K.N. Shiva

AICRPS

ANNUAL REPORT 2000-2001

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

Calicut - 673012, Kerala

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2000 - 2001

(APRIL 2000 to MARCH 2001)

ICAR

INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

CALICUT, KERALA, INDIA - 673 012

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CONTENTS

कार्यकारी सारांश

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (AICRPS) भारतीय कृषि अनुसंधान परिषद के अधीन आनेवाले 78 समन्वित अनुसंधान परियोजनाओं से एक होता है। अखिल भारतीय समन्वित मसाला अनुसंधान परियोजनाओं का लक्ष्य देश में मसाला अनुसंधान का आयोजन और समन्वय करना है। वर्ष 1971 में पांचवीं योजना में मसाला और काजू की संयुक्त परियोजना के रूप में इसका आरंभ हुआ। इस संयुक्त परियोजना को द्विभाजित करके 1986 में (पांचवीं योजना) अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना को स्वतन्त्र बनाया और आई आई एस आर (पहले एन आर सी एस) को इसका मुख्यालय बना दिया । अब इसके 19 केन्द्रों तथा 8 आश्रित केन्द्रों में 12 मसालों का काम होता है । आई सी आर आई का क्षेत्रीय स्टेशन (स्पाइसस बोर्ड) गांगटोक में स्वैच्छिक आधार पर बडी इलायची का काम चलता है।ए. आई.सी.आर.पी.एस में अब कुल 83 स्टाफ होता है जिसमें 51 वैज्ञानिकों 32 तकनीकी/ सहायक स्टाफ होता है।

ए.आई.सी.आर.पी.एस में बारह अधिदेश फसलों की 90 अनुसंधान परियोजनाएँ होती है। केन्द्र के वैज्ञानिक और स्टाफ बहुत परिश्रम करके अपना उत्तम योगदान प्रस्तुत करते है। वर्ष 1999 में कार्यशाला के दौरान एकीकृत कीट & रोग नियन्त्रण, जैव उर्वरक अध्ययन और मसालों की जैविक खेती पर जोर देकर नया कार्यक्रम संयोजित किया। ये नये परीक्षण अधिदेश फसलों पर चालू कार्यक्रम के साथ किया जाता है। यहां तकनीकी स्टाफों की कमी और नवीं योजना में एन आर सी पूरी तरह क्रियान्वित न होने से वैज्ञानिक अधिक कायिक और तकनीकी मदद दिया नहीं जा सकता। यद्यपि कुछ सीमाएँ होती है तो भी ये केन्द्र अपनी लक्ष्य पूर्ति के लिए बहुत कोशिश करते हैं। सभी केन्द्रों में जर्मप्लासम संग्रह को मजबूत करके मूल्यांकन किया गया। संबन्धित केन्द्रों में काली मिर्च, अदरक एवं हल्दी पर समन्वित किस्म परीक्षण (CVT) 2000-2001 किया जाता है। चालू वर्ष में बीज मसालों का समन्वित किस्म परीक्षण भी किया जाता है। पहचान किये कुछ आशाजनक किस्में विमोचन की दशा पर पहूंच गयी है। काली मिर्च, अदरक एवं हल्दी में असोस्पिरिल्लम & पी सोलुबिलैसर्स और ऑरगानिक फार्मिंग का प्रयोग करके जैव उर्वरक अध्ययन पर काम शुरू किया गया। कोयम्पतोर में मेथी का काम रोक लिया और कई मुसीबतों के कारण एरकॉड

के वृक्ष मसालों का काम पेचिपराई की ओर बदल दिया। मसालों के विमोचित किस्मों के बीज/रोपण सामग्रियों का उत्पादन और वितरण कार्य अनुकूल तौर पर प्रचरित किया। बुनियादी सुविधायें जैसे उपस्कर और आधारिक संरचनाओं की सुविधायें आवश्यक केन्द्रों को प्रदान किया जाता है। केन्द्रों द्वारा निष्पादित ए आई सी आर पी एस की मुख्य उपलब्धियाँ और मसालों के चालू तदर्थ अनुसंधान योजनाओं का 1.4.2000 से 31.3.2001 तक का संक्षिप्त विवरण इस रिपोर्ट में अंकित किया जाता है।

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की मुख्य उपलब्धियाँ निम्न प्रकार है।

- अधिदेश मसालों के जर्मप्लासम संग्रह को बढाया।
- आशाजनक जर्मप्लासम अक्सशनों/किस्मों को सूचिबद्ध किया।
- काली मिर्च, अदरक और हल्दी का 2000-2001 के नये समन्वित किस्म परीक्षण शुरू किया।
- मुडिगरे में ओ.पी बीज संततियों (D-237, CC- 730, OL- 692) की आशाजनक इलयची जीन रूप और अन्य उच्चतम क्लोन (ACC- 8-4-D11 और 7-24 -D 11) की पहचान की गयी।
- इलायची की सूखा सहयता युक्त किस्मो (CL- 668, P-6, D-237 और 2-2-D11) की पहचान की गयी।
- आशाजनक इलायची PS 27 (पांपाडुम्पारा) को नये समन्वित किस्म परीक्षण के लिए पहचान की जाती है।
- बहुसंकरो (Polycrosses)के अन्तर्गत इलायची के आशाजनक सामान्य संयोजन की पहचान की गयी।
- पन्नियूर में काली मिर्च के अन्तर-किस्म-संकरज को प्रबल बना दिया।
- सिरसी में काली मिर्च की आशाजनक अक्सशन 239 की पहचान की गयी।
- सभी अधिदेश फसलों में समन्वित किस्म परीक्षण में आशाजनक किस्मों की पहचान की गयीं।
- अदरक में V_3- S_1-8 और हल्दी में PTS- 59 और PTS- 55 को आशाजनक किस्मों के रूप में
- पहचान की गयी और ये पोटांगी में विमोचित करने की दशा पर पहूँच गयी।
- अदरक की किस्म V_1 E_8- 2(पोटांगी), हल्दी की किस्में PTS 43 (पोटांगी) और TCP-1 & TCP-2 (पुंडिबारी) को विमोचित करने के लिए प्रस्ताव किया गया।
- पन्नियूर और सिरसी केन्द्रों ने काली मिर्च के लिए सिंचाई और उर्वरक की मात्राएँ संस्तुत की।
- इलायची के लिए जैविक और अजैविक खादों का प्रयोग करके एकीकृत पोषण प्रबन्धन में 100: 100:175 कि. ग्राम NPK/हैक्टर की मात्रा में उर्वरक लगाना संस्तुत किया।
- अध्ययन द्वारा पुष्टि हुई कि सूक्ष्म पोषण लगाने से धनिया और बडी सौंफ की उपजता में वृद्धि हुई है।
- धनिया की विदेशी किस्म EC-2 32666 को वाणिज्यिक उगाई के लिए पर्ण प्रकार में उत्तम पहचान की गयी।

- हल्दी की आलप्पी किस्म और जिसके बाद BDJR-1260 को उच्चतम कुरकुमिन प्राप्ति और उपजता के लिए चयन किया गया।
- जीरा में उच्चतम बाष्पशील तेल प्राप्त होनेवाली किस्में EC-232684 (4.4%) और JC-147 (3.4%) है और बडी सौंफ UF-144 में होता है।
- पन्नियूर और सिरसी केन्द्रों में काली मिर्च के फाइटोफ्थोरा खुर विगलन के नियन्त्रण के लिए पौध संरक्षण का एक पैकेज संस्तुत किया।
- इडुक्कि जिले में आयोजित सर्वेक्षण से काली मिर्च में एन्थ्रेक्नोज रोग एवं सीमान्त पिटिका कीट का प्रभाव सूचित किया।
- सिरसी में ट्राइकोडरमा स्पीसीस के बहुगुणन केलिए एक सस्ते तकनोलजी खेत में प्रयोग करने केलिए विकसित किया गया।
- स्टोरेज द्वारा राइसोम रोट का नियन्त्रण किया जा सकता है और डीतैन एम -45+ बविस्टिन (5+3ग्राम / कि.ग्राम बीज) का मिश्रण भरे हुए गड्ढे में पौधा लगाने पर अधिक राइसोम की प्राप्ति और सबसे कम रोग आपतन देखा गया।
- बिहार के विभिन्न क्षेत्रों में आयोजित सर्वेक्षण से धनिया में तना बेधक रोग की कठोरता स्थापित हुई।
- धनिया की किस्में जैसे RCr-441, RCr-435, RCr-436, UD-446 और UD -684 जोबनेर में रूट नॉट नेमटोड के प्रतिरोधक देखा गया।
- नवेंबर 10वीं तारीख को जीरा बोना हरे उपजता (3.36/क्विंटल/ हेक्टर) अधिकतम बनाने के साथ म्लानी आपतन कम करने के लिए उत्तम भी होता है।
- गुजरात कुमिन 3, ACC-1136, ACC-1145,ACC-1165 आदि को साधारणतया फुसेरियम म्लानी के प्रतिरोधक देखा गया।
- कसूरी मेथी (मेथी) पाउडरी मिल्ड्यू के प्रतिरोधक देखा गया।

अनुसंधान उपलब्धियों के अलावा इस रिपोर्ट में वित्तीय लागत और खर्च, अनुमोदित तकनीकी कार्यक्रम, प्रकाशनों की सूचि और स्टाफ एवं केन्द्रों की सूचि, विभिन्न केन्द्रों का मौसम आंकडे आदि भी शामिल होता है। इस रिपोर्ट में मसालों पर चालू किये आइ सी ए आर तदर्थ अनुसंधान परियोजना की देन का सारांश भी जोड दिया है।

EXECUTIVE SUMMARY

AICRP on Spices is one among the 78 coordinated research projects under the Indian Council of Agricultural Research. The aim of AICRP on Spices (AICRPS) is to conduct and coordinate spices research in the country. It was established in Vth plan in 1971 as a combined project of spices & cashew. This combined project was bifurcated and made independent and the AICRPS came into existence in 1986 (VII plan) with IISR (earlier NRCS) as the head quarters. At present, there are 19 centres & 8 voluntary centres to work on 12 spices. The ICRI-RS (Spices Board) Gangtok is a centre to work on large cardamom on voluntary basis. The AICRPS at present has a total staff strength of 83, which includes 51 Scientists, 32 technicial/ auxiliary staff.

The AICRPS has about 90 research projects, covering the twelve mandate crops. The scientists and staff of the centres worked hard to contribute their best. During the workshop in 1999 new programmes were formulated giving emphasis on integrated pest & disease management, biofertilizer studies and organic farming in spices. These new experiments were laid out along with the existing programmes on the mandate crops. The scientists could not be given much physical and technical support, as the requirement technical positions of manpower and the NRC in IX plan could not be materialized fully. Inspite of certain limitations the centres carried on with their work to fulfil the targets. The germplasm collections were strengthened and evaluation has been taken up at all centres. The CVT 2000-2001 on black pepper, ginger and turmeric were laid out in the respective centres. The CVT of seed spices is to be laid out in the current year. A few promising lines identified are in the pipeline for release. Work on bioferilizer studies using *Azospirillum* & P-Solubilizers and organic farming in black pepper, ginger and turmeric have been initiated. The work on fenugreek discontinued at Coimbatore and inview of the many constraints. The work on tree spices at Yercaud is shifted to Pechiparai. The activity on production and distribution of seed/planting material of released varieties of spices are properly popularized. Basic facilities like equipments and infrastructure facilities were provided to the needy centres. The salient achievements of the AICRPS accomplished by the centres and of the ongoing ad-hoc research schemes on spices during the period of 1-04-2000 to 31-3-2001 are briefed in this report.

The highlights of achievements of AICRP on Spices are :

- Enriched the germplasm collections in the mandatory spices.
- Promising germplasm accessions/lines shortlisted.
- New CVT 2000-2001 in black pepper, ginger and turmeric initiated.
- Promising cardamom genotypes in OP seedling progenies (D-237, CC-730, CL-692), other superior clones (Acc. 8-4-D11 and 7-24-D11) were identified in cardamom by the Mudigere.
- Drought tolerant lines were identified in cardamom (CL-668, P-6, D-237 and 2-2-D11).

- The promising cardamom clone, PS-27 (Pampadumpara) is identified for the new CVT.
- Promising general combiners in cardamom under polycrosses were identified.
- Inter-varietal hybridization of pepper has been intensified at Panniyur.
- Acc.239 was identified as promising in pepper in Sirsi.
- Promising entries were identified in the CVT in all mandate spices.
- V_3S_1-8 in ginger and PTS-59 and PTS-55 in turmeric were identified as promising varieties and are in the pipeline for release at Pottangi.
- Ginger variety V_1E_8-2 (Pottangi), turmeric varieties PTS-43 (Pottangi) and TCP-1 & TCP-2 (Pundibari) were proposed for release.
- In black pepper, irrigation and fertilizer levels were recommended from Panniyur and Sirsi centres.
- A fertilizer dose of 100:100:175kg NPK/ha has been recommended in the integrated nutrient management using organic and inorganic manures in cardamom.
- Studies confirmed that micronutrient application increased the yield in coriander and fennel.
- Exotic line of coriander EC-2 32666 was identified as the best for leaf type for commercial growing.
- Turmeric varieties 'Alleppy' followed by 'BDJR – 1260' were selected for highest in curcumin content and yield.
- The highest volatile oil content in cumin was in EC-232684 (4.4%) and JC-147 (3.9%) and fennel in UF-144.
- A package of plant protection was recommended for management of *Phytophthora* foot rot in black pepper by Panniyur and Sirsi centres.
- Survey conducted noticed the occurrence of *anthrocnose* disease and marginal gall thrips in black pepper in Idukki district.
- A low-cost technology for mass multiplication of *Trichoderma* sp. for field application has been developed by Sirsi.
- Rhizome rot under storage can be managed and highest recovery of rhizome and the lowest disease incidence was obtained in sand layered pits mixed with Dithane M-45 + Bavistin (5g + 3g/kg of seed).
- Survey conducted established the severity of stem gall disease in coriander in different areas of Bihar.
- Coriander varieties RCr-441, RCr-435, RCr-436, UD-446 and UD-684 were resistant to root knot nematodes at Jobner.
- Sowing cumin on 10th November is best to minimise wilt incidence with maximise green yield (3.63 q/ha).
- Guj. cum.3, Acc-1136, Acc-1145, Acc.1165 were moderately resistant to *Furarium* wilt.
- Kasuri methi (fenugreek) seems to be resistant to powdery mildew.

Besides the research achievements, the report also contains financial out lay and expenditure, approved technical programmes, list of publications and staff as well as list centres, weather data of various centres, etc. The report also contains summary of achievements of the current ICAR ad-hoc research projects on spices.

INTRODUCTION

2.1 Brief History

Research on spices in India, initiated 50 years ago, underwent many organizational and functional changes. Research Schemes were initiated in 1940's at a few centres under the Department of Agriculture in Kerala, Tamil Nadu and Andhra Pradesh. Research on spices was initially limited in formulating cultural practices for major spices. Organized attempt to conduct research on spices was initiated in 1949. During that time the pepper research scheme in Panniyur (Kerala) and cardamom research schemes in Mudigere (Karnataka) and Pampadumpara (Kerala) were initiated. The main objectives of such schemes were adhoc funding of the research programmes carried out by the State Department of Agriculture/Universities.

The Spices Enquiry Committee (SEC) set up by the Govt. of India in 1953 strongly recommended to commence specific research activities by opening new research stations for spices research. Accordingly Research Centres were set up at Chettalli, Sirsi (Karnataka) and Dergaon (Assam) for Black pepper, Kandaghat (Punjab), Targaon (Maharashtra), Thodupuzha & Ambalavayal (Kerala) for ginger and turmeric, Kallar-Burliar (Tamil Nadu) for cloves and nutmeg, Fullia (West Bengal) and Coimbatore (Tamil Nadu) for minor spices. A few research schemes were also initiated for cardamom (Madras), ginger (Kerala) and turmeric (Orissa) during the pre plan periods.

Spices research received further impetus by the establishment of CPCRI at Kasaragod, having mandate on spices research. Simultanuously ICAR also sanctioned the All India Coordinated Spices and Cashew Improvement Project (AICS & CIP) in 1971 with its head quarters at CPCRI, Kasaragod, Kerala. Six centres were started in IV plan, Vittal & Panniyur was given the mandate to work on pepper. Pampadumpara, Mudigere and Gonicopal were assigned with research component on cardamom and Solan/Kandaghat to work on ginger and turmeric under AICS & CIP. During V plan, 5 more centres were added to work on seed spices and VI plan, 4 more centres were added, thus making to 13 centres, by delinking Vittal and Gonicopal centres. The quinquennial review committee constituted by ICAR in 1982 after reviewing the entire research work on spices and cashew recommended delinking of cashew and spices research from CPCRI and establishing two institutes (NRCs) one each on cashew and spices at Puthur & Calicut respectively. Subsequently this combined project was bifurcated and made independent and the **AICRP on Spices** came into existence in 1986 (VII plan) with the Indian Institute of Spices Research (earlier National Research Centre For Spices) Calicut, Kerala as the head quarters. During VII Plan, AICRPS was further strengthened by adding two more centres. During the annual plan period, Vellanikkara centre was delinked in 1998. Six more centres were opened in VIII plan, thus making to 20 centres. Subsequently the ICAR.RC NEH region, Gangtok (Non-plan) started in 1986 was

dropped in 1999 and large cardamom work was assigned to ICRI-RS (Spices Board) Gangtok as per the recommendation of the QRT 1998 and is functioning as a voluntary centre.

2.2 The mandates of the project (AICRPS) are:-

- Evolving high yielding, high quality varieties suitable for various agro-ecological situations, and that are tolerant / resistant to pests and diseases.
- 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)

2.3 Organisational set up

AICRPS, has its head quarters located at IISR. The project is spread out in 15 states of the country with 19 research centres (& 8 participating research centres) located in 15 Agricultural universities and one at ICRI-RS (Spices Board) Gangtok. These 19 centres are located in 13 Agro-climatic regions of India.

AICRPS centres and their mandate crops

Sl. No	Name of centre/ Location	Crops handled	State	Year of start
1	Chintapalli (ANGRAU)	Black pepper & ginger ***	Andhra Pradesh	1981 (VI Plan)
2	Coimbatore (TNAU)	Coriander, Fenugreek* & Turmeric ***	Tamil Nadu	1975 (V Plan)
3	Dapoli (KKV)	Black pepper, Nutmeg, Clove & Cinnamon	Maharashtra	1995 (VIII Plan)
4	Dholi (RAJU)	Turmeric, Coriander & Fenugreek	Bihar	1993 (VIII Plan)
5	Guntur (ANGRAU)	Coriander & Fenugreek	Andhra Pradesh	1975 (V Plan)
6	Hisar (CCSHAU)	Coriander, Fennel & Fenugreek	Haryana	1993 (VIII Plan)
7	Jagtial (ANGRAU)	Turmeric	Andhra Pradesh	1986 (VII Plan)
8	Jagudan (GAU)	Cumin, Coriander, Fennel, & Fenugreek	Gujarat	1975 (V Plan)
9	Jobner (RAU)	Cumin, Coriander, Fennel, & Fenugreek	Rajasthan	1975 (V Plan)
10	Kumarganj (NDUAT)	Turmeric , Ginger, Fennel Coriander, & Fenugreek	Uttar Pradesh	1995 (VIII Plan)
11	Mudigere (UAS-B)	Cardamom & Black pepper**	Karnataka	1971 (IV Plan)
12	Pampadumpara(KAU)	Cardamom & black pepper **	Kerala	1971 (IV Plan)
13	Panniyur (KAU)	Black pepper	Kerala	1971 (IV Plan)
14	Pottangi (OUAT)	Turmeric & Ginger	Orissa	1975 (V Plan)
15	Pundibari (BCKVV)	Black pepper, Turmeric & Ginger	West Bengal	1996 (VIII Plan)
16	Raigarh (IGKV)	Coriander, Turmeric & Ginger	Chattisgarh	1996 (VIII Plan)
17	Sirsi (UAS-D)	Black pepper	Karnataka	1981 (VI Plan)
18	Solan (YSPHUF)	Ginger & Turmeric *	Himachal Pradesh	1971 (IV Plan)
19	Yercaud (TNAU)	Clove**, Nutmeg**, Cinnamon**, Cardamom * & Black pepper **	Tamil Nadu	1981 (VI Plan)

Vittal to work on pepper and Gonicopal to work on cardamom established in 1971 discontinued in 1980. Vellanikkara (KAU) established in 1981 (for ginger & turmeric) discontinued with effect from 1.4.1990. ICAR-R.C. NEHR, Gangtok started in 1986 to work on large cardamom discontinued in 1998.

* *Crop discontinued* ** *Work initiated in 1993-94* *** *Work initiated in 1995-96.*

Voluntary/Participating Centres under AICRPS

Sl. No	Name of centre/ Location	Crops handled	State	Year of start
1.	Ambalavayal (KAU)	Black pepper, Clove& Cinnamon	Kerala	1992
2.	Bhavanisagar (TNAU)	Turmeric	Tamil Nadu	1993
3.	Gangtok (ICRI, RS)	Large cardamom	Sikkim	1999
4.	Myladumpara (ICRI)	Cardamom	Kerala	1993
5.	Pechiparai (TNAU)	Clove, Nutmeg & Cinnamon	Tamil Nadu	1993
6.	Sakleshpur (ICRIRS)	Cardamom	Karnataka	1993
7.	Thadiyankudisai (TNAU)	Clove, Nutmeg & Cinnamon	Tamil Nadu	1993
8.	Thadiyankudisai (ICRI, RS)	Cardamom	Tamil Nadu	1993

The research programmes are pursued under the areas of crop improvement, crop management, crop protection, post harvest technology and transfer of technology. The AICRPS operates from the headquarters of the Project Coordinator (Spices) located at IISR, Calicut, Kerala. The project was initiated under the supervision of Dr M C Nambiar of the unified AICRPS & CI at CPCRI, Kasaragod. Dr S Edison was the first Project Coordinator of the bifurcated AICRPS who coordinated the research activities of the project since its inception upto 1996. For about three years (1996-1998), Dr A K Sadanandan held the charge of Project Coordinator. Dr P N Ravindran took over as Project Coordinator in 1999. The website of the AICRPS and the research centres have also been established in 2001 (iisr.org).

2.4 Staff position

The AICRPS has a total staff strength of 83, which includes 51 Scientists, 32 technical/ auxiliary positions.

2.5 Budget

The coordinated project was started with a very modest budget of Rs.11.92 lakhs in IVth 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 in VIII Plan (ICAR share). The IX plan budget is Rs. 522.45 Lakhs shared by 75:25 basic by ICAR &SAU.

2.6 Achievements

It is pertinent to note that the impact of research under AICRPS on spice production and productivity. There has been remarkable increase in spices production and productivity during the past two decades, after the establishment of the coordinated project. Black pepper production, which over hovering around 26000 tonnes with productivity levels of 218 kg/ha in 1970-71, increased to 57300 tonnes in 1998-99 with a productivity of 316 kg/ha. Similarly in cardamom, the productivity increased from 34.65 kg to 149 kg, large cardamom 155.73 to 236 kg, ginger 1357kg to 3250 kg, turmeric 1871kg to 3931 kg, coriander 372 to 495 kg, cumin 324 to 403 kg/ha. Due to the concerted efforts of researchers, farmers and traders, the spices production and export recorded an all time high during 1998-99 with a national production of 3090000 tonnes

and export of 0.23 M T fetching Rs: 352 Million US $ in foreign exchange during 2000 - 2001.

The XV AICRPS workshop held in Calicut on 18-21 November 1999 critically evaluated the ongoing programmes and new programmes were formulated. These new programmes emphasized on integrated disease & pest management, biofertilizar studies & organic farming. All the programmes were initiated by the centres with their respective mandate crops.

The AICRPS has so far released about 70 varieties in spices for cultivation in different regions of the country and the production and distribution of seeds/planting material is also envisaged by the centres. The salient achievements of AICRPS and the ongoing *ad-hoc* research schemes on spices during the period 01-04-2000 to 31-03-2001 are summarized in this report. Besides, the research achievements, the report also contains, financial out lay and expenditure, approved technical programmes for 1999-2000, list of publications, proposed technical programmes for 2000-2001 and list of staff members of each centre. Brief reports of ICAR adhoc 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.

I sincerely hope that the information contained in Annual Report 2000-2001 would be useful to researchers, farmers and students. I trust that in the coming years, AICRPS will contribute more vigorously towards the cause of spices research in the country.

(P N RAVINDRAN)
Project Coordinator

PROJECT COORDINATOR'S REPORT

It gives me immense pleasure to present the Annual Report of AICRP on Spices for the period 2000-2001. This report presents an overview of the research activity in the area of Spices Research in the country under the AICRPS, the largest spices research network in the country.

The beginning of the new century has seen India establishing her supremacy as the largest producer and exporter of spices. The AICRPS together with organisations like IISR, ICRI, Spices Board and DASAD have also provided enough inputs for acceleration of the Research and Development process of spices that resulted in the present level of production and productivity. AICRPS has developed impressive network and infrastructure and made inter institutional linkages with other organisations dealing with spices. As a result, prospects for the growth and development of spices programme in our country in the coming decade are quite bright. The present report on highlights of research and achievements accomplished by the AICRPS centres summarized in the following pages also shall provide a glimpse of the present status of spices research in the country.

3.1 Genetic Resources

The genetic resource of Spices assembled at the AICRPS centres were enriched through further collection surveys and exchanges among centres. Exotic germplasm of seed spices were also received through NBPGR. The germplasm accessions were shortlisted, catalogued and conserved at the centres for further evaluation. The germplasm accessions were field evaluated and many promising lines were shortlisted for further comparative yield trials.

Promising germplasm accession lines at AICRPS centre

Spice	Centre	Accessions	Yield
Black pepper	Panniyur	Karimunda III	9.63g dry berry/vine
	Yercaud	PN-2 (Somaley)	4.35kg dry berry/vine
Cardamom	Mudigere.	CL-730	560kg/ha
		CL-681	540kg/ha
		CL-692	520kg/ha
Ginger	Solan	SG-876, SG-882	9.2kg/plant
	Kumaraganj	NDG-6	0.635g/plant
		NDG-17	0.560g/plant
Turmeric	Solan	No-262	7.4 kg/plant
		Cls-21 & ST-510	6.5 kg/plant

	Jagtial	**Long duration**	
		15B, Depaiguda Peddapasupu	
		Medium duration	
		Ethamukkala Avanigadda	
		Short duration	
		CL 1 Jyothi Kasthuri	
	Coimbatore	CL-101 CL-26 CL-147 CL-47 CL-154	
	Raigarh	RTS-36	214.46 q/ha
	Pundibari	TCP-2 TCP-1	
	Kumaraganj	NDH-18	522.25 q/ha
Coriander	Guntur	LCC-173	900 kg/ha
	Kumaraganj	ND-Cor-2	1773kg/ha
	Jobner	UD-743	1771kg/ha
	Coimbatore	CS-131 CS-14, CS-21 CS-12, CS-207 CS-27	
Fennel	Kumaraganj	NDF-5	1696 kg/ha
	Jagudan	JF-303	3122 kg/ha
Fenugreek	Guntur	LFC-84 .	1396 kg/ha
	Kumaraganj	NDM-19	1933 kg/ha
	Coimbatore	TF-105,TF-144 TF-103	

3.2 Crop Improvement

The promising accessions identified from the germplasm are put under CVT at different centres. New CVTs 2000-2001 in ginger, turmeric and black pepper have been initiated.

3.2.1 Cardamom

At Mudigere, in the preliminary evaluation trial the promising cardamom genotypes selected from open pollinated seedling progenies (D-237, CL-730, CL-692) were identified as superior for dry capsule yield. In another evaluation trial at Mudigere, Acc.8-4-D 11 and 7-24-D-11 were found superior compared to M1 &M2. Three drought tolerant lines identified at Mudigere (CL-668, P-6, D-237 and 2-2-D 11). Earlier studies at Mudigere made clear that improvement in yield in cardamom could be achieved by polycrosses. Six promising clones *viz.* Mudigere - 1 & 2, CL-692, HS-1, Sel-14, Sel-98, CCS-800, CL-691 were found to be better general combiners. The polycross seeds produced are under evaluation.

3.2.2 Black pepper

Trials for evolving varieties having superior yield and quality through intervarietal hybridization and selection are in progress at Panniyur. Intervarietal hybridization programmes were intensified and 36 cross combinations were made at Panniyur centre and the F13 are in the nursery. At Sirsi among the cultivars under evaluation, Acc-239 has given significantly higher fresh berry yield.

3.2.3 Ginger

Under the CVT at the Pundibari centre, Gorubathan recorded the highest yield of 9.28 kg/3m^2. Out of the six entries evaluated at Pottangi, highest fresh rhizome yield was recorded by $V_1 E_8$-2 (25.1 t/ha) followed by $V_3 S_1$-8 (22.1 t/ha).

3.2.4 Turmeric

At Coimbatore, 224 turmeric accessions were evaluated. Accession CL-101 registered the highest yield. Three other accessions viz. CL-26, CL-47, CL-154 recorded a yield of more than 50.0t/ha. The turmeric germplasm available at Jagtial (188) were classified based on duration *viz.*, long duration (8-9 months), medium duration (7-8 months) and short duration (6-7 months).

At Pundibari, in the CVT Rajendra Sonia, RH-5 & Acc-360 recorded the higher yields and at Jagtial, JTS-2 & JTS-1 showed the superiority. In MLT at Jagtial, PTS-15 gave highest yield, followed by PTS-59, (5.77 t/ha & 5.35 t/ha cured rhizome, respectively). Among the 10 entries evaluated at Pottangi, PTS-43 (7.46 t/ha) recorded the highest yield followed by PTS –62 (7.22 t/ha). At Dholi, among the 16 CVT entries, RH-5 yielded the highest.

3.2.5 Coriander

Among the 244 accessions evaluated at Coimbatore, the grain yield varied from 350 kg to 710kg/ha. At Coimbatore yield difference were highly significant in the CVT, varied from 501.33kg to 601.33kg/ha; Acc.12 (748) registered the highest yield. In another CVT at Coimbatore, cultivar Co-3 registered the highest yield of 646 kg/ha followed by Acc.207(964) with 646 kg/ha. At Dholi, DH-208 produced the maximum yield of 28.23 q/ha in the CVT. In the CVT at Guntur with 9 entries, LCC-128 recorded significantly higher yield of 883 kg/ha, followed by LCC-133 (850 kg/ha). An entry JCO-387 had recorded significantly higher yield

of 27.23 q/ha in the CVT at Jagudan. Under the coordinated trial at Coimbatore based on the mean performance, the accession CC- 748 was found to be superior with highest yield of 580 kg/ha followed by UD-686 (561 kg/ha).

3.2.6 Fenugreek

Under the CVT of fenugreek at Coimbatore, the yield varied from 455 to 558 kg/ha, the highest mean yield for three years was recorded by Acc.105 (UM-302/573.3 kg/ha). At Guntur in the CVT with 12 entries, JF-210 recorded significantly superior yield (1354 kg/ha) followed by JF-204 (1271 kg/ha). HM-350 (25.46 q/ha) followed by UM-305 (25.0q/ha) yielded the maximum in the CVT at Dholi.

Promising entries identified under CVT at different centres of AICRPS

Spice	Centre	Entry	Yield
Turmeric	Pundibari	TCP-2	16.43 kg/plot
	Kumaraganj	NDH-18	510.55 q/ha
	Jagtial	JTS-2	25.33 t/ha
		JTS-1	23.86 t/ha
		PTS-15	5.77 t/ha (dry)
		PTS-59	5.35 t/ha (dry)
Coriander	Guntur	LCC-128	883 kg/ha
	Kumaraganj	Kumaraganj Sel.(Check)	1971 q/ha
	Jagudan	JCO-387	2723 kg/ha
	Jobner	UD-744	1641 kg/ha
		DH-246	1576 kg/ha
Fenugreek	Guntur	JF-210	1354 kg/ha
	Kumaragnj	JF-195 & Kumaragaj Sel (check)	2191 kg/ha
	Jagudan	HM-350	2476 kg/ha
	Jobner	HM-350	1620 kg/ha
		JF-204	1602 kg/ha
Black pepper	Ambalavayal	Cul. 5128	1.064 kg/vine
	Sirsi	Cul. 239	1.92 kg/vine
	Panniyur	Cul. 5128	3.450 kg/vine
Fennel	Kumaraganj	HF-39	2053 kg/ha
	Jagudan	JF-192	2573 kg/ha
	Jobner	UF-143	1244 kg/ha
		JF-186	1206 kg/ha
Cumin	Jobner	UC-223	3290 kg/ha
Cardamom	Mudigere	CL-692 (Malabar)	282.6 kg/ha
		MCC-12 (Mysore)	1148 g/plot
Cinnamon	Ambalavayal	SL-203	0.315 kg dry quills

Promising varieties under pipe line in spice crops

Ginger	V_3S_1-8 (Pottangi)	High yielding, high oleoresin,low fibre content, disease tolerance & wide adaptability.
Turmeric	PTS-59 (Pottangi)	High yielding, long duration type. High dryage, high curcumin disease tolerance and wide adaptability.
	PTS-55 (Pottangi)	High yielding, short duration type with high curcumin and dryage disease tolerance and wide adaptability.

Spices varieties proposed for release at different centres of AICRPS

Spice	Centre	Variety	Special Features
Ginger	Pottangi	V_1E_8-2	High yield, low fibre, high oleoresin, disease tolerance, wide adaptability.
Turmeric	Pottangi	PTS-43	High yield & curcumin high dryage, disease tolerance & wide adaptability.
	Pundibari	TCP-1	High yield 24.2 t/ha with curcumin 5.1%, duration 225 days tolerant to leaf blotch disease & monthly result to rhizome rot result to rhizome scale & moderately resistant to shoot borer.
	Pundibari	TCP-2	Yield 29.2 t/ha with curcumin 5.7% & duration 235 days.

3.3 CROP PRODUCTION AND MANAGEMENT

3.3.1 Black pepper

New experiments on biofertilizer using *Azospirillum* and P-Solubilizers have been initiated in black pepper, cardamom and seed spices. Similarly studies on organic farming in spices have also been initiated.

In black pepper, irrigation cum fertilizer trials are in progress at Sirsi and drip irrigation trial at Panniyur. At Sirsi significant difference in yield of black pepper was recorded due to the effect of irrigation, manure and its interaction in the pepper-areca cropping system. Studies on drip irrigation of black pepper at Panniyur indicate that irrigation @ 2 Lit/ vine daily during summer months will enhance the total number of spikes and spikes yield.

A biofertilizer study in black pepper using *Azospirillum* and P-Solubilizers is initiated at Panniyur, Sirsi, Yercaud and Ambalavayal. Organic farming in black pepper is progressing at Sirsi and Yercaud. The preliminary results indicated that application of burnt earth to pepper vines had beneficial effect on yield.

3.3.2 Cardamom

An integrated nutrient management study conducted at Pampadumpara indicated that the fertilizer dose of 100:100:175 kg NPK/ha registered the more panicles (32.2), fresh yield (2.46 kg/plant) and dry yield (587 g/plant).

3.3.3 Turmeric

Studies at Pottangi over 3 years did not give any significant difference in yield; the variety Roma gave the highest yield (4.48 t/ha) followed by Alleppy (4.11 t/ha). At Coimbatore significant variations were observed among the varieties and the variety Suguna registered the highest yield (44.69 t/ha).

The turmeric collection at Solan was analysed for various quality parameters. The ranges were: dry matter content 13.4 to 28.3%; essential oil 2.0 to 8.0%; oleoresin 4.69 to 18.53%; and curcumin 1.0 to 4.93%. Alleppy finger had cucumin content of 4.58% and it was little lesser than BDJR- 1260 (4.93%) the top yielder, while dry matter recovery was maximum in CLS-13 (28.3%); essential oil (8.0%) in ST 8M and BDJR- 1034.

3.3.4 Coriander

The three years study conducted at Guntur for the performance of coriander leafy type for greens under Lam agroclimatic condition indicated the supremacy of EC-232666 with 19.7 t/ha greens followed by EC- 279048 with 18.8 t/ha. EC-243370 (18.3 t/ha) and EC- 279047 (17.6t/ha) which were significantly superior over check 'Sadhana' (14.0 t/ha). EC-232666 was superior to the other genotypes with lesser % of stem/branches in the greens.

A three year study at Jobner on the response of coriander to micronutrients confirmed that significantly higher seed yield over control can be obtained with soil application of $MnSO_4$ @ 25 kg/ha (9.22 q/ha) and $CuSO_4$ @ 25 kg/ha (8.83 q/ha); foliar application of $ZnSO_4$ @ 0.50% (9.09 q/ha) and $CuSO_4$ @ 0.50% (10.00 q/ha); and soil (5 kg/ha) + foliar (0.125%) application of $FeSO_4$ (9.03 q/ha), $MnSO_4$ @ 12.5 kg/ha + 0.25% (8.85 q/ha) and $CuSO_4$ @ 12.5 kg/ha + 0.25% (8.83 q/ha).

3.3.5 Cumin

The volatile oil content of 8 entries of cumin under CVT was analysed at Jobner and found to range from 2.6 to 4.4% with the highest (4.4%) being in EC-232684 followed by JC-147 (3.9%) and RZ-19 (3.3%). The mean data of 3 years indicated that highest mean volatile oil content of 3.56 L/ha. was recorded in JC-147 followed by 3.26 L/ha in EC 232684 and 3.23 L/ha in UC-223.

3.3.6 Fennel

The volatile oil content of fennel analysed at Jobner was found to be from 0.6 to 2.4%. The volatile oil content of 11 accessions (evaluated under CVT), analysed at Jobner ranged from 1.6 to 2.1%, the highest being in UF-144, followed by 2.0% in UF-143, HF-33 and JF-200.

3.3.7 Fenugreek

A three years study at Jobner on the response of fennel to Zn, Fe, Mn & Cu revealed significantly higher seed yield over control with soil application of $ZnSO_4$ @ 20 kg/ha (10.10 q/ha), foliar application of $ZnSO_4$ @ 0.50% (9.27 q/ha), $FeSO_4$ @ 0.25% (9.92 q/ha), $MnSO_4$ 0.5% (9.42 q/ha) and $CuSO_4$ @ 0.5% (9.45 q/ha) and soil + foliar application of Zn SO_4 @ 5.0 kg/ha + 0.125% (9.12 q/ha) and $MnSO_4$ @ 12.5 kg/ha + 0.25% (9.49 q/ha).

Studies at Jobner on the response of fenugreek varieties to row spacing and date of

sowing confirmed that fenugreek variety RMt-1 should be sown before 31st October.

3.4 CROP PROTECTION

3.4.1 Black pepper

For the *Phytophthora* foot rot management, the Sirsi centre recommended application of potassium phosphonate (Akomin) @ 0.3% as spray (3l/vine) and drench (5l/vine) twice during the season (ie before on set of monsoon once and again during second week of August. The observation trial for integrated management of foot rot was laid out at Panniyur centre in farmers field at two locations. Metalaxyl gold and *Trichoderma* was found effective against the disease in both the locations at Panniyur. However, at Sirsi Ridomil MZ 72 WP (1.25g) spraying and drenching and application of biocontrol agent *Trichoderma harzianum* (50 g/vine) have good control, which was superior to all other treatments. In another study at Sirsi in arecanut based cropping system, indicated that *Phytophthora* foot rot was least (15.0%) in vines treated with potassium phosphonate @ 0.50% as spray @ 2l/vine and drench 3l/vine and soil application of *Trichoderma harzianum* @ 50kg (10^7 CFU) in one kg of neem cake during the first week of June and second week of August.

In the crop protection experiment against *Phytophthora* foot rot of black pepper at Mudigere centre, spraying and drenching of Ridomil MZ 72 WP (1.25 g/lit) and application of biocontrol agent-*T. harzianum* 50g with one kg of neem oil cake during pre and post monsoon could effectively control foot rot disease in black pepper. Leaf and spike damage due to anthracnose disease in black pepper at Mudigere was to an extent of 24.48% and 9.93% respectively during the month of July. Pampadumpara centre made a survey in 9 panchayaths that revealed the occurrence of *anthrocnose* in all panchayaths and that the disease is caused by *Collectotrichum gloeosporides.*

In the study on the control of scale insect-pests in black pepper at Pampadumpara, the maximum suppression of the mussle scale was observed in dimethoate application. The pampadumpara centre also made a survey in 14 panchayaths of 4 taluks to study the occurrence of insect pest in black pepper. The most predominant insect-pest observed in all the gardens surveyed was marginal gall thrips (*Liothrips Karymyi*) ranging from 12.32% to 21.23% of vines. Leaf minor was recorded in 12 panchayaths, however the incidence ranged only 1.03%. Three types of scale insects were found in eleven panchayaths (0.61%), of which mussle scale of *Lepidosaphes piper* was predominant.

3.4.2 Cardamom

The experiment conducted at Mudigere on the evaluation of neem based insecticides against cardamom trips and borer revealed that none of the neem based insecticides proved effective on the control.

3.4.3 Ginger

Survey made by Solan centre reported wild spread incidence of rhizome rot in ginger. The incidence varied from 1 to 40% in different locations and the lowest incidence (1%) was recorded in Ladu location. A new trial on integrated management for the control of rhizome rot of ginger was initiated at Solan centre. It is observed from the preliminary studies that the disease incidence was minimum (3.5 to 4.5%) by the use of 0.25% Unilax and one percent Bordeaux mixture.

Storage study at Solan indicated better recovery of rhizome and the lower disease incidence, when rhizomes are stored in sand layered pits mixed with Dithane M-45 + Bavistin (5g + 3g/kg sand) followed by Bioshield. Both these treatments also showed minimum weight loss. Rhizome rot of ginger in most locations of HP was found to be due to a mixed infection by *Fusarium* sp. *Pythium* sp. and *Ralstonia solanacearum.*

Survey conducted by Pundibari and Dholi (Bihar) centres indicated that ginger crop suffers from rhizome rot disease in 3 districts in the former centre.

Dholi centre indicated that Ridomil MZ (200-300 ppm) as seed treatment provided better control of soft rot disease, thus giving higher yield.

3.4.4 Turmeric

Leaf blotch incidence was more severe in comparison with leaf spot disease in turmeric in Bihar. Turmeric germplasm lines were screened against foliar and rhizome rot disease. At Jagtial the long duration group TC-4 and intermediate duration type CLI-32, CLI-370, CLI-325 and JTS-302 showed only the lowest rhizome rot incidence. Out of the 46 varieties tested against *Colletotrichum* leaf spot diseases, 8 short duration, 26 mid duration and 12 long duration types were free from leaf spot. Out of 50 turmeric entries screened, Duggirala, Telupu, Armoor local, JTS-1, JTS-2 and TC-2 were found free from *Taphrina* leaf blotch disease.

The trial on chemical control on leaf blotch disease at Pundibari indicated that the treatment with Bordeaux mixture reduced the PDI (Percent Disease Incidence) and increased aerial dry biomass as well as fresh rhizome yield compared to other fungicides. In another trial at Pundibari to control both leaf blotch and leaf spot diseases, lowest disease incidence was in Mancozeb + Carbendazim applied as foliar spray (0.2%).

3.4.5 Coriander

Dholi centre found that coriander was severely affected by stem gall disease caused by *Protomyces macrosporus* in many districts of Bihar. At Jobner, 23 coriander entries were tested against stem gall disease. Three entries viz. RCr-41, RCr-435 and RCr-436 were found immune to the disease. Similarly 22 entries of coriander were tested against root knot nematode (*M.incognita*) at Durgapura, varieties RCr-41, RCr-435, RCr-436, UD-446 and UD-684 were found resistant.

3.4.6 Cumin

In studies on wilt incidence in relation to dates of sowing, the lowest wilt incidence was in 10th November sown crop (10%). The varieties Gujrat Cumin-3, Acc.1136, Acc.1145, Acc:1165 were moderately resistant to *Furarium* wilt in the screening at Jagudan centre under the wilt sick plot situation, but none was found resistant to blight or powdery mildew. At Jobner, UC-223 shows less wilt incidence.

In the epidemiological study of *Alternaria* blight of cumin, minimum incidence was recorded on 10th November sowing with grain yield of 3.63q/ha. At Jobner the wilt incidence was reduced to 15% and maximum yield of 229 g/ plot was recorded with the application of *T.harzianum* through seed treatment + soil application along with plot sprayed with Mancozeb @ 0.03% as compared to 31.3% wilt incidence in control.

