in cardamom, RCr-435, RCr-436, RCr-684 in coriander, RMt-303 & Guj Methi–1 in fenugreek and RF-101 in fennel and Guj cumin –3 in cumin. Another two varieties in seed spices (RCr-20 in coriander and CO-2 in fenugreek) were recommended by the respective state variety release committees.

Some disease/pest tolerant accessions have been identified from germplasm evaluated under screening programme. From quality studies in turmeric the Solan centre shortlisted three turmeric accessions (PCT-1, GL Puram, PTS-16) and at Coimbatore, accession CL-67 with 6.4% curcumin. Acc.BDJ-105 and Acc-360 have high dry recovery, ST-1M and ST-7M have high essential oil and oleoresin respectively. Solan centre identified SG-685 for high dry recovery and a few accessions with high essential oil. In coriander, JCo-331 is having high oil (0.45%). EC-232684 (2.4%) and UC-220 (2.3%) of cumin have high volatile oil.

Sirsi centre standardized the fertilizer and irrigation requirements for black pepper-arecanut mixed cropping system. Studies at Mudigere revealed the influence of micronutrients, boron and molybdenum, on green capsule yield in cardamom. Cardamom responded positively for the fertilizer application and increased dose of fertilizer resulted in increased yield. A fertilizer package, including the application of biofertilizer, was standardized for clove and nutmeg by the Yercaud centre. Yield and quality of coriander and fennel increased by the application of Zn, Fe, Mn & Cu.

Package of practices for ginger and turmeric were standardized by the Chintapalli centre. The vegetative propagation standardized in nutmeg through grafting technique gave 50.5% success at Yercaud.

In Gujarat sowing of cumin on 15th October is most appropriate in terms of high yield and less blight incidence and also indicated that increase in temperature reduced the disease incidence. A closer spacing of 15 X 10 cm and sowing in first week of October gave highest yield at Coimbatore and 31st October sowing in Jobner for fenugreek.

A package of technology for the management of *Phytophthora* foot rot disease in black pepper as well as nematode disease management using integrated methods were developed by Sirsi (Karnataka) and Panniyur (KAU) centres. Control measures for nursery disease in black pepper rooted cuttings (Panniyur) and cardamom nursery leaf spot were evolved. Management measures for rhizome rot of ginger in field and storage were recommended by Solan and Raigarh centres. Measures for management of leaf blotch of turmeric were evolved by the Pundibari and Chintapalli centres. The survey conducted by Pampadumpara centre revealed that the most predominent insect pest in pepper was marginal gall thrips at higher altitudes.

In seed spices epidemiological studies were conducted on *Alternaria* blight of cumin at Jagudan. Sowing of cumin on 15th October seems to be appropriate for high yield as well as less incidence of blight. The variety Guj.cumin-3 was found to be resistant to *Fusarium* wilt at Jagudan and the integrated management of wilt was recommended by Jagudan centre. Sowing of cumin on 20th December was recommended by Jobner for higher seed yield and lesser incidence of wilt. Seed treatment with *Trichoderma* was recommended for managing wilt in coriander and seed treatment with *Trichoderma* + neem cake application was recommended for controlling root rot of fenugreek at Coimbatore. The AICRP (Spices) centres multiplied and distributed nucleus planitng materials (cuttings/suckers/seeds) of different spices. This report also contains summary of achievements of the ICAR adhoc research projects on spices currently operating.

INTRODUCTION

Research on spices was initiated in 1949 by the then Government of Madras by setting up a Pepper Research Scheme at Panniyur. This was followed by the report of the spices enquiry committee in 1953, which made a strong recommendation to start spices research stations and accordingly centres were started at Mudigere, Sirsi, Chethalli (Karnataka), Thodupuzha, Pampadumpara, Ambalavayal (Kerala) Dergaon (Assam), Kallar, Burliar (Tamil Nadu), Fulia (West Bengal) Kandaghat (Himachal Pradesh) and Tasgaon (Maharashtra). These schemes lasted only for a few years thereby leaving a vaccum in spices research in the country. Hence, the ICAR launched a major programme for the first time to organize spices research in this country by establishing the All India Coordinated Research Project on Spices and Cashew Improvement Project (AICSCIP) in 1971 (IV Plan). In order to give adequate and undivided attention to spices, the combined project was bifurcated and made independent. AICRP on Spices came into existence in 1986 with the shifting of PC's cell, initially located at Central Plantation Crops Research Institute, Kasaragod to Headquarters at IISR, (the then Central Plantation Crops Research Institute, Regional Station) Calicut, Kerala. The AICRP on Spices was the first ever major effort to conduct organized research on spices in the world.

Initially AICRP on Spices started as a combined project of spices and cashew with 4/6 centres on spices located at Vittal (pepper), Panniyur (pepper), Pampadumpara (cardamom), Mudigere (cardamom), Gonicopal (cardamom) and Solan/Kandaghat (Ginger & Turmeric). During V year Plan (1975) five more centres were added *viz.*, Jobner (cumin, coriander, fennel), Guntur Lam (cumin, coriander, fennel, fenugreek), Jagudan (cumin, fennel, coriander) Coimbatore (coriander and fenugreek), Pottangi/Bhubaneshwar (ginger and turmeric). During the VI Plan (1980) four more centres were started *viz.*, Yercaud (cardamom), Vellanikkara (ginger and turmeric), Sirsi (pepper), Chintapalli (pepper) and discontinued the Vittal and Gonicopal centres, thereby making a total of 13 centres.

During VII Plan, the coordinated project was further strengthened with the addition of two more centres, Jagtial (turmeric) and Gangtok for large cardamom which was not covered by the project earlier.

During the annual plans 1990-91/1991-92, the centre at Vellanikkara was delinked from the AICRPS. In order to give better representation of the agroclimatic region not covered by the project earlier and to the Northern region of the country six more centres were started at Dholi, Hisar, Kumarganj, Raigarh, Dapoli and Pundibari, there by making the total centre to 20. The centre at ICAR, R.C, NEH Region, Gangtok to work on large cardamom was dropped from the coordinated project during IX Plan based on the recommendations of the 2nd QRT. The ICRI (Spices Board) Gangtok is included to function as a voluntary centre to work on large cardamom. There are six more voluntary centres functioning under AICRPS. The utility and efficiency of the programme were being reviewed critically during each five year plan. In view of the changed priorities research work on tree spices also was under taken at Yercaud during the VII Plan.

The mandate of the project are:-

- ☆ Evolving high yielding, high quality varieties suitable for various agro-ecological situations, and that are tolerant / resistant to disease and pests.
- ☆ Standardizing agro-techniques for different agro-climatic conditions
- ☆ Evolving measures for management of major pests and diseases
- ☆ Working as an interface between SAUs, Indian Institute of Spices Research (IISR) and Indian Council of Agricultural Research (ICAR)

(This project has mandate to conduct research on 12 spice crops (Table 1)

Table 1: The AICRPS coordinating centres

Sl No	Crop	No. of centers	Name of centres
1	Black pepper	7	Panniyur, Sirsi, Chintapalli, Pampadumpara, Yercaud, Pundibari, Dapoli,
2	Cardamom	2	Mudigere, Pampadumpara
3	Ginger	6	Solan, Pottangi, Raigarh, Kumarganj, Pundibari, Dholi
4	Turmeric	7	Pottangi, Jagtial, Dholi, Raigarh, Kumarganj, Pundibari, Coimbatore
5	Coriander	8	Coimbatore, Jobner, Jagudan, Guntur, Hisar, Dholi, Raigarh, Kumarganj
6	Cumin	2	Jobner, Jagudan
7	Fennel	4	Jobner, Jagudan, Kumarganj, Hisar
8	Fenugreek	7	Coimbatore, Guntur, Jobner, Jagudan, Hisar, Dholi, Kumarganj
9	Clove	2	Yercaud, Dapoli
10	Nutmeg	2	Yercaud, Dapoli
11	Cinnamon	2	Yercaud, Dapoli
12	Large cardamom	1	ICRI (Spices Board) Gangtok (Voluntary centre)

At present the AICRPS has 20 centres including the ICRI (Spices Board) Gangtok station to work on large cardamom. The centres are spread over in 15 states , in 15 SAUs and based in 13 agroclimatic zones (Table 2)

Table 2: AICRPS centres and mandate crops

Sl. No	Name of centres	Crops handled	State
1	Pampadumpara	Cardamom & Black pepper	Kerala
2	Mudigere	Cardamom	Karnataka
3	Yercaud	Clove, Nutmeg, Cinnamon & Black pepper	Tamil Nadu
4	Panniyur	Black pepper	Kerala
5	Sirsi	Black pepper	Karnataka
6	Chintapalli	Black pepper	Andhra Pradesh
7	Jagtial	Turmeric	Andhra Pradesh
8	Pottangi	Turmeric & Ginger	Orissa
9	Solan	Ginger	Himachal Pradesh
10	Coimbatore	Coriander, Fenugreek & Turmeric	Tamil Nadu
11	Guntur	Coriander & Fenugreek	Andhra Pradesh
12	Jobner	Cumin, Coriander, Fennel, & Fenugreek	Rajasthan
13	Jagudan	Cumin, Coriander, Fennel, & Fenugreek	Gujarat
14	Gangtok	Large cardamom	Sikkim
15	Hisar	Coriander, Fennel & Fenugreek	Haryana
16	Dholi	Turmeric, Coriander & Fenugreek	Bihar
17	Dapoli	Black pepper, Nutmeg, Clove & Cinnamon	Maharashtra
18	Raigarh	Ginger, Turmeric & Coriander	Madhya Pradesh
19	Kumarganj	Ginger, Turmeric, Coriander, Fenugreek & Fennel	Uttar Pradesh
20	Pundibari	Black pepper, Ginger, Turmeric	West Bengal

The AICRPS operates from the headquarters of the Project Coordinator (Spices) located at IISR, Calicut, Kerala. The AICRPS has a total staff strength of 83, which includes 51 Scientists, 32 technical/auxiliary positions.

The coordinated project was started with a very modest budget of Rs.11.92 lakhs in IV five year plan. This was raised to Rs.30.25 lakhs in V Plan, Rs.68.03 lakhs in VI Plan, Rs.104.86 lakhs in VII Plan and Rs.300.00 lakhs and VIII Plan and Rs.395 lakhs in IX Plan (ICAR share).

The AICRPS conducts biennial Workshops/National Group Meeting (NGM) which is the forum for presentation/discussion and finalization of research programme and to re-

view and evaluate the progress of research work. The workshop recommends technologies /package of practices including recommendations for release of improved spices varieties. The XV Spices Workshop was conducted at Calicut during November 18-21, and in this Workshop new programmes were formulated and existing ones modified based on the present needs.

The present report embodies the work done by various AICRPS centres during 1999-2000 according to the technical programmes assigned to the coordinating centres during the XV Workshop on Spices held at Calicut during November 18-21, 1999.

The detailed summery of research accomplishments on crop improvement, crop production, crop protection along with recommendations are given in this report. Besides, the research achievements, the report also contains, financial out lay and expenditure, approved technical programme for 1999-2000, list of publication, proposed technical programme for 2000-2001 and list of staff members of each centre. Brief reports of ICAR ad-hoc schemes on spices are also included in this annual report. Suggestions are welcome from spices workers for the improvement of the report in the years to come.

(P N RAVINDRAN)

Project Coordinator

PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices and Cashew started functioning from 1970 with four centers for spices. Due to the importance of spices, the ICAR bifurcated the project of spices and cashew in 1986 to become independent projects. The AICRP (spices) centers as well as the mandate crops increased since then and at present AICRPS is the largest spices research network in the country, consisted of 12 spice crops with 19 centres and eight voluntary centres based in 15 SAUs and one at Indian Cardamom Research Institute, Regional Station (Spices Board), Gangtok. The headquarters of AICRPS is stationed at Indian Institute of Spices Research, Calicut. The annual budget of 1999-2000 is Rs.120 lakhs (Rs.90.00 lakhs ICAR share) shared by ICAR & SAUs in 75:25 basis. The budget expenditure was Rs.131.65 lakhs during the year 1999-2000.

I have immense pleasure to present the report on the progress of work and achievements accomplished during the year 1999-2000. The XV National Workshop of the AICRPS was held under the auspices of IISR, Calicut during 18-21 November 1999 at Calicut, Kerala. The Workshop was inaugurated by Dr. K Shyamasundaran Nair, Vice Chancellor, Kerala Agricultural University. Dr R N Pal, Assistant Director General (PC), ICAR was also present during the workshop.

A distinct feature of the workshop has been the separate preworkshop concurrent meetings of three groups' *viz.*, genetic resources and crop improvement, crop production and crop protection. These groups critically reviewed the existing programmes and formulated need based and action based new research programmes for meeting the future targets and challenges. Twenty five new projects were formulated based on the discussion among panel members, resource persons and scientists.

The following new programmes were identified to be initiated in 1999-2000/2000-2001 at different centres.

Black pepper

- Management of *Phytophthora* foot rot in black pepper
- Efficiency of biofertilizer studies using *Azospirillum*
- Efficiency of biofertilizer studies using P-solubilisers
- Organic farming in black pepper
- CVT of black pepper

Cardamom

- Efficiency of biofertilizer studies using *Azospirillum*
- Efficiency of biofertilizer studies using P-solubsilisers
- CVT of cardamom
- Management of root grubs of cardamom
- Bioecology of natural enemies of major pests of cardamom.

Turmeric

- Studies on the efficiency of biofertilizers
- Rhizome rot control of turmeric

Ginger

- Disease Surveillance survey and etiology of rhizome rot in ginger
- Management of storage rot of ginger
- Biocontrol studies on rhizome rot of ginger
- Studies on the effiency of biofertilizers
- Organic farming in ginger

Coriander

- Studies on the efficiency of biofertilizer in coriander
- Biocontrol of wilt in coriander
- CVT-V of coriander

Cumin

- Intergrated management of cumin wilt disease
- Efficicency of biofertilizers in cumin

Fennel

- Efficicency of biofertilizers in fennel
- CVT - IV

Fenugreek

- Studies on the efficiency of biofertilizer in fenugreek

The report of the progress of work and highlights of research achievements accomplished by the coordinating centres/voluntary centres are briefly given below.

Genetic resources

The spices genetic resources assembled at centres were enriched through collection surveys and are maintained for further evaluation. The Raigarh centre collected 48 turmeric, 12 ginger, 15 fennel, 17 fenugreek and 29 coriander accessions from the neighboring districts. Punidibari centre collected five turmeric accessions. In black pepper, Chintapalli collected four wild accessions and Panniyur centre collected 21 cultivated/indigenous types. The Jagudan centre collected 22 cumin from different cumin growing areas of the state. Dapoli centre collected eight elite promising types of nutmeg, two black pepper accessions and two cinnamon accessions.Hisar centre collected six entries in coriander, four in fennel and five in fenugreek. Pampadumpra collected seven new lines in cardamom. Pottangi centre collected three new accessions in ginger and two new accessions of *C.longa*. Solan centre added 20 new collections in ginger.

At present the germplasm holdings of AICRPS centres consist of 386 black pepper, 320 cardamom, 421 ginger, 1109 turmeric, 23 clove, 51 nutmeg, 38 cinnamon, 1661 coriander, 595 cumin, 334 fennel and 910 fenugreek accessions. The germplasm accessions of different spices crops are under evaluation and the shortlisted ones for further studies are given below.

Promising germplasm accessions under evaluation at different centres

Spice	Centre	Accessions	Yield
Black pepper	Yercaud	PN 2 (Somaley) and PN-59	8.25 & 7.50 kg/vine
	Chintapalli	Panniyur -1	6.0 kg fresh berry/vine
	Panniyur	Karimunda III (PRS-22)	3.92 kg/vine
		Valli (PRS-61)	2.28 kg/vine
		Kalluvally IV (PRS 17)	2.10 kg/vine

Clove	Yercaud	SA-1	Vigorous growth
Cinnamon	Yercaud	CV-5	180 g dry bark/tree
Cardamom	Mudigere	CL-681, CL-730, CL-692, EB-1277-7, P-20,	
		OP seedlings progenies, D-237, CL-692,	1600-850 g/clump
		CL-730, D-496, D-202	1800-910 g/clump
Turmeric	Solan	BDJR-1180, BDJR-1025, BDJR-1268, BDJR-1130	6.0 to 6.5 kg/plot
	Kumarganj	NDH-18	508.33 g/plot
	Coimbatore	CL-132 (Suvarna)	-
	Pottangi	CLS-13	12.6 kg/3m^2
Ginger	Solan	Wynad	9.0 kg/plot
	Pottangi	S-554	4.6 kg/3m^2
		Poona, V_1E_4-1	to 4.4 kg/3m^2
	Kumuarganj	NDG-6	0.623 kg/plot
Coriander	Guntur	LCC-212	633 kg/ha
	Coimbatore	CS-187	170 g/plant
Fennel	Hisar	HF-107, HF-116, HF-117, HF-118,	High
		HF-122, HF-125, HF-127, HF-129, HF-175	afielders
Fenugreek	Hisar	HM-239, HM-242, HM-273, HM-281-6,	
		HM-283-5, HM-292-1, HM-299	-
	Guntur	LFC 113	1000 kg/ha

Crop Improvement

There are coordinated varietal trials (CVT) comparative yield trials (CYT) and initial evaluation trials (IET). The lines short listed are presented below.

Promising accessions of spices under CVT

Spice	Centre	Accessions	Yield
Black pepper	Sirsi	Cul. 239	1.92 kg/vine
		Cul. 331	
		Cul. 141	1.5 kg/vine
Ginger	Solan	SG-534	10351 kg/ha
		V_1E_6 - 2	89241 kg/ha
		Acc-64	8900 kg/ha
	Pundibari	Garubathan	9.28 kg/3m^2
		Acc-64	8.46 kg/3m^2

	Pottangi	$V_1E_8.2$	25.1 t/ha
		V_3S_1-8	22.1 t/ha
		V_1S_1-8	21.16 t/ha
Turmeric	Pundibari	Rajendra Sonia	11.7 kg/3m²
	Raigarh	RH-5	30350 kg/ha
	Pottangi	PTS-43 & JTS-1	31.26 q/ha to 30.84 t/ha
	Chintapalli	BSR-1 & PTS-62	36.5 & 27.36 t/ha
	Coimbatore	CL-147	-
Clove	Yercaud	Sel 1	Vigorous growth
Cinnamon	Yercaud	Sel. 189	490 g dry bark/tree
Coriander	Coimbatore	UD-748, CS-14, CS-21, Acc. 202	-
	Jobner	UD-684	989 kg/ha
	Kumarganj	Jco-327	19.34 q/ha
		UD-685	19.25 q/ha
		Kumjarganj sel	19.25 q/ha
	Jagudan	Jco-387	2723 kg/ha
Fenugreek	Coimbatore	HM-141	-
		TF-464	-
	Jobner	UM-303	2344 kg/ha
		HM-305	2079 to 2029 kg/ha
		J.Fen-102	
		HM-291	
	Kumarganj	Kumarganj Sel, HM-114	26.80 q/ha
		UM-304	25.69 q/ha
	Guntur	JF-210	967 kg/ha
		JF-204	883 kg/ha
Fennel	.Raigarh	HF-39	-
	Hisar	HF-33	194 kg/ha
Cumin	Jobner	UC-223	208 kg/ha
		EC-232684	199 kg/ha
		EC-279081	187 kg/ha

The following disease/pest tolerant accessions have been identified.

Disease/pest tolerant accessions identified in the screening

Spice	Centre	Accessions	Disease/pest tolerance
Turmeric	Coimbatore	CL-31	Free from leaf spot
	Jagtial	JTS-602, JTS-604, PTS-14 (Short duration), JTS-302, 303, 304, 306, 308, CLI-317, 330, 370, PTS-9, PTS-19 (mid duration) JTS 3, 8, 9, 15, 13, TC-2, TC-4 (long duration)	Free from rhizome rot
	Jagtial	PCT-14, CLI-330, TC-2, Durggirala, Armoor	*Taphrina* leaf spot
Coriander	Jobner	Rcr-41, RCr-435, RCr-436	Immune to stemgall
		RCr-446, UD-684, UD-685	Root knot nematode
Fenugreek	Jobner	UM-305, UM-32, UM-34	Root knot nematode
		UM-34, UM-302, UM-304, UM-305	Powdery mildew

The following accessions have been proposed for CVT 2000-2001 in different spices from different centres

Spice/centre	Accessions
Black pepper	
Panniyur	Karimunda II (PRS-21)
	Karimunda III (PRS-22) (released)
	Kalluvally (PRS-17)
	Cul –5489
	Cul-5308
Cardamom	
Pampadumpara	PS-44, S-1
Mudigere	CL-692 & 730
Myladumpara	MCC-13, 18, 200 & 347
Ginger	
Pottangi	V_1C_8 and V_1S_1-2
Turmeric	
Pundibari	TCP-1
Pottangi	PTS-55, Tu.No 1, PTS-11, 15, 52 & 59
Jagtial	JTS-6, 313 & TCP-2
Dholi	RH-5

From the quality studies the following high quality accessions are short listed

Spice		Accessions	Quality
Turmeric			
		PCT-1 (Megha), CL Puram, PTS-16	Curcumin (5.37 to 4.82%)
		Acc-360, Sugandham, ST4M, T.No.890	Dry recovery (2.95-28.7%)
		ST 1 M, BDJ-634, CLS-24, Duggirala	Essential oil (9.0%)
	Solan	ST 7 M, CLS-24, Duggirala, ST 8 M	Oleoresin (19.57-16.84%
	Coimbatore	CL-67	Curcumin (6.357%)
Ginger			
	Solan		
		SG-685	Dry recovery
		Shilli, Bangi, Himgiri, Acc-64 & V_1E_4-4,	
		PGS-23, SG-706	Essential oil
Coriander			
	Jobner	JCo-331	Essential oil (0.45%)
Cumin			
	Jobner	EC-232684	Essential oil (2.4%)
		UC-220	Essential oil (2.3%)

New varieties

Ten new varieties of spices were recommended by the XV Workshop for presentation before central/state variety release committees. These were Panniyur-6 and Panniyur-7 in balck pepper form PRS, Panniyur (KAU), RR-1 cardamom form IISR, RCr-435, RCr-436, RCr-684 in coriander, RMt-303 in fenugreek and RF-101 in fennel developed by Rajasthan Agricultural University; Guj. Methi-1 (Fenugrek) and Guj.Cumin-3 developed by Gujarat Agricultural University, Jagudan. Panniyur-6 is a clonal selection from local cultivar Karimunda and Pannyur-7 a selection from a OP seedling progeny of local cultivar Kalluvally, yielding 2127 & 1410 kg respectively. RR-1 in cardamom is the first rhizome rot resistant variety yielding 238 to 848 kg/ha depending upon the growing condition. It is a selection from OP progeny of early bearing plants of 4th generation Clone-37, a collection from RRS, Mudigere. In seed spices seven varieties, three in coriander, one in fennel, two in fenugreek and one in cumin were recommended for release. The coriander RCr-435 and UD-436 and RCr-684 yielded 1000 kg & 1200 and 990 kg/ha respectively. The fennel RF-101 yielded 1400 kg/ha and fenugreek RMt-303 and Guj

Methi-1 yielded 1900 kg and 1865 kg/ha respectively and Guj cumin-3 the first wilt resistant variety had a productivity of 663 kg/ha.

Another two varieties in seed spices, RCr-20 in coriander and Co-2 in fenugreek were released by the respective state variety release committee.

The fenugreek Co-2 released from Tamil Nadu Agricultural University, Coimbatore is a short duration (85-90 days), high yielding (482 kg /ha), (21% more than Co-1) field tolerant to wilt, suited for growing both during kharif and rabi, throughout Tamil Nadu.

Coriander RCr-20 released by SKN College of Agriculture, Jobner (RAU) Rajasthan yield 900 kg/ha with bold and oblong grains suitable for unirrigated areas and or under limited moisture condition.

Crop Production & Management

Black Pepper: For black pepper-arecanut mixed cropping system, the Sirsi centre recommended the fertilizer dose of 100:40:140 g NPK/palm/year with irrigation of IW/CPE 0.33 10 mm water (10 l/palm/vine/day) for high yield. A low cost technology for mass multiplication of *Trichoderma* sp for field application has been developed at Sirsi.

Cardamom : Micronutrient application influenced the green capsule yield significantly. Economic analysis revealed that highest marginal returns were realized by application of borax and molybdenum (Rs.4980) followed by application of molybdenum alone or boron alone.

For evaluating the optimum fertilizer level for high density cropping studies conducted at Mudigere confirmed that cardamom under natural shade responded positively for the fertilizer application and significantly influenced the yield. Increase in the dose of fertilizer (150:75:75 kg NPK/ha) resulted in increased yield (740 kg/ha). The recommended fertilizer application of 75:75:150 kg NPK/ha (for a spacing of 1.8x1.8 m) is economical, giving an yield of 656 kg/ha, and is recommended by the Mudigere centre.

Studies on integrated nutrient management using organic and inorganic manure on yield of cardamom at Mudigere during the last four years confirmed that inorganic manure alone gave higher yield over the control and 100% organic manure application. Micronutrients play an important role along with other management practices in increasing yield. Application of boron in the form of disodium tetraborate @ 20 kg/ha or molybdenum in the form of sodium molybdate @ 0.25 kg/ha mixed with appropriate quantity of FYM @ 1kg/plant minimum) should be applied at the onset of monsoon (May or June first week) for higher cardamom yield (by 20%).

Ginger : Ginger variety IISR Varada is found to be suitable for Chintapalli area. A package of practices for ginger cultivation was standardized at Chintapalli centre : time of sowing of ginger in June-July, seed rate 1700 kg/ha at 30X20 cm spacing and fertilizer dose is 75:50:50 N, P_2O, K_2O kg/ha.

Turmeric : BSR-1 variety of turmeric is found good for Chintapalli. The Jagtial centre made a survey of fertility status of turmeric soils in North Telengana zone. The package of practices for turmeric developed at Chintapalli centre includes seed rate of 2500 kg/ha, sowing first fortnight of May at 30 X 20 cm spacing in raised beds, and fertilizer schedule of N, P_2O_5, K_2O 30:30:60 kg/ha.

Tree spices : In the vegetative propagation of nutmeg the use of two leaved stage of root stock with orthotropic scion is found to be optimum and recorded 50.5% success. The same two leaved stage of root stock with semihard wood scion has recorded 47.7 % success. The study conducted at Yercaud made clear that in clove, application of 100 kg FYM + 400:350:350:1200 NPK/tree/year (two split doses during June & September) along with 50g each of *Azospirillum* and phosphobacteria 15 days before the application of inorganic fertilizers for good bud yield (3.53 kg/plant), number of buds/cluster (7.3) as well as yield attributing characters such as the highest mean tree girth (34.7 cm) and annual increase in tree girth (3.8 cm). This also resulted in the increase in population of soil microflora. Combined application of inorganic and biofertilizers influenced both the vegetative and yield parameters. Application of 100 kg FYM, 400:350:1200 g NPK per plant per year and 50 g each of *Azospirillum* and phosphobacteria (15 days before the application of inorganic fertilizers) significantly increased the number of fruits/plant as well as yield attributing characters. The treatment gave an increased mean girth (54.1 cm), annual increase in tree girth (9.4 cm), mean fruit weight (69.05 gm) and mean fruit yield (529 nos.).

Coriander : The response of coriander to micronutrients was studied at Jobner. Highest seed yield was obtained with soil application of $ZnSo_4$ @ 0.5 (13.37 q/ha). This study also indicated that volatile oil content increased in coriander with $FeSo_4$ (0.25%) foliar application (0.4%) or $ZnSo_4$ (0.5%) foliar application.

Cumin : The dates of sowing of cumin significantly influenced the blight incidence in Gujarat. Sowing of cumin on 15th October seems to be most appropriate, recording lesser blight disease incidence (1.82) and with higher yield (216.5 kg/ha). The maximum temperature was found to have significant negative correlation with blight intensity in 5th & 25th October and 5th November sown crops, indicating that increase in temperature reduced the disease incidence.

Fennel: The response of fennel to the application of Zn, Fe, Mn, & Cu at Jobner resulted in highest seed yield of 11.94 q/ha with foliar application of $FeSo_4$ @ 0.25%. Foliar application of $FeSo_4$ @ 0.25% have good response on yield of fennel.

Fenugreek: Fenugreek has to be sown during the first week of October adopting a closer spacing of 15 x 10 cm for higher yield at Coimbatore. At Jobner early sowing on or before 31 st October gave better yield (19.14 q/ha) at 25 cm row spacing.

Crop Protection

Black pepper : Presently *Phytophthora* foot rot disease of black pepper is managed through phytosanitation and by the use of various fungicides. A package of technology for the management of *Phytophthora* by the Sirsi centre (Karnataka) includes: 1) application of Potassium Phosphonate (Akomin) @ 0.3 % as spray @ 3l/vine and drench @5l/vine twice during the season or combination of Potassium Phosphonate @0.03% as spray (@ 3l/vine) twice in a season (2) application of antagonistic organism *Trichoderma viride* to the basin of the vine @ 50 g /vine along with 1 kg of neem cake and 5 kg of FYM during the first week of June. First round of treatment is to be applied just before the onset of monsoon ie. June first week and second round during August. Panniyur centre recommended

a package of technology for the management of *Phytophthora* foot rot and nematode disease. This includes all cultural practices + application of 1 kg neem cake + 3 g a.i phorate/ vine + 1% Bordeaux mixture first spray + 0.2% Akomin second spray.

Based on the results of the studies conducted at Panniyur the following management practices for *Phytophthora* foot rot disease was developed. After the receipt of a few monsoon showers all the vines are to be drenched over a radius of 45-50 cm with 0.3% Potassium phosphonate @ 5-10 lits/vine. A foliar spray with 0.3% potassium phosphonate is also to be given. A second drenching and spray with 0.3% potassium phosphonate are to be repeated just before the north east monsoon. If the monsoon is prolonged, a third round of drenching may be given during October.

Akomin (Potassium phosphonate) spraying and drenching followed by application of biocontrol agent (50 g/vine) recorded the least leaf infection and branch infection. Bordeaux mixture (1%) spraying and drenching with 0.2% copper oxychloride is effective in checking death of vines due to wilt. Studies on the control of *Phytophthora* foot rot disease of black pepper at Farmers field at Panniyur indicated that treatment receiving 1.0% Bordeaux Mixture and drenching with 2.0% copper oxychloride was superior.

In Sirsi *Phytophthora* disease incidence was least (7.36%) in vines sprayed and drenched twice with Potassium phosphonate @ 0.3%. Disease incidence of 10.42% was noticed in vines sprayed with 1% Bordeaux mixture and sprayed and drenched with copper oxychloride @ 0.3% twice. The treatments were imposed twice during the season ie. before onset of monsoon (June) and second round at 35-45 days after first round of spray (August). A low cost technology for mass multiplication of *Trichoderma* sp. for field application has been developed and transferred to farmers by the Sirsi centre.

One of the main constraints in the production of rooted pepper cuttings is the rotting of cutting in the nursery caused by fungi *viz. Pythium* sp., *Rhizoctonia solani*, *Colletrotrichum* sp., *Phytophthora capsici* and *Sclerotium rolfsii*. Minimum percentage of roting of cutting was observed in treatment: dipping in *Trichoderma harzianum* as well as in treatment receiving 1% Bordeaux mixture spraying and drenching.

The most predominent insects pest of black pepper in Idukki was the marginal gall thrips, *Liothrips karnyi*, observed in 21.69% of the leaves and reported from all gardens surveyed.

Three species of scale insects viz., mussel scale, *Lepidosaphos piperis*, soft scale, *Marisipi coccus marsupiale* and coconut scale *Aspidioutus destructor* have been observed in twelve Panchayats (3.53%). Scale insects were mostly recorded from Thodupuzha (49.3%) and occurrence at high ranges was very negligible.

Cardamom : Three sprays of Carbendazim @ 0.1% at an interval of 20-25 days from July onwards effectively check the cardamom nursery leaf spot.

Ginger : For the control of rhizome rot of ginger the Solan centre recommended seed rhizome treatment with Dithane M 45 (0.25%) + Bavistin 0.1% as well as soil application of Thimet 12 kg/ha for maximum sprouting of rhizome (92.5%) with less disease incidence

(9.9%). Studies at the Raigarh centre confirmed that application of neem cake (@ 5%) plus Mahua cake @ 5% effectively control the rhizome rot and gave higher yield in ginger. The biocontrol studeis at Solan for the management of rhizome rot in ginger revealed that seed rhizome treatment with *T.harzianum* in cow dung slurry (0.5%) gave highest rhizome emergence (86.5%) with least disease incidence (10.4%) and higher yield (5.4 kg/3m^2) in combination with a low yield of 2.6 kg/3m^2 and higher disease incidence (20.5%) in control. In a trial on the management of storage rot of ginger the incidence of rhizome rot of ginger was found minimum with Dithane M-45 (0.25%) + Bavistin (0.1%) + Durmet (0.2%)

Turmeric : At Chintapalli centre foliar application of Dithane M-45 (0.25%) was found effective against leaf blotch disease of turmeric. At Pundibari, Bordeaux mixture application decreased the PDI and increased aerial dry biomas as well as fresh rhizome yield compared to other fungicides.

Cumin : Epidemiological studies of *Altenaria* blight of cumin was conducted at Jagudan (Gujarat) to identify the epidemiological parameters related to disease development. The study revealed that the dates of sowing significantly influenced the blight incidence and yield. The study confirmed that sowing at 15th October was most appropriate and gave less disease incidence (1.82%) as well as higher yield (216.5 kg/ha). Guj.cumin 3 was the only variety found resistant against *Fusarium* in the screening under wilt sick plot at Jagudan.

In the integrated management of disease of cumin at Jobner, minimum incidence of wilt (32.67%) with maximum grain yield was obtained where *T.harzianum* was applied through seed treatments + soil application along spraying with mancozeb (Indofil-45) 0.3%.

Coriander : Seed treatment with *Trichoderma viride* at 4 kg/ha of seed has been recommended for the management of coriander wilt at Coimbatore.

Fenugreek : Seed treatment with *Trichoderama viride* at 4 g/kg of seed, followed by soil application of neem cake 150 kg/ha is recommended for the control of root rot disease at Coimbatore. Kasuri Methi was found resistant to powdery mildew disease in the screening at Jagudan.

Planting material production and distribution

All the Coordinating centres took active participation in planting material production programme and produced 1,53,137 rooted cuttings of black pepper, 2150 kg ginger, 10100 kg turmeric and 814 grafts of cinnamon, 116 kg coriander, 10 kg fenugreek and 101 seedlings of nutmeg.

TECHNICAL PROGRAMMES

Project code	Title	Center
BLACK PEPPER		
PEP/CI/1	**Genetic resources**	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Panniyur, Sirsi, Chintapalli Yercaud, Dapoli and Pundibari
PEP/CI/2	**Hybridization trial**	
PEP/CI/2.1	Inter varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/3	**Coordinated varietal trial (CVT)**	
PEP/CI/3.1	CVT 1987 – Series III	Panniyur and Sirsi
PEP/CI/3.2	CVT 1991-Series IV	Panniyur, Chintapalli, Ambalavayal, Yercaud and Pampadumpara
PEP/CM/1	**Irrigation trial**	
PEP/CM/1.1	Irrigation –cum-fertilizer requirements of black pepper and arecanut in a mixed cropping system	Sirsi
PEP/CM/1.2	Trial on drip irrigation in black pepper	Panniyur
PEP/CP/1	**Disease management trial**	
PEP/CP/1.1	*Phytophthora* foot rot disease management in black pepper	Sirsi
PEP/CP/1.2	Biological control of *Phytophthora* foot rot of black pepper – nursery trial	Chintapalli
PEP/CP/1.3	Studies on the control of nursery disease of black pepper including biocontrol	Panniyur
PEP/CP/1.4	Control of *Phytophthora* disease of black pepper in farmers' field – observation trial	Panniyur
PEP/CP/1.5	*Phytophthora* foot rot incidence in black pepper under different density in an arecanut garden	Sirsi
PEP/CP/1.6	Survey for occurrence of disease in black pepper	Pampadumpara and Dapoli

Project code	Title	Center
PEP/CP/2	**Pest management trial**	
PEP/CP/2.1	Control of scale insects in black pepper	Pampadumpara
PEP/CP/2.2	Survey for the incidence of insect pests in black pepper at high altitudes	Pampadumpara
CARDAMOM		
CAR/CI/1	**Genetic resources**	
CAR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Mudigere and Pampadumpara
CAR/CI/2	**Hybridization and selection**	
CAR/CI/2.1	Evaluation of synthetics and OP progenies	Mudigere
CAR/CI/3	**Coordinated varietal trial (CVT)**	
CAR/CI/3.1	CVT 1998-Series II	Pampadumpara
CAR/CI/3.2	CVT 1991/1998 -Series III with Malabar Type	Mudigere and Sakleshpur,
CAR/CI/3.3	CVT 1991/1998 -Series III with Mysore Type	Mudigere, Sakleshpur and Myladumpara
CAR/CI/4	**Varietal / evaluation trial**	
CAR/CI/4.1	Yield evaluation of open pollinated seedling progenies	Mudigere
CAR/CM/1	**Nutrient management trial**	
CAR/CM/1.1	Effect of fertilizer on the yield of cardamom under natural shade	Mudigere
CAR/CM/1.2	Influence of micronutrients on the yield of cardamom	Pampadumpara and Mudigere
CAR/CM/1.3	Trial on integrated nutrient management of organic and inorganic manures	Mudigere and Pampadumpara
CAR/CP/1	**Disease management trial**	
CAR/CP/1.1	Chemical control of cardamom nursery leaf spot	Mudigere
CAR/CP/1.2	Biological control of clump rot in cardamom nursery	Mudigere

Project code	Title	Center
GINGER		
GIN/CI/1	**Genetic resources**	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Solan, Pottangi, Pundibari, Kumarganj, Dholi and Raigarh
GIN/CI/2	**Coordinated varietal trail (CVT)**	
GIN/CI/2.1	CVT 1996 – Series IV	Pottangi, Chintapalli, Solan and Pundibari
GIN/CI/3	**Varietal / Evaluation trial**	
GIN/CI/3.1	Comparative yield trial (CYT I & II)	Pottangi, Solan and Raigarh
GIN/CI/3.2	Initial Evaluation Trial	Solan and Pottangi
GIN/CI/4	**Quality evaluation trial**	
GIN/CI/4.1	Evaluation of germplasm for quality	Solan
GIN/CP/1	**Disease management trial**	
GIN/CP/1.1	Integrated management of rhizome rot of ginger	Solan, Dholi and Pundibari
GIN/CP/1.3	Effect of seed treatment of soft rot disease of ginger	Dholi
TURMERIC		
TUR/CI/1	**Genetic resources**	
TUR/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Solan, Pottangi, Pundibari, Jagtial, Dholi, Kumarganj, Raigarh and Coimbatore
TUR/CI/2	**Coordinated varietal trial (CVT)**	
TUR/CI/2.1	CVT 1996 – Series IV	Pottangi, Dholi, Pundibari, Chintapalli, Jagtial and Raigarh
TUR/CI/3	**Varietal / evaluation trial**	
TUR/CI/3.1	Comparative yield trial (CYT I & II)	Pottangi, Dholi and Jagtial and Raigarh
TUR/CI/3.2	Initial Evaluation Trial	Pottangi and Dholi
TUR/CI/4	**Quality evaluation trial**	
TUR/CI/4.1	Quality evaluation of Germplasm / varieties	Solan and Coimbatore

Project code	Title	Center
TUR/CI/4.2	Impact of environment on quality of turmeric	Solan, Pottangi and Coimbatore
TUR/CP/1	**Disease management trial**	
TUR/CP/1.1	Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases	Dholi, Jagtial and Coimbatore
TUR/CP/1.2	Chemical control of *Taphrina* leaf blotch disease of turmeric	Pundibari and Dholi
TUR/CP/1.3	*Effect of seed treatment on leaf spot disease*	*Dholi*
TUR/CP/1.4	Investigations of the causal organism of rhizome rot of turmeric and screening of biocontrol agents for the management	Jagtial
TREE SPICES		
TSP/CI/1	**Genetic resources**	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Yercaud, Pechiparai and Dapoli
TSP/CI/2	**Coordinated varietal trial**	
TSP/CI/2.1	CVT 1992 in clove	Yercaud, Pechiparai and Dapoli
TSP/CI/2.2	CVT 1992 in cinnamon	Yercaud and Ambalavayal
TSP/CM/1	**Propagation / multiplication trial**	
TSP/CM/1.1	Vegetative propagation in nutmeg clove and cinnamon	Yercaud, Dapoli and Pechiparai
TSP/CM/2	**Irrigation trial**	
TSP/CM/2.1	Drip irrigation studies in clove and nutmeg	Yercaud
TSP/CM/3	**Nutrient management trial**	
TSP/CM/3.1	Biofertilizer trial in tree spices	Yercaud
CORIANDER		
COR/CI/1	**Genetic resources**	
COR/CI/1.1	Germplasm collection, description, characterization,evaluation, conservation and screening against diseases	Jobner, Jagudan, Guntur, Kumarganj, Coimbatore, Hisar, Dholi and Raigarh

Project code	Title	Center
COR/CI/2	**Coordinated varietal trial (CVT)**	
COR/CI/2.1	CVT 1993 – Series II	Dholi, Raigarh, Coimbatore and Kumarganj
COR/CI/2.2	CVT 1996 – Series III	Jobner, Coimbatore, Hisar, Dholi and Kumarganj
COR/CI/2.3	CVT 1998 – Series IV	Jobner, Jagudan, Guntur and Dholi
COR/CI/3	**Varietal / evaluation trial**	
COR/CI/3.1	Comparative yield trial	Dholi and Coimbatore
COR/CI/3.2	Initial Evaluation Trial	Raigarh, Jagudan, Jobner, Guntur , Dholi and Hisar
COR/CI/4	**Quality evaluation trial**	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/1	**Nutrient management trial**	
COR/CM/1.2	Response of coriander to micronutrients	Jobner
COR/CP/1	**Disease management trial**	
COR/CP/1.1	Survey to identify the disease incidence, collection and identification of causal organism	Dholi
COR/CP/1.2	Studies on wilt and powdery mildew management in coriander. Biocontrol of wilt in coriander	Coimbatore
COR/CP/1.3	Studies on stemgall disease management of coriander by different fungicides	Dholi
CUMIN		
CUM/CI/1	**Genetic resources**	
CUM/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Jobner and Jagudan
CUM/CI/2	**Hybridization trial**	
CUM/CI/2.1	Mutation studies and hybridization programme in cumin	Jagudan
CUM/CI/3	**Coordinated varietal trial**	
CUM/CI/3.1	CVT 1994 – Series II	Jobner and Jagudan
CUM/CI/3.2	CVT 1999-Series III	Jagudan

Project code	Title	Center
FGK/CI/2	**Hybridization trial**	
FGK/CI/2.1	Evolving varieties resistant to powdery mildew through mutation breeding and crossing programme	Jagudan
FGK/CI/3	**Coordinated varietal trial (CVT)**	
FGK/CI/3.1	CVT 1995 – Series III	Coimbatore , Jobner, Guntur, Hisar, Jagudan, Dholi and Kumarganj
FGK/CI/3.2	CVT 1999 – Series IV	Jobner, Kumarganj and Dholi
FGK/CI/4	**Varietal evaluation trial**	
FGK/CI/4.1	Comparative yield trial	Coimbatore and Dholi
FGK/CI/4.2	Initial Evalaution Trial	Jobner and Hisar
FGK/CM/1	**Spacing / sowing trial**	
FGK/CM/1.1	Effect of time of sowing and spacing	Coimbatore
FGK/CM/2	**Nutrient Management trial**	
FGK/CM/2.1	Response of fenugreek varieties to row spacing and date of sowing	Jobner
FGK/CP/1	**Disease management trial**	
FGK/CP/1.1	Biocontrol of root rot in fenugreek	Coimbatore

ACRONYMS

PEP	:	Black pepper	CUM	:	Cumin
CAR	:	Cardamom	FNL	:	Fennel
GIN	:	Ginger	FGK	:	Fenugreek
TUR	:	Turmeric	CI	:	Crop Improvement
TSP	:	Tree Spices	CM	:	Crop Management
COR	:	Coriander	CP	:	Crop Protection

PROGRESS OF WORK AND ACHIEVEMENTS

BLACK PEPPER

PEP/CI/1 Genetic Resources

PEP/CI/1.1 Germplasm collection, characterization, evaluation and conservation

Panniyur, Sirsi, Chintapalli, Yercaud, Dapoli & Pundibari

Panniyur centre maintains 105 accessions of black pepper in field genebank. Among these, 52 accessions flowered in the current year. The general performance of all the accessions in the germplasm was poor when compared to that of last year. The best yielder was Karimunda-III (PRS-22) with a mean green berry yield of 3.92 kg/vine, followed by Valli (2.28 kg) and Kalluvally-IV (2.10 kg). The highest spike length was recorded in Valli followed by TMB-IV (PRS-54) with a mean length of 11.89 cm and 11.40 cm respectively. The highest mean number of spikes produced was in Karimunda-III (1511) followed by Valli and Kalluvally-IV (1372 and 1026/vine respectively).

At Sirsi centre 75 cultivated and 21 wild accessions were collected and maintained. Twentythree germplasm collections were evaluated during 1999-2000. Culture 239 (Panniyur-5) has given the highest yield of 1.95 kg per vine followed by Kuthiravally (1.76 kg) and Panniyur-1 (1.76 kg)

At Yercaud, 106 accessions are being maintained. During the current year (10th year of planting) fruit set was observed only in 20 accessions due to the absence of showers. The yield and yield attributing characters were recorded. Among the 20 accessions PN-2 has recorded the highest green berry yield of 8.25 kg/vine followed by PN-59 (7.5 kg/vine).

At Chintapalli four new wild accessions were collected. This centre maintains 51 accessions, which includes 26 cultivated and 25 wild collections. Among cultivated varieties, Panniyur-1 recorded highest yield of fresh and dry berries/vine (6 kg and 1.76 kg) during 1999-2000. The highest number of spikes per vine was in Panniyur-1 (1200 spikes). Dry berries per vine was more in collection Maredumalli followed by Chapagedda (0.41kg dry berrie/vine).

At Dapoli the germplasm collections consisted of 11 entries and is under evaluation. Seven different black pepper germplasm collections are being maintained at Pundibari.

PEP/CI/2 Hybridization Trial

PEP/CI/2.1 Inter-varietal hybridization to evolve high yielding varieties

Panniyur

Trials for evolving varieties having superior yield and quality through inter-varietal hybridization and selection is in progress at Panniyur. All the lines in the OP and hybrid progenies showed poor performance during the year 1999-2000, and yield record was very low. The highest green yield recorded was 710 g (OP of Panniyur–3) followed by 640 g in Cheriyakaniyakadan.

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.1 CVT-1987-Series – III

Panniyur and Sirsi

The trial was laid out at Panniyur and

Sirsi to compare the performance of promising cultures and released varieties.

At Panniyur the varietal evaluation trial was conducted from 1990-1999 with 10 genotypes (eight cultivars/varieties and 2 (Checks). The experiment was laid out in RBD with four replications and with six vines/treatments. The vines started flowering during 1992-93. First harvesting was done during 1993 and observations were taken for eight years. During 1999-2000 Panniyur-1 gave the highest mean green berry yield of 4.51 kg/vine followed by Karimunda and Cul.5128 with a green berry yield of 3.82 and 3.55 kg/vine respectively.

Pooled analysis showed that there was no interaction of variety with years. So in this case over-all pooled analysis is not effective. The yearwise data is presented in table 1. Significant difference among varieties is observed only year-wise.

Table 1: Yield performance of 10 black pepper genotypes under CVT at Panniyur (MLT 1987 Series III) (Mean yield over seven years 1993-94 to 99-2000)

Genotype type	'93-94	'94-95	95-96	96-97	97-98	98-99	99-'00	Total	Mean
Panniyur 2	0.32	0.27	1.57	1.65	1.87	3.61	2.95	12.24	1.75
Panniyur 5	0.71	0.54	1.81	0.95	1.42	2.73	1.77	9.93	1.42
Panniyur 3	0.36	0.44	1.40	1.38	1.74	3.02	2.50	10.84	0.73
Cul. 1558	0.36	0.36	1.47	2.23	1.99	2.60	1.86	10.87	1.55
Cul. 5128	0.22	0.13	2.15	2.24	1.92	2.91	3.55	13.12	1.87
Sreekara	0.97	0.47	1.33	0.44	0.87	0.78	1.70	6.56	0.94
Subhakara	0.32	0.28	0.66	0.75	1.58	1.11	0.93	5.63	0.80
KS 88	0.24	0.43	1.09	1.61	1.40	0.45	2.80	8.02	1.15
Panniyur 1	0.78	0.31	1.37	1.76	1.32	4.98	4.51	15.03	2.15
Karimunda	0.68	0.67	2.37	1.88	4.69	2.26	3.82	16.37	2.34
CD	NS	0.12	NS	NS	0.29	2.70	2.27		

Among the cultivars being evaluated under CVT at Sirsi, cul. 239 has given significantly higher fresh berry weight of 1.92 kg followed by cul. 331 and cul. 141 (1.51 kg each)

PEP/CI/3.2 CVT-1991-Series IV

Panniyur, Chintapalli, Ambalavayal, Yercaud and Pampadumpara

The trial was laid out with nine released varieties [Sreekara, Subhakara, Panchami, Pournami, Panniyur-1, 2, 3, 4 and 5, four promising cultures (Kottanadan (Acc. 2426 and 2445), cul. 1558 (OP Kalluvally) and cul. 5128 (OP Cheriyakaniyakadan) and a check (Karimunda)] with the objective of testing the performance of promising cultures vis-a-vis released varieties and local check.

At Ambalavayal, the trial was started in 1992. During the 1999-2000 Panniyur-4 gave the highest wet weight of berries/vine (0.81kg/vine) followed by Panchami (0.68 kg/vine). The highest dry weight of berries/vine was in Panchami (0.27 kg/vine) and Panniyur-4 (0.22 kg/vine). Longest spike was in Panniyur-5 (9.72 cm) and Panniyur-4 (9.06 cm). Panniyur-4 had the highest number of spike/vine (177.55) and number of berries/spikes.

At Yercaud, the trial was initiated in 1992 with 5 entries along with local check. Flowering and fruit set were observed from 96-97 onwards. Among the accessions, Panniyur-3 consistently performed well with the mean yield of 0.95, 0.98, 1.50 kg/vine green berries during the year 1996-97, 97-98 and 1998-99 respectively. Panniyur-3 has long spikes and higher spike intensity, whereas Panniyur-1 has more number of berries per spike and higher green berry weight.

At Panniyur, among the 13 promising cultures planted in 1993, Panniyur-5 gave the highest green berry yield of 2.79 kg/vine followed by Cul.1558 (OP of Kalluvally) and Panniyur-2 with mean green berry yield of 2.33 kg/vine and 1.81 kg/vine respectively (Table 2).

At Chintapalli the trial was laid out in 1996-97. The Acc.2445 and culture 5128 could not be established in the field. Panniyur-1, 2, 3, 4, 5 and Panchami were affected by stunted disease. Maximum plant height was recorded with Malligesara followed by Panniyur. The variety Sreekara recorded highest yield (1.03 kg dry berry/vine) and more number of spikes/vine (745) with high dry recovery (35%). Spike length and number of berries per spike were more in Panniyur-1.

The trial was laid out at Pampadumpara in 1992. Out of fourteen varieties being evaluated, Kottanadan (Acc.2445), gave the highest fresh as well as dry yield (1.2 kg fresh/379.2 g dry weight), followed by Cv.239 (OP.Perumkodi) that produced 1.02 kg and 352.5 g of wet and dry yield respectively. The

Table 2: Performance of black pepper in the CVT –1991 at Panniyur (1999-2000)

SL.No	Cul./Variety	No. of spikes/vine	Green berry yield/vine (Kg)
1	Kottanadan (Acc.2426)	300.00	1.17
2	Kottanadan (Acc.2425)	305.68	0.91
3	Culture 1558	496.20	2.33
4	Culture 5128	260.67	1.35
5	Sreekara	288.12	0.78
6	Subhakara	226.93	0.65
7	Panchami	364.13	1.50
8	Pournami	174.43	0.46
9	Panniyur 1	317.50	1.46
10	Panniyur 2	289..47	1.81
11	Panniyur 3	314.03	1.40
12	Panniyur 4	350.50	1.78
13	Panniyur 5	622.48	2.79
14	*Karimunda* (check)	229.58	0.73
	CD (0.05)		0.85

number of spikes recorded was also highest in Kottanadan (285.3). The length of spikes is more in Panniyur-3 (12.5 cm), and highest volatile oil content of 5.06% was noted in cul.5128.

PEP/CM/1 Irrigation Trial

PEP/CM/1.1 Irrigation-cum-fertilizer requirement for arecanut and pepper mixed cropping system

Sirsi

At the Sirsi centre this trial was laid out in 1992-93 with the variety Panniyur-1. The trial consists of three irrigation levels and four fertilizer levels, to study their effect on pepper and arecanut in a mixed cropping system that receives the recommended dose of fertilizer at 100:40:140 g NPK/palm/year. There was significant difference in yield of black pepper due to the effect of irrigation, manure and its interaction. Highest yield was recorded in irrigation treatment I-3 (1.07 kg/vine) and the fertilizer treatment M-3 (1.04 kg/vine) (table 3). There was also significant effect due to interaction of irrigation X fertilizer treatment I 3 x M 3 (1.39 kg/vine).

PEP/CM/1.2 Trial on drip irrigation in Black pepper

Panniyur

In order to find out the efficacy of drip irrigation on black pepper varieties, this trial was laid out during 1996 in a factorial RBD with three levels of irrigation and three varieties. The period of irrigation was from January to April. The results (1999-2000) presented in table 4 did not show any significant difference with respect to the number of spikes produced per vine and green spikes yield per vine.

Table 3: Effect of different levels of irrigation and fertilizer on the yield of black pepper at Sirsi

			Fresh berry yield (kg/vine)		
I/M levels	M-0	M-1	M-2	M-3	Mean
I-1	0.72	0.78	0.80	0.86	0.79
I-2	0.75	0.80	0.83	0.88	0.81
I-3	0.81	0.93	1.17	1.39	1.07
Mean	0.76	0.84	0.93	1.04	

	Irrigation (I)	Manure (M)	Interaction (IxM)
S.Em±	0.004	0.02	0.04
CD at 5%	0.06	0.07	0.12

I-1 = IW/CPE = 1.00, 30 mm water, (30 l /plam/vine/day)

I-2 = IW/CPE = 0.66, 20 mm water, (20 l /plam/vine/day)

I-3 = IW/CPE = 0.33, 10 mm water, (10 l /plam/vine/day)

M0 = Control; M1 = 50:20:70 NPK g/vine

M2 = 100:40:140 NPK g/vine;

M1 = 150:60:210 NPK g/vine

Table 4:Effect of different levels of irrigation on pepper varieties (Panniyur 1,3 & 5)

Sl.No	Treatment	Number of spike	Spike yield (g/vine)
1	I_0V_1	116.67	1336.67
2	I_0V_2	333.67	2092.00
3	I_0V_3	119.67	993.67
4	I_1V_1	264.00	2043.00
5	I_1V_2	240.00	1592.00
6	I_1V_3	130.67	838.33
7	I_2V_1	100.33	954.00
8	I_2V_2	115.33	826.67
9	I_2V_3	145.00	1073.33
	CD (0.05)	NS	NS

The interaction effect between different levels of irrigation and varieties was also non-significant.

PEP/CP/1 Disease Management Trial

PEP/CP/1.1 *Phytophthora* foot rot disease management in black pepper

Sirsi

This experiment was conducted in six locations in farmers' field around Sirsi for the management of *Phytophthora* foot rot disease. Black pepper vines were grown as inter crop in arecanut garden. There were five treatments (Table 5). Treatments were imposed twice during the season *i.e.*, once before the onset of monsoon (June) and second round at 35-45 days after first round spray (August). The results over the years are presented in table 5. *Phytophthora* foot rot disease incidence was least (11.67 per cent) in vines treated with Potassium phosphonate 0.3 per cent as spray (@ 3 l/vine) and drench (@ 5 l/vine) twice during the season. Death of vines were more in untreated check (41.67 per cent). This was followed by vines sprayed with 0.3% Potassium phosphonate 3 L/vine twice in the season and application of *Trichoderma viride @ 50* g/vine along with 5 kg of FYM to basins of vines (17.8 per cent.) (table 5).

PEP/CP/1.2 Biological control of *Phytophthora* foot rot of black pepper – Nursery trial

Chintapalli

Not reported

PEP/CP/1.3 Studies on the control of nursery disease of black pepper including biocontrol

Panniyur

One of the main constraints in the production of rooted pepper cuttings is the rotting of cuttings in the nursery caused by fungi such as *Pythium* sp, *Rhizoctonia solani* and *Sclerotium rolfsii*. For management of these an experiment was laid out in RBD having three replications and 500 numbers of cuttings

Table 5: *Phytophthora* foot rot disease management in black pepper at Sirsi (pooled data from 1996-97 to 1999-2000

Sl No	Treatments	Percentage disease incidence				Mean Cost benefit ratio
		96-97	97-98	98-99	99-2000	
1	Control	33.8	17.77	34.44	41.67	31.92
2	Bordeaux mixture (@ 1%) spraying and Copper oxychloride (@ 0.3% drenching twice)	8.88	6.11	7.22	19.45	10.421:6:65
3	Potassium Phosphonate (@ 0.3%) spraying and drenching twice	6.66	4.44	6.67	11.67	7.361:8:60
4	Bioagent (*Trichoderma viride)* @ 50 g/vine to the basin of the vine along with 5kg of FYM/vine	20.55	7.20	10.56	20.56	14.721:6:70
5	Potassium phosphonate (0.3%) spray twice and bioagent (*Trichoderma viride)* @ 50 g/vine to the basin of the vine along with 5 kg of FYM	17.77	5.00	8.89	17.78	12.361:4:70
	S Em	0 86	1.28	1.19	1.73	1.27
	CD at 5%	2.52	3.76	3.50	5.10	3.72

for each treatment for three consecutive years. The cuttings were planted in polythene bags kept in nursery and usual nursery management practices were given apart from the treatments. Treatment with 1% Bordeaux mixture spraying and drenching was applied at fortnightly intervals from the emergence of the first leaf onwards. Two sets of treatments, 100 days and 75 days, were maintained at the nursery and observations on the rotting of cuttings due to disease was measured by counting the numbers of rotted cuttings in each treatment.

The pooled analysis of three years data is presented in table 6. The treatments did not show significant difference over control during the years for the 1st set (100 days after treatment). But there is significant difference among treatment in 2nd set (75 days). All the treatments are superior to control. Lowest disease incidence was noticed in the treatment receiving dipping in *Trichoderma harzianum* followed by treatments receiving 1 % Bordeaux mixture spraying and drenching.

Table 6: Nursery disease management of black pepper cuttings at Panniyur (pooled data from1997-2000)

Treatments	Percentage of rotted cuttings	
	1st set (100 days after treatment)	2nd set (75 days after treatment)
1% Bordeaux Mixture spraying and drenching	10.85 (25.84)	5.15 (12.15)
Dipping in *T.harzianum*	8.91 (15.94)	3.48 (8.80)
Dipping in *T.viride*	20.95 (26.56)	8.03 (16.17)
Soil solarisation of potting mixture	18.30 (25.10)	8.43 (16.17)
Control	30.20 (33.21)	14.93 (21.84)
CD (0.05)	NS	2.70

Values in parenthesis are transformed ones

PEP/CP/1.4 Control of *Phytophthora* disease of black pepper in farmers' fields – observational trial

Panniyur

In order to develop effective and economic management practices to control *Phytophthora* disease, an experiment was conducted at Panniyur to test an integrated method of using fungicides along with biocontrol agent. The trial was laid out during 1997 and continued up to 2000 in two locations viz., Pepper Research Station, Panniyur and at Kunnoth Estate, Payam. The treatments were imposed during pre-monsoon and post-monsoon periods (Table 8). Observations on the incidence of disease were taken as leaf infection and branch infection and the death of vines due to wilt. The pooled data of three years with respect to leaf infection, branch infection and death of vine due to wilt in the two locations were presented in table 7.

Table 7: Observational trial for control of *Phytophthora* foot rot disease of black pepper at two locations (Pooled data for three years from 1997 to 2000)

Treatments	Location – Panniyur		
	Percentage of disease incidence		
	Leaf infection	Branch infection	Wilting
T1–Akomin3 ml/1 spraying & drenching	1.37 (5.74)	0.33 (3.14)	0.58 (4.09)
T2-T1 + biocontrol agent	2.70 (8.13)	0.50 (4.05)	0.33 (3.14)
T3-Biocontrol agent (750g/vine)	1.20 (5.74)	1.16 (5.74)	0.29 (2.56)
T4-1% BM spraying and drenching with 0.2% COC	2.54 (8.13)	1.00 (5.74)	0.61 (1.81)
T5-Control	3.41 (9.98)	3.50 (9.98)	1.0 (5.74)
CD (0.05)	0.42	NS	0.24

Values in parenthesis are transformed ones

Treatments	Location – Payam		
	Percentage of disease incidence		
	Leaf infection	Branch infection	Wilting
T1	7.87 (5.34)	0.00 (0.57)	0.16 (1.81)
T2	6.08 (14.1)	0.08 (0.57)	0.18 (1.81)
T3	6.41 (14.1)	0.37 (5.74)	0.29 (2.56)
T4	8.20 (4.13)	0.41 (4.13)	0.16 (1.81)
T5	7.51 (5.34)	1.08 (5.74)	0.66 (4.75)
CD (0.05)	NS	0.05	NS

Values in the parenthesis are transformed values

At Panniyur in respect of leaf infection there was significant difference in the treatment receiving biocontrol agent. *Trichoderma harzianum* was found to be superior to all other treatments. But death of vine showed significant difference among the treatments. Treatments receiving 1% Bordeaux mixture spray and drenching with 2% copper oxychloride was found to be superior.

At Payam with respect to leaf infection and death of vines no significant differences could be found over the years. In the case of branch infection, there is significant difference among treatments. Akomin (3ml/l) spraying and drenching was found to be superior followed by Akomin Spraying and drenching + bio-control agent. Taking the incidence of leaf infection, in both the locations, the least incidence was noticed in treatment receiving biocontrol agent. In the case of branch infection similar trend is noticed at both locations. Least incidence was noticed in treatment receiving Akomin 3ml./l spraying and drenching followed by Akomin 3ml./l spraying and drenching + biocontrol agent. In the case of wilting, similar trend is seen at both locations, least incidence of disease was in treatment receiving 1% Bordeaux mixture spraying and drenching.

In the present study, the most effective treatment is akomin (Potassium phosphonate) spraying and drenching followed by application of biocontrol agents in respect of leaf infection and branch infection. But in the case of death of vines due to wilt 1% Bordeaux mixture spraying and drenching with 0.2% copper oxychloride is found to be effective.

PEP/CP/1.5 *Phytophthora* foot rot incidence in black pepper under different plant density in an arecanut garden

Sirsi

Sirsi centre laid out an experiment involving different densities of black pepper in an arecanut garden (25,50,75 and 100 per cent of black pepper population) during 1996-97. *Phytophthora* incidence was not observed in any of the treatments. Experiment is in progress.

PEP/CP/1.6 Survey for the occurrence of disease in black pepper

Pampadumpara and Dapoli

Five *Panchayaths* were surveyed by the Pampadumpara centre for the incidence of anthracnose on the leaves, and the incidence was highest in Pallivasal (20%). Since spike

initiation is in the early stage, infection could not be seen on the spikes in most of the gardens. However, the incidence of foot rot is severe in the Panchayaths surveyed, the highest being in Karunapuram (54.7%).

Survey was undertaken by Dapoli centre in 26 farmers field in Shrivardhan, Divenagar, Alibag, Chaul and Revdnda areas of Raigad districts. The *Phytophthora* foot rot and leaf blight was severe and the occurrence of anthracnose was moderate.

PEP/CP/2 Pest Management Trial

PEP/CP/2.1 Control of scale insects in Black Pepper

Pampadumpara

An experiment with four treatments *viz.*, Phosphomidon (0.05%), Dimethoate (0.05%), Monocrotophos (0.05%) and Nimbicidene (0.5%) was started during January 2000. The first treatment led to significant suppression of mussel scale insects, while there was significant increase in the scale insect population after the second spray of Nimbicidene. However, other treatments suppressed the scale insect population even after the second spray.

PEP/CP/2.2 Survey for the incidence of insect pests in black pepper at high altitudes

Pampadumpara

This study was initiated at Pampadumpara in 1996. During the year 20 *Panchayaths* in four Taluks have been surveyed for the occurrence of insect pests in black pepper. The results presented in Table 5 revealed that the most predominent insect pest was the marginal gall thrips, *Liothrips karnyi,* observed in 21.7% of the leaves and reported from all the gardens surveyed. Three species of scale insects viz., mussel scale (*Lepidosaphes piperis),* soft scale (*Marisipococcus marsupiale)* and coconut scale, *Aspidiouts destructor* have been observed in twelve panchayats (3.5%). Scale insects were mostly recorded from Karimkunnam at Thodupuzha (49.3%) and their occurrence at high ranges was very meagre. A serpentine leaf miner, a leaf gall midge and a bag worm have been observed in 1.0%, 0.1% and 0.2% of the leaves respectively. Among the twenty *Panchayts* surveyed, pollu beetle, *Longitarsus nigripennis* was recorded only in the plains of Thodupuzha (4.0%) and was observed in only one garden at high ranges (Vazhathopu 0.8%). An aphid and a looper were registered from Mariyapuram and Vellathoval *Panchayats* respectively.

CARDAMOM

CAR/CI/1 Genetic Resources

CAR/CI/1.1 Germplasm collection, characterization, evaluation and conservation

Mudigere and Pampadumpara

The Mudigere centre maintains 245 accessions of cardamom. Eighteen promising germplasm accessions shortlisted were evaluated for yield and yield attributes. Clones EB-1277-7, CL-692, CL-682, CL-681, CL-730 and P-20 recorded higher values for most of the characters studied. The clones CL-681, CL-730, CL-692 and EB-1277-7 were found promising and were significantly superior to Mudigere-1 and Mudigere-2.

Pampadumpara centre has a germplasm holding of 78 cultivated types of cardamom. All the germplasm lines were replanted in Ettukettu area during August 1999. During 1999-2000 seven new cardamom lines were added. These accessions were maintained and evaluated. The biometrical traits of the top ranking ten accessions are provided in table 8.

Table 8: Biometrical traits of promising cardamom entries at Pampadumpara (1999- 2000)

Sl. No	Accession	Plant height (cm)	No.of tillers (cm)	Panicle length	Panicle No.	Seeds/ capsule	Wet weight (g)	Dry weight (g)
1	PV-4	3.69	49.33	74.54	61.83	15.53	1787.33	374.06
2	MBP	3.6	68.83	71.27	80.73	20.53	2141.00	437.33
3	Clone 57	3.46	40.50	75.47	50.16	31.16	1003.60	169.66
4	S-1	3.57	41.66	68.36	78.83	17.83	3376.66	647.33
5	PS-5	3.63	41.50	101.50	52.17	20.50	1878.66	400.00
6	PS-27	3.12	43.16	59.37	71.83	18.67	1850.33	390.00
7	PS-29	3.06	48.83	49.72	50.00	18.23	2375.66	426.00
8	PS-24	3.07	43.66	47.71	62.66	16.56	1613.00	303.33
9	PS-31	3.15	54.16	52.59	49.83	14.26	1067.00	216.66
10	MCC-40	2.88	42.16	39.50	59.00	15.10	1771.33	393.33

Out of the ten high yielding accessions, S-1 recorded highest yield (3376.7 gm fresh and 647.33 g dry) of capsules. The highest panicle length of 101.5 cm was observed in PS-5. MBP recorded more seeds per capsules then others followed by Acc. S-1.

CAR/CI/2 Hybridization and selection

CAR/CI/2.1 Evaluation of synthetics and OP progenies

Mudigere

Earlier studies carried out at Mudigere revealed that improvement in yield of cardamom could be achieved by utilizing the promising clones in a polycross and selecting the progeny with better performance by conducting polycross progeny test. Seeds from 61 different cross combinations were sown during 1998 and the same was transferred to secondary nursery during 1998. Seeds of 33 different cross combinations were sown in raised nursery bed during November 1999 and 95% of germination was observed.

CAR/CI/3 Coordinated Varietal Trial (CVT)

CAR/CI/3.1 CVT 1998 Series II

Pampadumpara

The trial was relaid out during 1999 at Pampadumpara with 10 accessions *viz.*, CI-679, Sel.800, M-1, Sel-112, Sel-262, CI-726, CI-683 SKP-51, SKP-14 and PV-1 as per the decision of the XII AICRPS Workshop. During the year PV-1 recorded the highest yield of capsules (1055 g fresh wt.) followed by M-1 (1030.6 g fresh wt.). However, the dry yield of capsules was highest in M-1 (189.6 gm) closely followed by PV-1 (164.2 g). Seeds per capsule was more in cul-679 and Sel.262 (18.3), where as 100 capsule weight was more (70 g) in Sel. 262. M-1 and Sel-800 were found to be relatively tolerant to thrips where as SKP-51 was tolerant to borer infestation. Number of tillers per plant was maximum in PV-1 and minimum in Sel-112. Number of panicles per plant was highest in SKP-51.

CAR/CI/3.2 CVT 1991/1998-Series III with Malabar Type

Mudigere and Sakelshpur

As per the decisions of the XIV AICRPS Workshop (1997) this trial has been re-laid out in 1998 at Mudigere and Sakleshpur and the crop growth is satisfactory. At Sakleshpur, in the CVT-1993 (Series III in the Malabar Type) with 13 accessions morphological and yield data were recorded for the year 1999-2000. The morphological characters did not show significant difference among the treatments except for number of bearing tillers. However, the number of tillers were more in MUD-1 (21.1) followed by CL-679 (20.9). Panicles were more in CL-679 (9.8) followed by CCS-800 and CL-726 (9.4). Flower clusters (cincinni) /panicles were more in T4 & T9 (PV-1, MCC-34,12.2). Non significant differences has been noticed among the treatments for yield, however highest yield of 56.4 kg/ha have been observed in T10 (SKP-14) followed by T4(PV-1). The percentage of bold capsule (67.6%) retained in 8 mm sieve was more in T6 (CL-683). The experiment is in progress. The yield in general was very poor during the current year.

CAR/CI/3.3 CVT-1991/1998 Series III with Mysore Type

Mudigere, Sakleshpur and Myladumpara

The trial was relaid out (XV AICRPS Workshop decision) at all the centres. At Mudigere, the trial was relaid out with five entries viz. MCC-12, MCC-21, MCC-61, MCC-85 and SKP-51 along with local check in 1998. Now the crop growth is satisfactory.

At Sakleshpur, the trial was relaid out in 1996. Non significant differences have been noticed among the treatments for morphological and yield data. However, MCC-85 grew higher (261 cm), SKP-51 (18.6) produced more tillers, MCC-21 (15.2) produced more panicles and MCC-21 yielded higher (84.6 kg/ha). Bold capsules with 44.6% capsules retained in 8 mm sieve was more in MCC-61. The experiment is in progress at Sakleshpur.

CAR/CI/4 Varietal Evaluation Trial

CAR/CI/4.1 Yield evaluation of OP seedling progenies of promising cardamom selections.

Mudigere

The OP seedling progenies were evaluated at Mudigere in 1999. The clone D-237 followed by CL-692, CL-730, D-496, D-202 were found superior for most of the characters. Clone D-237, developed from the OP seedling progeny, recorded higher green capsule yield compared to Mudigere-1 and Mudigere-2.

CAR/CM/1 Nutrient Management Trial

CAR/CM/1.1 Effect of fertilizer on the yield of cardamom under natural shade

Mudigere

This trial was conducted for evaluating the response of cardamom to various levels of NPK and aimed at evaluating the optimum fertilizer level for high density. The experiment (comprising of six treatments of graded levels of NPK fertilizer levels) was conducted at RRS, Mudigere during 1992-1999. The variety chosen for the study was Mudigere-1, spaced at 1.8 x 0.9 m. In each treatment, fertilizers were applied in two split doses, first in May last week and second in September first week. The study confirmed that cardamom responded

positively to the fertilizer application and significantly influenced the yield when grown under natural shade. Increase in the dose of fertilizer resulted in increased capsule yield. The highest dose of 150:150:225 kg NPK/ha recorded highest green capsule yield (740 kg/ha). However, application of 75:75:150 kg NPK/ha recorded 656 kg/ha and found economical.

The pooled data over five years of study (Table 9) indicated that application of 38-38-75 kg/ha resulted in around 100 kg higher green capsule yield over control. Increase in NPK 75:75:150 kg/ha resulted in another 100 kg higher green capsule yield, but further increase in fertilizer levels failed to make consistent increase. But it was possible to enhance green capsule yield to a level of 644 kg by applying 150:150:225, that is almost 300 kg over the control.

The BCR worked out confirmed that application of 75:75:150 kg/ha is more cost effective (the recommended fertilizer application for the normal spacing 1.8 x 1.8 m) by achieving 200 kg more yield over absolute control and maximum BC ratio of 4.66 (Table 10) under high density population at 1.8 x 0.9 spacing.

Table 9: Effect of fertilizer levels of NPK on capsule yield of cardamom at Mudigere (pooled data from 1995-1999)

Treatment NPK (kg/ha)	Green capsule yield (kg/ha)					
	1995	1996	1997	1998	1999	Mean
0 – 0 – 0	410	204	163	464	455	339
38 – 38 – 75	530	355	181	572	533	434
75 – 75 – 150	620	493	284	684	656	547
100 – 100 – 175	684	496	295	742	732	590
125 – 125 – 200	706	571	302	734	679	598
150 – 150 – 225	854	559	280	786	740	644
S. Em. +	31.8	62.8	13.6	31.3	20.9	16.2
C.D (.05)	95.9	189.2	41.1	93.8	63.1	46.9
C.V (%)	10.0	28.2	10.9	9.4	6.5	13.7

Table 10: Effect of fertilizer levels of NPK on economics of cardamom at Mudigere

Treatment	Mean yield	Dry yield	Return (Rs.)	Marginal Returns	Marginal Cost	Benefit Cost Ratio
NPK (Kg/ha)						
0 – 0 – 0	339	67.8	20340			
38 –38- 75	434	86.8	26040	5700	1400	4.07
75-75-150	547	109.4	32820	12480	2680	4.66
100-100-175	590	118.0	35400	15060	3380	4.46
125-125-200	598	119.6	35880	15540	4100	3.79
150-150-225	644	128.8	38640	18300	4800	3.81

CAR/CM/1.2 Influence of micronutrients on yield of cardamom under natural shade

Mudigere & Pampadumpara

To study the influence of micronutrients (Boron, Zinc & Molybdenum) on yield of cardamom a trial was conducted at Mudigere and Pampadumpara. At Mudigere the trial was conducted during 1992-99 using Mudigere-1 suckers, comprising seven treatments of different micronutrients involving boron and molybdenum. The variety chosen for the study was Mudigere-1, spaced at 1.8 x 1.8 m following the normal package of practices. The effect of different micronutrients on green capsule yield is presented in table 11. Micronutrient application influenced the green capsule yield significantly during 1998 and 1999. Application of borax in the form of disodium tetra borate @ 20 kg/ha or molybdenum in the form of sodium molybdate @ 0.25 kg/ha, either independently or in combination resulted in significant green capsule yield over control. Where NPK alone applied, the initial three years yield remain statistically non significant, but registered thereafter higher yield over other treatments. The pooled data of five years were found significant and the trend remained same recording 20 percent higher yield over control.

The economic analysis of pooled data (Table 12) revealed that highest marginal returns were realized with application of borax and molybdenum(Rs.4980) followed by application of molybdenum alone or borax alone.