3.4.7 Fenugreek

At Jagudan, in the screening of fenugreek entries against powdery mildew, Kasuri Methi was found resistant.

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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**	
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/CI/3.3	CVT 2000-Series V	Panniyur and Ambalavayal
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	Drip irrigation in black pepper	Panniyur
PEP/CM/2	**Nutrient Management Trial**	
PEP/CM/2.1	Efficacy of biofertilizer using *Azospirillum* on black pepper	Sirsi, Panniyur, Yercaud and Ambalavayal
PEP/CM/2.2	Efficacy of biofertilizer using P-Solubilizers on black pepper	Sirsi, Panniyur, Yercaud and Ambalavayal
PEP/CM/2.3	Organic farming in black pepper	Sirsi and Yercaud
PEP/CM/3	**Multiplication Trial**	
PEP/CM/3.1	Rapid multiplication of black pepper on soil mound	Dapoli
PEP/CP/1	**Disease Management Trial**	
PEP/CP/1.1	*Phytophthora* foot rot disease management in black pepper	Sirsi (closed)

PEP/CP/1.2	Biological control of *Phytophthora* foot rot of black pepper – Nursery trial	Chintapalli, Ambalavayal and Pampadumpara
PEP/CP/1.3	Studies on the control of nursery disease of black pepper including biocontrol	Panniyur (closed)
PEP/CP/1.4	Control of *Phytophthora* disease of black pepper in farmers' field – observation trial	Panniyur, Sirsi, Ambalavayal and Mudigere
PEP/CP/1.5	*Phytophthora* foot rot incidence in black pepper under different densities in an arecanut garden	Sirsi and Panniyur
PEP/CP/1.6	Survey for the occurrence of diseases in black pepper modified as "Incidence, epidemiology and management of anthracnose of black pepper"	Pampadumpara, Dapoli and Mudigere
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 on 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**	
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 and Sakleshpur
CAR/C1/3.4	CVT 2000- Series IV	Mudigere, Myladumpara, Pampadumpara and Saklespur.
CAR/CI/4	**Varietal Evaluation Trial**	
CAR/CI/4.1	Yield evaluation of open pollinated Seedling progenies (VET-I)	Mudigere
CAR/CI/4.2	Yield evaluation of promising cardamom selection (VET-II)	Mudigere

CAR/CI/4.3	Yield evaluation of promising cardamom selection (VET-III)	Mudigere
CAR/CI/4.4	Yield evaluation of promising cardamom selection (VET-IV)	Mudigere
CAR/CI/5	**Screening of cardamom clones for abiotic stress**	Mudigere
CAR/CM/1	**Nutrient Management Trial**	
CAR/CM/1.1	Effect of fertilizer on the yield of cardamom under natural shade	Mudigere (closed)
CAR/CM/1.2	Influence of micronutrients on the yield of cardamom	Pampadumpara and Mudigere (closed)
CAR/CM/1.3	Integrated nutrient management in cardamom	Mudigere and Pampadumpara
CAR/CM/1.4	Efficacy of biofertilizer using *Azospirillum* on cardamom	Mudigere, Pampadumpara, Myladumpara and Sakleshpur
CAR/CM/1.5	Efficacy of biofertilizers using P-solubilizers on cardamom	Mudigere, Pampadumpara, Myladumpara and Sakleshpur
CAR/CP/1	**Disease Management Trial**	
CAR/CP/1.1	Chemical control of cardamom nursery leaf spot	Mudigere (closed)
CAR/CP/1.2	Biological control of clump rot in cardamom nursery	Mudigere (closed)
CAR/CP/2	**Pest Management Trial**	
CAR/CP/2.1	Evaluation of plant based isecticides for the control of thrips and fruit borers	Mudigere
CAR/CP/2.2	Management of root grub of cardamom	Pampadumpara
CAR/CP/2.3	Bioecology of natural enemies of major pests of cardamom	Pampadumpara
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**	
GIN/CI/2.1	CVT 1996 – Series IV	Pundibari (closed)

GIN/CI/2.2	CVT 2000 – Series V	Solan, Pottangi, Raigarh, Pundibari and Chintapalli
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/CM/1	**Nutrient Management Trial**	
GIN/CM/1.1	Efficacy of biofertilizer using *Azospirillum* on ginger	Solan, Pottangi, Ambalavayal and Raigarh
GIN/CM/1.2	Organic farming in ginger	Solan, Pottangi, Ambalavayal and Raigarh
GIN/CP/1	**Disease Management Trial**	
GIN/CP/1.1	Integrated management on rhizome rot of ginger	Solan, Dholi and Pundibari
GIN/CP/1.3	Effect of seed treatment on soft rot disease of ginger	Dholi and Pundibari
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/Bhavanisagar
TUR/CI/2	**Coordinated Varietal Trial**	
TUR/CI/2.1	CVT 1996 – Series IV	Pundibari, Kumaraganj and Jagtial
TUR/CI/2.2	CVT 2000-Series V	Raigarh, Pundibari, Pottangi, Dholi, Chintapalli and Jagtial
TUR/CI/3	**Varietal Evaluation Trial**	
TUR/CI/3.1	Comparative yield trial (1999-2000)	Pottangi, Dholi, Jagtial, Raigarh and Pundibari
TUR/CI/3.2	Initial evaluation trial	Pottangi
TUR/CI/4	**Quality Evaluation Trial**	
TUR/CI/4.1	Quality evaluation of germplasm / varieties	Solan and Coimbatore
TUR/CI/4.2	Impact of environment on quality of turmeric	Pottangi and Coimbatore

TUR/CM/1	**Nutrient Management Trial**	
TUR/CM/1.1	Efficacy of biofertilizer using *Azospirillum* on turmeric	Coimbatore, Pottangi, Ambalavayal Raigarh and Kumarganj
TUR/CM/1.2	Effect of different organic inputs on turmeric	Pottangi
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, Raigarh and Pundibari
TUR/CP/1.2	Chemical control measures against leaf blotch disease of turmeric	Pundibari and Kumarganj
TUR/CP/1.3	Effect of seed treatment on leaf spot and leaf blotch diseases of turmeric	Dholi and Pundibari
TUR/CP/1.4	Investigations on the causal organism of rhizome rot of turmeric and screening of biocontrol agents for its 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
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	Dapoli and Pechiparai
TSP/CM/2	**Irrigation Trial**	
TSP/CM/2.1	Drip irrigation in clove and nutmeg	Yercaud
TSP/CM/3	**Nutrient Management Trial**	
TSP/CM/3.1	Biofertilizer trial in tree spices	Yercaud (closed)
TSP/CP/1	**Disease Management Trial**	
TSP/CP/1.1	Survey for disease incidence in tree spices	Dapoli

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
COR/CI/2	**Coordinated Varietal Trial**	
COR/CI/2.1	CVT 1993 – Series II	Raigarh, Coimbatore and Kumarganj
COR/CI/2.2	CVT 1996 – Series III	Coimbatore, Hisar, Dholi and Kumarganj
COR/CI/2.3	CVT 1998 – Series IV	Jobner, Jagudan, Guntur, Hisar and Dholi
COR/CI/3	**Varietal Evaluation Trial**	
COR/CI/3.1	Comparative yield trial	Coimbatore
COR/CI/3.2	Initial evaluation trial	Jagudan, Jobner, Hisar and Guntur
COR/CI/4	**Quality Evaluation Trial**	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/1	**Nutrient Management Trial**	
COR/CM/1.1	Response of coriander to micronutrients	Jobner and Kumaraganj
COR/CM/1.2	Efficacy of biofertilizer using *Azospirillum* on coriander	Coimbatore, Guntur and Kumaraganj
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	Management of wilt and powdery mildew diseases in coriander	Kumaraganj
COR/CP/1.3	Studies on stemgall disease management in coriander by 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 III	Jobner
CUM/CI/3.2	CVT 1999-Series IV	Jagudan and Jobner
CUM/CI/4	**Varietal Evaluation Trial**	
CUM/CI/4.1	Initial evaluation trial	Jagudan
CUM/CI/5	**Quality Evaluation Trial**	
CUM/CI/5.1	Quality evaluation in cumin	Jobner
CUM/CP/1	**Disease Management Trial**	
CUM/CP/1.1	Control of blight disease by manipulation of agronomic practices	Jagudan (closed)
CUM/CP/1.2	Epidemiological study of *Alternaria* blight of cumin	Jobner
CUM/CP/2	**Pest Management Trial**	
CUM/CP/2.1	Integrated management of pests and disease of cumin	Jobner and Jagudan
FENNEL		
FNL/CI/1	**Genetic Resources**	
FNL/CI/1.1	Gemplasm collection, characterization, evaluation, conservation and screening against diseases	Jobner, Jagudan, Hisar, Dholi and Kumaraganj
FNL/CI/2	**Hybridization Trial**	
FNL/CI/2.1	Mutation studies and crossing programme in fennel	Jagudan
FNL/CI/3	**Coordinated Varietal Trial**	
FNL/CI/3.1	CVT 1994 – Series III	Jobner, Jagudan, Hisar and Kumaraganj – closed
FNL/CI/4	**Varietal Evaluation Trial**	
FNL/CI/4.1	Initial evaluation trial	Jagudan
FNL/CI/5	**Quality evaluation trial**	
FNL/CI/5.1	Quality evaluation in fennel	Jobner

FNL/CM/1	**Nutrient Management Trial**	
FNL/CM/1.1	Response of fennel to the application of Zn, Fe, Mn, and Cu	Jobner – closed
FNL/CM/1.2	Efficacy of biofertilizer using *Azospirillum* and P- Solubilizers on fennel	Kumaraganj, Jagudan and Jobner

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
FGK/CI/2	**Hybridization Trial**	
FGK/CI/2.1	Evolving varieties resistant to powdery mildew through mutation breeding and crossing programme To be modified as "Evolving varieties resistant to powdery mildew"	Jagudan
FGK/CI/3	**Coordinated Varietal Trial**	closed
FGK/CI/3.1	CVT 1995 – Series III	Coimbatore, Guntur, Jagudan, and Kumarganj
FGK/CI/3.2	CVT 1999 – Series IV	Jobner, Kumarganj, Hisar and Dholi
FGK/CI/4	**Varietal Evaluation Trial**	
FGK/CI/4.1	Comparative yield trial	Coimbatore and Dholi
FGK/CI/4.2	Initial evaluation trial	Hisar
FGK/CM/1	**Spacing / Sowing Trial**	
FGK/CM/1.1	Effect of time of sowing and spacing	Coimbatore (closed)
FGK/CM/2	**Nutrient Management Trial**	
FGK/CM/2.1	Response of fenugreek varieties to row spacing and date of sowing	Jobner
FGK/CM/2.2	Efficacy of biofertilizer using *Azospirillum* on fenugreek	Coimbatore, Guntur and Kumaraganj – centres ?

Quality evaluation in fenugreek

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 and *Pundibari*

Panniyur centre maintains 138 accessions of black pepper in the field gene bank. Among these, 72 have flowered and produced spikes during the period. The cultivar Karimunda- III recorded the highest berry yield of 963g/vine (dry) with a total spike number of 1170 followed by Panniyur-1 with 690g/vine dry berry yield and 407 spikes/vine.

At Sirsi centre 75 cultivated and 20 wild types have been maintained in the germplasm block. Twenty five accessions have been planted on arecanut standards. Karimunda was the most susceptible to *Phytophthora* foot rot and the other varieties exhibited varying degrees of susceptibility. None of the varieties exhibited complete tolerance / resistance to *Phytophthora* foot rot. Passport data for the variety Karimalligesara, Uddakare and Doddigya are collected.

At Yercaud 106 accessions are being maintained. During the current year berry set was observed only in four accessions. Dry berry yield was high in PN-2 (Somaleg) (1.138 kg/ vine).

Chintapalli centre maintains thirty seven cultivated varieties and 29 wild collections. Among the cultivated varieties this year also Panniyur-1 recorded the highest yield of fresh and dry berries/ vine (5.04 kg fresh & 1.42 kg dry). Perumkodi, Kanjiramunda, Vattamundi, Chenganoor kodi, Malabar, Kallubalankotta, Palulauta, Kaniyakadan, Murithothan, Vellarimunda and P-24 were collected during the current year.

At Pundibari, 10 genotypes have been collected from IISR in July 2000.

The germplasm of black pepper consists of 11 varieties at Dapoli. The growth performance of the varieties were recorded and it is satisfactory.

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 are in progress. Thirty six crosses were made. The seeds of five combinations were sown and the seedlings were transplanted in the main field during August 2000. The seeds of other crosses were collected and sown in pots, and are at the seedling stage.

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.1 CVT 1987 - Series III

Sirsi and *Panniyur*

The trial was laid out at Panniyur and Sirsi to compare the performance of promising cultivars and released varieties. At Sirsi, cultivar 239 recorded the highest yield of 1.92 kg of fresh followed by cultivar 331 and 141 (1.51kg fresh

yield each) during 1999-2000. The trial has already completed at Panniyur.

PEP/CI/3.2 CVT 1991- Series IV

Panniyur, Chintapalli, Yercaud, Pampadumpara and *Ambalavayal*

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

At Ambalavayal, the trial was started in 1992 with 14 entries. The biometric and yield characters recorded in January 2000 is given in Table 1. Among the 14 entries tested in multilocational trial, Cul. 5128 recorded the highest yield (1.065 kg fresh and 0.359kg dry) per standard. PN-4 recorded the highest number of spikes (213) followed by cul.5128 (173). Panniyur-1 produced the longest spike (10.12cm) followed by cul. 1558 (9.90cm) & PN-3 (9.8cm). Number of berries/spike was more in PN-3(67.01) followed by Acc-2445 (59.33).

Table 1: Yield performance of black pepper genotypes under CVT at Ambalavayal (MLT 1987 Series III)

Genotype	Wet wt.of berries (Kg)	Dry wt. of berries (Kg)	No. of spikes	Spike length (cm)	No. of berries / spike	1000 berry wt. (g)	1000 berry volume (cc)
Sreekara	0.115	0.052	52.5	6.95	35.5	121.67	103.34
Subhakara	0.107	0.040	33.5	6.02	34.9	110.83	105.00
Panchami	0.503	0.183	127.0	9.33	55.0	150.00	105.00
Ottaplackal Kottanadan [ACC 2426]	0.134	0.047	71.0	6.76	29.84	138.89	111.11
Kottanadan (ACC 2445)	0.235	0.061	70.5	8.34	51.29	146.25	113.75
PN1	0.605	0.205	149.0	8.22	59.33	183.33	130.00
PN2	0.372	0.186	127.6	10.12	46.72	168.89	134.44
PN3	0.175	0.061	73.6	7.66	28.50	123.33	109.17
PN4	0.930	0.312	148.6	9.80	67.01	107.33	126.66
Cul 1558	0.686	0.188	213.5	7.90	49.28	125.00	104.75
Cul 5128	0.193	0.055	68.0	9.90	51.7	100.00	80.00
Cul 239	1.065	0.359	173.5	8.8	46.4	183.33	113.34
Karimunda	0.139	0.059	53.5	9.2	27.7	133.33	126.67
	0.060	0.035	57.0	6.0	28.2	100.00	70.00

At Panniyur, among the 14 cultivars planted in 1993, cul-5128 recorded the highest green berry yield of 3.450 kg/vine followed by cul-1558 with 3.350kg/vine. (Table 2). Spike number per vine was more in Panchami (844) followed by Panniyur-4 (721). The number of developed berries/spike was highest in Panniyur-1 (50.10); culture 1558, Panniyur-1, cul-239 were having longer spikes (>14cm) and were significantly superior to all other varieties. The 100 berry wt. was more in cul.5128 (16g) and this was statistically on par with varieties Pournami, Panniyur-1, 2 & 3.

Table 2: Yield and its attributing characters of black pepper under CVT at Panniyur (2000-01)

Cultures/varieties	Green berry yield (kg)	No.of Spikes	No.of developed berries/spike	spike length (cm)	100 berry wt. (g)
Sreekara	0.550	219	22.45	8.55	9.0
Subhakara	2.350	604	26.90	7.95	12.0
Panchami	1.500	844	23.35	9.05	10.5
Pournami	0.250	144	29.05	9.90	14.0
Kottanadan (2426)	1.250	498	32.10	9.40	11.0
Kottanadan (2445)	2.150	471	35.95	10.05	13.0
Panniyur 1	2.150	322	50.10	14.20	14.5
Panniyur 2	2.200	512	32.35	9.70	15.0
Panniyur 3	1.900	382	40.90	12.90	14.0
Panniyur 4	2.750	721	33.05	10.00	11.5
Cul-1558	3.350	701	40.60	15.25	12.0
Cul-5128	3.450	323	32.25	12.35	16.0
Cul-239	2.450	434	43.65	14.15	11.5
Karimunda	1.250	488	27.70	8.15	11.5
CD (0.05)	NS	NS	NS	2.0	2.8

The trial was laid out at Chintapalli in 1996-97 with 14 varieties / selections. Among them highest yield of 1.03 kg (dry berry/vine) was obtained in Sreekara during the 4th year of planting (1999-2000), which was significantly superior to other varieties. The varieties were affected by stunted virus and the vines were removed. Replanting will be taken up in July 2000-2001.

The trial was laid out at Pampadumpara in 1992. Out of the 14 promising varieties tested, ACC 2426 gave the highest green berry yield of 5.8 kg per plot followed by Cul.239 (5.2kg/plot) (Table 3) However, the highest dry berry yield of 2.0 kg was obtained in Cul. 239 closely followed by ACC 2.4 (1.9kg). The length of spike was more in Panniyur-3 followed by Panchami.

Table 3: Yield attributing traits of different varieties of black pepper in CVT at Pampadumpara

Variety	Spike weight (g)	Spike length (cm)	No.of berries	Green berry weight (g plot^{-1})	Dry berry weight (g plot^{-1})
Sreekara	2300	10.3	147	1250	496
Subakara	3067	7.0	38	2633	1299
Panchami	6034	12.0	59	4666	1670
Ottaplackal	4300	9.5	42	3103	1439
Kottanadan (ACC 2426)	6967	10.5	45	5800	1916
Kottanadan (ACC 2425)	6200	9.5	67	5033	1439
Panniyur-1	2300	11.5	70	1933	1095
Panniyur-2	1030	11.5	32	810	346
Panniyur-3	5500	13.5	83	4606	1948
Panniyur-4	3110	9.0	38	2416	923
Cul.1558	816	11.0	53	580	206
Cul.5128	1967	10.2	52	1466	482
Cul.239	5900	11.3	63	5200	1990
Vellanamban	5400	10.8	38	4466	1920
CD at 5%	14.42	NS	2.3	9.68	10.31

At Yercaud, the trial was laid out in 1992 but during the reported year, the centre has not submitted the report.

PEP/CI/3.3 CVT 2000-Series V

Panniyur and *Ambalavayal*

A new CVT to evaluate the performance of released varieties as well as promising selections under different situations was laid out at Panniyur and Ambalavayal as per the XV AICRPS workshop decision. The experiment was laid out at Ambalavayal using *Erythrina* as standard.

PEP/CM/1 Irrigation Trial

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

Sirsi

This trial was laid out in 1992-93 using the variety Panniyur-1, with three irrigation levels as well as fertilizer levels to study their effect on pepper and arecanut mixed cropping system that receives the recommended dose of fertilizer at 100:40:140 g NPK/palm/year. During the previous year significant difference in yield of

black pepper was recorded due to the effects of irrigation, manure and its interaction. But during the current year (Aug.2000) more than 40% of the vines perished due to the disease. Replanting has been taken up.

PEP/CM/1.2 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 at Panniyur in 1996 in a factorial RBD with three levels of irrigation and three varieties. The period of irrigation was from December to April. During 2000-2001, data on total number of spikes, spike yield, developed berry %, spike length, undeveloped berry %, fungal pollu, insect pollu, height and width of plants were recorded. The results showed that irrigation at 2 litre /vine daily was superior to the control and 4 liters per day with respect to spike yield, total number of spike and spike weight and spike length though the data was not statistically significant. Under irrigated conditions, performance of Panniyur-5 was good with respect to total number of spike and spike weight. Interaction effect was also non-significant, though spike length was more under 4 liters/vine. But the other factor i.e. varieties showed significant difference for yield attributing characters. Infestation due to fungal pollu was more at this irrigation level. Results in general indicated that irrigation level @ 2 lit/vine daily during summer months can enhance total number of spikes and yield.

PEP/CM/2 Nutrient Management Trial

PEP/CM/2.1 Efficacy of biofertilizer using *Azospirillum* on black pepper

Sirsi, Panniyur, Yercaud and *Ambalavayal*

The trial was laid out at Sirsi, Panniyur, Yercaud and Ambalavayal centres during 2000-2001 with the six treatments and six vines/treatment. They are T1- Inorganic N (100%) + *Azospirillum* (50g) + 10 kg FYM; T2 - Inorganic N (75%) + *Azospirillum* (50g) + 10 kg FYM; T3 - Inorganic N (50%) + *Azospirillum* (50g) + 10 kg FYM;T4 – FYM (10kg) + *Azospirillum* (50g); T5 – FYM (10kg) alone and T6 – Recommended dose of inorganic fertilizer.

P&K are common as rock phosphate and MOP, respectively.

Two split applications May-June and August-September.

At Sirsi, this trial was laid out using arecanut as standard. The statistical data indicated no significant difference in yield due to treatments (Table 4).

Table 4 : Efficacy of biofertilizer on black pepper using *Azospirillum* at Sirsi.

Treatment	Mean fresh yield (kg/vine)
T1 – Inorganic N (100%) + *Azospirillum* (50g) + 10kg FYM	6.49
T2 – Inorganic N (75%) + *Azospirillum* (50g) + 10kg FYM	6.23
T3 – Inorganic N (50%) + *Azospirillum* (50g) + 10kg FYM	6.49
T4 – FYM (10kg) + *Azospirillum* (50g)	6.40
T5 – FYM (10kg) alone	6.83
T6 – Recommened dose of fertilizers	5.91
C.D. at 0.05%	NS

At Yercaud, the trial was laid out in 2000 using *Erythrina* as standard and the treatments were imposed. The observations showed that the height of vine was higher (30.58cm) in the T-2 [Inorganic N (75%) + *Azospirillum* (50 g) + 10kg FYM] and the number of leaves and leaf area were higher (6.88 and 37.58cm) in treatment T-3 (Inorganic N (50%) + *Azospirillum* (50g) + 10kg FYM.

The trial was laid out at Panniyur with six treatments and the initial observations on plant height and width were recorded.

The trial will be laid out at Ambalavayal in the ensuing season.

PEP/CM/2.2 Efficacy of biofertilizer using P- Solubilizer on black pepper

Sirsi, Yercaud, Panniyur and *Ambalavayal*

This Trial was laid out at Sirsi, Yercaud, Panniyur and Ambalavayal centres with the following treatments consisting of 6 vines/treatment. N and K are common as urea and MOP. P is applied in the form of rock phosphates in two splits in May – June and August – September.

At Sirsi the trial was laid out using arecanut as standard. The result indicated no significant difference in yield due to treatments (Table 5). The statistical analysis of the data indicated no significant difference among treatments.

Table 5 : Efficacy of biofertilizer in black pepper using P- solubilizers at Sirsi

Treatments	Mean fresh yield (kg/vine)
T1-Inorganic P100% + P-Solubilizer 50g + 10kg FYM	6.68
T2-Inorganic P75% + P-Solubilizer 50g + 10kg FYM	5.74
T3-Inorganic P50% + P-Solubilizer 50g + 10kg FYM	6.31
T4-FYM 10kg + P-Solubilizer 50g	6.00
T5-FYM 10Kg-alone	5.74
T6-Recommended dose of fertilizer	6.28
CD at 5%	NS

At Yercaud, the trial was laid out in 2000, using *Erythrina* as standard and the treatments were imposed. The height of vine was more (33.98cm) in T4 (FYM 10kg + phosphobacteria 50g), no. of leaves per vine was higher (8.19) in T2 (Inorganic P 75% + phosphobacteria (50g) + 10kg FYM) and leaf area was higher (66.43 cm) in T1 (Inorganic P 100% + phosphobacteria (50g) + 10kg FYM)

The trial was laid out at Panniyur centre of Kannur district in RBD with four replications. The treatments were imposed and the initial observations were recorded.

The trial will be laid out at Ambalavayal in the forthcoming season.

PEP/CM/2.3 Organic farming in black pepper

Sirsi and *Yercaud*

A new experiment on organic farming was laid out at Sirsi with five treatments consisting of six vines per treatment on arecanut as standard. The results of the study indicated that application of burnt earth to black pepper vines had beneficial effect on yield and it recorded, significantly higher yield (6.74 kg/vines) over other treatments (Table 6).

Table 6 : Organic farming in black pepper at Sirsi

Treatments	Mean fresh yield (kg/vine)
T1-FYM 10kg/vine + P 40g + 2kg wood ash	5.36
T2-Vermicompost + FYM 10kg/vine + P 40g + 2kg wood ash	5.06
T3-FYM 10kg + burnt earth 10kg	6.74
T4-FYM 10kg + *Azospirillum* 50g/vine + 2 kg wood ash	5.05
T5-FYM 10kg + leaf manure 10kg (local practice) + 2 kg wood ash	5.61
CD at 0.05%	0.85

The trial is laid out at Yercaud but the treatments are yet to be imposed.

PEP/CM/3 Multiplication Trial

PEP/CM/3.1 Rapid multiplication of black pepper on soil mound

Dapoli

A study was conducted at Dapoli for standardising an indigenous technique for rapid multiplication of pepper and to study the proper spacing for pepper vines on soil mound for multiplication, with four spacings. It is evident from the study that vine, length, average number of roots produced per vine, and the number of branches produced per vine were not influenced significantly by different spacing. However, the number of rooted cuttings produced per vine were statistically significant. Closer spacing ie. vines planted at 15.0 cm spacing recorded the highest number of rooted cuttings (310.67) per hill/year (in three harvests). In all the treatments after two months of planting the rooted cuttings survived was above 88%.

PEP/CP/1 Disease Management Trial

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

Pampadumpara, Ambalavayal and *Chintapalli*

This trial consisted of the following treatments viz., T1- Planting in solarized soil; T2- Planting in non-solarized soil; T3- Solarized soil fortified with *T.harzianum* 50g/kg of soil + 100 cc of VAM inoculum /1kg of soil; T4- Non-solarized soil fortified with *T.harzianum* @ 50g/kg of soil plus with 100cc of VAM inoculums / kg of soil ; T5- Ridomil spray and drench (1.25g/l Ridomil MZWP) ;T6- T5+T2; T7- Copper oxychloride drench (0.2%) + T_1 and T8- Copper oxychloride drench (0.2%) + T_2.

The trial was laid out at Pampadumpara during 2000. After two months of planting only 56% of sprouting was recorded. Drenching of Ridomil and copper oxychloride (0.2%) was carried out in April 2001.Observations are being recorded. The trial was laid out with 8 treatments at Ambalavayal.

Chintapalli centre has not laid out this trial.

PEP/CP/1.4 Control of *Phytophthora* disease of black pepper in farmers fields-observation trial

Sirsi, Panniyur, Ambalavayal and *Mudigere*

A new experiment was conducted at Panniyur to test an integrated method of using fungicide along with biocontrol agent and neem cake. In order to develop effective and economic management practices to control *Phytophthora* disease, the trial was laid out in two locations (Padiyoor and Valiampara) - at Mattanoor area with five treatments. (Akomin could not be included in the treatments) *viz.*, T1- Metalaxyl gold (spraying and drenching) ; T2- *Trichoderma* (Neem based formulation) ; T3- Metalaxyl gold + *Trichoderma* ; T4- Neem Cake and T5- Control.

Among the five treatments, the Metalaxyl gold + *Trichoderma* was found most effective against the disease, followed by Metalaxyl gold. There was no wilt infection at Padiyoor location in the treatment Metalaxyl gold + *Trichoderma.*

The new experiment for the management of *Phytophthora* foot rot disease is to be laid out by the Ambalavayal centre in two locations with seven treatments as per the decisions of XV AICRPS workshop.

The trial was laid out at Mudigere under coffee based cropping system in two locations *viz.*, (1) Gonibeedu and (2) Beeju Halli. At Location-I 11.67% disease was recorded during May before imposing the treatments. The treatments were imposed during the 1st week of June and the observations made are given in Table 7. I. Ridomil MZ72WP (1.25g/l) as well as the bio control agent (*Trichoderma harzianim* - 50g/vine) alone has given good control (100%), which was superior to all other treatments in checking the disease during pre-and post monsoon periods.

Table 7: Management of *Phytophthora* foot rot disease at Mudigere (Location-I)

Sl. No.	Treatments	Mean per cent disease incidence for different foliar symptoms of vine				
		May 2000 (Before treatment)	June 2000	September 2000		
		Y	Y	Y	D	LI
1.	Akomin @ 3ml/l , 5l/vine both spray and drench	6.67 *(2.33)	3.33 (1.80)	0.00 (0.71)	0.00 (0.71)	6.67 (2.65)
2.	Ridomil MZ 72WP (1.25 g/l)	8.33 (2.94)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
3.	Bio agent (50 g/vine) (*Trichoderma harzianum*)	6.67 (2.65)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
4.	T3 + T1	6.67 (2.65)	0.00 (0.71)	5.00 (2.35)	5.00 (2.35)	3.33 (1.80)
5.	T3 + T2	6.67 (2.33)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	3.33 (1.80)
6.	Neam oil cake (1kg/vine)	11.67 (3.06)	3.33 (1.80)	5.00 (2.35)	5.00 (2.35)	5.00 (2.35)
7.	Control	1.67 (1.26)	3.33 (1.80)	5.00 (2.35)	5.00 (2.35)	5.00 (2.35)
	CD @ 0.05	11.57 (2.51)	3.45 (1.10)	0.00	0.00	6.24 (1.25)

* Figures in paranthesis are transformed values.

The data on the mean percent of disease incidence presented in Table 8 indicated that at Location-II, there was an increase in incidence of disease from 3.3 to 5.0 % during last week of May. When the treatments were imposed during the first week of June, the performance of spraying and drenching of Ridomil and application of biocontrol agent and also the combination of these two were found effective in controlling the disease and they were on par with the spraying of Akomin and its combination with bioagent.

Table 8: Management of foot rot disease in black pepper at Mudigere (Location-II)

	Treatments	Mean per cent disease incidence based on foliar symptoms of vine								
		May 2000 (Before treatment)	June 2000				September 2000			
		Y	Y	D	LI	SI	Y	D	LI	SI
1	Akomin @ 3ml/l, 5 l/vine both spray and drench	5.00 (2.35)	7.67 (2.85)	6.67 (2.67)	20.00 (4.47)	6.67 (2.40)	14.67 (3.89)	6.75 (2.67)	16.67 (4.14)	0.00 (0.07)
2	Ridomil MZ 72 WP (1.25 g/l)	5.00 (2.35)	9.63 (3.15)	6.10 (2.55)	0.00 (0.71)	0.00 (0.71)	17.00 (4.17)	8.83 (3.02)	10.00 (3.18)	0.00 (0.71)
3	Bio agent (50 g/vine) (*Trichoderma harzianum*)	3.33 (1.80)	5.67 (2.48)	6.11 (2.61)	3.33 (1.55)	6.67 (2.61)	15.67 (4.01)	7.00 (2.73)	5.00 (2.68)	5.00 (2.10)
4	T3 + T1	3.33 (1.80)	7.67 (2.85)	5.42 (2.42)	11.67 (3.40)	16.67 (4.10)	14.67 (3.87)	7.10 (2.73)	11.67 (2.63)	8.33 (2.63)
5	T3 + T2	3.33 (1.80)	7.67 (2.85)	7.00 (2.71)	6.67 (2.65)	0.00 (0.71)	15.00 (3.92)	7.00 (2.73)	8.33 (2.88)	5.00 (2.10)
6.	Neem oil cake (1kg/vine)	3.33 (1.80)	10.00 (3.21)	5.33 (2.42)	25.00 (5.08)	16.67 (4.08)	16.00 (4.06)	7.92 (2.92)	11.67 (3.41)	8.33 (2.88)
7	Control	5.00 (2.35)	9.67 (3.15)	5.67 (2.48)	26.67 (5.19)	26.67 (5.21)	18.33 (4.34)	9.00 (3.09)	11.67 (3.47)	11.67 (3.37)
	CD @ 0.05	3.63 (1.19)	3.33 (0.52)	2.12 (0.39)	7.26 (1.18)	7.43 (1.18)	2.99 (0.38)	2.11 (0.39)	7.72 (1.76)	8.64 (1.76)

Y = D=Defoliation LI = Leaf infection SI=Spike infection

The new experiment was laid out at Sirsi under arecanut based cropping system in two locations. The design was RBD and consisted of the 7 treatments with 20 vines each and two replications. The treatments were given in first week of June and second week of August. The result of the study presented in Table-9 indicated that *Phytophthora* foot rot was least (15.0%) in vines treated with potassium phosphonate (Akomin) @ 0.50 % as spray @ 2l/vine and drench 3l/vine and soil application of *T. harzianum* @ 50g in one kg of neem cake during first week of June and second week of August.

Table.9 ***Phytophthora*** **foot rot disease management in black pepper at Sirsi**

Sl.No.	Treatments	Per cent disease incidence (PDI)
1.	Metalaxyl gold MZ 68 WP @ 100 ppm, 2.5 g/l as spray (2l / vine) and drench (3 l/vine) twice	17.50 (24.16)*
2.	Akomin (0.5 Per cent) as spray and drench twice	17.50 24.16
3.	Soil application of *Trichoderma harzianum* (10^7 cfu, @ 50 g / vine) with 1kg of neem cake twice	27.50 (30.87)
4.	Metalaxyl gold MZ 68 WP @ 100 ppm, 2.5 g/l as spray (2 l/vine) and drench (3 l / vine) twice + soil application of *Trichoderma harzianum* (10^7 cfu, @ 50 g / vine) with 1kg of neem cake twice	17.50 (24.53)
5.	Akomin (0.5 per cent) as spray and drench twice + soil application of *Trichoderma harzianum* (10^7 cfu, @ 50 g/ vine) with 1kg of neem cake twice	15.00 (22.13)
6.	Neem cake application @ 1kg / vine	37.50 (37.72)
7.	Untreated control	52.50 (46.50)
	CD at 5 %	9.3

* figures in paranthesis are angular transformed values

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

Panniyur and *Sirsi*

The trial was laid out at Sirsi centre in 1996-97 and pepper cuttings were planted as an intercrop at four levels of population using arecanut palm as standard (25, 50, 75 and 100% black pepper population). The experiment in RBD with plot size of 25 vines were maintained in each level of population. *Phytophthora* foot rot affected the establishment of cuttings in different population levels. The data indicated that 80% of establishment and maximum vine length of 189cm was observed in 25 percent population of pepper vines in arecanut garden. The panniyur centre laid out as per the technical programme of Sirsi centre.

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

Pampadumpara, *Dapoli* and *Mudigere*

Nine panchayaths were surveyed by the Pampadumpara centre for the incidence of anthracnose in leaves. The results are presented in Table 10. The anthracnose disease caused by *Collectotrichum gloeosporoides* was very severe in Konnathady panchayath (17.56%). Three panchayaths recorded < 1% of the disease.

Table 10: Percent disease incidence of anthracnose in black pepper in Idukki district

Panchayaths	Mean% of incidence
Konnathady	17.56
Udumpanchola	13.17
Santhapara	5.81
Rajakumari	3.36
Rajakad	1.17
Kattapana	10.72
Kamakshi	0.69
Mariyapuram	0.37
	0.59

Survey was also conducted by Pampadumpara (KAU) centre during 2000 in different agro-climatic conditions of 5 zones of Idukki district. The intensity of the pest and disease on pepper were recorded. Dapoli centre has not submitted the report in the current year.

Studies on leaf and spike damage due to anthracnose disease under coffee based cropping system were carried out at Mudigere. The percent disease incidence (PDI) in spike and leaf are scored (0 to 5 scale scoring) at monthly intervals from May to August 2000 at six locations. During the current year, the maximum average disease incidence due to anthracnose recorded was 24.48% on leaf and 9.93% on spike in the month of July third week (Table 11).

Table 11 : Percent disease incidence on leaf and spike damage due to anthracnose disease in black pepper under coffee based cropping system – PDI (0 to 5 scale scoring) during 2000 at Mudigere

Location	May		June		July		August		Average	
	L	S	L	S	L	S	L	S	L	S
Nandipura	9.30	1.12	17.73	2.60	39.40	21.91	27.80	10.67	23.56	9.10
M.G. Halli	3.21	0.50	11.33	1.93	36.11	10.23	23.11	7.90	18.44	5.14
Hesgal	4.50	0.33	10.80	1.80	26.30	8.77	19.46	8.30	15.27	4.80
Chakkod	4.10	0.22	10.13	1.60	21.85	10.40	19.00	7.46	13.77	4.92
Salumara	1.38	0.00	4.33	0.27	8.20	2.93	7.66	2.10	5.39	1.33
Beejuvalli	2.64	0.00	6.80	0.53	15.00	5.33	12.75	3.36	9.30	2.31
APD	4.19	0.36	10.19	1.46	24.48	9.93	18.30	6.63	14.29	4.60

L-leaf ; S- spike

Studies on crop loss due to anthracnose disease at the time of spiking in black pepper were carried out at Mudigere at six locations at monthly intervals from May to August 2000. The average spike loss at the time of spiking was 9.93 % in July and 0.36% in May (Table 12). Crop loss in yield due to anthracnose disease at 6 locations are also scored and presented in Table 13. It was observed that maximum loss of 9.93% (1.01 kg/vine) in July and minimum loss of 0.36% (0.04 g/vine) in May was recorded.

Table 12 : Percent disease incidence due to anthracnose disease at the time spiking in black pepper – PDI (0 to 5 scale scoring) at Mudigere.

	Percent disease incidence (PDI)				
Location	May	June	July	August	Average
Nandipura	1.12	2.60	21.91	10.67	9.10
M.G. Halli	0.50	1.93	10.23	7.90	5.14
Hesgal	0.33	1.80	8.77	8.30	4.80
Chakkod	0.22	1.60	10.40	7.46	4.92
Salumara	0.00	0.27	2.93	2.10	1.33
Beejuvalli	0.00	0.53	5.33	3.36	2.31
APD	0.36	1.46	9.93	6.63	4.60

However, the overall loss of berries in all the six locations worked out to 4.6% (0.46 kg / vine) and in terms of cost Rs. 46/- per vine which is not significant as compared to the total of 10.06 kg / vine). Hence, control measures in respect of this disease is not advisible, at the Mudigere conditions (Table 13).

Table. 13 Crop loss in yield due to anthracnose disease at the time spiking in black pepper – PDI (0 to 5 scale scoring) at Mudigere

Location	Average PDI	Av. no.of spikes/ vine	Av. no.of berries / spike	100 berries weight (g)		Total wet yield of berries/ vine (g)	Loss of berry /vine (g)		Total dry yield/ vine (g)	% loss / vine
				Wet	Dry		Wet	Dry		
Nandipura	9.10	1785	99.70	12.95	4.32	23.05	2.09	0.70	7.68	9.10
MM.G.Hilli	5.14	1960	93.00	14.43	4.81	26.30	1.35	0.45	8.77	5.14
Hesgal	4.80	2320	100.80	12.64	4.21	29.56	1.42	0.47	9.85	4.80
Chakkod	4.92	2226	102.10	11.55	3.85	26.25	1.29	0.43	8.75	4.91
Salumara	1.33	3591	108.00	11.43	3.81	44.33	0.59	0.20	14.78	1.33
Beejuvalli	2.31	2700	106.80	10.95	3.65	31.58	0.73	0.24	10.53	2.31
APD	4.60	2430	101.70	12.33	4.12	30.18	1.40	0.46	10.06	4.60

PEP/CP/2 Pest Management Trial

PEP/CP/2.1 Control of scale insects in black pepper

Pampadumpara

An experiment with four treatments for the control of scale insects in black pepper was laid out. Results indicated that maximum reduction of black pepper mussel scale was possible with only two sprays of dimethoate or monocrotophos (Table 14). However, there was an increase in scale population even after the second spray with nimbecidine application. Better suppression of scales was observed in dimethoate applications. Neem based insecticides seem to be not useful in the control of scale insects.

Table 14 : Effect of insecticides on black pepper mussel scale at Pampadumpara

Treatment	Percentage reduction of scale population			
	After first spray		After second spray	
	Leaf	Twig	Leaf	Twig
Phosphamidon (0.05%)	22.28 (27.86)[b]	20.76 (26.87)[c]	44.17 (41.60)[b]	34.53 (35.94)[b]
Dimethoate (0.05%)	62.23 (52.17)[a]	59.12 (50.28)[a]	90.02 (71.74)[a]	94.36 (76.21)[a]
Monocrotophos (0.05%)	64.43 (53.47)[a]	57.71 (49.44)[a]	90.91 (72.85)[a]	91.10 (72.95)[a]
Nimbecidine (0.5%)	27.33 (31.29)[b]	38.32 (38.23)[b]	20.03 (26.43)[c]	34.66 (36.01)[b]
Control	9.81 (18.13)[c]	9.15 (17.25)[d]	21.17 (27.25)[c]	20.47 (26.77)[c]
CD (P=0.05)	4.20	2.47	3.49	3.17

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

Pampadumpara

Surveys were conducted by Pampadumpara centre in 14 panchayaths in four taluks to study the occurrence of insect pests in black pepper. The data on the percentage incidence of insect pests at high attitude of Idukki is presented in Table 15.

Table 15: Percentage incidence of insect-pests on black pepper at high ranges of Idukki district.

Panchayath (Taluk)	Marginal gall thrips	Leaf miner	Scale insects	Aphid	Leaf gall
1) Nedumkandam (U)	17.76	0.80	0.00	0.00	0.00
2) Karunapuram (U)	15.95	1.12	0.96	2.03	0.00
3) Vandanmedu (U)	14.51	0.75	1.17	1.33	0.00
4) Chakupallam (U)	13.97	0.85	0.37	0.00	0.00
5) Kumily (P)	12.32	1.65	0.69	0.00	0.48
6) Kunnathady (D)	12.85	1.49	1.17	0.00	0.27
7) Udumbanchola (U)	21.23	1.81	30.00	0.00	0.00
8) Shanthampara (U)	18.29	2.67	0.48	0.00	0.00
9) Rajakumari (U)	19.09	1.87	1.87	0.00	0.00
10) Rajakad (U)	18.67	1.01	0.12	0.21	0.00
11) Kattappana (U)	15.41	0.00	1.44	0.00	0.59
12) Erazttaiyar (U)	14.93	0.11	0.05	0.00	0.16
13) Kamakshi (U)	15.95	0.27	0.21	0.00	0.00
14) Mariyapuram (U)	18.51	0.00	0.00	0.00	0.00
Mean	16.39	1.03	0.61	0.26	0.11

U = Udumbanchola ; D = Devikulam ; P = Peerimade

The most predominant insect pest damage observed in all the gardens surveyed was marginal gall thrips (*Liothrips karnyi*) ranging from 12.32 % to 21.23% of the vines. Leaf minor was recorded in 12 panchayaths, however the incidence averaged only 1.03 %. Three types of scale insects were registered in eleven panchayaths (0.61%), of which mussel scale (*Lepidosaphes piperis)* was predominant. Aphids were recorded in Karunapuram, Vandanmedu and Rajakad panchayaths. Root mealy bug (*Planococcus* sp.) was observed in one garden at Nariyampara, Kattappana, and stem borer (*Pterolophia griseovaria*) at Kumily.

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. In the evaluation of 18 germplasm accessions that were short listed earlier, clones CL-730, CL- 681, CL- 692 and EB-1277-7 were superior for most of the characters compared to Mudigere I and II (Table 16). Clones CL-730, CL-692 and CL-681 were significantly superior for dry capsule yield, registering 560, 540 and 520 kg/ ha respectively.