Table 11: Effect of different micronutrients on cardamom capsule yield at Mudigere (Mean of 1995 to 1999)

Treatments	Green capsule yield (kg/ha)					
	1995	1996	1997	1998	1999	Mean
NPK – P.P Dose	367	370	268	376	327	342
Borax – 10 kg/ha (Soil application)	385	450	287	390	366	378
Borax – 20 kg/ha (Soil application)	425	443	260	476	401	401
Borax-0.2% (Foliar spray)	392	416	258	445	347	372
Molybdenum – 0.25 kg/ha (Soil application)	365	463	295	474	424	404
Molybdenum – 0.50 kg/ha (Soil application)	347	404	277	447	370	369
Borax – 10 kg/ha + Molybdenum-0.25 kg/ha	455	498	264	465	443	425
S.Em. ±	26.2	33.0	16.2	20.8	7.0	10.7
C.D. (.05)	NS	NS	NS	64.1	21.1	29.7
C.V. (%)	13.4	10.6	11.9	16.6	3.6	12.5

Table 12: Effect of different micronutrients on cardamom economics at Mudigere

Treatments	Mean green capsule yield	Addnl. Yield over NPK	Correspon -ding dry yield	MR (Rs.)	MC (Rs.)	BCR
NPK (P.P)	342	—	—	—	—	—
Borax – 10 kg/ha (Soil application)	378	36	7.2	2160	1700	1.27
Borax – 20 kg/ha (Soil application)	401	59	11.8	3540	3200	1.10
Borax-0.2% (Foliar spray)	372	30	6.0	1800	600	3.00
Molybdenum–0.25 kg/ha (Soil application)	404	62	12.4	3720	612.50	6.07
Molybdenum–0.50 kg/ha (Soil application)	369	27	5.4	1620	1025	1.58
Borax – 10 kg/ha + Molybdenum-0.25 kg/ha	425	83	16.6	4980	2115	2.35

MR = Marginal Returns, MC = Marginal Cost, BCR = Benefit cost ratio. Cardamom @ Rs.300/kg

The trial had to be re-laidout at Pampadumpara in a new area having irrigation facility.

CAR/CM/1.3 Integrated nutrient management of organic and inorganic manures

Mudigere and Pampadumpara

The trial with six treatments was laid out at Mudigere (1994) (Table 13). In the first year of harvest (1996) application of organic and inorganic manures in different proportions did not give any significant difference among the treatments, but in subsequent years (1997, 1998 & 1999) treatments resulted in significant variation in yield. Inorganic manure application alone gave higher yield over the control and 100% organic manure application (Table 13).

The pooled data over the four years (Table 13) also indicated the same trend.

At Pampadumpara, this trial was laid out with six treatments. Significant differences existed among various growth parameters and yield except for plant height and length of panicles. Highest fresh yield of capsule was recorded with the application of NPK 75:75:150 kg/ha + 0.5 kg neem cake per plant. Application of NPK @ 150:150:225 kg/ha recorded the highest and significant dry yield of 124 g per plant.

CAR/CP/1 Disease Management Trial

CAR/CP/1.1 Chemical control of cardamom nursery leaf spot

Mudigere

This trial was laid out at Mudigere with 5 different fungicides [chlorothalonil 75% WP (0.2%), mancozeb 75% WP (0.25%), Bordeaux mixture (1%), carbendazim 50% WP (0.1%) and copper oxycholide 50% WP

Table 13: Effect of integrated nutrient management on yield of cardamom at Mudigere (1996-1999)

Treatment	Green capsule yield (kg/ha)				
	1996	**1997**	**1998**	**1999**	**Mean**
100 % Organic Manure (OM)	708	479	534	345	517
100 % Inorganic Manure (IOM)	840	707	760	434	685
75 % OM + 25% IOM	765	624	606	362	591
50 % OM + 50% IOM	710	602	684	343	585
25 % OM + 75% IOM	716	609	744	349	605
CONTROL (No manure)	685	400	480	277	461
S.em. +/-	29.4	63.1	40.1	24.2	21.0
C.D (.05)	NS	189.9	120.8	72.8	58.1
C.V (%)	8.0	22.1	12.6	13.7	14.6

100% OM = 78-72-96 kg NPK/ha (0.65-0.6-0.8 % NPK 12,000 kg/ha)

100% IOM = 75-75-150 kg NPK/ha

75% OM +25 % IOM = 77-73-110 kg NPK/ha

50% OM + 50% IOM = 76-73-123 kg NPK/ha

25% OM + 75% IOM = 76-74-137 kg NPK/ha

(0.3%)]for controlling the leaf spot disease in cardamom nursery (Table 14). Among the different treatments imposed in the first week of July, carbendazim @ 0.1% gave very effective control of the disease as the PDI recorded was lowest (14.6%) and the disease control was to the extent of 72%, followed by chorothalonil (20%), copper oxychloride (22.08%) and Bordeaux mixture (23.75%0 which were on par and significantly superior over check. However, the spraying was repeated during August and September months to keep the disease to

Table 14: Effect of different fungicides for controlling leaf spot disease in cardamom nursery

Tr. No	Treatments	Mean per cent disease index			
		Before spray	July	August	September
1	Chlorothalonil 75% WP (0.2%)	52.50	20.00 *(62.00)	12.50 (76.00)	10.42 (80.00)
2	Mancozeb 75% WP (0.25%)	47.08	45.00	30.00	24.58
3	Bordeaux mixture (1%)	50.42	23.75 (0.2%)	18.75 (63.00)	14.58 (71.00)
4	Carbendazim 50% WP (0.1%)	52.92	14.59 (72.00)	6.25 (88.00)	5.00 (91.00)
5	Copper oxychloride 50% WP (0.3%)	52.50	22.08 (58.00)	17.09 (67.00)	10.00 (81.00)
6	Control	49.17	58.33	59.58	44.17
	CD @ 0.05		5.65	4.65	3.90
			12.23	13.81	14.28

* Figures in the paranthesis represent the percent disease controls.

the minimum a carbendazim has further given an excellent control with a lowest PDI in August (6.25%) and September (5%).

CAR/CP/2.2 Biological control of clump rot in cardamom nursery

Mudigere

A trial was laid out in RBD at Mudigere in *kharif* 1998, comprising six treatments (Bordeaux mixture 1%, Metalaxyl MZ 0.2%, Copper oxychloride 0.3%, Tridemorph 0.1%, *Trichoderma viride* 100 g/plot) to control clump rot in cardamom nursery. As there was no incidence of clump rot during *kharif* 1999, it was suggested to go for studies on controlling damping off disease in the nursery with different treatments.

GINGER

GIN/CI/1 Genetic Resources

GIN/CI/1.1 Germplasm collection, characterization, evaluation and conservation

Solan, Pottangi, Pundibari, Kumarganj, Dholi and Raigarh

The Solan centre maintains 176 germplasm accessions, which were evaluated for different yield and quality characters. The evaluation of different characters indicated that the range was wide for yield per plot (1.0-9.0 kg) followed by yield per plant (45.0 – 133.0 g). During the year, Wynad recorded the highest yield followed by Kindi, No. 47/95, Juggijan and SG.646 (Table 15).

Table 15: Performance of ginger germplasm at Solan

S.No	Character	Range	Name and value of the promising collections
1	Survival (%)	50-100	SG819, SG825, SG834, BDJR1053, SG816 with 100% and SG850, SG858, SG849, SG843 and SG842 with 98% survival.
2	No. of tillers per plant	4.2-8.4	SG646(8.4), PGS-10(8.2), SG871(8.0), Charna(7.8), No 21/95(7.6), Anamica(7.5), SG883(7.4), Chanog(7.3), BLP-9(7.2) and Himgiri(7.0)
3	Pseudosterm length (cm)	46.0-81.0 cm	SG 854 (81.0), SG 876 (79.4), SG 877 (79.0), SG 886 (78.6), SG 856 (78.2)
4	Yield per plant (g)	45.0-133.0g	SG869(133.0), SG805 (130.0), SG 828 (127.0), SG 684 (123.0), Thaffiingiva (121.0), SG 683 (117.0), SG 885 (116.0), Wynad (114.0), SG 247 (113.0) and SG 699 (112.0).
5	Yield per plot (kg)	1.0-9.0 kg	Wynad (9.0), Kindi (8.0), No 47/95 (7.9), Juggijan (7.5), SG 646 (7.3), SG 503 (6.8), SG 212 (6.5), SG 868 (6.0), SG 202 (5.9) and Himgiri (5.8)

The incidence of rhizome rot was less than 10 percent in all the promising collections except in 47/95. The quality attributes *viz.*, dry matter content, essential oil and oleoresin were maximum in SG 212, Himgiri and Kindi respectively (Table 16).

At Dholi out of 19 varieties screened against soft root disease caused by *Pythium* sp. and *Fusarium* sp. no entry was found resistant.

18 germplasm collections, 11 accessions were evaluated for different yield and yield contributing characters as well as disease index. Highest fresh rhizome yield/ plant was recorded in GCP-12 followed by GCP-8.

Twelve accessions were collected, maintained and evaluated during *kharif* 1999-2000 at Kumarganj centre. Highest rhizome yield was obtained with NDG-6 (0.623 kg/plant) followed by NDG-5 and NDG-2.

Table 16: Performance of promising ginger collections for disease incidence and quality attributes at Solan

Collection	Disease incidence (%)	Dry recovery (%)	Essential oil (%)	Oleoresin %
Wynad	4.5	15.8	1.5	5.9
Kindi	4.0	15.6	1.2	7.2
47/95	12.5	15.8	1.5	6.0
Jaggijan	5.5	15.0	1.0	5.0
SG 646	6.5	15.2	1.3	6.8
SG 503	7.5	15.0	1.5	7.1
SG 212	4.0	20.0	1.5	5.8
SG 868	3.0	18.1	1.0	5.3
SG 202	6.5	13.6	1.2	6.1
Himgiri	3.5	15.8	2.0	5.9

The Pottangi centre is maintaining 168 accessions with three new additions during the year under report. One hundred and fortyone accessions were evaluated, out of which 13 yielded more than 3 kg/3m^2 bed. Highest fresh rhizome yield was in S-554 (4.6 kg/3m^2) followed by Poona (4.5 kg/3m^2) and V_1E_4-1 (4.4 kg/3m^2).

Eighteen elite, local and wild ginger collections were made from different sources *viz.*, Terai zones and Himalayan foot hills (13) and the remaining from IISR, Pottangi & Solan, are being maintained at Pundibari centre. Out of

The experiment failed at Raigarh due to severe rhizome rot disease.

GIN/CI/2 Coordinated Varietal Trial CVT 1996 Series IV

GIN/CI/2.1

Solan, Pottangi, Pundibari and Chintapalli

The CVT 1996 consisting of six entries V1E8-2, V1S1-8, V3S1-8, Suprabha, SG-554 and Acc.64 (Varada) from Pottangi, Solan, Jagtial and IISR, Calicut were laid out at the above coordinating centres during 1997 - 98.

The trial comprising the six collections plus the check (Himgiri) was laid out at Solan during 1999. The observations were recorded on horticultural characters, disease incidence and quality attributes. Non significant differences for all the characters were observed except for tillers per plant and yield per plot. Maximum yield was recorded in check Himgiri (6.20 kg), which was on par with SG 554 (5.10 kg). Other collections were on par. The experiment completed three years, the pooled performance of three years indicated that there were non-significant differences amongst varieties and varieties x years on yield per plot (Table 17). However, the collections behaved differently during the period of studies. The yield was poor during 1999 while it was consistent during 1997 & 1998. The over all mean indicated that SG 554 was top yielder followed by ACC 64 and V1E8-2. The results of the quality analysis (Table 18) also indicated inconsistent performance for quality attributes. Dry matter content, essential oil and oleoresin were more in Suprabha, Acc-64 & V_1S_1 – 8 respectively when over all performance of the three years were considered. Natural incidence of rhizome rot disease under MLT, recorded during the years showed that none of the entries were resistant.

At Chintapalli, the trial was laid out with six accessions during 1996-97 to 1999-2000. The variety, IISR Varada was significantly superior in its plant height (63.32 cm). This was followed by V_1S_1-8 (57.97 cm) and V_3S_1 –8 (56.82 cm) and they were on par. Tillers per plant were higher in V_1S_1 – 8 (9.57), V_3S_1-8

Table. 17 : Yield performance of ginger accessions under CVT 1996 series IV at Solan (1997-1999)

Sl No	Name	Yield per plot (kg)			Mean	Converted yield (g/ha)
		1997	1998	1999		
1	SG 554	5.45	4.90	5.10	5.15	103.51
2	V1S1-8	4.35	4.67	3.43	4.15	83.41
3	V3S1-8	4.30	5.23	3.50	4.34	86.80
4	V1E8-2	4.67	4.97	3.67	4.44	89.24
5	Suprabha	4.45	4.42	3.4	4.10	82.41
6	ACC 64	4.80	4.75	3.79	4.45	89.00
	Mean	4.67	4.82	3.82		
	SE ±	0.22	0.55	NS		
	CD5%	0.77	0.49	1.21		
		SE +	CD5%			
	Years	0.21	0.43			
	Vars	0.30	NS			
	Vars. x years	0.39	NS			

Table 18: Quality attributes of ginger accessions under CVT 1996-series IV at Solan (1997-1999)

Sl No	Name	Dry matter (%)			Essential oil (%)			Oleoresins (%)		
		1997	1998	1999	1997	1998	1999	1997	1998	1999
1	SG 554	17.1	16.5	14.5	1.50	2.00	1.51	3.77	5.15	7.16
2	V_1S_1-8	14.8	17.0	17.1	1.75	1.50	1.25	8.75	5.02	4.82
3	V_3S_1-8	15.7	19.5	13.3	1.50	1.60	1.50	3.55	4.88	7.00
4	V_1E_1-2	13.8	23.0	13.8	1.50	1.50	2.00	4.87	6.66	6.51
5	Suprabha	15.8	23.4	14.5	1.50	1.50	1.50	4.82	6.03	6.88
6	Acc 64	16.8	20.0	17.0	1.50	2.00	2.00	4.56	6.00	5.93
	Mean	15.5	19.9	15.0	1.37	1.58	1.62	5.05	5.62	6.38

(8.70) and IISR Varada (7.85). Significantly higher number of leaves/plant were recorded in V1E8 –2 (90.5) and V3S1 –8 (88.6), whereas maximum leaf length was recorded in IISR Varada (18.92 cm). The varieties *viz.*, V3S1 – 8, SG-554 and V1S1 –8 recorded higher leaf breadth and were on par. Significant variation in rhizome yield was also noticed among varieties. IISR Varada recorded significantly higher rhizome weight per clump (176.8 g) followed by V3S1 –8 (160.5 g), V1E8 –2 (140.2 g) and SG-554 (130 g).

IISR Varada was significantly superior in productivity of fresh rhizome (Table 19). The varieties, SG-554 and V3S1 –8 were on par with IISR Varada in respect of rhizome yield during 1996-97 and 1997-98 respectively. The lowest yield was recorded in V1E8 –2 during 1996-97 and 1999-2000. Data of three crop seasons indicated that var. IISR Varada performed consistently well in Chintapalli area.

The CVT 1996 consisting of six entries from Pottangi, Solan, Jagtial and IISR was laid out in RBD with four replications at Pottangi during 1996-97 to 1999-2000. The average performance of the entries over four years

Table 19: Performance of ginger accessions under CVT at Chintapalli (96-97 to 99-2000)

Variety	Source	Fresh rhizome yield in Tonnes/ha		
		1996-97	1997-98	1999-2000
SG-554	Solan, HP	20.04	16.67	18.50
IISR Varada	IISR, Calicut	21.54	25.00	23.37
V3S1 –8	HARS, Pottangi	9.15	26.62	15.45
V1E8 –2	HARS, Pottangi	5.50	20.83	8.25
V1S1 –8	HARS, Pottangi	13.93	9.17	14.19
Chintapalli local	Chintapalli	16.67	15.40	13.25
CD at 5%		2.49	1.62	2.38

(Table 20) Indicated that V1E8-2 gave significantly higher yield followed by V3S1-8 (22.12 t/ha).

The Pundibari centre laid out the trial with five accessions. Data on growth parameters and yield were recorded at 180 days after sowing /after harvest (Table 21). The mean yield of other ginger entries did not differ much, except in cv. Garubathan. These ginger entries were tested during 1996-97 to 1999-2000 against *Phyllosticta* leaf spot and rhizome rot disease respectively. The incidence of *Phyllosticta* leaf spot was higher during 1999-2000 as compared to previous years. The mean PDI value for the disease ranged from 9.2-14.2%, the highest being in V_3S_1-8.

GIN/CI/3 Varietal Evaluation Trial

GIN/CI/3.1 Comparative yield trial (CYT I & II)

Solan, Pottangi & Raigarh

In the comparative yield trial CVT I with six collections including check (Himgiri) were evaluated in RBD at Solan. The differences were found to be non-significant. Himgiri recorded highest yield and was followed by SG-700 (Table 22), both were almost at par for yield. The incidence of the disease ranged from 3.0 to 5.2 percent. SG-692 recorded highest dry matter contents while oleoresin was more in SG-707 and essential oil in SG-680 and Himgiri.

Table 20: Performance of ginger accessions under CVT at Pottangi (1996-97 to 1999-2000)

Sl.No	Cultivar	Fresh rhizome yield over 4 years (kg/3m²)					Projected yield (t/ha)
		96-97	97-98	98-99	99-2000	Mean	
1	V3S1-8	3.92	12.89	13.45	5.13	8.85	22.12
2	V1E8-2	6.39	10.20	18.25	5.37	10.05	25.13
3	ACC-6f4	5.19	9.32	12.36	4.95	7.96	19.89
4	V1S1-8	4.13	10.35	13.22	6.16	8.47	21.16
5	SG-554	5.57	7.32	11.48	4.55	7.23	18.08
6	Suprabha	5.42	8.62	8.31	4.99	6.84	17.09
C.D. (P=0.05)		NS	1.476	NS	NS	3.05	7.63

Table 21: Performance of ginger accessions under CVT at Pundibari (1996-97 to 1999-2000)

Entries	Tillers/ clump	Plant height (cm.)	Leaf number	Leaf length (cm)	Leaf breath (cm)	Fresh rhizome yield (kg/3m² plot)				Mean
						96-97	97-98	98-99	99-2000	
SG-536	13.5	63.7	18.3	19.9	2.47	3.86	8.21	8.80	7.82	7.17
V1S1-8	15.0	63.3	17.9	21.4	2.47	4.12	8.47	9.55	8.05	7.55
ACC-64	14.5	67.8	18.6	19.6	2.30	3.76	9.02	9.02	8.46	7.57
V3S1-8	16.2	60.8	17.8	17.5	2.07	-	-	7.26	7.86	7.56
Garubathan	10.6	68.1	18.8	20.7	2.37	-	13.20	11.01	9.28	11.16
SEM ±	0.7	NS	NS	0.6	NS	NS	0.5	0.52	0.07	
CD.05	2.4	-	-	1.8	-	-	1.8	1.68	0.24	

Table 22: Comparative yield performance of ginger in CYT I at Solan

Sl.No	Collection	Yield /Plot (Kg)	Converted yield (q/ha)	Disease incidence (%)	Dry matter (%)	Essential oil (%)	Oleoresin (%)
1	SG 68	4.92	98.90	5.0	15.00	2.00	5.80
2	SG 700	5.40	108.54	3.0	14.80	1.50	6.43
3	SG 707	5.02	100.90	3.0	15.83	1.50	7.26
4	SG 692	4.85	97.48	5.2	16.60	1.00	6.09
5	No 22/95	5.00	100.50	3.0	14.16	1.25	6.06
6	Himgiri (Check)	5.52	110.95	3.0	15.60	2.00	5.89
	SE ±	0.48					
	CD5%	NS					

Another CYT II, using six collections laid out during 1998 at Solan was repeated during 1999. Significant differences were observed during 1999 while these were non-significant during 1998. The over all mean indicated that the check was the top yielder followed by BDJR-1130 and BDJR-1179 (Table 23). The disease incidence was maximum in PGS23 and minimum in SG 711 and BDJR 1179. The dry matter content, essential oil and oleoresin were higher in BDJR-1130, Himgiri and PGS-23 respectively.

The CYT laid out at Raigarh failed to establish due to severe rhizome rot disease incidence.

At Pottangi the CYT I was laid out in RBD with six accessions with 4 replications during the last four years. The mean yield performance for four years is given in table 24. Out of the 6 cultivars evaluated for 4 years, the average projected yield is highest in V_1E_6-2 (29.4 t/ha), followed by V_3S_1-8 (25.64 t/ha), V_1S_1-2 and V_1C-8 and they were promoted to the new CVT.

Table 23: The mean yield per plot (kg) and converted yield (q/ha) at Solan

Sl. No	Name	Yield/plot (kg)		Mean	Converted yield (q/ha)	Disease incidence (%)	Dry Matter (%)	E.oil (%)	Oleoresin (%)
		1998	1999						
1	SG 711	6.00	4.30	5.15	103.51	3.0	13.8	1.50	6.54
2	PGS 23	5.70	4.27	4.98	100.19	5.5	15.0	1.25	8.50
3	SG 695	5.60	4.30	5.5	101.50	5.0	15.3	1.25	5.24
4	BDJR 1130	6.80	4.25	5.52	111.05	3.5	17.3	1.00	4.30
5	BDJR 1179	6.40	4.27	5.33	107.23	3.0	13.3	1.50	7.10
6	Himgiri (Check)	6.10	5.52	5.81	116.78	3.2	15.8	2.00	5.89
	SE ±	0.47	0.39						
	CD 5%	NS	0.84						

Table 24: Yield performance of ginger accessions under CYT I at Pottangi (1996-97 to 99-2000)

Sl No	Cultivar	Fresh rhizome yield over 4 years (kg/3m²)					Projected)
		96-97	97-98	98-99	99-2000	Mean	yield (t/ha
1	V1E8-2	7.45	13.11	18.84	7.38	11.70	29.24
2	V1S1-2	6.42	10.33	11.30	4.40	8.11	20.28
3	V1C-8	4.99	10.58	8.90	5.69	7.54	18.85
4	V3S1-8	5.16	9.91	19.79	6.17	10.26	25.64
5	SC-666	3.46	8.54	8.61	3.71	6.08	15.20
6	Suprabha	3.61	8.16	9.60	5.28	6.66	16.66
	C.D (P=0.05)	2.52	1.16	8.22	2.25	4.12	10.30

GIN/CI/3.2 Initial Evaluation Trial

Solan and Pottangi

Seventeen collections along with check Himgiri were planted and evaluated at Solan. Significant differences amongst collections were observed for yield per plot. Though the differences were found to be significant, none of the collections surpassed the check Himgiri. However, SG-718 gave comparatively better yield than other collections but was significantly less than the check.

In the IET at Pottangi, out of the 16 accessions evaluated, highest fresh rhi-zome yield was recorded by Vengara (15.5 t/ha) followed by S-558 (15.05 t/ha). Four- year-yield data is presented in table 25. In the pooled data, the highest fresh rhizome yield was observed in V_2E_4-5 (27.06 t/ha) followed by Vengara (25.69 t/ha) and V_3S_1-8 (25.28 t/ha). The promising accessions *viz.*, V_2E_4-5, Vengara, S-641, S-646, ZO-17 and Singhjhava were promoted for the new CYT at Pottangi.

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm from quality

Solan

Eightyone germplasm collections of ginger harvested during 2000 were analysed for different quality attributes like dry matter (%) essential oil (%) and oleoresin (%). The results indicated that dry matter contents varied from 13.3 to 22.5%, essential oil 1.00 to 2.00% and oleoresin 3.56 to 8.50%. SG-685 gave highest dry ginger recovery while essential oil was more in Shilli, Bangi, Himgiri, Acc-64 and V_1E_4-4 and oleoresin in PGS-23 and SG-706.

GIN/CP/1 Disease Management Trial

GIN/CP/1.1 Integrated management of rhizome rot of ginger

Solan, Dholi and Pundibari

The Pundibari centre isolated the pathogen *Pythium sp.* and established the pathogenity of rhizome rot, prevalent in that area.

A new experiment on management of storage rot of ginger was initiated at solan during 1999-2000 with 3 treatments. The incidence of rhizome rot of ginger was found least (5%) in a combination of treatment of Dithane M-45 + Bavistin + Durmet (T1) as compared to control (15%) (Table 26).

During 1999 a survey was conducted by Dholi centre in ginger growing areas of Bihar. It was found that ginger crop suffers from rhizome rot and soft rot disease seriously.

Table 25: Yield performance of ginger accessions under IET at Pottangi

Sl. No	Cultivar	Fresh rhizome yield over 4 years (kg/3m²)					Projected Yield (t/ha)
		96-97	97-98	98-99	99-2000	Mean	
1	S-547	3.10	7.97	10.05	-	7.04	17.60
2	S-558	3.10	8.85	11.64	4.15	6.94	17.34
3	S-641	6.08	9.64	16.53	6.02	9.57	23.92
4	V_2E_4-5	5.57	12.31	20.84	4.57	10.82	27.06
5	V_3S_1-8	7.38	10.81	17.31	4.94	10.11	25.28
6	S-646	6.99	7.45	17.00	5.85	9.32	23.31
7	SS-1	3.06	9.17	12.92	3.24	7.10	17.74
8	SG-666	4.74	8.80	13.40	4.20	7.79	19.46
9	ZO-17	5.06	10.13	18.05	3.83	9.27	23.17
10	Vengara	8.75	10.34	15.86	6.13	10.28	25.69
11	Singhjhara	6.53	12.08	15.23	5.48	9.83	24.58
12	Raigarh	7.26	9.76	15.15	3.49	9.03	22.57
13	Jugijan	5.90	9.07	12.04	4.04	7.76	19.41
14	Nadia	6.47	4.30	14.49	4.42	7.42	18.55
15	Anamica	5.65	10.34	12.75	3.90	8.16	20.40
16	Suprabha	5.35	9.72	19.38	5.34	9.95	24.87
C.D. (P=0.05)		2.02	1.69	4.75	2.40	2.23	5.58

Table 26: Effect of pre-storage /post-harvest treatments on incidence of rhizome rot and recovery of rhizomes at Solan

Treatment	Disease incidence (%)	Recovery (%)
Dithane M-45(0.25%) + Bavistin(0.1%) + Durmet (0.2%)	5.0	90.0
Dithane M-45(0.25%) + Bavistin(0.1%) + *T.harzianum* cowdung slurry	8.0	80.0
Control	15.0	70.0

GIN/CP/1.3 Effect of seed treatment on soft rot disease of ginger

Dholi

The study to find out the effect of seed treatment with five different fungicides on the soft rot disease of ginger was conducted at Dholi.

The pooled data of three years (1997-98 to 1999-2000) presented in table 27 showed that minimum disease incidence (16.39%) was recorded by one hour seed treatment with ridomil MZ @ 3 gm/lit of water which was followed by Indofil M-45 seed treatment (25.31%).

Table 27: Pooled data on the effect of seed treatment on rhizome rot of ginger at Dholi (1997-98 to 1999-2000)

	Treatments	97-98	98-99	99-2000	Pooled mean
T_1	Ridomil MZ @ 3 gm/litre	20.00	13.50	15.66	16.39
T_2	Indofil M-45 @ 2 gm/litre	19.50	30.50	25.93	25.31
T_3	Bavistin @ 1 gm/litre	30.00	35.50	34340	33.30
T_4	Indofil M-45 + Bavistin @ (2+1) gm/litre	26.50	26.50	26.40	26.45
T_5	Blitox-50 @ 2 gm/litre	20.20	36.00	28.96	28.39
T_6	Control	50.20	58.50	57.53	55.41
	CD at 5%	13.86	16.14	4.06	7.42
	CV (%)	24.28	27.93	7.12	13.20

TURMERIC

TUR/CI/1 Genetic Resources

TUR/CI/1.1 Germplasm collection, characterization, evaluation and conservation

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

The Solan centre is maintaining 172 accessions and they were evaluated for different horticultural and yield characters. The germplasm evaluation studies indicated wide range for leaf length, yield per plot and yield per plant. The yield of the best collections ranged from 5.4 to 6.5 kg per plot. BDJR-1180, BDJR-1025, BDJR-1268 and BDJR-1130 were the top yielders having yield per plot of 6.5, 6.4, 6.1 and 6.0 kg respectively.

The Pottangi centre maintains 187 turmeric accessions including two new collections. Out of 187 accessions evaluated in two replications, highest fresh rhizome yield was obtained in CLS-13 (12.6 kg/3m^2) among 155 accessions of *C.longa;* Sorispadar (5.7 kg/3m^2) among 17 accessions of *C.aromatica;* and CAM-3 (8.7 kg/3m^2), among four accessions of *C.amada*. Two new accessions of *C.longa* were also collected.

At Kumarganj centre fortyeight germplasm collections were maintained and evaluated for their agronomic traits. Among them NDH-18 was the best yielder (508.3 g/ha) followed by Rajendra Sonia and NDH-14. All the germplasm collections were infected by foliage disease, however, NDH-29 & NDH-31 showed lower incidence of leaf spot while Rajendra Sonia was infected severely.

The Raigarh centre holds 34 turmeric accessions and they have been evaluated for two years. Five high yielders identified were RTS-23 (301.3 q/ha), RTS-7 (256.6 q/ha), RTS-38 (226.6 q/ha), RTS-6 (204.6 q/ha) and RTS-42 (203.3 q/ha). None of the collections were

free from the *Colletotrichum* leaf spot disease. Collections RTS-11 and RTS-33 were highly susceptible to *Taphrina* leaf blotch. RTS-51, RTS-11, RTS-12, RTS-23, Acc.642 were moderately resistant to *Colletotrichum* leaf spot.

The Pundibari centre has 65 accessions out of which 43 were evaluated. The yield per plant ranged from 190 g (TCP-21) to 925 g (TCP-56). Out of the 43 collections, 19 did not take up leaf blotch disease in the field.

A total of 224 germplasm accessions assembled were evaluated at Coimbatore, and the yield of these accessions ranged from 15 g to 429 g per plant. The accession CL-132 registered the highest yield (429 g) followed by CL-131 (368 g). Out of them, only eight accessions registered a yield range from 3000 to 429 g. The exotic introduction CL 224 (Indonesia) registered the lowest yield (15 g).

At present 188 turmeric germplasm lines are being maintained at Jagtial centre. Based on duration, cultivars 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 in growth and yield characters. Among the long duration types 15B & Deepaigudu Pedda Pasap yielded 8.6 and 8.2 kg fresh rhizome/3m^2 and in medium duration Ethamukala and Avanigadda (7.2 & 7.6 kg fresh rhizome/3m^2) and short duration CLI Jyothi and Kuthuri with 7.6 and 7.4 kg/3m^2 were found promising. These accessions were also screened against the rhizome rot, *Colletotrichum* leaf spot and *Taphrina* leaf blotch. Three short duration cultivars were free from rhizome rot disease, 46 were free from leaf spot and five free from *Taphrina* leaf blotch out of 48 lines tested.

Fifty one germplasm accessions have been collected and maintained at Dholi centre; thirtynine of them screened against leaf spot disease caused by *T. maculans*. Culivars viz., Kohinur, G.L puram, R. Sonia and RH-5 were graded resistant to moderately resistant. cul. Kohinur and G.L Puram were found resistant to C. *capcisi*.

TUR/CI/2 Coordinated Varietal Trial

TUR/CI/2.1 CVT 1996 Series IV

Pottangi, Dholi, Pundibari, Raigarh, Jagtial and Chintapalli

Among the 10 entries evaluated under CVT, at Pottangi PTS-43 (45.0 t/ha) recorded the highest fresh rhizome yield, closely followed by PTS-62 (43.0 t/ha). The pooled analysis of the 10 entries evaluated during the last four years and the projected yield of both fresh and dry yield are presented in table 28. The highest fresh rhizome yield was recorded in JTS-2 (31.26 t/ha) followed by PTS-43 (30 t/ha). But the highest dry turmeric yield was in PTS-43 (7.46 t/ha) and PTS-62 (7.22 t/ha)

The CVT was laid out with seven cultivars during 1996-97 to 1998-99 at Chintapalli. During 1996-97 among different entries tested, higher number of tillers/plant were recorded with BSR-1, PTS-62 and IISR Prathibha. Similarly BSR-1 variety recorded highest rhizome weight/clump (215 g) as well as fresh yield of rhizomes per ha. (34.84 t/ha), followed by PTS-62 (32.72 t/ha). These two lines are on par in respect of fresh yield. During 1997-98 significantly higher plant height was given by PTS-62 (54.57 cm) followed by IISR Prabha (52.57 cm). However, there were no significant differences among the entries in respect of number of leaves and leaf width. Entries

Table 28: Comparative yield performance of turmeric accessions under CVT at Pottangi (96-97 to 99-2000)

SL No	Cultivar	Fresh rhizome yield (kg/3m²)					Projected yield (t/ha)	Dry Yield (t/ha)
		96-97	97-98	98-99	99-2000	Mean Yield		
1	JTS-1	7.51	11.56	12.40	12.40	12.34	30.84	4.49
2	JTS-2	7.94	13.65	11.82	11.82	12.50	31.26	4.59
3	PTS-12	5.04	10.77	14.07	14.07	11.27	28.18	6.31
4	PTS-43	7.67	10.70	18.08	18.08	12.39	30.98	7.46
5	PTS-62	4.64	9.85	17.90	17.90	11.06	27.64	7.22
6	ACC-360	6.34	8.06	10.50	10.58	8.87	22.18	5.06
7	ACC-361	5.24	11.65	10.02	14.37	10.32	25.82	6.97
8	R.H-5	9.42	9.36	14.95	11.79	11.38	28.45	4.64
9	R.Sonia	9.08	10.24	17.43	11.49	12.06	30.15	4.28
10	ROMA	4.34	10.30	14.46	12.77	10.47	26.17	6.28
CD (P=0.05)		2.84	2.11	5.24	6.13	3.20	8.00	

PTS-62, PTS-43, PTS-12 and BSR-1 were on par in respect of fresh yield per ha. During 1998-99 also BSR-1 and PTS-62 performed well recording 36.5 t/ha and 27.36 t/ha of fresh rhizomes respectively. The pooled data of three crops seasons presented in table 29 indicated that BSR-1 and PTS-62 performed consistently well in Chintapalli area.

Pundibari centre conducted the trial with 7/9 entries from 1997-98 to 1999-2000. During the year none of the growth parameters were significant except tillers/clump and leaf breadth. Fresh rhizome yield was higher in Rajendra Sonia (11.7 kg/3m² plant) followed by RH-5 and JTS-1 during 1999-2000 (Table 30). But mean yield per 3m² plot presented in table 30 indi-

Table 29: Yield performance of turmeric varieties in CYT at Chintapalli (1996-97 to 1998-99)

Variety	Source	Fresh rhizome yield in tonnes/hectare		
		1996-97	1997-98	1998-99
IISR Prabha	IISR, Calicut	19.47	26.76	26.60
IISR Prathibha	IISR, Calicut	26.77	28.56	19.61
PTS-12	HARS, Pottangi	17.67	33.56	25.99
PTS-43	HARS, Pottangi	23.32	33.33	24.88
PTS-62	HARS, Pottangi	32.72	34.43	27.36
Rajendra Sonia	Dholi, Bihar	19.16	27.23	14.10
BSR-1	RARS, Bhavanisagar	34.84	32.23	36.50
CD at 5%		5.93	3.59	9.89

cated that Rajendra sonia is the best yielder followed by RH-5, Acc.360 and others.

At Raigarh, 11 accessions were evaluated in the CVT for the last four years. Mean yield performance of accessions evaluated for four years are presented in table 31. The top yielders are RH-5 (303.5 q/ha), Rajendra Sonia (269.4 q/ha), PTS-43 (267.5 q/ha), JTS-1 (253.5 q/ha) and JTS-2 (246.3 q/ha). These entries were screened against *Taphrina* leaf blotch and *Colletotrichum* leaf spot disease. Entries PTS-12, Acc-360, Acc-361 were found free, where as JTS-1 and PTS-62 were highly resistant to *Taphrina* leaf blotch. Disease incidence of *Colletotrichum* leaf spot were lowest in Acc-361 (16.23%) followed by Rajendra Sonia (19.64%).

Table 30:Yield performance of turmeric varieties under CVT at Pundibari (1996-97 to 1999-2000)

Entries	Tillers/ clump	Plant height (cm.)	Leaf number	Leaf length (cm)	Leaf breath (cm)	Fresh rhizome yield (kg/3m² plot)				Mean yield (kg/3m²)
						96-97	97-98	98-99	99-2000	
RH-5	2.1	121.5	9.8	53.9	12.1	14.3	12.0	14.0	10.5	12.7
Rajendra Sonia	2.2	118.2	9.6	50.5	12.3	14.4	13.9	13.9	11.7	13.5
PTS-12	1.5	122.5	9.8	59.3	14.9	8.2	15.9	12.6	9.3	11.5
PTS-43	2.2	118.7	9.5	52.1	10.7	12.7	13.4	12.0	10.4	12.1
PTS-62	1.5	116.8	10.0	55.3	13.3	11.3	16.9	12.7	9.5	12.6
ACC-360	2.2	115.1	10.1	55.8	15.0	12.1	16.3	12.5	9.8	12.7
ACC-361	1.9	123.0	10.6	56.5	14.5	10.3	16.7	12.8	9.5	12.3
JTS-1	1.7	101.7	10.3	55.4	13.4	-	-	10.8	10.5	10.7
JTS-2	2.0	107.6	10.9	53.4	12.9	-	-	8.4	8.9	8.7
S.EM ±	0.1	NS	NS	NS	0.3	0.9	0.87	0.8	0.4	
CD.05	0.4	-	-	-	1.0	2.9	2.4	2.3	1.1	

Table 31 : Yield performance of accessions under CVT at Raigarh (1996-99)

Sl No	Cultivars	Days to maturity	Fresh rhizome yield (q/ha)				Mean yield (q/ha)
			1996	1997	1998	1999	
1	Raj Sonia	208	372.9	204	315.3	185.5	269.4
2	RH-5	210	523.7	226	263.3	201.1	303.5
3	PTS-43	231	302.4	220	320.0	227.7	267.5
4	PTS-12	227	214.7	136	260.0	204.4	203.7
5	PTS-62	233	306.9	180	285.3	177.7	237.4
6	ACC-360	231	235.4	273	273.3	194.4	244.0
7	ACC-361	233	317.4	223	215.3	184.4	235.0
8	JTS-1	232	319.3	183	277.6	234.4	253.5
9	JTS-2	234	231.7	256	290.0	207.7	246.3
10	RTS-1 (ch)	212	220.0	196	244.0	187.7	211.9
11	RTS-2 (ch)	209	117.0	166	185.3	167.7	159.0
	CD at 5%					29.9	
	CV%					10.2	

The mean performance of the accessions evaluated for four years showed that RH-5 produced the highest rhizome yield followed by R.Sonia, and Acc-360. These nine entries of turmeric were tested against the common disease. The leaf blotch disease caused by *Taphrina maculans* was the only foliar disease recorded. PDI indicated that the entries Acc. 360, Acc-361, PTS-12, PTS-62, JTS-1 & JTS-2 were field resistant to leaf blotch. Though RH-5 and Rajendra Sonia showed considerably higher disease incidence still they gave higher yield/plot.