Table 16: Evaluation of cardamom germplasm at Mudigere

Sl. No	Clones	Aerial stem height (cm)	Suckers/ clump	Productive suckers / clump	Panicles / clump	Panicle length (cm)	Flowers/ panicle	Dry capsule yield (kg/ha)
1.	EB 1277-7	282.5	34.1	18.0	33.0	57.0	70.4	385
2.	P 17	250.7	19.5	10.9	16.9	30.5	33.9	213
3.	CL-728	243.3	20.5	9.6	16.0	34.9	38.6	250
4.	CL-692	265.6	32.0	17.5	31.3	59.4	71.8	540
5.	ERC	250.0	19.0	10.0	18.4	40.4	39.9	240
6.	P-12	213.1	23.2	12.3	19.7	35.0	31.1	170
7.	CL-730	267.4	35.4	20.4	36.0	63.7	73.4	560
8.	CL-757	235.8	21.0	11.9	20.1	47.1	44.4	280
9.	P-20	210.0	29.9	16.6	20.0	45.0	48.3	285
10.	CL-709	240.9	18.0	9.5	17.3	41.3	36.0	230
11.	P-15	211.5	20.1	10.0	18.4	43.3	35.0	190
12.	CL-802	245.3	26.6	12.5	21.0	45.8	38.8	185
13.	CL-668	230.0	18.8	10.3	17.3	39.7	47.3	275
14.	P-18	205.6	27.5	12.7	21.0	40.6	37.7	230
15.	CL-682	251.7	22.0	13.5	21.6	45.0	46.0	290
16.	CL-681	270.7	33.9	19.0	32.6	64.8	73.3	520
17.	M-1(CL)	235.3	24.8	14.0	20.7	50.3	53.6	315
18.	M-2(CL)	256.6	26.3	15.1	22.3	55.7	59.8	410
	Mean	242.5	25.1	13.5	22.4	46.6	48.8	309.3
	CD @ 5%	19.1	6.4	3.8	8.4	6.2	9.0	35.0

The Pampadumpara centre has a germplasm holding of 78 cultivated types. During 2000-01, 16 more accessions were added, which were collected based on the characters such as yield, sterility, tolerance to pest and disease and drought. They include one Malabar, 11 Vazhukka and 4 Mysore types. These types were collected from Chemmannar, Udumbanchola, Vandanmedu, Vandiperiyar, Santhampara, Puliyanmala, Nariyampara of CHR, Idukki Dist. All these types are being multiplied for further evaluation.

CAR/CI/2 Hybridization and Selection

CAR/CI/2.1 Evaluation of synthetics and OP progenies

Mudigere

Earlier studies at Mudigere indicated that improvement in yield could be achieved by polycross. Six promising clones viz., Mudigere 1, Mudigere 2, CL-692, HS-1, Sel.14, Sel. 98, CCS 800, CL. 691, which were found to be better general combiners, were planted in 1995-96 at closer spacing of 6 x 3 in order to produce polycross seeds for evaluation and selection. During 1998, 693 polycross seedling progenies were raised and during 1999, 374 seedlings were raised and transferred to secondary nursery and subsequently to the mainfield at a spacing of 6♀x 6♂for further screening, during 2000-2001.

CAR/CI/3 Coordinated Varietal Trial (CVT)

CAR/CI/3.1 CVT 1998 - Series II

Pampadumpara

The CVT with 10 entries (CL.679, Sel 800, M-1, Sel-262, Sel 112, Cl-726, Cl-683, SKP-51, SKP-14 and PV-I) was laid out in RBD at Pampadumpara. During 2000-01, M-1 recorded the highest yield of capsule (14.5 kg fresh / plot) and dry yield (3.5 kg/ plot) followed by PV-1. Out of eight characters studied, number of panicles per plant, 100 capsule wt., fresh and dry wt. of capsules, differed significantly among the 10 entries. Sel. 262 was the tallest (247.2), followed by sel.800 (244.1 cm). Tillering was more in PV-1 (43.4), panicle length in Sel. 262 (43.8 cm), number of seed capsule in Cl. 673 and Sel. 262 (18.3) where as 100 capsule wt. was more in Sel. 262.

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

Mudigere and *Sakleshpur*

This trial with 15 accessions was relaid out at Mudigere in RBD design at 6♀x 6♀spacing. The observations on morphological, yield and its attributing characters were recorded with significant differences among the accessions. Clone 683 recorded highest number of bearing suckers per clump (13.8) followed by CL. 692 (12.5) CL. 726 (12.5) and SKP 100 (11.4) and they were significantly superior to Mudigere 1 (7.9). SKP-21, MCC-34 and PV-1 were found to have more flowers per node. Regarding the dry capsule yield, clone CL-692 gave highest yield (282.6 kg/ha) and this was significantly superior to Mudigere 1 (Table 17). Considering the overall performance, clones CL-692, CL-679, and CL-683 were promising. Clone, CL-692 is identified as the promising one which gave an increase in yield by 23% over Mudigere 1 and 2.

Table 17 : Comparative yield trial of promising cardamom clones (MLT - III, 1998) - Malabar types at Mudigere

Sl. No.	Clones	Green capsule yield / plot (kg)	Dry capsule yield (kg/ha)
1.	CL 679	5.19	259.8
2.	CL 683	4.56	228.1
3.	CL 692	5.65	282.6
4.	CL 726	4.50	225.1
5.	CCS 800	3.64	182.1
6.	CCS 872	3.09	154.5
7.	CCS 893	3.08	154.1
8.	HS 1	2.76	138.1
9.	M-1	3.62	181.1
10.	MCC 34	3.00	150.3
11.	PV 1	1.61	80.8
12.	SKP 14	4.15	207.5
13.	SKP 21	2.60	130.3
14.	SKP 72	4.15	207.8
15.	SKP 100	3.37	168.5
	Mean	3.66	183.4
	CD @ 5%	1.68	84.3
	CV (%)	27.40	27.48

At Sakleshpur, during 2000-2001, number of tillers (29.6), bearing tillers (21.9), panicles (54.8) and racemes (19.1) were significantly higher in SKP 14, followed by MCC 39) for tillers (28.4) and CL 679 for panicles (34.1). Yield data showed that SKP14 is the best yielder (452.9 kg/ha) followed by CL 679 (392.9 kg/ha) and SKP 170 (382.9 kg/ha). However, there was no significant differences among the treatments. SKP 170 had the highest percentage of bold capsules (58.6%) retained in 8 mm sieve, followed by CL 726 (56.5%). CCS 872 got maximum no. of seeds/capsule (22.6). Better seeds to husk ratio was observed in CCS 893 (77.6 : 22.4), followed by CCS 872 and PV1 (5.6 %). The experiment is in progress.

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

Mudigere and *Sakleshpur*

This trial was relaid out at all the centres. At Mudigere, the trial was relaid out in 1998 with 5 entries in RBD design at 6' x 6' spacing. Performance of the clones was evaluated for yield and yield attributing characters. Observations on plant height, total suckers/ clump, bearing suckers/clump, panicle length, no.of panicles/

clump, no. of nodes/panicle, no. of flowers/ node, internodal length, green capsule / plant were found significant among the accessions.

The highest plant height was recorded in clones SKP-51 (179.9 cm) and MCC-21 (179.3 cm); higher number of suckers per clump in MCC 12 (19.5) and MCC 21 (18.3); highest number of productive suckers in MCC. 21(7.8) and MCC-12 (7.0) and panicle length was more in MCC -12 (37.0 cm). MC-12 registered more no. of nodes per panicle and flowers per node (14.80 and 8.12, respectively). MCC-12 (1148 g/plant) recorded the highest yield. Among the 5 clones, considering the overall performance, clone MCC-12 and MCC-21 were promising.

At Sakleshpur, the morphological and yield data have been recorded, compiled and analysed. Tillers were more in SKP 51 (20.6), followed by MCC 21 (19.2). Panicles/plant were found more in MCC 21 (11.6) followed by MCC 12 (10.6). No significant differences were noticed among the treatments. MCC 21 has the highest yield of 118.2 kg/ha, followed by MCC 85 – (104.2 k/ha). Yield data also showed no significant differences among the treatments. MCC 61 has the highest percentage of bold capsules with 26.3% capsules retained in 8 mm sieve followed by MCC 85 (20.9%). MCC 85 has more seeds/capsule (19.0). Better seed to husk ratio was observed in MCC 61 – (71.2 – 28.8) followed by MCC 21 (71.0 : 29.0). Oil percentage was higher in MCC 61 and MCC 85 (5.2%). The experiment is in progress.

CAR/CI/3.4 CVT 2000 - Series IV

Myladumpara, Pampadumpara, Saklespur and *Mudigere*

A new CVT was laid out with 14 entries from the different coordinating centres at Mudigere.

At ICRI, Myladumpara, four elite cardamom clones were identified for multiplication. These include MHC-10, MHC-13, MHC-18 and MCC-200. Multiplication of suckers of these clones was carried out for the trial at different centres under AICRPS.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Yield evaluation of OP seedling progenies (VET-I).

Mudigere

Twenty five promising OP seedling progenies planted in 1997 were tested at Mudigere in 2000-01 along with Mudigere-1 and Mudigere-2. The genotypes having superior dry capsule yield were 8-4-D 11 (510.5 kg) and 7-24-D 11 (502.4 kg), followed by 3-27-D 11 (490.8 kg), compared to the checks-clone M1 and M2 (362.7 and 394.6 kg/ ha, respectively).

CAR/CI/4.2 Yield evaluation of promising cardamom selection (VET-II)

Mudigere

A set of 20 OP seedling selections were tested at Mudigere along with Mudigere 1 and M-2 for yield and its attributing characters. Significant differences were observed for plant height, suckers/ clump, productive suckers/ clump, plant length, no. of panicles/ clump, and dry capsule yield. Clones D-237, CL. 730 and CL- 692 were promising and were found superior for the most of the characters studied. The clones D-237, CL-730, and CL-692 were significantly superior for dry capsule yield, giving 556.0, 512.1, at 494.5 kg/ ha, respectively compared to M1 and M-2 (319.9 and 415.8 kg/ha, respectively).

CAR/CI/ 4.3Yield evaluation of promising cardamom clones (VET –III)

Mudigere

Suckers of promising OP seedling prog

enies were multiplied and planted at Mudigere during 1999. Observations on production of suckers/ clump indicated that the clones 24-17-D10, 7-10 - D 11 and 7-24-D17 were found promising, with more suckers/ clump (30.2, 21.6 and 21.6 respectively) compared to Mudigere-1 (14.2) and Mudigere-2 (15.8).

CAR/CI/4.4 Yield evaluation of promising cardamom clones (VET-IV)

Mudigere

Open pollinated seedling progenies were screened and suckers of 17 promising seedling progenies were multiplied and planted during 1999. Among the17 clones tested, CL-722, Sel. 98 and CL-692 recorded more suckers per clump(20.6, 17.4 and 17.3, respectively).

CAR/CI/5 Screening of cardamom clones for abiotic stress

Mudigere

Seventy four cardamom clones selected from germplasm OP seedling progenies (55 germplasm + 19 OP seedlings) were planted during 1999 for screening against drought situation. The observations on total no. of suckers and survivability of suckers were recorded to identify drought tolerant lines. Hundred percent survival under high moisture stress condition was given by only two genotypes (CL-668, 2-2-D 11), where all the clones planted were survived. In this preliminary study, clones CL-668, P6, D 237 and 2-2-D11 were found to survive better under moisture stress conditions.

CAR/CM/1 Nutrient Management Trial

CAR/CM/1.3 Integrated nutrient management in cardamom

Mudigere and *Pampadumpara.*

The trial with six treatments laid out at Mudigere in 1994 was relaid out in 2000. The initial growth characters were monitored.

At Pampadumpara, this trial was laid out with six treatments to find out the effect of different levels of nutrients on biometric characters and yield of cardamom. Significant differences were observed for no. of panicles, fresh and dry yield of capsules except for tiller height, no. of tillers/ clump and length of panicle. Treatments receiving 100: 100: 175 kg NPK/ha registered the highest no. of panicles (32.2) and fresh yield (2.462 kg/ plot) as well as dry yield (587 g/ plot).

CAR/CM/1.4 Efficacy of biofertilizer using *Azospirillum* on cardamom

Pampadumpara, Mudigere, Myladumpara and *Sakleshpur*

This experiment was initiated in this season at these centres with seven treatment combinations.

CAR/CM/1.5 Efficacy of biofertilizers using P-solubilizers on cardamom.

Mudigere, Pampadumpara, Myladumpara and *Sakleshpur*

The experiment was laid out during the year 2000 at Mudigere. The initial growth and populations were monitored. Other centres also will layout the experiment in the forthcoming year.

CAR/CP/2 Pest Management Trial

CAR/CP/2.1 Evaluation of plant based insecticides for the control of thrips and fruit borer

Mudigere

An experiment on evaluation of neem based insecticides against cardamom thrips and borers were conducted. Four commercially available neem based insecticides (Neem gold 3%, Neem oil 3%, NSKE 4% and neem cake @ ½ kg / plant) were applied along with recommended chemical management practices of spraying monocrotophos (1.5%) followed by phosalon (2.0%) thrice at a gap of 25-30 days

between sprays. None of the neem based insecticides proved effective against thrips and capsule borer.

CAR/CP/2.2 Management of root grub of cardamom

Pampadumpara

Studies were conducted at Pampadumpara during 2000-01 to find out the effect of three insecticides (in two concentrations) on root grub population in cardamom fields. The initial root grub population in one cubic foot of soil area was 17.7. At this population level, there was slight yellowing of leaves due to root feeding. Reduction in population of grub after drenching with insecticide was observed. The maximum suppression of grub population was observed in drenching with higher concentration of Chloropyrifos, Carbofuran and Imidacloprid (Table 18). At higher doses, all the three insecticides were very effective in reducing grub population and there existed significant differences in the efficiency of three insecticides at lower doses.

Table 18 : Effect of insecticides on cardamom root grub at Pampadumpara (2000-01)

Treatment	Grub population (nos.)	Reduction after drenching (%)
T1-Chlorpyrifos 0.05%	17.6	54.3 (47.45)^{b}
T2-Chlorpyrifos 0.07%	18.2	79.7 (63.27)^{a}
T3-Carbofuran @ 100g plant^{-1}	16.7	49.5 (44.69)^{b}
T4-Carbofuran @ 150g plant^{-1}	17.6	77.6 (66.77)^{a}
T5-Imidacloprid 0.5ml per litre	18.0	57.7 (49.45)^{b}
T6-Imidacloprid 0.75ml per litre	17.7	79.8 (63.31)^{a}
T7-Control	18.4	15.1 (22.69)^{c}

CAR/ CP/ 2.3 Bioecology of natural enemies of major pests of cardamom

Pampadumpara

In the studies conducted on natural enemies of major pests of cardamom during 2000-01, one hymenopteran larval – pupal parasitoid as well as one dipteran parasitoid with mosquito like plumose antenna were recorded on cardamom stem borer (*Congethes punctiferalis*). Nearly 10% parasitization by the hymenopteran parasitoid was observed on stem borer larvae collected from field. Two entomopathogenic fungi identified as *Aschersonia placenta* and *Verticillium sp.*were found infecting nymphs as well as pseudopupae of cardamom whitefly (*Kanakarajiella cardamomi*). One green coloured fungus was found infecting on cardamom grub, (*Basilepta fulvicorne*). However, no natural enemies (predator/ parasitoid/ pathogen) was recorded on cardamom thrips (*Sciothrips cardamomi*).

GINGER

GIN/CI/1 Genetic Resources

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

Solan, Pottangi, Pundibari , Dholi, Kumaraganj and Raigarh

The Solan centre maintains 221 germplasm accessions, which includes 45 new collections from Sirmour, Bilaspur, Solan and Shimla districts during 2000-2001. Germplasm accessions were evaluated during 2000-2001 for yield, yield attributing and quality characters. Yield per plot ranged from 1.0 to 9.2kg, yield per plant from 110.0 to 380.0g, rhizome length from 9.0 to 20.2cm and breadth from 5.0 to11.0cm. The yield of promising collections varied from 8.2 to 9.0kg and the highest was in SG – 876 followed by SG – 882 and SG – 810. This indicated that the germplasm accessions behaved almost consistently for yield per plot compared with the yield data in 1999. However, in general the newly added collections performed better for most of the characters studied. The passport data of the new collections have been prepared. Accessions were screened for both rhizome rot and *Phyllosticta* leaf spot diseases at Solan. Acc.33 and Acc.27 showed less than 5% incidence for both the diseases.

At Pottangi, 170 accessions including two new collections made from Keonjhar and Puri districts, were maintained during current year. Out of this, 141 accessions were evaluated. The highest fresh rhizome yield was recorded in Acc.No 9 (6.5kg / 3m^2) followed by Z0 - 2 (6.2kg / 3m^2) and Z0 - 27 (6kg / 3m^2).

Six new accessions have been added to the germplasm collections at the Pundibari centre during 1999-2000 making the total number to 21. The collections were evaluated during 1999-2000 and 2000-2001 in respect of growth and yield parameters. GCP – 12 ranked first in plant height (73.8cm), GCP – 12 produced the highest tiller number (17.3), leaf breadth (2.6cm) and yield per plant (300gm).

Fourteen ginger accessions were evaluated at Dholi for their performance with regards to growth, maturity, yield and disease reaction. In the screening of accessions against soft rot, none of them was found to be resistant.

The Raigarh centre holds 20 entries in ginger and is under evaluation.

The Kumaraganj centre maintain a total of 20 accessions in ginger.

GIN/CI/2 Coordinated Varietal Trial (CVT)

GIN/CI/2.1 CVT 1996 - Series IV

Pundibari – concluded

The Pundibari centre laid out the trial with 5 entries. Data on growth parameters and yield are presented in Table 19.

Table 19: Growth parameters and yield of ginger entries under MLT –IV (1996) at Pundibari

Entry	1	2	3	4	5	Fresh rhizome yield (kg/3m^2 plot)				
						1996-97	1997-98	1998-99	1999-2000	Mean
SG-536	13.5	63.7	18.3	19.9	2.47	3.86	8.21	8.80	7.82	7.17
V_1S_1-8	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
V_3S_1-8	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
CD (P= .05)	2.4	NS	NS	1.8	NS	NS	1.8	1.68	0.24	-

1. Tillers /clump, 2. Plant height (in cm), 3. Leaf number, 4. Leaf length (in cm), 5. Leaf breadth (in cm)

Among the growth parameters, leaf length and tiller no. per clump were significant. Highest mean leaf length (21.4cm) and tillers/clump (16.2) were found in V_1S_1-8 and V_3S_1-8 respectively. Fresh rhizome yield/ $3m^2$ plot was found highest in Garuhathan (9.28kg) followed by Acc.64 (8.64kg). Except in Garuhathan, the mean yield of other entries did not differ significantly.

GIN/CI/2.2 CVT 2000 Series V

Solan, Chintapalli, Pottangi, Pundibari and *Raigarh*

A new CVT, proposed in the XV workshop, with entries from IISR,(Acc.35 & Acc 117) Pottangi (V_1C-8 & $V_1S_1$2) and Solan was laid out. At Pottangi, significantly higher fresh rhizome yield was recorded in V_1E_8-2 (29.20 t/ha) and in $V_3S_1$8 (26.59 t/ha). At Solan and Pundibari the trial was laid out in the current season. The trial could not be laid at Chintapalli, due to non-receipt of seed material from the centres. Raigarh centre laid out the trial with Acc 35 & Acc 117.

GIN/CI/3 Varietal Evaluation Trial

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

Solan, Pottangi and *Raigarh*

In the CVT-1, six collections, including a check selected based on the performance of IET 1999, were evaluated in a RBD at Solan. The difference in yield per plot was non significant. None of the collections out-yielded the check. However one collection BLP-6 gave yield almost equal to that in the check (Table 20).

Table 20: Comparative yield performance of ginger under CYT – I at Solan

Collection	Yield/plant (kg)	Converted yield (q/ha)
SG-718	5.87	117.99
Jamaica	7.25	145.72
SG-709	7.37	148.14
SG-723	7.25	145.72
BLP-6	7.87	158.19
Himgri (check)	7.92	159.19
Mean	6.09	122.4
F test	NS	

Another CYT- II at Solan using six collections, was laid out together with collections selected from CYT during 1999. Non significant differences among collections were observed for yield per plot. Similar results were also observed during 1999. The mean of both the years indicated that the local check was the top yielder (Table 21).

Table 21: Yield performance of ginger under CYT – II at Solan

S.No.	Collection	Yield per plot (kg)			Converted yield (q/ha)
		1999	2000	Mean	
1	SG 680	4.92	7.35	6.13	123.31
2	SG 700	5.40	5.45	5.42	109.04
3	SG 707	5.02	5.25	5.13	103.21
4	SG 692	4.85	7.35	6.10	122.61
5	22 / 95	5.00	6.20	5.60	112.56
6	Himgiri	5.52	7.92	6.72	135.07
	Mean	5.12	5.50	5.76	115.77
	F Test	NS	NS		

At Pottangi, the CVT was laid out with the 8 entries. Among them, significantly higher fresh rhizome yield was recorded in S – 646 (26.50 t /ha), followed by $V_2 E_5$-2 (22.25 t /ha).

The Raigarh centre could not start the CVT owing to non availability of seed material.

GIN/CI/3.2 Initial evaluation trial (IET)

Solan and *Pottangi*

Fifteen collections including check selected on the basis of yield performance during 1999, were evaluated at Solan during 2000. Non significant differences for yield per plot were observed among the collections. One collection 47/95 gave comparatively higher yield (174.87 q/he) over the check (Himgri, 164.82 q/ha), while SG.869 was on par with it (164.82 q/ha).

Out of 15 entries evaluated in the IET at Pottangi, significantly higher fresh rhizome yield was recorded in $V_3 S_1$ –8 (29.10 t /ha) and Raigarh (28.58 t /ha).

GIN/CI/4 Quality Evaluation Trial

GIN/CI/4.1 Evaluation of germplasm for quality

Solan

Seventy eight collections of ginger harvested during 1999 were analysed during 2000 for different quality attributes. The ginger samples harvested during 2000 are in the process of analysis at Solan.

GIN/CM/1. Nutrient Management Trial

GIN/CM/1.1 Efficacy of biofertilizers using *Azospirillum* on ginger

Solan, Pottangi, Ambalavayal and *Raigarh*

This new experiment with 9 treatmental combinations was laid out at Solan. The study revealed non significant difference for yield per plot amongst the treatments. However, treatment T-2 gave comparatively higher yield (Table 22). The other horticultural characters like survival (%), pseudostem length, leaf length and breadth, rhizome length, breadth and yield per plant showed non-significant differences.

Table 22: Effect of biofertilizer (*Azospirillum*) on the yield of ginger at Solan

Treatment	Yield / plot (kg)	Converted yield (q/ha)
T1- 100%N + *Azospirillum* + FYM (5T/ha)	5.7	114.57
T2- 75%N + *Azospirillum* + FYM (5T/ha)	6.0	120.60
T3- 50% N + *Azospirillum* + FYM (5T/ha)	4.6	92.46
T4- FYM (5T/ha) alone	5.3	106.53
T5- FYM (10T/ha) alone	5.7	114.57
T6- FYM (10T/ha) + *Azospirillum*	5.3	106.53
T7- FYM (10T/ha) alone	5.0	100.50
T8- NPK recommended dose (100:50:50 kg/ha)	5.3	106.53
T9- *Azospirillum* @ 5kg/ha as Soil application	5.36	-
Mean	NS	-

This trial was laid out with 8 treatments at Pottangi during 2000-2001. There was no significant difference among the treatments, however the highest rhizome yield was recorded in T1 (Table 23).

Table 23 : Effect of biofertilizer using *Azospirillum* on the yield performance of ginger at Pottangi (2000-2001)

Sl. No	Treatments	Fresh rhizome yield (kg/3m^2)	Projected yield (t/ha)	Cost benefit		
1	T_1= Inorganic N 100% + *Azospirillum* (50gm) + 5kg FYM	7.23	18.08	1.02	2.71	1.69
2	T_2=Inorganic N (75%) + *Azospirillum* (50gm) + 5kg FYM	6.81	17.03	1.01	2.55	1.54
3	T_3=Inorganic N (50%) + *Azospirillum* (50gm) + 5kg FYM	6.68	16.68	1.00	2.50	1.5
4	T_4=0N + 0 + 5 kg FYM	5.53	13.83	1.00	2.07	1.07
5	T_5=0N + *Azospirillum* (50gm) + 5kg FYM	5.45	13.63	0.98	2.04	1.06
6	T_6=0N + *Azospirillum* (50gm)+ 10kg FYM	5.84	14.60	1.00	2.19	1.19
7	T_7= 10kg FYM alone	5.22	13.05	0.97	1.96	0.99
8	T_8=Recommended dose of fertilizer & manure.	7.14	17.85	1.00	2.68	1.68
	C.D (P=0.05)	NS				

The cost benefit ratio is 1.69, which is on a par with T8 (Recommended dose of inorganic fertilizer).

The trial will be taken up at Raigarh with seven treatments.

The trial laid out at Ambalavayal during April 2000 fertilizers were applied as per the POP. The crop was harvested in January 2001. The treatment (T2) 75% inorganic nitrogen + *Azospirillum* + 5 kg FYM recorded the highest yield of 2.847 kg (14.235 t/ha) followed by T6 (FYM 10 kg + *Azospirillum*) with yielded 2.367 kg/plant (11.835 kg/ha). However there is no significant difference between these two treatments. Both are on par with each other.

GIN/CM/1.2 Organic farming in ginger

Solan, Pottangi, Ambalavayal and *Raigarh*

This new experiment with 8 treatments was laid out at Solan. The nutrient source of organic origin were FYM/ vermicompost / neem cake / biofertilizer + rock phosphate + wood ash. The observations were recorded on different horticultural characters as well as rhizome yield / plot. Non significant differences were observed for all the characters. The mean yield / plot and converted yield indicated comparatively higher yield when *Azospirillum* was followed by neam cake + P + wood ash. The commercial fertilizers gave yield equal to neem cake and *Azospirillum* + P + wood ash (Table 24).

Table 24: Effect of organic fertilizers on yield of ginger at Solan

Treatment	Yield/ plot (Kg)	Converted yield (q/ha)
FYM+P+ wood ash	6.2	124.62
Azospirillum + P + wood ash	6.0	120.60
P (alone)	5.8	116.50
Wood ash (alone)	6.0	120.60
Azospirillum alone	7.0	140.70
Neem cake + P + wood ash	6.6	132.66
Neem cake alone	6.0	130.65
NPK(100:50: 50kg/ha)	6.5	120.60
Mean	6.25	
'F' Test	NS	

Note: FYM 20 t/ha - 10kg/plot; P 50kg/ha - 250g/plot; Wood ash 10kg/ha - 5g/plot; Neem Cake 2t/ha - 1kg/plot; *Azospirillum* 5kg/ha - 2.5g/plot

The organic farming in ginger was laid out at Raigarh with organic and conventional type of nutrient applications. Ambalavayal will initiate the trial in the current year.

Organic farming: FYM 200 kg/ha + rock phosphate 150 kg/ha + wood ash 100q/ha

Conventional farming: 100:60:60 kg NPK/ha

Results indicated significant difference for yield as well as tiller / clump. The yield was 1.243 kg/plot in conventional farming and 0.937 kg/ plot under inorganic farming.

At Pottangi no significant difference between different organic inputs was observed, however highest rhizome yield (20.32 t /ha) was recorded in treatment using inorganic fertilizers followed by all the organic inputs (Table 25).

Table 25: Effect of organic inputs on yield performance of ginger var. 'Suprabha' at Pottangi

Treatments	Fresh rhizome yield (kg/3 m^2)	Projected yield (t/ha)	Cost : Benefit
T_1 All organics (A+B+C+D+E+F)	7.48	16.25	0.8:0.8
T_2 0 FYM +B+C+D+E+F	5.43	13.58	0.5:0.7
T_3 0 Pongamia +A+C+D+E+F	5.47	13.68	0.6:0.6
T_4 0 Neem cake +A+B+D+E+F	5.41	13.53	0.7:0.6
T_5 0 Rockphosphate +A+B+C+D+F	5.89	14.73	0.6:0.7
T_6 0 Sterameal +A+B+C+E+F	4.69	11.73	0.7:0.5
T_7 0 Wood ash + A+B+C+D+F	5.21	13.03	0.6:0.8
T_8 Inorganic recommended dose of fertilizer	8.13	20.33	1.0:1.1
C.D. (0.05%)	NS	NS	

Note:

'A' = FYM - 10kg/3m^2, 'B' = Pongamia cake - 250gm/3m^2
'C' = Neem cake - 250gm/3m^2, 'D' = Sterameal - 250gm/3m^2
'E' = Rock phosphate - 500gm/3m^2
'F' = Wood ash - 250gm/3m^2

GIN/CP/1 Disease Management Trial

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

Solan, Dholi and *Pundibari*

Nine locations in Himachal Pradesh were surveyed by Solan centre to record the incidence of rhizome rot of ginger. The incidence varied from 1 to 40% in different locations. The lowest incidence (1%) was recorded in Ladu location while highest (40%) was in Chandni and Shillai areas. An experiment to manage the rhizome rot under storage was initiated in 1999-2000 (at Solan), with 9 treatments. The data obtained are presented in Table 26. The highest recovery of rhizome and the lowest disease incidence was in sand layered pits mixed with Dithane-M-45 + Bavistin – (5 + 3g/kg sand). The next lowest was Bioshield that recorded rhizome recovery of 90.7% with disease incidence of 5.5%.

Table 26: Management of rhizome rot of ginger under storage at Solan

S.No	Treatments	Disease incidence (%)	Loss in rhizome weight (%)	Rhizome recovery (%)
1.	Dithane M-45 (0.25%) + Bavistin (0.1%) + Durmet (0.2%)	7.0	11.0	88.9
2.	Dithane M-45 (0.25%) + Bavistin (0.1%) + *Trichoderma harzianum* (0.5%)	13.5	17.7	82.3
3.	Durmet (0.2%)	10.0	16.6	83.4
4.	Unimax (0.25%) + Durmet (0.2%)	12.0	16.9	83.0
5.	Uthane M-45 (0.25%) + Zoom (0.1%) + Durmet (0.2%)	12.5	17.0	82.9
6.	Bioshield (PF) @ 4%	5.5	9.3	90.7
7.	Dithane M-45 (0.25%) + Bavistin (0.1%) + Streptocyline (0.02%) + Durmet (0.2%)	8.0	11.6	88.4
8.	Dithane M-45 + Bavistin (5+3 g/kg sand) mixing in sand layers	1.5	6.6	93.4
9.	Control	15.0	17.7	82.0
	CD (0.05)			0.031

Rhizome rot of ginger in most localities of Himachal Pradesh was found to be due to a mixed infection by *Fusarium* sp., *Pythium* sp. and *Ralstonia solanacearum*. A field trial was laid out at Solan with seven treatments. Rhizomes were given pre-sowing treatments with six different fungicides. The data presented in Table 27 showed that the lowest disease incidences of 3.5 and 4.5% were recorded with unilax (0.25%) and Bordeaux mixture (1%) respectively. These treatments were equally effective in increasing the yield of ginger.

Table 27: Effect of pre-treatment with fungicides on incidence of rhizome rot and yield of ginger at Solan

Sl.No.	Treatments	Disease incidence (%)	Yield (Kg / 3m^2)
1	Indofil M-45 (0.25%)	9.0	6.317
2	Bordeaux mixture (1%)	4.5	7.450[a]
3	Biltox-50 (0.3%)	9.0	6.433
4	Captaf (0.25%)	8.5	6.417
5	Ridomil MZ (0.25%)	10.5	5.817
6	Unilax (0.25%)	3.5	7.533[a]
7	Control	15.5	3.708
	CD (0.05)		0.471

At Pundibari, ginger entries under MLT Series IV (1996) were tested during 1996-1997 to 2000-2001 against *Phyllosticta* leaf spot / rhizome rot diseases. The incidence of *Phyllosticta* leaf spot was higher during 2000-2001 compared to the previous years. The average disease incidence for the last 5 years varied from 10% to 16%, the highest disease incidence was in V_3S_1-8. Regarding yield cv. Gorubathan had given higher rhizome yield.

Similarly the incidence of rhizome rot under field conditions was recorded from 1997-98 to 2000-2001 and the average disease incidence varied from 22% to 39%, and none was resistant to rhizome rot. The Terai region of West Bengal witnesses high incidence of rhizome rot every year. Pundibari centre made extensive surveys in Cooch Behar, Jalpaiguri and Darjeeling districts during July and September 2000. Survey indicated that ginger crop suffers from rhizome rot disease moderately in all the three districts as evident from Table 28. The Pundibari centre isolated and identified the pathogen *Pythium aphanidermatum* and established the pathogenity of rhizome rot prevalent in that area.

Table 28 : Severity of ginger diseases in different blocks of northern districts of West Bengal.

Block	No. of places	Varieties	Disease severity		
			Leaf spot	Rhizome rot	Rhizome rot & bacterial wilt complex
Cooch Behar district					
Cooch Behar-II	7	Garubathan, Local, Vaisi	+	++	-
Toofanganj	5	Local, Garubathan	++	++	-
Jalpaiguri District					
Madarihat	7	Garubathan, Local	++	++	-
Jaigaon	4	Garubathan, Vaisi	+	+	-
Malbazar	6	Local, Garubathan	+	+	-
Alipurduar	5	Local, Garubathan	++	++	-
Darjeeling district					
Garubathan	12	Garubathan	+	+	++
Kalimpong	7	Garubathan	+	-	++
Pedong	5	Garubathan., Local	+	-	++

+ = Mild; ++ = Medium; +++ = Severe ; - = Nil

A new experiment on biocontrol of rhizome rot in ginger was initiated with seven treatments at Pundibari during 2000-2001. The results presented in Table 29 indicated that seed treatment with hot water and *Trichoderma* mixed with neem cake and seed treatment with *Trichoderma* alone significantly reduced the disease incidence *ie.*, 74% and 56% as compared to the untreated check and this treatment had also given higher yield. *In vitro* study of the fungi toxicity assay against the causual agents (*Pythium aphanidermatum*) indicates that *T.harzianum* gave higher growth inhibition of the pathogen compared to *T.viride* and *Gliocladium virens.*

Table 29: Efficacy of bio-control agents for the control of rhizome rot disease in ginger.

Treatments	Germination %	Incidence of rhizome rot (%)	Percent reduction in rot over control	Fresh rhizome yield	
				Kg/3m^2	t/ha
T_1 = Control Seed sown directly	88.9	31.7	-	4.80	16.0
T_2 = Seed tr. with hot water	99.1	26.9	15.1	5.76	19.20
T_3 = Seed tr. with Mancozeb	91.1	27.9	11.9	5.00	16.67
T_4 = Seed tr. with *T. harzianum*	95.6	13.7	56.8	7.58	25.27
T_5 = Seed tr. With hot water + Mancozeb	95.6	23.9	24.6	6.56	21.87
T_6 = Seed tr. with hot water + *T. harzianum* mixed with neem cake	97.8	8.2	74.1	9.22	30.73
T_7 = Soil application of neem cake	93.3	22.0	30.6	6.07	20.23
CD at 5%		2.73		1.38	

Survey conducted by Dholi centre in Bihar reported that the ginger crop seriously suffers from rhizome rot.

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

Dholi and *Pundibari*

A new experiment was initiated at Pundibari with 3 treatments on management of storage rot of ginger (2000-2001). The result of the study in the first year indicated that the incidence of rot was least (7%) in a combination treatment of SAAF @ 0.2% and monocrotophos (Table 30).

Table 30: Effect of post harvest treatment on storage rot of ginger at Pundibari (2000-2001)

Treatment	Disease incidence (%)	Rhizome recovery (%)
SAAF (0.2%) + Monocrotophos (0.25%)	9.0	85.0
SAAF (0.2%) + *Trichoderma harzianum*	7.0	89.0
Control	18.0	72.0

At Dholi centre, a study to find out the effect of seed treatment with 5 different fungicides on the control of soft rot disease of ginger was concluded. A new experiment was started with four treatments including seed treatment, on the use of *Trichoderma* as seed treatment and soil applications and seed treatment with Metalaxyl mancozcb (200 – 300ppm). The result of the study presented in Table 31 indicated that ridomil MZ (200-300 pm) as seed treatment provided better control of the disease, giving the highest yield of 119.79 q /ha with less incidence of disease (20.25%).

Table 31: Effect of seed treatment on soft rot of ginger at Dholi

Treatment		Disease incidence (%)	Yield (q /ha)
T1-	Metalaxyl mancozcb @ 200-300 ppm (Ridomil MZ) – seed treatment	20.25	119.79
T2-	Biocontrol seed treatment (*Trichoderma viride*)	24.25	70.31
T3-	Biocontrol - soil application and seed treatment	27.50	59.90
T4-	Metalaxyl - seed treatment and soil application of biocontrol agent	22.25	88.84
T5-	Control	34.50	40.37
	CV %	7.61	14.50
	CD at 5%	4.52	25.31

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 / Bhavanisagar

The Solan centre is maintaining 172 accessions and they were evaluated for different horticultural and yield characters. The germplasm evaluation studies indicated wide range of variation for pseudostem length, number of leaves per plant, leaf length, breadth, rhizome length, breadth, yield per plant and yield per plot. The yield per plot varied from 1.00 to 7.4 kg while that of the 10 promising collections from 5.3 to 7.4 kg. Turmeric No. 262, Cls-21, ST-510, ST-291 and Co-1 recorded yield of 7.4, 6.5, 6.5, 6.2 and 6.1 kg per plot respectively. TNo-262 recorded the highest yield.

Two new collections were made from Puri and Narayanapatna area by the Pottangi centre. Out of the 189 accessions at Pottangi, which include 22 wild and related species, 175 were evaluated. Among 15 accessions of *C. longa*, highest fresh rhizome yield was obtained in PTS-50 (9.2 kg/3 m^2).; Chayaparupu 11 (7.4 kg/3 m^2) gave the highest yield among *C. aromatica* type and CAM-3 (6.4 kg/3 m^2) among four accessions of *C. amada.*

A total of 224 germplasm accessions assembled were evaluated at Coimbatore. Among the accessions, the yield ranged from 0.80 to 60.6 tonnes per hectare. The accession CL-101 registered the highest yield (60.6 t/ha). Three other accessions *viz.* CL-26, CL-47 and CL-154 recorded a yield of more than 50 t/ha.

The Kumarganj centre collected 18 new turmeric accessions during 2000-01 from the neighbouring districts of eastern UP, thus making the total to 66 accessions. Altogether 66 germplasm collections were evaluated for their agronomic traits as well as yield along with Rajendra Sonia as check. Among the germplasm, highest fresh rhizome yield was obtained in NDH-18 (522.25 q/ha), followed by Rajendra Sonia (502.22 q/ha) and NDH-14 (501.66 q/ha); the differences being non significant.

The Raigarh centre holds 24 local accessions and 20 improved varieties of turmeric and they have been evaluated. Among the 20 entries of improved varieties/accessions evaluated, RH-5 and local germplasm RTS-36 recorded the highest fresh rhizome yield. The yields of the best five accessions of the local and improved varieties are given in Table 32.

Table 32: Fresh rhizome yield of the promising turmeric varieties/accessions at Raigarh

Improved accessions/varieties	Fresh rhizome yield (q/ha)
RH-5	209.05
JTS-2	162.80
Suroma	161.76
Rashmi	116.50
PTS-12	114.50
Local accessions	
RTS-36	214.46
Local	209.80
RTS-44	207.83
RTS-1	196.15
RTS-46	139.95

The Pundibari centre collected 9 new accessions from terai region of West Bengal during the current year making the total to 69 accessions. These accessions were evaluated for morphological, yield and its attributing characters. Among these, TCP-2 and TCP-1 performed well and have been incorporated for CVT.

At present, 188 turmeric germplasm lines are being maintained at Jagtial centre. Based on duration, cultures were grouped into long duration, medium duration and short duration types. In the evaluation during this year, 15B, Depaigudu, Peddapasap (long duration), Ethamukala, Avanigadda (medium duration) and CLI Jyothi and Kasthuri in (short duration) were found promising (Table 33). Dholi centre collected 58 accessions in turmeric from the local areas of Bihar and different states of India and they are being maintained.

Table 33: Growth and yield of promising turmeric germplasm collections at Jagtial (2000-2001)

S. No	Culture	Plant height (cm)	No. of Leaves	Stem girth (cm)	Fingers		Fresh rhizome yield (kg/3m^2)
					No.	Length	
I	**Long duration**						
1.	15 B	100	8.1	2.2	8.0	5.6	6.6
2.	Depaiguda Peddapasupu	98	7.9	2.0	7.4	5.2	6.0
II	**Medium duration**						
3.	Ethamukkala	90	7.6	2.1	7.8	5.1	5.8
4.	Avanigadda	85	7.2	1.9	7.6	4.9	5.4
III	**Short duration**						
5.	CLI Jyothi	80	6.9	1.8	6.9	4.2	5.0
6.	Kasthuri	76	6.4	1.7	6.4	4.0	5.2

In turmeric 120 accessions are maintained at RARS, Bhavanisagar. The growth and yield parameters of 120 accessions were evaluated.

TUR/CI/2 Coordinated Varietal Trial (CVT)

TUR/CI/2.1 CVT 1996-Series IV

Kumarganj, Pundibari and *Jagtial*

The trial was laid out at Kumarganj with 15 cultivars from the coordinated centres along with two checks. Altogether 17 cultivars were evaluated and out of these, NDH-18 produced the highest yield (510.55 q/ha). The next best cultivar was Rajendra Sonia that has produced 498.95 q/ha.

Pundibari centre conducted the trial with 9 entries from 1996-97 to 1999-2000. The experiment was conducted and the data on 4 years yield are presented in Table 34.

Table 34: Growth parameters and yield of turmeric entries under MLT –IV at Pundibari (1996 to 2000)

Entries	Tillers/ clump	Plant height (cm.)	Leaf number	Leaf length (cm.)	Leaf breath (cm.)	Fresh rhizome yield (kg/3m² plot)				
						1996-97	1997-98	1998-99	1999-2000	Mean
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
CD (P=0.05)	0.4	-	-	-	1.0	2.9	2.4	2.3	1.1	-

During these years none of the growth parameters were found significant except tillers/ clump and leaf breadth. Highest tiller number per clump was recorded in Rajendra Sonia. Significantly higher leaf breadth was recorded in ACC. 360. Highest fresh rhizome yield was recorded in Rajendra Sonia (11.7 kg and in 3m²) followed by RH-5 and JTS-1. But the mean yield of 3m² plot was found highest in Rajendra Sonia, followed by RH-5 and Acc. 360.

The CVT-IV with 10 genotypes was tested at Jagtial for the last five years (under Turmeric-Maize cropping system). During 2000-01, JTS-2 gave higher fresh and cured rhizome yield (25.53 t/ha and 5.05 t/ha respectively), followed by JTS-1 (23.86 t/ha and 4.56 t/ha respectively) in comparison to 16.86 t/ha and 3.22 t/ha of fresh and dry rhizome yield in the check Duggirala (Table 35).

Table 35: Yield performance of turmeric varieties under MLT-IV at Jagtial (2000-2001).

S.No	Cultivar	Fresh rhizome yield (kg/3m^2)	Fresh rhizome yield (t/ha)	Cured yield (t/ha)	Curing percentage
1	RH 5	5.46	18.22	3.29	18.03
2	360	5.06	16.88	3.28	19.46
3	PTS 12	6.10	20.33	4.08	20.10
4	PTS 62	4.63	15.43	3.04	19.73
5	JTS 2	7.66	25.53	5.05	19.80
6	361	5.93	19.76	3.85	19.50
7	PTS 43	5.63	18.76	3.90	20.83
8	Raj. Sonia	6.53	21.76	3.95	18.16
9	JTS 1	7.16	23.86	4.56	19.13
10	Duggirala	5.06	16.86	3.22	19.10
	C.D.	0.86	-	-	-

The pooled mean of fresh rhizome yield of the five years is presented in Table 36. The results confirmed the superiority of JTS-2 and JTS-1 over the other entries tested.

Table 36: Fresh rhizome yield (t/ha) under MLT-IV at Jagtial (1996-'97 to 2000-'01)

Sl.No	Culture	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	Pooled Mean
1	RH 5	22.2	23.8	24.1	18.33	18.22	21.33
2	360	24.8	23.6	17.9	17.90	16.88	20.22
3	PTS 12	11.9	13.1	18.7	18.30	20.33	16.47
4	PTS 62	14.0	16.0	14.5	14.00	15.43	14.79
5	JTS 2	39.0	30.6	27.7	18.50	25.53	28.27
6	361	32.7	21.5	25.8	16.90	19.76	23.33
7	PTS 43	11.6	15.2	18.9	18.00	18.76	16.49
8	Raj. Sonia	17.0	26.1	16.6	16.00	21.76	19.49
9	JTS 1	25.7	29.2	25.7	18.00	23.86	24.49
10	Duggirala	30.1	28.4	25.9	11.10	16.86	22.47
	C.D.	5.8	4.0	2.6	0.77	-	-

TUR/CI/2.2 CVT 2000 Series V

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

The trial could not be conducted at Raigarh due to the non-availability of seed rhizomes.

In the new CVT (with 15 entries) laid out at Pundibari there was 13 entries and one check (Acc. 126). The data in respect of different morphological and yield parameters were recorded. The mean value for rhizome yield and yield components for the entries are presented in Tables 37 and 38.

Table 37: Rhizome yield of turmeric entries under CVT at Pundibari

Entry	Wt. of mother rhizome/clump (g)	Yield (kg/plot 3m^2)	Potential yield (t/ha)
Prabha	72.37	13.87	27.44
PTS-52	64.33	11.57	23.24
TCP-1	63.87	13.57	27.04
Acc. 126	72.79	14.50	29.00
PTS-59	61.35	8.35	16.90
TCP-2	66.60	16.43	32.06
Acc. 584	52.97	12.55	25.40
PTS-11	47.17	10.61	22.22
Pratibha	64.0	12.01	24.64
PTS-55	61.67	13.23	26.56
Tu-1	55.73	12.73	25.96
Acc. 585	39.33	9.77	19.94
PTS-15	36.85	10.65	21.30
RH-5	37.40	12.98	25.96
CD (0.05)	6.98	1.96	4.28

Table 38 : Yield components of turmeric entries under CVT at Pundibari

Variety	Weight of primary/ clump (gm.)	No. of secondary /clump	Length of secondary (cm.)/clump	Weight of secondary (gm.)/clump	Projected yield (t/ha)	PDI values for leaf blotch
Prabha	147.07	13.11	4.75	36.52	27.44	0.0
PTS-52	140.23	17.78	4.99	104.92	23.24	0.0
TCP-1	148.73	18.85	5.19	110.46	27.04	0.0
ACC-126	116.40	14.01	4.51	113.49	29.00	0.0
PTS-59	168.20	16.33	5.57	109.15	16.90	22.5
TCP-2	173.27	16.75	6.75	110.89	32.06	24.6
ACC-584	170.20	19.03	5.85	111.36	25.40	7.8
PTS-11	153.10	13.07	4.77	86.67	22.22	10.6
Pratibha	135.93	12.22	5.50	102.70	24.64	2.3
PTS-55	161.67	12.88	5.04	90.53	26.56	2.3
TU-1	161.77	10.36	5.65	98.60	25.96	2.3
ACC-585	125.53	11.50	4.77	100.56	19.94	0.0
PTS-15	117.93	18.40	5.47	89.67	21.30	2.3
RH-5	146.57	11.66	6.00	119.93	25.96	61.8
C.D. (0.05)	13.73	1.70	1.02	10.94	4.28	-

Among the entries, the highest fresh yield was recorded in TCP-2 (16.43 kg/3 m^2). All other genotypes except Acc. 126 had significantly lower yield when compared to TCP-2. TCP-2 had registered highest mean for length of primaries and secondary fingers as well as length of secondary fingers.

In the CVT-V 14 cultures were listed at Jagtial. Out of the cultures tested PTS-15 gave more cured yield (5.77 t/ha) followed by PTS-59 (5.35 t/ha). Among the fifteen entries evaluated at Pottangi the highest fresh rhizome yield was obtained in PTS-11 (28.32 t/ha), followed by PTS-52 (25.60 t/ha) (Table 39).

Table 39: Yield performance of turmeric cultivars under CVT –2000 V at Pottangi

Cultivar	Fresh rhizome yield (kg/3m^2)	Projected yield
RH-5	8.99	22.48
PTS-52	10.24	25.60
PTS-55	8.46	21.15
PTS-11	11.33	28.33
PTS-59	9,32	23.30
NDH-18	5.81	14.53
TCP-1	7.89	18.22
TCP-2	6.25	15.63
ACC-585	7.29	18.23
ACC-584	6.08	15.21
Tu No.-1	7.10	17.76
Surama	9.21	23.03
Roma	8.13	21.33
PTS-15	7.32	18.30
PCT-8	7.96	19.90
C.D.(0.05)	1.96	4.90

The trial initiated at Chintapalli during 2000-01 with 10 entries from different co-ordinating centres. Among the 10 varieties/selections, maximum plant height was recorded with BSR-1 (82.2 cm). However, there is no significantly difference in varieties/ selections in respect of weight of rhizome/clump. The fresh rhizome yield ranged from 9.2 t/ha to 25.0 t/ha. The varieties BSR-1 (check) and NDH-18 are significantly superior to other varieties in respect of fresh rhizome yield, giving 25.0 t/ha and 23.0 t/ha, respectively.

The new CVT with 16 promising genotypes were tested at Dholi during 2000-01 out of which RH-5 yielded the highest (501.13 q/ha) with early maturity.

TUR/CI/3 Varietal Evaluation Trial

TUR/CI/3.1 Comparative yield trial (CYT) 1999-2000

Pottangi, Dholi, Raigarh, Pundibari and *Jagtial*

At Pottangi among the eight turmeric entries evaluated, highest yielder was PTS-34 (22.28 t/ha) followed by PTS-39 (21.68 t/ha)(Table 40).

Table 40. Yield performance of turmeric varieties under CYT at Pottangi

Sl. No.	Cultivar	Fresh rhizome yield (kg/3m²)			Projected Yield (t/ha)	Dry yield (t/ha)	Dry Rec. (%)
		98-99	99-00	Mean			
1.	Roma	8.76	5.55	7.16	17.90	4.48	25.0
2.	R. Sonia	12.66	5.37	9.02	22.55	3.16	14.0
3.	Alleppey	10.77	5.67	8.22	20.55	4.11	20.0
4.	Jts-2	13.28	6.95	10.12	25.30	3.80	15.0
5.	Acc-360	8.72	3.80	6.26	15.65	3.44	22.0
6.	Bsr-2	9.30	4.79	7.05	17.63	3.42	19.4
	C.D. (P=0.05)	NS	2.38	NS	NS	-	-

The CYT conducted at Dholi during 2000-01 with 8 centres and the performance of the entries was studied. Out of the 8 different genotypes, RHS produced maximum fresh rhizome (462.96 q/ha) with early maturity (189 days).

A CYT was laid out at Raigarh in 1999 and 2000 with 5 entries viz. Prabha, Prathiba, Acc. 528, Acc. 126, Acc. 585 along with RTS-1 as check. The mean yield of two years revealed that Prabha gave maximum rhizome yield of 178.86 q/ha compared to check (145.71 q/ha).

The CYT was laid out at Pundibari with five different entries during 1999-2000. Observations on plant height, tillers/clump, leaves/plant, length and breadth and fresh rhizome yield / 3m² plot were recorded. Highest number of tillers/clump and number of leaves per plant were recorded in Acc. 126 (2.6) and Prabha (10.0) respectively. However, highest plant height of 11.0 cm, leaf length of 41.7 cm and leaf breadth of 4.8 cm were found in Pratibha, Acc. 585 ; Pratibha and Acc. 126 respectively.

The CYT with long, medium and short duration accessions were conducted at Jagtial for evaluation of promising types in turmeric-maize cropping system. The results on yield and other characters are presented in Table 41. In the long duration group, out of 7 entries tested, JTS-15 recorded more cured rhizome yield (5.02 t/ha) followed by JTS-11 (4.91 t/ha) compared to 3.28 t/ha in the check cv. Duggirala. In the intermediate duration type, out of 13 entries tested JTS-323 has given more cured rhizome yield (4.59 t/ha) followed by JTS-319 (4.56 t/ha) as compared to 3.12 t/ha cured yield in check (LLI-317). In short duration varieties tested, JTS-612 gave higher cured rhizome yield (4.22 t/ha) followed by JTS-608 (4.20 t/ha).

Table 41: Comparative yield performance and curing (%) of turmeric varieties (long, medium and short duration) under CYT (2000-2001) at Jagtial.

Cultivar	Fresh rhizome yield (kg/3m^2)	Fresh rhizome yield (t/ha)	Cured yield (t/ha)	Curing percentage
Long duration				
JTS 14	7.30	24.3	4.73	19.5
JTS 15	8.33	27.6	5.02	18.2
JTS 10	6.33	23.2	4.61	19.9
JTS 11	7.26	24.2	4.91	20.3
JTS 12	6.06	20.2	4.20	20.8
JTS 13	5.66	18.8	3.60	19.2
Duggirala	4.83	16.1	3.28	20.4
C.D	0.72			
Medium duration				
JTS 314	6.73	22.4	4.30	19.2
JTS 315	5.70	19.0	3.66	19.3
JTS 316	5.26	17.5	3.41	19.5
JTS 317	5.40	18.0	3.45	19.2
JTS 318	5.80	19.3	3.66	19.0
JTS 319	7.00	23.3	4.56	19.6
JTS 320	5.53	18.4	3.60	19.6
JTS 321	4.80	16.0	3.05	19.1
JTS 322	5.73	19.1	3.64	19.1
JTS 323	7.26	24.2	4.59	19.0
JTS 324	5.73	19.1	3.66	19.2
JTS 325	4.90	16.3	3.12	19.2
JTS 326	4.76	15.8	3.06	19.4
CLI 317	4.90	16.3	3.12	19.2
C.D.	0.59			
Short duration				
JTS 607	5.53	18.43	3.26	17.70
JTS 608	6.93	23.10	4.20	18.20
JTS 609	4.93	16.43	2.96	18.06
JTS 610	7.50	25.00	4.05	16.20
JTS 6 11	5.40	18.00	3.27	18.20
JTS 612	7.43	24.76	4.22	17.06
PCT 13	6.56	21.86	3.97	18.20
C.D.	0.76			

Eight different genotypes *viz.*, PCT-8, PCT-11, Acc. 360, Acc. 361, JTS-1, RH-5, Sugandham and Rajendra Sonia (check) were tested under CVT at Dholi. The highest yield was recorded in RH-5 (462.96 q/ha).

TUR/CI/3.2 Initial evaluation trial

Pottangi

Significant differences among 15 entries were recorded at Pottangi for the fresh rhizome yield. The highest yield was recorded by TU No. 3 (26.53 t/ha) followed by TS-39 (23.58 t/ha).

TUR/CI/4 Quality Evaluation Trial

TUR/CI/4.1 Quality evaluation of germplasm/varieties

Solan and *Coimbatore*

At Solan, 154 collections of turmeric crop, harvested during 2000, were analysed for various quality parameters *viz.* curcumin, essential oil, oleoresin and dry mater contents. Dry matter content of germplasm collections varied from 13.4 to 28.3%, essential oil 2.0 to 8.0%, oleoresin 4.69 to 18.53 % and curcumin 1.0 to 4.93%. Alleppey finger had curcumin content of 4.58% which was little less than BDJR-1260 (4.93%) the top yielder. The dry matter recovery was found to be maximum in Cls-13 (28.3%) followed by Turmeric No. 5 (25%), ST-693 (24.8%). Essential oil was maximum (8.0%) in ST 8M and BDJR-1034 followed by BDJR-1260 (7.5%) and PCT-5 (7.5%). Oleoresin was maximum in Ammamiganda (18.53%), followed by BDJR-1244 (18.27%) and Turmeric No. 14A (18.05%). Curcumin contents were maximum in BDJR-1260 (4.93%) followed by BDJR-1250 (4.60%) and Alleppey finger (4.58%).

At Coimbatore, the accession CL-147 was isolated with higher curcumin content (5.5%). Further analysis of curcumin in 65 turmeric accessions were made during 1999. It was observed that the curcumin levels varied in different accessions which ranged from 0.986 to 6.357%. The highest curcumin content of 6.357% was recorded in CL-87. Among the 65 accessions tested, 5 accessions registered more than 5.0% curcumin and 20 accessions registered more than 4.0% curcumin contents.

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

Pottangi and *Coimbatore*

Evaluation of the released varieties over three years at Pottangi indicated that there is no significant difference for yield. The highest dry recovery of 26% was recorded by Roma in the pooled data of three years (Table 42).

Table 42: Yield performance (fresh) and dry recovery (%) of turmeric cultivars at Pottangi

Cultivar	Fresh rhizome yield (kg/ 3 m^2)				Projected yield (t/ha)	Dry recovery (%)
	1998-99	1999-00	00-01	Average		
ROMA	8.76	5.50	9.50	7.92	19.80	26.0
R. SONIA	12.66	5.37	7.80	8.61	21.53	14.0
Alleppey	10.77	5.67	8.21	8.22	20.55	20.0
JTS -2	13.28	6.95	6.71	8.98	22.45	14.0
ACC - 360	8.12	3.80	7.42	6.44	16.10	21.0
BSR - 2	9.30	4.79	6.84	6.98	17.45	19.0
CD (0.05)	NS	2.38	NS			

At Coimbatore, a trial was laid out with six improved varieties. The yield data indicated significant variation among the cultivars (Table 43). The cultivar Suguna registered the highest mean yield of 44.69 t/ha. The highest curing percentage was recorded in JTS-2 and Roma (23.67%), which is not significant. The curcumin analysis of these varieties is being carried out.

Table 43: Impact of environment on yield and quality of turmeric accessions at Coimbatore

Acc. No.	Yield (t/ha)	Curing percentage
131 (Suguna)	44.69	20.67
151 (Acc. 360)	31.69	23.00
141(Rajendra Sonia)	22.95	22.67
140 (JTS-2)	29.46	23.67
2 (BSR-2)	21.08	22.00
133 (Roma)	21.87	23.67
CD (p=0.05)	2.50	N.S.

TUR/CM/1 Nutrient Management Trial

TUR/CM/1.1 Efficacy of biofertilizer using *Azospirillum* on turmeric

Coimbatore, Pottangi, Raigarh, Ambalavayal and *Kumarganj*

A new experiment consists of the following seven treatments was laid out at Coimbatore.

T1 – Inorganic N (100%) + *Azospirillum* (50 g) + 5 kg FYM; T2 – Inorganic N (75%) + *Azospirillum* (50 g) + 5 kg FYM; T3 – Inorganic N (50 %)+ *Azospirillum* (50 g) + 5 kg FYM ; T4 –FYM (5 kg) + *Azospirillum* (50 g); T5 – FYM (5 kg) alone; T6 – FYM (10 kg) + *Azospirillum* (50 g) ; T7 – FYM (10 kg) alone and T8-recommended dose of fertilizers (control).

The results of the study indicated that there was no significant difference among the treatments for yield. The highest yield of 38.89 t/ha was registered by T3, followed by T2 (37.04 t/ha).

There is no significant difference among the treatments 100% N + *Azospirillum* (50 g) +5 kg FYM with respect to fresh rhizome yield at Pottangi. The highest yield was recorded in T1 (100% N + *Azospirillum* (50g) + 5 kg FYM) with cost benefit ratio of 0.82:0.65 (Table 44) which is on par with control (T8).

Table 44: Effect of biofertilizer on yield performance of turmeric at Pottangi

Treatments	Fresh rhizome yield F : B	Projected yield (t/ha)	Cost Benefit		
			Cost (Rs. lac)	Gross Return	Benefit
T_1	8.41	21.03	0.82	1.47	0.65
T_2	7.10	17.75	0.81	1.24	0.43
T_3	6.64	16.60	0.80	1.16	0.36
T_4	5.44	13.60	0.78	0.95	0.17
T_5	6.21	15.53	0.78	1.09	0.31
T_6	6.42	16.05	0.78	1.12	0.34
T_7	6.21	15.53	0.78	1.09	0.31
T_8	7.34	18.35	0.80	1.28	0.48
C.D. (0.05)	NS	-	-	-	-

Note: Treatments (T1 to T8) are as that of Coimbatore centre.

A trial was laid out at Kumarganj with 7 treatments during 2000-2001 and observations were made for the yield and its attributes as well as morphological characters. Data presented in Table 45 indicated that the use of *Azospirillum* together with 100% N and 5 kg of FYM produced maximum fresh rhizome yield (498.33 q/ha), followed by T2 (*Azospirillum* + 75% NPK + 5 kg FYM). However, values with respect to fresh rhizome yield were found to be on par when *Azospirillum* (50 g) together with 75% and 50% inorganic fertilizers were incorporated.

The trial has to be laid out at Ambalavayal as well as at Raigarh.

Table 45: Yield of turmeric as influenced by *Azospirillum* at Kumarganj (2000-01)

Treatments	Yield (q/ha)
T_1 Inorganic N (100% + *Azospirillum* (50g) + 5kg FYM	498.33
T_2 Inorganic N (75% + *Azospirillum* (50g) + 5kg FYM	481.66
T_3 Inorganic N (50% + *Azospirillum* (50g) + 5kg FYM	435.16
T_4 FYM (5kg) + *Azospirillum* (50g)	408.33
T_5 FYM (5kg) Alone	376.66
T_6 FYM (10kg) + *Azospirillum* (50g)	416.66
T_7 FYM (10kg) Alone	405.50
CD (P=0.05)	24.50

TUR/CM/1.2 Effect of different organic inputs on turmeric

Pottangi

No significant difference was observed at Pottangi among the treatments (Table 46) of different organic inputs applied in relation to yield at Pottangi. Highest rhizome yield was recorded in T7 (without wood ash-24.28 t/ha), which is on par with T8.

Table 46: Yield performance of turmeric variety 'Ranga'

Treatments		Rhizome yield/ plot (Kg / 3 m^2)	Projected yield (t/ha)	C:B
a+b+c+d+e+f	(T_1)	8.00	20.0	0.7 : 0.7
b+c+d+e+f	(T_2)	6.32	15.80	06 : 0.6
a+c+d+e+f	(T_3)	6.54	16.35	06 : 0.7
a+b+d+e+f	(T_4)	8.56	21.40	06 : 08
a+b+c+e+f	(T_5)	8.47	21.18	06 : 0.7
a+b+c+d+f	(T_6)	9.75	24.08	0.6 : 0.8
a+b+c+d+e	(T_7)	9.71	24.28	0.6 : 0.7
Inorganic	(T_8)	8.54	21.35	0.8 : 08
C.D(0.05)		NS		

'a'-Pongamia cake @ 250 g/plot; 'b' – FYM @ 10 kg/plot;
'c'-Neem cake@ 250 g/ plot; 'd' – Sterameal @ 250 g/plot;
'e'-Rock phosphate@ 500g/plot; 'f'-wood ash @ 2 kg/plot;

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, Raigarh and *Pundibari*

The elite turmeric germplasm lines were screened against foliar and rhizome rot diseases at Jagtial during the period from 1997-98 to 2000-01. The long duration group, TC-4 and intermediate duration type, CLI-32, CLI-370, CLI-325 and JTS-302 showed only the lowest rhizome rot incidence. Out of 50 cultures (8 short duration, 26 mid duration and 16 long duration) tested against leaf spot diseases during the period from 1997-98 to 2000-01, 46 varieties (8 short duration, 26 mid duration and 12 long duration varieties) were found free from *Colletotrichum* leaf spot under natural conditions, in comparison with susceptible check-Duggirala, Telupu and Armoor (Table 47).

Table 47: Turmeric cultures free from leaf spot disease caused by *Collectotrichum capsici* (1997-2000) at Jagtial

S.No	Variety	S.No.	Variety
Short duration			
1	PCT 10	5	JTS 606
2	JTS 604	6	JTS 601
3	PCT 14	7	G.S
4	JTS 602	8	JTS 605
Mid duration			
1	JTS 306	14	JTS 313
2	JTS 308	15	JTS 301
3	PTS 19	16	JTS 312
4	CLI 320	17	JTS 304
5	JTS 307	18	JTS 309
6	JTS 305	19	CLI 370
7	JTS 302	20	CLI 330
8	PTS 38	21	CLI 325
9	CLI 38	22	JTS 310
10	PTS 9	23	PTS 10
11	CLI 367 II	24	PTS 24
12	JTS 311	25	CLI 317
13	JTS 303	26	T5
Long duration			
1	JTS 3	7	BSR 1
2	JTS 8	8	JTS 6
3	JTS 9	9	ST 365
4	15 B	10	ST 510
5	TC 2	11	JTS 7
6	TC 4	12	361

Out of 50 turmeric entries screened under natural conditions from 1997-98 to 2000-01, long duration varieties (Duggirala, Telupu, Armoor local, JTS-1, JTS- and TC-2) were found free from *Taphrina* leaf blotch disease.

Fifty eight germplasm accessions have been collected and maintained at Dholi centre. Their morphological characters were studied and some promising lines have been identified. All of them were screened against diseases and out of which, GL.Puram and Kohinoor were found resistant to leaf spot and leaf blotch diseases.

The Dholi centre made a survey in turmeric growing areas of N. Bihar *viz*. Sitamarhi, East and West Champaran. It was observed that leaf blotch incidence was more severe than the leaf spot disease. In the same area of E. Champaran, rhizome rot disease was also found. In comparison to previous year, the leaf blotch disease was less severe during 2000 due to less rains.

The 41 germplasm entries were screened and graded for their reaction to *Taphrina* leaf blotch and *Colletotrichum* leaf spot diseases at Raigarh centre. In the screening during the current year, 27 entries showed resistance to *Taphrina* leaf blotch and 4 entries against *Colletotrichum* leaf spot.

The entries under CVT were tested against foliar diseases of turmeric at Pundibari. Among the entries, Acc. 584 and Prathibha, PTS-52 and TCP-1 showed immune to the foliar diseases.

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

Pundibari and *Kumarganj*

A trial with seven treatments was laid out at Kumarganj. Data presented in Table 48 indicated minimum percent of disease incidence in case of Rajendra Sonia (43.13), when rhizomes were treated with carbendazim + biocontrol agent as soil application and similar response was also observed with RH-5. However, incidence of disease was slightly higher in RH-5 than Rajendra Sonia.

Table 48: Effect of fungicides and bioagent on reaction to disease, fresh rhizome yield and their attributes in turmeric at Kumarganj

Treatments	Wt. of fresh rhizome/clump(g)		Total no.of fingers/clump		Yield of rhizome (q/ha)		PDI Leaf blotch		Leaf spot	
	R.Sonia	RH-5	R.Sonia	RH-5	R.Sonia	RH-5	R.Sonia	RH-5	R.Sonia	RH-5
T_1. Mancozeb (seed treatment + spray @ 0.2%)	0.850	0.780	20.0	18.0	426.66	389.96	49.00	48.10	53.06	56.46
T_2. Carbendazim (seed treatment + spray @ 0.2%)	0.885	0.790	20.0	19.0	441.66	394.29	47.30	46.40	52.53	55.36
T_3. Mancozeb + Carbendazim (seed treatment + spray @ 0.2%)	0.920	0.800	21.0	21.0	458.28	399.96	44.20	42.40	49.16	53.66

T_4 Bio-control agent (seed treatment ; *T. harzianum*)	0.845	0.735	20.0	19.0	421.62	366.63	52.80	50.20	67.53 63.00
T_5 Mancozeb (seed treatment + bio control agent; *T. harzianum* soil application)	0.950	0.870	22.0	21.0	473.28	433.29	39.00	33.20	44.55 50.90
T_6 Carbendazim (seed treatment + bio control agent; *T. harzianum* soil application)	0.990	0.920	23.0	22.0	494.28	459.95	34.20	36.40	43.13 49.43
T_7 Control	0.650	0.590	18.0	15.0	326.63	296.63	58.80	56.30	73.53 70.02
CD (P= 0.05)									6.15

Pundibari centre conducted an experiment with eight treatments including control, using the cultivar 'Sugandham'. The treatment consisted of four non-systemic fungicides *viz.*, Captaf 50N, Cuman L., Bordeaux Mixture and Syllit-65 WP and two systemic fungicides *viz.*, Bavistin and Hinosan and an antifungal antibiotic, Griseoderm 250. Data on Percent Disease Index (PDI), aerial dry biomass (kg/3m^2) and fresh rhizome yield/plot indicated that Bordeaux mixture is effective, which reduced the PDI and increased aerial dry biomass as well as fresh rhizome yield as compared to other fungicides (Table 49).

Table 49 : Effect of different fungicides on leaf blotch disease incidence, dry biomass and fresh rhizome yield of turmeric at Pundibari

Treatments	Dosage	Percent disease index	Aerial dry biomass yield (kg/3m^2 plot)	Fresh rhizome yield (kg/3m^2 plot)
Captaf 50W (Captan 50%)	1.5 g	85.3 (67.5)*	2.55	9.18
Cuman L (Ziram, 27% Sc)	1.5 ml	83.4 (66.1)	2.43	10.34
Bordeaux mixture (Copper Sulphate, 1%)	10.0 g	49.7 (44.8)	3.46	14.45
Syllit 65 WP (Dodine, 65%)	1.5 g	84.6 (67.1)	2.68	9.90
Bavistin (Carbendazim, 50% WP)	1.0 g	92.2 (74.3)	2.50	10.45
Hinosan (Ediphenphos, 50% EC)	1.0 ml	87.9 (69.7)	2.39	9.82
Griseoderm 250 (Griseofulvin, 25 mg)	0.75 mg	90.7 (72.5)	2.53	9.36
Control	-	90.9 (72.6)	2.46	9.12
CD .05		6.0	0.57	1.38

*Figure within parenthesis indicates arch- sine transformed value.

TUR/CP/1.3 Effect of seed treatment on leaf spot and leaf blotch diseases of turmeric

Dholi and *Pundibari*

A new management trial on leaf spot and leaf blotch diseases of turmeric has been initiated at Pundibari by using fungicide and biocontrol agent (*Trichoderma viride*). With the test varieties RH-5 and Rajendra Sonia, four sprays of fungicides were given at 20 days interval starting from first appearance of the disease. The seeds were treated with *T. viride* for 30 minutes. The data on percent disease index (PDI), aerial dry biomass (kg/3 m^2) and yield (kg/3 m^2) presented in Tables 13 and 14 indicate that lowest disease incidence was recorded in combined application of Mancozeb (0.2%) and Carbendazim (0.2%) applied as foliar spray. The second best was spraying of carbendazim alone in both the test varieties. This treatment reduced the disease index by 43 and 47% compared to the untreated check on Rajendra Sonia and RH-5, respectively. The yield of rhizomes and aerial biomass also followed the same trend.

A new trial was laid out at Dholi with seven treatments including the use of biocontrol agent to study the effect of different treatments on leaf blotch (*T. maculans*) and leaf spot (*C. capsici*) diseases. The treatments consists of T1- Mancozeb (0.2%) @ 2 g/lit water ; T2 - Carbendazim (0.2%) @ 2 g/lit water ; T3 - Mancozeb + Carbendazim (0.2%) ; T4 - *Trichoderma viride* ; T5 - Mancozeb as seed treatment + *Trichoderma* as soil application ; T6- Carbendazim as seed treatment + *Trichoderma* as soil application and T7-Control.

The results indicated that treatment with Mancozeb (0.2%) + Carbendazim (0.2%) proved to be better in managing the leaf spot (23.0%) and leaf blotch (26.0%) and giving better yield of 148.15q /ha compared to a yield of 92.59 q/ha in control with 41.0% leaf spot and 43.33% leaf blotch incidence.

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

Jagtial

A new trial was laid out at Jagtial to develop suitable management practice for rhizome rot of turmeric with the following six treatment combinations along with check as that of Dholi centre. The trial was laid out at two locations *viz.* Armoor and Jagtial using the varieties JTS-1 and JTS-2 and observations on the incidence of rhizome rot disease were recorded. Seed treatment with carbendazim (0.2%) recorded less incidence of rhizome rot compared to other treatments.

In the etiological study of rhizome rot of turmeric, *Fusarium solani* was isolated by the Jagtial centre.

TREE SPICES

TSP/CI/1 Genetic Resources

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

Yercaud, Pechiparai and *Dapoli*

At Yercaud, 13 accessions of clove, collected from Kallar (3), Nagercoil (1) and Courtallam (9), were maintained and evaluated for growth and yield characters. The trial was laid out in RBD in 1992 with three replications. Accession SA-1 exhibited fast growth, having a plant height of 185cm and 20 branches. In cinnamon, the centre holds 11 accessions. They are collected from IISR (10) and Valparai (1). They are planted at Yercaud in RBD with three replications in 1992. Among the 11 accessions, CV- 9 recorded better growth characters. During the ensuing season, the coppicing will be done.

The Dapoli centre conducted a survey in Dahanu Pulghar and Talasheri Tahsils, Thane district of Maharashtra to locate elite types of nutmeg, pepper, clove, and cinnamon. Two nutmeg trees, one clove and four cinnamon plants were located during the survey and clonal materials were collected and added on to the germplasm.

Nutmeg : Germplasm of nutmeg consists of 14 accessions at Dapoli. They are being evaluated for growth and yield contributing characters.

Eight elite nutmeg accessions collected from IISR were planted in coconut garden in RBD with 3 replications with 3 plants/ treatment. The growth observations were recorded. Data showed that none of the morphological characters was significantly differed among accessions.

Cinnamon: In cinnamon, 13 accessions are being evaluated for growth, yield and quality parameters. Nine elite cinnamon types procured from IISR, Calicut were planted in September 1997 in design RBD with three replication and 3 plants/treatment. All the elite types were copiced in April 2000 and observations on bark yield, leaf yield and growth were recorded at the time of harvest and statistically analaysed. None of the parameters was statistically significant.

Clove: The germplasm of clove consists of three types are being evaluated for different growth characters. The growth performances of the clove seedlings are satisfactory.

The Pechipari centre maintains the following germplasm accessions in tree spices.

Nutmeg: Four selections collected from IISR Calicut and one from SHF, courtallum were planted in 1991. Seven local collections were added to the germplasm in 1994. Among these, the IISR selection MF2 recorded the highest mean tree height of 5.9m with 27cm stem girth. Among the local collections, MF6 recorded the maximum height of 4.2m with a stem girth of 25cm.

Cinnamon: Nine elite selections collected from IISR were planted in 1991. Three local types were planted in 1994 at Pechiparai for evaluation. Among the 9 IISR selections, CV-203 recorded highest bark yield of 3.8kg and

38 kg of leaves, followed by CV-64 (3.4kg Bark and 35kg of leaves). Among the local collections, CV-3 recorded the highest yield of 3.6 bark and 35kg of leaves followed by CV-1 (3.22kg bark and 30kg leaves).

Clove: In clove, 19 accessions are being maintained at Pechiparai centre which include 9 selections from IISR (planted in 1991) and 10 local collections from Pechiparai region (planted in 1994). These accessions are under evaluation and among which, Sel. 7 from IISR performed well both for growth and yield parameters. Among the local types, selection-13 recorded the maximum height of 8.0 m and stem girth of 36.5m. During the period under report, selection 13 had produced 100g flower buds (dry) and selection 12 produced 52g flower buds (dry).

TSP/CI/2 Coordinated Varietal Trial (CVT)

TSP/CI/2.1 CVT 1992 in clove

Yercaud / Pechiparai

In CVT 1992 at Yercaud among 6 entries in the trial, Sel.1 exhibited a height of 196cm with 36 branches.

TSP/CI/2.2 CVT 1992 in cinnamon

Yercaud and Ambalavayal

The CVT with seven accessions was laid out at Ambalavayal during August 1992 and first coppicing was done in May 1996. Biometric characters and yield of quills recorded during May 2000 are provided in Table 50. Sel/203 recorded the heigher wet (0.781kg) and dry weight (0.315kg) of quills per plant.

Table 50: Evaluation of cinnamon in the CVT-1992 at Ambalavayal

Accessions	Colour of new flush	Wet weight of quills (kg/plant)	Dry weight of quills (kg/plant)
SL.44	Pink	0.384	0.161
SL.203	Pink	0.781	0.315
SL.63	Pink	0.546	0.265
SL.189	Pink	0.572	0.287
SL.53	Light green	0.516	0.245
RARS Type-1	Light green	0. 380	0.140
RARS Type-2	Light green	0.169	0.072

At Yercaud, the CVT 1992 was laid out with five accessions. In the ensuing season, the coppicing will be done.

TSP/CM/1 Propagation / Multiplication Trial

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

Pechiparai and Dapoli

At Pechiparai, hard wood and terminal

cuttings, ground and air layering, approach, softwood and epicotyl grafting, and T-budding were tried in clove. In air layering 20% and in approach grafting 12% success were recorded.

Epicotyl and approach grafting were tried in Nutmeg at Pechiparai. The success in epicotyle grafting was 35% and approach grafting was 80% under this region.

An experiment was carried out at Dapoli to find out the optimum period for softwood grafting in nutmeg and clove. The experiment started in April 2000 and soft wood grafting was done in every month and the percentage of success is under observation in nutmeg and clove.

TSP/CM/2 Irrigation Trial

TSP/CM/2.1 Drip irrigation in clove and nutmeg

Yercaud

Drip irrigation trial was laid out in clove in 1992 and drip system was in operation since 1993 with four irrigation levels at Yercaud.

The treatment details are: T1- Dripping of 2 liters of water / plant / day; T2- Dripping of 4 liters of water / plant / day; T3- Dripping of 6 liters of water / plant / day; T4- Dripping of 8 liters of water / plant / day and T5- Pot watering of 8 liters of water / plant / week (control).

Pot watering of 8 liters of water / week / plant (T5) functioned as check. The growth parameters such as plant height, and number of branches per plant were recorded. Dripping of 8 liters of water / day / plant recorded the highest plant height of 205.5cm with 49 branches per plant.

TSP/CP/1 Disease Management Trial

TSP/CP/1.1 Survey for disease incidence in tree spices

Dapoli

A survey was conducted to record the incidence of diseases in tree spices occurring in the Thane district of Konkan region of Maharashtra during 2000-01. In nutmeg, incidence of shot hole disease was found to be moderate. At Shirgaon location, low incidence of red rust caused by algae was observed. Moderate to low incidence of shot hole disease was also recorded in cinnamon.

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*

Jobner centre maintains 383 germplasm accessions. Of these, 352 accessions (old and new) were evaluated along with 5 checks (RCr-20, RCr-41, RCr-435, RCr-436 and local check.). Of the 352 accessions planted, 49 accessions showed poor germination, therefore the plants were kept for sibmating to obtain the seed for next season and the observations for the morphological, yield and yield attributing characters of the remaining 303 accessions were recorded. Out of these 25 accessions were better than all the check variety. Some of the promising accessions identified were UD-119 (52 g), UD-

531 (48 g), UD-530 (43 g), UD-483 (42 g), UD-611 (41 g), UD-194 (41 g) and NS-3 (40 g).

Twenty entries of coriander were tested against stem gall disease caused by *Protomyces macrosporus* at farmers' field in Danta (Sikar). Three entries *viz.*, RCr-41, RCr-435 and RCr-436 were found immune and others were resistant to highly susceptible. (Table-51). Out of the 22 entries tested against root knot nematode (*M. incognita*) at Durgapura, varieties RCr-41, RCr-435, RCr-436, UD-446 and UD-684 were found resistant.

Table 51: Evaluation of coriander entries against stemgall disease at Danta (1990-2000).

Categories	Nature of disease reaction	Entries
Immunue (I)	0	RCr-41, UD-435 and 436
Resistant (R)	1	UD-684, UD-685 and UD-686
Moderately resistant (MR)	2	UD-446, UD-447 and UD-20
Susceptible (S)	3	UD-30, UD-35, UD-61, UD-75, UD-257 and UD-262
Highly susceptible (HS)	4	UD-311, UD-393, UD-407, UD-742, UD-743, CS-2, CS-6 and Local.

At Coimbatore, 224 accessions are being maintained, and were evaluated for yield during kharif 2000. Grain yield varied from 350 kg to 710 kg per hectare. Acc. No. 131 registered the highest yield. The released variety Co-3 registered an yield of 520 kg of grain per hectare. The accessions that registered a yield of 700 kg/ha or above are CS-13, CS-16, CS-22, CS-52 and CS-130.

Jagudan centre retained 83 coriander accessions including 18 exotic and 65 indigenous collections. In the screening trial 61 entries were screened, and none was resistant/tolerant against powdery mildew disease under natural conditions.

Guntur centre is maintaining 230 accessions, of which 110 accessions were evaluated during rabi 2000-2001. LCC-173 recorded highest yield of 900 kg/ha followed by LCC-134, LCC-216, LCC-212 and LCC-228 with 883, 883, 867 and 833 kg/ha respectively. The check (Sadhana) recorded an yield of 667 kg/ha.

Kumarganj centre collected 11 new germplasm accessions during rabi 2000-2001 making the total to 40 accessions, and they were evaluated for their growth and yield. Among them, ND Cor-2 produced 17.33 q/ha, which was superior from the checks Kumarganj selection and Pant Haritima.

At Dholi, seventy six germplasm accessions are under evaluation. The morphological characters were studied and some promising lines identified. These accessions were screened against stemgall disease in breeders plot, and only a few like Pant Harithma and Rajendra Swati were graded resistant.

At Hisar 75 accessions were evaluated in two row plots of 2.5 meters length using Pant Haritina, DH-5 and Narnaul selection as checks during 1997-98 to 1999-2000. The mean seed yield of germplasm material ranged from 270g (DH-275) to 517g (DH-234). The most promising lines for seed yield are DH-206, DH-209, DH-222, DH-234, DH-250, DH-252. These lines were maintained by sibmating under muslin cloth and self seed of all the lines.

COR/CI/2 Coordinated Varietal Trial (CVT)

COR/CI/2.1 CVT 1993 – Series II

Coimbatore, Kumarganj and Raigarh

At Coimbatore, this trial was laid out with 10 varieties including Co-3 as a check. During rabi-1999, the yield difference among the different accessions were highly significant. The yield varied from 501.33 kg to 601.33 kg/ha. The Acc. No. 12 (748) registered the highest yield and Co-3 the lowest yield. (Table 52). The mean yield data of three years (kharif 1998 to 2000) are presented in Table 53. The results observed that the accessions differed significantly in their yield. Based on the mean performance, the acc. C-748 was found to be superior with the highest yield of 579.3 kg/ha followed by UD-686 (561.0 kg). Except the accessions UD-684, UD-685 and UD-745, all other accessions registered higher yield than the check (529.6 kg/ha).

Table 52: Performance of coriander varieties under CVT (1999 II) at Coimbatore (1999)

Sl. No.	Accession No.	Yield (kg/ha)
1.	123 (464)	507.33
2.	208 (DH3)	554.33
3.	97 (UD 685)	487.67
4.	82 (CO. 3)	501.33
5.	12 (748)	601.33
6.	101 (DH 48)	538.00
7.	8 (DH 52)	544.33
8.	203 (745)	518.33
9.	102 (UD 686)	561.67
10.	211 (1080)	516.33
	CD (P = 0.05)	35.76

Table 53 : Mean performance of coriander accessions under CVT (1993 - Series II) at Coimbatore

Accessions	Yield (kg/ha)			
	1998	1999	2000	2001
UD 684	416.7	588.3	507.3	504.1
UD 685	489.2	546.1	487.7	507.7
UD 686	499.7	621.6	561.7	561.0
CC 745	468.5	570.5	518.3	519.1
CC 748	468.5	668.2	601.3	579.3
DH 13	468.5	617.2	554.3	546.7
DH 52	520.5	595.0	544.3	553.3
DH 48	530.9	586.0	538.0	551.7
CO.3 (Check)	530.9	550.6	507.3	529.6
CD @ 5%	20.92	44.83	35.76	31.33

The trial laid out at Raigarh in 1998 with 14 entries. During rabi 2000-01 entries LOC-18 are maximum seed yield of 20.94 q/ha closely followed by LCC-15 (20.25 q/ha), but chck-2 (18.53) RCS-1 (17.88 q/ha) and JCO-387 (16.44 q/ha) which was significantly superior over the remaining entries. The trial was completed 3 years. The pooled and analysed data to be presented by the Raigarh centre.

The CVT entries were screened against powdery mildew and the observation disease index for the three years (1998, 99 & 2000) were recorded at Raigarh. None of the coriander was found free from PMD, but based on the mean value, JCO-387 at DH-38 only were recorded as resistant.

Kumarganj centre has not reported the final report of the CVT 1993 – Series II.

COR/CI/2.2 CVT 1996 – Series III

Coimbatore, Kumarganj, Dholi and *Hisar*

The trial (CVT) 1996 – Series III at Coimbatore consisting of 10 accessions was laid out in RBD. The yield difference among the accessions was non-significant. The cultivar Co-3 registered the highest yield of 645.0 kg/ha. The mean performance for 3 years (1998-2000) indicated non significant yield difference among the accessions. Only one accession CC 964 registered slightly higher mean seed yield (579.8 kg/ha) than Co-3 (574.9 kg/ha).

At Kumarganj, the CVT with 10 entries from the different coordinating centres including the local check Kumarganj selection was laid out. The yield and ancillary observations were recorded. The highest yield was obtained with Kumarganj Selection (19.71 q/ha) followed by RCr-41 (18.88 q/ha).

At Dholi, out of the seven genotypes evaluated along with check, DH 208 produced the maximum seed yield (28.23 q/ha) but took longer to mature.

The Hisar centre has not submitted the results of CVT 1996.

COR/CI/2.3 CVT 1998 - Series IV

Jobner, Jagudan, Guntur, Hisar and Dholi

The CVT with 8 entries from different coordinating centres (UD-743 and UD-744 from Jobner, DH-208 and DH-246 from Hisar, LCC-128 and LCC-133 from Guntur) with two checks (viz., RCr-41 and Local) were tested in rabi 1999 at Jobner. The observations were recorded as days to 50% flowering, plant height (cm), branches/plant, umbels/plant, umbellets per umbel, grains per umber, test weight (g), frost incidence (%), volatile oil content and grain yield (q/ha). The entries differed significantly for all the characters. Out of the 8 entries, UD-744 recorded the highest grain yield of 16.41 q/ha followed by DH-246 (15.76 q/ha), UD-743 (14.20 q/ha), while RCr-41 yielded 13.08 q/ha (Table 54). The maximum volatile oil content of 0.45% was recorded in UD-744.

Table 54: Growth and yield of coriander entries under CVT at Jobner

Entries	Days to Days to 50% flowering	Plant ht. (cm)	Branches per plant	Umbel per plant	Umbellets per umbel	Grains per umbel	Test wt. (gm)	Frost incidence (%)
UD-744	80.5	84.2	7.10	40.85	5.20	18.30	14.56	3.75
DH-246	78.5	89.3	7.70	38.10	5.55	23.60	12.02	1.25
UD-743	80.8	96.7	6.85	26.55	4.80	28.50	9.49	-
RCr-41C	86.8	121.6	7.75	36.45	5.45	42.65	8.25	-
DH-208	66.8	80.1	6.50	33.65	4.75	16.30	10.82	7.50
Local C	62.0	77.7	6.45	38.45	5.05	22.13	11.92	23.75
LCC-128	57.3	70.4	5.50	22.65	3.20	12.70	15.13	58.75
LCC-133	57.8	67.3	5.15	21.00	3.15	15.00	14.67	53.75
CD at 5%	1.55	9.20	1.02	12.33	0.50	7.77	0.41	-
CV %	1.48	7.28	10.52	26.02	7.36	23.88	2.34	-

At Jagudan, the trial had nine entries. Observations on morphological, yield and yield attributing characters were recorded. Among the entries, the yield differences were significant, but none of the entries gave significantly superior yield over control. However, an entry J.Co-283 had given higher yield (17.13 q/ha) than the control, which was 12.11% higher than control. However, the pooled data over two years gave significant yield differences among the entries, but none of the entries was superior to the control. J.Co-283 had given higher yield (17.91q/ha) than the control (Table 55).

The CVT laid out at Dholi continued with seven entries for the 2nd year each data on different parameters were observed. The genotype DH-208 gave the maximum yield (28.23 q/ha).

Table 55: Yield performance of coriander under CVT at Jagudan (1999-2000 and 2000-01)

Entry	Yield (q/ha)		Average yield	% increase
	1999-2000	2000-2001	(q/ha)	over control
DH-208	16.34	16.23	16.29	1.62
DH-246	14.81	14.60	14.71	-
J.Co.-283	18.68	17.13	17.91	11.73
J.Co.-387	19.23	15.47	17.35	8.23
LCC-128	17.27	14.76	16.01	-
LCC-133	16.29	16.53	16.41	2.37
UD-743	13.07	11.52	12.30	-
UD-744	16.34	11.71	14.03	-
G.Co.-2 (C)	16.78	15.28	16.03	-
C.D.at 5%	1.97	3.46	2.00	
C.V.%	6.88	13.48	10.37	

At Guntur, eight coriander entries from different coordinating centre were tested during rabi 2000-2001 using RDB with Sadhana as check. Among the entries tested, LCC-128 recorded significantly higher yield of 883 kg/ha, followed by LCC-133 with 850 kg/ha. The check variety Sadhana recorded a yield of 700 kg/ha.