The CVT IV with 10 genotypes was tested at Jagtial. JTS-2 yielded more (5.5 kg/3m^2; 18.5 t/ha), followed by RH-5 (5.5 kg/3m^2; 18.5 t/ha) and PTS-12 (5.5 kg/3m^2 ; 18.3 t/ha). The curing percentage was more in the genotype Acc. 361 (20.1) followed by PTS-12 (20.0). The highest cured yield was recorded in JTS-2 (3.7 t/ha) followed by PTS-12 (3.7 t/ha).

In the CVT at Dholi the comparative performance of nine entries along with Rajendra sonia (check) were tested during 1997-98 to 1999-2000. Highest fresh rhizome yield of 432.85 t (table 32) and maximum number of tillers /plant were obtained by RH-5 followed by RH-10.

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.1 Comparative yield trial (CYT)

Pottangi, Dholi, Raigarh and Jagtial

In Pottangi this trial was laid out using six each of long and short duration cultivars. Out of the six long duration entries evaluated over the last four years, the highest average fresh rhizome yield was in PTS-62 (29.9 t/ha followed by PTS-55 (29.0 t/ha) (Table 33). The accessions PTS-55 and Tu.No 1 were promoted to the new CVT. Among the six entries evaluated the highest fresh rhizome yield was recorded by PTS-59 (313.5 t/ha) followed by PTS-

Table 32: Pooled data of turmeric under CVT at Dholi (1997-98 – 1999-2000)

	Varieties	Yield/plot (kg)			Mean	Projected
		1997-98	1998-99	1999-2000	yield (kg/plot)	yield (q/ha)
1	PTS-12	4.30	3.99	5.03	4.44	158.57
2	PTS-43	4.30	4.23	5.65	4.73	168.92
3	PTS-62	4.50	4.60	5.63	4.91	175.35
4	JTS-1	6.00	6.30	7.03	6.44	230.00
5	JTS-2	5.00	5.27	6.77	5.68	202.85
6	ACC-360	5.50	6.00	7.13	6.21	221.78
7	Acc-361	6.16	5.83	7.37	6.45	230.35
8	RH-5	10.66	13.17	12.52	12.12	432.85
9	RH-10	10.60	12.33	11.20	11.38	406.42
	CD at 5%	2.00	3.82	1.71	1.01	
	CV (%)	18.16	26.70	12.89	8.45	

15 (28.6 t/ha). Accessions PTS-59, PTS-15, PTS-11 and PTS-52 were promoted to the new CVT.

A CYT was laid out at Raigarh in 1999 with five treatments and control. All the entries evaluated (Prabha, Prathibha, Acc-584, Acc-126, Acc-585) were statistically superior in yield than the check RTS-1.

Seven cultivars [PCT-8, PCT-11, Sonali, Sugandham, Manipuri, Morangia and Rajendra Sonia (as local check)] were tested at Dholi centre. The mean pooled yield data of three years presented in table 34. The highest rhizome yield was obtained by Rajendra Sonia (Check).

Table 33 : Yield performance of turmeric accessions 1996-97 to 1998-99 at Pottangi in the CYT (1996-97 to 99-2000)

Sl No	Cultivar	Fresh rhizome yield (kg/3m²)					Projected yield (t/ha)	Dry yield (t/ha)
		96-97	97-98	98-99	99-2000	Mean		
Long duration								
1	PTS-43	6.84	13.80	12.26	13.15	11.51	28.8	6.8
2	PTS-62	6.75	12.94	15.13	13.01	11.96	29.9	7.0
3	PTS-55	8.31	9.55	16.02	12.60	11.62	29.0	7.0
4	Tu No 1	6.44	11.12	11.12	11.82	10.13	25.3	6.1
5	PTS-22	6.25	8.51	16.56	10.15	10.37	25.9	6.2
6	ROMa	4.73	9.48	11.21	11.65	9.27	23.2	6.1
	CD (P=0.05)	1.98	2.04	4.31	2.33	2.05	5.1	
Short duration								
1	PTS-59	11.53	10.92	13.24	14.77	12.62	31.5	7.9
2	PTS-15	7.57	11.04	13.81	13.30	11.43	28.6	6.9
3	PTS-11	7.39	9.59	12.66	12.54	10.55	26.6	6.1
4	PCT-8 (ch)	6.99	9.80	13.95	12.79	10.86	27.1	6.2
5	PTS-52	8.24	8.11	13.42	12.16	10.48	26.2	6.3
6	K. local (ch)	5.09	7.34	10.68	10.21	8.33	20.8	4.6
	CD (P=0.05)	2.11	1.71	NS	3.71	3.40	8.5	-

Table 34: Pooled yield data of turmeric under CYT at Dholi (1997-98 to 1999-2000)

	Varieties	Yield /plot in kg			Pooled	Pooled
		1997-98	1998-99	99-2000	mean	mean (q/ha)
1	PCT-8	19.42	21.48	19.41	20.10	276.16
2	PCT-11	15.52	15.15	16.16	15.61	216.80
3	Sonali	12.85	12.75	13.75	13.12	118.22
4	Sugandham	15.92	15.83	15.98	15.91	220.97
5	Manipuri	15.20	15.20	15.64	15.35	213.19
6	Morangia	17.95	17.89	17.00	17.61	244.58
7	Rajendra Sonia (check)	29.05	29.50	29.16	29.24	406.11
	CD at 5%	3.61	4.97	3.08	1.09	
	CV (%)	13.54	14.43	8.44	3.70	

The CYT with long, medium and short duration accessions was conducted at Jagtial for evaluation of promising types in turmeric-maize cropping system in red sandy loam with well water irrigation. The results on yield and other characters are presented in table 35.

In the long duration trial, out of seven entries tested, JTS-11 gave more fresh rhizome yield (8.9 kg/3m^2 29.7 t/ha) followed by JTS-15 (8.5 kg/3m^2 28.5 t/ha). The curing percentage was more in JTS-12 (20.9) followed by check Duggirala (20.6). The maximum cured yield was recorded in JTS -11 (5.9 t/ha) followed by JTS-15 (5.4 t/ha)

In the intermediate duration trial, out of 14 cultures tested, JTS-323 gave more fresh rhizome yield (7.5 kg/3m^2; 25.1 t/ha), followed by JTS-314 (7.4 kg/3m^2; 24.70 t/ha). The curing percentage was more in culture JTS-320 (19.9) followed by JTS-3319 (19.7). The cured yield was more in JTS-314 (4.8 t/ha) followed by JTS-323 (4.7 t/ha). In short duration trial out of seven entries tested the best yielder was JTS 610 (11.1 kg/3m^2; 37.1 t/ha) followed by JTS-612 (10.3 kg/kg/3m^2 3m^2; 34.3 t/ha). The curing percentage was maximun in JTS-611 and PCT-13 (18.3) followed by JTS-609 (18.1). The cured yield was maximum in JTS-610 (5.9 t/ha) followed by JTS-612 (5.8 t/ha).

TU/CI/3.2 Initial Evaluation Trial (IET)

Pottangi and Dholi

Among 16 accessions evaluated, higher fresh rhizome yields were obtained in PTS-34 (24.5 t/ha) and PTS-51 (18.3 t/ha). The yield performance based on the pooled analysis of four years is presented in table 36. Among the 16 accessions evaluated, the top yielders were PTS-4, PTS-16, PTS-34, PTS-39, PTS-50, PTS-51 and Tu No 6, which were promoted to CYT.

Seven promising turmeric lines were tested under IET at Dholi during 1997-98 to

Table 35: Comparative yield evaluation of turmeric accessions at Jagtial (1999-2000)

Accession	Rhizome weight kg/3m²)	Yield (t/ha)	Curing (%)
Long duration			
JTS 14	8.02	26.7	19.7
JTS 15	8.55	28.5	18.1
JTS 10	7.38	24.6	20.0
JTS 11	8.91	29.7	20.1
JTS 12	5.28	17.6	20.9
JTS 13	5.76	19.0	19.4
Duggirala	4.80	16.0	20.7
GM	6.95	23.1	20.0
S.Ed	0.14	0.5	0.2
C.D	0.31	1.1	0.4
Medium duration			
JTS 314	7.41	24.7	19.3
JTS 315	6.78	22.6	19.4
JTS 316	6.63	22.1	19.6
JTS 317	6.39	21.3	19.2
JTS 318	6.72	22.4	19.2
JTS 319	7.14	23.8	19.8
JTS 320	6.54	21.8	19.9
JTS 321	6.60	22.0	19.3
JTS 322	6.06	20.2	19.2
JTS 323	7.53	25.10	19.0
JTS 324	6.60	22.0	19.3
JTS 325	5.91	20.0	19.3
JTS 326	5.55	16.8	19.5
JTS 327	5.55	18.5	19.2
GM	6.52	21.7	19.4
S Ed	0.14	0.9	0.1
CD	0.29	1.8	0.2
Short duration			
JTS 607	7.53	25.1	17.7
JTS 608	8.80	29.3	18.0
JTS 609	8.03	26.8	18.2
JTS 610	11.10	37.1	16.0
JTS 611	7.93	26.4	18.3
JTS 612	10.30	34.3	17.0
PCT 13	7.96	26.55	18.3
GM	8.33	29.4	18.0
S.Ed	1.90	2.6	0.04
CD	NS	5.7	0.08

1999-2000 for growth and yield characters. Pooled yield data of 3 years in IET presented in table 36 showed that out of seven varieties Rajendra Sonia out yielded (397.50 q/ha) other accessions (Table 36). The variety RH-24 was the tallest however maximum number of tillers were recorded by Rajendra Sonia (6.22 tiller/plant).

TUR/CI/4 Quality Evaluation Trial

TUR/CI/4.1 Quality Evaluation of germplasm/ varieties

Solan and Coimbatore

At Solan 127 collections planted during 1998 and harvested in 1999 were analyzed for various quality parameters *viz.*, *Curcumin,*

Table 36 : Yield performance of turmeric accessions under IET at Pottangi (1996-97 to 1999-2000)

SL No	Cultivar	Fresh rhizome yield (kg/3m²)					Projected yield (t/ha)
		96-97	97-98	98-99	99-2000	Mean	
1	PTS-4	12.32	10.66	12.70	6.92	10.65	26.6
2	PTS-6	9.43	10.43	9.80	8.05	9.43	23.6
3	PTS-13	6.44	10.62	13.09	5.86	9.00	22.5
4	PTS-136	10.77	11.17	13.38	6.91	10.71	26.8
5	PTS-27	9.02	13.68	11.24	5.64	9.90	24.7
6	PTS-29	6.81	11.48	14.14	6.75	9.80	24.5
7	PTS-34	9.65	11.73	14.92	9.75	11.51	28.8
8	PTS-39	7.54	12.77	16.90	6.71	10.98	27.4
9	PTS-47	7.17	10.65	12.10	6.50	9.11	22.8
10	PTS-50	8.53	13.25	12.18	6.36	10.08	25.2
11	PTS-51	11.15	11.65	14.30	7.32	11.11	27.8
12	Tu No 3	8.57	11.18	12.43	7.51	9.92	24.8
13	Tu No 6	7.17	10.49	16.03	6.73	10.11	25.3
14	Alleppy	9.63	9.65	8.75	7.82	8.96	22.4
15	Roma	7.30	11.62	12.04	8.03	9.75	24.4
16	Ranga	-	-		5.80	5.80	14.5
	CD (P=0.05)	2.06	1.76	4.09	2.35	2.10	5.2

essential oil, oleoresin and dry matter contents.

Dry matter content of germplasm collections varied from 15.0 to 29.5%, curcumin 0.92 to 5.37 %, essential oil 3.0 to 9.0 and oleoresin 6.23 to 19.57%. PCT-1 (Megha), C.L Puram, PTS-16, and BDJ-105 showed higher curcumin content while dry matter, essential oil and oleoresins were higher in Acc-360, ST 1M and ST 7M respectively.

At Coimbatore, analysis of 65 accessions showed that curcumin levels ranged from 0.99 to 6.36%. Among them, five accessions registered more than 5.0% curcumin and twenty accessions registered more than 4.0 percent curcumin. The highest content (6.4%) was in CL-67 followed by CL-18 (6.3%).

TUR/CI/4.2 Impact of environment on quality of turmeric

Solan, Pottangi and Coimbatore

To study the impact of environment on quality of turmeric, a trial was laid out at Solan during 1998 & 1999 with eight collections (including four from Solan). Non-significant differences were observed for all the characters studied except yield per plot. Highest yield of 6.20 kg/plot was recorded in ST-365 followed by ST-330 and Rajendra Sonia (5.0 kg each). The curcumin content was highest in JTS-2. The trial completed two years and the results for yield per plot were pooled and analysed. The pooled analysis is presented in table 37. ST-365 and ST-330 were top yielders. The curcumin content was more in Acc-360, JTS-2 and Rajendra Sonia.

Table 37 : Impact of environment on yield and quality of turmeric at Solan (98-99)

Vars/ Collection	Yield per plot (kg)			Converted yield	Curcumin (%)		Essential oil (%)		Oleoresin (%)	
	1998	1999	Mean		1998	1999	1998	1999	1998	1999
R Sonia	3.93	5.00	4.46	89.74	3.45	2.88	5.0	5.5	13.32	12.63
Acc 360	3.70	4.60	4.15	83.41	4.56	2.90	5.5	5.3	14.70	13.43
JTS-2	3.27	5.50	4.38	88.14	3.22	3.58	5.5	6.5	10.21	14.02
BSR-2	3.60	4.20	3.90	78.40	3.96	2.88	7.0	5.0	13.32	10.04
ST365	5.03	6.20	5.61	112.86	2.22	1.64	5.0	4.0	10.72	11.21
ST148	5.27	4.80	5.03	101.20	3.44	2.45	5.2	6.0	14.08	12.78
ST 85	6.00	4.70	5.35	107.53	3.11	2.14	4.5	3.5	12.41	10.40
ST 330	6.10	5.00	5.5	111.55	3.21	2.54	4.5	6.0	16.45	15.09
Mean		4.61	5.00							
SE +		0.42	0.28							
CD5%		0.90	0.62							

At Coimbatore, a trial was laid out with five improved varieties. During the year 1999, the variety Suguna registered the highest yield of fresh rhizome (418.0 g per plant) compared to 236.1 g/plant for BSR-2. The curing percentage ranged from 20.6 to 23.6 and was not significant among the varieties. The analysis of the curcumin content is in progress.

Six high yielding standard varieties were evaluated at Pottangi. Fresh rhizome yield was highest in JTS-2 (17.4 t/ha) followed by Alleppy (14.2 t/ha); while in terms of dry turmeric Roma gave the highest yield of (3.5 t/ha) followed by Alleppy (2.8 t/ah), JTS-2 (2.6 t/ha). Evaluation of two years pooled data (table 38) indicated that the highest average dry turmeric yield was recorded in Roma (4.8 t/ha) followed by Alleppy (4.11 t/ha).

TUR/CP/1 Disease Management trial

TUR/CP/1.1 Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against disease

Dholi, Jagtial and Coimbatore

Out of 196 accessions screened for leaf spot incidence at Coimbatore, CL-31 was found to be totally free from leaf spot. Low incidence (11-20%) was seen with 108 accessions. Out of 196 accessions screened for rhizome scales, during 1998-99, CL-125, CL-30 and Cl-154 were found to be tolerant. The studies will be continued at Coimbatore for confirmatory results.

The elite turmeric germplasm lines were screened at Jagtial to identify sources of resistance against foliar diseases viz., leaf blotch disease caused by *T.maculans*, leaf spot caused by *Colletotrichum capsici* and rhizome rot disease complex. During 1999-2000 three short duration cultivars *viz.*, JTS-602, JTS-604 and PCT-14, 10 mid duration cultivars *viz.*, JTS-302, 303, 304, 306, 308, CLI-317, 330, 370, PTS-9, PTS-19 and six long duration cultivars *viz.*, JTS-3, 8, 9 15, TC-2, TC-4 were free from rhizome rot disease.

Dholi centre conducted survey in the turmeric growing areas of North and South Bihar. It was found that leaf blotch disease incidence was more severe in comparison to leaf spot disease. Out of 39 germplasm accessions screened against leaf blotch disease caused by *T.maculans*, Kohinur, G L Puram, R.Sonia and RH-5 graded as resistant to moderately resis-

Table 38 : Yield performance and dry recovery percentage of turmeric varieties at Pottangi

Sl.No	Cultivar	Fresh rhizome yield (kg/3m²)			Projected yield (t/ha)	Dry turmeric yield (t/ha)	Dry Recovery (%)
		1998-99	99-2000	Mean			
1	ROMA	8.76	5.55	7.16	17	4.5	25.0
2	R.SONIA	12.66	5.37	9.02	22	3.2	14.0
3	ALLEPPY	10.77	5.67	8.22	20	4.1	20.0
4	JTS-2	13.28	6.95	10.12	25	3.8	15.0
5	ACC-360	8.72	3.80	6.26	15	3.4	22.0
6	BSR-2	9.30	4.79	7.05	17	3.4	19.4
C.D (P=0.05)		NS	2.38	NS	NS		

tant and in the screening against leaf spot disease caused by *Colletotrichum capsici* the variety Kohinur graded as highly resistant and G L Puram as resistant reaction.

Fortysix out of fortyeight lines tested were free from leaf spot infection. Five out of 48 lines tested were free from *Taphrina* leaf blotch disease.

TUR/CP/1.2 Chemical control measures against leaf blotch disease of turmeric

Pundibari and Dholi

Pundibari centre conducted an experiment during the year with 8 treatments including control using the cultivar Sugandham as test plant. The treatments consist of four non-systemic fungicides *viz.*, Captafol 50 N, Cuman L., Bordeaux mixture and Syllit-65 WP, two systemic fungicides viz., Bavistin and Hinosan and an antifungal antibiotic – Griseodum 250. Four sprays of fungicides were given from the first appearance of the disease at 20 days interval. Data indicated that Bordeaux mixture reduced PDI and increased aerial dry biomass as well as fresh rhozome yield compared to other fungicides.

A trial with six different fungicide was laid out at Dholi to control the leaf blotch of turmeric caused by *Taphrina*. The pooled data of 3 years presented in table 39. the minimum disease incidnce was recorded by Indofil M-45 (20.20%) which was followed by Blitox-50 (22.65%).

TUR/CP/1.3 Effect of seed treatment on leaf spot disease of turmeric

Dholi

A trial with six different fungicide was laid out at Dholi to control the leaf spot of turmeric caused by *Collectotrichum capsici*. The pooled data of 3 years presented in table 40 showed that the minimum disease incidence was recorded when treated with Emisan-6 (12.29%) followed by Bavistin.

Table 39: Effect of foliar spray of fungicides to control leaf spot disease of turmeric at Dholi (1997-98 to 99-2000)

Disease incidence (%)

Treatments	97-98	98-99	99-2000	Pooled mean
T_1 Ridomil MZ @ 3gm/litre	20.00	30.00	25.30	25.10
T_2 Indofil M-45 @ 2 gm/litre	19.50	21.00	20.10	20.20
T_3 Bavistin @ 1 gm/litre	30.00	25.00	28.06	27.67
T_4 Indofil M-45 + Bavistin @ (2 + 1gm/litre)	26.50	30.00	28.46	28.32
T_5 Blitox-50 @ 2.5 gm/litre	20.20	25.00	22.76	22.65
T_6 Emisan-6 @ 1 gm/litre	25.00	26.70	30.66	27.45
T_7 Control 56.20	60.00	59.33	58.51	
CD at 5%11.08	15.64	4.50	4.93	
CV (%) 25.34	27.24	8.25	9.10	

Table 40: Pooled data on effect of seed treatments to control leaf spot disease of turmeric (1997-98 to 1999-2000)

Treatments	97-98	98-99	99-2000	Pooled mean
T_1 Ridomil MZ @ 3gm/litre	30.20	30.50	32.26	30.99
T_2 Indofil M-45 @ 2 gm/litre	25.00	25.60	26.26	25.62
T_3 Bavistin @ 1 gm/litre	18.50	13.00	16.06	15.85
T_4 Indofil M-45 + Bavistin @ (2+1gm/litre respectively)	25.40	20.90	23.20	23.17
T_5 Blitox-50 @ 2.5 gm/litre	21.60	22.00	20.76	21.45
T_6 Emisan-6 @ 1 gm/litre	12.50	12.00	12.43	12.29
T_7 Control	65.00	56.50	59.43	60.31
CD at 5%	9.54	8.66	3.14	3.51
CV (%)	16.7	15.47	6.49	7.27

TUR/CP/1.4 Investigations on the causal organism of rhizome rot of turmeric and screening of biocontrol agents for its management

Jagtial

A trial was laid out at Jagtial to identify suitable biocontrol agents for the management of turmeric rhizome rot complex disease.

The results of the study during 1999 – 2000 is presented in table 41. The incidence of rhizome rot disease decreased with FYM and biocontrol agents. Percent reduction in rhizome rot was 60% in treatment with FYM ± recommended doses of NPK combined with *T.viride* + *P. fluorescence* basal and top dressing @ 12.5 kg and 25 kg hectares respectively (Table 41).

Table 41: Efficacy of bio-control agents for control of rhizome rot disease complex of Turmeric

Treatment	Incidence of Rhizome rot (%)	Percent reduction in rot over control	Fresh rhizome yield	
			Per plot ($9m^2$) kg	Per hectare (t/ha)
T1 = Recommended NPK	25.0	—	14.6	16.2
T2 = Recommended NPK + Farm yard manure	15.0	40.0	15.6	17.3
T3 = Recommended NPK + *Trichoderma viride* + *Psedomonas flurescence* @ 4 g/kg of seed material	30.0	-20.0	14.0	15.6
T4 = *T.viride* + *Pseudomons flurescence* basal. Application at 12.5 kg/ha + Topdressing at 25 kg/ha	25.0	0.0	14.8	16.4
T5 = T2 + T3	15.0	40.0	15.7	17.4
T6 = T2 + T4	10.0	60.0	19.5	21.6
T7 = T2 + T3 + T4	10.0	60.0	19.6	21.7
T8 = T2 + *Bacillus subtilis* 'Biostarat' seed soaking for ½ hour. Bacterial solution @ ml/lit of water	15.0	40.0	15.5	17.2
SEM ±	:	1.36	0.235	
C.D	:	3.03	0.525	
C.V	:	16.0%	1.5%	

TREE SPICES

TSP/CI/1 Genetic Resources

TSP/CI/1.1 Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon

Yercaud, Pechiparai and Dapoli

In clove, 13 accessions are being maintained at Yercaud and are being evaluated for growth and yield characters. Among them, the accession SA-1 exhibited vigorous growth (167 cm) with 15 branches. In cinnamon the centre holds 11 accessions. The dry bark yield/tree ranged from 62 gm (Cv.11) to 180 gm (Cv.5) among the accessions. Among the five accessions PD-1 and PD-2 flowered and produced fruits.

Pechiparai centre is maintaining 19 clove accessions. The 14 high yielding selections supplied by IISR (planted in 1991) and seven local collections planted (in 1994) were under evaluation. Among the collections from IISR, Calicut, selection-7 has performed well in growth and yield parameters. In the nutmeg germplasm, four selections were collected from IISR and along with selections from SH farm Courtallam were planted in 1991. Seven local collections were added to the germplasm in 1994. The nutmeg type MF-2 registered the highest growth performance followed by MF-1. Nine elite selections collected from IISR were planted 1999. In the nine cinnamon germplasm collections, Cv-312 and Cv-65 recorded more number of coppice/stump and leaves and stem girth respectively. In another germplasm trial with seedlings Cv-3 and Cv-2 registered more height, stem girth and number of branches.

At Dapoli, germplasm of nutmeg consists of 14 types including the eight elite types collected from IISR. The growth and performance of these accessions are satisfactory. Growth observations have been recorded and statistically analyzed. Growth performance of eight nutmeg types is presented in table 42. In cinnamon 15 collections were made from IISR and one from R.C.R.S. The growth and observations of the nine accessions planted in 1999 have been recorded and statistically analyzed. The result did not give any significant differences. But from the over all observations A-5 was found to be more vigorous. In clove two types were planted in 1997 and one in 2000. The growth of clove seedlings is satisfactory. The growth observations are being recorded.

The Dapoli centre conducted a survey in Shrivardhan and Alibag taluks of Maharashtra to locate elite types in tree spices and 11 elite nutmeg types were located. The seeds and the bud sticks were collected and the seedlings and the grafts were made. Five grafts of four types and five seedlings of other four types are ready for field planting.

TSP/CI/2 Coordinated Varietal Trial (CVT)

TSP/CI/2.1 CVT 1992 in clove

Yercaud, Dapoli and Pechiparai

In CVT 1992 at Yercaud, among 6 entries, the accessions Sel. 1 exhibited vigorous growth (172 cm with 32 branches). The above accession flowered during the reporting period 1998-99 and produced seven buds per cluster. However, the other accessions did not flower during this year 1999-2000. (Table 43)

Table 42: Growth performance of eight nutmeg types at Dapoli

SLNo	Accession No.	Plant height (cm)	Stem girth (cm)	Plant spread (cm)	No. of Shoots	Remarks
1	A-9/9	95.89	6.57	100.60	14.88	—
2	A-9/12	68.89	4.71	64.99	9.89	Compact and dwarf
3	A-9/20	99.33	6.16	104.16	18.41	—
4	A-4/22	101.17	5.37	93.66	15.27	—
5	A-11/70	111.68	6.76	108.49	18.00	Vigorous
6	A-9/72	102.77	5.93	95.44	15.55	—
7	A-9/79	84.83	5.33	87.97	13.50	—
8	Bulk	111.22	7.19	99.32	16.33	—
	S.E +9.34	0.36	10.70	2.38		
	C.D 5%	N.S	1.08	N.S	N.S	

Table 43: Growth characteristic of clove under CVT-1992 at Yercaud

Sl. No	Type	Plant height	No. of branches/plant
1	Sel. 1	172	32
2	Sel. 2	128	28
3	Sel. 3	141	28
4	Sel. 4	149	31
5	Sel. 5	121	29
6	Kallar local	116	26

TSP/CI/2.2 CVT 1992 in cinnamon

Yercaud and Ambalavayal

At Yercaud, the CVT (1992) was laid out with five accessions. Among this the Sel.44 recorded the highest leaf oil (4.1%) while Sel.189 recorded the highest bark oil (4.0%). Bark oleoresin was high in Sel.53 and 63 (16.0%)

In the CVT of cinnamon at Ambalavayal, SL.189 and SL.53 were found promising. The stand of the crop is satisfactory.

TSP/CM /1 Propagation/Multiplication Trial

TSP/CM/1.1 Vegetative propagation in nutmeg, clove & cinnamon

Yercaud, Pechiparai and Dapoli

At Yercaud, an experiment was carried out in nutmeg to identify optimum stage of scion and root stock for getting maximum success through grafting technique. The experiment was conducted using orthotropic scion and semi-hard wood scion. The scions were collected from two types of shoots (orthotropic

and plagiotropic) and four different stages of root stock (T1 – epicotyl, T2- Two leaved stage of root stock, T3- Four leaved stage of root-stock, T4 – Six leaved stage of root stock).

Observations over six years were pooled and analysed (Table 44). The results indicated that the two leaved stage of root stock with orthotropic scion is found to be optimum and recorded 50.5% success. The percentage of success ranged from 45 to 55% over six years. The same two leaved stage root stock with semi-hard wood scion has also recorded 47% success. In this treatment the percentage of success ranges from 42 to 51% (Table 44).

At Pechiparai air layering was tried in clove and the success rate was 20%. In nutmeg only 32% success was obtained in the epicotyle grafting tried on nutmeg root stock.

TSP/CM/2 Irrigation Trial

TSP/CM/2.1 Drip irrigation in clove and nutmeg

Yercaud

Drip irrigation trial was laid out in 1992 and drip system was in operation since 1993 with four irrigation levels (2,4,6,8 litres /plant/day). Pot watering 8 Lits of water/week/plant (T5) functioned as check. The growth parameters viz., plant height and number of branches per plant were recorded.

Growth parameters of clove under drip irrigation at Yercaud are presented in table 45. Observations made during the last five years clearly indicated that dripping of 8 litres of water per day per plant (T4) during the summer months was promising and led to vigorous plant growth (197.90 cm). The plant height progressively increased from 158.6 cm to 231.6 cm during the years 1994-95 to 1998-99 (Table 45), and also significantly influenced the branching of plant (38 nos.). Branches per plant in the above treatment varied from 8.9 to 54.4 numbers during the years 94-95 to 98-99 (Table 46).

TSP/CM/3 Nutrient Management Trial

TSP/CM/3.1 Biofertilizer trial in tree spices

Yercaud

To study the influence of biofertilizer on growth and yield of clove and nutmeg a trial was laid out at Yercaud.

Table 44: Evaluation of vegetative propagation technique in hutmeg at Yercaud (1993-94 to 98-99)

Type of scion	Stages of root stock	Mean percent of success						
		93-94	94-95	95-96	96-97	97-98	98-99	Grand mean
Ortho-	T1	26	23	24	20	25	23	23.5
tropic	T2	52	45	48	50	55	53	50.5
scion	T3	23	20	22	25	27	28	24.2
	T4	14	15	15	18	20	21	17.2
Semi hard	T1	24	20	23.4	24.6	22.0	20	22.3
wood	T2	48	42	46.4	48.0	51.6	50	47.7
scion	T3	22	20	20.4	24.8	26.0	25	23.0
	T4	12	15	14.0	16.0	19.0	18	15.7
CD (5%)							Shoot	0.8778
							Stage of root stock	1.4320
							Shoot x State of root stock	1.7540

Table 45: Growth parameters of clove (mean plant height (cm)) under drip irrigation at Yercaud

Treatments	94-95	95-96	96-97	97-98	98-99	Mean
T1	140.0	157.3	189.0	200.4	208.2	178.98
T2	138.1	148.1	198.0	211.0	220.6	183.16
T3	146.2	163.6	203.0	216.2	228.3	191.46
T4	158.6	169.9	209.0	220.4	231.6	197.90
T5	102.4	111.9	150.0	158.2	164.8	137.46
CD (5%)						2.120

Table 46: Growth parameters of clove (mean number of branches/plant) under drip irrigation at Yercaud

Treatments	94-95	95-96	96-97	97-98	98-99	Mean *
T1	7.9	18.6	33.2	37.4	40.4	27.5
T2	8.4	19.2	35.0	37.2	41.0	28.2
T3	8.6	22.4	39.6	42.5	44.8	31.6
T4	8.9	29.0	48.0	51.6	54.4	38.4
T5	5.7	18.0	23.2	26.1	29.0	20.4
CD (5%)						1.90

* The mean values are rounded off to the nearest values.

The treatments were imposed on bearing clove trees (15 years old) in a private plantation at Yercaud. The treatments consisted of:

T1 Control (local practice) i.e., 50 kg FYM + 5 kg bone meal

T2 100 kg FYM + Present recommendation of 400 g N, 350 g P_2O_5 and 1200 g of K_2O/tree/year

T3 T2 + 50 g each of *Azospirillum* and Phosphobacteria/tree/year

T4 75% T2 + 50 g each of *Azospirillum* and Phosphobacteria/tree/year

T5 50% of T2 + 50 g each of *Azospirillum* and Phosphobacteria/tree/year

The treatments were imposed in two split doses during June & September. The population dynamics of soil microflora viz., phosphobacteria, fungi, actinomycetes and *Azospirillum* were observed at 45th and 90th day after the application of biofertilizers. The mean yield characters such as mean tree girth, annual increase in tree girth, mean number of buds per cluster, mean 100 green bud weight and mean bud yield were recorded for six years from 1993-94 to 98-99 (Table 47).

The soil microflora increased in plots, which received biofertilizer treatment (Table 48). Significant increase in phosphobacteria, fungi, actinomycetes and *Azospirillum*, was recorded in plot which received biofertilizers. The increased microbial population helped in the absorption and uptake of soil nutrients and made available the fixed nutrients to the plants. This might have been the reason for the increased yield of the clove trees that received both inorganic fertilizers and biofertilizers.

Table 47: Effect of biofertilizer on growth and yield attributes in clove at Yercaud (1993-94 to 1998-99)

Treatments	Tree girth (cm)	Annual increase in tree girth (cm)	No. of buds/cluster	100 bud wt (g)	Green bud yield kg/tree
T1	29.6	1.80	6.45	19.22	2.16
T2	31.5	1.80	6.87	21.08	2.95
T3	34.7	3.80	7.32	21.09	3.53
T4	33.6	2.80	7.27	20.10	3.05
T5	31.3	2.30	6.77	19.72	3.01
CD (5%)	2.66	0.12	0.84	0.43	0.04

Table 48: Effect of biofertilizer on population dynamics of soil microflora in clove garden at Yercaud (over the period of six years-1993-94 to 1998-99)

Treatments	Phosphobacteria 10^3/g soil		Fungi 10^3/g soil		Actinomycetes 10^2/g soil		Azospirillum 10^6/g soil	
	45	90	45	90	45	90	45	90
T1	5.73	6.16	4.03	5.96	3.20	4.27	0.092	0.140
T2	6.56	7.13	4.98	6.68	4.33	5.40	0.120	0.169
T3	9.61	10.56	7.96	9.95	6.26	7.45	0.215	0.279
T4	8.02	9.19	6.99	9.05	5.64	6.52	0.151	0.206
T5	7.80	8.64	6.09	7.89	5.15	6.14	0.128	0.179

The pooled statistical analysis over six years indicated the superiority of the treatment (T3) over the others with respect to yield attributing characters (Table 48). Among the five treatments, the highest bud yield (3.53 kg/ plant) as well as number of buds/cluster (7.3) was recorded in the treatment T3. The same treatment also recorded the highest mean tree girth (34.7 cm), annual increase in tree girth (3.8 cm) and 100 green bud weight (21.09 g). The study made clear that application of 100 kg FYM + 400:350:1200g NPK/tree/year along with 50 g each of *Azospirillum* and Phosphobacteria 15 days before the application of inorganic fertlizers resulted in the highest yield in clove. The project has been recommended to conclude in the XV AICRPS Worskhop.

Nutmeg

The trial with same treatments as in clove was laid out in 15 year-old, bearing nutmeg trees in a private plantation at Yercaud. Treatments were imposed in two split doses during June & September. Yield and yield attributing characters and the population dynamics of soil microflora were recorded for six years.

The data on microbial population (Phosphobacteria, fungi, actinomycetes, *Azospirillum)* presented over a period of six years showed that the rate of multiplication was high in the plots which received biofertilizer treatments whereas, only a marginal increase was observed in other plots at 45th and 90th day of treatment application. (Table 49)

The pooled analysis on the influence of biofertilizers in nutmeg showed that the combined application of inorganic and biofertilizers influenced both vegetative and yield parameters (Table 50). The Treatment T3 (100 kg FYM, 400:350:1200 g NPK per plant per year and 50 g each of *Azospirillum* and Phosphobacteria) differed significantly among other treatments in yield attributing characters. The above treatment gave an increased mean tree girth (54.1 cm), annual increase in tree girth (9.4 cm), mean fruit weight (69.05 g) and mean fruit yield (529 nos.)

Among the treatments, the plants receiving biofertilizers gave higher yield. This might be due to the increase in microbial population in the root zone of the treated plants. This microbial population helps in the mobility and uptake of soil nutrients and make them available to the plants. Thus the increase in yield of nutmeg can be attributed to the biofertilizer application.

The study confirmed that in nutmeg, application of 100 kg FYM, 400:300:1200 g NPK/plant/year and 50 g each of biofertlizers viz., *Azospirillum* and phosphobacteria 15 days before the application of inorganic fertilizers increased the number of fruits per plant.

Table 49: Effect of biofertilizer on population dynamics of soil microflora in nutmeg at Yercaud (1993 to 99)

Treatments	Phosphobacteria 10^3/g soil		Fungi 10^3/g soil		Actinomycetes 10^2/g soil		*Azospirillum* 10^6/g soil	
Days	45	90	45	90	45	90	45	90
T1	7.45	9.88	3.90	5.57	4.27	5.49	0.034	0.057
T2	7.88	10.40	5.00	6.50	5.92	7.54	0.050	0.059
T3	7.70	10.21	4.19	5.52	5.71	7.40	0.073	0.096
T4	8.51	10.99	6.13	7.48	7.17	9.20	0.135	0.159
T5	8.01	10.47	4.94	6.36	6.92	9.08	0.084	0.107

Table 50: Influence of biofertilizer on growth and yield attributes in nutmeg from1993-94 to 1998-99)

Treatments	Tree girth (cm)	Annual increase in tree girth (cm)	Mean fruit wt (g)	Mean fruit yield (nos.)
T1	33.6	4.60	59.54	361.27
T2	47.4	5.90	63.58	462.20
T3	45.4	5.40	63.74	442.53
T4	54.1	9.40	69.05	528.49
T5	37.3	5.10	65.39	473.63
CD (5%)	0.43	0.24	3.90	21.89

CORIANDER

COR/CI/1 Genetic Resources

COR/CI/1.1 Germplasm collection, description, characterization, evaluation, conservation and screening against diseases

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

The Jobner centre maintains 761 coriander accessions, which include 631 indigenous, 112 exotic and 18 new collections. Fifty-three accessions along with five checks (RCr-20, RCr-41, RCr-435, RCr-436 and local) were evaluated during 1998-99. None of the accessions was better than RCr-41, RCr-20 and RCr-435. However, four accessions were better than RCr-436 and local check. Some of the promising accessions identified with respect to yield were EC-363974 (55 gm) UD-318 (51 gm) UD-335 (37 gm) and UD-326 (35 gm). The germplasm accessions were classified based on different characters and promising accessions identified.