The CVT started in 1999-2000 at Hisar with 10 entries including two from Guntur (LCC-128, and LCC-133) two from Hisar (DH-208 and DH-246), two from Jagudan (JCO-283 and JCO-387) and two from Jobner (UD-743 and UD-744) along with Hisar Anand and Narmaul Sel. as check. Observations on yield and yield attributing characters recorded significant difference for all the parameters observed. Maximum seed yield was recorded in DH-246 (18.6 q/ha) which is closely followed by DH-208 (17.8 q/ha) and UD-744 (16.7 q/ha).

COR/CI/3 Varietal Evaluation Trial

COR/CI/3.1 Comparative yield trial (CYT)

Coimbatore — closed

At Coimbatore, the trial was laid out with 10 entries in an RBD with three replications. Among the entries, the yield varied from 471.3 to 577.6 kg /ha. Acc.27 (CC 462) registered significantly higher yield (574.33 kg /ha) followed by Acc.82 (Co-3). The pooled data over three years (1998-2000) is presented in Table 56. The accessions differed significantly in yield during 1998-2000 but not during 1999. The pooled data also indicated that the yield difference among the accessions was not significant. The yield of the accession CC-462 (584.5 kg/ha) was higher than that of the check Co. 3 (576.3 kg/ha).

Table 56: Yield performance of coriander accessions under CYT at Coimbatore (1998 2000).

Sl. No.	Accessions	Yield (kg/ha)			Mean
		1998	1999	2000	
1	DH 36	479.2	575.0	525.0	526.4
2	DH 38	500.0	606.1	552.0	552.7
3	ATP 77	500.0	523.9	471.3	498.4
4	ATP 102	510.4	566.1	520.3	532.3
5	ATP 748	554.3	495.1	449.0	499.5
6	CC 462	554.3	621.6	577.7	584.5
7	CC 1080	489.2	577.2	523.7	530.0
8	UD 446	458.3	581.6	521.7	520.5
9	JCO 123	489.2	626.0	565.3	560.2
	CO.3 (Check)	530.9	623.8	574.3	576.3
	CD @ 5%	45.70	NS	65.17	NS

COR/CI/3.2 Initial evaluation trial (IET)

Jobner, Jagudan, Hisar and *Guntur*

At Jobner 18 entries, including checks, were evaluated in IET during rabi 1998 and 1999. Observations were recorded on days to 50% flowering, plant height (cm), branches /plant, umbels /plant, umbellates /umbel, grains /umbel, test weight (gm), frost incidence (%), volatile oil (%) and grain yield (q /ha) and the data indicate that the entries differed significantly for all the characters. UD-743 recorded the highest grain yield of 17.71 q /ha followed by RCr-41 (16.50 q /ha), UD-480 (15.79 q/ha) and UD-262 (15.10 q /ha).

The data on yield performance of the two years (1998-1999, 1999-2000) presented in Table 3 indicated the superior performance of UD-743 producing 10.55 % higher yield (13.72 q /ha) than RCr-41 (12.41 q /ha). Other promising entries identified were UD –480 (12.76 q / ha), RCr-41 (12.41 q /ha), UD-118 (11.45 q / ha) and UD 262 (11.20 q /ha) (Table 57).

Table 57 : Yield performance of coriander entries under IET at Jobner (1998-'99 and 1999-2000).

Sl. No.	Entries	Grain yield (q/ha)		
		1998	1999	Mean
1.	UD-745	7.98	12.67	10.32
2.	UD-743	9.73	17.71	13.72
3.	UD-88	7.29	10.25	8.77
4.	UD-118	8.33	14.58	11.45
5.	UD-262	7.29	15.10	11.20
6.	UD-340	6.60	12.14	9.37
7.	UD-358	5.56	12.67	9.11
8.	UD-753	5.90	11.81	8.85
9.	UD-480	9.73	15.79	12.76
10.	UD-746	6.60	14.75	10.42

11.	UD-747	3.82	12.14	7.98
12.	UD-748	5.04	11.45	8.24
13.	UD-749	5.21	12.14	8.67
14.	UD-751	3.82	7.29	5.55
15.	UD-752	4.69	14.06	9.37
16.	RCr-436	5.21	8.69	6.95
17.	RCr-20	9.38	12.33	10.85
18.	RCr-41	8.33	16.50	12.41
	CD at 5%	2.05	2.92	-
	CV %	17.93	13.61	-

At Jagudan, IET having 8 entries was initiated in 1999-2000. Observations on morphological, yield and its attributing characters indicated significant yield differences among the entries, though none was significantly superior to the control. However,' Dhana-89' gave the highest yield of 15.90 q /ha. The pooled results on yield differences were found significant but none of the entry was found superior to control, except Dhana-25 (16.78 q/ha), which gave 10.54% higher yield than control.

An IET with 9 accessions initiated at Hisar in 1999-2000. The results indicated that DH-205, DH-234, DH-242 and DH-256 were found significantly superior over check.

Guntur centre evaluated 10 promising coriander germplasm entries during rabi 2000-2001 along with Sadhana as check. Among the 11 accessions tested, LCC-174 recorded highest yield of 933 kg/ha in the current year. The next best yielders are LCC-223 and LCC-176 with 900 and 867 kg /ha respectively. The check variety 'Sadhana' recorded an yield of 733 kg / ha. The accession LCC-174 recorded significantly higher plant height (64.6cm), followed by LCC-225 (63.2cm) and LCC-176 (62.1cm).

Guntur centre studied the performance of coriander leafy type (7 types) under Lam agroclimatic conditions. During 1996-97 to 2000-01 along with Sadhana as check. The pooled data are presented in Table –58.

Table 58: Pooled yield data of leafy type coriander under CYT at Guntur

Entry	Yield (q/ha)				Mean % of Stems/ branches in greens
	1997-98	1998-1999	2000-2001	Pooled	
EC-232666	24.2	16.3	18.6	19.7	(13.0)
EC-232671	14.2	7.0	10.7	10.6	(13.7)
EC-243370	23.1	14.7	17.1	18.3	(15.6)
EC-279047	22.2	14.0	16.6	17.6	(17.9)
EC-279048	23.4	15.3	17.7	18.8	(21.0)
UD-373	19.2	10.4	12.9	14.2	(11.5)
Rcr-41	20.0	11.0	13.4	14.8	(19.3)
Sadhana (c)	19.4	10.0	12.6	14.0	(25.9)
C.D. at 5%	4.3	3.7	3.0	1.8	

During 1997-98, among the eight genotypes tested, EC-232666 recorded significantly higher yield of 24.2 t/ha. During 1998-99 and 2000-2001 seasons, EC-232666 recorded significantly higher green yield followed by EC-279048, EC-243370 and EC-279047. The pooled data of three years indicate the supremacy of EC-232666 with 19.7 t/ha of greens followed by EC-279048 (18.8 t/ha), EC-243370 (18.3 t/h) and EC-279047 (17.6 t/ha) which were significantly superior to check, Sadhana (14.0 t/ha). With regards to green yield, EC232666 was superior to the other genotypes with lesser percentage of stems/ branches in the greens.

COR/CI/4 Quality Evaluation Trial

COR/CI/4.1 Quality evaluation in coriander

Jobner

At Jobner, 7 entries of coriander were analysed for volatile oil content under CVT. The volatile oil of 7 entries of coriander tested under CVT ranged from 0.03% to 0.45%. The highest volatile oil of 0.45% was in UD-744 followed by 0.40% in DH-246 and LCC-128, 0.35% in local check and 0.3% in UD-743, DH-208 and RCr-41. The total yield of volatile oil/ha depended upon the grain yield. The volatile oil yield was found to be maximum i.e. 7.38 l/ha in UD-744 followed by 6.30 l/ha in DH-246 and 4.26 l/ha in UD-743 (Table 59). The volatile oil contents of entries evaluated in CVT for two years (1998-99 and 1999-2000) indicated that the highest mean volatile oil of 5.06 l/ha was in DH-246 followed by 4.56 l/ha in UD-744 and 3.68 l/ha in LCC-133 (Table-60).

Table 59: Volatile oil contents of entries of coriander under CVT (1999-2000).

Entries	Volatile oil (%)	Grain yield (q/ha)	Volatile oil yield (l/ha)
UD-744	0.45	16.41	7.38
DH-246	0.40	15.76	6.30
UD-743	0.30	14.20	4.26
RCr-41 Check	0.30	13.08	3.92
DH-208	0.30	12.04	3.61
Local Check	0.35	9.05	3.16
LCC-128	0.40	4.82	1.92
LCC-130	0.30	4.82	1.44
Range	0.3-0.45	1.23-16.41	1.44-7.38

Table 60 : Volatile oil yield performance of coriander entries under CVT (1998- '99 and 1999-2000).

Entries	Mean grain yield of 2 years	EO (%)		Mean	Mean volatile oil yield (l/ha)
		1998-1999	1999-2000		
DH-246	11.91	0.45	0.40	0.425	5.06
LCC-133	4.36	0.40	0.30	0.35	1.52
RCr-41	12.27	0.30	0.30	0.30	3.68
LCC-128	4.30	0.35	0.40	0.375	1.61
UD-743	11.20	0.30	0.30	0.30	3.36
DH-208	8.82	0.30	0.30	0.30	2.64
Local	4.64	0.30	0.35	0.325	1.50
UD-744	12.17	0.30	0.45	0.375	4.56

The mean volatile oil contents of entries evaluated in IET over two years (1998-99 and 1999-2000) indicated that the promising entries were UD-751 (0.5%), UD-88 (0.40%) and UD-262 (0.375%) with respect to volatile oil percentage and UD-743 (4.29 l/ha), UD-262 (4.09 l/ha) and UD-480 (4.05 l/ha) with respect to volatile oil yield. (Table 61).

Table 61: Mean performance of coriander entries evaluated under IET (1998-1999 and 1999-2000) for volatile oil contents

Entries	Oil (%)			Oil yield (l/ha)		
	1998-1999	1999-2000	Mean	1998-1999	1999-2000	Mean
UD-745	0.30	0.40	0.35	2.39	5.07	3.73
UD-743	0.30	0.35	0.325	2.38	6.20	4.29
UD-88	0.35	0.45	0.40	2.55	4.61	3.58
UD-118	-	0.35	-	-	5.10	-
UD-262	0.40	0.35	0.375	2.91	5.28	4.09
UD-340	0.25	0.35	0.30	1.65	4.25	2.95
UD-358	0.20	0.30	0.25	1.11	3.80	2.45
UD-753	-	0.30	-	-	3.54	-
UD-480	0.35	0.35	0.35	3.38	4.73	4.05
UD-746	0.20	0.15	0.175	1.32	2.21	1.76
UD-747	0.25	0.25	0.25	.945	3.03	1.98
UD-748	0.30	0.30	0.30	1.51	3.43	2.47
UD-749	0.20	0.15	0.175	1.04	1.82	1.43
UD-751	0.40	0.60	0.50	1.52	4.01	2.76
UD-752	0.30	0.25	0.275	1.40	3.51	2.45
RCr-436	0.30	0.40	0.35	1.56	3.04	2.30
RCr-20	-	0.20	-	-	2.46	-
RCr-41	0.30	0.30	0.30	2.50	4.95	3.72

At Jobner 133 accessions of coriander along with 5 checks, *viz.*, RCr-20, RG-41, RG-435, RCr-436 and local check were evaluated for volatile oil content. The volatile oil content was in the range of 0.01 % to 0.55 % and it was classified in to 3 groups *viz.*, low, medium and high groups. The promising accessions of these groups are shown in Table 62.

Table 62: Germplasm evaluation of coriander for volatile oil

Character	Range%	No. of accessions	Promising accessions identified
Volatile oil %	0.10-0.55	133	UD-467 (0.55%); UD-16, UD-48,
			UD-362, UD-374, UD-466, UD-571,
Low	(0.10-0.25)	28	UD-640, UD-751 (0.50% each),
			UD-464 (0.475%), UD- 31, UD-51,
Medium	(0.26-0.40)	84	UD-109, UD-489, UD-700, (0.45% each);
			UD-104, UD-353, UD-458, UD-632,
High	(0.41-0.55)	21	NC-99-15 (0.425% each)

COR/CM/1 Nutrient Management Trial

COR/CM/1.1 Response of coriander to micronutrients

Jobner and *Kumarganj*

To study the response of coriander to micronutrients, an experiment was laid out during 1997-98 to 2000 at Jobner in RBD with three replications using the variety RCr-435 involving 13 treatment combinations. Three years (1997-98, 1998-99 and 1999-2000) data presented in Table 63 revealed significantly higher seed yield with soil application of $MnSO_4$ @ 25 kg/ha (9.22 q/ha) and $CuSO_4$ @ 25 kg/ha (8.83 q/ha), foliar application of $ZnSO_4$ @ 0.50 % (9.09 q/ha) and $CuSO_4$ @ 0.50% (10.00 q/ha) and soil application of $FeSO_4$ @ 5 kg/ha + 0.125 % (9.03 q/ha), $MnSO_4$ @12.5 kg/ha + 0.25% (8.85 q/ha) and $CuSO_4$ @ 12.5 kg/ha + 0.25% (8.83 q/ha).

Table 63: Effect of Zn, Fe, Mn and Cu on growth and yield attributes of coriander at Jobner

			Seed yield (q/ha)			
Treatments	Biological yield (q/ha)	Straw yield (q/ha)	1997-1998	1998-1999	1999-2000	Mean
Control	19.80	12.47	3.21	12.33	7.33	7.62
$ZnSO_4$ @20 kg/ha-s.a.	20.84	13.16	3.30	13.37	7.68	8.12
$ZnSO_4$ @ 0.50%-f.a.	21.88	11.36	3.39	13.37	10.52	2.09
$ZnSO_4$ @10 kg/ha-s.a.+0.25%-f.a.	20.49	12.23	3.47	13.03	8.25	8.25
$FeSO_4$ @10 kg/ha-s.a.	23.27	13.86	3.39	13.03	9.40	8.61
$FeSO_4$ @0.25%-f.a.	20.49	12.75	4.08	12.33	7.76	8.06
$FeSO_4$ @5 kg/ha-s.a.+0.125%-f.a.	23.62	14.69	5.99	12.16	8.93	9.03
$MnSO_4$ @ 25 kg/ha-s.a.	25.36	13.93	2.87	13.37	11.41	9.22
$MnSO_4$ @ 0.50 %-f.a.	22.23	12.37	2.95	12.50	9.85	8.43
$MnSO_4$ @12.5 kg/ha + 0.25%-f.a.	22.58	12.71	3.65	13.03	9.87	8.85
$CuSO_4$ @25 kg/ha-s.a.	20.84	10.52	3.13	13.03	10.33	8.83
$CuSO_4$ @ 0.50% -f.a.	28.13	14.00	3.39	12.50	14.12	10.00
$CuSO_4$ @12.5 kg/ha-s.a +0.25%-f.a.	23.97	13.00	2.52	13.03	10.95	8.83
CD at 5%	3.02	2.03	0.81	NS	1.56	1.05

Note: s.a – soil application; f.a – foliar application.

A trial was laid out with 13 treatments in RBD during 2000-2001 at Kumarganj. Observations on the influence of micronutrietns - Zn, iron, manganese and copper were studied. The data presented in Table 14 revealed that the highest yield of coriander ie. 15.85 q/ha was obtained with the use of ferrous sulphate 5 kg/ha + 0.125 % as foliar spray, followed by zinc sulphate @ 10 kg/ha + 0.25% foliar spray (Table 64).

Table 64: Yield performance of coriander as influenced by micro-nutrients

Treatments	Yield (q/ha)
T_1 Control	11.35
T_2 Zinc sulphate 20 kg/ha as soil application	14.25
T_3 Zinc sulphate 0.5% as foliar application	14.30
T_4 Zinc sulphate 10 kg/ha + 0.25% as foliar application	15.50
T_5 Ferrous sulphate 10 kg/ha as soil application	14.65
T_6 Ferrous sulphate 0.25% as foliar application	14.46
T_7 Ferrous sulphate 5 kg/ha + 0.125% as foliar application	15.85
T_8 Manganese sulphate 25 kg/ha as soil application	14.55
T_9 Manganese sulphate 0.5% as foliar application	14.20
T_{10} Manganese sulphate 12.5 kg/ha + 0.25% as foliar applications	14.65
T_{11} Copper sulphate 25kg/ha as soil application	13.30
T_{12} Copper sulphate 0.5% as foliar application	13.45
T_{13} Copper sulphate 12.5% kg/ha + 0.25% as foliar application	13.20
CD (P=0.05)	0.15

COR/CM/1.2 Efficacy of biofertilizer using *Azospirillum* on coriander

Coimbatore, Guntur and *Kumarganj.*

A new experiment was initiated at the seed spice centres during 2000-2001 to study the efficacy of *Azospirillum* in seed treatment in supplementing the nitrogen requirement of coriander crop. The experiment was laid out with 8 treatments in RBD with three replications. The results of the experiment conducted during kharif 2000 at Coimbatore have indicated that the yield difference among the different treatments was non-significant. However, the highest yield of 566.67 kg/ha was recorded in T3 (Inorganic 50% + FYM 5 kg + *Azospirillum* 50 g).

At Guntur, the experiment was laid out during rabi 2000-2001 with 8 different combinations of inorganic nitrogen, FYM & *Azospirillum* in RBD replicated thrice. Among the treatments, plant height was more in T1 (62.8 cm) followed by T2 (62.1 cm) and T3 (61.2 cm). Regarding no.of primary and secondary branches, no. of umbels/ plant, umbellates/ umbel and yield the same trend continued with T1 recording significantly higher followed by T2 and T3. The highest yield was in T1 (783 kg/ha) which was on par with T2 (767 kg/ha) and T3 (758 kg/ha) (Table 65).

Table 65 : Efficiency of *Azospirillum* on the yield of coriander at Guntur

Treatments	Yield (kg/ha)
T1-100% N + *Azospirillum* + 5 t/ha FYM	783
T2-75% N + *Azospirillum* + 5 t/ha FYM	767
T3-50% N + *Azospirillum* + 5 t/ha FYM	758
T4-5t/ha FYM + *Azospirillum*	675
T5-5 t/ha FYM alone	600
T6-10t/ha FYM + *Azospirillum*	709
T7-10t/ha FYM alone	642
T8-100% Inorganic N	650
CD at .5%	80.4

At Kumarganj, the highest yield of 18.05 q/ha was recorded when inorganic fertilizer 100% at recommended dose of NPK+50 g. *Azospirillum* + 5 kg FYM were used, however the data was not significantly different when 75% and 50% inorganic dose of NPK along with 50 g *Azospirillum* and 5 kg of FYM were used. (Table 66).

Table 66: Yield of coriander due to the use of *Azospirillum* at Kumaraganj

Treatments	Yield (q/ha)
T_1 Inorganic N (100%)+ *Azospirillum* (50g) + 5 kg FYM	18.05
T_2 Inorganic N (75%) + *Azospirillum* (50g) + 5 kg FYM	17.85
T_3 Inorganic N (50%) + *Azospirillum* (50g) + 5 kg FYM	17.72
T_4 5kg FYM + *Azospirillum* (50g)	15.97
T_5 5 kg FYM alone	15.65
T6 10 kg FYM + *Azospirillum* (50g)	15.66
T7 FYM (10 kg) Alone	15.80
CD (P=0.05)	1.65

COR/CP/1 Disease Management Trial

COR/CP/1.1 Survey to identify the disease incidence, collection and identification of casual organisms.

Dholi

A survey was conducted during 2000-2001 to find out the severity of stem gall disease in different areas of Bihar. Coriander was severely affected by stem gall disease in many districts of Bihar.

COR/CP/1.2 Management of wilt and powdery mildew diseases in coriander.

Kumarganj.

An experiment on wilt management in coriander with biocontrol agent was laid out with 7

treatments at Kumarganj during rabi 2000-2001. The wilt incidence (PDI) and yield of coriander were recorded. The data in indicated that the incidence of wilt disease was below 10% in all the treatments including control (Table 67).

Table 67: Effect of biocontrol agent and carbendazim on yield and disease incidence of wilt in coriander at Kumaraganj.

Treatments	Yield (q/ha)	P.D.I
T_1 (Treatment with carbendazim)	15.00	6.0
T_2 (Treatment with *Trichoderma viridae*)	15.70	3.8
T_3 (Treatment with *Trichoderma harzianum* + soil application)	17.05	3.5
T_4 (Treatment with *Bacillus subtilis* + soil application)	16.10	3.4
T_5 (Treatment with *Pseudomonas fluorescence* + soil application)	15.35	4.0
T_6 (Seed treatment with soil drenching of carbendazim)	15.28	4.2
T_7 *Control*	14.47	9.5
CD (P=0.05)		0.95

PDI – Percent Disease Incidence

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

Dholi

This centre has not submitted the report for the current year.

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 holds a total of 340 accessions, which include 10 exotic and 16 new collections. At Jagudan, 52 new collections were made from the cumin growing areas of the state during the current year. The 180 entries available in germplasm collection include 7 exotic and 173 indigenous accessions. The 52 new accessions collected have the following characters: (Table 68)

Table 68 : Characterization of cumin accessions at Jagudan

Characters	No. of accessions
Dwarf type	5
Early type	7
Less leafy type	7
More leafy type	3
More no.of seeds/ umbellate	7
Wilt resistant	10
Light resistant	5
Bold seed type	8
Total	52

In the screening of entries at Jagudan, variety GC-3, Acc-1136, Acc.1145, Acc. 1165 were moderately resistant against *Fusarium* wilt whereas all others were susceptible under wilt sick plot situation. Under the screening for resistance against blight and powdery mildew, 15 entries were screened for resistance. None was found resistant/tolerant against powdery mildew. The incidence of *Alternaria* blight was very low during the current year.

CUM/CI/2 Hybridization Trial

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

Jagudan

Crossing programme was started in Jagudan with the objective to establish the method of crossing in cumin. Crosses were made between GC-2 x. Hairy cumin and Guj cumin 3 x Guj. Cumin 2. The segregation for hairy character was observed in F2 plants. 558 plants have hairy characters and 163 have characters of Gujarat cumin-2, indicating that hairy character is dominant over non-hairy. From the results of trials, the relative efficiency of various crossing methods tested could not be ascertained due to insufficient germination of hybrid seeds under different treatments and the same crossing programme will be continued.

CUM/CI/3 Coordinated Varietal Trial (CVT)

CUM/CI/3.1 CVT 1994 Series III

Jobner

At Jobner the CVT was laid out during rabi 2000 and consisted of eight entries from different centres, including three from Jobner (UC-217, UC-220 and UC-223), three from Jagudan (JC-147, EC-232684 and EC-279081) and two checks (RZ-19 and local check), which were evaluated in RBD with four replication. The results of the trial indicated that entries differed significantly for all characters except plant height and umbellets per umbel. The mean days to flowering ranged from 82.8 (local) to 89.8 days (UC-223), plant height from 29.4 (JC-147) to 33.50 cm (UC-223 and EC-232684), branches per plant from 3.95 (UC-220) to 6.10 (UC-223), umbels per plant from 16.0 (UC-217) to 30.80 (UC-223), umbellets per umbel from 4.35 (JC-147) to 5.20 (UC-223), grains per umbel from 22.65 (EC-232684) to 32.55 (UC-223), and the volatile oil content from 2.6 (UC-217) to 4.41% (EC-232684). Out of the 8 entries, UC-223 recorded the grain yield of 3.23 q/ha followed by local check (2.54 q/ ha). UC-220 yielded 2.30 q/ha, RZ-19 with 2.11 q/ha, while lowest grain yield of 0.24 q/ha was recorded in EC-279081. No wilt incidence was observed in UC-147 and EC-279081, whereas the highest wilt incidence of 8.80% was observed in local check.

The mean performance of the entries evaluated in CVT at Jobner over 3 years (1995-96, 1996-97 and 1999-2000) is presented in Table 69. The data showed the superior performance of UC. 223 yielding 3.29 q/ha followed by UC-217 and local check (2.62 q/ha), Rz-19 (2.61 q/ha) and UC-220 (2.23 q/ha), while EC-279081 recorded lowest grain yield of 1.70 q/ ha. On the basis of 3 years observations, the lowest wilt incidence was observed in UC-223 (6.68%).

Table 69 : Yield performance of cumin entries evaluated for grain yield and wilt incidence under CVT (1995-96 to 1999-2000) at Jobner

Entries	Yield (q/ha)				Wilt incidence
	1995-96	1996-97	1997-2000	Mean	(%)
UC-217	2.60	1.95	2.24	2.62	18.33
UC-220	2.96	1.43	2.30	2.23	15.41
UC-223	3.12	3.52	3.23	3.29	6.68
JC-147	2.84	2.55	0.34	1.91	23.13
EC-232684	1.80	2.86	1.61	2.15	18.35
EC-279081	2.81	2.02	0.27	1.70	16.12
RZ-19 Check	2.43	2.86	2.11	2.61	15.52
Local Check	2.72	2.60	2.54	2.62	19.60
CD at 5%	0.70	0.88	0.40	0.29	-
CV %	17.97	24.14	15.03	8.97	-

The entries were also evaluated under CVT for reaction to wilt disease. Out of the eight entries evaluated, the percent mortality due to wilt disease is lowest in UC-223 (1.3%) with the grain yield of 3.23 q/ha, where as the local entry gave the highest wilt disease incidence (8.8%) with grain yield of 1.61 q/ha (Table 70).

Table 70: Screening of cumin lines against wilt under field condition.

Sl. No.	Entry	Percentage disease incidence	Yield (q/ha)
1	UC-147	5.0	0.34
2	UC-217	5.0	2.24
3	UC-220	7.5	2.30
4	UC-223	1.3	3.23
5	EC-279081	5.0	0.27
6	EC-232684	8.8	1.61
7	LOCAL	8.8	2.54
8	RZ-19	8.8	2.11

Out of eight entries evaluated, the percent mortality due to wilt disease was lowest in UC-223 (1.3%) with the grain yield of 3.23 q/ha, where as the local gave highest incidence of wilt disease (8.8%) with grain yield of 1.61 q/ha.

CUM/C1/3.2 CVT 1999-Series IV

Jagudan and *Jobner*

The CVT 1999-Series IV was initiated in Rabi 1999-2000 at Jobner. The trial consisted of 8 entries including two from Jobner (UC-231, & UC –310), four from Jagudan (JC-94-37, JC-94-128, JC-94-148 and JC-94-262) along with two checks *viz.* RZ-19 and local check. The observations recorded indicated that all the entries differed significantly for morphological yield and yield attributing characters and quality. The entry UC-310 recorded the highest grain yield of 3.28 q/ha, followed by UC-231 (2.84 q/ha), Local check (2.71 q/ha) and Rz-19 (2.65 q/ha), while lowest grain yield of 1.68 q/ha was recorded in JC-94-262.

The CVT with 8 entries was conducted at Jagudan during 1999-2000 and 2000-2001 and yield and ancillary observations were made. The yield differences were significant among the entries. But none of the entries gave significantly higher yield than control. However, JC-94-37 (11.65 q/ha) and JC-94-128 (11.24 q/ha) recorded higher yield than other checks. The pooled results of the two years yield were found non significant. However, JC-94-37, JC-94-128 and UC-310 gave 15.30, 8.97 and 6.96 percent higher yield as compared to GC-2. But none of the entries was better than the wilt resistant variety GC-3(C) (Table 71).

Table 71: Yield performance of cumin entries under CVT at Jagudan (1999-2000 and 2000-2001)

Entry	Yield (q/ha)		Average yield (q/ha)	% increase over control	
	1999-2000	2000-2001		GC-2	GC-3
JC-94-37	5.57	11.65	8.61	15.30	4.24
JC-94-128	5.03	11.24	8.14	8.97	-
JC-94-148	4.73	9.94	7.33	-	-
JC-94-262	5.35	8.24	6.80	-	-
UC-231	4.20	10.84	7.52	-	-
UC-310	5.41	10.57	7.99	6.96	-
GC-2 (C)	4.36	10.58	7.47	-	-
GC-3 (C)	4.76	11.77	8.26	10.58	-
C.D. at 5%	0.87	1.88	NS		
C.V. %	12.03	12.08	12.85		

CUM/CI/4 Varietal Evaluation Trial

CUM/CI/4.1 Initial evaluation trial (IET)

Jagudan

In the IET at Jagudan, the results showed significant yield difference among the entries but none of the entries gave significantly higher yield than both checks GC-2 and GC-3. In pooled results, yield differences were significant, but none was superior over the checks GC-2 and GC-3 (Table 72).

Table 72 : Yield performance of cumin entries under IET at Jagudan (1999-2000 and 2000-2001)

Sl. No.	Entry	Yield (q/ha)		Average yield (q/ha)	% increase over control	
		1999-2000	2000-2001			
1	JC-94-34	3.67	8.99	6.33	-	-
2	JC-94-55	3.93	9.06	6.49	-	-
3	JC-94-57	3.85	8.49	6.17	-	-
4	JC-94-59	4.17	9.92	7.05	-	-
5	JC-94-61	4.27	9.01	6.64	-	-
6	JC-94-115	3.73	9.10	6.42	-	-
7	JC-94-165	3.99	9.31	6.65	-	-
8	JC-94-277	4.10	8.99	6.55	-	-
9	JC-95-8	4.68	10.31	7.49	-	-
10	JC-96-15	4.73	8.00	6.37	-	-
11	GC-2 (Ch)	4.60	12.16	8.38	-	-
12	GC-3 (Ch)	5.29	10.87	8.08	-	-
	C.D. at 5%	NS	2.19	1.25		
	C.V. %	17.15	13.57	15.23		

CUM/CI/5 Quality Evaluation Trial

CUM/CI/5.1 Quality evaluation in cumin

Jobner

The volatile oil contents of 8 entries of cumin tested under CVT were determined at Jobner, which ranged from 2.6 to 4.4%. The highest oil content (4.4%) was recorded in EC 232684 followed by JC-147 (3.9%), RZ-19 (3.3%) and the lowest in UC-217 (2.6%). The mean data of volatile oil content of entries evaluated in the CVT for the three years (1995-96, 1996-97 and 1999-2000) indicated that the highest volatile oil of 3.56 l/ha was recorded in JC-147, followed by 3.26 l/ha in EC-232684 and 3.23 l/ha in UC-223 (Table 73). The volatile oil content of 8 new entries under CVT was evaluated for volatile oil contents. The contents ranged from 3.1 to 4.4%. The maximum volatile oil of 4.4% was recorded in JC-94-37 followed by 4.2% in JC-94-148.

Table 73: Essential oil content of cumin entries evaluated under CVT at Jobner (1995-96 to 1999-2000)

Entries	Essential oil (l/ha)			
	1995-96	1996-97	1999-2000	Mean
UC-217	3.3	-	2.6	2.95
UC-220	3.4	3.0	3.0	3.13
UC-223	3.5	3.0	3.2	3.23
JC-147	3.6	3.2	3.9	3.56
EC-232684	2.8	2.6	4.4	3.26
EC-279081	3.0	2.8	3.6	3.13
RZ-19 Checks	3.0	2.8	3.3	3.03
Local check	3.3	3.0	3.2	3.16

CUM/CP/1 Disease Management Trial

CUM/CP/1.1 Control of blight disease by manipulation of agronomic practices

Jagudan

An experiment involving six treatment combination conducted at Jagudan (1994-95 to 1998-99) to find out the factor involving blight disease and to find out the treatment significantly influenced the yield. The three years pooled data of a disease % and yield are presented in Table 74. The minimum disease incidence and highest yield obtained with treatment T3.

Table 74: Effect of different treatment on blight disease incidence (%)

Treatments		1994-95		1996-97		1998-99		Pooled	
		Dis. (%)	Yield kg/ha	Dis. (%)	Yield kg/ha	Dis. (%)	Yield kg/ha	Dis. (%)	Yield kg/ha
T1	Control	20.09	427	17.19	659	17.69	645	18.33	577
T2	Straw mulch	21.49	619	15.25	762	15.25	685	17.33	696
T3	Every next day inter-culturing after irrigation	21.68	688	15.03	853	14.43	748	17.05	763
T4	Remove of dew by cloth or rope	21.32	524	15.49	738	15.49	647	17.43	636
T5	Providing strip of more cooling type crop (Gram)	20.01	516	17.42	724	18.09	690	18.51	643
T6	By putting hygroscipic chemical in plot (CaCI2)	21.21	476	17.93	683	18.18	558	19.21	572
	S.Em.	1.20	28.5	0.82	50.3	0.98	31.7	0.60	-
	C.D. at 5%	NS	86.0	NS	NS	NS	95.6	NS	-
	C.V.%	11.43	10.5	10.04	13.7	—	9.6	11.27	-
	Y X T	—		—				NS	

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

Jobner

A field experiment was laid out at Jobner, involving five dates of sowing of cumin at an interval of 10 days (10,20,30 November and 10 & 20 Dec) to study the effect of sowing on incidences of wilt and blight as well as yield of cumin. Severity of blight was scored by using 0-5 scale. Besides blight, the wilt incidence was recorded in each treatment, as the percentage of plants wilted till maturity of the crop. Blight disease did not appear during 1999. However, the data on the wilt incidence was recorded. Out of five dates of sowing, the lowest wilt incidence (10%) was recorded in 10th November sown crop with the grain yield of 3.63 q/ha, followed by November 20th sowing, where as 20th December sowing showed maximum wilt incidence (30.0%) with the grain yield of 0.63 q/ha (Table 75).

Table 75: Effect of date of sowing on wilt incidence and yield of cumin at Jobner

S.No	Date of sowing	1999-2000	
		Disease incidence (%)	Yield (q/ha)
1	10th Nov.	10.0	3.63
2	20th Nov.	15.0	2.03
3	30th Nov.	22.5	1.69
4	10th Dec.	25.0	1.41
5	20th Dec.	30.0	0.63

CUM/CP/2 Pest Management Trial

CUM/CP/2.1 Integrated management of pests and diseases of cumin

Jobner and *Jagudan*

An experiment was laid out in 1999-2000 at Jobner with the following four main treatments *viz.*, T1 - Seed treatment (ST) and soil application of *T.harzianum* (SA of TH); T2 - Seed treatment of carbendazim (ST.C) @ 0.1% + soil application of *T. harzianum* (SA of TH); T3 - Application of oil cake (Neem cake) (AOC (Neem)) and T4 - control.

These four main treatments were comprised of 13 sub-treatments. Three sprayings were given at an interval of 15 days. The wilt incidence and % of plants wilted till maturity of the crop were recorded in each treatment. Observations on blight and powdery mildew diseases as well as number of aphids and thrips per plant before and after 72 hours of sprays were recorded. Population densities of *T. harzianum* and wilt pathogen *Fusarium oxysporum* were also determined. It was observed that in all the treatments (seed treatment and soil application of *T.harzianum* and application of oil cake) except control, CFU of *T. harzianum* (6.5×10^3, 4.5×10^3, 3.5×10^3) per gram dry soil was increased and that of *F.oxysporum* sp.*cumini* (1.25×10^3, 1.6×10^3 and 1.3×10^3) per grams dry soil decreased, respectively and the control plot expressed a reverse trend (ie.), CFU of *T.harzianum* decreased (2.5×10^3), where as the *Fusarium oxysporum* f sp. *cumini* increased (2.0×10^3). Similarly incidence of wilt disease in

all main treatments decreased in comparison to the control.

Similarly basal application of *T.harzianum* with and without carbendazim and neem cake as soil application reduced the incidence of wilt in comparison to the control. Lowest incidence of wilt (15.0%) with grain yield of 229 g/plot was recorded in plots, where *T. harzianum* was applied through seed treatment + soil application along with plot sprayed with Mancozeb (Indofil M-45) @ 0.3%. In control, wilt incidence was the highest (31.3%) with grain yield of 92g/plot (Table 76). Overall, efficiency of foliar fungicides, insecticides, neemoil cake and tipol either alone or in combination with basal application could not be worked out due to low incidence of foliar diseases (blight and powdery mildew) and pests (aphids and thrips).

Table 76: Integrated management of cumin diseases at Jobner.

S. No	Sub.Treat & Concentration	Main Treatments							
		ST + SA of TH		ST.C + SA of TH		AOC (Neem)		Control	
		*PWI	** Yield (g/p)	*PWI	** Yield (g/p)	*PWI	** Yield (g/p)	*PWI	** Yield (g/p)
1	Mb @ 0.3%	15.0	229.0	21.0	167.6	30.0	127.3	28.3	105.0
2	Mb 0.3% + NO	20.6	186.6	21.3	164.6	24.0	202.6	31.6	90.0
3	@ 1% + TP@1%	22.0	156.6	22.0	160.0	26.6	165.6	29.0	97.6
4	Mb 0.3% + MOP @ 0.075 %	19.6	179.3	23.0	124.3	29.0	140.3	40.0	62.6
5	Hex (Contaf) @ 0.05 %	22.3	148.0	25.0	129.3	33.0	116.3	35.0	79.6
6	Hex@0.05 + NOil@1% +TP@1%	23.3	144.0	23.0	133.6	26.3	160.0	38.3	83.3
7	Hex @ 0.05% + MOP @ 0.04%	26.0	117.6	22.6	114.6	28.0	149.3	42.0	64.0
8	Hex @ 0.05% + Acep@ 0.07%	21.3	151.6	26.0	104.0	26.0	178.6	30.0	84.3
9	Penc. (Topas) @ 0.05%)	24.6	141.6	29.0	98.3	25.0	158.3	37.3	74.0
10	Penc. (Topas) @ 0.05% + MOP @ 0.04%)	25.3	134.3	30.0	99.0	24.6	158.0	36.0	74.0
11	Thp. Me (Top.M) @ 0.07%	21.0	155.3	32.0	80.3	33.0	94.6	35.0	80.6
12	Thp. Me (Top.M) @ 0.07% + MOP @0.04%	25.0	120.0	35.0	74.6	31.0	97.3	36.6	82.0
13	Control (No spray)	31.3	92.3	37.3	74.3	33.3	89.6	48.3	52.0

Note : *PWI –Percent wilt Incidence, **Yield – g/plot

Abs:

Mb	-	Mancozeb	TP	-	Tipol
NO	-	Neemoil	Penc	-	Penaconzole
Acep	-	Acephate	Thp. Me	-	Thiophanate Methyl
Hex	-	Hexaconazole	MOP	-	Monocrotophos

The trial was laid out for 5 years at Jagudan (1995-96 to 99-2000) with 11 treatments. The two major diseases of cumin are wilt and blight and pests *viz.*, thrips and aphids. The incidence of this disease-pest did not occur in some year and in another year the cumin crop failed due to very high incidence of blight. Hence the trial was vitiated due to unavailable circumstances. The observation s during the year 1999-2000 revealed that the incidence of blight and wilt was very high during the season. Soil and seed treatment with *T. harzianum* were found significantly different were both the disease. Among the spraying treatment, spraying of mancozeb + Acephate was found superior to manage both the disease as compared with other fungicial treatments.

FENNEL

FNL/CI/1 Genetic Resources

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

Jobner, Jagudan, Hisar, Dholi and Kumarganj

The Jobner centre evaluated 176 accessions (old and new) along with 4 checks (RF-101, RF-125, UF-134 and local). Eight accessions showed poor germination so the plants were kept for sib mating to obtain seeds for next season and observations were recorded for the remaining 168 accessions. A uniform one meter section from each entry was covered by muslin cloth bag before flowering for sibmating to obtain the seed for next season. Of the 168 accessions evaluated during rabi (1999-2000), 16 accessions were better than all the checks. Some of the promising accessions identified were UF 139 (122 gm), UF-130 (120 gm), UF(M)-1 (120 gm), UF-50 (110 gm), UF 73 (105 gm), UF-49 (102 gm) UF 86 (91 gm), UF-119 (90 gm), UF-67 (90 gm) and UF 56 (80 gm).

At Jagudan, out of the 304 germplasm accessions, 141 were retained after a preliminary evaluation. During the current year, 43 new accessions are collected for different characters from farmers' fields of Kheda districts, of which 17 were selected. At Jagudan, 17 entries were screened against *Ramularia* blight, but blight was not noticed during this season in the natural field condition.

The Kumarganj centre made a survey and collection during the period i.e., 16 coriander accessions from Faizabad. Out of the 16 germplasm collections, highest yield was recorded in NDF-5 (16.96 q/ha), followed by NDF 16.

At Dholi, 38 germplasm accessions are being maintained. During the current year, there was no disease or pest incidence.

At Hisar 64 accessions of fennel were evaluated in two row plots of 2.5m length.

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 um-

bels. Some entries (JF-399-1, JF-399-2, JF-413-1, JF-427-1, JF-427-2, JF-427-3, JF-427-4, JF-427-5, JF-484-1, JF-484-2, GF-2-1, GF-2-2, GF-2-3, GF-2-4) showed poor seed setting in primary umbel and other characters of sterility. The following three entries were crossed with elite line GF-2 and F1 seeds were harvested as under

Parents	No. of F1 seeds harvested	Purpose
JF-399-1 x GF-2	13	Sterility study
JF-413-1 x GF-2	17	Hetrosis study
JF-427-3 x GF-2	23	Hetrosis study

The F1 seeds were sown in nursery, but seed germination was very poor. Three F1 seeds of crosses JF-413 x GF 2 and seven F1 seeds of crosses JF-399 x GF 2 were germinated in field. All the hybrids had shown the characters of the female parent.

FNL/CI/3 Coordinated Varietal Trial (CVT)

FNL/CI/3.1 CVT 1994-Series III

Jobner, Jagudan, Kumarganj and *Hisar.*

The trial with 8 entries, including two from Jobner (UF-143, UF-144), three from Jagudan (JF-186, JF-192, JF 200) and two from Hisar (HF-33 and HF 39) along with local check, were conducted at Jobner in RBD. Observations indicated non-significant differences among the entries for the most of the characters including grain yield, except days to 50% flowering, umbels per plant, umbellets per umbel and test weight. The differences in grain yield among the entries were non significant, however, the entry UM-143 recorded the highest grain yield of 12.44 q/ha, followed by JF-186 (12.06 q/ha) and UF-144 (10.50 q/ha). The mean performance of the entries evaluated during 1998-99 and 1999-2000 (Table 10) also revealed the superior performance of UF-143 (yield 11.23 q/ha), followed by UF-144 (10.18 q/ha), JF-186 (10.09 q/ha) and JF200 (9.15 q/ha).

In the CVT-III at Jagudan, during 2000-2001, significant differences were observed among the entries for yield. The entry JF-192 recorded higher yield (22-87 q/ha) than control, which was on par with UF-143, UF-144 and JF-200. In the pooled analyses of four years data, JF-192 gave significantly superior yield (25.73 q/ha) over control, which was on par with JF 200 and JF-186 (Table 77).

Table 77: Yield performance of fennel under CVT at Jagudan (1997-98 to 2000-01)

Sl. No.	Entry	Yield (q/ha)				Average yield (q/ha)	% increase over control
		1997-98	1998-99	1999-00	00-01		
1.	JF-186	27.66	26.06	21.81	19.25	23.69	2.78
2.	JF-192	26.18	27.43	26.45	22.87	25.73	11.63
3.	JF-200	28.33	26.06	24.89	20.38	24.92	8.11
4.	UF-143	23.60	23.07	21.81	21.83	22.58	-
5.	UF-144	26.50	24.02	17.90	20.77	22.30	-
6.	HF-33	17.37	20.79	18.38	16.51	18.26	-
7.	HF-39	21.40	19.47	22.85	16.08	19.95	-
8.	GF-2 (Ch)	25.39	25.54	21.85	19.40	23.05	-
	C.D. at 5%	5.77	3.16	NS	3.30	2.37	
	C.V. %	15.97	8.92	18.72	11.41	14.36	

Nine cultivars of fennel including the local check NDF-5, have been evaluated for three years (1998-99, 1999-2000 and 2000-2001) at Kumarganj. The highest yield (20.53 q/ha) was obtained with HF-39 which was significantly superior to others (Table 78).