Thirty entries of coriander were tested against stemgall disease caused by *Protomyces macrosporous* at farmers' fields in Danta (Sikar). Three entries (RCr-41, RCr-435 and RCr-436) were found immune and others were moderately resistant to highly susceptible to stemgall disease. Out of the 30 entries tested against root knot nematode (*M.incognita)* at Durgapura by Jobner centre, varieties RCr-41, RCr-435, RCr-436, RCr-446, UD-684 & UD-685 were found moderately resistant against nematodes.

Kumarganj centre is maintaining 29 coriander cultures. Coriander-2 produced highest yield (17.50 g/ha) under evaluation. The other cultures *viz.*, Cor-19 & Cor-22 were also found promising. Coriander accessions Cor-4, Cor-6, Cor-7, Cor-19, Cor-20, Cor-14, Co-21 showed resistant reaction against stem gall diseases.

The Guntur centre is maintaining 232 accessions. Among the 112 coriander accessions evaluated, LCC-212 recorded highest grain yield of 633 kg/ha, followed by LCC-173 LCC-176, LCC-174 and LCC-225 with 600, 583, 550 and 550 kg/ha. The check (Sadhana) recorded an yield of 383 kg/ha.

The Jagudan centre maintained 83 coriander accessions consisting of 18 exotic and 65 indigenous collections. In the screening trial against powdery mildew disease, all the nine entries screened were found highly susceptible.

At Coimbatore 221 accessions are being maintained. These accessions were evaluated for yield during *kharif* 1999. The mean grain yield per plant ranged from 30 g (CS-8) to 170g (CS-187). Nine accessions registered a very poor yield. The released variety Co-3 (CS-82) registered a yield of 65 g per plant. Among these CS-187 registered the highest yield of 170 g per plant.

At Hisar 70 accessions of coriander were evaluated in two row plots of 2.5 m length (2.5 sq.m) each using Pant Haritima, DH-5 and Narnaul selection as checks. The seed yield of germplasm ranged from 240 g (DH-263) to 520 g (DH-208). Fourty-seven lines gave higher seed yield than DH-5, 64 lines were higher than Narnaul selection and 50 lines out yielded Pant Haritima

One hundred and two germplasm collections of coriander were assembled, evaluated and are being maintained at Dholi centre.

These germplasm collections were screened for resistance to stemgall disease. Acc. M-1, D-1, Pant Haritima and Rajendra Swati were graded resistant.

COR/CI/2 Coordinated Varietal Trial (CVT)

COR/CI/2.1 CVT 1993 series II

Coimbatore, Kumarganj, Raigarh and Dholi

At Coimbatore this trial was laid out with 10 varieties including Co-3 as a check.During 1999, UD-748 (Acc. No.12) registered the highest yield of 3.01 g per plant, which was significantly superior to the check Co-3 (2.48 g/plant). UD-685 (Acc-97) registered the lowest yield of 2.46 g / plant.

At Kumarganj, the trial was laid out with 14 entries. Among different entries JCo-327 produced highest yield (19.34 q/ha). The entries UD-685 and Kumarganj selection were on par with JCo-327. Early flowering was noticed in RD-23 and JCo-331 and took 60 days for 50% flowering.

At Raigarh, the trial was conducted with 20 entries in 1999-2000. During *rabi* 1999, DH-13 was found higher yielder (16.77 kg/ha) followed by all entries except DH-208, LCC-128, LCC-133, UD-743, UD-744 and UD-686. The mean of two years of evaluation with 15 entries is presented in table 51. Highest yield was given by DH-13 (13.08 g/ha), followed by Local-1 (12.11 g/ha), DH-36 (11.82 q/ha), DH-48 (11.62 g/ha) and DH-246 (11.55 g/ha).

The CVT at Dholi with 10 entries was conducted during 1997-98 to 1999-2000. The grain yield for three years and the pooled mean data are presented in table 52. The maximum yield was obtained in UD-686 (21.16 q/ha)

Table 51 :Seed yield in Coriander in the CVT – 1993 series II at Raigarh

S.N	Entries	Days to maturity	Seed yield (q/ha)		Mean
			1999	1998	
1	DH-13	100	16.8	9.4	13.1
2	DH-48	100	16.4	6.8	11.6
3	DH-52	99	11.5	7.0	9.2
4	DH-208	102	9.9	4.6	7.2
5	DH-246	103	14.1	9.0	11.5
6	JCO-327	99	11.5	5.0	8.2
7	JC0-331	98	12.4	8.8	10.6
8	LCC-15	97	13.0	6.9	9.9
9	LCC-32	95	12.2	9.3	10.7
10	LCC-128	96	9.0	8.1	8.5
11	LCC-133	97	9.1	8.7	8.9
12	DH-36	100	11.4	12.2	11.8
13	DH-38	101	12.4	9.1	10.7
14	Local –1	100	14.2	10.0	12.1
15	Local-2	103	13.0	9.4	11.2
16	JCO-387	103	11.4	-	
17	JCO-283	104	12.0	-	
18	UD-743	104	10.9	-	
19	UD-744	105	10.0	-	
20	UD-686 (Old)	106	8.6	-	
	CD at 5%		5.8	2.0	

Table 52: Pooled yield data of coriander MLT at Dholi (1997-98 to 1999-2000)

Varieties	Grain yield (q/ha)			Pooled mean
	1997-98	1998-99	1999-2000	
1 DH-52	11.8	11.6	14.6	12.7
2 LCC-15	12.0	9.3	10.2	10.5
3 LCC-32	18.5	14.2	17.3	16.7
4 UD-684	19.6	17.8	18.0	18.5
5 UD-685	15.5	12.3	14.1	14.0
6 UD-686	24.1	19.1	20.2	21.1
7 UD-435	13.8	9.5	14.1	12.5
8 UD-336	15.5	12.5	14.3	14.1
9 RD-23	15.2	12.6	13.8	13.9
10 RD-120	13.8	9.4	12.6	11.9
11 Rajendra Swathi (Check)	18.0	13.7	15.2	15.6
CD at 5%	4.0	2.1	-	-
CV (%)	11.8	8.6	-	-

COR/CI/2.2 CVT 1996 Series III

Jobner, Coimbatore, Kumarganj, Dholi and Hisar

At Jobner, 12 accessions from different coordinating centres were tested in *rabi* 1998-99 in RBD having four replications. Days to flowering, plant height, banches/plant, umbels/plant, umbelletes/umbel, grains/umbel, test weight (gm) volatile oil (%) and grain yield (q/ha) were recorded. The entries differed significantly for all characters except in the case of unbelletes/umbel. Of the 12 entries, UD-684 recorded maximum grain yield of 11.98 q/ha followed by UD-686 (11.46 q/ha). Mean performance of entries evaluated in CVT during 1996-97 to 1998-99 revealed superior performance of UD-684 and yielded 9.9q/ha followed by UD-686 (8.5 q/ha), DH-13 (8.0 q/ha) while RCr-41 and local check recorded grain yield of 7.8 q/ha and 5.4 q/ha respectively (Table 53)

The trial (CVT) at Coimbatore consists of 10 accessions was laid out in RBD having three replications. The results revealed that the yield difference among the entries was not significant. The highest yield of 2.73 g per plant was recorded by Acc-202 compared to 2.70 g in check variety Co-3 (Acc No.82)

Of the 8 cultures of coriander evaluated at Kumarganj (1999-2000) maximum yield was obtained for Kumarganj selection (19.25 g/ha) followed by RCr-41 and UD 41-124.

Fifteen entries were evaluated, including Hisar Anand and Narnaul selection as checks, for four years (1995-96 to 1998-99). The design was RBD and the plot size was 4.0 x 2.4 m accommodating eight rows of 4m length spacing 30 cm apart with plant to plant spac-

Table 53: Mean yield (q/ha) performance of coriander entries under CVT at Jobner (1996-97 to 1998-99)

Entries	19996-97	1997-98	1998-99	Mean
1 UD – 684	8.8	8.8	12.0	9.9
2 UD – 685	5.5	5.6	11.1	7.4
3 UD – 686	8.7	5.4	11.5	8.5
4 DH – 13	7.4	7.2	9.3	8.0
5 DH – 48	6.9	6.3	9.4	7.5
6 DH – 52	6.4	5.3	10.0	7.2
7 Lcc – 15	3.7	5.8	5.3	4.9
8 Lcc – 32	2.9	5.0	5.1	4.3
9 JCo – 327	4.8	6.1	6.6	5.8
10 JCo – 331	4.6	7.6	6.0	6.1
11 RCr – 41	6.0	7.3	10.0	7.8
12 L.Check	2.8	8.7	4.7	5.4
CD at 5%	2.0	NS	2.5	1.6
CV %	24.8	31.3	20.2	16.1

ing of 20 cm. There was heavy incidence of stemgall during 1998-1999 and hence the data collected was not reliable though significant differences could be noticed. On the basis of three years performance, Hisar Anand recorded the highest yield of 20.7 q/ha which was 41.8% higher over the check, Narnaul selection, followed by UD-685 (26.7%) and UD-684 (24.0%).

COR/CI/2.3 CVT 1998 Series IV

Jobner, Jagudan, Guntur and Dholi

The trial laid out at Jobner with 12 entries from different coordinating centres *viz.*, five from Jobner, Rajasthan (UD-742, UD-743, UD-262, RCr-41 and local check) five from Hisar, Haryana (DH 38, DH 36, DH 52, DH 208 and DH 246) and two from Guntur, Andhra Pradesh (LCC-128, LCC-133) were evaluated in RBD with four replication. The entries differed significantly for all characters except for volatile oil percentage. None of the entries exceeded RCr-41 (check) as far as grain yield is concerned, however, UD-743 recorded maximum grain yield of 8.21 q/ha amongst the entries.

At Guntur eight coriander entries from different coordinating centres were tested using an RBD with Sadhana as check. As there was no grain set in six of the 9 entries tested (*viz.*, DH 208, DH 246, JCo 283, JCo-388, UD-743, UD-744) due to the severe drought conditions prevailed, the trial was abandoned.

At Jagudan the trial had nine treatments. Among the entries, the yield differences were found significant. JCo-387 had recorded significantly superior yield (27.23 q/ha).

At Dholi the trial was laid out with seven accessions. The variety DH-208 gave maximum yield (15.27 q/ha) but took larger periods for maturity. JCo-387 have taller plants (110 cm) compared to other varieties.

COR/CI/3 Varietal/Evaluation Trial

COR/CI/3.1 Comparative Yield Trial

Coimbatore and Dholi

At Coimbatore, the trial was laid out with 10 accessions in RBD with three replications during *kharif* 1999. The results revealed that the yield difference among the ten entries was not statistically significant.

The CVT at Dholi consists of ten entries. The pooled data for 1997-99 were analysed and presented in table 54. The results indicated that the maximum yield UD-446 (18.3 q/ha) followed by DH-36 (14.9 q/ha)

COR/CI/3.2 Initial Evaluation Trial

Jobner, Guntur, Raigarh, Hisar, Dholi & Jagudan

At Jobner, of the 19 progenies evaluated in the IET (*rabi* 1998), UD-743, UD-744 and UD-480 recorded higher grain yield of 9.7 q/ha; followed by RCr-20 (9.4 q/ha), RCr-41 and UD-118 (8.3 q/ha) UD-745 (8.0 q/ha) and UD-88 (7.29 q/ha) while RCr-436 produced grain yield of 5.21 q/ha.

At Raigarh, 11 entries were evaluated in IET during 1998 and 1999. The top yielders when considering the mean yield were RCS-12 (11.6 q/ha) RCS-11 (9.7 q/ha) RCS-14 (8.0 q/ha) RCS-13 (7.9 q/ha) and RCS-15 (7.5 q/ha).

At Jagudan an IET having eight entries was initiated in 1999-2000. Significant yield differences were observed among entries, though none was significantly superior to the control. However, the entry JCo-328 and Dhana –25 gave higher yield (25.4 q/ha and 25.1 q/ha respectively) than the control.

During 1999-2000 ten promising coriander germplasm accessions were tested at Guntur along with Sadhana as check. Among the entries LCC-174 recorded highest grain yield of 567 kg/ha which was on par with LCC-176 (517 kg/ha), LCC-25 (500kg/ha), LCC-227 (467 kg/ha) and significantly superior over the check, Sadhana (367 kg/ha).

Table 54: Pooled yield data of CVT at Dholi (1997-98 to 1999-2000)

Varieties		Grain yield (q/ha)			Pooled mean
		1997-98	1998-99	1999-2000	
1	DH-36	15.5	12.0	14.1	14.9
2	DH-38	13.0	9.7	12.6	11.7
3	DH-52	13.6	11.3	12.5	12.4
4	UD-446	20.0	16.1	18.7	18.3
5	UD-447	15.8	13.1	13.6	14.1
6	JCO-64	10.5	8.8	12.6	10.6
7	JCO-123	13.5	8.8	12.8	11.7
8	JCO-462	10.9	9.4	11.2	10.5
9	ATP-77	14.9	10.9	13.8	13.2
10	ATP-102	12.2	10.6	12.5	11.7
11	Rajandra Swathi	14.5	10.9	14.2	13.2
	CD at 5%	4.3	3.3	90.8	1.5
	CV (%)	18.11	15.44	5.50	7.08

Two initial evaluation trials, one for leafy type another for grain yield, were conducted at Hisar with nine accessions along with Pant Haritima and Hisar Anand as checks. The pooled data of three years at Hisar center is presented in tables 55 and 56.

In the IET at Dholi nine accessions along with Rajendra Swathi were tested for yield and yield attributing characters. The maximum number of branches/plant was recorded by Rajendra Swathi followed by DH-48. However, number of grains/umbel and grain yield was observed maximum in UD-684 (Table 57)

The results indicated the superior performance of DH-202, DH-228 under leafy type and DH-208 and DH-246 among the grain type.

Table 55: Yield performance of leafy type of coriander in th initial Evaluation Trial (IET) at Hisar (1996-97 to 1998-99)

Sl No	*Accession number*	Seed yield (q/ha)			
		1996-97	1997-98	1998-99	Mean
1	DH-202	12.3	17.5	17.9	15.9
2	DH-203	11.4	15.8	15.4	14.2
3	DH-224	10.4	15.0	17.5	14.3
4	DH-228	15.8	13.9	15.4	15.0
5	DH-230	11.6	15.8	13.9	13.8
6	DH-231	9.7	13.1	12.6	11.8
7	DH-259	10.1	12.8	13.2	12.0
8	DH-261	7.8	10.9	10.6	9.8
9	DH-266	11.5	9.8	13.6	11.6
10	Pant Haritima	10.1	12.0	11.4	11.2
	CD at 5%	2.1	3.4	2.8	

Table 56: Yield performance of coriander in the initial Evaluation Trial (IET) at Hisar (996-97 to 1998-99)

Sl.No	Accession number	Seed yield (q/ha)			
		1996-97	1997-98	1998-99	Mean
1	DH-201	13.6	18.4	14.0	15.3
2	DH-206	16.9	21.8	17.7	18.8
3	DH-208	16.9	22.5	21.3	20.2
4	DH-233	13.1	16.9	14.3	14.8
5	DH-234	17.0	23.8	18.3	19.7
6	DH-244	13.5	17.3	13.6	14.8
7	DH-246	17.6	23.6	20.8	20.7
8	DH-253	15.0	15.4	14.6	15.0
9	DH-257	15.0	15.8	14.6	15.1
10	Hisar Anand	14.6	196.9	15.7	15.7
	CD at 5%	2.3	3.0	2.8	

Table 57 : Pooled yield data of coriander under IET at Hisar (1997-98 to 1999-2000)

Varieties		Grain yield in q/ha			Pooled mean
		1997-98	1998-99	1999-2000	
1	DH-13	13.0	10.6	11.1	11.6
2	DH-38	18.0	19.4	17.3	18.2
3	DH-48	16.2	20.8	11.8	16.3
4	UD-20	13.0	13.9	13.3	13.4
5	UD-684	20.0	23.8	20.1	21.3
6	UD-685	18.8	22.5	17.5	19.6
7	UD-686	13.0	12.5	13.1	12.9
8	ATP-77	19.9	17.1	9.5	15.5
9	ATP-102	12.0	12.0	11.2	11.7
10	Rajendra Swathi	18.5	15.2	12.2	15.3
	CD at 5%	1.0	3.2	-	3.9
	CV (%)	8.4	9.9	-	14.7

COR/CI/4 Quality Evaluation Trial

COR/CI/4.1 Quality Evaluation in coriander

Jobner

At Jobner, 13 coriander accessions tested under CVT were analysed for volatile oil content. The oil content ranged from 0.25 to 0.45%. The highest volatile oil of 0.45% was observed in JCo-331 followed by 0.40% in local check (LCC-15 (0.35%). The total yield of volatile oil/ha depends upon the grain yield. The volatile oil yield was found to be maximum ie 3.59 l/ha in UD-684 followed by 3.0 l/ha in RCr-41, DH-52 and 2.86 l/ha in UD-686. The mean performance of volatile oil contents evaluated over three years is presented in table 58, which indicated that highest mean volatile oil of 2.96 l/ha in UD-684 followed by 2.48 l/ha in RCr-41, and 2.42 l/ha in JCo-331 (Table 58)

Table 58: Performance of coriander entries under CVT for volatile oil at Jobner (1996-97 to 1998-99)

Sl.No	Entries	Mean Grain yield (q/ha)	Volatile oil (%)				Mean yield of volatile oil (l/ha)
			96-97	97-98	98-99	Mean	
1	Jco-331	6.0	0.4	0.3	0.4	0.4	2.4
2	Local	5.3	0.3	0.4	0.3	0.3	1.9
3	LCC-32	4.3	0.3	0.4	0.3	0.3	1.5
4	DH-52	7.2	0.4	0.3	0.3	0.3	2.3
5	LCC-15	4.9	0.3	0.3	0.3	0.3	1.6
6	JCO-327	5.8	0.3	0.3	0.3	0.3	1.8
7	RCr-41	7.7	0.3	0.3	0.3	0.3	2.4
8	UD-684	9.8	0.3	0.3	0.3	0.3	2.9
9	UD-686	8.5	0.3	0.2	0.2	0.2	2.3
10	UD-685	7.3	0.3	0.2	0.2	0.2	2.0
11	DH-13	7.9	0.2	0.3	0.3	0.2	2.0
12	DH-48	7.5	0.2	0.2	0.2	0.2	1.8
	Range	4.32 to 9.8					1.51 to 2.9

Ten new entries were evaluated at Jobner in a CVT along with local check and RCr-41 (check). The volatile oil content ranged from 0.2 to 0.45%. The maximum volatile oil of 0.45% was recorded in DH-246 followed by 0.40% in UD-262 and LCC-133 and 0.35% in LCC-128 and DH-52. The total yield of volatile oil/ha depended upon the grain yield and was found maximum in DH-246 (3.63 l/ha) followed by RCr-41 (3.43 l/ha).

In the IET, UD-262 & UD-751 were found to contain 0.4% oil and UD-88 & UD-480 0.35% volatile, and they were promising among the 18 entries evaluated at Jobner.

COR/CM/1 Nutrient Management Trial

COR/CM/1.2 Response of coriander to micronutrients

Jobner

To study the response of coriander to micronutrients, an experiment was laid out during 1997-98 & 1998-99 at Jobner in RBD with three replications using the variety RCr-435 and involving 13 treatment combinations. During 1998-99, application of micronutrients did not cause any significant variation in seed yield. However, highest seed yield was obtained with soil application of $ZnSO_4$ @ 0.5 (13.37 q/ha) as against the lowest of 12.33 q/ha under control. The two years experimental finding revealed that the best mean seed yield (9.08 q/ha) was obtained with the soil application of $FeSO_4$ @ 5.0 kg/ha followed by its foliar application @ 0.125% as against 7.77q/ha under control.

Effect of micronutrient on the quality (volatile oil content) of corinader was evaluated at Jobner. The results indicated that volatile oil contents marginally increased in treatment with $FeSO_4$ (0.25%) foliar application (0.4%) or $ZnSO_4$ (0.5% foliar application) followed by $FeSO_4$ 10 kg/ha soil application (0.375%) while in control it was found to be 0.3%.

COR/CP/1 Disease Management Trial

COR/CP/1.1 Survey to identify the disease incidence, collection and identification of causal organism

Dholi

A survey was conducted by Dholi centre to find out the severity of stem gall disease in coriander. It was found that coriander was severely affected by stem gall disease.

COR/CP/1.2 Studies on wilt and powdery mildew management – Biocontrol of wilt in coriander

Coimbatore

Studies were carried out at Coimbatore to evolve an effective biocontrol measure for wilt in coriander using the 16 treatment combinations including the control. The results of this trial are presented in table 59. The influence of biocontrol treatment on percent wilt incidence and yield of coriander was statistically significant. The seed treatment with *T. viride* followed by foliar spray with hexaconazole was the best, with the lowest wilt incidence (3.5%) and the highest yield (355 kg/ha).

COR/CP/1.3 Studies on stemgall disease management of coriander by different fungicides

Dholi

A study was conducted at Dholi for three years to findout the effect of seed treatment

Table 59: Biocontrol of coriander wilt at Coimbatore

Sl. No	Treatments	Wilt incidence (%)	Yield kg/ha
1	S.T. with *T.viride* + Hexaconazole F.S. on 25th, 40th, 55th DAS	3.5	355.0
2	S.T. with *T.viride* + Thiophanate methyl F.S. on 25th, 40th, 55th DAS	3.5	350.0
3	S.T. with *T.viride* + Mancozeb F.S. on 25th, 40th, 55th DAS	4.0	340.0
4	S.T. with *T.viride* alone	4.5	345.0
5	S.T. with Carbendazim + Hexaconazole F.S. on 25th, 40th, 55th DAS	5.0	315.0
6	S.T. with Carbendazim + Thiophanate methyl F.S. on 25th, 40th, 55th DAS	5.5	320.0
7	S.T. with Carbendazim + Mancozeb F.S. on 25th, 40th, 55th DAS	6.0	305.0
8	S.T. with Carbendazim alone	7.0	300.0
9	S.A of neem cake + Hexaconazole F.S. on 25th, 40th, 55th DAS	6.5	295.0
10	S.A of neem cake + Thiophanate methyl F.S. on 25th, 40th, 55th DAS	6.5	300.0
11	S.A of neem cake + Mancozeb F.S. on 25th, 40th, 55th DAS	7.0	310.0
12	S.A of neem cake alone	9.5	295.0
13	Hexaconazole F.S. on 25th, 40th, 55th DAS	10.0	249.0
14	Thiophanate methyl F.S. on 25th, 40th, 55th DAS	9.5	248.0
15	Mancozeb F.S. on 25th, 40th, 55th DAS	10.5	250.0
16	Control	20.0	240.0
	CD (P=0.05)	1.55	2.05

with six different fungicides on the control of stem gall disease of coriander. The minimum disease incidence was in seed treatment with Bavistin (1 g/kg seed) for 15 minutes in comparison to other treatments (Table 60).

Table 60: Three years pooled data on the effect of seed treatment to control stem gall disease of coriander

	Treatments	97-98	98-99	99-2000	Pooled mean
T_1	Captaf –2.5 gm/kg seed	50.00	45.50	46.50	47.33
T_2	Emisan 6-2.5 gm/kg seed	45.50	47.00	46.25	46.25
T_3	Difoltan –2.5 gm/kg seed	30.50	35.00	32.75	32.75
T_4	Thiram-2.5 gm/kg seed	35.00	32.50	33.00	33.50
T_5	*Bavistin –1 gm/kg seed*	20.00	18.50	18.75	19.08
T_6	Control (No treatment)	70.60	72.50	70.00	71.03
	CD at 5%	20.12	13.74	-	3.08
	CV (%)	26.38	10.06	8.59	4.07

CUMIN

CUM/CI/1 Genetic Resources

CUM/CI/1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases

Jobner and Jagudan

The Jobner centre maintains 323 accessions of cumin, 43 accessions were planted for evaluation along with the check variety RZ-19. Observations were recorded only for 25 accessions of which six accessions yielded better than the check. Some of the promising accessions identified were UC-253 (26 gms), UC-266 and UC-276 (24 gms) UC-258 and UC-268 (20 gms) and UC-273 (18 gms) per plot compared with 16 gm/ plot by the check.

The germplasm entries were also evaluated for reaction to wilt disease. Out of eight entries evaluated the percent mortality due to wilt incidence was lowest in UC-223 ie. 11.25%, with the highest seed yield of 1.19 q/ha, followed by UC-217 and EC-232684. The highest wilt incidence was in local ie.33.7% with the seed yield 0.8 q/ha.

At Jagudan, 22 new collections were made during the current year from cumin growing area of the state. At present 168 accessions are maintained. One culture (GC-3) was found resistant to *Fusarium* wilt, out of 40 entries tested under wilt sick plot conditions, all the other entries were found highly susceptible. None was found resistant or tolerant to blight disease out of the 90 different entries screened under blight sick plot condition.

CUM/CI/2 Hybridization Trial

CUM/CI/2.1 Mutation studies and hybridization programme in cumin

Jagudan

Crossing programme started in Jagudan with the objective to establish the method of crossing in cumin. During 1999-2000 the F1 seeds from inter varietal crosses failed to germinate.

To determine the ideal time of pollination (days after emasculation) crosses were made between GC-2x hairy cumin. F1 seeds (140) harvested from various pollination treatments were sown in October 1999. But the seeds did not germinate. During *rabi* 1999 another 172 F2 seeds were harvested and will be evaluated during *rabi* 2000. Out of the F1 seeds (216) collected and sown in rabi 1999 only one germinated. It was a hairy type obtained from the treatment, pollination on next day after emasculation at 11 A.M. The seeds harvested from this plant will be evaluated in rabi 2000. The same crossing programme was also conducted in the current year and 119 seeds were collected from different treatments.

CUM/CI/3 Coordinated Varietal Trial

CUM/CI/3.1 CVT-1994 Series III

Jobner and Jagudan

At Jobner the CVT was laid out in RBD with three replications during rabi 1999 involving eight entries from different centres. The results of the trial indicated that entries differed significantly only for days to flowering as well as test weight. The entry UC-223 recorded highest grain yield of 1.19 q/ha followed by EC-232684 (1.18 q/ha), EC-279081

(1.10 q/ha) and UC-220 (0.98 q/ha) while local check and RZ-19 recorded grain yield of 0.84 and 0.73 q/ha respectively.

The mean performance of accessions evaluated in the CVT over 1995-96 to 1998-99 revealed the superior performance of the entry UC-223 which gave a grain yield of 2.08 q/ha followed by EC-232684 (1.99 q/ha) and EC-279081 (1.87 q/ha) while RZ-19 and local check produced grain yield of 1.73 and 1.75 q/ha respectively. (Table 61). The lowest wilt incidence of 11.3% was observed in UC-223 followed by EC-232684(13.3), RZ-19 (20.6) while highest wilt incidence of 23.9% was observed in local check (Table 61)

CUM/CI/3.2 Coordinated Varietal Trial on Cumin (CVT – 1999)

Jagudan

The CVT 1999 with eight entries including two checks was initiated in 1999-2000 at Jagudan. The yield differences were significant but none of the entries was better than the control. However, the entry, JC-94-37 gave higher yield (5.57 q/ha) followed by UC-310 (5.41 q/ha) and JC-94-262 (5.35 q/ha)

CUM/CI/4 Varietal Evaluation Trial

CUM/CI/4.1 Initial Evaluation Trial

Jobner and Jagudan

This trial consisted of 11 entries evaluated in RBD. Observations were recorded on morphological characters, yield and wilt incidence. The result indicated superior performance of the entry UCM-29, producing grain yield of 2.63 q/ha, followed by UCM-36 (1.67 q/ha), UC-231, UCM-79 and RZ-19 (1.50 q/ha each) while local check yielded of 1.08 q/ha.

The new IET (1999-2000) consisted of 10 entries laid out at Jagudan. Non-significant differences were observed for yield among entries and none of the entries gave higher yield than the latest released variety GC-3.

Table 61 : Mean performance of cumin entries evaluated for grain yield & wilt incidence in CVT at Jobner (1995-96 to 1998-99)

Sl No	Entries	Grain yield (q/ha)					Wilt incidence (%)				
		95-96	96-97	97-98	98-99	Mean	95-96	96-97	97-98	98-99	Mean
1	UC-223	3.1	3.5	0.4	1.1	2.0	5.0	13.8	15.0	11.3	11.3
2	EC-232684	1.8	2.8	2.1	1.1	1.9	15.	12.3	8.3	17.5	13.3
3	EC-279081	2.8	2.2	1.5	1.1	1.8	20.	31.3	21.7	15.0	22.0
4	UC-220	2.9	1.3	0.6	0.9	1.4	12.	26.3	33.3	20.0	23.0
5	UC-217	2.6	1.9	0.9	0.9	1.5	28.	21.3	23.3	20.0	23.4
6	L.Check	2.7	2.6	0.8	0.8	1.7	27.	22.5	11.7	33.8	23.9
7	RZ-19	2.4	2.8	0.9	0.7	1.7	25.	12.3	13.3	31.3	20.6
8	JC-147	2.8	2.5	1.3	0.7	1.8	27.	18.8	6.7	31.3	23.6
CD at 5%		0.70	0.88	0.51	NS	-	-	-	-	-	-
CV%	17.97	24.14	31.59	40.80	-	-	-	-	-	-	

CUM/CI/5 Quality Evaluation Trial

CUM/CI/5.1 Quality Evaluation in Cumin

Jobner

The volatile oil contents of seven entries of cumin tested under CVT ranged from 1.8% to 2.4%. The highest volatile oil of 2.4% was recorded in EC-232684 followed by 2.3% in UC-220, 2.1% in local check.

CUM/CP/1 Disease Management Trial

CUM/CP/1.1 Blight disease control by manipulation of agronomic practices

Jagudan

CUM/CP/1.2 Epidemiological study of *Alternaria* blight of cumin

Jobner

A field experiment laid out at Jobner involving five dates of sowing of cumin at an interval of 10 days (10,20,30 November and 10 and 20 December) to study the effect of dates of sowing on wilt and incidence of blight as well as yield of cumin. Blight disease did not appear during this year. However, the data on the wilt incidence was recorded. Out of the five dates of sowing the lowest wilt incidence of 21.3% was recorded in 20th December 1998 sowing with the highest seed yield of 67 g/plot, where as in 10th November 1998 sowing highest wilt incidence of 33.75% with a lowest seed yield of 12 g/plot was recorded.

CUM/CP/2 Pest Management Trial

CUM/CP/2.1 Integrated Management of pests and disease of cumin

Jobner

The Jobner centre conducted the trial with four main treatments (T1-Seed treatment and soil application with *Trichoderma harzianum*, T2-Seed treatment with 0.1% Carbendazim + soil application of *T.harzianum*, T3-neem cake, T4-control) and 13 sub treatments and was laid out in a split plot design with three replications.

Wilt incidence was recorded in each treatment as the percentage of plants wilted till maturity of the crop. Three sprays were given at an interval of 15 days. Observations were made for blight and powdery mildew incidence and the number of aphids and thrips per plant before and after 72 hours of each spray and at the time of harvest.

The population densities of *Trichoderma harzianum* and the pathogen *Fusarium oxysporum* in the rhizosphere of cumin was determined. In all the treatments (seed treatment and soil application of *T.harzianum* and application of oil cake) except control, Colony Forming Units (CFU) of *T.harzianum* (6.0×10^3, 4.0×10^3 and 3.0×10^3 respectively in the treatment) per gram dry soil has increased and that of *Fusarium oxysporum* (1.5×10^3, 1.6×10^3, 4.0×10^3 and 1.5×10^3 respectively) per gram of dry soil decreased. The control plots registered a reverse trend ie., *Trichoderma* decreased and *Fusarium* increased. Similarly incidence of wilt disease in all main treatments. (Table 62) shows that the lowest incidence of wilt (32.67%) with highest grain yield (43 g/plot) was recorded in plot were *T.harzianum* was applied as seed treatments + soil application along with plot sprayed with Mancozeb (Indofil M-45) @ 0.3% where as in control wilt incidence was the highest (44.67%) with the grain yield of 20 g/plot.

Table 62: Integrated management of cumin diseases at Jobner

S.N	Sub. Treat & concentration	Main treatments							
		ST+SA of T H		ST.C+ SA T H		A OC (Neem)		Control	
		*PWI	**Y(g/p)	*PWI	**Y(g/p)	*PWI	**Y(g/p)	*PWI	**Y(g/p)
1	Mb @ 0.3%	32.7	33.0	32.0	22.0	35.0	33.0	47.0	17.0
2	Mb @ 0.3% + No @ 1% + TP @ 1%	33.7	42.0	33.0	28.0	37.0	27.0	45.0	13.0
3	Mb @ 0.3% + MOP @ 0.04%	38.7	25.0	32.3	28.0	34.3	23.0	38.3	12.0
4	Mb @ 0.3% + ACEP @ 0.075%	36.3	38.0	31.0	32.0	39.3	28.0	50.0	12.0
5	Hex (content) @ 0.05%	39.0	43.0	34.0	18.0	41.0	30.0	45.3	18.0
6	Hex @ 0.05% NO @ 1% + Tp @ 1%	38.3	32.0	30.3	25.0	43.0	25.0	50.0	20.0
7	Hex @ 0.05% MOP @ 0.04%	39.3	33.0	33.0	30.0	44.0	37.0	51.7	15.0
8	Hex @ 0.05% + Acep @ 0.075%	33.7	23.0	35.3	18.0	41.3	40.0	52.7	20.0
9	Penc. (Topas) @ 0.05%	33.0	40.0	34.0	20.0	39.0	30.0	48.7	22.0
10	Penc. (Topas) @ 0.05% + MOP @ 0.04%	35.7	27.0	30.3	17.0	43.7	28.0	49.3	18.0
11	Thp.Mc (Top.M) @ 0.07%	36.7	30.0	29.7	23.0	43.3	27.0	50.1	15.0
12	Thp.Mc (Top.M) @ 0.07% + MOP @ 0.04%	38.0	35.0	33.7	22.0	41.0	27.0	53.0	17.0
13	Control (No spray)	44.7	20.0	43.3	13.0	46.0	13.0	56.7	12.0

* = Percent wilt incidence (PWI) and ** = Yield gm/plot (Av. Of 3 reps)

Abs :

ST	=	Seed Treatments	Acept	=	Acephate
SA	=	Soil Application	Hex	=	Hexaconazole
ST with SA	=	ST with Carbendazim + SA	Tp	=	Tipol
OC	=	Oil cake	Pene	=	Penaconzole
TH	=	*Trichoderma harzianum*	Thp Me	=	Thiophanate Methyl
Mb	=	Mancozeb	MOP	=	Monocrotophos
NO	=	Neem oil			

FENNEL

FNL/CI/1 Genetic Resources

FNL/CI/1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases

Jobner, Jagudan, Hisar and Dholi

The Jobner centre is maintaining 193 fennel accessions out of which 31 accessions were evaluated along with checks (RF-101 & RF-125). Nine accessions produced more grain yield compared to RF-101 (59 gms) while one accessions UF-148 (110 gms) was better than RF-125 (106 gms). Germplasm accessions were classified into various morphotypes based on days to flowering, plant height, branches/plant, umbels/plant, umbelettes/umbel, grains/umbel, grain yield etc.

Fifteen germplasm collections were maintained and evaluated at Kumarganj. Accession NDG-5 produced the highest yield (16.90 q/ha) followed by NDG-4 & NDG-6 (16.50 & 16.43 q/ha)

At Jagudan out of 179 accessions, 121 were retained after a preliminary evaluation. During the current year 114 new accessions were made from farmers' fields of Sabarkantha and Kheda districts. From the existing germplasm material 46 entries were isolated for specific characters *viz.*, Early type (8), Dwarf type (25), Tall type (1), Erect plant habit (7), more branching type (2), compact seed in unbellate (1), other characters (2). In the screening programme 42 entries were screened, but *Ramularia* blight was not observed during the season in the field.

At Hisar 64 accessions of fennel were evaluated in two row plots of 2.5 m length (2.5 sq.m) using PF-35 and GF-1 and local checks during 1996-97 to 1998-99. The mean seed yield of the germplasm ranged from 360 g (HF-159) to 740 g per pot (HF-127). Thirty-four lines gave higher seed yield than the highest yielding check PF-35. The most promising lines identified were HF-107, HF-113, HF-116, HF-118, HF-122, HF-125, HF-127, HF-129 and HF-175. These lines were maintained by sibmating and selfed seeds of all the lines have been harvested.

Thirty three germplasm accessions have been collected and maintained at Dholi

FNl/CI/2 Hybridization trial

FNL/CI/2.1 Mutation studies and crossing programme in fennel

Jagudan

In the sterility and hetrosis study with a view to find out cytoplasmic male sterile lines, all the germplasm entries were critically examined for fruit setting in primary and higher order umbels. The entries JF-399 and JF-413 showed poor seed setting and other characters of sterility. Two entries were crossed with the eilite line GF-2 and (JF-399 X GF-2 and JF-413 x GF-2) and F1 seeds, 24 & 32 numbers, were harvested for evaluation for sterility and hybrid vigour.

FNL/CI/3 Coordinated Varietal Trial

FNL/CI/3.1 CVT 1994-Series III

Jobner, Jagudan, Kumarganj and Hisar

At Jobner nine entries from different centres were evaluated in RBD in 1998-99. Observations recorded indicated wide range of variability existing for all characters except umbelettes per umbel.

Of the nine entries evaluated, entry UF-143 recorded higher grain yield of 10.23 q/ha followed by UF-144 (9.8 q/ha), JF-200 (8.5 q/ha), while local check yielded of 8.3 q/ha.

Nine accessions of fennel were evaluated including local check (NDG-5) at Kumarganj. Highest yield was recorded with HF-39 (20.4 q/ha) followed by HF-33.

In the CVT III at Jagudan non significant differences for yield were observed among the eight entries tested. However, the entries JF-192 and JD-200 were better yielders (ie. 26.4 q/ha and 24.9 q/ha, 21.0 and 13.9% respectively over control). The pooled data for three years presented in table 63 show significant yield difference among the entries. But none of the entries was significantly superior to control. However the entries JF-192 and JF-200 gave higher yield than control (Table 63).

Ten entries of fennel were tested in RBD at Hisar during 1997-98 & 1998-99. Observations on yield and yield attributing characters showed, significant differences for all the parameters. Yield ranged from 24.3 q/ha to 15.2 q/ha. Highest seed yield was recorded in HF-33 (24.3 q/ha) which was on par with PF-35 (22.8 q/ha) and was significantly different from others during 1998-99. Two years mean yield data also showed HF-33 (20.0 q ha) as the highest yielder closely followed by PF-35 (19.4 q/ha)

FNL/CI/4 Varietal Evaluation Trial

FNL/CI/4.1 Initial Evaluation Trial on fenugreek

Jagudan

The IET was initiated in *Rabi* 1998-99 at Jagudan. During *rabi* 1999-2000 significant yield differences were observed among the 10 entries. An entry JF-303 had recorded significantly superior yield (31.2 qt/ha) than control which was 24.6 per cent higher over control .

The pooled analysis of data for two years presented in table 64 shows non significant

Table 63: Yield performance of fennel in coordinated varietal trial at Jagudan (1997-98 to 99-2000)

SL.No	Entry	Yield (q/ha)			Average yield q/ha	% increase over control
		97-98	98-99	99-2000		
1	JF-186	27.66	26.06	21.81	25.18	3.79
2	JF-192	26.18	27.43	26.45	26.69	10.02
3	JF-200	28.33	26.06	24.89	26.43	8.94
4	UF-143	23.60	23.07	21.81	22.83	-
5	UF-144	26.50	24.02	17.90	22.81	-
6	HF-33	17.37	20.79	18.38	18.85	-
7	HF-39	21.40	19.47	22.85	21.24	-
8	GF-2 (ch)	25.39	25.54	21.85	24.26	-
	S.Em ±	1.96	1.07	2.06	1.04	
	C.D at 5%	5.77	3.16	NS	2.97	
	C.V %	15.97	8.92	18.72	14.91	

differences in yield among entries. However, an entry JF-303 recorded 17% higher yield (33.07 qtr/ha) than the control. The entries JF-234 and JF-332 appear promising.

FNL/CI/5 Quality Evaluation Trial

FNL/CI/5.1 Quality Evaluation in Fennel

Jobner

The volatile oil content of 11 accessions (evaluated under CVT) analysed at Jobner ranged from 1.5 to 1.8%. The highest volatile oil of 1.8% was recorded in UF-143, RF-101 and HF-39 followed by 1.8% in UF-144, 1.7% in JF-192 and minimum of 1.5% in JF-2000 and local check. The total yield of volatile oil was found to be highest in UF-143 (18.5 l/ha followed by UF-144 (17.2 l/ha) and lowest in HF-39 (6.6 l/ha).

The volatile oil content of fennel entries grown at Jobner & Hisar are compared. Most of the entries grown at Jobner conditions yielded higher volatile oil compared to those under Hisar condition. The climatic conditions are affecting the synthesis of volatile oil.

FNL/CM/1 Nutrient Management Trial

FNL/CM/1.1 Response of fennel to the application of Zn, Fe, Mn and Cu

Jobner

An experiment consisting of 13 treatments including four elements were evaluated in RBD at Jobner in 1997-98 and 1998-99. During the first year, the crop was adversely affected by hail storm (1997-98). In 1998-99 significantly higher seed yield was obtained with soil application of $ZnSo_4$ @ 20 kg/ha (13.5 q/ha). Foliar appliction of $ZnSo_4$ @ 0.5% (13.5 q/ha) $FeSo_4$ 0.25% (12.8 q/ha) and $MnSo_4$ @ 0.5% (13.5 q/ha) followed by their foliar application (11.6 q/ha) led to an yield of 12.85 q/ha compared to control (9.0 q/ha).

Two years experimental finding revealed that highest mean seed yield (11.9 q/ha) was obtained with foliar application of $FeSo_4$ @ 0.25%, whereas, the lowest mean seed yield (7.9 q/ha) was obtained in control.

The results on changes in volatile oil content due to the application of micronutrients as soil or foliar application or both resulted in decreased volatile oil content.

Table 64: Yield performance of fennel in initial evaluation trial at Jagudan (1998-99 to 99-2000)

SL.No	Entry	Yield (q/ha)		Average yield q/ha
		1998-99	99-2000	
1	JF-234	37.6	265.3	32.0
2	JF-237	31.9	20.4	26.2
3	JF-250	31.4	27.6	29.5
4	JF-303	34.9	31.2	33.1
5	JF-326	36.4	22.3	29.4
6	JF-332	33.7	28.8	31.3
7	JF-335	29.3	28.9	29.1
8	JF-342	32.23	25.1	28.7
9	JF-343	31.23	23.8	27.6
10	GF-2 (Ch)	31.5	225.0	28.3
	S.Em. ±	4.1	1.62	2.1
	.D at 5%	NS	4.81	NS
	C.V%	21.50	10.79	18.30

FENUGREEK

FGK/CI/1 Genetic resources

FGK/CI/1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases

Jobner, Jagudan, Guntur, Hisar, Dholi and Kumarganj

Out of 26 varieties tested in root knot infected field at Durgapura by the Jobner centre, variety UM-305 was found resistant, UM-32 & UM-34 were moderately resistant and others were susceptible to highly susceptible. In the screening trial, out of 26 varieties UM-34, UM-302, UM-304, UM-305 were free from powdery mildew disease.

The Guntur centre conserves 124 accessions and 54 accessions were evaluated during *rabi* 1999-2000. The accessions LFC-113 recorded the highest yield of 1000 kg/ha. LFC-114, LFC-87, LFC-84 and FFC-103 yielded 967, 900, 883 and 867 kg/ha respectively. The check var. Lam.Sel – 1 yielded 733 kg/ha.

Jagudan centre holds 50 accessions, in which 48 are indigenous and two exotic. Out of nine entries in the screening programmes for resistance against powdery mildew disease, Kasuri Methi was found resistant whereas other entries were highly susceptible.

Sixty-five accessions of fenugreek were evaluated at Hisar using Hisar Sonali as control during 1997-98 and 1998-99. Seventeen accessions gave higher seed yield than Hisar Sonali. The mean seed yield ranged from 14.63 q/ha (HM-241) to 23.5 q/ha in HM-242. The other promising accessions identified in the evaluation were HM-239, HM-242, HM-273, HM-281-6, HM-285-5, HM-292-1 and HM-299.

Seventeen fenugreek germplasm collections are maintained at Kumarganj, out of which, Rajendra Kanti produced highest seed yield (19.0 q/ha), followed by NDM-7 (16.5 q/ha). Lowest percentage of wilt was noticed in NDM-7 followed by NDM-14. Out of the 17 germplasm accessions screened against powdery mildew disease, lowest incidence was recorded in NDM-7.

Dholi centre collected and maintained 103 germplasm accessions in fenugreek. These germplasm accessions were screened against *Cercospora* leaf spot disease, and no variety is resistant to the disease.

FGK/CI/2 Hybridization Trial

FGK/CI/2.1 Evolving varieties resistant to powdery mildew through mutation breeding and crossing programme

Jagudan

Crossings were made between Gujarat Methi – 1 X Kasuri. F1 seeds collected during 1998-99 were sown and only one seed germinated and the plant appeared normal type. From that plant 240 seeds were collected for F2 study. During the year 53 F_1 seeds were harvested from Gujarat Methi-1 X Kasuri crosses for further study.

FGK/CI/3 Coordinated Varietial Trial

FGK/CI/3.1 CVT-1995 Series III

Coimbatore, Jobner, Guntur, Hisar, Dholi and Kumarganj

At Jobner, the CVT consisting of 14 accessions from different coordinating centres including local check, was laid out in RBD with four replications. The results indicated that the

entries differed significantly for all the characters except for plant height, pod length & seeds per pod. The entry UM-303 recorded highest seed yield of 23.4 q/ha followed by RM-5 (21.6 q/ha), HM-305 (21.3 q/ha), HM-291 (20.8 q/ha), while the released variety used as check (RMt-1) gave yield of 19.5 q/ha during 1998-99.

The mean performance of entries evaluated in CVT over 1996-97 to 1998-99 at Jobner presented in table 56 revealed superior performance of UM-303 yielding 23.4 q/ha followed by HM-305 (20.8 q/ha), J.Fenu -102 (20.6 q/ha) and HM-291 (20.3 q/ha) while RMt -1 recorded a grain yield of 20.2 q/ha. The lowest incidence of powdery mildew was recorded in UM-302, whereas the incidence was highest in HM-110 (Table 65)

Sixteen accessions obtained from other coordinating centres were evaluated at Kumarganj. Highest yielder was Kumarganj selection (26.8 q/ha), which was on par with HM-114 (26.5) followed by UM-304 (25.7 q/ha). Out of the 16 cultivars evaluated against wilt lowest wilt percentage was in HM-110 followed by HM-350 and UM-304.

At Guntur, 12 accessions from different coordinating centres were evaluated in RBD having three replications during rabi 1999-2000. The accessions differed significantly for yield over check, Lam Sel-1. Highest yielder was JF-210 (967 kg/ha), which was on par with JF-204 with 883 kg/ha.

At Jagudan, the CVT with 12 accessions was initiated in 1998-99. During 1999-2000 the yield differences were found non-significant among entries. However, the entries HM-350 and UM-305 gave higher yield (24.38 and 23.15 q/ha respectively) than the control. The pooled data over two years have shown non-significant differences for yield among entries. However, the entry HM-350 gave 19.3% higher yield than control (20.37 q/ha) (Table 66).

Table 65: Mean performance of fenugreek entries evaluated in CVT at Jobner 1996-97 to 1998-99)

Sl. No	Entries	Grain yield (q/ha)				Powdery mildew (0-9 score)			
		96-97	97-98	98-99	Mean	96-97	97-98	98-99	Mean
1	UM-301	19.7	20.7	18.23	19.5	4.0	5.0	5.7	4.9
2	UM-302	14.5	16.5	14.84	15.3	2.0	1.0	2.2	1.7
3	UM-303	21.4	24.9	23.44	23.2	4.0	4.5	5.2	4.5
4	UM-304	22.1	18.6	15.10	18.6	0.7	4.0	1.5	2.0
5	HM-110	19.5	21.0	18.89	19.5	6.5	8.0	5.2	6.5
6	HM-114	19.5	22.7	18.23	20.1	5.3	7.5	4.2	5.6
7	HM-291	19.61	20.3	20.83	20.2	1.5	3.5	4.0	3.0
8	HM-305	9.4	21.6	21.35	20.7	2.3	8.0	5.2	5.1
9	HM-464	15.8	20.2	20.57	18.9	2.0	6.0	4.2	4.0
10	CO-1	15.5	20.2	19.79	18.5	2.0	6.0	5.0	4.3
11	JF-58	17.5	20.7	15.10	17.8	2.5	7.0	1.7	3.7
12	JF-102	18.6	22.9	20.18	20.5	6.3	6.0	6.2	6.1
13	RMt-1	18.1	23.0	19.53	20.2	4.8	6.0	5.5	5.4
14	L.check	16.9	14.9	14.98	15.6	2.5	5.0	3.2	3.5
CD at 5%		4.31	4.99	4.25	4.07				
CV %		16.35	16.96	15.83	15.11				

Table 66: Yield performance of fennel in the CVT at Jagudan (1998-99 to 99-2000)

Sl.No	Entry	Yield (q/ha)		Average yield (q/ha)
		1998-99	99-2000	
1	Jfenu – 195	16.9	20.6	18.7
2	Jfenu-204	16.8	21.6	19.2
3	Jfenu-210	14.6	19.4	17.0
4	Jfenuu-321	13.4	20.2	16.8
5	UM-305	13.5	18.4	16.0
6	UM-322	12.7	23.1	17.9
7	UM-324	14.2	19.4	16.8
8	HM-346	12.7	20.5	16.6
9	HM-530	16.3	24.3	20.3
10	AM-1	16.1	16.3	16.2
11	AM-5	13.5	14.0	13.8
12	Gfenu-1 (Ch)	15.6	18.4	17.0
	S.Em. ±	0.86	2.67	1.43
	C.D at 5%	2.53	NS	NS
	C.V %	15.68	23.46	19.95

The trial with 9 entries including the check Co-1, was laid out in a RBD at Coimbatore. The yield difference among the accessions was not significant. The Acc. 105 (UM-302) registered the highest yield of 2.73 g per plot compared to 2.50 gm per plant in Co-1 (Acc-10). The Acc. 15 (UM-304) registered the lowest yield of 2.22 g per plot.

At Hisar, 14 entries from different centres were evaluated over a period of four years (1995-96 to 1998-99). Significant differences were obtained for all growth and yield parameters during 1998-99 except for length of pods. Highest seed yield was in Hisar sonali (24.2 q./ha), which was statistically on par with JF-102, HM-114 and UM-302. The pooled yield data for four years is presented in table 67. Hisar sonali maintained the superiority and provided highest seed yield of 23 q/ha which was 36.9% higher over local check followed by UM-302 (25.0%) JF-102 (22.0 %) and HM-114 (20.8 %)

FGK/CI/3.2 CVT-1999 Series IV

Jobner, Kumarganj and Dholi

The trial consisted of thirteen entries, seven from Rajasthan (UM-305, UM-321, UM-322, UM-323, UM-324, RMt-1, and local) three from Jagudan, Gujarat (JF-195, JF-204 and JF-201) three from Hisar, Haryana (HM-65, HM-346 and HM-350). Wide range of variability for all characters including powdery mildew incidence was observed. None of the entries yielded more than the released variety RMt-1 (18.75 q/ha). Other superior entries identified were JF-204 (18.10 q/ha), JF-195 (16.80 q/ha), HM-346 (16.28 q/ha), and HM-350 (16.02 q/ha) while local check yielded 14.32 q/ha.

Table 67: Performance of fenugreek genotypes in the CVT at Hisar (1995-96 to 1998-99)

Sl. No	Name of entry	Source	Seed yield q/ha					% increase over local check
			95-96	96-97	97-98	98-99	Mean	
1	CF-464	Coimbatore	-	14.9	19.2	18.2	17.4	3.6
2	CO-1	Coimbatore	-	16.0	19.0	18.8	17.9	6.5
3	HM-110	Hisar	16.9	17.2	19.8	19.7	18.4	9.5
4	HM-114	Hisar	19.4	18.2	21.3	22.3	20.3	20.8
5	HM-291	Hisar	17.8	18.3	20.5	19.8	19.1	13.7
6	HM-305	Hisar	16.7	17.7	19.5	19.0	18.2	8.3
7	JF-58	Jagudan	15.9	18.3	20.8	19.3	18.6	10.7
8	JF-102	Jagudan	18.8	19.4	21.3	22.6	20.5	22.0
9	UM-301	Jobner	21.8	17.1	19.8	18.5	19.3	14.9
10	UM-302	Jobner	21.4	19.2	20.8	22.4	21.0	25.0
11	UM-303	Jobner	18.6	17.5	20.8	20.7	19.4	15.5
12	UM-304	Jobner	17.3	15.3	18.5	18.0	17.3	3.0
13	Hisar sonali		23.8	21.6	22.3	24.2	23.0	36.9
14	Local check		16.6	15.9	16.8	17.8	16.8	-
	C.D at 5%		3.6	3.2	1.6	2.8		
	C.V %		11.3	10.8	4.3	12.1		

Seven cultures of fenugreek were evaluated at Kumarganj under CVT. Highest yield ie. 21.87 q/ha was obtained from JF-195 followed by JF-210. Out of the seven cultures evaluated lowest wilt incidence was found in UM-321.

The CVT was laid out at Dholi during 1999-2000. Best yielder was Rajendra Kanthi (17.63 g/ha.).

FGK/CI/4 Varietal Evaluation Trial

FGK/CI/4.1 Comparative Yield Trial

Coimbatore and Dholi

At Coimbatore, the CYT was laid out with nine accessions during *kharif* 1999 in a RBD with 3 replications. The accessions showed significant differences in respect of yield. The Acc-114 (HM-141) registered the high yield of 2.53 g compared to 2.36 g per plot in check CO-1. The Acc-122 (CF-390) registered the lowest yield of 1.38 g per plot.

The trial was laid out with 13 accessions to study the relative growth and yield parameters at Dholi. The variety Rajendra Kanthi (Check) produced higher yield (17.77 g/ha).

FGK/CI/4.2 Initial Evaluation Trial

Jobner and Hisar

In this trial 28 progenies along with two checks (RMt-1 & local) derived from RMt-1 treated with different doses of gamma radiations were evaluated in RBD. The observations were recorded for morphological, yield and yield attributing characters and disease

incidence. The results indicated superior performance of progeny 504-4 yielding 21.2 q/ha during 1998-99. Mean performance of progenies evaluated in IET over 1996-97 to 1998-99 revealed superior performance of 504-1, combining high yield potential as well as low incidence of powdery mildew (19.7 q/ha and 1.67 pm score). Other superior entries identified were 504-4 (19.6 q/ha and 0.78 pm score), 549-1 (18.9 q/ha & 2.55 pm score) and 549.2 (18.8 q/ha pm score 1.56).

The Initial Evaluation trial at Hisar in fenugreek was conducted for green seed coat mutant lines (1995-96 to 1998-99). The highest seed yield was obtained with HM-346 (23.4 q/ha) with an increase of 42.7% over Pusa Early Bunching and 17.0% over Hisar Sonali (Table 68)

FGK/CM/1 Spacing/Sowing Trial

FGK/CM/1.1 *Effect of time of sowing and spacing in fenugreek*

Coimbatore

The centre laid out an experiment to find out the optimum spacing and time of sowing for fenugreek under Coimbatore condition with three spacing *viz.*, 15 x 10 cm, 22.5 x 10 cm and 30 x 10 cm and six dates of sowing *viz.*, 5th September, 20th September, 5th October, 20th October, 5th November and 20th November were attempted. The higher grain yield was observed in 5th October sown crop (1.304 t/ha) followed by 20th October sown crop (1.27 t/ha). The difference between 5th October and other dates of sowing was significant. In general, the closer spacing (15 x 10 cm) gave the higher yield compared to wider spacing.

Table 68: Yield performance of Green Seed coat mutant lines of fenugreek under Initial Evaluation Trial (IET) at Hisar (1995-96 to 1998-99)

S.No	Accession number	Seed yield q/ha					Increase over check (%)	
		95-96	96-97	97-98	98-99	Mean	PEB	Hisar Sonali
1	HM-338	24.0	21.0	19.8	20.4	21.3	29.9	6.5
2	HM-339	15.5	22.2	17.3	18.3	18.3	11.6	-8.5
3	HM-340	16.8	22.2	18 7	18.5	18.6	13.4	-7.0
4	HM-341	16.3	25.6	19.3	20 2	20.4	24.4	2.0
5	HM-342	17.8	23.3	20.5	22.8	21.1	28.7	5.5
6	HM-343	17.8	14.7	16.7	18.0	16.8	2.4	-16.0
7	HM-344	16.7	22.2	18.8	19.8	19.4	18.3	-3.0
8	HM-346	19.0	26.7	23.6	24.2	23.4	42.7	17.0
9	PEB (Check)	15.5	16.7	16.2	17.1	16.4	-	-
10	Hisar Sonali (Check)	19.0	20.1	20.9	19.8	20.0	-	-

FGK/CM/2 Nutrient Management Trial

FGK/CM/2.1 Response of fenugreek varieties to row spacing and date of sowing

Jobner

An experiment consisting of 18 treatments to study the response of two fenugreek varieties to spacing and date of sowing was laid out during *rabi* 1997-98 and 1998-99. During 1998-99, variety RMt-1 produced significantly higher seed yield (17.05 q/ha) over UM-305 (15.2 q/ha). Row spacing of 25 cm was on par with 20 cm, and these treatments produced significantly higher seed yield (17.1 q/ha) than 30 cm row spacing (15.05 q/ha).

The two years data showed that variety RMt-1 yielded higher mean seed yield (19.14 q/ha) over UM-305 (18.0 q/ha). Crop sown at 25 cm row spacing produced higher mean seed yield (19.2 q/ha) (18.1 q/ha) over 20 cm row spacing. Early sowing on 31st October gave higher mean seed yield (20.5 q/ha) and further delay in sowing decreased the yield.

FGK/CP/1 Disease Management Trial

FGK/CP/1.1 Biocontrol of root rot in fenugreek

Coimbatore

To evolve effective biocontrol measures to fenugreek root rot, an experiment comprising eight treatment combinations was laid out at Coimbatore in a RBD with three replications. The treatments showed significantly different efficacy for management of root rot (Table 69)

Among the treatments, the lowest root rot incidence of 2.5 per cent and the highest yield of 390.0 kg/ha were recorded in seed treatment with *Trichoderma viride* plus soil application of neem cake (Table 69)

Table 69: Biocontrol of root rot in fenugreek (Coimatore)

Sl.No.	Treatments	Root rot incidence (%)	Yield Kg/ha
1.	S.T. with carbendazim + soil drenching	3.5	345.0
2.	S.T. with *T. viride*	2.7	385.0
3.	S.A of *T. viride* 20 DBS	2.9	335.0
4.	S.A. of neem cake	5.0	315.0
5.	S.T. with *T. viride* + S.A. of neem cake	2.5	390.0
6.	S.A. of *T. viride* + S.A. of neem cake	3.0	388.0
7.	S.T. with carbendazim, soil drenching	5.5 + S.A. of neem cake	318.0
8.	Control	25.0	295.0
	CD (P = 0.05)	1.53	4.35

S.T : Seed treatment , S.A . Soil application

GENETIC RESOURCES OF SPICES AT AICRPS CENTRES

(As on 31-3-2000)

Crop/Centre	Indigenous		Exotic	Total
	Cultivated	Wild and related sp		
Black pepper				
Panniyur	105			105
Sirsi	75	21		96
Chintapalli	26	29		55
Yercaud	106			106
Pundibari	7			7
Dapoli	9			9
Dholi	7	1		8
Cardamom				
Pampadumpara	78			78
Mudigere	245	7		252
Ginger				
Pottangi	163	2	3	168
Solan	196			196
Dholi	19			19
Kumarganj	12			12
Pundibari	18			18
Turmeric				
Pottangi	165	22		187
Jagtial	188			188
Dholi	51			51
Bhavanisagar	124			124
Raigarh	34			34
Kumarganj	48			48
Pundibari	65			65
Solan	172			172
Coimbatore	232		2	234
Clove				
Yercaud	13			13
Thadiyankudisai	1			1
Pechiparai	19			19

Nutmeg			
Yercaud	15		15
Thadiyankudisai	1		1
Pechiparai	12		12
Dapoli	14		14
Cinnamon			
Yercaud	11		11
Thadiyankudisai	6		6
Pechiparai	9		9
Dapoli	12		12
Coriander			
Jobner	649	112	761
Jagudan	83	18	101
Coimbatore	205	205	410
Guntur	230		230
Hisar			
Dholi	102		102
Raigarh	20		20
Kumarganj	29		29
Cumin			
Jobner	313	10	323
Jagudan	168	8	153
Kumarganj	19		19
Fennel			
Jobner	185	8	193
Jagudan	121	20	141
Hisar			40
Dholi	40		15
Kumarganj	15		
Fenugreek			
Jobner	325	12	337
Jagudan	50	2	52
Coimbatore	262		262
Guntur	124		124
Hisar			
Dholi	103		103
Raigarh	13		13
Kumarganj	17		17

ACTION TAKEN REPORT ON THE RECOMMENDATIONS OF THE XV WORKSHOP ON SPICES HELD AT CALICUT DURING NOVERMBER 1999 AND ACTION TAKEN REPORT ON THE EARLIER DECISIONS

Decisions	Actions taken/Remarks
GENERAL	
1.Ajowan may be included in the coordinated trial. It is necessary to describe the ajowan germplasm lines available at Guntur, Dholi, Jagudan and Hisar.	The ajowan germplasm collections are being evaluated and maintained at some of the centres. The crop is yet to be included as a mandate crop, due to the paucity of personnel and funds.
2.Paprika may be included in the AICRPS subject to the decision of ICAR.	The research on Paprika is in progress at Coimbatore centre. The issue will be placed before the next QRT. Some of the existing crops have to be deleted before paprika is included.
3.The passport data of germplasm collections at all centres should be supplied to NBPGR and get IC number to avoid duplication.	Directions have been given to all centres.
4.Crop cafetaria of all released varieties to be established in all centres.	Work has been initiated in this direction by various centres and are in progress.
5.The facility available at NBPGR, should be utilized for collection and characterization of germplasm.	Centres are advised accordingly.
6.Utilization of the germplasm collected should be given more emphasis.	Advised the centres accordingly. However, the lack of breeders in various centres make it difficult to initiate breeding programmes.
7.*In situ* conservation may be given importance in case of certain species specific to certain locality.	Noted. However since IISR and ICRI are in a better position to do this, the decision was brought to the notice of these centres.
8.All centres should sent one set of germplasm to IISR for conservation in the national conservatory	All centres are requested to supply one set to the IISR.
9.Characterization and documentation of existing germplasm of turmeric will be completed within two years.	The turmeric Scientists are advised accordingly.

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 with out altering the original treatment schedule.	New technical programmes are formulated based on this decision.
11.Priority should be given for hybridization programme in black pepper and cardamom.	The pepper Research Station Panniyur will take up the work on pepper and the Mudigere centre will take up the work on cardamom.
12.Coordinated multilocational approach should be strictly followed in all projects.	Being followed.
13.The released varieties should be properly popularized.	Being followed.
14.Passport data must be prepared for the germplasm collected and duplicate set of collection along with a copy of the passport data must be sent to IISR.	In germplasm of spices the passport data and characterization of all available germplasm is in progress at all the centres. The decision is brought to the notice of various centres.
15.Voucher specimens should be prepared at the time of collection. Passport data has to be prepared. Distinct entries are to be registered with NBPGR after getting IC Number. Collection work to be completed after intensive survey with in two years. Documentation and characterization are to be carried out wherever necessary.	The Scientists of various centres are advised accordingly.
16 For carrying out various CVT/MLT trials the various centres should despatch the material to other coordinating centers that are taking up the trials without delay.	The exchange of materials were completed well in time.
17.Local checks along with the best released varieties should be included in all varietal trial in future.	Being followed in the new varietal trials.
18.The new CVT in ginger and turmeric to be initiated.	The new CVT in turmeric was laid out at all centres. Ginger trial was not taken up as Pottangi centre could not sent the seed material in the current year.
19.New experiment on efficiency of biofertilizers have to be initiated in turmeric, coriander and fenugreek.	The trials have been laid out as per the IX Workshop decision.

20.Survey of fruit drop in nutmeg to be closed at Dholi.	Noted.
21.The new trial on organic fertilizers and biofertilizers have to be initiated in ginger, turmeric, cardamom etc.	Already initiated.
22.Jagudan centre will discontinue the work on coriander and will concentrate on cumin and fennel.	Noted.
23.The work on fenugreek will be discontinued by Coimbatore centre.	Noted.
24.The germplasm collection work can be completed after intensive survey with in two years. Documentation and characterisation are to be carried out wherever necessary.	Noted
25.The need for reduction in quantity of chemical input usage and experiments on organic farming to create data base on large scale support of the concept was emphasized.	Noted. The newly formulated projects will be useful for this purpose.
26.Absolute necessity for experiments on the use of location specific biofertilizers for productivity increase was stressed.	Noted for future guidance. The biofertilizer trials in various centres used locally available formulations only.
27.The new programme under crop production were discussed in detail and location specific experiments on organic farming and biofertilizer studies in spices identified.	The detailed technical programme on organic farming and biofertilizers formulated in black pepper, cardamom, turmeric, ginger and seed spices.
28.Comparison is to be made between organically grown ad conventionally grown spices in black pepper, ginger and turmeric.	The organic farming in spices is to be initiated using nutrient source of organic origin using PoP on organic farming available at ICRI.

BLACK PEPPER

1.Action may be taken to widen the genetic base of black pepper at all centres.	At Panniyur, 21 cultivated/indigenous type of black pepper were collected and planted during 1999-2000.
2.An action plan on collection should be prepared and submitted by Panniyur. A data base on collected variability should be developed and passport data prepared and communicated to Project Coordinator.	Action plan has already been prepared under the NATP programme.

3. Chintapalli centre has to complete the collection in Eastern Ghats in two years and one set of collection is to be sent to IISR. Intensive survey has to be carried out by Yercaud centre.	The centres has been instructed.
4.A new CVT in black pepper would be started in June 2000 at four centres viz., Panniyur, Sirsi and Ambalavayal with 13 treatments and three replications.	The Scientists are multiplying the materials required f or the trial.
5.Priority should be given for hybridization programme. Action may be initiated to streamline the breeding approaches. Intervarietal hybridization will be continued.	Hybridization programme was intensified by crossing released varieties with promising cultures at Panniyur.
6. A new trial to be initiated in black pepper for foot rot management. A *Phytophthora* foot rot management in Areca-pepper cropping system is also suggested for Sirsi and biocontrol of *Phytophthora* nursery trial for Pampadumpara and Ambalavayal.	It was suggested to take up foot rot management programme in Mudigere centre. Survey was made by Mudigere centre to know the disease intensity and identified the locations in farmers fields for laying out the trails.
7.All centres *viz.*, Panniyur, Sirsi and Mudigere will have a common programme for foot rot management with major emphasis on biocontrol agents.	Biocontrol technology is already available to the govt. agency as well as farmers. RRS Mudigere is producing and supply disease free material to the farmers.
8.Large scale field trials will be laid out in HP based on the result obtained on *Pythium* rhizome foot rot disease management.	Could not be done due to the paucity of funds.
9.Preparation of black pepper passport data and submitting to PC. Voucher specimens are to be collected and herbaria deposited. Distinct genetic entries are to be registered with NBPGR.	The workers are advised to follow the recommendation.
10.All pepper centres have a common programme for foot rot management with major emphasis on biocontrol agent.	Panniyur, Sirsi and Mudigere centres laid out a new experiment for this purpose.
11.The programme on *Phytophthora* foot rot management in black pepper under different cropping system to be followed by Panniyur centre. Final report of *Phytophthora* foot rot disease management to be submitted to Project Coordinator and large scale field trials will be laid out based on the results obtained.	The Panniyur centre is advised accordingly.

12.Survey, crop loss and etiology of anthracnose will be taken up at Mudigere and Pampadumpara and at RARS, Ambalavayal as a voluntary centre. *Survey for insect pests will be conducted during* appropriate season at Pampadumpara. Control of scale insect trial also to be conducted during two seasons at Pampadumpara.	There is no problem of anthracnose at Mudigere. The Pampadumpara centre and Myladumpara have taken up the trail. The survey was completed.
13.New set of experiment on control of nursery disease of black pepper including biocontrol will be laid out after obtaining relevant information from plant pathologist.	Will be laid out in the coming season.

Cardamom

1.Passport data on germplasm collection to be submitted to Project Coordinator by Mudigere. Major estates may be surveyed for locating superior clumps. Drought tolerant lines may be collected through survey by Pampadumpara centre.	The centre has been advised accordingly.
2.For all future varietal trials in cardamom "green gold" and farmers varieties should be included as a control *adopting the released* package of practices.	Will be included in the future varietal trials.
3.Uniform varieties and PoP should be adopted in the experiments at Myladumpara and Pampadumpara.	New experiments are formulated accordingly.
4.A new CVT on cardamom would be taken up in four centres viz., Myladumpara, Sakleshpur, Pampadumpara and Mudigere with 14 treatments and three replications with a population of 18 plants/plot.	The materials are put for multiplication.
5.A new project on root grub management will be taken up at Mudigere and Pampadumpara. Experiment on the natural enemies of major pests of cardamom to be taken up at Pampadumpara also.	Noted. The Scientists of the centre are advised to start the experiments.
6.The experiment on nutrient management shall be concluded at Mudigere and Pampadumpara will continue the experiment. The experiment on micronutrient is progressing at ICRI. This programme can be modified and started at Mudigere and	The programmes have been initiated.

Pampadumpara. ICRI will give the technical programme for the new trial. The experiment on integrated nutrient management has to be laid out at Pamapdumpara with additional treatments.

GINGER

1.Passport data on ginger germplasm to be submitted to NBPGR by Pottangi for getting IC numbers.	The Pottangi centre is preparing the passport data.
2.Survey to be conducted for germplasm. Documentation and characterization of germplasm to be completed in next two years. Passport data to be collected and send to NBPGR.	Noted.
3.The CVT-1996 will be concluded and new CVT to be started.	Noted. The new CVT has been initiated.
4.Based on the results obtained in ginger for rhizome rot management, large scale field trials will be conducted along with biocontrol agent in six major districts of HP with the financial assistance of ICAR/University.	Could not be done due to the paucity of funds.
5.Programme on biocontrol studies on rhizome rot of ginger may be identified with uniform programmes to the ginger centres.	Already identified.
6. Disease surveillance survey in ginger is to be carried out at all centres. Biocontrol studies on rhizome rot of ginger to be taken up at all ginger centres except at Solan.	Being done, and experiments laidout.

TURMERIC

1.Passport data must be prepared and supplied to NBPGR for getting IC numbers.	All turmeric centres have been advised.
2.Local turmeric collection from Thalavadi (high elevation types) must be carried out besides documentation and characterization.	The IISR shall take up this work during its survey work.
3.Curcumin of 157 accessions should be analyzed within next two years.	This work is in progress at Coimbatore.
4.Trial on impact of environment on quality of turmeric will be continued.	The trial is in progress. The trial has been laid out during the year at Coimbatore.

5.The CVT 1996 will be concluded. A new CVT will be taken up next season.	The new CVT has been laid out.
6.All turmeric centres may send the turmeric accessions Acc.360 and 361 to IISR, Calicut for quality analysis.	Action over.
7.New experiment on rhizome rot of turmeric has to be taken up at Coimbatore, Guntur and Jagtial.	This work will be initiated next year. There is a still doubt as to the correct etiology of this disease.
8.Dholi and Pundibari centre to formulate new set of experiment on *Taphrina* leaf blotch avoiding the use of metalaxyl and emisan.	Experiment have been laid out.
9.The experiment on leaf blotch and leaf spot disease may be finalized and new experiment on rhizome rot formulated.	Being carried out.

TREE SPICES

1.The Programme on germplasm collection will continue.	Noted
2.The experiment on propagation/ multiplication trial to be concluded at Yercaud.	Noted
3.The study on fruit drop in nutmeg may be concluded since it is not a major concern.	Noted
4.The Tree spices genetic resources work at Yercaud could be shifted to Pechiparai (Voluntary centre). The tree spices genetic resources work will be discontinued at Dapoli.	Being executed

CORIANDER

1.Quality analysis (oil) of the existing accessions of coriander will be completed within two years.	Will be completed before 2002 at Coimbatore.
2.Survey work will be temporarily suspended at Jobner.	Noted
3.Documentation and characterization of 50 accessions of coriander should be done on priority by Jobner, Jagudan, Coimbatore, Dholi centres	Will be completed before 2002 at Coimbatore.
4.The CVT 1996 on coriander will be concluded.	The trial has been concluded in all the centres.

5.The disease management trial in coriander to be strengthened and new experiment on biocontrol of wilt of coriander formulated.	Evaluation and screening programme identified for the centres. The centres are advised to start the new programmes based on the recommendation of the Workshop in 2000 planting season.
6.Collection of leafy types of coriander will be done. Characterization and documentation must be completed. Quality analysis also to be carried out.	The work is in progress at Coimbatore.
7.The Dholi centre should finalize the programme in seed spices and details submitted to Project Co-ordinator.	In view of the paucity of staff the seed spices work is kept in abeyance.
The experiment on the response of coriander to micronutrients at Jobner can be concluded and the same experiment shall be initiated at Kumarganj.	Noted.

CUMIN

1.The CVT 1994 will be concluded. CVT III 1996 will be continued. New CVT will be taken up next season.	Trials will be continued as per the decision in technical sessions and new CVT will be planted in 2000 rabi season.
2.The germplasm available will be evaluated for blight and wilt resistance, and tolerant ones included in the programmes. Integrated cumin wilt disease management suggested for Jagudan.	New programme will be formulated for 2000 planting season. Integrated management of cumin wilt will be initiated.

FENNEL

1.Documentation of germplasm accessions to be completed and passport data should prepared and sent to NBPGR for giving IC numbers.	Centres are advised accordingly.
2.New CVT will be taken up in fennel	Will be laid out in 2000 sowing season.
3.Quality evaluation, documentaion and characterization to be carried out in fennel.	Centres are directed to follow this decision.

FENUGREEK

1.Characterization and documentation of 50 accessions of fenugreek should be completed and passport data prepared and passed on to NBPGR for getting IC.	Will be completed before 2002 at Coimbatore.
2.The work on fenugreek will be discontinued by Coimbatore centre.	The work on fenugreek discontinued at Coimbatore.

3.New CVT to be started in fenugreek centres. The CVT-1995 will be closed.	New CVT is formulated.
4.The study on spacing/sowing trial can be concluded.	Concluded.

ICAR *AD-HOC* RESEARCH SCHEMES

PROJECT TITLE : **DEVELOPMENT OF RESISTANT VARIETY / LINES OF CUMIN TO WILT CAUSED BY *FUSARIUM OXYSPORUM* USING *IN VITRO* TECHNIQUES**

Principal Investigator : **S Gangopadhyay, S.N. Saxena**
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Objectives:

- Establishment of callus culture from explant of cumin
- To survey, isolate, identify and characterize different pathogenic strains involved in disease development in plants
- To formulate and standardize the protocol for regeneration from callus cultures
- To isolate and purify the toxin from virulent *Fusarium* strain
- Bioassay, demonstration of manifestation of wilt disease symptoms in the presence of toxin
- *In vitro* selection of cell line tolerant / resistant to wilt toxin
- Regeneration of plants from tolerant/resistant cell line

Progress of work:

Purification and soil inoculation studies

Fifty six *Fusarium* isolates were collected from major cumin growing areas of Rajasthan. Single spore cultures of 12 *Fusarium oxysporum* isolates were prepared and pathogenicity tests were carried out. Soil inoculation technique was standardized in order to screen cumin genotypes against *Fusarium oxysporum* f. sp. *cumini* under controlled conditions. The fungus was mass cultured in Czapek-Dox broth at 25°C for 15 days. The harvested mycelia mat was homogenized in sterile distilled water and used for soil inoculation at the rate 1.0, 2.5, 5.0, 7.5 and 10.0g/kg soil. Autoclaved, sterile sandy soil was used in the experiment. Sterilized soil without fungus inoculam served as control. The fungal inoculated soil was incubated for three days. Ten seeds of cumin var. RZ 19 were sown in each pot. The inoculated pots along with control were kept in the growth chamber maintained at 20 and 15°C temperature at day and night respectively with 10/14 hours of light period.