Table 78: Yield data of fennel under CVT at Kumarganj (1998-99 to 2000-01)

Cultivar	Yield (q/ha)			Total (q/ha)	Pooled data of 3 years (q/ha)
	1998-99	1999-2000	2000-2001		
J.F.-195	17.00	15.62	17.25	47.89	15.96
J.F.-186	16.36	16.66	17.01	50.03	16.67
J.F.-200	18.84	17.87	17.18	53.89	17.96
U.F.-143	15.45	14.23	14.92	44.60	14.86
U.F.-144	17.18	17.22	17.42	51.82	17.27
R.F.-101	14.93	15.27	14.95	45.15	15.05
H.F.-33	20.05	19.44	19.57	59.06	19.68
H.F.-39	20.30	20.48	20.83	61.61	20.53
NDF-5 (ch)	-	16.90	16.97	33.87	16.93
CD (P=0.05)	3.06	2.03	1.93	-	2.30

Ten entries of fennel from different centres were tested in RBD at Hisar during 1997-1998 to 1999-2000. The observations on yield and yield attributing characters were recorded. Significant differences were obtained for all the parameters during 1999-2000. Maximum seed yield was recorded in HF-33, which was statistically at par with JF- 192, JF-200 and HF-39. On the basis of average yield of two years (1998-99 and 1999-2000), the maximum seed yield was recorded as 23.2 q/ha in HF-33 followed by HF-39 (21.2 q/ha) and PF-35 (20.9 q/ha).

FNL/CI/4 Varietal Evaluation Trial

FNL/CI/4.1 Initial evaluation trial (IET)

Jagudan

The IET was initiated in Rabi 1998-99 at Jagudan. During rabi 2000-2001, the yield differences were observed to be non significant among the entries. However, the yield performance of JF-332, JF 303, JF-342, JF-250, (28.30 q/ha, 28.12 q/ha, 28.04 q/ha and 27.75 q/ha respectively) were better than others.

The pooled data of yield for three years had shown non significant differences for yield. However the entry JF-303 recorded higher yield (31.42 q/ha), which was 16.07 percent more than the control (Table 79).

Table 79: Yield performance of fennel under IET at Jagudan (1998-99 to 2000-01)

S. No.	Entry	Yield (q/ha)			Average yield (q/ha)	% increase over control
		1998-1999	1999-2000	2000-2001		
1	JF-234	37.64	26.35	27.23	30.41	12.34
2	JF-237	31.98	20.43	25.23	25.88	-
3	JF-250	31.42	27.66	27.75	28.94	6.91
4	JF-303	34.93	31.22	28.12	31.42	16.07
5	JF-326	36.41	22.36	24.80	27.85	2.88
6	JF-332	33.72	28.85	28.30	30.29	11.90
7	JF-335	29.31	28.96	26.97	28.41	4.95
8	JF-342	32.29	25.09	28.04	28.47	5.17
9	JF-343	31.28	23.87	25.98	27.04	-
10	GF-2(Ch)	31.51	25.05	24.65	27.07	-
	C.D. at 5%	N.S.	4.81	N.S.	N.S.	
	C.V.%	21.50	10.79	10.62	16.46	

FNL/CI/5 Quality Evaluation Trial

FNL/CI/5.1 Qualtiy evaluation in fennel

Jobner

At Jobner, 68 germplasm accessions of fennel along with checks (RF-101, RF-125 and UF-134) were evaluated for volatile oil content. The volatile oil content ranged from 0.6% to 2.4% and the accessions were classified into viz., low, medium and high groups (Table 80).

Table 80 : Evaluation of fennel germplasm for volatile oil content at Jobner

Character	Range %	No. of accessions	Promising accessions identified
Volatile oil %	0.6-2.4	68	UF-3, UF-9 (2.4%);
			UF 89 (2.3%); UF-41,
Low	0.6-1.2	8	UF-125 (2.2%), UF-154 (2.1%);
			UF-55, UF-102, UF-130,
Medium	1.3-1.8	45	Rajendra Swati, NC-99-6 (2.0% each);
			UF-49, UF-170, NC-99-1,
High	1.9-2.4	15	NC-99-18 (1.9% each)

The volatile oil content of 8 accessions (evaluated under CVT) were also analysed at Jobner, which ranged from 1.6 to 2.1 %, the highest being in UF-144 (2.1%) followed by 2.0% in UF-143, HF-33 and JF-200 (Table 81). The total yield of volatile oil was found to be highest in UF-143 (24.88 L/ha) followed by UF-144 (22.05 l/ha).

Table 81: Volatile oil content and yield of fennel accessions under CVT at Jobner

Entries	Grain yield (q/ha)	Essential oil	
		%	Yield (l/ha)
UF-143	12.44	2.0	24.88
JF-186	12.06	1.8	21.70
UF-144	10.50	2.1	22.05
HF-33	9.94	2.0	19.88
JF-200	9.81	2.0	19.62
JF-192	9.56	1.9	18.16
Local Ch.	9.31	1.9	17.68
HF-39	7.94	1.6	12.70

The yield of volatile oil of entries evaluated under CVT for two years (1998-1999 & 1999-2000) is presented in Table 82. The highest mean volatile oil was recorded in UF 144 (1.92%), followed by UF-143 (1.90%) and HF-33 (1.81%). The highest mean volatile oil yield was 21.7 l/ha (UF 143) followed by 19.64 l/ha (UF-144) and 17.15 l/ha (JF-86).

Table 82: Mean performance of fennel entries evaluated under CVT for volatile oil (1998-99 and 1999-2000).

Entries	Volatile oil (%)			Volatile oil yield (l/ha)		
	1998-99	1999-2000	Mean	1998-99	1999-2000	Mean
UF-144	1.75	2.1	1.925	17.23	22.05	19.64
UF-143	1.80	2.0	1.90	18.52	24.88	21.70
HF-33	1.60	2.0	1.80	9.82	19.88	14.85
JF-192	1.65	1.9	1.775	12.83	18.16	15.49
JF-200	1.50	2.0	1.75	12.75	19.62	16.18
Local	1.50	1.9	1.70	12.45	17.68	15.06
HF-39	1.80	1.6	1.70	6.64	12.70	9.67
JF-186	1.55	1.8	1.675	12.60	21.70	17.15

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 during 1997-98, 1998-99 and 1999-2000. The highest biological yield was obtained with the soil application of ZnSO4 @ 20kg/ha (45.50q/ha). Straw yield increased significantly with the soil application of $ZnSO_4$ @ 20kg/ha and foliar application of 0.5% over control. Significant increase in seed yield resulted with the soil application of $ZnSO_4$ and $FeSO_4$ foliar application of $CuSO_4$ and soil + foliar application of Zn SO_4, $FeSO_4$ and Mn SO_4 (Table 7). Three years (1997-98, 1998-99 and 1999-2000) mean data on the response of fennel to Zn, Fe, Mn and Cu revealed significantly higher seed yield over control with soil application of $ZnSO_4$ @ 20 kg/ha (10.11 q/ha), foliar application of $ZnSO_4$ @0.50 % (9.27 q/ha), $FeSO_4$@0.25% (9.92 q/ha), $MnSO_4$@0.5% (9.42 q/ha) and Cu SO_4 @ 0.50 % (9.45 q/ha) and soil + foliar application of Zn SO_4@ 5kg/ha+0.25% (8.89 q/ha), $FeSO_4$@5 kg/ha + 0.125% (9.12 q/ha) and Mn SO_4(12.5 kg/ha + 0.25%) (9.49 q/ha) (Table 83).

Table 83: Effect of Zn, Fe, Mn and Cu on growth, yield and its attributes of fennel at Jobner.

Treatments	Biological Yield (q/ha)	Straw yield q/ha	Seed yield (q/ha) 1997-1998	1998-1999	1999-2000	Mean
Control	37.86	31.89	6.77	9.03	5.97	7.26
$ZnSO_4$ 20 kg/ha-s.a	45.50	36.61	7.90	13.55	8.88	10.11
$ZnSO_4$ 0.50%-f.a	44.46	37.69	7.47	13.55	6.79	9.27

$ZnSO_4$ 10 kg/ha-s.a. + 0.25%-f.a	36.12	28.76	7.64	11.64	7.38	8.89
$FeSO_4$ 10 kg/ha-s.a.	43.07	35.57	7.99	10.07	7.51	8.52
$FeSO_4$ 0.25%-f.a.	37.51	31.64	11.03	12.85	5.88	9.92
$FeSO_4$ 5 kg/ha-s.a. + 0.125% -f.a.	42.46	36.30	6.69	12.50	8.16	9.12
$MnSO_4$ 25 kg/ha-s.a.	38.21	31.99	7.55	10.77	6.23	8.18
MnSO4 0.50%-f.a.	40.29	33.48	7.90	13.55	6.82	9.42
$MnSO_4$ 12.5 kg/ha + 0.25%-f.a.	44.46	36.30	8.16	12.16	8.16	9.49
$CuSO_4$ 25 kg/ha-s.a	37.51	30.53	7.99	9.55	6.97	8.17
$CuSO_4$ 0.50%-f.a.	43.42	34.25	8.34	12.16	7.86	9.45
$CuSO_4$ 12.5 kg/ha- s.a.+ 0.25%-f.a.	35.01	28.34	7.03	11.81	6.72	8.52
C.D. at 5%	6.77	4.61	1.78	1.92	1.40	1.57

s.a = Soil application ; f.a. = foliar application

FNL/CM/1.2 Efficacy of biofertilizer using *Azospirillum* and P- Solubilizers on fennel

Kumarganj, Jagudan and Jobnaer

This new experiment on biofertilizers was laid out in RBD with 7 treatments and 3 replications at Kumarganj during rabi 2000-2001. During the first year, the highest yield of 17.22 q/ha was obtained with 100% inorganic N+ *Azospirillum* (50g) + 5 t/ha FYM application followed by 16.94 q/ha with 75% inorganic N + *Azospirillum* (50g) + 5 t/ha FYM and 16.66 q/ha with 50% inorganic N + *Azospirillum* (50g) + 5 t/ha FYM. Jagudan and Jobner centres will layout the experiments in current year on *Azospirillum* and all the 3 centres will initiate the trial on P- Solubilizer in the current year.

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.*

The Jobner centre holds 302 accessions (old and new) and these were evaluated along with six checks (RMt-303, UM-305, UM-144, RMt-143, RMt-1 and local). Twenty four accessions showed poor germination and therefore, observations were taken only for 278 accessions. On the basis of grain yield per plant, the promising accessions identified were UM-235, UM-236, UM-184, UM-102 and UM-18, which were better than all the checks.

Twenty eight entries of fenugreek genotypes were screened against root knot nematode *(Meleiodogyne incognita)* under field conditions by the Jobner centre at Durgapura. The variety UM-305 was found immune while UM-32, UM-34 and UM 303 were resistant. In the screening trial, out of 28 entries, UM-305 was completely free from powdery mildew, while one or two patches per plant were observed in a few scattered plants among accessions *viz.*, UM-32, UM-34, UM-43 and UM-143.

The Guntur centre conserves 124 accessions and 54 accessions were evaluated during rabi 2000-2001. LFC-84 was the highest yielder (1396 kg/ha), followed by LFC-87, LFC-113, LFC-103 and LFC 105 with 1375, 1354, 1333 and 1313 kg/ha, respectively. The check variety, Lam sel.1 recorded an yield of 1083 kg/ha.

Altogether 86 germplasm of fenugreek have been collected and maintained at Dholi. Their morphological characters were studied and some promising lines have been identified based on their yield, quality and disease resistance. The germplasm were screened against cercospora leaf spot and a few lines are found moderately resistant.

Jagudan centre holds 50 accessions including two exotic collections. Sixty one entries were field screened for resistance against powdery mildew disease. None of them was found resistant/ tolerant.

Thirteen fenugreek germplasm accessions were collected by Kumarganj centre from other districts of Uttar Pradesh during Rabi 2000-01 season, thus, making the total to 30 accessions. These were evaluated for their agronomic traits as well as seed and yield attributes, out of which NDM-19, NDM-25 and NDM-22 produced higher yield.

At Hisar 75 accessions of fenugreek were evaluated using Hisar Sonali as check during 1997-98 to 1999-00. The results indicated that 21 accessions gave higher seed yield than Hisar Sonali. The mean yield ranged from 16. 0 q/ha (HM-241) to 23.6 q/ha (HM-242). The most promising lines were HM-242, HM-273, HM-281-6, HM-283-5, HM-292-1, HM-299, HM-305, HM-307 and HM-355.

FGK/CI/2 Hybridization Trial

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

Jagudan

Crosses were made between GM-1 x UM- 305 as well as its reciprocal crosses. The F1 seeds collected during 1999-2000 were sown, but none of them germinated. Crosses were made between GM1 x UM 305 and its reciprocal and the seeds harvested during the current season for further studies.

FGK/CI/3 Coordinated Varietal Trial

FGK/CI/3.1 CVT 1995-Series III

Coimbatore, Guntur, Kumarganj and *Jagudan*.

The trial with 9 entries including the check, Co-1 was laid out in a RBD at Coimbatore during the rabi season. Significant differences were observed in yield among the nine accessions. The yield ranged from 454.67 kg to 557.67 kg/ha. The highest yield was recorded in the Acc. 105 (UM-302) (Table 84).

Table 84: Yield performance of fenugreek varieties under CVT at Coimbatore

Sl.No.	Accessions	Yield (kg/ha)
1	106 (HM 114)	529.00
2	105 (UM 302)	557.67
3	242 (HM 295)	535.33
4	113 (HM 291)	454.67
5	107 (UM 301)	475.00
6	10 (CO.1)	552.33
7	116 (HM 110)	505.33
8	115 (UM 304)	465.00
9	11 (UM 303)	523.67
	CD (P = 0.05)	62.18

The pooled yield data over the three years are presented in Table 85. The results indicated that the varietal difference was significant during 1998 & 2000. However, the three years pooled analysis, indicated that the difference was significant, with the height yield of 573.3kg/ha in UM-302 compared to 523.4kg in the check (Co3).

Table 85: Yield performance of fenugreek accessions under CVT at Coimbatore (1998 to 2001)

Sl.No.	Accessions	Yield (kg/ha)			
		1998	1999	2000	2001
1	UM 301	490.0	519.5	475.0	494.8
2	UM 302	556.0	606.1	557.7	573.3
3	UM 303	556.0	566.1	523.7	548.6
4	UM 304	467.0	492.8	465.0	474.9
5	HM 110	534.0	557.2	505.3	532.2
6	HM 114	530.0	588.3	529.0	549.1
7	HM 291	490.0	503.9	454.7	482.9
8	HM 295	467.0	583.9	535.3	528.7
9	CO.1 (Check)	463.0	555.0	552.3	523.4
	CD @ 5%	5.60	NS	62.2	42.5

At Guntur, 12 accessions from different coordinating centres were evaluated in RBD during 2000-2001 rabi season. JF-210 recorded significantly superior yield (1354 kg/ha), followed by JF-204 (1271 kg/ha) than the check Lam sel.1, which recorded an yield of 1031 kg/ha. With regard to plant height also, JF-210 was superior with 49.8 cm, followed by JF-204 with 47.6 cm. In number of podes/ plant and pod length also, JF-210 recorded significally higher values.

During 1998-99, among the twelve entries from different coordinating centres tested, JF-210 recorded significantly higher grain yield (1417 kg/ha), followed by JF-204 (1300 kg/ha). During 1999-2000, JF-210 repeated its performance and gave significantly higher yield (967 kg/ha). The genotype, JF-204 was on par with check, Lam selection-1.The pooled data over the three years indicate the superiority of the JF-210 in grain yield with 1246 kg/ha, followed by JF-204 with 1151 kg/ha, while JF-195 with 910 kg/ha and UM-321 with 893 kg/ha were on par with check, Lam selection-1 (944 kg/ha) (Table 86).

Table 86 : Yield performance of fenugreek accessions under CVT at Guntur (1998-99 to 2000-01)

Sl.No.	Entry	Yield (q/ha)			
		1998-99	1999-2000	2000-2001	Pooled
1.	RM-1	850	650	875	792
2.	HM-305	811	600	854	755
3.	HM-346	700	517	750	656
4.	HM-350	833	633	865	777
5.	JF-195	1000	750	979	910
6.	JF-204	1300	883	1271	1151
7.	JF-210	1417	967	1354	1246
8.	UM-321	983	717	979	893
9.	UM-322	783	600	813	732
10.	UM-323	650	550	677	626
11.	UM-324	916	667	948	844
12.	Lam Sel.1 (c)	1017	783	1031	944
	C.D. at 5%	131.6	115.9	134.3	69.6

At Jagudan, the CVT with 12 accessions were evaluated during 1998-99, 1999-2000 and 2000-2001. During 2000-2001, the yield differences were significant among entries. The entry, HM-350 gave significally higher yield (24.76 q / ha) than control.

The pooled data of three years (Table 87) have shown significant differences among the entries. The entry, HM-350 has recorded significally higher yield (21.83 q/ha) than control, which was 17.7% higher than control, GM-1.

Table 87 : Yield performance of fenugreek entries under CVT at Jagudan (1998-99 to 2000-01)

Sr.No	Entry	Yield (q/ha) 1998-1999	1999-2000	2000-2001	Average yield (q/ha)	% increase over control
1.	JF enu-195	16.94	20.62	19.78	19.12	3.13
2.	JF enu-204	16.85	21.60	21.52	19.99	7.82
3.	JF enu- 210	14.63	19.48	19.76	17.95	
4.	UM-321 13.46	20.25	17.35	17.02	-	
5.	UM-305 13.58	18.43	18.57	16.86	-	
6.	UM-322 12.78	23.15	16.63	17.52	-	
7.	UM-324 14.26	19.44	20.50	18.07	-	
8.	HM-346 12.72	20.56	19.44	17.57	-	
9.	HM-350 16.36	24.38	24.76	21.83	17.70	
10.	AM-1 16.17	16.30	19.76	17.41	-	
11.	AM-5 13.55	14.04	18.94	15.51	-	
12.	GM-1 (c)	15.68	18.46	21.48	18.54	
	C.D.at 5%	2.53	NS	3.10	2.86	
	C.V. % 10.14	23.46	9.20	16.56		

Eight cultivars including Kumarganj selection as local check were evaluated at the Kumarganj centre under CVT. The yield differences among these entries were found significant. J. Fenu-1954 produced the highest yield of 21.91 q/ha, followed by the check K.selection (21.88 q/ha).

FGK/CI/3.2 CVT 1999 - Series-IV

Jobner, Kumarganj, Hisar and *Dholi*

The trial consisting of eight entries including three from Jobner (UM-305, UM-321 and UM-322) three from Jagudan (JF 195, JF-204, JF 210) and two from Hisar (HM-346 and HM-350) along with two checks, namely RMt-1 and local was conducted at Jobner. The observations recorded during rabi 1998-1999 indicated that the entries differed significantly for all the characters, except branches per plant, grains per pod and grain yield. But non-significant differences were observed among the entries for grain yield. However, entry HM-350 recorded higher grain yield (16.20 q/ha) followed by JF-204 (16.02 q/ha) JF-195 (15.88 q/ha) and RMt-1 (15.68 q/ha). The yield data of 2000-01 revealed the superior performance of JF-204 (17.60 q/ha) followed by RMt-1 (17.21 q/ha), JF-195 (16.34 q/ha) and HM-350 (16.11 q/ha) (Table 88).

Table 88 : Yield performance of fenugreek entries under CVT at Jobner (1998-99 to 2000-01)

S.No	Entry	Grain yield (q/ha)		
		1998-99	1999-2000	2000-2001
1	HM-350	16.02	16.20	16.11
2	JF-204	18.10	16.02	17.60
3	JF-195	16.80	15.88	16.34
4	RMt-1	18.75	15.68	17.21
5	HM-346	16.28	15.50	15.39
6	JF-210	15.36	15.52	15.44
7	Local Ch.	14.32	15.43	14.87
8	UM-321	15.63	15.24	15.43
9	UM-305	14.98	13.42	14.15
10	UM-322	10.68	12.55	11.61
	CD at 5%	3.71	NS	-
	CV (%)	17.42	16.40	-

Eight cultures including local check (Kumarganj selection) of fenugreek were evaluated for the yield and ancillary characters at Kumarganj centre, out of which J. Fenu 195 produced the highest yield (21.91 q/ha), however, the yield of Kumarganj selection was found to be on par.

The CVT laid out for the 2nd year at Dholi with 9 entries from different centres. Data on growth and yield parameters were recorded. HM-350 attained the maximum height, no. of breeders, no. of pods/ plant, no. of grains/ pod and grain yield. However it was found statistically on par with entries HM-305, UM-321, UM-322, HM-346 and check Rajendra Kanti in respect of yield.

The CVT at Hisar consisted of 13 entries including two from Dholi (RM-1 and RM-5), two from Hisar (HM-346 and HM-350), three from Jagudan (JF195, JF-204 and JF-210), three from Jobner (UM-305, UM-321 and UM-322) along with PEB and Hisar Sonali and local check were tested during 1999-2000. Significant differences were obtained for all the parameters. Maximum seed yield was recorded in HM-346 (20.1 q/ha) which was statistically at par with Hisar Sonali (19.4 q/ha). Both the entries significantly increased yield over check.

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 in RBD with three replications. The results of this experiment conducted during rabi-1999 have given significant differences (Table 89) in yield among the accessions. The highest yield of 506.33 kg was obtained in Acc. 144 (HM-141) followed by Acc. 103 (UM-144) with an yield of 503.33 kg/ha.

Table 89 : Yield performance of fenugreek accessions under CYT at Coimbatore (1999).

Sl.No.	Accession No.	Yield (kg/ha)
1	242 (HM 295)	414.53
2	104 (UM 143)	445.33
3	103 (UM 144)	503.33
4	10 (CO.1)	478.67
5	108 (JF 145)	441.67
6	122 (CF 390)	279
7	109 (HM 103)	382.67
8	111 (JF 148)	456.33
9	114 (HM 141)	506.33
	CD (P = 0.05)	54.85

The pooled analysis data for three years from 1998-2000 (Table 90) indicated that the yield difference among the accessions was not significant during 1998 but was significant during 2000, but none was statistically superior to the check. However, the accession HM-141 registered the highest yield of 511.3kg/ha compared to 486.6 kg in the check (Co-1).

Out of 13 accessions evaluated at Dholi Centre, the accession HM - 291 produced maximum grain yield of 22.22 q/ha.

Table 90: Yield performance of fenugreek accessions under CVT (1998-2001)

Sl.No	Accessions	Yield (kg/ha)			
		1998	1999	2000	Mean
1	UM 143	488.3	486.2	445.3	473.3
2	UM 144	422.0	541.7	503.3	489.0
3	HM 103	510.7	428.5	382.7	440.6
4	HM 141	466.0	561.7	506.3	511.3
5	JF 145	466.3	472.9	441.7	460.3
6	JF 148	488.3	503.9	456.3	482.8
7	CF 169	488.3	446.2	414.5	449.7
8	CF 390	533.0	306.4	279.0	372.8
9	CO.1 (Check)	457.3	523.9	478.7	486.6
	CD @ 5%	NS	NS	65.17	NS

FGK/CI/4.2 Initial evaluation trial

Hisar

The IET's, one for green seed coat mutant lines and other on yellow seed coat mutant of fenugreek were conducted at Hisar with 9 accessions during 1999-2000 and 2000-2001. The results indicated that HM-444 (23.5 q/ha) for green seed coat mutant and HM-372 (33.85 q/ha) for yellow seed coat gave the highest seed yield during both the years.

FGK/CM/2 Nutrient Management Trial

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

Jobner — Concluded

An experiment consisting of 18 treatment combinations (including two varieties *viz.* RMt-1 and UM-305) was conducted at Jobner during rabi 1997-98, 1998-99 and 1999-2000. The treatments were evaluated in RBD with three replications. The observations were recorded on plant height, branches and pods/plant, pod length, seed/pod, test wt., biological, straw and seed yield/ plot. The crop was adversely affected due to hail storm to some extent at harvest in 1997-98 and due to moisture stress in 1998-99 and 1999-2000.

During 1999-2000 (Tables 91 & 92) the variety RMt-1 gave significantly higher plant height, pods/plant, biological, straw and seed yield compared to variety, UM-305 whereas the latter produced significantly more test wt. than the former. Row spacing of 30 cm gave significantly more number of pods/plant compared to 20 and 25 cm row spacing. Row spacing of 25 and 30 cm gave significantly higher test weight over 20 cm row spacing. Row spacing of 20 cm, being at par with 25 cm row spacing, recorded significantly higher seed yield over 30 cm row spacing.

Fenugreek sown on 31st October produced significantly taller plants, more number of branches and pods/ plant, test weight, biological, straw and seed yield over the crop sown on 15th and 30th November. Fenugreek crop sown on 31st October gave maximum seed yield of 16.46 q/ha, which decreased significantly with delayed sowing on 15th November (12.94 q/ha) and 30th November (11.07 q/ha).

Three years mean data revealed the superiority of RMt-1 (17.90 q/ha) over UM-305 (15.88 q/ha). Crop sown at 25 cm row spacing produced higher mean seed yield of 17.34 q/ha compared to 16.66 q/ha under 20 cm row spacing. Early sowing on 31st October gave higher mean seed yield (19.15 q/ha) and further delay in sowing decreased the seed yield significantly. The interaction effect of variety and date of sowing on seed yield (Table 93) was significant. The seed yield of RMt-1 decreased significantly with delayed sowing after 31st October, whereas the variety, UM-305 could be sown upto 15th November without marked reduction in seed yield.

Table 91 : Effect of row spacing and date of sowing on growth, yield attributes and yield of fenugreek varieties at Jobner

Treatments	Pl.height (cm)	Branches /plant	Umbels /plant	Umbellets /umbel	Grains /umbel	Test weight (g)
A. Variety						
RMt-1	46.5	5.3	24.8	10.0	14.6	11.31
UM-305	34.8	5.4	20.8	9.9	13.9	11.63
CD at 5%	1.6	NS	1.7	NS	NS	0.16
B. Row spacing						
20 cm	41.2	5.3	20.5	10.0	14.1	11.17
25 cm	41.2	5.2	22.2	9.9	14.9	11.59
30 cm	39.6	5.4	25.7	9.8	13.8	11.63
CD at 5%	NS	NS	2.1	NS	'NS	0.19
C. Sowing date						
31st October	42.9	5.9	29.3	9.8	14.3	12.77
15th November	40.6	5.0	24.3	10.1	14.0	11.17
30th November	38.5	5.0	14.8	9.8	14.5	10.47
CD at 5%	2.0	0.2	2.1	NS	NS	0.19

Table 92: Effect of row spacing and date of sowing on growth, yield attributes and yield of fenugreek varieties at Jobner.

Treatments	Biological Yield (q/ha)	Straw Yield (q/ha)	Seed yield (q/ha) 1997-1998	1998-1999	1999-2000	Mean
A. Variety						
RMt-1	46.58	31.05	21.22	17.05	15.45	17.90
UM-305	35.74	24.17	20.86	15.26	11.53	15.88
CD at 5%	4.00	1.14	NS	0.87	0.57	1.09
B. Row spacing						
20 cm	42.10	28.24	19.93	16.30	13.83	16.69
25 cm	41.47	27.82	21.25	17.12	13.66	17.34
30 cm	39.91	26.88	21.99	15.05	12.98	16.66
CD at 5%	NS	NS	NS	1.06	0.70	NS
C. Sowing date						
31st October	49.49	33.03	23.14	17.86	16.46	19.15
15th November	43.35	30.43	21.72	16.09	12.94	16.92
30th November	30.66	19.59	18.25	14.51	11.07	14.61
CD at 5%	4.94	1.39	1.65	1.06	0.70	1.35

Table 93 : Interaction effect of varieties and date of sowing on seed yield (q/ha) of fenugreek at Jobner.

Variety	Date of sowing		
	31st Oct.	15th Nov.	30th Nov.
RMt-1	21.41	17.52	14.78
UM-305	16.79	16.32	14.45
CD at 5%	1.90		

FGK/CM/2.2 Efficacy of biofertilizers using *Azospirillum* on fenugreek

Coimbatore, Guntur and *Kumarganj*

The results of the study conducted at Coimbatore during kharif 2000 revealed that the difference among the treatment was significant. The highest yield of 413. 33 kg/ha was obtained in T1, followed by T6, T2 and T7. (Table 94).

Table 94: Efficacy of *Azospirillum* on the yield of fenugreek at Coimbatore

	Treatments	Yield (kg/ha)
T_1	Inorganic N (100%) + *Azospirillum* (50g) + 5kg FYM	413.33
T_2	Inorganic N (75%) + *Azospirillum* (50g) + 5kg FYM	373.33
T_3	Inorganic N (50%) + *Azospirillum* (50g) + 5kg FYM	273.33
T_4	FYM (5kg) + *Azospirillum* (50g)	243.33
T_5	FYM (5kg) alone	266.67
T_6	FYM (10kg) + *Azospirillum* (50g)	383.33
T_7	FYM (10kg) alone.	333.33
	CD (P = 0.05)	85.46

At Guntur, an experiment to study the efficiency of *Azospirillum* consisting of eight different treatments was conducted on fenugreek during 2000-2001. The observations revealed that T1 (100% N + *Azospirillum* (50g) + 5 kg FYM) recorded tallest plant with 47.1 cm, followed by T2 (75% N + *Azospirillum* (50g) + 5 kg FYM) with 46.7 cm and T3 with 46.2 cm. Number of pods per plant was also significantly higher in T1 (30.5) followed by T2 (30.1) and T3 (50% N + 50 g *Azospirillum* + 5 kg FYM) with 28.9. The largest pods were obtained in T1, followed by T2 and T3. T1 recorded higher yield (1198 kg/ha), which was on par with T2 and T3 (1177 and 1167 kg/ha respectively).

Biofertilizer studies at Kumarganj indicated that the highest yield of 20.20 q/ha was recorded with fenugreek, when 100% inorganics as N

(recommended dose) along with 50 g of *Azospirillum* + 5 kg FYM was applied. Differences were not significant, when 75% and 50% inorganic fertilizers were used along with 50 gm of *Azospirillum* and 5kg of FYM. The lowest yield (17.55 q/ha) was obtained with T5, where only 5 kg FYM was alone used (Table 95).

Table 95 : Yield and ancillary observations on fenugreek due to use of *Azospirillum*

Treatments	Days to 50% flowering	Plant height (cm)	No.of Branches / plant	No.of Pods / plant	Length of pod (cm)	No.of grain/ pod	1000 seeds weight (g)	Days to maturity	Yield (q/ha)
T_1 - InorganicN (100%) + *Azospirillum* (50g) + 5.0 tons/ha FYM	65.29	84.33	7.00	90.15	10.66	17.66	12.75	147.13	20.20
T_2 - Inorganic N (75%) + *Azospirillum* + 5.0 tons/ha FYM	65.05	83.33	6.93	88.36	10.50	17.20	12.45	147.00	20.00
T_3 - Inorganic N (50%) + *Azospirillum* + 5.0 tons/ha FYM	64.95	82.00	6.66	86.66	10.00	17.05	12.13	146.65	19.85
T_4 - FYM 5.0 tons/ha + *Azospirillum*	64.50	75.00	6.15	83.60	9.00	16.60	11.33	146.05	19.05
T_5 - FYM 5.0 tons/ha alone	63.95	71.13	5.67	81.45	8.13	16.00	10.50	145.25	17.55
T_6 - FYM 10 tons/ha + *Azospirillum*	64.75	78.33	6.35	85.13	9.16	16.90	11.85	146.33	18.45
T_7 – FYM 10 tons/ha alone.	64.13	72.93	6.00	82.33	8.56	16.33	11.00	145.75	18.65
CD (P = 0.05)									1.40

GENETIC RESOURCES OF SPICES AT AICRPS CENTRES (As on 31-3-2001)

Crop/Centre	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Black pepper				
Panniyur	138			138
Sirsi	75	21		96
Chintapalli	26	29		55
Yercaud	106			106
Pundibari	7			7
Dapoli	11			11
Dholi	7	1		8
Cardamom				
Pampadumpara	78			78
Mudigere	245	7		252
Ginger				
Pottangi	165	2	3	170
Solan	221			221
Dholi	19			19
Kumarganj	12			12
Pundibari	21			21
Turmeric				
Pottangi	167	22		189
Jagtial	188			188
Dholi	58			58
Bhavanisagar	124			124
Raigarh	34			34
Kumarganj	66			66
Pundibari	69			69
Solan	172			172
Coimbatore	232		2	234
Clove				
Yercaud	13			13
Thadiyankudisai	1			1
Pechiparai	19			19
Dapoli	3			3

Nutmeg				
Yercaud	15			15
Thadiyankudisai	1			1
Pechiparai	12			12
Dapoli	14			14
Cinnamon				
Yercaud	11			11
Thadiyankudisai	6			6
Pechiparai	9			9
Dapoli	13			13
Coriander				
Jobner	649		112	761
Jagudan	70		18	88
Coimbatore	205		205	410
Guntur	230			230
Hisar				
Dholi	102			102
Raigarh	20			20
Kumarganj	29			29
Cumin				
Jobner	313		10	323
Jagudan	173		7	180
Kumarganj	19			19
Fennel				
Jobner	185		8	193
Jagudan	284		20	304
Hisar				
Dholi	76			76
Kumarganj	40			40
Fenugreek				
Jobner	325		12	337
Jagudan	48		2	50
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 NOVEMBER 1999 AND ACTION TAKEN REPORT ON THE EARLIER DECISIONS

Decision	Action 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. Coordinated multilocational approach should be strictly followed in all projects.	Being followed.
4. The facilities available at NBPGR should be utilized for collection and characterization of germplasm.	Being done in various universities under NATP programmes.
5. Passport data of germplasm collections should be supplied to NBPGR and get IC numbers to avoid duplication	Instructions have been issued to all centres. Problem still exists in the case of vegetatively propagated spices as tissue cultured materials have to be supplied to the NBPGR *in vitro* gene bank. Facilities for this are not available in the centres.
6. Crop cafeteria for all the released varieties to be established	Action for this has been started at all the centres.
7. *In situ* conservation may be given importance in case of certain species specific to certain locality.	Noted for future guidance. However, this may be beyond the capability of the AICRPS centres.
8. All centres should send one set of germplasm to IISR for conservation in the national conservatories.	The centres are advised.

9. All centres should follow the uniform technical programme as decided in the workshop. If necessary, 1 or 2 treatments as per local requirements may be included without altering the original treatment schedule.	New technical programmes are formulated based on this decision.
10. 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. Hybridization was carried out in pepper and 36 cross combinations were produced.
11. Utilization of germplasm collected should be given more emphasis.	More emphasis are given to the collected germplasm for its utilization. But centres have no facility for quality analysis.
12. The released varieties should be properly popularized.	This is being done.
13. 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.	All the centres are advised accordingly. Panniyur centre prepared passport data for 18 new collections and 7 released varieties.
14. 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 within two years. Documentation and characterization are to be carried out, wherever necessary.	The Scientists of various centres are advised accordingly. The decision is being implemented by various centres, except the completion of survey due to the lack of vehicle in most cases.
15. 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 was completed well in time.
16. Local checks along with the best released varieties should be included in all varietal trial in future.	Being followed in the new varietal trials.

17. The new CVT in ginger and turmeric is 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 during 2000, which will be supplied this year.
18. New experiment on efficiency of biofertilizers, using *Azospirillum* & P-solubilisers, has to be initiated with black pepper, turmeric, coriander, ginger, fenugreek and cardamom.	The trials have been laid out at all the respective centres as per the technical programme. In coriander, the programme could not be takenup at Jagudan due to the shortage of water.
19. The new trials on organic fertilizers and biofertilizers have to be initiated in black pepper, ginger, turmeric, cardamom & seed spices.	Already initiated.
20. Jagudan centre will discontinue the work on coriander but will concentrate on cumin and fennel.	Noted.
21. The work on fenugreek will be discontinued by Coimbatore centre.	Noted.
22. The germplasm collection work can be completed after intensive survey within two years. Documentation and characterization are to be carried out wherever necessary.	Noted . Documentation has been prepared by Jagudan for all variable entries in cumin and fennel.
23. The need for reduction in quantity of chemical inputs and experiments on organic farming to create a data base to support the concept was emphasized.	Noted. The newly formulated projects will be useful for this purpose.
24. Absolute necessity for experiments on the use of location specific biofertilizers for increase in productivity was stressed.	Noted for future guidance. The biofertilizer trial in various centres used locally available formulations only.
25. The new programmes 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 were formulated in black pepper, cardamom, turmeric, ginger and seed spices.

26. Comparison is to be made between organically grown and conventionally grown black pepper, ginger and turmeric.	This will be done.
27. Hybridization programme in seed spices.	Hybrization in cumin, fennel and fenugreek were taken at Jagudan.

BLACK PEPPER

1. An action plan on collection should be prepared and submitted by Panniyur. A data base on variability collected should be developed and passport data prepared and communicated to Project Coordinator.	Action plan has already been prepared under the NATP programme, and is being followed.
2. A new CVT in black pepper would be started in June 2000 at four centres viz., Panniyur, Sirsi, Pampadumpara and Ambalavayal with 13 treatments and three replications.	The entries were supplied and the centres are multiplying the materials required for the trial. This trial will be laid out during June 2001 at all centres. Lay out of the experiment was done at Ambalavayal.
3. Priority should be given for hybridization programme. Action may be initiated to streamline the breeding approaches. Intervarietal hybridization will be continued.	Inter-varietal hybridization programme was intensified at Panniyur.
4. A new trial to be initiated in black pepper for foot rot management. *Phytophthora* foot rot management in Areca-pepper cropping system is also suggested for Sirsi and biocontrol of *Phytophthora* nursery trial for Pampadumpara and Ambalavayal.	The trials were laid out in farmers' field at Mudigere. The trial is yet to start at Pampadumpara and Ambalavayal.
5. 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, and these are being followed.

6. 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. The final report will be prepared by incorporating data for this year also.
7. 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 and Myladumpara centres have taken up the trail. The survey was completed.
8. 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. Trial is in progress and preliminary report was submitted by Pampadumpara.
9. All the centres should have a common program for foot rot management with major emphasis on bio control agents	Carried out all the technical programmes in respect of foot rot management of black pepper, by Panniyur, Sirsi and Mudigere centres. Studies were conducted on leaf & spike damage due to anthracnose disease at the time of spiking, *Trichoderma* based bio-control technology and certification of pepper planting material to ensure supply of disease free materials to farmers.
10. The CVT1987 series to be closed	Closed and final report received.
11. Survey on black pepper insect-pests at high ranges in Idukki.	The Survey was conducted by Pampadumpara centre. ICRI also participated in the survey programme.

12. Action may be taken to widen the genetic base of black pepper at all centres. Chintapalli has to complete the collection in eastern ghats. Intensive survey has to be made by the Yercaud centre.	At Chintapalli, 11 cultivated accessions of black pepper were collected. They belong to *Piper attenuatum* and *Piper argyrophyllum*. Panniyur intensified the collection of indigenous types.
13. Information on new insect-pests of black pepper	Occurance of stem borer in Kumily region and root mealy bug in Kattapana was reported by Pampadumpara
14. Crop loss due to anthracnose including leaf and spike damage	Report on the data generated from the survey has to be submitted by Pampadumpara
15. Trial on biological control of *Phytophthora* foot rot of black pepper	The experiment as per the technical programme was started during May 2001
16. Collection of elite lines of Karimalligesara to be initiated by Sirsi and collection from Uttara Kannada area to be completed within next 2 years	Five lines have been collected. It is being continued.
17. At Sirsi, variability in Karimalligesara has to be collected.	Collection is being made
18. Collection and evaluation of elite lines of Karimalligesara should be initiated at Sirsi	It is initiated
19. Irrigation –cum-fertilizer requirement of black pepper and arecanut in the mixed cropping experiment.	It is being continued
20. *Phytophthora* foot rot incidence in black pepper under different density in an arecanut garden to be laid out at Sirsi.	It is being laid out at Sirsi. The programme identified for Sirsi centre will be started in 2001 at Panniyur.
21. Efficacy of bio fertilizer studies using *Azospirillum* & P-Solublizers	The experiment was laid out at Panniyur, Sirsi, Thadiyankudisi, Yercaud and Ambalavayal
22. Comparison to be made between organically grown & conventionally grown Black pepper.	Will be done once the harvesting starts

23. Large scale field trial should be laid out in *Phytophthora* foot rot managerial based on the results obtained with major emphasis in bio control agents studies on the control of nursery disease of black pepper including bio control	Could not be done to the lack of sufficient funds, vehicle and personnel
24. Survey, crop loss and etiology of anthracnose to be taken up at Mudigere, Pampadumpara and Ambalavayal.	New set of experiments will be laid out after obtaining relevant information from pathologist at Mudigere.

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. The passport data are being prepared.
2. For all the future varietal trials in cardamom "green gold" 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 clonal materials are put for multiplication and the CYT will be laid out during next season.
5. The programme on nutrient management at ICRI can be modified and started at Mudigere and Pampadumpara as well. 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.	The programmes have been initiated.

6. Collection of elite cardamom lines will be initiated	Survey has been made around Mudigere and Sakleshpur and collected eleven elite cardamom germplasm lines by the Mudigere centre. Pampadumpara collected 15 superior clumps and added to the germplasm.
7. The experiments on effect of fertilizer levels and influence of the micro nutrients on the yield of cardamom have to be closed at Mudigere	Accordingly both the experiments were closed and final report submitted by the Mudigere and Pampadumpara centres.
8. Drought tolerant lines in cardamom to be collected	One drought tolerant cardamom line was collected by Pampadumpara
9. CVT to be continued for one more year and then concluded	Sufficient data was generated at Pampadumpara. Pooled analysis of data will be presented in the workshop.
10. New trial should be formulated on the bio-ecology of natural enemies on major pests.	The experiment was initiated during 2001 at Pampadumpara.
11. New trial for management of root grub of cardamom should be started.	The experiment was initiated during 2001.
12. A new CVT on cardamom would be taken up in four centres with 14 treatments	Entries were identified for the trial and put for clonal multiplication.
13. Efficacy of biofertilizar using *Azospirillum* & P-Solublizers should be studied.	The trial was laid out at Mudigere, Pampadumpara and ICRI, Myladumpara.
14. Bio-ecology of natural enemies of major pests of cardamom has to be initiated.	Pampadumpara centre initiated the survey and the experiment.

Ginger

1. Passport data of ginger germplasm to be submitted to Coordinator by Pottangi and Solan	The Pottangi and Solan centres are preparing the passport data.
2. The CVT-1996 will be concluded and new CVT to be started.	Noted. The new CVT has been initiated.

3. 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 and vehicle.
4. Programme on biocontrol studies on rhizome rot of ginger may be identified with uniform programmes to the ginger centres.	Already identified.
5. Disease surveillance survey in ginger is to be carried out at all centres. Biocontrol studies on rhizome rot of ginger to be taken up by all ginger centres except Solan.	Being done, and experiments laidout.
6. The CVT 1996 will be concluded and new CVT on ginger to be initiated	New CVT has been initiated
7. Efficacy of biofertilizar using *Azospirillum* may be started.	The trial has been initiated at Pottangi, Solan and Ambalavayal
8. Comparison will be made between organically grown and commercially grown ginger	Will be done.
9. Solan centre has to complete the documentation and characterization of ginger in the next two years.	The Solan centre has been advised to complete the documentation and characterization.
10. Pottangi, Dholi, Kumaraganj, Raigarh and Pundibari centres have to survey the un exploited regions.	The centres are advised. The lack of vehicles for survey has been indicated as constraint.
11. A trial on use of organic farming in ginger to be initiated.	The trial has been laid out as per the technical programmes.
Turmeric	All turmeric centres have been advised.
1. Passport data must be prepared and supplied to NBPGR for getting IC numbers.	
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. Collection have been made by Coimbatore centre and added to the germplasm

3. Survey for germplasm to be continued by Solan, Pottangi, Kumaraganj, Dholi, Pundibari, Jagtial and Coimbatore centres. Passport data must be collected and documentation and characterization may be carried out in two years.	Centres have been advised. The lack of vehicle for collection work is indicated as the constraint.
4. Curcumin of 157 accessions should be analyzed within next two years.	This work is in progress at Coimbatore.
5. 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.
6. The CVT 1996 will be concluded. A new CVT will be taken up in the next season.	The new CVT has been laid out.
7. All turmeric centres may send the turmeric accessions (Acc.360 and 361) to IISR, Calicut for quality analysis.	Action over.
8. Dholi and Pundibari centres to formulate new experiment on *Taphrina* leaf blotch by avoiding the use of metalaxyl and emisan.	Experiment has been laid out.
9. The experiments on leaf blotch and leaf spot diseases may be finalized and new experiment on rhizome rot formulated.	Being carried out. The new experiment on rhizome rot is in progress at Coimbatore
10. Characterization and documentation of existing germplasm of turmeric will be completed within two years	Will be completed by 2002 at Coimbatore centre.The other centres have been advised.
11. Trial on impact of environment on quality of turmeric will be continued.	The trial has been continued at all the turmeric centres.
12. The CVT 1996 will be concluded and new CVT in turmeric to be initiated.	CVT in turmeric has been initiated.
13. Nutrient management trial	Both the experiments at Kumaraganj & Raigarh may be concluded after harvest of the current season crop.