Wilt incidence increased with the increase in inoculum density (ID) of the pathogen. Survival of plants was least (6.66%) at ID level of 10.0g/kg soil respectively. The survival of plants was 45.33 and 37.33 percent at ID level of 5.0 and 7.5g/kg soil. In uninoculated control survival of plant was 90.66 per cent. An inoculum density of 7.5g/kg soil is appropriate for initial screening of cumin genotypes against *F. oxysporum* f. sp. *cumini* under controlled conditions.

Bioassay of crude culture filtrate

Single spore isolate of *Fusarium oxysporum* f. sp. *cumini* (isolate F 3-1) was grown on Czapek-Dox broth at 25°C for 15

days. The harvested mycelial mat was used in soil inoculation tests. The culture filtrate was passed through bacterial proof filter. The toxicity of sterile crude culture filtrate (CCF) was tested on microshoots of cumin var. RZ 19. The CCF was tested at four concentrations i.e. 100, 75, 50 and 25 per cent using sterile distilled water along with two controls i.e. sterile distilled water and Czapek-Dox broth. Two milliliter of each concentration of CCF was taken in 25 ml test tube. Two microshoots were kept in each test tube containing CCF. The test tubes containing CCF and microshoots were incubated in growth chamber having day temperature 20°C, night temperature 15°C and relative humidity 70 percent under fluorescent light.

The CCF induced wilting in microshoots to varying extent. Initiation of wilting was observed in pure and 75 percent CCF after 48 hours of incubation. Complete wilting of microshoots was recorded after 120 hours of incubation, in pure as well as 75 percent CCF. While in 25 and 50 percent CCF the initiation of wilting was recorded after 72 hours of inoculation. The symptoms of wilting were less servere at these two concentrations even upto 168 hours of inoculation. The microshoots in both the controls, sterile distilled water and Czapek-Dox, broth remained healthy upto 168 hours. For screening, microshoots raised from various cumin genotypes, 50 percent CCF of *Fusarium oxysporum* f.sp. *cumini* can be used.

Regeneration studies in cumin

The seeds of cumin (var. RZ 19, UC 216, UC 220) were surface sterilized with 0.1% mercuric chloride for three minutes and washed with sterile distilled water. These seeds were kept on paper bridges in autoclaved culture tubes containing distilled water for germination. These culture tubes were kept in dark at 15°C. After germination, seedlings were kept in light for 16/8 hours light period. Different explants *viz.*, cotyledons, hypocotyl, roots, shoot tips and leaves taken from 14 to 17 day old aseptically grown seedlings, were cultured on MS medium having different hormonal combinations.

Roots: Roots were cultured on MS medium supplemented with different auxins *viz.*, 2,4-D, NAA, IBA, IAA, PAA (0.1-1.0 mg/l). Only rooting along with slight callusing was observed on IBA, IAA and NAA supplemented medium. Cream, friable callus along with granular embryoids was observed on 2,4-D supplemented media. This callus when subcultured on lower 2,4-D (0.001 mg/l) gave rise very good embryoids. However, these embryoids could not develop further. Roots sowed compact, green callusing on BAP (0.5-1.5 mg/l) containing medium.

Hypocotyl: Hypocotylar segments (1.0 cm) when cultured on MS medium containing NAA, IAA, and IBA (0.1-1.0 mg/l) showed rooting and slight callusing. Friable, creamish, globular callus was observed on 2,4-D containing medium. This callus turned purplish after one month of its formation and converted into distinct embroyids. These embroyids did not germinate on media containing different hormonal combinations viz., MS + GA_3 MS + GA_3 + glucose, ½ MS, MS + IAA etc.

Hypocotyl was also cultured on Kn, BAP and TDZ (0.01-1.0 mg/l) supplemented media. Friable and compact green callus was observed on Kn and BAP supplemented medium. No organogenesis was observed. Hypocotyl

showed shoot regeneration on various concentration of TDZ tested. But maximum shoot buds were observed at 0.1 mg/l. So subculturing of these shoots on Kn supplemented medium led to prolific shoot formation. Different combination of auxins and cytokinin were also tried but no shoot generation was observed.

Cotyledons: Cotyledons cultured on media supplemented with different auxins NAA, IAA, IBA, PAA (0.1-1.0 mg/l, showed only rooting. Cream, friable, nodulr callus was observed on 2,4-D (0.1-1.0 mg/l) containing medium. This callus showed distinct embroyids after one month. But embroyids did not germinate in media supplemented with various combinations of hormones.

Very compact, hard, green and nodular callus was observed when cotyledons were cultured on medium containing cytokinins (Kn and BAP). Two to three shoots/explants were observed from cotyledons cultured on TDZ (0.01-1.0 mg/l) containing medium and percent response was very poor.

Shoots obtained from TDZ containing medium were rooted on MS medium with IAA and IBA (0.5-1.0 mg/l). Very poor rooting along with callusing was observed on IAA containing medium. Experiments for perfect rooting are going on .

Leaf: Leaf segment showed friable, creamish callus on 2,4-D (0.1 –1.0 mg/l) supplemented medium. Rooting and callusing was observed from cut ends of leaf on medium containing IAA and IBA (0.1-1.0 mg/l)

Shoot tips: Shoots tips of 14 days old aseptically grown seedlings were cultured on media supplemented with Kn, BAP and different combinations of BAP + NAA (0.5-2.0 mg/l) and BAP + PAA (0.5-2.0 mg/l). Very good shoot multiplication was observed on Kn supplemented medium. Shoot tips cultured on BAP supplemented medium showed stunted growth. Although many auxiliary shoot buds arose but these did not develop into full plant.

Shoot tips cultured on BAP + NAA supplemented medium showed very stunted multiple shoots. These shoots did not elongate. Flowering was observed when these were subcultured on GA_3 containing medium.

PROJECT TITLE : **CHARACTERIZATION OF NUTMEG GERMPLASM FOR QUALITY**

Principal Investigator : **B Krishnamurthy**
Co-Investigator : **T. John Zachariah**
Indian Institute of Spices Research, Calicut

Objectives

- Characterizing nutmeg germplasm based on quality evaluation
- Identification of quality nutmeg accessions from germplasm conservatory.

Progress report

As per the technical programme identified for the first year, analysis of essential oils, oleoresin, NVEE and the gas chromatographic profile of the oil was initiated. Eight accessions were selected for the study. The dried seeds and mace were used for the study. Standardization of leaf oil was also carried out.

Percentage of nutmeg fat (butter) was determined by cold extraction with petroleum ether (40°-60°C). The butter percentage in the seed varied from 24 to 40 and in mace it varied from 18 to 42. Saponification value of the fat was determined using alcoholic KOH and phenolphthaline indicator. Protein was extracted from the defatted sample using tris buffer (pH 7.4) and then estimated using Lowry·s method. Phenol present in the sample was extracted using 80% ethanol and then estimated using Folin-Ciocalteau reagent. Starch and total carbohydrate present in the sample was estimated using phenolsulphuric acid method. Percentage of reducing sugars is determined from the defatted sample using molybdic acid. Determination of essential oil percentage from seed, mace and leaf was carried out by hydro distillation method of ASTA usig Cleavenger Trap. Oleoresin is extracted by acetone, the solvent is evaporated and its percentage calculated.

Nutmeg seed contained 4.5-12.4% essential oil and mace contained 4.9-15.8%. Myristicin and elemicin ranged from 1-18% and 1-22% respectively. Both seed and mace possess butter. The butter in mace is little different from seed as it contains the oleoresin and the pigment lycopene. Nutmeg clearly separates into a solid mass while that of mace remains more or less as an emulsion. The main fatty acid in nutmeg butter is myristic acid.

Leaf contain 1-2.5% oil which has relatively low myristicin and elemicin compared to seed and mace.

The study revealed that accession No.A9-150 has high oil level (12.4% and 9.7% respectively) in seed and mace, and A9-12 besides having high oil levels in (9% and 11%) also has high seed oleoresin (17%) level.

Myristicin and elemicin are the two compounds which cause hallucination. The nutmeg accessions with high myristicin (17%) is A9-41 and very low myristicin are A4-22 and A9-69.

The study of leaf volatile oil levels showed that there is no definite trend with regard to oil in male and female lines. It also revealed the fact that leaf can also be exploited for extracting oil throughout the year with relatively low myristicin and elemicin concentrations. The whole study clearly established the objective of characterizing the germplasm for its chemical profile.

PROJECT TITLE : **PRODUCTION OF HAPLOIDS OF CARDAMOM (*ELETTARIA CARDAMOMUM* MATON.) THROUGH ANTHER CULTURE /POLLEN CULTURE**

Principal Investigator : **Dr P N Ravindran, Dr K Nirmal Babu**
Indian Institute of Spices Research, Calicut

One of the important parameter in anther culture is the selection of anthers at an appropriate stage of pollen development. In most of the plant species uninucleate stage of microspore has been reported to give optimal response. Squash preparations of anthers from flower buds of a single raceme were made. Flower bud size, anther size and stage of microspore development were recorded. The result of the study is given below.

buds, at different maturity, with anther at different stages of microsporogeneisis, were collected from Cardamom Research Centre (CRC), Appangala, Koorg, Karnataka; Indian Institute of Spices Research (IISR) experimental farm, Peruvannamuzhi, Kerala and Sugandhagiri Cardamom Project, Vythiri, Wynad. Flower buds from different varieties like Malabar, Mysore

Nature of flower	flower size (cm)	Anther size (cm)	stage of microspore Development
I flower (opened)	2.5	0.7	Late uninucleate
II flower (unopened)	1.1	0.5	Early uninucleate
III flower (unopened)	0.6	0.3	Tetrad
IV flower (unopened)	0.4	0.2	MMC

It was found that 1.1 cm long flower buds just emerging form the leafy bracts contain microspores at the early uninucleate stage. So, in our subsequent studies anthers from such flower bud were used.

Pollen viability was also studied and the percentage of viable pollen from Malabar and Mysore are given below.

IISR, Calicut (cv. Malabar)	14%
Experimental farm, Peruvannamuzhi (cv.Malabar)	30%
CRC, Appangala (cv. Malabar)	72%
Sughandhagiri cardamom project (cv Mysore)	65%

Explant collection

Flower elusters (cineinni) with 3-5 flower

and Vazhukka and important lines from CRC, Appangala like CCS-1, NKE-34, RR-1, MB-3 and green gold were used in the present study. Flower buds were excised and collected in polythene covers These covers were tied and kept in icebox and brought to the lab.

Disinfection of flower buds

Flower buds collected in polythene

covers were taken out and were brushed well with detergent. The bracts covering each bud were removed with the help of a needle and washed in running tap water before being surface sterilized with 0.1% mercuric chloride for 5 min. followed by three washings in sterile distilled water.

After surface sterilization, flower buds were cut of with the help of a sterile surgical blade and forceps and the anther in each bud was dissected out under sterile conditions. Excised anther was inoculated in different basal media with or without growth regulators and incubated in dark at 24 $\pm$2°C or under cold as well as hot conditions.

Pretreatment of inoculated anthers

Cold and heat shock treatments were proved to be beneficial for anther culture in many of the horticultural crops. For cold treatment, keeping cardamom flower bud under cold conditions for more than one day, resulted in decaying of anther due to bacterial infection. So, after inoculation in culture media they were given cold treatment at 4°C and 16°C for 1-7 days. Anther remained fresh under cold conditions at 4°C and 16°C but when transferred to 24$\pm$2°C they become brownish and blackened and within four days of transfer. For heat shock, inoculated anthers were kept under 28°C and 32°C for 1-7 days under dark conditions. Anther remained as such without any promising results.

Culture media

Nutritional requirement of anthers is one of the important factor, which determine androgenesis. So for culture initiation, seven different basal media, with or without growth regulators, were issued. They include Keller's, Murashigue & Skoog (MS), Nitsch, Nitsch & Nitsch (NN), Schenk & Hildbrndt (SH), B_5 and Brewbaker and Kwack's medium. Different growth regulators like a-naphthalene aceticacid (NAA), 2-4-dichlorophenoxyaceticacid (2,4-D), indole-3-acetic acid (IAA), indole-3-butyricacid (IBA), 6-benzylaminopurine (BAP) and Kinetin (KN) at different combinations and concentrations ranging from 0.0-10.0 mg/l were ued to induce androgenesis. Both liquid as well as solid media were tested.

Anthers, incubated in different basal media enriched with BAP (0.5 mgl^{-1}) and NAA (0.5-2.0 mgl^{-1}) under dark at 24 $\pm$2°C, swelled within 4-6 days of inoculation. The highest percentage of response (62.00) was that observed in SH medium followed by MS, Nitsch & Nitsch and Kellers. All of the swelled anthers did not develop further in any of the media tested, except one, which when transferred to MS medium with BAP (0.5 mgl^{-1}), NAA (1.0 mgl^{-1}) and KN (0.5 mgl^{-1}) produced embryo like structure after six months of inoculation. Studies are going on to regenerate plants from those structures.

Squash preparations of the inoculated anthers, at two days of intervals, were made in FDA (1%) and propionocarmine (2%) to find out the viability and to trace the development of the microspores. The viability of the microspore lost within 4-6 days of inoculation and the nuclei of the microspores showed a tendency towards degeneration.

In liquid medium percentage of anthers showing swelling was more than that in solid medium. In SH medium 85.00% of the inoculated anthers showed swelling.

PROJECT TITLE : ESTABLISHING *IN VITRO* CONSERVATORY OF SPICES GERMPLASM

Principal Investigator : Dr K V Peter, DR K Nirmal Babu

PROGRESS OF RESEARCH (1999-2000)

Developing cryopreservation protocols

a) Black pepper

Studies were conducted to standardize a protocol for cryopreservation of zygotic embryos by encapsulation/dehydration method and also after giving cryoprotective pretreatments. Encapsulated embryos were desiccated to 1-4 before plunging into liquid nitrogen (LN_2). In another set of experiment the embryos were cryoprotected using Dimethyl solfoxide (DMSO), glycerol and sugar, singly as well as in combinations, ranging from 5-15% for 30-60 m and kept in dark. After LN_2 treatment, thawed embryos as well as the controls were cultured on recovery medium.

The LN_2 treated encapsulated embryos showed only 5% viability and trials are going on to refine the technique so as to get high rate of viability. In the first post-freeze recovery stage, 20% of the LN_2 exposed embryos, which were treated with the cryo protectant solution containing 15% DMSO, 10% sucrose and 10% glycerol for 30m, showed slight enlargement. Later callus proliferation was noted from that tissue. The low frequency of embryo germination, after cryopreservation, indicates need for refinement of cryopreservation procedures and also post-thaw culture medium and conditions.

b) Cardamom

In the present study apical and axillary buds were cultured in MS liquid medium, prechilled at 4°C for 1-2 days and gradually exposed to prechilled PVS2 solution from a lower concentration of 10, 20, 40, 60, 80 and 100% for a predetermined period of time. The shoot tips were then freezed, thawed and recultured in recovery medium. The same experiment was repeated using a cryoprotectant solution containing 15% DMSO, 10% glycerol and 10% sucrose and encapsulated shoot buds as the material.

The control, which showed maximum survival rate of 80%, was the one which were gradually exposed to vitrification solution of 10, 20, 40 and 60% for 30, 15, 10 and 8 m duration respectively. In the first post freeze recovery stage of the LN_2 exposed shoot buds, green colouration of the shoot buds were evident after the treatment. The shoot buds retained the colour for 5-7 days, but was lost later on. The encapsulated shoot buds, which were treated with the vitrifying solution and cryoptotectant solution for 30-60 m, also germinated with a survival rate of 60%-80%. The LN_2 exposed shoot buds also showed a first post-thaw viability response. The first post freeze recovery response indicate the post thaw -viability. Hence, further experimentation is needed in this direction, to recover and regenerate cryopreserved shoot tips.

c) Ginger

Encapsulation/Dehydration method was tried using encapsulated shoot buds from *in vitro* grown cultures of ginger. Beads were freezed, thawed and recultured on recovery

medium. After one week the beads were broken and the shoot buds were cultured on same combination of solid medium for further growth responses. Among the 20 trials conducted the controls showed 90-100% viability and survival and their respective LN_2 treated ones showed 0-30% viability. Recovery and regrowth was very slow. The tissue turned green and growth in size was also observed. Plantlet formation is yet to achieve. Desiccation for 2-5h found deleterious to the tissue and no viability observed. In the controls 10-15% viability was observed.

d) Vanilla

Shoot buds were dissected out from *in vitro* grown cultures of vanilla, desiccated for 1-2h and were given cryoprotective pretreatment using DMSO and glucose at 5% and 2.5% concentration, singly and in combination. The samples were kept at 4°C and 25°C for 24h. The shoot buds were freezed, thawed and cultured on recovery medium.

Shoot tips, which were desiccated for 1h exhibited 90% recovery in the control, whereas the LN_2 treated ones showed only 20% viability. Desiccation for 2h was lethal and shoots dried up. Shoot tips which were precultured in 5% DMSO at 25°C for 24h, showed 90% viability in terms of retaining the green colour immediately after thawing and initiation of growth after 2 weeks of culture. The same treatment at 4°C, was not promising, as it showed vitrification eventhough remain green soon after reculture. In all other treatments the shoot tips turned white and/vitrified and no favourable growth response was observed.

Retrieval of conserved germplasm

In order to assess the efficiency of any *in vitro* storage method, *in vitro* cultures of all the species, which were in minimum growth storage conditions were transferred to multiplication medium for recovery and regrowth. Cultures of all the species, after 1 year of storage could be brought back to normal conditions with 90% success and are transferred to soil. The rooted plantlets were established in the soil with 80% success. Vanilla culture could be transferred to the soil directly from the slow growth medium with 90% success.

Conservation of spices germplasm *in vitro*

Establishment of accessions *in vitro*, was attempted and priority was given to those with important characteristics like high quality, high yield, resistance to disease etc. Newly established *Piper* species include *P. peepuloids*, a high elevation species and *P.cubeba*, a medicinally important species. Important cardamom accessions established are CCSI, a released variety with high quality ad yield and RR 1 a rhizome rot tolerant variety. The *in vitro* repository at present holds 505 accessions of all the spices.

PROJECT TITLE : **PRODUCTION OF SOMACLONES AND SOMATIC HYBRIDS OF CARDAMOM (*ELETTARIA CARDAMOMUM* MATON.) FOR HIGH YIELD AND RESISTANCE TO DISEASES**

Principal Investigator : **K V Peter, K Nirmal Babu**

Progress of work – Production of somaclones

Callus induction and regeneration: Callus could be induced from *in vitro* derived leaf and pseudostem explants of cardamom (PVIX CI 37, NKE 27 & 30) when cultured on MS medium with 2.0 mgl^{-1} 2,4-D. The calli produced were of two different types, one is hard exbryogenic callus on transfer to MS medium with 0.5 mgl^{-1} NAA and 1.0 mgl^{-1} BAP turned organogenic and this callus can be used for further plant regeneration. Regenerating callus cultures were subcultured on to MS medium with 0.5 mgl^{-1} NAA and 1.0 mgl^{-1} BAP. Large number of plants were regenerated from these callus cultures. The plantlets exhibited 3 morphotypes in culture itself.

Hardening of somaclones: Callus regenerated plants (somaclones) were rooted in basal MS medium. The rooted plants for hardening were transferred to the hardening facility.

Field planting of somaclones: Hardened plants were transferred into poly-bags with garden soil and maintained in the green house for 60-80 days till they are ready for transfer to field. Plants 50-60 cm height was transferred to field at Cardamom Research Centre, Appangala. The plants were planted in 2x2 m spacing.

Protoplast isolation and culture

Protoplast isolation: In the present attempt to isolate protoplast from cardamom, different tissues such as young leaves from nursery grown plants, leaves from *in vitro* cultures, creamy white fragile callus and cell suspension cultures were used. Two enzymes were used in the course of trials, they were Macerozyme R-10 and Cellulase Onozuka R-10 at different concentration ranging 0.5% to 2.0%. In the present trials, mannitol was used at four concentrations (8%, 9%, 10% and 13%) as osmoticum. After incubation, the enzyme solution with protoplast was filtered through a stainless steel mesh (60 mesh size-sigma) to remove portions of undigested tissues and cell clumps. A sample was observed under inverted microscope to confirm enzymatic digestion and release of protoplast.

Protoplast culture: Five drops of culture medium I containing protoplast were placed in the bottom half of the petridish, which were then sealed with parafilm to reduce the loss of water from the culture medium. The preparation was covered with aluminum foil and kept in dark at 25°C. After seven days in culture, fresh culture medium with low osmoticum was added to replenish the nutrients. The samples were periodically observed for all regeneration and division. Wall formation was observed in 90% of the protoplasts after two days in culture. After 20 days of culture the cells showed further division. At this stage the protoplast suspension was plated on agar solidified culture medium II. Within 30 days of culture, 30% of the dividing cells produced microcallii. Further divisions and changes are to be traced.

Isolation of protoplasts from embryogenic suspension cultures: Protoplasts isolated from leaf mesophyll cells after purification, plated on to protoplast culture medium fortified with different combinations of growth regulators did not develop beyond the microcallus stage. As regeneration from mesophyll derived protoplasts was found to be difficult, embryogenic suspension cultures were initiated from different explants of cardamom for isolation of protoplasts.

Initiation and maintenance of embryogenic suspension cultures :

Callus was induced from different explants on MS medium containing 2,4-D alone or in combination with BA & Kin.as growth regulators. Thin transverse sections of the psudostem of *in vitro* grown plants in MS medium containing 2mgl^{-1} 2,4-D and 0.5 mgl^{-1} BA gave the best results in terms of callus induction and proliferation. Explants were cultured for an initial period of 28 days in dark for callus initiation and then transferred on to the same medium in light for further proliferation.

Initiation and maintenance of suspension cultures:

Friable callus initiated in MS medium containing 2,4-D and BA was transferred to liquid medium containing different combinations of growth regulators and maintained in dark and light conditions on orbital shaker at 90 rpm. Medium containing 2.0 mgl^{-1} 2,4-D and 0.2 mgl^{-1} TDZ produced embryogenic cells and were maintained in the same medium by subculture at an interval of 20days.

Protoplast isolation from suspension derived embryogenic cells: Cells (approximately 1 g) from embryogenic suspension cultures were treated with 5ml of the enzyme solution. Different combinations of enzyme solutions were used for the isolation of protoplasts. Of the different enzyme solutions tried, ESH, consisting of 10% Manitol, 3% Cellulase and 1% Macerozyme gave the best results in terms of number of protoplasts isolated and viability. Further studies are on to arrive at a combination of enzymes wherein the yield and viability of the protoplasts are suitable for further culture and regeneration.

Field evaluation of somaclones

Callus regenerated plants (four months old) were transferred to the field at Cardamom Research Centre, Appangala (Regional Station of Indian Institute of Spices Research). Data collected from these plants after two years showed considerable variations in terms of morphological characters. The prominent variations observed include some robust plants with very dark leaves, some very tall plants, one plant even showed the production of inflorescence from the terminal portion of the pseudostem.

Assessment of variability among somaclones, using isozyme markers

Native Poly Acrylamide Gel Electrophoresis (Native PAGE) was done to assess the variability among the somaclones in peroxidase and esterase isozymes. Initial studies showed differences among the somaclones in esterase isozyme patterns. Peroxidase isozyme patterns did not show much differences among the somaclones. Further studies are on to assess the variability among the somaclones using more number of isozyme markers.

PROJECT TITLE : **EFFECT OF ORGANIC FERTILIZERS ON SOIL QUALITY, PRODUCTIVITY AND QUALITY OF BLACK PEPPER AND CARDAMOM**

Principal Investigator : **V. Srinivasan**
Indian Institute of Spices Research, Marikunnu Post, Calicut-673 012

Objectives:

- Investigations for understanding the organic status of traditional pepper and cardamom growing soils of Kerala and Karnataka states.
- Investigations into changes induced in soil quality by introduction of various kinds of organic fertilizers on physical, physico-chemical and microbiological properties of soils.
- Investigations on effect of organic fertilizers in making available native and added nutrients
- Investigations into effect of organic matter decomposition, entry of organic ions into root system and plant body, which help better translocation of nutrient ions.
- Investigations of effect of organic fertilizer on nutrient use efficiency
- Investigations on effect of organic fertilizers on production and quality of organic spices.
- To workout the production cost.

Progress of Research

For the third consecutive year, field experiments were laid out in Coorg district of Karntaka, both for pepper and cardamom in split plot design. Main plot treatments were-with and without pesticides application. The sub-plot treatments were-check, FYM, neem cake, leaf compost, vermi-compost and NPK @ 100:40:140 kg/ha. The same treatments were imposed for bush pepper cv-Panniyur-1 and Karimunda under greenhouse experiment at Peruvannamuzhi, Calicut. Organic sprays of vermiwash and neem oil were also given.

Green house Experiment

Among the organic sources, leaf compost treatment recorded higher soil availability of O.C, K, Ca and Mg whereas Fe, Zn and Cu content were highest in vermicompost treatment.

Application of organic sprays had little but significant role in the soil nutrient availability. The soil from pots which were sprayed with organics was significantly high in P, K, Mg, Mn and Zn.

Organic fractionation of experimental soil showed that fulvic acid content was higher than humic acid content.

The leaf nutrient composition revealed a higher uptake of Ca, Mg, and Fe in vermi-compost treatment in both the varieties. Regarding berry-uptake, N, P and K uptake was significantly higher in FYM treatment followed by vermi-compost.

The highest yield in bush pepper (273 g/pot for Panniyur and 177 g/pot for Karimunda)

were recorded for FYM treatment followed by vermi-compost and leaf compost treatments. The piperine content was also significantly high in FYM treatment in Panniyur, whereas in Karimunda, leaf compost treatment recorded higher piperine of 5.5%. Oleoresin content was on par in FYM and leaf compost treatments in both varieties.

At harvest, highest bacterial population was observed in neem cake treatment followed by FYM. The population of phosphate solubilizing bacteria was highest in neem cake, while fungal population was highest in vermi compost and that of actinomycetes in FYM treatment.

Field experiment

Application of organic fertilizers improved the soil physical properties by decreasing the bulk density and increasing the water holding capacity of the soil.

There is build up of organic carbon and P at harvest, but depletion of K, Fe, Mn and Zn. Humic acid fraction was dominant over fulvic acid among the soil organic matter fractions.

There was substantial reduction in phosphate solubilizers and N fixers in plots with pesticide application, at harvest. In plots without pesticide application, FYM treatment showed maximum population of bacteria, fungi, free-living N-fixing bacteria and P-solubilizing bacteria. Bad weather condition and alternate bearing of Panniyur variety resulted in poor yield of pepper in the field.

Cardamom

Water holding capacity increased with organics. The percentage organic carbon was highest in neem cake treatment followed by leaf compost, which also showed higher availability of P, K, Ca and Mg at harvest. The content of humic acid fraction was hgher than that of fulvic acid. In general, Cu content in leaf was high. Microbial population increased with application of organic fertilizers.

The highest dry yield of 1.1 kg/clump was recorded for neem cake treatment, which was on par with vermi-compost treatment.

Quality parameters – 1-8, cineol and alpha-terpinylacetate were found to be significantly higher in FYM and vermi-compost treatments.

PROJECT TITLE : **HYBRIDIZATION IN GINGER, *ZINGIBER OFFICINALE* (ROSC.) THROUGH *IN VITRO* POLLINATION.**

Principal Investigator : **P A Valsala,**
College of Horticulture, Vellanikkara – 680 654, Trissur

Technical programme

Production of hybrids

In vitro crosses in the following combinations will be made

- Rio-de-Janeiro x Maran
- Maran x Rio-de-Janeiro
- Rio-de-Janeiro x S.G.66
- Rio-de-Janeiro x Kuruppampady
- Rio-de-Janeiro x Nadia
- Rio-de-Janeiro x V K Local

Mature seeds will be germinated and hybrids will be raised.

Progress of research

Since conditions required for germination could not be identified during the first year, intensive work was done to achieve this objective. Exploratory research was carried out to optimize media requirements for the development of the seed. For this endosperm development in seeds in various hormone and sucrose combination was examined. In contrast to previous years research embryo rescue and germination studies were done with seeds of 20 days maturity. Previous year this was done with 40 to 80 days old seeds.

1 Optimize media components for seed development.

Influence of various levels of sucrose i.e. 3 to 12% along with cytokinin and auxin in endosperm development was examined. The influence of BAP and kinetin at 2.5 mgl^{-1} along with NAA (0.5 mg l^{-1}) or 2,4-D (0.5 mg l^{-1}) or IAA (0.05 to 0.2 mg l^{-1}) and varying levels of sucrose i.e. 3, 6, 8, 12% in basal media of ½ MS and full MS for endosperm development was examined in 20 days old seeds.

2 Embryo rescue and germination studies was repeated with 20 days old seeds.

3 Germination studies as per the technical programme of 1st year was repeated with 20 days old seeds as given below.

3.1 Primary treatments

The seeds of 20 DAP were kept on moist filer paper, moist sand and basal medium (both solid and liquid) for germination.

3.2 Treatment with hormones

Seeds will be incubated in various media combinations involving cytokinins, auxins, GA_3 and ethylene. BAP as well as KIN at 5, 8, 10, 15 mg l^{-1} in combination with 0.1 to 2 mgl^{-1} 2, 4-D or IAA or NAA will be tried . The effect of GA_3 and ethylene at levels of 5, 6, 8 and 10 mgl^{-1} will be studied. The cultures will be kept in dark as well as in light conditions.

3.3 Chemical scarification

Treating with HNO_3 25% for 10 min. and sowing under *in vitro* conditions.

3.4 Stratification

Seeds will be subjected to low temperature of 2°C to 5°C at varying time intervals of 6, 12, 18 and 24 hours. Stratified seeds will be incubated in various hormone combinations.

3.5 Washing the seeds in running water and sowing

Seeds will be washed in running water at various time intervals of 2, 6, 8 and 12 hours and will be sown under *in vitro* conditions.

3.6 Priming of seeds and sowing

Seeds will be inoculated in 12% mannitol or PEG 4000 for 10 to 15 days and will be allowed to imbibe water for 12 hours. Then they will be kept for germination in the following media combinations.

½ MS + 3% sucrose + IAA o.1 mgl^{-1} + BAP 5 to 20 mgl^{-1}

½ MS + 3% sucrose + 2, 4-d 0.2 mgl^{-1} + BAP 5 to 20 mgl^{-1}

c) For the next year

Clonal multiplication of hybrid population. The hybrids will be multiplied by the identified procedure and will be field established.

1 Optimizing media components for Endosperm filling

The seeds were developed in all tested media combinations. The seeds developed in the media combinations of BAP 2.5 mg/l, NAA 0.5 or IAA 0.05 or 0.2 or 2,4-D 0.5 along with varied concentrations of sucrose 3 to 12%. But the endosperm filling was not complete 20 days after pollination (DAP). Same was the results with similar treatments with kinetin 2.5 mg/l. The longitudinal section of the seed showed two seed coats, enclosing a cavity. In the cavity endosperm with embedded embryo was seen. The central cavity was not fully filled by endosperm.

In ginger, seed set and seed development is not usually observed in nature.

2. Embryo rescue studies

The seeds of 20 DAP was subjected to embryo rescue studies. The technique followed was transfer of embryo along with endosperm. The rescued embryo along with a small bit of endosperm was incubated in ½ MS medium containing combination of 2, 4-D (0.5, 1.0), NAA (0.5, 1.0) of IAA (0.05) with BAP (5, 10, 15, 20) mgl^{-1}.

Embryo rescue technique tried had no favourable response on the germination of embryo.

3. Seed germination studies

3.1 Primary treatments

The seeds of 20 DAP are subjected to various primary treatments i.e., keeping on moist filter paper, moist sand and basal medium (both solid and liquid) for germination.

3.2 Treatment with hormones

The seeds 20 DAP were incubated in various media combinations for germination.

3.2.1 Influence of 2,4-D and BAP

The results of 2,4-D-BAP combination studies indicated that 2,4-D (0.1 to mg/l) along with BAP (5 to 20mg/l) in the basal medium of ½ MS + 6% sucrose had no influence on the germination of ginger seeds.

3.2.2 Influence of NAA with BAP and 2ip

NAA (0.5 to 2mg/l) along with BAP (5 to 20mg/l) in the basal medium of ½ MS+6% sucrose recorded no response on seed germination. The combination of NAA (0.5 mg/l) along with 2ip (2.5 to 5 mg/l) also did not produce germination in ginger seeds.

3.2.3 Influence of IAA with BAP and 2ip

The growth hormone IAA (0.05 to 0.2 ,]mg/l) along with BAP (5 to 20 mg/l) in the basal medium of ½ MS + 6% sucrose recorded no response on seed germination in ginger. Similarly IAA (0.05 to 0.2 mg/l) along with 2ip (2.5 to 5 mg/l) also did not positively influence seed germination.

3.2.4 Influence of GA_3 and ethylene

GA_3 (0.1 to 10 mg/l0) and ethylene (5 to 10mg/l) had no influence on seed germination in ginger.

3.3 Chemical scarification

Seeds were scarified with HCl (50%) and HNO_3 (25%) for 3 to 10 minutes and after washing were incubated in the ½ MS medium alone or with NAA 1mg/l and BAP 10 mg/l.

The data on results of chemical scarification showed no response on germination of ginger seeds.

PROJECT TITLE : **BIOLOGICAL CONTROL OF PLANT PARASITIC NEMATODES OF MAJOR SPICE CROPS**

Principal Investigator : **K V Ramana and Santhosh J Eapen,**
Indian Institute of Spices Research, Calicut.

Objectives:

- Isolation and identification of native isolates of biocontrol agents from the rhizosphere and rhizoplane of ginger and turmeric.
- *Culturing and maintenance of above isolates;* testing their efficacy in suppressing target nematode species in *in vitro* and *in vivo* studies.
- Understanding the ecology and mode of action of these isolates on plant parasitic nematodes.
- Standardizing mass multiplication of promising biocontrol agents and developing suitable delivery systems.

Progress of research

1 Isolation of naturally occurring biocontrol agents (BCAs)

A random survey was conducted in three major ginger and turmeric growing districts of Kerala viz., Calicut, Idukki and Ernakulam during the year. Altogether 27 soil and root samples were collected and on processing using standard techniques, 33 bacterial and 43 fungal isolates were obtained.

2 Growth and morphology of different isolates of BCAs

Colony morphology and growth of 57 isolates of different fungi were studied and there was a wide variability in the colony morphology of several fungal collections. Isolates of the same species differed in their rate of growth and appearance in the same media as well as different growth media. Growth of isolate 34 was very fast and maximum in PDA while isolates 31 and 35 grew better in CMA and carrot agar, respectively.

3 Mode of action of BACs

Mode of action of promising fungal isolates on root knot nematode (*Meloidogyne incognita*) was studied in three different assays viz., hatching suppression, egg parasitization and toxic metabolites. All the 23 fungal isolates tested showed inhibition on hatching of nematode eggs ranging from 25 to 96 %. Five isolates (Isolate No.11, 32, 34, 35 and 36) have very high inhibitory effect (>90%) on the hatching while another nine isolates suppressed egg hatching by more than 80%.

Twenty-five isolates were studied to see their egg parasitizing ability. Isolate No.13, 15, 20, 27, 32, 33, 34, 35, 41, 44,49 and 57 showed good parasitization of root knot nematode eggs.

Culture filtrates of six fungal isolates (Is.31,32,34,35,36 and 57) were tested for their effect on root knot nematode juveniles and eggs. These tests have shown that there was no significant difference between sterile and non sterile culture filtrates on the mortality or hatching suppression. It also proves the involvement of toxic metabolites of fungi,

which are thermo stable, in the nematode suppression, in addition to the direct parasitism by some fungi.

a) In vivo evaluation in green house

Aspergillus rugulosus (Is No.2) were studied separately in three different green house experiments for their ability to suppress root knot nematodes infesting tomato. Among the three isolates, *P.lilacinus* was noteworthy as it has profound effect on the growth of tomato plants. All the three fungal isolates significantly suppressed the nematode population in both soil and roots and hence can be used as potential biocontrol agents.

Another greenhouse trial was conducted using four fungal biocontrol agents (*Fusarium oxysporum, Aspergillus rugulosus, Verticillium chlamydosporium,* and *Trichoderma harzianum*) to study their effect on root knot nematodes infesting ginger. None of the isolates tested have any adeverse effect on the growth of ginger plants. However, only *V.chlamydosporium* improved growth of ginger plants in the presence of root knot nematodes.

b) Studies on mass multiplication and delivery system

Different carrier substances such as rice, neem oil cake, saw dust, coir pith, terra care, tea waste, cocoa pith, ginger and turmeric shoot powder were tested for their efficacy as substrates for the growth of two promising fungi, *P.lilacinus* and *A.rugulosus*. Both rice and ginger shoot powder supported very good sporulation and multiplication of *P.lilacinus* and *A.rugulosus*. *A.rugulosus* multiplied well in tea waste too. Ginger shoot powder was an ideal carrier substances as it is light in weight and esily available as an agricultural waste in ginger fields.

PROJECT TITLE : **COLLECTION, MAINTENANCE, EVALUATION AND STANDARDIZATION OF AGRO-TECHNIQUE FOR SOME SEED SPICES OF N.E.INDIA.**

Principal Investigator : **Luchon Saikia,**
Assam Agricultural University, Jorhut -785013

Progress of research

Cumin

Cumin is predominantly cultivated in the drier regions of India particularly Rajasthan and Gujarat. However, in a very limited scale in the lower Brahmaputra valley cumin is found to be grown by a section of people. The climatic conditions of Assam are humid tropic with irregularly distributed rainfall through out the year. Pre monsoon rain during the early spring i.e. in the month of March and April is very common.

Seed germination was restricted to 15-20% in the field during the year.

PROJECT TITLE : **SCHEME FOR INTENSIFICATION RESEARCH ON VANILLA (*VANILLA PLANIFOLIA* ANDREWS)**

Principal Investigator : **N Kumar,**
Tamil Nadu Agricultural University, Coimbatore

Approved technical programme for the year

1 Collection, conservation and evaluation of vanilla genotypes.

2 Studies on integrated nutrient management in vanilla

3 Standardization of quicker mass multiplication

4 To study the effect of growth regulators on pod set, pod growth and maturity.

5 Standardization of optimum curing technique.

A total of 11 genotypes have been assembled form different sources and planted in the field.

In each treatment 20 cuttings were employed. The mean data on length of vine, internodal length, number of leaves and number of laterals are recorded. It may be inferred from the table that among the various genotypes tried VP.11 collected from M/S. Limenaph chemicals (P) Ltd., Rajapalayam registered the maximum length of vine (440.22 cm), Internodal length (15.1 cm), number of leaves 78.51 and number of laterals (5.53) than the rest of the genotypes.

Programme No.2: Studies on Integrated Nutrient Management (INM) in Vanilla

To optimize the NPK requirements of vanilla, a trail was initiated with varying levels of inorganic fertilizers in combination with biofertilizers.

The following are the treatment combinations for this trial

T_1 - Control

T_2 - Application of 25g. each of VAM, Azospirillum and phosphobacterium/vine/year

T_3 - 25g of NPK/vine/year

T_4 - $T_2 + T_3$

T_5 - 50g. of NPK/vine/year

T_6 - $T_2 + T_3$

T_7 - 75 gm of NPK/vine/year

T_8 - $T_2 + T_7$

T_9 - 100g of NPK/vine/year

T_{10} - $T_2 + T_9$

The biometric characters on length of vine, number of laterals, internodal length and number of leaves were recorded. The length of vine (540.20 cm) internodal length (15.16) and number of leaves (102.20) were maximum in the treatment 100 gm of NPK/vine/year with 25 gm each of VAM, Azospirillum and phosphobacterium/vine/year. The treatment viz., 75 gm NPK/vine/year recorded maximum number of laterals (6.83).

Programme No.3 : Standardization of quicker mass multiplication techniques.

This trial was taken up with different type of cuttings, growing medium and various concentration of growth regulators. The details of the treatments are:

Type of cuttings:

C_1 - Single node cuttings

C2 - Two node cuttings

C3 - Three node cuttings

C4 - Four node cuttings

C5 - One metere length cuttings (Conventional practice)

Type of medium

M1 - Forest soil : Sand: Coir dust (1:1:1 ratio)

M2 - Forest soil : sand : cow dung (1:1:1 ratio)

Growth regulators : Using quick dip method

1. 1000 ppm of IBA
2. 2000 ppm of IBA
3. 5000 ppm of IBA

In each treatment 20 cuttings were employed. The experiment was laid out in completely randomized block design with two replications. The mean data recorded on per cent success (rooting), mean plant growth (new flush formation) and the root length (cm) indicated that among the various types of cuttings tried, one metre length cuttings registered the highest percent of rooting (100%) followed by four, three, two and single nodal cuttings in order. One metre length cuttings also produced more plant growths and root length than the rest of the cuttings. There is no perceptible differences among the types of media in influencing the rooting success. Among the various concentrations of IBA tried, 2000 ppm appeared to induce better rooting concomitant with better plant growth and root length.

PROJECT TITLE : **EXPLORING THE POSSIBILITY OF SPICE CROP UNDER HUMID SUB-TEMPERATE CONDITIONS OF HIMACHAL PRADESH**

Principal Investigator : **Yudhvir Singh,**
Himachal Pradesh Krishi Viswa Vidhyalaya, Palampur.

Technical Programme

All the genotypes collected in ginger will be put under variability studies and high yielding rhizome rot resistant lines will be multiplied on a larger area. Trial on effect of size and spacing on yield and yield contributing traits and nutritional requirement of ginger crop will be carried out. Storage experiments on ginger and turmeric will be conducted. Various fennel genotypes will be evaluated for their adaptability and yield contributing characters.

Progress of research

Among the forty-seven genotypes of ginger, evaluated during the second year of research, D-2 yielded highest fresh rhizomes/ plant (266.6 g/plant) but it showed susceptible reaction to rhizome rot, a devasting disease of the crop in the state, under field conditions. However it was marked the best genotype on the basis of its norphological appearance in the field. Some other genotypes showing promise from yield point of view were K-Local (230.7 g/plant) which gave highest yield during 1998, Samoh-II (227.2 g/plant), Naraga (220.5 g/plant), Ruana Local (214.2 g/plant), Jwalapur (211.5 g/plant) and Samoh-1, which showed resistance to rhizome rot disease. Genotypes Himachal Ginger-1, and Jwalapur were found superior in moisture per cent and crude oil per cent respectively. In size and spacing experiment of ginger, the combination large size (75.0g) at closer spacing (30 x 20 cm) produced the highest yield (606.66 q/ha). The combination–medium size rhizome (50.0 g) at closer spacing (30x20 cm)–was the second highest yielder (388.33 q/ha). Under nutritional requirement-experiment of ginger it was observed that N:P:K at the ratio of 75:50:50 produced the maximum (252.0g) yield per plant (fresh) followed by 247.0 g per plant at the ratio of 75:50:25 kg/ha N:P:K, respectively. In storage experiment of ginger it was observed that when rhizomes treated with fungicide were put in pits covered with a layer of sand, there was less rotting whereas in storage *in-situ* and heap storage (local method) rotting/drying of rhizomes was more than pit storage (treated with fungicide). Ten genotypes were rated as very good (G_1), nineteen as good (G_2), eleven as moderate (G_3) and six as poor (G_4) for storage capability under pit storage with sand (rhizomes were treated with Dithane (Indofil) M-45). Treatment of fungicide given for 30 minutes duration to kill the surface pathogens.

Sixty-five genotypes of turmeric were screened, Kangra Local-3 yielded highest fresh rhizomes per hectare (336.66 q/ha) and was also marked the best genotype on the basis of its morphological appearance. Some other genotypes showing promise from yield point of view were Manenthody (323.33 q/ha), PTS-10-A, KS-1 (316.66q/ha) and Alleppy (301.11 q/ha). These genotypes exhibited good morphological appearance under field conditions.

An experiment on intercropping of turmeric with maize, okra, colocasia and French bean (dwarf & pole type) was also conducted to observe their effect on yield of turmeric and to generate extra income from short duration vegetables. It was noticed that shading effect of intercrops on turmeric gave luxuriant growth without distributing the spacing, however with colocasia as intercrop lower yield of turmeric was obtained. This may be because of the competition for the development of rhizomes of both the crops. Out of these, French bean and okra proved the best intercrops. In another experiment one set of genotypes of turmeric was left in the field to verify and compare their performance for yield contributing traits and curcumin content after one year and two years of growth.

Thirty-four genotypes of fennel were screened for studying their variability and yield potential under Palampur conditions. EC 279039 followed by EC 279042, JF-252, EC 386375 qnd RF-125 were found superior in respect of seed yield/ plant. Among these collections EC 386375 was introduced from Germany which is dwarf and long duration type. Another dual purpose (vegetable type + seed type) introduction, PLPF-1, performing extremely well was found highly promising in respect of seed yield as well as fresh yield as vegetable.

Thirteen genotypes of large cardamom were screened for their adaptability and variability studies regarding yield and its contributing traits under Palampur condition. Genotypes TS-1 (137.0cm), OS-1 (273.6) and JC-2 (30.4) were found superior in respect of plant height, leaf number and tiller number per plant, respectively.

PROJECT TITLE : **ELUCIDATION OF BIOSYNTHETIC PATHWAYS OF CURCUMIN IN TURMERIC**

Principal Investigator : **B Chempakam, NK Leela**
Indian Institute of Spices Research, Calicut
Dr K. Vasu, Center for water Resources Development and Management, Calicut

Technical programme

i) Analysis of curcumin and other secondary metabolites (Essential oil and Oleoresin) and starch during development in leaf, root and rhizomes

ii) Formation and distribution of curcuminoids in turmeric rhizomes

iii) Tracer studies using ^{14}C-carbonate

Progress of research

Five varieties including the four released varieties (Prabha, Prathibha, Suguna and Sudarsana) and the other local variety (Alleppey) were selected for the studies. The rhizomes were planted at the institute campus during June 1999, following the normal agricultural and management practices. Samples (Leaf, root and rhizome were taken starting from 120 DAS (Days after sowing) upto 240 DAS, at 30 days intervals. The samples were dried and powdered and then subjected to analysis for curcumin, essential oil, oleoresin and starch.

1. Analysis of curcumin, starch and other secondary metabolites (E O and O R) during plant growth in leaf, root and rhizomes.

Table 1&2 show the percentage of curcumin and other constituents in developing rhizomes. It is seen that generally between 120 and 150 DAS, maximum content of curcumin is seen in the five varieties which decreased gradually and remained stable after 180 DAS.

Essential oil content (Table 1) decreases gradually as the rhizomes develop. Higher concentration was seen in the first two stages (120 and 150 DAS), where, among the varieties, higher concentrations were seen in Alleppey and Prabha. Varieties, Suguna and Sudarsana were having only 4.4 to 4.8% in the early stages. Oleoresin also showed a gradual decline during the maturity of the rhizome (Table 2). Oleoresin in the early stages ranged from 17.5-24% in the immature rhizomes, while it ranged form 6.6-9.64% in the mature ones, accounting for about 50-70% of decline. Varieties Prabha and Alleppey possessed higher OR (24.01% and 23.9% respectively) in the initial stages.

As regards to starch a gradual increase was seen in all the five varieties during rhizome growth. Highest starch content was seen in variety Prabha. Except for the variety Alleppey, where the starch content increased by 8.7%, other varieties showed no change during the last two stages (210 DAS and 240 DAS).

Higher dry recovery (DR) was seen in varieties Prabha, Prathibha and Alleppey (25.7%, 20.2% and 23.9% respectively) in the mature stage, while Suguna and Sudarsana had lower DR. (11.9% and 13.2% respectively). Curcumin and EO content were higher in the initial stages, which declined with the growth of the plant. Interestingly, leaf EO was about 3 times higher in Suguna and Sudarsana, as compared to the other 3 varieties. Curcumin content in these varieties showed a sudden decline, at later stages and was noticeably lower than the other three varieties.

In roots, no definite pattern was seen with respect to curcumin and EO, but the oleoresin was higher at 150 DAS and 180 DAS (12.4%-16.8%), and came down at full maturity (7.33 to 9.8%). Among the varieties tried, roots from variety Alleppey had highest curcumin content while Suguna and Sudarsana had highest EO and OR.

Tracer studies using ^{14}C-CO_3

^{14}C-labeled potassium carbonate was purchased from BRIT (Board of Radiation Isotope Technology). Incorporation of ^{14}C are being studied in the very early stages of rhizome growth (upto 3 months) with regard to phenolic acids, acetate and other components.

Gas Chromatographic analysis of EO

The individual components of (EO) in rhizomes, roots and leaves were detemined using gas chromatograph. (Table 3). The data show that in root and rhizome, the major constituents are ar-turmerone (46.8 & 31.5%) while in leaf, the major component is α-phellandrene (32.62%).

Table 1. Essential oil (EO) percentage in turmeric rhizomes during development

Varieties	Stage 1	Stage 2	State 3	Stage 4	Stage 5
Prabha	6.9	5.33	5.11	4.56	3.64
Prathibha	4.9	6.66	4.05	4.57	4.99
Alleppy	7.2	6.33	4.1	4.39	5.3
Suguna	4.8	4.28	3.21	3.58	5.32
Sudarsana	4.4	4.28	3.02	2.59	5.24

Table 2. Oleoresin (OR) percentage in turmeric rhizomes during development

Varieties	Stage 1	Stage 2	State 3	Stage 4	Stage 5
Prabha	24.01	17.95	14.0	9.36	6.69
Prathibha	20.88	17.95	14.9	10.72	9.48
Alleppy	23.96	19.38	18.9	11.96	10.72
Suguna	22.52	11.49	11.4	8.87	8.83
Sudarsana	17.55	15.42	12.6	9.09	9.64

Table 3. Major essential oil constituents in turmeric rhizome, root and leaf

Rhizome	Root	Leaf
Ar-turmerone (31.5)	Ar-turmerone (46.8)	α-phellandrene (32.62)
Turmerone (9.9)	Ar-curcumene (7.02)	Terpenolene (25.95) Curlone
(10.5)	B- sesquiphellandrene (2.34)	P-cymene (5.0)
Ar-curcumene (6.27)	Dehydrocurcumene (4.27)	1,8-cineole (6.52)
β-sesquiphellandrene (2.5)	P-cymene (2.98)	Myrcene (2.3)
β-bisabolene (tr)		α-pinene (2.78)
Dehydrocurcumene (2.23)		β-pinene (2.13)
P-cymene (2 98)		

(Values in brackets show the percentage)

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ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGETARY DETAILS AND ACTUAL EXPENDITURE
BUDGET PROVISION - 1997-98

(Rupees in lakhs)

Name of the centre	Details of sanctioned provision for pay & allowances					
	Pay	TA	RC	Total	ICAR share	State share
Pampadumpara (KAU)	3.60	0.30	1.20	5.10	3.82	1.28
Panniyur (KAU)	5.60	0.40	1.60	7.60	5.70	1.90
Mudigere (UAS-B)	5.30	0.40	1.60	7.30	5.48	1.82
Sirsi (UAS-D)	2.10	0.20	0.80	3.10	2.33	0.77
Yercaud (TNAU)	2.30	0.20	0.80	3.30	2.47	0.83
Coimbatore (TNAU)	2.00	0.20	0.80	3.00	2.25	0.75
Chintapalli (APAU)	2.10	0.20	0.80	3.10	2.33	0.77
Jagtial (APAU)	1.60	0.20	0.80	2.60	1.95	0.65
Guntur (APAU)	1.50	0.20	0.80	2.50	1.88	0.62
Solan (YSPUHF)	3.20	0.30	1.20	4.70	3.52	1.18
Pottangi (OUAT)	2.90	0.20	0.80	3.90	2.93	0.97
Jobner(RAJAU)	6.50	0.50	2.00	9.00	6.75	2.25
Jagudan (GAU)	1.00	0.20	0.80	2.00	1.50	0.50
Hisar (HAU)	2.00	0.20	0.80	3.00	2.25	0.75
Dholi (RAU)	1.80	0.20	0.80	2.80	2.10	0.70
Kumarganj (NDUAT)	2.50	0.30	1.20	4.00	3.00	1.00
Pundibari (BCKVV)	2.50	0.30	1.20	4.00	3.00	1.00
Dapoli (KKV)	3.00	0.30	1.20	4.50	3.37	1.13
Raigarh (IGKVV)	3.00	0.30	1.20	4.50	3.37	1.13
Total	**54.50**	**5.10**	**20.40**	**80.00**	**60.00**	**20.00**
ICAR share	40.87	3.83	15.30	60.00		
State share	13.63	1.27	5.10	20.00		

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGETARY DETAILS AND ACTUAL EXPENDITURE
RELEASE OF GRANTS DURING 1997-98

(Rupees)

Name of the centre	Ist half release released	IInd half release	Additional fund	Total release
Pampadumpara (KAU)	191000	191000		382000
Panniyur (KAU)	285000	285000		570000
Mudigere (UAS-B)	274000	274000	50000	598000
Sirsi (UAS-D)	116500	65500*		182000
Yercaud (TNAU)	123500	62500*		186000
Coimbatore (TNAU)	112500	112500		225000
Chintapalli (APAU)	116500	116500		233000
Jagtial (APAU)	97500	69500*		167000
Guntur (APAU)	94000	94000		188000
Solan (YSPUHF)	176000	176000	45000	397000
Pottangi (OUAT)	146500	146500	4000	297000
Jobner(RAJAU)	337500	337500		675000
Jagudan (GAU)	75000	75000	50000	200000
Hisar (HAU)	112500	112500		225000
Dholi (RAU)	105000	96000*		201000
Kumarganj (NDUAT)	150000	150000		300000
Pundibari (BCKVV)	150000	150000		300000
Dapoli (KKV)	168500	168500		337000
Raigarh (IGKVV)	168500	168500		337000
Total (ICAR share)	**3000000**	**2851000**	**149000**	**6000000**

* Funds demanded was less than the funds allocation, hence an over all saving of Rs.1.49 lakhs (Sirsi = 0.51, Yercaud = 0.61, Jagtial = 0.28, Dholi = 0.09 = Rs.1.49 lakhs). This amount has been released additionaly to Mudigere, Solan, Pottangi and Jagudan centres.

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGETARY DETAILS AND ACTUAL EXPENDITURE
BUDGET PROVISION - 1998-99

(Rupees in lakhs)

Name of the centre	Details of sanctioned provision for pay & allowances					
	Pay	TA	RC	Total	ICAR share (Rs.)	State share
Pampadumpara (KAU)	4.92	0.30	1.20	6.4200	481500	1.61
Panniyur (KAU)	6.86	0.40	1.60	8.8600	664500	2.22
Mudigere (UAS-B)	6.43	0.40	1.60	8.4300	632300	2.11
Sirsi (UAS-D)	2.38	0.20	0.80	3.3800	253500	0.85
Yercaud (TNAU)	2.63	0.20	0.80	3.6300	272200	0.91
Coimbatore (TNAU)	2.78	0.20	0.80	3.7800	283500	0.95
Chintapalli (APAU)	2.78	0.20	0.80	3.7800	283500	0.95
Jagtial (APAU)	2.36	0.20	0.80	3.3600	252000	0.84
Guntur (APAU)	2.78	0.20	0.80	3.7800	283500	0.95
Solan (YSPUHF)	3.74	0.30	1.20	5.2400	393000	1.31
Pottangi (OUAT)	3.88	0.20	0.80	4.8800	366000	1.22
Jobner(RAJAU)	7.96	0.50	2.00	10.4600	784500	2.62
Jagudan (GAU)	2.78	0.20	0.80	3.7800	283500	0.95
Hisar (HAU)	2.08	0.20	0.80	3.0800	231000	0.77
Dholi (RAU)	2.78	0.20	0.80	3.7800	283500	0.95
Kumarganj (NDUAT)	4.34	0.30	1.20	5.8400	438000	1.46
Pundibari (BCKVV)	4.34	0.30	1.20	5.8400	438000	1.46
Dapoli (KKV)	4.34	0.30	1.20	5.8400	438000	1.46
Raigarh (IGKVV)	4.34	0.30	1.20	5.8400	438000	1.46
Total	**74.50**	**5.10**	**20.40**	**100.0000**	**7500000**	**25.00**
ICAR share	55.88	3.82	15.30	75.0000	**1070000***	
State share	18.62	1.28	5.10	25.00	**8570000****	

The allocation of of 1998-99 was Rs. 75.00 lakhs

* Additional fund sanctioned/released - Rs. 10.70 lakhs. ** Total budget released - Rs. 85.70 lakhs

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGETARY DETAILS AND ACTUAL EXPENDITURE
RELEASE OF GRANTS DURING 1998-99

(Rupees)

Name of the centre	Ist half release	IInd half release	**Additional fund released	Total release
Pampadumpara (KAU)	240750	240750	31610	513110
Panniyur (KAU)	332250	332250	19361	683861
Mudigere (UAS-B)	316150	316150	332567	964867
Sirsi (UAS-D)	126750	126750	33199	286699
Yercaud (TNAU)	136100	136100		272200
Coimbatore (TNAU)	141750	141750	240366	523866
Chintapalli (APAU)	141750	141750		283500
Jagtial (APAU)	126000	126000		252000
Guntur (APAU)	141750	141750		283500
Solan (YSPUHF)	196500	196500	134000	527000
Pottangi (OUAT)	183000	177500*		*360500
Jobner(RAJAU)	392250	392250	543982	1328482
Jagudan (GAU)	141750	141750	5915	289415
Hisar (HAU)	115500	115500		231000
Dholi (RAU)	141750	141750		283500
Kumarganj (NDUAT)	106500	130500*		237000
Pundibari (BCKVV)	106500	331500		438000
Dapoli (KKV)	106500	267000*		373500
Raigarh (IGKVV)	106500	331500		438000
Total (ICAR share)	**3300000**	**3929000**	**1341000**	**8570000**

* Funds released is less than the actual fund allocation hence a savings of Rs.2.71 lakhs (Pottangi - Rs.0.055, Kumarganj - Rs.2.01, Dapoli - Rs.0.645, Total - 2.71 lakhs).

** An additional fund of Rs.13.41 lakhs have been released to 8 centres from the over all savings of Rs. 2.71 lakhs plus the additional fund of Rs.10.70 lakhs received from ICAR for clearance the arrear pay and allowances upto the VIII Plan (1996-97).

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGETARY DETAILS AND ACTUAL EXPENDITURE

BUDGET PROVISION - 1999-2000 (Rupees)

Name of the centre	Details of sanctioned provision for pay & allowances						
	Pay	TA	RC	Total (Rs.)	ICAR share	NRC (ICAR share)	Total (ICAR)*
Pampadumpara (KAU)	4.84	0.30	1.20	634000	475500	142500	618000
Panniyur (KAU)	6.80	0.40	1.60	880000	660000	187500	847500
Mudigere (UAS-B)	6.35	0.40	1.60	835000	626250	213750	840000
Sirsi (UAS-D)	2.32	0.20	0.80	332000	249000	82500	331500
Yercaud (TNAU)	2.57	0.20	0.80	357000	267750	240000	507750
Coimbatore (TNAU)	2.72	0.20	0.80	372000	279000	108750	387750
Chintapalli (APAU)	2.72	0.20	0.80	372000	279000		279000
Jagtial (APAU)	2.31	0.20	0.80	331000	248000		248000
Guntur (APAU)	2.72	0.20	0.80	372000	279000	292500	571500
Solan (YSPUHF)	3.68	0.30	1.20	518000	388500		388500
Pottangi (OUAT)	3.81	0.20	0.80	481000	360750		360750
Jobner(RAJAU)	7.91	0.50	2.00	1041000	780750		780750
Jagudan (GAU)	2.72	0.20	0.80	372000	279000		279000
Hisar (HAU)	2.08	0.20	0.80	308000	231000	37500	268500
Dholi (RAU)	2.74	0.20	0.80	374000	280500		280500
Kumarganj (NDUAT)	4.22	0.30	1.20	572000	429000	109500	538500
Pundibari (BCKVV)	4.22	0.30	1.20	572000	429000	171750	600750
Dapoli (KKV)	4.22	0.30	1.20	572000	429000		429000
Raigarh (IGKVV)	4.22	0.30	1.20	572000	429000		429000
Total	**73.17**	**5.10**	**20.40**	**9867000**	**7400000**	1586250	8986250
AICRPS Workshop						15000	15000
ICAR share	54.88	3.82	15.30	74.00		**1601250**	**9001250**
State share	18.29	1.28	5.10	24.67			

* The total allocation of 1999-2000 was Rs.90.00 lakhs. As per the IX Plan EFC the budget provision is Rs. 74.00 lakhs for pay and allocances and NRC is Rs.38.00 lakhs out of which Rs.16.0125 lakhs (NRC) is included in the budget of 1999-2000.

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
BUDGETARY DETAILS AND ACTUAL EXPENDITURE
RELEASE OF GRANTS DURING 1999-2000

(Rupees)

Name of the centre	Ist half release	IInd half release	NRC released	Total release
Pampadumpara (KAU)	237750	237750	142500	618000
Panniyur (KAU)	330000	330000	187500	847500
Mudigere (UAS-B)	313125	313125	213750	840000
Sirsi (UAS-D)	124500	124500	82500	331500
Yercaud (TNAU)	133875	133875	240000	507750
Coimbatore (TNAU)	139500	139500	108750	387750
Chintapalli (APAU)	139500	139500		279000
Jagtial (APAU)	124000	124000		248000
Guntur (APAU)	139500	139500	292500	571500
Solan (YSPUHF)	194250	194250		388500
Pottangi (OUAT)	180375	180375		360750
Jobner(RAJAU)	390375	390375		780750
Jagudan (GAU)	139500	139500		279000
Hisar (HAU)	115500	115500	37500	268500
Dholi (RAU)	140250	140250		280500
Kumarganj (NDUAT)	214500	214500	109500	538500
Pundibari (BCKVV)	214500	214500	171750	600750
Dapoli (KKV)	214500	214500		429000
Raigarh (IGKVV)	214500	214500		429000
AICRPS Workshop			13343	13343
Total (ICAR Share)	**3700000**	**3700000**	**1599593**	**8999593**

An amount of Rs.15,000 was kept under NRC for the AICRPS Workshop, out of which Rs.13343 have been spent and a balance of Rs.407 is retained at IISR out of Rs.90.00 lakhs sanctioned and released from ICAR.

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1. Performance of different turmeric varieties in high altitude area of Andhra Pradesh. *Centennial Conference on Spices and Aromatic Plants*, Sept. Calicut, Kerala.
2. Evaluation of ginger varieties for high altitude and tribal area of Andhra Pradesh. *Centennial Conference on Spices and Aromatic Plants*, Sept. Calicut, Kerala.

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a) Scientific articles

1. Baskar Rajan, G., Shanmugasundaram, K.A and Chezhiyan, N. 2000. Micro propagation of turmeric. Centennial Conference on spices and aromatic plants, Sept. Calicut, Kerala (Accepted)
2. Mohanalakshmi, M., Thangaraj, T. and Shanmugasundaram. 2000. The effect of maturity on the rooting of curry leaf cuttings. Centennial Conference on spices and aromatic plants, Sept. Calicut, Kerala. (Accepted)
3. Prabhakaran, G., Chezhiyan, N., Ganga, M. and Shanmugasundaram, K.A. 2000. Micropropagation of Curry leaf (*Murraya koenigii* Speng.) through in vitro axillary bud culture. Proceedings of National Symposium on Recent Trends in Crop Improvement for Sustainable Development. P.60.
4. Prabhakaran, G., Chezhiyan, N., Ganga, M. and Shanmugasundaram, K.A. 2000. Suitable culture medium for in vitro Shoot proliferation of Curry leaf (*Murraya koenigii* Speng.) from axillary bud explants. Proceedings of National Symposium on Recent Trends in Crop Improvement for Sustainable Development. P.64.
5. Ramar, A., Thangaraj, T., Chezhiyan, N. and Shanmugasundaram, K.A. 2000. Performance of black cumin (*Nigella sativa* L.) under Coimbatore conditions. Centennial Conference on spices and aromatic plants, Sept. Calicut, Kerala. (Accepted)
6. Shanmugam. P., Vijayakumar. M. and Shanmugasundaram, K.A. 2000. Standardization of planning material with reference to the stages of sprouting in turmeric (*Curcuma longa* L.). Centennial Conference on spices and aromatic plants, Sept. Calicut, Kerala. (Accepted)
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9. Thangaraj, T., Shanmugasundaram, K.A. and Ramar, A. 1998. Breeding of yield and quality towards a secured turmeric industry (*Curcuma longa* L.). Proceedings of International Conference on Food Security

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11. Thangaraj, T., Mohanalakshmi, M. and Shanmugasundaram, K.A. 2000. Evaluation and selection for yield in coriander. Centennial Conference on spices and aromatic plants, Sept. Calicut, Kerala. (Accepted)

12. Thangaraj, T., Mohanalakshmi, M., Manonmani, P. Pujara and Shanmugasundaram, K.A. 2000. Performance of Paprika-A Source of Natural Colour in Tamil Nadu. Centennial Conference on spices and aromatic plants, Sept. Calicut, Kerala. (Accepted)

b) Popular articles

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2. Mohanalakshmi, M and Shanmugasundaram, K.A. 1999. Medicinal uses in certain spices (Tamil). Kisan World. 26(11):58.

3. Muthuvel, I., Shanmugasundaram, K.A. and Thangaraj, T. 2000. Tamarind-a suitabletree for drought condition (Tamil). Thamilaga Vivasayee Ulagam. 1(8):37.

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METEOROLOGICAL DATA 1999

Pamapdumpara

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

Month	Rainfall (mm)	Rainy days (No)	Temperature (°C)		Humidity (%)
			Max	Min	
January	0.4	1	23.4	15.2	77.0
February	29.8	3	24.9	16.5	73.0
March	3.4	1	28.6	18.1	79.0
April	88.4	9	26.0	18.8	83.0
May	231.0	18	23.9	18.4	91.0
June	186.0	21	22.9	17.9	95.0
July	397.1	29	20.6	17.5	95.0
August	106.2	25	23.0	18.34	91.0
September	85.8	16	25.7	17.5	82.0
October	458.6	28	24.4	17.9	91.0
November	166.2	11	24.6	16.6	82.0
December	23.4	8	23.1	15.8	77.0
Total/Mean	1776.3	170	24.26	17.38	

Pundibari

Latitude : 26° 19.86"
Longitude : 89° 23.5"
Altitude : 43m MSL
Soil type : Sandy loam to loam

Month	Rainfall (mm)	Rainy days (No)	Temperature (°C)		RH (%)	
			Max	Min	Max	Min.
January	0	0	21.9	9.4	95.4	58.2
February	3.0	1	26.3	11.4	94.7	47.4
March	70.1	3	28.2	14.2	89.7	51.2
April	205.0	8	30.1	17.3	93.2	64.7
May	310.3	12	33.2	24.2	91.4	63.5
June	670.2	18	32.1	24.3	95.3	79.5
July	1380.2	24	30.3	23.2	98.0	83.1
August	930.9	22	31.3	24.1	98.1	87.2
September	48.2	5	33.6	23.5	96.1	69.2
October	105.7	4	30.3	19.5	93.8	73.6
November	60.5	1	28.9	16.6	92.3	67.5
December	0	0	23.3	11.2	94.2	71.3
Total/Mean	3784.1	98	29.13	18.24		

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	Morning
January	—	—	30.20	16.17	92.03
February	—	—	33.32	18.66	88.75
March	—	—	36.30	22.80	89.40
April	—	—	39.71	26.10	89.13
May	8.3	4	39.89	27.36	85.19
June	91.6	15	37.66	26.23	80.13
July	264.6	16	35.23	25.55	82.42
August	156.7	9	34.16	25.07	79.48
September	155.4	10	33.34	24.67	83.93
October	98.1	7	32.66	23.56	86.03
November	0.0	0	32.06	20.14	86.67
December	0.0	0	30.44	16.06	89.23
Total/Mean	774.7	61	34.58	22.70	

Sirsi

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

Month	Rainfall (mm)	Rainy days (No)
January	0	0
February	0	0
March	0	0
April	0	0
May	218.10	5
June	514.30	23
July	1096.40	23
August	234.00	22
September	64.70	14
October	391.0	16
November	0	0
December	0	0
Total/Mean	2518.5	103

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	Forenoon
January	Nil	Nil	24.48	6.74	83.61
February	Nil	Nil	28.75	12.33	79.46
March	12.2	1	32.40	16.03	79.29
April	69.8	5	33.98	19.51	83.33
May	84.2	8	31.59	21.96	78.45
June	145.9	11	28.51	22.40	83.06
July	169.2	11	26.35	21.74	88.19
August	140.16	15	25.74	21.50	88.38
September	82.3	9	26.16	21.51	88.40
October	163.5	8	26.50	19.91	88.32
November	28.2	4	26.20	14.70	80.46
December	Nil	Nil	26.10	8.96	82.90
Total/Mean	895.46	72	28.40	17.27	

Kumarganj

Latitude : 26'-47 N
Longitude : 82.12 E
Altitude : 113m MSL
Soil type : Slity loam

Month	No. of rainy days		Temperature (°C)
			Max
January	2	16.0	6.4
February	2	9.6	14.3
March	0	0	18.6
April	0	0	20.0
May	3	21.8	25..4
June	9	126.3	26.2
July	14	325.8	26.5
August	17	401.1	25.5
September	10	231.5	25.3
October	5	105.4	21.4
November	0	0	13.1
December	1	6.3	8.4
Total/Mean	63	103.65	19.26

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	-	-	20.9	8.6	97
February	-	-	26.4	12.6	82
March	-	-	32.2	15.1	72
April	-	-	37.9	22.2	74
May	142.2	6	34.1	24.6	82
June	339.2	12	34.3	26.1	83
July	342.5	16	31.5	26.4	85
August	470.3	14	31.1	25.5	86
September	91.2	10	31.3	25.7	83
October	89.8	6	31.1	22.9	80
November	-	-	28.6	15.9	78
December	-	-	26.1	11.2	95
Total/Mean	1475.2	64	30.46	19.73	

Panniyur

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

Month	Rainfall (mm)	Rainy days (No)	Mean Temperature (°C)		RH (%)
			Max	Min	
January	—	—	34.3	19.0	86.0
February	—	—	36.8	21.0	86.0
March	—	—	37.0	24.0	81.7
April	—	—	36.7	24.5	75.0
May	416.8	20	31.6	23.5	85.0
June	729.0	25	29.5	22.4	93.0
July	1099.6	30	28.2	22.5	94.0
August	438.0	21	29.4	22.5	93.0
September	92.4	14	31.1	22.4	90.0
October	330.0	25	31.4	23.2	90.0
November	20.1	7	33.3	22.0	93.0
December	—	—	34.4	19.9	91.0
Total/Mean	3125.9	142	32.8	22.2	88.14

Coimbatore

Latitude : 11°N
Longitude : 77° E
Altitude : 426.72m MSL
Spoil type : Clay loam

Month	Rainfall (mm)	Rainy days (No)	Temperature (°C)		RH (%)
			Max	Min	
January	—	—	29.8	17.1	89
February	3.0	1	32.5	19.5	87
March	—	—	35.5	20.3	85
April	29.0	5	34.8	22.5	86
May	33.0	3	33.5	23.4	81
June	24.0	4	30.6	22.4	81
July	25.8	4	30.7	22.6	81
August	21.9	2	31.8	21.6	83
September	28.0	3	32.7	22.2	85
October	306.1	16	30.0	22.1	91
November	104.2	6	29.2	19.9	91
December	23.2	3	27.8	19.2	90
Total/Mean	598.2	47	31.58	21.07	

Jobner

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

Month	Total Rainfall (mm)	Rainy days (No)	Temperature (°C)		RH (%)
			Max	Min	
January	2.0	—	21.2	4.3	70
February	—	—	25.9	9.9	66
March	—	—	36.7	10.7	43
April	—	—	39.9	18.2	31
May	13.3	1	39.8	24.3	41
June	45.9	3	37.6	26.0	50
July	213.7	8	34.8	26.1	70
August	16.1	2	33.9	24.5	71
September	12.0	3	34.5	23.9	71
October	10.4	2	33.9	16.0	61
November	—	—	30.1	9.4	56
December	—	—	24.6	4.9	62
Total/Mean	313.4	19	32.74	16.52	

Solan

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

Month	Total Rainfall (mm)	Temperature (°C)		RH (%)
		Max	Min	
January	11.5	18.0	2.50	74.5
February	9.7	21.8	2.40	71.5
March	15.6	24.7	7.5	54.4
April	-	32.3	13.4	42.5
May	63.7	31.6	16.8	55.8
June	18.1	30.5	17.4	62.8
July	124.4	28.6	19.7	83.9
August	37.7	28.0	19.7	86.6
September	37.3	28.1	17.1	88.2
October	—	27.0	10.3	69.8
November	—	24.4	5.2	56.9
December	—	20.6	2.4	64.8
Total/Mean	321	26.3	11.2	

Pottangi

Latitude : 18°34N
Longitude : 82°C52 E
Altitude : 917m MSL
Soil type : Sandy loam

Month	Rainfall (mm)	Rainy days (No)	Temperature (°C)		RH (%)
			Max	Min	
January	—	—	23	16	81
February	—	—	24	16	81
March	—	—	24	17	80
April	76.2	4	26	21	82
May	200.2	16	28	21	85
June	282.4	11	29	22	86
July	157.6	17	27	21	88
August	223.9	23	23	20	92
September	336.2	21	23	20	89
October	98.2	9	24	19	90
November	36.8	4	23	18	90
December	—	—	22	17	80
Total/Mean	1411.5	105	24.67	19	

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	—	—	23.50	11.20	61.00
February	—	—	25.75	14.21	56.07
March	—	—	30.29	14.71	56.03
April	102.0	3	30.40	15.80	65.23
May	348.4	12	27.23	16.47	65.70
June	63.2	5	26.92	16.65	69.43
July	144.2	8	30.75	16.32	68.81
August	217.6	14	25.52	15.75	68.74
September	208.2	10	27.13	15.31	64.97
October	380.6	21	23.00	15.56	67.20
November	254.3	8	23.75	14.35	66.03
December	76.0	6	21.76	11.58	62.70
Total/Mean	1794.55	87	26.33	14.83	

Hisar

Month	Rainfall (mm)	Rainy days (No)	Temperature (°C)		RH (%)
			Max	Min	
January	2.0	1	19.0	3.8	92
February	26.9	3	22.5	7.5	89
March	26.7	5	26.2	13.2	83
April	0.0	0	39.7	16.2	44
May	33.5	4	40.9	23.0	52
June	42.0	5	39.6	25.1	59
July	65.9	5	37.5	26.9	70
August	72.2	6	36.4	24.6	75
September	4.0	1	36.6	23.7	75
October	0.0	0	34.6	15.8	78
November	0.0	0	30.4	9.0	76
December	0.0	0	23.6	3.7	90
Total/Mean	273.2	30	32.25	16.04	

Mudigere

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

Month	Total Rainfall (mm)	Rainy days (No)	Temperature (°C)		RH (%)
			Min	Max	Morning
January	—	-	12.1	28.2	80
February	3.4	1	14.8	30.3	78
March	8.6	2	17.3	32.0	89
April	25.0	5	17.8	30.4	89
May	337.6	16	18.1	26.6	92
June	406.4	18	17.5	20.9	90
July	837.2	24	17.4	22.8	94
August	282.0	18	17.2	24.0	93
September	120.0	11	16.7	25.5	94
October	379.2	16	17.4	26.9	92
November	1.6	1	15.4	27.3	84
December	-	-	13.2	27.4	86
Total/Mean	2401.0	112	16.24	26.86	

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