14. Efficacy of biofertilizer using *Azospirillum.*	The experiment will be laid out at Coimbatore, Kumaraganj, Raigarh, Pottangi and Ambalavayal during the coming season.
15. Comparison should be made between organically grown and conventionally grown turmeric.	Will be done.

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. Survey of fruit drop in nutmeg at Dapoli to be closed from 2000-2001.	Closed the trial at Dapoli
4. The tree spices research at HRS, Yercaud can be shifted to HRS, Pechiparai through a work arrangement by the university.	The University has not done this inspite of repeated requests. It was represented to the Dean (Hort.), Tamil Nadu.
5. Nutrient management trial	Four years pooled data are available. The experiment is concluded.

Coriander

1. Quality analysis (oil) of the existing accessions of coriander will be completed within two years.	Will be completed before 2002 at Coimbatore. Volatile oil estimation of 100 accessions have been completed.
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. Jobner centre completed the documentation of 100 accessions.
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 a new experiment on biocontrol of wilt in coriander formulated.	All the centres will lay out their trials this year.
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 Coordinator.	In view of the paucity of staff, the seed spices work is kept in abeyance.
8. The experiment on the response of coriander to micronutrients at Jobner can be concluded and the same experiment shall be initiated at Kumarganj.	Noted.
9. Nutrient management trial	The experiment is yet to be concluded.
10. Response of coriander to micronutrients.	The experiment at Jobner centre to be continued and the same experiment to be initiated with similar set of treatment at Kumaraganj
11. Survey of under explored areas for collecting variability is to be done and to be completed in two years by all centres	All centres are advised accordingly. The lack of vehicle is indicated as a constraint for undertaking surveys.

Cumin

1. The CVT 1994 will be concluded. CVT III 1996 will be continued. New CVT will be taken up in the next season.	Trials will be continued and new CVT has been initiated 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 has been formulated for 2000 planting season. Integrated management of cumin pest and diseases of cumin at Jagudan initiated.
3. Efficacy of biofertilizar using *Azospirillum*	The trial will be laid out at Jagudan, Kumaraganj and Jobner, this year.

4. Germplasm collection from different areas for high yielding types.	Germplasm collection from these specified areas are in progress at Jobner.

Fennel

1. Documentation of germplasm accessions to be completed and passport data should be prepared and sent to NBPGR for giving IC numbers.	Centres are advised accordingly, and is being attended to by the centres.
2. New CVT will be taken up in fennel	Will be laid out in 2001 sowing season.
3. Quality evaluation, documentaion and characterization to be carried out in fennel.	Centres are directed to follow this decision. Jobner centre completed the documentation.
4. Volatile oil estimation in 100 accessions	Volatile oil estimation in 100 accessions have been completed at jobner.

Fenugreek

1. Characterization and documentation of 50 accessions of fenugreek should be completed and passport data prepared and passed on to Project Coordinator.	Will be completed before 2002 at Coimbatore.
2. The work on fenugreek will be discontinued by Coimbatore centre.	Discontinued.
3. New CVT to be started in fenugreek centres. The CVT-1995 will be closed.	New CVT is formulated, and old CVT closed.
4. The study on spacing/sowing trial can be concluded.	Study was conducted for two seasons and then concluded.
5. Nutrient management trial	The experiment was concluded
6. Biofertilizer using *Azospiriullum*	Jobner, Jagudan, Coimbatore and Guntur will lay out this trial in this year.
7. Germplasm collection from Chittoor and surrounding areas far high yielding and disease resistance types.	Germplasm collections from these areas are in progress at Jobner.

PRODUCTION OF SOMACLONES AND SOMATIC HYBRIDS IN CARDAMOM (*Elettaria cardamomum* Maton.) FOR HIGH YIELD AND RESISTANCE TO DISEASES

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This project was initiated with the following **objectives:**

- Production of somaclonal variants through callus regeneration
- Production of somatic hybrids through fusion of protoplasts of cardamom with that of other related taxa like *Alpinia* sp. and *Hedychium* sp.
- Screening of somaclones and somatic hybrids against 'Katte' and evaluation for high yield and other desirable quality characters.

There are two important aspects of work involved in this project

1. Developing plants with resistance to 'katte', high yield and other desirable characteristics using somaclonal variation.
2. Producing plants resistant to 'katte' using somatic hybridization.

Production of somaclones

The procedure adopted in this project, for production of somaclones with high yield, resistance to katte and other desirable characteristics comprised of the following steps.

1. Induction and growth of callus or suspension cultures for several cycles.
2. Regeneration of a large no of plants from such cultures.
3. Screening of desirable traits in the regenerated plants and their progenies.
4. Testing the selected variants in subsequent generations for desired traits.
5. Multiplication of stable variants to develop new breeding lines.

Establishment of *in vitro* cultures

In vitro cultures of different varieties of cardamom was established using rhizomes from field grown plants as explants for culture initiation. Cultures were established from PV1xCl37, CCS1, RR1 and Natural Katte Escape lines such as NKE 28 and 30.The rhizomes were collected from field grown plants from Cardamom Research Station Appangala, washed well and treated with 0.3% Phytolan (copper oxy chloride) fungicide for 20 minutes. The explants were brought to a laminar flow hood and were trimmed in such a way that the apical bud and the surrounding part of the rhizome only remained. The explants were treated with 0.1% (W/V) aqueous mercuric chloride solution for 3 minutes and were incubated onto MS medium containing 1mg l^{-1} BA and were incubated in dark for a period of two weeks on which there was growth of the apical bud. The cultures were then transferred to MS medium devoid of any growth regulators and incubated in light. These established cultures were used for collection of explants for the induction of callus and isolation of protoplasts.

Induction of callus

Callus could be induced from *in vitro* derived leaf, leaf sheath and pseudostem explants of cardamom, when cultured on MS medium with different concentrations of 2,4-D alone or along with BA. The cultures were incubated in dark for 15 days and callus initiation was ob-

served. After callus initiation, the cultures were subcultured to fresh medium of same composition and kept in light. Proliferation of callus was achieved within 7 days after culture of the callus into fresh medium in light. When 2,4-D alone was used, the callus produced was friable in nature. When BA was used along with 2,4-D the calli produced were of two different types, one is hard embryogenic callus and the other type is creamy white friable callus. The embryogenic 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. The callus upon subculture to MS medium with 2.0 mgl^{-1} 2,4-D produced more and more friable callus. This friable callus is used for establishment of cell suspension cultures and for protoplast isolation.

Callus regeneration and large-scale production of somaclones

Regenerating callus cultures, which are being maintained in the biotechnology laboratory, were used for plant regeneration. Hard and regenerating callus cultures were subcultured on to MS medium with 0.5 mgl^{-1} NAA and 1.0 mgl^{-1} BAP. Large numbers of plants were regenerated from these callus cultures. The plantlets exhibited three morphotypes in culture; they are (i) plants with short needle like leaves (ii) short and stout plants with small but normal leaves (iii) and plants with long internodes and normal leaves. In about 30% of the cultures, two of the morphotypes could be observed in the same culture itself. Plants with variegated leaves were produced from callus cultures. The somaclones produced were got rooted in MS basal medium.

Hardening of somaclones

Callus regenerated plants (somaclones) were rooted in basal MS medium. The rooted plants for hardening were transferred to the hardening facility. Initially the plants were kept in low temperature (24± 2^0c) covered with polythene bags to retain humidity for 20 days (in chamber II of the hardening facility). The plants were then transferred to the chamber III of the hardening facility with temperature 29^0C and relative humidity 70% for 30 days. The hardened plants were, then transferred to ploy- bags with garden soil and maintained in green house.

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 with 50 -60 cm height were transferred to field at Cardamom Research Center, Appangala. The plants were planted in 2x2 m spacing.

Field evaluation of somaclones : Callus regenerated plants (four months old) were transferred to the field at Cardamom Research Center, Appangala. Data collected from these plants after three, four and five years showed considerable variations in terms of morphological and other yield related characters.

Production of somatic hybrids

Protoplast isolation

Cardamom

Source tissue: The source material and the physiological state of the tissue are the most critical factors, which determine success of protoplast isolation and culture. Standardization of age and state of the starting material are essential and need to be similar from one experiment to the next.

In the present attempt to isolate protoplasts 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.

Protoplast isolation: Leaves collected from *ex vitro* grown plants were washed with mild detergent (teepol) and rinsed with water. The material was dipped in 70% ethanol for 15 seconds and then treated with sodium hypochlorite solution and Tween-20 for seven minutes with periodical stirring. The material is rinsed 4-5 times with sterilized distilled water, after pouring off the surface sterilant, to remove any residual surface sterilant. Surface sterilization is not required if the starting material are from an aseptic source ie. *in vitro* cultures. The lower surface of leaves were scored with a blade and cut into smaller pieces, as it is difficult to peal the epidermis off, to ensure proper enzyme digestion. The tissue used for protoplast isolation was subjected to a mixture of enzymes including macerozyme and cellulase. Osmotic pressure of the protoplast medium was maintained by the use four concentrations (8%, 9%, 10% and 13%) of mannitol. Enzymes were dissolved in Cell Protoplast Washing (CPW) medium with different levels of mannitol and filter sterilized using Millipore filter sterilization unit. One gram each of the mechanically macerated leaves, fragile callus and cell mass from suspension cultures were immersed in 10 ml each of the isolation solution and kept in dark for 18-24 hours at 28°C. The callus tissues were kept under agitation of 53 rpm. The changes occurring during incubation were observed at hourly interval up to 24 hours.

Periodical observation of changes occurring during enzyme digestion of *in vitro* derived leaf tissue of cardamom revealed that after 30 minutes of incubation, the maceration of tissue started. The leaf tissue lost its integrity and clumps of cells start separating. After four hours of incubation, cell clumps and cells with partially digested wall start liberating. Further incubation up to 6-10 hours, the numbers of cells/cell clumps liberated were found to increase. After 18-24 hours, cells devoid of cell wall were observed. Duration of 18-20 hours is ideal for getting viable protoplast and further incubation leads to plasmolysis or protoplast lysis based on the concentration of osmoticum used.

After incubation, gentle shaking could liberate the protoplast entangled in the undigested debris. Out of 20 enzyme solutions tried, ES-13 (0.5% macerozyme + 2% cellulase + 9% mannitol) and ES-15 (1.0% macerozyme + 2% cellulase + 9% mannitol) were found to give good yield of protoplast. In ES-15, certain amount of protoplast lysis was observed. Extending the incubation period beyond 20 hours resulted in protoplast lysis. Same enzyme concentration with 13% and 10% mannitol was not favorable as the protoplast showed high degree of plasmolysis. Mannitol at 13% and 10% level with all the combination of enzyme resulted in plasmolyzed cells/protoplast. Mannitol at 8% level yielded more than 70% of broken protoplasts. At low levels of enzyme concentration, the liberation of cells or protoplast and wall degradation was not satisfactory.

Friable callus tissue and the cell mass from cell suspension cultures responded similarly to the enzyme solutions tried. No enzyme solution except the one with 1% macerozyme R10 and 2% onozuka cellulase R10 with 8% mannitol was sufficient to liberate protoplasts after 24 hours

of incubation. The cell suspension culture consisted of two types of cells, such as highly vacuolated cells with less cytoplasm and slightly vacuolated cells with dense cytoplasm.

Protoplast purification: A combination of filtration, centrifugation and washing was used to purify the protoplast. 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.

The filtrate is distributed into sterilized screw capped centrifuge tubes and centrifuged in Beckman tabletop centrifuge for 10-15 minutes at 600-800 rpm. The protoplast is collected as a pellet at the bottom of the tube. The enzyme solution was removed using a Pasteur pipette without disturbing the pellet. The pellet was suspended in Cell Protoplast Washing (CPW) medium and then centrifugation and re-suspension in fresh medium were repeated three times so as to wash the protoplast. Before the last wash, a sample was taken and observed for intact and broken protoplast. Samples from three tubes were pooled and re-suspended in 1 ml of the CPW medium and layered on top of 9 ml of floatation medium. A green ring is formed at the junction in the floatation medium containing 21gl^{-1} sucrose. It is centrifuged at 700-1000 rpm for 10 minutes. After centrifugation, the ring formed is disturbed, so floatation centrifugation is not suitable for protoplast purification. The protoplasts can be collected as a ring without centrifugation. Centrifugation at 600-700 rpm was suitable for separation of protoplasts. Yield of protoplast was estimated using haemocytometer and the viability was assessed by Evan's Blue and fluorescein diacetate staining. Culturing of protoplasts was done after centrifugation.

Protoplast yield and viability: In enzyme solution ES-13, a protoplast yield of 3.5 x 10^5 protoplasts per g leaf tissue was obtained. The viability of the protoplast was 72-75% after Evan's blue and fluorescein diacetate staining. In the same enzyme solution, the callus tissue and cell suspension cultures yielded $1x10^5$ protoplasts per one g of tissue. Protoplast viability was low ranging 20-30%

Protoplast culture: Isolated protoplasts were cultured in petri dishes. The protoplast, which was collected as pellet after washing in the CPW medium or as a band after floatation centrifugation, were re-suspended in culture medium 1. Five drops of culture medium 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^{0}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 of culture in culture medium. Division of protoplast (70%) was initiated after four days in culture. Culture medium was added every seven days interval. After 20 days of culture the cells showed further division. At this stage the protoplast suspension was plated on agar solidified culture medium. Within 30 days of culture, 30% of the dividing cells produced microcallii.

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 induction

Callus was induced from different explants of cardamom leaf base, leaf sheath, thin longitudinal and transverse sections of the pseudostem of both field grown and *in vitro* grown plants. MS medium containing 2,4-D alone or in combination with BA &Kin. was used. Thin transverse sections of the pseudostem of *in vitro* grown plants in MS medium containing 2mgl^{-1} 2,4-D and 0.5 mg l^{-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 mg l^{-1} 2,4-D and 0.2 mg l^{-1} TDZ produced embryogenic suspension cultures characterized by fast growing, isodiametric, thin walled and richly cytoplasmic cells. These embryogenic cells were maintained in the same medium by subculture at an interval of 20 days. Cells from this embryogenic suspension cultures were used for isolation of protoplasts.

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% Mannitol, 3% Cellulase and 1% Macerozyme gave the best results in terms of number of protoplasts isolated and viability.

Callus induction in *Hedychium*

Callus was induced from leaf and root explants of *in vitro* multiplied plants of *Hedychium* in MS medium with 2.0 mg l^{-1} 2,4-D. These calli were used as source material for protoplast isolation.

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 difference among the somaclones. Further studies are to be done to assess the variability among the somaclones using more number of isozyme as markers.

Screening of somaclones against katte

Callus regenerated plants (somaclones 700 numbers) were transferred to cardamom research Centre, Appangala and screened against katte. Of the 700 plants screened about 50 plants survived after three rounds of screening.

PRODUCTION OF HAPLOIDS OF CARDAMOM (*Elettaria Cardamomum* Maton.) THROUGH ANTHER CULTURE/ POLLEN CULTURE

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Production of haploids through anther culture

Production of diploid homozygous pure lines is a very important step in hybrid breeding; this is traditionally achieved by many generations of backcrossing to reach homozygosity. This approach is time consuming and may result in inbreeding depression. By making use of haploid induction *in vitro*, with a subsequent doubling of chromosome number, pure lines can be obtained and incorporated into breeding programmes for genetic improvement. Haploids are autonomous, sporophytic plants that have gametophytic chromosome number because they originate from a gametic cell. Haploids can originate from an egg cell or from a male gamete. It can also originate from the microspore nucleus before first pollen grain mitosis when pollen or anther is cultured *in vitro*. Anther culture is the culture of anthers in nutrient rich media, under *in vitro* conditions, regenerate haploids from pollen grains. Important factors influencing the performance of anther and microspore culture has been identified and are listed as follows.

1. The genotype of the donor parent
2. The donor plant growth conditions
3. The stage of microspore development
4. The culture medium and cultural conditions

The work in this project has been undertaken taking these factors into consideration.

Different genotypes of cardamom have been used in this study to find out the comparative performance of these genotypes in anther culture. Flower buds from important genotypes such as CCS1, NKE lines (NKE 3,9,27,34), RR1, MB3, Green gold were used. Flower buds were collected from plants growing in ideal conditions.

Standardization of culture medium and culture conditions

This year's work mainly involved in standardizing the ideal culture medium and culture conditions needed for the production of haploids from anthers cultured *in vitro*.

Effect of growth regulators

The presence of an appropriate concentration of growth regulators in the medium plays a critical role in callus or embryo formation in anther culture. As there are no reports on the production of haploids in cardamom by anther culture, the role of individual growth regulators were studied.

Different growth regulators like a- naphthalene aceticacid (NAA), 2,4- dichlorophenoxy aceticacid (2,4-D), indole-3-acetic acid (IAA), indole–3-butyricacid (IBA), 6-benzylaminopurine (BAP), Kinetin (KN) and Thidiazuron (TDZ) at different concentrations

ranging from 0.1 -10.0 mgl-1 (in the case of TDZ concentrations ranging from 0.01-0.9 mgl-1 were used) were tested for their efficacy to induce androgenesis. Both liquid as well as solid media were tested.

Anthers cultured on to media containing different growth regulators individually did not show any specific response expect in the case of TDZ. The anthers remained intact for 4-6 days and started browning after that. The anthers were retained in the same medium for a period of 30-40 days and observed, but did not show any specific response. When TDZ was used in different concentrations the anthers responded by getting swollen. Maximum percentage (68%) of response (swollen anthers) was observed when 0.1mgl-1 TDZ was used in MS medium. The anthers that showed a swelling response were retained in the same medium for 30 days and subcultured on to the same medium and observed for a period of 60-70 days did not show any other response other than swelling. Studies were conducted to ascertain the effect of different growth regulators individually when the anthers were cultured on liquid medium, using the flotation method. In liquid medium also the anthers did not show any specific response to individual growth regulators tried.

The effect of different growth regulators in combinations of different concentrations was tried in MS medium to study their effect on anther culture. NAA (0.5-1.0mgl^{-1}) when used with 0.5mgl ^{1}BAP alone and along with 0.5-2.0mgl ^{1}KN showed only swollen response in the anthers cultured. 2,4-D also produced the same response when used along with BAP alone or along with BAP and KN in the same concentrations. 2,4-D at concentrations 0.5-2.0 mgl^{-1}when used with 0.5-2.0mgl^{-1}KN produced friable callus with the maximum percentage of anthers responding in MS medium fortified with 2.0mgl^{-1} 2, 4-D and 1.0 mgl^{-1}KN.

When NAA (0.5-2.0mgl^{-1}) was used with KN (0.5-2.0mgl^{-1}) there was production of nodular callus from the anthers, with maximum percentage of anthers responding in MS medium containing 2.0mgl^{-1}NAA and 1.0mgl-1KN. When TDZ (0.1mgl ^{1}) was used along with NAA/ 2,4-D (0.5-2.0 mgl^{-1}) there was production of nodular callus from anthers with a greater percentage of anthers responding, the maximum being 54% in MS medium containing 0.5 mgl^{-1} 2, 4-D and 0.1mgl^{-1}TDZ.

Effect of different culture media

Nutritional requirement of anthers is one of the important factors, which determine androgenesis. So, the effect different basal media, other than Murashigue & Skoog (MS) were studied. They include Keller's, Nitsch & Nitsch (NN), Schenk & Hildbrandt (SH). The effect of growth regulator combinations, that gave response in MS media, was tried in these media also. The results obtained were not significantly better than those obtained in MS medium.

Effect of different additives

To study the effect of different additives on anther culture, different additives were incorporated along with growth regulators in MS media. Additives were used along with the growth regulator combinations that gave response in terms of nodular callus formation. Additives such as Coconut water (CW) (15-20%), Casein hydrolysate (CH) (0.1-0.2%) and Trypton (0.1-0.1%) were used. Incorporation of additives did

not alter the nature of response of the anthers, but there was a significant increase in the percentage of anthers responding by producing nodular callus. Maximum number of anthers responded (68%) in MS medium containing 0.5mgl^{-1} 2,4-D, 0.1mgl^{-1} TDZ and 0.2% Trypton.

Effect of different carbon sources

Alternative carbon sources other than sucrose such as Glucose, Maltose and Fructose were also incorporated in to the medium. MS media with 0.5 mgl^{-1} 2,4-D+0.1 mgl^{-1}TDZ+0.2% Trypton that gave best response in terms of nodular callus formation was used for all experiments with different carbon sources. Alternative carbon sources such as glucose maltose and fructose were used along with sucrose so as to make the total carbon source availability as 30%, the above-mentioned carbon sources were also used individually (Table.5). MS media with 0.5 mgl^{-1} 2,4-D+0.1 mgl^{-1}TDZ, 0.2% Trypton along with 25% sucrose and 5% glucose or 15% sucrose and 15% glucose produced shoots along with shoots. These shoots developed onto plantlets on transfer to medium containing.

Effect of cold treatment on anther culture of cardamom

Cold treatment has proved to be beneficial for androgenic induction in many of the horticultural crops. Treatment of cardamom flower buds with a cold shock prior to inoculation was not possible as the anthers decayed and turned brown due to bacterial infection if kept for more than 24 hours after collecting from the plant. To avoid this the chilling treatment was given after inoculation on to the medium. The inoculated anthers were incubated in a BOD incubator at temperatures ranging from 4-16^{0}C for 8-72 h. The cultures were transferred to normal culture conditions after this treatment. Cold treatment did not trigger any specific responses in cultured cardamom anthers.

Culture of Cardamom anthers along with cardamom callus (Nurse culture)

Anthers were cultured along with cardamom callus, separated from the callus using a sterilized filter paper. Media in which anthers gave best response when cultured with out callus, were used in this experiment also (MS media with 0.5 mgl^{-1} 2,4-D+0.1 mgl^{-1}TDZ, 0.2% Trypton along with 25% sucrose and 5% glucose or 15% sucrose and 15% glucose). Anthers cultured in this way did not evoke any specific response except swelling.

In order to trace the reason for the non response of many anthers, 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. It was found that the viability of the microspore looses within 4 – 6 days of inoculation and the nuclei of the microspores showed a tendency towards degeneration after that.

The project is being continued with the following **objectives:**

- Enhancing the repeatability of plant regeneration from anthers and anther derived callus.
- Cytological indexing of anther/anther callus derived plants and identification of haploids.
- Microspore culture for enhanced haploid production.

CHARACTERISATION OF NUTMEG GERMPLASM FOR QUALITY

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This project was initiated with the following **objectives**:

1) Characterising nutmeg germplasm based on quality evaluation.

2) Identification of quality nutmeg accessions from germplasm conservatory.

Nutmeg, mace and leaf were evaluated for butter, volatile oil and oleoresin. Nutmeg fat or butter, which is extracted using petroleum ether ranged from 21.0 to 42%. Acc. A 4/12 contained 42% butter. A 11/10, A 4/11, A 9/18, A 9/4/16 are some of the other accessions with high butter.

Nutmeg essential oil ranged from 4.5 to 16.5 %. A 9/18 contained 16.5% oil. Other high oil containing accessions are A 4/5, A 11/12, A 9/53 and A 9/150. Myristicin and elemicin are the two hallucinogenic principles in nutmeg oil. Myristicin content ranged from 1.3 to 17.6% in nutmeg oil. Mace contained 4.9 to 26% oil. High mace oil accessions are A 4/5, A 9/86, A 9/95, A 9/53, A 4/11, A 9/18 and A 9/63. Myristicin in mace oil ranged from 0.6 to 22 %. Oleoresin in nutmeg ranged from 4 to 17% and mace ranged from 11 to 32%.

The pigment which impart colour to mace is lycopene. Accession A 4/5, A 9/11, A 4/12, A 9/74 and A 9/53, A 9/86 are the ones with high lycopene. A 9/74 has 273.9 mg% lycopene. Lycopene is not a stable pigment, and is sensitive to sunlight. When mace is powdered and stored the lycopene content decrease to about 25% of the original. Pectin content in the dried rind is about 8%.

Leaf oil content ranged from 1.0 to 2.5% and myristicin ranged from 0.3 to 11.8% and elemicin from 0.3 to 7.2%. The analysis indicated that there is no definite trend with regard to oil in male or female lines.

Forty- nine accessions were characterised using the isozyme pattern. Peroxidase and polyphenol oxidases were found to be useful in the study. Peroxidase gave about nine bands and polyphenol oxidase one band. We could not get any significant variability in isozyme pattern among the accessions.

ORGANISATION OF GINGER AND TURMERIC GERMPLASM BASED ON MOLECULAR CHARACTERISATION

B. Sasikumar
Indian Institute of Spices Research, Calicut.

This project was initiated with the following **objectives**:

1. Characterisation of ginger and turmeric germplasm using molecular markers.
2. Build up a core collection of ginger ad turmeric germplasm based on molecular and morphological features.
3. DNA profiling of improved varieties of ginger and turmeric as well as cultivars.

Progress of work

a) Isolation of DNA

Many protocols are available for isolation of DNA from plant tissues. They all start with some form of cell lysis followed by deproteinisation and recovery of DNA.The main differences between various approaches lie in the extent of deproteinisation and in molecular weight of DNA produced.

Among different methods tested the one developed by Maghai –Maroof *et al* (1984) with very slight modifications was found most suitable for ginger and turmeric.

Segments of tender leaves (approximately five grams) were crushed in liquid nitrogen and disrupted in aqueous solution containing a chelating agent 2,mercapto-ethanol to inhibit nuclease action and a detergent CTAB (cetyl trimethyl ammonium bromide) for solubilizing membranous materials. The proteins from the extract were denatured and precipitated using phenol. Poly vinyl pyrolidone (PVP) was added to the extraction buffer to remove phenolic compounds. DNA, precipitated in ice-cold isopropanol was desalted with 70% ethanol .The extracted DNA was quantified spectrophotometrically and was found relatively pure. Intact high molecular weight DNA was visualized in 0.8 percent agarose gel electrophoresis.

b) Standardization of PCR conditions

Polymerase chain reaction is based on the *in vitro* enzymatic amplification of the target DNA using four dNTPs, a pair of oligonucleotide primers and the enzyme Taq-polymerase.The reaction involves repeated cycles, each consisting of a denaturation, a primer annealing and an elongation step. Varying conditions for each of these steps were experimented with varying concentrations of components in the polymerase chain reaction mixture. Final concentration of 0.15 to 0.25 mM dNTPs along with 2.5mM $MgCl_2$ and 0.5U Taq DNA Polymerase was found suitable for good amplification. The denaturing and annealing temperatures were found highly specific for ginger and turmeric and primer extension was found optimal at 72°C.

c) RAPD Profiling

Using 10mer primers *viz.* OPQ-20, R-5, T-13 and X-7 twenty accessions of turmeric were DNA profiled. Work on remaining accessions and with other suitable primers are in progress. Primer scanning for ginger varieties is also started.

EFFECT OF ORGANIC FERTILIZERS ON SOIL QUALITY, PRODUCTIVITY AND QUALITY OF BLACK PEPPER AND CARDAMOM

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This project was started with the following **objectives**:

1. Investigations for understanding the organic status of traditional pepper and cardamom growing soils of Kerala and Karnataka states.
2. Investigations into changes induced in soil quality by introduction of various kinds of organic fertilizers on physical, physico-chemical and microbiological properties of soils.
3. Investigations on effect of organic fertilizers in making available native and added nutrients.
4. Investigations into effect of organic fertilizers on soil organic matter decomposition.
5. Investigations into effect of organic fertilizers on nutrient use efficiency.
6. Investigations on effect of organic fertilizers on production and quality of organic spices.
7. To work out the production cost.

For the third consecutive year, sub-plot treatments viz., Check, FYM, Neem Cake, Leaf Compost, Vermicompost and NPK @ 100:40:140 kg/ha were imposed for pepper and cardamom in the experimental field in Coorg and at Chelavoor in a split plot design.

Greenhouse Experiment

Morphological observations reveal that the East-West and North-South canopy width increased with the application of organics. It was highest in the vermicompost treatment.

Soil chemical analysis showed that the pH of the soil treated with organic fertilizers has increased considerably when compared to the absolute control and the NPK chemical and fertilizers treated soil, which may be attributed to buffering from bicarbonate and organic acids in organic fertilizers. As compared to the organic treatments, % organic carbon was very low in the NPK treated soil. Release of organic acids helped in the solubilisation of P among the organic treatments but P availability was low in the NPK treated soil. The micronutrient availability was significantly high in vermicompost treatment followed by leaf compost and FYM treatments when compared to the inorganic treatment. Soil organic matter fractionation showed that humic acid content of the soil was high in FYM and leaf compost treatments, whereas fulvic acid content was high in neem cake treatment.

The quality analysis of pepper berries showed that the piperine content was highest in leaf compost treatment while FYM and vermicompost treatments were on par with NPK treatments. The yield was highest in vermicompost treatment followed by NPK, leaf

compost and FYM treatments that are on par with each other.

Field experiments

Application of organic fertilizers improved the soil physical properties by decreasing the bulk density and increasing the water holding capacity and hydraulic conductivity. It also increased the soil availability of macro and micronutrients. After 90 days of treatments, organic carbon content was highest in FYM. Phosphorus availability was significantly high in vermicompost followed by leaf compost treatments. Leaf compost showed highest availability of K also. Zn availability was maximum in vermicompost.

Microbial population was found to be high in the plots without pesticide sprays. Total bacterial population was highest in neem cake followed by FYM. Vermicompost treatment recorded highest population of phosphate solublising bacteria. Population of N-fixers was high in neem cake, FYM and leaf compost application.

The yield was low in the plot studied due to incidence of Anthracnose disease causing severe spike shedding and yield loss. Hence the recorded yield was on par among the treatments studied.

Cardamom

Water holding capacity of the soil increased from 55% in absolute control to 70% in vermicompost treatment. The organic treatments increased the soil pH. The organic carbon content decreased from that at 90 days, which could be due to microbial activity. The soil availability of P, K, Ca was high in leaf compost treatment. At 90 days the humic acid and fulvic acid contents were higher than at harvest.

The highest yield of 1.13 kg dry/clump was recorded for neem cake treatment, which was on par with vermicompost treatment. Quality parameters 1,8 cineol and a-terpinyl acetate were found to be significantly high in FYM and vermicompost treatments.

IDENTIFICATION AND EVALUATION OF BIOACTIVE PEPTIDES : A BIOTECHNOLOGICAL APPROACH TOWARDS CONTROLLING THE FUNGAL PATHOGEN OF THE QUICK WILT DISEASE OF BLACK PEPPER.

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This project was initiated with the following **objectives:**

(1) To screen synthetic peptides for the identification of bioactive lead peptides against *Phytophthora capsici*

(2) To compare the anti-fungal properties of selected bioactive peptides with other synthetic chemical fungicides.

(3) *In vitro*/ field studies and evaluation of crop protection efficiency of the selected peptides.

Technical programme identified for the year and the work done are given below

(i) Standardization of innoculum concentration and growth conditions of fungal hyphae for bio-assay.

Fungal cultures were obtained and culturing is in progress to standardize the innoculum concentration and growth conditions of fungal hyphae for bioassay.

(ii) Synthesis of peptides

Peptide synthesis has been initiated and is progressing well. The first part of the work is to develop a suitable insoluble polymer resin. Styrene and Polyethyleneglycolacrylamide were selected as the monomers to develop the polymer resin. The resin developed from these monomers possesses the features suitable for peptide synthesis, such as good mechanical and chemical stability, good swelling in solvents used for peptide synthesis and good hydrophobic-hydrophilic balance. We carried out the inverse suspension polymerization and obtained a gel type cross-linked copolymer resin. The resin was purified by soxhletting in various solvents. Then the functional group (amino propyl), to which the peptides should be attached, was introduced in the resin by the functionalisation procedure. The number of functional groups in mol per gram of the resin was judiciously adjusted, so that the peptide synthesis could be carried out most effectively in the next phase of the work.

BIOLOGICAL CONTROL OF PLANT PARASITIC NEMATODES OF MAJOR SPICE CROPS

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This project was initiated with the following **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 the 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.

1. Isolation of naturally occurring biocontrol agents (BCA s)

a) Isolation of bacterial biocontrol agents

Random surveys were conducted in three black pepper growing districts of Kerala namely, Idukki, Ernakulam and Malappuram and 22 soil and root samples were collected from the rhiozosphere of black pepper vines and other plant species. Six soil and root samples were also collected from turmeric fields in Andhra Pradesh. These samples were processed using standard techniques and 241 bacterial isolates were obtained and pure cultures are maintained (Table 1).

Table 1. Isolation of bacterial biocontrol agents

State	Black Pepper	Turmeric	Other plants	Total
Kerala	172	-	50	222
Andhra Pradesh	-	19	-	19
Total	172	19	50	241

b) Identification of fungal biocontrol agents

Out of the 60 fungal biocontrol agents collected and maintained in the repository, 46 isolates were identified with the collaboration of Centre for Advanced Studies in Botany, Guindy Campus, University of Madras, Chennai using the morphological characteristics. Most of these isolates were identified up to the species level, while a few isolates could be identified only up to the generic level. (Table 2).

Table 2. Promising fungal biocontrol agents identified and maintained in the repository

Isolate No.	Name	Isolate No.	Name
Is.1	*Penicillium citrinum*	Is.31	*Verticillium chlamydosporium*
Is.2	*Aspergillus tamarii*	Is.32	*Verticillium chlamydosporium*
Is.3	*Fusarium* sp.	Is.33	*Trichoderma harzianum*
Is.4	*Penicillium fumiculosum*	Is.34	*Verticilluim chlamydosporium*
Is.5	*Humicola* sp.	Is.35	*Verticillum lecani*
Is.6	*Fusarium* sp.	Is.36	*Paecilomyces lilacinus*
Is.7	*Aspergillus restrictus*	Is.37	*Trichoderma viride*
Is.10	*Aspergillus nidulans*	Is.38	*Trichoderma* sp.
Is.11	*Fusarium oxysporum*	Is.39	*Trichoderma* sp.
Is.13	*Fusarium* sp.	Is.40	*Gliocladium* sp.
Is.14	*Scopulariopsis* sp.	Is.41	*Gliocladium* sp.
Is.15	*Scolecobasidium* sp.	Is.42	*Gliocladium* sp.
Is.16	*Trichoderma* sp.	Is.44	*Drechslera* sp.
Is.17	*Penicillium* sp.	Is.45	*Aureobasidium* sp.
Is.19	*Humicola* sp.	Is.46	*Aspergillus fumigatus*
Is.20	*Paecilomyces* sp.	Is.47	*Trichoderma* sp.
Is.21	*Aspergillus ustus*	Is.49	*Aspergillus* sp.
Is.23	*Penicillium digitatum*	Is.51	*Penicillium* sp.
Is.25	*Trichoderma viride*	Is.53	*Paccilomyces* sp.
Is.26	*Fusarium* sp.	Is.56	*Trichoderma* sp.
Is.27	*Paecilomyces carneus*	Is.57	*Verticillum chlamydosporium*
Is.29	*Trichoderma harzianum*	Is.59	*Aspergillus* sp.
Is.30	*Aspergillus fumigatus*	*Is.60*	*Verticillum tenerum*

2. Ecology of biocontrol agents

Studies were conducted to determine the optimum pH and temperature required for growth of the promising fungal biocontrol agents.

a) Effect of pH on the growth of fungal biocontrol agents

The optimum pH required for growth of promising fungal biocontrol agents namely two isolates of *T. harzianum* (Is. 33 and 56) and one isolate of *F. oxysporum* (Is. 11) was assessed in the laboratory. Growth of these fungi was tested on PDA with pH ranging from 3 to 9. The pH of the medium was adjusted by addition of 1N HCL or 1 N NaOH. One day old cultures of test fungi (4 mm dia. discs, cut at the growing edges of the fungal colony) were trans-

ferred to the centre of the petri plates containing PDA adjusted to different pH and sealed with parafilm. Three replication were maintained for each treatment. Radial growth of the fungus in each petri plate was measured at 24, 48 and 72 h after inoculation.

The results showed that the pH required for optimum growth of the fungi varied with the isolates of the test fungi. There was a general reduction in the growth of the fungi in the media with pH above 6. All the 3 fungi grew well up to pH 6 and the growth was also increased with time. Growth of *T. harzianum,* grown in Is. 33 was fast and at 72 h, the fungus covered the whole petri plate. The results showed that a pH 4 for *T. harzianum* Is. 33, pH 5 for *T. harzianum* Is. 56 and pH 6 for *F. oxysporum* Is. 11 is optimum for growth.

b) Effect of temperature on the growth of fungal biocontrol agents

A laboratory study was conducted to find out the optimum temperature required for growth of 3 promising fungal biocontrol agents namely *T. harzianum* (Is. 33), *Paecilomyces lilacinus* (Is. 36) and *Verticillium chlamydosporium* (Is. 34). One day old cultures of the test fungi (4 mm disc) were transferred to PDA in petri plates and were incubated at different temperatures (15, 20 25, 30 and 35 °C) in the incubator. Three replications were maintained for each fungus at each temperature. Growth of these fungi (radial measurement) were recorded at 24, 48 and 72 h after incubation.

There was an increase in growth of *T. harzianum* (Is. 33) with increase in temperature from 15 to 30 °C and at 35 °C the growth was significantly reduced at all intervals of observation. Similarly, the growth of *P. lilacinus* was maximum at 30°C. However, maximum growth of *V. chlamydosporium* was at 25 °C and there was a significant reduction in growth above 25 °C.

The results of the study showed that the optimum temperature for growth of *T. harzianum* and *P. lilacinus* was 30°C while it was 25 °C for *V. chlamydosporium*.

3. Mode of action of Plant Growth Promoting Rhizobacteria on (PGPRs) *M. incognita*

The bioefficacy of the bacterial isolates (PGPRs) against root knot nematode, *M. incognita* was evaluated *in vitro* by different methods to identify the efficient isolates and also their mode of action in suppressing the nematodes.

a) Bacterial metabolites

The effect of metabolites released by the bacterial biocontrol agents in to the buffer solution on the mortality of root knot nematodes was assessed. Potassium phosphate buffer (pH 6.8, 5 ml) was taken in a culture tube and sterilized to which a loop full of bacterial cells of the test isolate was added and incubated at 4 °C for 10 days. The buffer from this culture tube was transferred to 3 wells @ 100 µl/well in microtitre plate. Similarly, for each of the 81 test isolates, 3 wells were maintained. Nematode suspension (100 µl) containing around 25 surface sterilized second stage juveniles of *M. incognita* was added to each well. The wells containing only surface sterilized nematodes in sterile water served as control. Number of nematodes dead in each well was recorded after 48 h of exposure under a stereoscopic microscope to assess the suppressive action of bacterial isolates on root knot nematodes.

Nematode mortality after 48 h of exposure was lowest in Is. 75 (1.41%) and highest in 15.83 (77.16). Nine isolates (Is. 77, 83, 87, 105, 107, 110, 113, 116, 118) caused above 60 % mortality of the nematodes. Thus study indicates that the metabolites released by the bacteria caused the death of the second stage juveniles of root knot nematodes and are useful as biocontrol agents.

b) Bacterial culture filtrate

The nematicidal property of culture filterates of 59 bacterial isolates on the root knot nematodes was assessed. The test organisms were grown in peptone water for 48 h and then centrifuged at 13,600 g for 5 min. The supernatant was taken out and transferred to the wells of microtitre plates @ 100 µl/well aseptically. Each one is surrounded by wells containing sulphuric acid (0.05m) to trap the toxic ammonia liberated from the bacterial filterate. Controls consisted of sterile peptone water and sterile distilled water (100 µl/well). For each treatment 3 replications were maintained. An aqueous suspension containing sterilized second stage juveniles of root knot nematodes was added to each well @100 µl/well. After 48 h of incubation, the number of nematodes dead in each well was recorded with the aid of stereoscopic microscope. Ammonia trapped in the sulphuric acid was estimated using Wessler's reagent.

The results showed that there was a wide range in the mortality of the nematodes in the culture filterates of different isolates. The highest nematode mortality was in the culture filterate of bacterial isolate C 18 (93.04 %) and it was above 90% in many of the culture filterates. Thus study also indicated that culture filteration of most of the bacterial isolates caused higher mortality of the nematodes with in a short period of 48 h.

c) Direct action of bacteria on nematodes

Bacterial suspension were prepared in Peptone water (5 ml) by inoculating with 100 µl of 24 h old bacterial culture incubated at 28°C. This bacterial suspension was transferred to sterile cavity blocks @ 1 ml/block and surface sterilized second stage juveniles of *M. incognita* were added and maintained at 28°C. Fifty eight isolates were tested. For each isolate 3 replications were maintained. Nematodes in sterile water without bacterial suspension served as control. The mortality of the juveniles was recorded with the aid of a stereo microscope after 48 h and compared with that of uninoculated control.

The results showed that all the bacterial isolates tested killed the second stage juveniles of root knot nematodes in various degrees except the isolate C3 where there was no mortality of the nematodes. The mortality of the nematodes was lowest in isolate 126 (0.33%) followed by isolate 113 (2.09%). Highest mortality of the nematodes was found in isolate 109 (93.02%) followed by isolate 62 (92.07%) and isolate 125 (90.34%). All the other isolates caused more than 60% mortality of the nematodes.

d) Becker method

Bacterial isolates were cultured in Nutrient broth in culture tubes and aerated in an incubator shaker for 2 days at 28°C. A loop full of the bacterial suspension was streaked as a cross (x) on Triptic Soy Agar 10% medium contained in petri plates and incubated at 27°C for 4-6 days depending on the growth rate of the test organism. From these petri plates 3 discs (5 mm dia.)

were cut close to the centre of the cross with a sterile cork borer and transferred to 3 wells @ 1 disk/well of sterile microtitre plate. To each of these wells 40 µl of buffered 1.5% water agar (with 10mm HEPES, pH 7.2) containing rifampicin (100 µg/ml) was added and these microtitre plates were covered with lid, sealed with parafilm. After incubating over night, nematode suspension (50 µl) with around 20 surface sterilize second stage juveniles of root knot nematodes in sterile water was added to each well and sealed with parafilm and kept at room temperature. Nematode suspension without bacterial suspension served as control. The mortality of the nematodes in each well was recorded. Six bacterial isolates were tested using this method.

The mortality of the nematodes in all the isolates tested was very low indicating that this method may not be useful in screening the bacterial isolates for their efficacy as biocontrol agents of nematodes.

4. Effect of volatile and non-volatile metabolites of bacteria on the suppression of nematodes

The effect of volatile and non-volatile metabolites of 61 bacterial isolates on the mortality of root knot nematode was assessed in the laboratory. Bacterial suspensions (100µl) of the test isolates were added to the sterilized nutrient agar (50 ml) at 45°C in a conical flask and it was then poured into petri plates. After solidification of the medium, nematode suspension (50 µl) containing about 20-25 surface sterilized second stage juveniles of *M. incognita* was added to each petri plate. Similarly, nematode suspension was added to petri plates containing nutrient agar without bacterial suspension. The top of the petri plates were removed and the bottom dish of the petri plates containing bacteria seeded medium was covered with a bottom dish of the petri plate containing nutrient agar medium with nematodes (without bacteria) and a cavity block containing 0.05 M H_2SO_4 to trap toxic ammonia liberated by bacteria under aseptic condition. Suitable controls were also maintained.

After 24 h, 100 µl of Wessler's reagent was added to the cavity blocks inside the petri plate assemblies and the intensity of the colour developed was recorded on visual basis. The mortality of the nematodes in both the dishes of the each assembly was recorded under a stereoscopic microscope. The live and dead nematodes were distinguished by addtion of 2-3 drops of 1N NaOH to the petri plates. The results showed that many of the isolates tested released metabolites toxic to the root knot nematodes.

5. Compatibility of biocontrol agents with agro chemicals

The compatibility of the fungal biocontrol agents with agrochemicals was studied by poisoned food technique. Potato dextrose agar medium was prepared in 100 ml aliquots in conical flasks and sterilized. To the medium the requisite quantity of the chemicals to be tested was added separately so as to get the required final concentration of the test chemical. A series of concentrations from 0 ppm to 48 ppm were prepared. The chemicals were thoroughly mixed by stirring. The medium was then poured into sterile petri plates aseptically. The cultures of the test fungi were grown on PDA for 24 h at the optimum temperature for growth. Small discs (4mm) of the fungus culture was cut from the growing edge of the colony with a sterile cork borer and

transferred aseptically to the center of the petri dish containing the medium with a particular concentration of the chemical. Suitable checks were also kept in the same condition on PDA without the chemical. The plates were incubated at the optimum temperature. The fungus colony diameter was measured every 24h and compared with the control.

The chemicals tested were metalaxyl, potassium phosphonate, phorate and chlorpyriphos. Three fungal isolates viz. *Trichoderma* (Is. 33), *Verticillium* (Is.34) and *Paecilomyces* (Is.36) were included in this experiment.

The results showed that potassium phosphonate, phorate and chlorpyriphos at recommended levels have no adverse effect on these biocontrol agents. However, Metalaxyl at all concentrations reduced the growth and sporulation of all the above fungi tested.

Evaluation of the bacterial isolates in green house

Bacteria were grown on nutrient agar medium for 48 h and suspended in sterile water (10^{10} cfu/ml). Tomato seedlings were raised in 200 ml thermocol cups containing sterilized soil (300 g soil/cup). The rhizosphere of 10 day old tomato seedlings was drenched with 1ml of the respective bacterial suspension. Twenty days after planting, 5 ml of nematode suspension containing about 100 J_2 of root knot nematodes was inoculated to the plants. The plants were carefully uprooted and washed throughly after 50 days. Plant growth parameters such as shoot length, shoot weight, root length, root weight etc. were recorded. The root system was stained with phloxin B and egg masses and galls were counted. Altogether 75 bacteria were tested in 4 different experiments.

These results showed that most of the bacterial isolates improved the growth of tomato plants and suppressed the nematode infestation and multiplication though their efficacy varied in different isolates.

Evaluation of biocontrol agents for the suppression of root knot nematodes in turmeric

Turmeric (variety Prathibha) was planted in microplots ($1m^2$) containing root knot nematodes infested soil. Different fungal isolates were added to the rhiozosphere soil 40 days after planting. Rice grains colonized by the respective fungus having 10^7 cfu/g of carrier (2g/kg soil) was used as the fungal inoculum. At the time of harvest the plants were carefully uprooted and washed thoroughly. Weights of the rhizome were recorded. The root system was stained with phloxin B and the number of egg masses and galls were counted. The fungi were reisolated from all the respective soils at the end of the experiment. Fifteen fungal biocontrol agents were tested.

The results showed that isolate C2 and F13 are highly effective in suppressing the root knot nematode population and increasing the total biomass of the test plant.

SCHEME FOR INTENSIFICATION OF RESEARCH ON VANILLA (*Vanilla planifolia* Andrews)

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Vanilla is an important spice crop in Western Ghats and Pulney hills and there is much scope for improving this crop from export point of view. This project was started with the following **objectives**:

a. Identification of ideal genotypes for Pulney hills.
b. Formulation of integrated production technologies for higher yield and quality of vanilla including processing.
c. Mass multiplication of selected genotypes.

The programme consisted of the following items of work:

1. Collection, conservation and evaluation of vanilla genotypes.
2. Studies on integrated nutrient management.
3. Standardization of quicker mass multiplication techniques.
4. To study the effect of growth regulators on pod set, pod growth and maturity.
5. Standardization of a suitable processing techniques.

Collection, conservation and evaluation of vanilla genotypes :

The mean data recorded on length of vine, internodal length, number of leaves and number of laterals showed that among the various genotypes tried, VP, 11, collected from M/s Limenaph Chemicals (P) Ltd., Rajapalayam registered the maximum length of vine, internodal length, number of leaves and number of laterals. The crop has come to flowering this year.

Studies on Integrated Nutrient Management (INM) in Vanilla :

The biometric characters on length of vine, number of laterals, internodal length and number of leaves were recorded for each treatment. It was observed that the length of vine, internodal length, number of laterals and number of leaves were more in the treatment 100g of NPK/plant/year along with 25g each of VAM, *Azospirillum* and Phosphobacterium / plant / year. The crop has just started flowering during this phase.

Standardization of Quicker Mass Multiplication Techniques :

This trial was conducted in two seasons. The mean data recorded on per cent success (rooting), mean plant growth (new flush formation) and root length (cm) showed that among the various types of cuttings tried, one metre long cuttings registered the highest per cent of rooting (100%) followed by four, three, two and single nodal cuttings in that order. The one metre length cutting also produced more plant growth and root length than the rest of the cuttings. There is no perceptible difference 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.

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

This trial is taken up in the current year. The treatment combination of this trial are:

T_1 – 2,4 – D at 5 ppm spray during flowering
T_2 – 2,4 – D at 10 ppm spray during flowering
T_3 – 2,4 – D at 25 ppm spray during flowering
T_4 – T_1 + GA 50 ppm 7-10 days after fruit set
T_5 – T_2 + GA 50 ppm 7-10 days after fruit set
T_6 – T_3 + GA 50 ppm 7-10 days after fruit set
T_7 – Control

In each treatment four vines were employed with three replications. The observations on percentage of pod set, pod maturity period, pod size, number of pods harvested per vine and quality of cured beans will be recorded. The crop has come to flowering this year.

Standardization of an optimum curing techniques

This trial will be taken up only after the harvesting of vanilla beans. The treatments of this trial are :

T_1 – Peruvian process
T_2 – Guiana process
T_3 – Mexican process
T_4 – Bourbon process

The cured vanilla beans will be subjected to following chemical analysis, such as vanillin content, secondary aromatic compounds like aldehyde, alcohol and esters, volatile oils, resins, organic acids and sugar to determine the best cured beans.

Among the various research programmes, the results of quicker mass multiplication technique could be exploited on pilot (or) field scale. The mean data recorded on percent success (rooting), mean plant growth (new flush formation) and the root length (cm) showed that among the various types of cuttings tried, one metre long cuttings registered the highest per cent of rooting (100%) followed by four, three, two and single nodal cuttings. The one metre length cutting also produced more plant growths and root length than the rest of the cuttings. There is no perceptible difference 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.

ELUCIDATION OF BIOSYNTHETIC PATHWAYS OF CURCUMIN IN TURMERIC

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This project was initiated with the following **objectives**:

a) To study the nature of precursors, intermediates and degradation products of curcumin so as to understand the biosynthetic pathway.

b) To assay and localize the key enzymes involved in the biogenesis, based on the established pathway.

c) Exploring the possibilities of utilizing the data generated from the scheme for establishing the pathways of biosynthesis of the active principles in other spices viz; Pepper and Ginger.

1. PAL activity in the early germination phase

The activity of PAL, the key enzyme involved in curcumin biosynthesis,was determined in the vegetative parts of turmeric viz, rhizomes, leaves and roots, starting from the early phase of germination upto three months (Table 1).

Table 1. PAL activity in rhizomes , roots and leaves(As μmoles of trans cinnamic acid released / min / mg protein) x 10^{-3}

	Rhizomes	Leaves	Roots
Stage 1	82.3	30.3	6.87
Stage 2	20.4	22.5	8.11
Stage 3	21.2	17.0	21.8
Stage 4	14.4	21.7	25.4
Stage 5	14.4	12.0	28.4

2. Cell fractionation for PAL activity

Distribution of PAL in different cell fractions of turmeric leaves showed maximum activity in mitochondrial fraction (Table 2).

Table 2 : PAL distribution in various cell fractions in turmeric leaves

Speed	Time	Fractions		PAL Activity (x 10^{-2})
200 g	5'	Crude extract	R	25.31
1000 g	10'	Chloroplast	R	14.65
10,000 g	15'	Mitochondria	R	28.35
1,05,000 g	2 hrs	Microsomes	R	13.33
		Soluble protein	S	Nil

R – Residue S —Supernatant

3. Distribution of curcuminoids in rhizome during development

Curcumin, the coloring principle in turmeric consists of three compounds - Curcumin I (Curcumin), Curcumin II (demethoxy curcumin) and Curcumin III (bisdemethoxy Curcumin). These compounds are present in varying amounts in rhizomes and possess different medicinal properties.

Eventhough the individual curcuminoids differ in their biological activity, there exists a synergestic functioning of the compounds. Thus the 'Curcumin C 3 –complex' as it is rightly called, possesses a collective effect of all the curcuminoids. The distribution of the three curcuminoids at various stages of plant growth was undertaken so as to get a preliminary information on the *in vivo* synthesis of these compounds.

Analysis of the pooled rhizome samples showed maximum content of curcumin I at 180 DAS (63.9 % of oleoresin), while it was lower (53.3%) at full maturity with a concomitant increase in curcumin II and III (Table 3). Data indicate the possibility that methylation, the final process in the formation of Curcumin I, is maximum at 180 DAS. Further studies on other enzymes involved in the biosynthesis are needed to confirm this

The distribution of the pigments has been observed individually in mother, primary and secondary rhizomes during different stages of growth. Curcumin I, which forms the major portion of the curcuminoids, is distributed uniformly in mother, primary and secondary rhizomes only in the initial stage (120 DAS). As the rhizomes develop, the primary and secondary rhizomes contain higher proportion of curcumin I (61.8-73.6 %) as compared to mother rhizomes (46.4 %). At full maturity, however, primary rhizomes had the highest content. This indicates that at later stages there was a lower production of curcumin II and III, which are the two demethoxy forms. These compounds probably substantiate by providing the methyl acceptor to the final methylated form.

Table 3. Distribution of total curcuminoids in the oleoresin in turmeric rhizomes during development(expressed as percentage)

	Curcumin I	Curcumin II	Curcumin III
120 DAS	57.95	20.31	21.73
150 DAS	57.45	21.34	21.2
180 DAS	63.87	16.36	19.77
210 DAS	53.3	22.4	24.86
240 DAS	58.32	21.56	20.12

4. Identification of phenolic acids and volatile components

Major phenolic acids which act as intermediate precursors of curcumin biosynthesis were identified as caffeic, coumaric and ferulic acids

The relative distribution of the essential oil components through gas chromatograph was attempted. Ar-turmerone was the major component in rhizomes and roots(31.5 & 46.8% respectively), while a-phellandrene was the major component in leaves (32.6%) (Table 4).

Table 4 : Major Essential oil constituents in turmeric rhizome, root and leaf (Through GC) *(Expressed as percentage)*

Rhizome	Root	Leaf
Ar-turmerone (31.5)	Ar-turmerone (46.8)	a-phellandrene (32.62)
Turmerone (9.9)	Ar-curcumene (7.02)	Terpenolene (25.95)
Curlone (10.5)	b-sesquiphellandene(2.34)	P-cymene (5.0)
Ar-curcumene (6.27)	Dehydrocurcumene (4.27)	1,8-cineole(6.52)
b-sesquiphellandrene (2.5)	P-cymene (3.3)	Myrcene (2.3)
b-bisabolene (tr)		a-pinene (2.78)
Dehydrocurcumene (2.23)		bpinene (2.13)
P-cymene (2.98)		

STUDIES ON THE COMPATIBILITY OF *AZOSPIRILLUM* AND BIOCONTROL AGENTS IN TURMERIC

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This project was initiated with the following **objectives**:

1. To study the effect of *Azospirillum* on the nitrogenous fertilizer saving and rhizome rot management in turmeric.
2. To evolve compatible isolates of *Azospirillum* and biocontrol agents for turmeric.
3. To study the effect of combined inoculation of *Azospirillum* with biocontrol agents.
4. To develop pellet formulation consisting of both *Azospirillum* and biocontrol agents.
5. To study the method of application of *Azospirillum* and biocontrol agents to derive the maximum benefit.

Isolation of *Azospirillum*

Thirty strains of *Azospirillum* were isolated from the rhizome and rhizosphere soil of collected turmeric using N-free malic acid semi solid medium and the same was purified and stored as slant cultures.

Out of the thirty isolates, fifteen were obtained from rhizome and the rest from rhizosphere soil. The isolates were named based on the place from where the samples were collected.

Isolation of *Pythium*

Pythium, the causal organism of rhizome rot of turmeric was isolated from the infected turmeric rhizome samples collected from Gobichettipalayam using Potato Dextrose Agar medium. The isolates were confirmed by the microscopic observation. The microscopic observation revealed the multinucleate hyphal characters and lobed sporangia. The pathogenicity of the organism was confirmed by Koch's postulates and test.

Isolation of *Bacillus subtilis*

Attempts were made to isolate *Bacillus subtilis*, an antagonistic soil borne bacterium from turmeric grown soil collected at various places of Coimbatore, using Nutrient agar medium. Following tests were carried out to characterize and identify the organism:

1. Starch hydrolysis
2. Growth in different temperature
3. Microscopic observation

Based on the results, the organism was confirmed as *Bacillus subtilis*.

Characterization of *Azospirillum*

The *Azospirillum* isolates were confirmed by the following tests:

1. Potato infusion agar for non-selective growth and purity check.
2. Gram reaction
3. Nitrate reductase test
4. Utilization of carbon sources
   - (a) Sucrose
   - (b) Mannnitol
   - (c) Fructose

5. Requirement of Biotin
6. Indole production test

Size and shape of the *Azospirillum* isolates were viewed by the microscopic observation (Table 2).

Testing antagonistic activity of biocontrol agents

Antagonistic effect of *Bacillus subtilis*, *Pseudomonas fluorescens* and *Trichoderma viride* against *Pythium* were tested. A medium containing the nutrients required by *Pythium* and antagonistic organism was prepared, autoclaved and plated.

Pythium disc of 8 mm diameter was kept at one end of the Petri plate and incubated at 37°C for three days. After that the plates were observed for suppression of *Pythium* by antagonistic organism.

The results revealed that among the three biocontrol agents *Bacillus subtilis* was highly inhibitory to the *Pythium*.

Testing compatibility of *Azospirillum* with biocontrol agent

A cross streak assay was conducted to study the compatibility of *Azospirillum* and biocontrol agents. A medium containing the nutrients required for the growth of *Azospirillum* and biocontrol agents was prepared, autoclaved and plated. Antagonistic organism was streaked at one end as a single streak and the test organism was cross streaked and incubated at 37°C for 5 days.

The result revealed that *Azospirillum* and *B.subtilis* are highly compatible with each other.

COLLECTION, MAINTENANCE, EVALUATION AND STANDARDIZATION OF AGRO-TECHNIQUE OF A FEW SEED SPICES OF N.E. INDIA

Luchon Saikia
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The project was visualized for developing agrotechniques for seed spices for the Assam regions. The over all works done indicated that black cumin, fennel and fenugreek could be very successfully grown in Assam condition. While coriander is a risky crop due to adverse climatic conditions for seed production purposes. The main conclusions emerged out of this project are the following:

(a) Cumin has no scope of cultivation due to adverse climatic conditions.

(b) Black cumin cultivation was found to be a very promising area for its seeds. All the collections were found to be very promising and observed to be free from natural enemy.

(c) The local germplasm of fenugreek and coriander were found to be inferior in quality and low yielder.

(d) Local coriander collections were found to be susceptible to stem gall diseases and low yielding.

(e) The only local germplasm of fennel could show promising results.

Experimental data on standardization of agro-technique such as spacing, fertilizer doses and date of sowing revealed that each crop responded significantly in respect of the each trial.

1. Sowing date

(a) **Black cumin:** Black cumin could be sown in a wide range from mid October to November.

(b) **Coriander :** Mid November sowing was found to be optimum for coriander. However, there was always a threat from rains during the later part of the crop which may become as a bottleneck for the proper harvesting and storage of the crop.

(c) **Fenugreek :** Fenugreek was found to be bumper producer of seed under Assam conditions and it was observed that the time of sowing could be adjusted from mid October to November.

(d) **Fennel :** One year experiment of fennel indicated that mid November was suitable for sowing the crop.

2. Spacing

(a) **Black cumin :** 30 cm x 10 cm spacing was found to be the highest yielding for black cumin when the crop was sown on mid November.

(b) **Coriander :** 30 cm x 20 cm spacing was adjusted as the optimum for coriander.

(c) **Fenugreek :** 30 cm x 10 cm spacing was found to be best for fenugreek.

(d) **Fennel :** 60 cm x 45 cm was found to be the optimum spacing for fennel.

3. Fertilizer doses

(a) **Black cumin :** The fertilizer dose of 20:30:30 kg of NPK/ha was recommended for the black cumin (8.17 q/ha).

(b) **Coriander :** 60 : 60 : 60 NPK kg/ha produced the maximum yield of coriander (7.85 q/ha).

(c) **Fenugreek :** 25:25:30 kg NPK/ha was found to be best for fenugreek with an yield of 11.80 q/ha.

(d) **Fennel :** 40 : 30 : 30 kg NPK/ha produced the maximum yield of fennel (10.57 q/ha).

Results which can be exploited on pilot or field scale : The crops viz., black cumin, coriander, fenugreek and fennel could be exploited on field.

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

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This project was initiated with the following **objectives**:

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

The progress made during the current year is summarized below.

Soil inoculation studies

Soil inoculation technique has been standardized in order to screen cumin genotypes against *Fusarium oxysporum* f.sp. *cumini* under controlled conditions. Single spore isolates of the fungus was mass cultured on Czapek-Dox broth at 25°C for 15 days. Harvested mycelial mat was homogenized in sterilized distilled water and used for soil inoculation at different concentrations. Cumin variety RZ 19 was used in the test. The fungus inoculated pots alongwith 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. The results revealed that wilt incidence increased with the increase in inoculum density. The wilt incidence varied from 10.0 to 70.0 per cent. The isolate F_3-4 proved to be the most virulent, which caused 70 percent wilt incidence.

Bioassay of crude culture filtrate

The toxicity of sterile crude culture filtrate (CCF) of *F.oxysporum* f. sp. *cumini* was tested in microshoots of cumin variety RZ 19. The CCF was tested at four concentrations i.e. 100,75,50 and 25 percent using sterile distilled water along with controls. Complete wilting of microshoots was recorded after 120 hours of incubation in pure as well as 75 percent CCF(Table 1). For screening microshoots raised for cumin genotypes, 50 percent CCF of *F.oxysporum* f.sp. *cumini* can be used.

Table 1: Effect of crude filtrate (CCF) of *Furarium oxysporum f.sp. cumini* on microshoots of cumin var. RZ 19.

CCF:SDW	Duration of treatment (hours)			
	48	72	120	144
100:0	+	++	+++	+++
75:25	+	++	+++	+++
50:50	H	+	++	++
25:75	H	+	+	++
SDW	H	H	H	H
CDB	H	H	H	H

CCF : Crude culture filtrate
SDW : Sterile distilled water
CDB : Czapek-Dox broth
H : Healthy

+ : Initiation of wilting
++ : Partial wilting
+++ : Complete wilting

Detection of fusaric acid in culture filtrate

The culture filtrate of *Fusarium oxysporum* was extracted with ethyl acetate and the residue was further tested by paper chromatography using solvents butanol : formic acid : water (75 : 15 :10). The colour of the spots developed indicated the presence of fusaric acid in culture filtrate.

Effect of nitrogen sources on growth of *Fusarium*

Effect of three nitrogen sources i.e. sodium nitrate, asparagines and ammonium sulphate on mycelial growth of *Fusarium oxysporum* f.sp. *cumini* was studied. Czapek-Dox media was supplemented with nitrogen sources @ 2g/litre medium. Ten single spore isolates were used in the test. Observation on mycelial dry weight was taken after 15 days of incubation at 25±1 °C. Maximum growth of most of the isolates was recorded in presence of sodium nitrate while it was least in case of ammonium sulphate. Asparagine was next preferred source. The test isolates showed variability in mycelial growth with respect to source of nitrogen. Mycelial growth was relatively higher in isolates F_1 and F_3-4 in presence of sodium nitrate compared to other isolates.

Regeneration studies in cumin

Three cumin varieties i.e. RZ 19, UC 216 and UC 200 were used in regeneration studies. Different explants viz., roots, colyledons, hypocolyl, shoot tips and leaves taken from 14 to 17 day old aseptically grown seedlings, were cultured on MS medium having different hormonal combinations viz., 2,4-D, TDZ, NAA, IBA, PAA (0.1-1.0 mg/l). Embryoids were developed from roots, hypocotyl and cotyledons on 2,4-D supplemented media. However, these embryoids did not germinate in media supplemented with various combinations of hormones. Rooting and callusing was observed from cut end of roots on medium containing IAA and IBA (0.1-1.0 mg/l). Very good shoot multiplication was observed on kn supplemented media.

Maturation and germination of embryoids of cumin

Effect of different combinations of 2,4-D, TDZ, BAP, ABA, sucrose levels and amino acids viz, proline, arginine, serine and glutamine in maturation and germination of somatic embryoids of cumin was studied. Only morphological changes of embryoids were observed in response to certain treatments; but the embryoids did not germinate.

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15 Tirhut College of Agriculture, RAU, Dholi

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17 Narendra Dev University of Agriculture and Technology, Kumarganj

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18 Indira Gandhi Krishi Vishwa Vidhyalaya, Raigarh

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Technical Assistant	:	Vacant

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

RELEASE OF GRANTS DURING 2000-2001 (Rupees)

Name of the centre	Allocation 2000-2001	Amount released Ist half	IInd half	NRC released	Total	Additional fund released	Grant total released
Pampadumpara (KAU)	558000	279000	279000		558000	75000	633000
Panniyur (KAU)	770025	385012	385013		770025	300000	1070025
Mudigere (UAS-B)	735975	367987	367988		735975	200000	935975
Sirsi (UAS-D)	303900	151950	151950		303900	50000	353900
Yercaud (TNAU)	323025	161512	161513		323025	50000	373025
Coimbatore (TNAU)	333900	166950	166950		333900	200000	533900
Chintapalli (APAU)	333900	166950	68713		235663		235663
Jagtial (APAU)	303000	151500	151500		303000	150000	453000
Guntur (APAU)	333900	166950	127000		293950		293950
Solan (YSPUHF)	1104750	235500	235500	633750	1104750	500000	1604750
Pottangi (OUAT)	822525	208012	208013	406500	822525	150000	972525
Jobner (RAJAU)	1257650	458325	458325	341000	1257650	835000	2092650
Jagudan (GAU)	521400	166950	166950	187500	521400	100000	621400
Hisar (HAU)	660975	142987	142988	375000	660975	225000	885975
Dholi (RAU)	374475	166987	128514	40500	336001		336001
Kumarganj (NDUAT)	512025	256012	256013		512025	165000	677025
Pundibari (BCKVV)	512025	256012	32674		288686		288686
Dapoli (KKV)	726525	256012	256013	214500	726525		726525
Raigarh (IGKVV)	512025	256012	256013		512025		512025
Total (ICAR Share)	***110.00L	**4400620**	**4000630**	**2198750**	*10600000	**3000000	***13600000

*An amount of Rs. 4.00L obtained as savings from Guntur (Rs. 0.39950 L), Chintapalli (Rs. 0.98237L), Dholi (Rs.0.38475L) and Pundibari (Rs. 2.23338L)

*** Total allocation & Expenditure for 2000- 2001 Rs. 136.00L

** An amount of Rs. 30.00 L has been released additionally under pay and allowance to 13 Centres from the over all saving of Rs. 4.00L and additional fund of Rs. 26.00L received from ICAR vide Council Fax No.6(34)/2000 Budget Dt. 29.3.01 of Under Secretary

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

BUDGET PROVISION - 2000-2001

Name of centre	Details of sanctioned provision for pay & allowances					Grant total	
	Estt	TA	RC	Total	NRC Equipments/ works	(ICAR) share	State share
Pampadumpara (KAU)	5.940	0.30	1.20	7.440		558000	186000
Panniyur (KAU)	8.267	0.40	1.60	10.267		770025	256675
Mudigere (UAS-B)	7.813	0.40	1.60	9.813		735975	245325
Sirsi (UAS-D)	3.052	0.20	0.80	4.052		303900	101300
Yercaud (TNAU)	3.307	0.20	0.80	4.307		323025	107675
Coimbatore (TNAU)	3.452	0.20	0.80	4.452		333900	111300
Chintapalli (APAU)	3.452	0.20	0.80	4.452		333900	111300
Jagtial (APAU)	3.040	0.20	0.80	4.040		303000	101000
Guntur (APAU)	3.452	0.20	0.80	4.452		333900	111300
Solan (YSPUHF)	4.780	0.30	1.20	6.280	8.45	1104750	368250
Pottangi (OUAT)	4.547	0.20	0.80	5.547	5.42	822525	274175
Jobner (RAJAU)	9.722	0.50	2.00	12.222	4.55	1257650	419550
Jagudan (GAU)	3.452	0.20	0.80	4.452	2.50	521400	173800
Hisar (HAU)	2.813	0.20	0.80	3.813	5.00	660975	220325
Dholi (RAU)	3.453	0.20	0.80	4.453	0.54	374475	124825
Kumarganj (NDUAT)	5.327	0.30	1.20	6.827		512025	170675
Pundibari (BCKVV)	5.327	0.30	1.20	6.827		512025	170675
Dapoli (KKV)	5.327	0.30	1.20	6.827	2.86	726525	242175
Raigarh (IGKVV)	5.327	0.30	1.20	6.827		512025	170675
Total	91.850	5.10	20.40	117.35	29.32	11000000	3667000
ICAR share	68.887	53.825	15.30	88.01	21.99		
State share	22.963	1.275	5.10	29.34	7.33		

LIST OF PUBLICATIONS

AMBALAVAYAL

a) Research Articles

Pradeep Kumar,T., Vasantha Kumar.Aipe K.C., Kumaran,K., Susamma,P.George., Manomohanan Das,T.P. and Anith, K.N. 1999. Studies on yielding behavior of black pepper CV Panniyur-1. *Indian Cocoa, Arecanut & Spices Journal*,**1**(3):88-90.

b) Popular article

Susamma,P. George. 2000. Malayorangalil manjukala pachakari, *Karshashree* **6** (1): 26-27.

CHINTAPALLI

1. Performance of different Turmeric varieties in high altitude and tribal areas of Andra Pradesh. *Proceedings of the Centennial conference on spices and aromatic plants*, held at Calicut from 18-21 Sept., 2001.
2. Evaluation of Ginger varieties for high altitude and tribal areas of Andra Pradesh. *Proceedings of the Centennial conference on spices and aromatic plants*, held at Calicut from 18-21 Sept., 2001.

COIMBATORE

a) Research articles

1. Chezhiyan, N and Selvarajan .M. 2001. Three Decades of Spices Research in Tamil Nadu. 'Agriculture – 2000', TNAU Convocation publication series Vol.II. Pp. 319-327.
2. Cheziyan, N and Selvarajan .M. 2001. Coconut Diversity for mite tolerance (Abstract). *National Symposium on Biodiversity vis-à-vis Resource Exploitation: An Introspection*, held on April 23rd to 24th, 2001 at Port Blair, Andaman.
3. Cheziyan, N and Selvarajan . M. 2001. Evaluation of turmeric for curcumin. *National Symposium on Biodiversity vis-à-vis Resource Exploitation: An Introspection*, held on April 23rd to 24th, 2001 at Port Blair, Andaman.
4. Cheziyan, N and Selvarajan .M., 2001. Evaluation and selection for yield in coriander (*Coriandrum sativum, L.*). *National Symposium on Biodiversity vis-à-vis Resource Exploitation: An Introspection* held on April 23rd to 24th, 2001 at Port Blair, Andaman.

b) Popular Article

Chezhiyan, N., Subbiah, .A. and Basker Rajan, G. 2001. Vanilla cultivation techniques (Tamil). *Valarum Velanmai*, March 2001.

GUNTUR

Hari Prasada Rao, N and Sarada, C. 2000. Evaluation of coriander (*Coriandrum Sativam* L.) genotypes for suitability and productivity in Andra Pradesh. *Indian Spices,* **37**(2): 23-24.

JOBNER

1. Agarwal, S. 2000. Constituent analysis of essential oil of *Foeniculum vulgare. Centaninial Conference on Spices and Aromatic Plantsi*, held at Calicut from 20-23 Sept,2000.

2. Agarwal, S. 2000-2001. Quality aspects and export potential in seed spices. In: *Spice Crops of India* (Ed. Prem Singh Arya), Kalyani Publishers Ludhiana, pp. 51-59.

3. Agarwal, S., Sharma, R.K. and Edison, S. 2001. Cumin wilt- Prospects and perspectives. *Spice India*, **14**: 17-20.

4. Dashora, A., Sharma, R.K., Sastry, E.V.D. and Singh, D. 2000. Combining ability analysis in varietal diallel cross of fennel (*Foeniculum vulgare* Mill.) *Centeninial Conference on Spices and Aromatic Plants,* held at Calicut from 20-23 Sept,2000.

5. Sastry, E.V.D.; Kumha,B.L. and Singh,D. 2000. Assosiation studies for seed yield and its attributes in M4 generation of fenugreek. *Centeninial Conference on Spices and Aromatic Plants,* held at Calicut from 20-23 Sept,2000.

6. Singh, D., Rajpput, S.S. and Sastry, E.V.D. 2000. A new method of emasculation in fennel (*Foeniculum vulgare* Mill.). *Centeninial Conference on Spices and Aromatic Plants,* held at Calicut from 20-23 Sept,2000.

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1. Ravishankar, C.R., Chandrappa, H.M., Dinesh Kumar,M. and Tyagaraj, N.E. 2000. Performance of promising cardamom (*Elettaria cardamomum*, Maton) germplasm under high elevation and high rainfall areas. *PLACROSYM.* Dec., 12-15th 2000.

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1. Backiyarani, S., Murugan, M., Joseph Rajkumar, A., and Sainamole, Kurian, P. 2000. Association of yield and yield components in small cardamom (*Eletteria cardamomum*, Maton). *Proceedings of the Twelfth Kerala Science Congress*, 27- 29thJanuary , 2000, Trivandrum.

2. Joseph Rajkumar, A., Saninamole Kurian, P., Backiyarani, S. and Murugan, M. 2000 Occurence of insect - pests on black pepper at high altitudes of Idukki district of Kerala. *Proceedings of the Twelfth Kerala Science Congress*, 27-29th January, 2000, p. 417-420.

3. Sainamole Kurian, P., Josephrajkumar, A., Backiyarani, S and Murugan, M. 2000. Case study of "Pollu" diease epidemic of black pepper in high range of Idukki district. *Proceedings of the Twelth Kerala Science Congress*, 27-29th January, 2000, p. 494-496.

4. Joseph Rajkumar, A., Sainamole Kurian P., Backiyarani, S. and Murugan, M. 2000 Efficacy of conventional insecticides on the suppression of black pepper mussel scale, (*Lepdosaphes piperis* Gr.) (Diaspididae: Hemipptera)- *Entomocongress*, November 5-8, 2000, Trivandrum.

5. Joseph Rajkumar, A., Sainamol Kurian, P., Backiyarani, S.and Murugan, M. 2000.

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1. UnniKrishnan Nair, P.K., Mammooty, K.P. and Sivakumar, G. 2000 (poster presentation), Management of nursery diseases of black pepper. *Centennial Conference on Spices & Aromatic plants,* held at Calicut from 20-23rd Sept. 2000.
2. Unnikrishnan Nair, P.K., Mammooty, K.P. and Sivakumar, G. 2000 (oral presentation). Management of *Phytophthora* foot trot of black pepper. *Centennial Conference on Spices & Aromatic plants,* held at Calicut from 20-23rd Sept.2000.

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1. Panja, B.N. and De, D.K. 2000. Characterization of blue turmeric : A new hill collection. *J. Enteraead,* **4**(4) : 550-557.
2. Panja, B.N., De, D.K. and Mazumder, D. 2001. Evaluation of turmeric (*Curcuma longa* L.) genotypes due to leaf blotch disease (*Taphrina maculans*, Butl.) from tarai region of West Bengal. *Env. & Ecol.* **19**(1) : 125-129.
3. Panja, B.N., De, D.K.and Majumder, D. 2000. Assessment of yield loss in turmeric genotypes due to leaf blotch disease (*Taphrina maculans* Butl.) for tarai region of West Bengal. *Plant Protection Bulletin* **52** (3+4) (Accepted).
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SOLAN

1. Aggarwal, Sonia, Korla B.N and Veena Sharma. 2000. Effects of dates of sowing and mulch treatments on growth and yield of ginger. *Haryana J.Hort. Sci* (in press)
2. Bhrigu Nath and Korla, B.N. 2000. Studies on effect of biofertilizers in ginger. *Indian J. Hort.57* (2): 168-171.
3. Dohroo, N.P and Korla , B.N. 2000. Effect of harvesting stages and curing time of rhizomes on storage rot of ginger in mild-hills of Himachal Pradesh. *Pl. Dis. Res.*, **15**(1) : 85-88.
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In: *Advance in Vegetable Production* (Ed. Kohli et. al.).Centre of Advanced Studies, Deptt.of Vegetable Crops, UHF, Nauni: pp 214-219.

7. Dohroo, N.P. 2000. Study on rhizome mycoflora and rot management of ginger. *Symp. Imp.Pl. Dis. Qual. Prod. Cum Ann. Meet* (NZ) IPS, DWWR Karnal, 20-21 Oct., 2000 :p8(S1).
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10. Dohroo, N.P. 2001. Fast Spreading disease of ginger. *The Tribune*, Agriculture Section, p.17.

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Popular Articles

1. Richard Kennedy, R. and Balakrishnamoorthy, G. 2000. Kudampuli Vivasayam. *Spice India*, **13**(4): 17-22.
2. Richard Kennedy, R. and Balakrishnamoorthy, G. 2000. Sarvasugandhi sagupade, *Spice India*, **13**(15):
3. Richard Kennedy, R. and Balakrishnamoorthy, G. 2000. Murugal sagupadi. *Spice India*, **13**(11): 5-7.
4. Nageswari. K., Pugalendhi L. and Azhakiamanavalan R.S., 2000. Propagation studies in cinnamon (*Cinnamomum zeylanicum*). *Spice India*, **13**(2) : 11-12.
5. Pugalendhi. L., Nageswari K. and Azhakiamanavalan R.S., 2000. Studies on the influence of biofertilizers in nutmeg. *Spice India*, **13**(11) : 16-18.
6. Nageswari, K., Richard Kennedy, R., Jeeva Jothi, L. and Murugesan, R. 2001. Thotta kalai Arachi Nilayam, Yercaud. *Valarum Velanmai*, February, 2001. pp. 31-36.

METEOROLOGICAL DATA 2000

Pamapdumpara

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

Month	Rain fall (mm)	No. of rainy days	Temperature (°C) Max.	Min.	Humidity (%)
January	22.2	6	26.5	14.0	64
February	214.2	9	29.0	13.5	60
March	Nil	Nil	30.0	15.5	43
April	96.8	8	31.5	16.0	62
May	123.8	13	29.0	16.0	66
June	348.5	19	25.8	16.0	87
July	176.4	19	27.6	15.0	80
August	494.3	27	27.6	16.8	89
September	213.8	15	28.5	17.0	75
October	68.9	15	28.8	14.5	68
November	115.0	7	26.0	13.4	67
December	85.8	5	27.5	11.0	60
Total	**1959.70**	**143**			

Pundibari

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Max	Min	RH (%) 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	**3784.1**	**98**	**29.13**	**18.24**	**94.4**	**68.0**

Guntur

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Max	Min	RH (%) Morning	Evening
January	-	-	31.39	17.09	89.26	57.64
February	83.4	4	32.31	21.01	89.35	65.38
March	-	-	35.43	20.76	89.68	30.68
April	18.7	2	39.38	25.72	86.43	63.13
May	46.2	4	40.59	26.87	68.94	46.13
June	205.6	12	36.18	25.67	71.87	53.53
July	145.2	10	34.24	24.90	80.58	64.03
August	401.4	17	31.67	24.49	82.77	67.29
September	71.2	7	34.76	24.46	82.37	62.33
October	96.4	5	33.76	22.88	84.45	61.05
November	8.6	1	31.84	19.27	87.49	61.50
December	39.6	1	29.74	15.86	88.48	54.29
Total						

Sirsi

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Max	Min	RH (%)
January	0	0	32.1	14.3	70.0
February	0	0	30.4	12.5	78.7
March	0	0	35.7	16.4	82.5
April	20.2	2	34.1	20.7	87.8
May	91.4	6	33.4	21.5	87.9
June	504.6	23	27.5	20.7	89.7
July	679.2	20	27.6	20.6	98.2
August	524.6	22	28.5	20.7	100.0
September	215.8	11	30.3	21.0	97.1
October	91.8	8	31.1	20.6	92.5
November	7.8	1	31.1	16.8	87.2
December	0	0	29.5	12.7	74.4
Total	**2135.4**	**93**			

Kumarganj

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

Month	No. of rainy days	Temperature (°C)		RH (%)
		Max	Min	
January	1	23.20	6.30	
February	0	28.70	10.20	
March	0	32.00	13.00	
April	1	38.50	21.20	
May				
June	14	33.70	26.00	
July	17	33.10	25.60	
August	9	33.40	25.40	
September	10	31.80	24.00	
October	1	33.80	20.30	
November	0	26.10	9.40	
December	0	25.00	6.00	
Total				

Dholi

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

Month	Temperature(° C)		RH(%)		Rainfall	No.of rainy days
	Min	Max	7hr.	14hr.	(mm)	
January	9.2	21.6	88	57	-	-
February	10.5	24.0	85	47	5.0	1
March	14.5	30.3	79	40	5.0	1
April	20.5	35.5	74	42	39.0	4
May	24.9	35.4	82	59	173.0	7
June	26.1	33.8	89	71	295.1	14
July	27.7	33.5	89	85	250.5	11
August	24.0	33.6	89	72	194.5	11
September	25.3	31.3	90	74	260.7	9
October	21.4	33.4	88	54	21.5	2
November	16.9	28.8	91	48	-	-
December	9.5	25.1	91	45	-	-

Panniyur

Latitude : 12.5^0 N
Longitude : 74.55 E
Altitude : 95m MSL
Soil type : Laterite

Month	Rainfall (mm)	No. of rainy days	Temperature (^{0}C) Max	Min	RH (%)
January	50.1	3	35.0	20.4	90.0
February	-	-	35.4	20.4	86.6
March	3.0	1	37.2	22.1	83.8
April	105.9	7	36.6	24.8	85.2
May	197.1	9	35.8	24.4	86.3
June	850.6	29	29.1	22.5	94.6
July	513.2	20	29.4	22.0	95.0
August	606.2	24	28.8	22.4	95.0
September	188.9	16	31.2	22.8	92.2
October	344.5	18	31.2	22.2	93.7
November	110.4	2	32.9	21.5	88.3
December	1.9	2	33.1	18.7	91.5
Total	**2971.8**	**131**			

Coimbatore

Latitude : 11^{0}N
Longitude : 77^0 E
Altitude : 426.72m MSL
Spoil type : Clay loam

Month	Rainfall (mm)	No. of rainy days	Temperature Max	Min	RH (%) Morning	Evening
January	2.0	-	30.7	19.5	89	46
February	36.9	4	31.6	19.3	90	48
March	-	-	34.5	20.9	86	32
April	19.9	3	35.2	23.4	85	45
May	13.9	3	35.3	23.4	81	41
June	27.4	5	31.8	22.7	78	53
July	15.7	2	31.5	22.7	78	50
August	163.6	8	30.4	22.5	82	60
September	210.4	9	31.6	22.2	89	59
October	36.8	7	30.9	21.2	91	58
November	75.3	4	29.9	20.8	90	53
December	22.6	3	31.0	18.0	88	46
Total						

Solan

Latitude : 30.5^{0}N
Longitude : 77.8^0 E
Altitude : 1000m MSL
Soil type : Loam

Month	Rainfall (mm)	No. of rainy days	Temperature (^{0}C) Max	Min	RH (%)
January	64.7	6	18.6	3.8	55
February	121.5	6	16.8	2.4	57
March	47.9	3	22.7	7.7	44
April	59.4	4	30.8	12.7	34
May	119.0	8	31.8	17.8	54
June	392.5	11	28.6	18.4	70
July	592.7	15	27.3	20.0	86
August	125.3	8	28.7	19.7	81
September	6.9	1	28.5	16.0	68
October	Nil	Nil	28.2	10.7	52
November	Nil	Nil	23.2	7.2	50
December	Nil	Nil	21.9	2.7	42
Total					

Pottangi

Latitude : 18^{0}34N
Longitude : 82^{0}C52 E
Altitude : 917m MSL
Soil type : Sandy loam

Month	Rainfall (mm)	No. of rainy days	Temperature (^{0}C) Max	Min	RH (%)
January	-	-	29.2	18.7	81.0
February	91.4	16	26.8	14.4	87.0
March	-	-	30.4	19.3	82.0
April	-	-	34.3	21.2	81.0
May	147.6	10	32.6	24.3	81.0
June	211.3	20	29.2	23.4	87.0
July	384.5	22	26.6	18.7	81.0
August	479.6	21	25.4	16.2	94.0
September	131.6	13	24.3	15.6	87.0
October	82.4	6	21.4	15.3	86.0
November	21.6	3	21.2	14.6	87.0
December	-	-	-	11.6	87.0
TOTAL	1550	111			

Yercaud

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Max	Min	RH (%)
January	-	-	-	-	-
February	130	6	32.00	13.5	67.00
March	7	1	28.95	16.37	57.71
April	136.2	6	31.17	15.02	62.70
May	172.1	11	30.00	17.29	64.83
June	57.7	5	25.58	16.10	68.39
July	44.0	3	27.03	16.24	85.56
August	316.4	12	22.47	14.95	63.97
September	305.0	10	24.58	15.68	64.17
October	250.8	7	25.39	16.62	63.48
November	247.9	4	22.77	14.70	64.93
December	46.0	4	21.61	11.73	64.29
Total	**1713.1**	**69**			

Mudigere

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Min	Max	RH (%) Morning	Evening
January	-	-	14.40	29.00	81.00	35.00
February	-	-	14.00	28.80	86.00	40.00
March	-	-	18.30	31.00	83.00	31.00
April	114.40	6	18.90	31.00	90.00	51.00
May	64.00	8	18.50	28.10	90.00	61.00
June	539.60	20	18.20	24.30	90.00	78.00
July	719.00	22	17.79	24.60	92.39	73.94
August	418.80	24	18.06	22.46	91.64	21.38
September	264.60	16	18.03	26.05	90.00	74.26
October	154.80	5	17.74	26.68	89.51	25.50
November	13.60	2	16.68	28.42	72.23	47.30
December	5.00	1	13.75	27.82	67.51	28.51
Total	**2293.8**	**104**				

Ambalavayal

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Max	Min	Humidity (%)
January	0.8	Nil	28.1	16.5	90
February	1.4	Nil	28.5	17.2	94
March	1.4	Nil	31.3	18.9	93
April	110.8	9	30.0	19.8	94
May	107.0	9	28.9	19.1	90
June	335.0	22	24.8	18.6	93
July	222.4	14	25.2	18.2	91
August	395.3	22	24.3	18.2	96
September	276.5	17	26.6	18.3	95
October	138.2	11	26.4	17.8	93
November	53.8	3	27.3	17.2	89
December	106.2	2	25.6	15.1	86
Total					

Raigarh

Latitude : 21°15' N
Altitude : 237 m MSL
Longitude : 82°55' E
Siol tupe : Sandy loan with acidic in nature

Month	Rainfall (mm)	No. of rainy days	Temperature (°C) Max	Min.	Relative humidity (%) Max.	Min.
January	1.42	1	29.31	9.92	76.98	45.20
February	1.44	1	28.84	14.10	80.35	53.92
March	17.78	1	35.21	17.42	79.90	31.42
April	3.04	1	43.13	23.93	62.00	22.53
May	7.62	1	41.42	27.80	70.00	29.06
June	154.94	9	33.66	26.26	83.74	71.83
July	336.23	13	31.93	25.06	90.96	79.35
August	323.85	11	31.50	25.58	87.45	79.84
September	81.28	7	31.50	24.53	88.03	79.83
October	-	-	33.45	21.22	84.03	64.19
November	-	-	30.96	15.50	79.40	47.17
December	-	-	28.32	9.83	77.94	35.58
Total	**917.60**	**45**				

Jagtial

Latitude : Longitude :
Altitude : Soil type :

Month	Rainfall (mm)	No.of rainy days	Temperature (^{0}C) Max	Min	Humidity (%)
January	0.2	1	30.6	12.9	74
February	15.0	2	31.4	17.0	75
March	-	-	36.6	16.3	56
April					
May					
June	247.5	12	34.9	22.1	76
July	152.5	11	31.0	21.1	84
August	355.7	15	30.5	21.0	85
September	40.3	4	32.5	20.6	81
October	22.0	1	33.9	18.2	75
November	-	-	32.2	12.9	70
December	-	-	30.4	7.8	63
Total					

Jagudan

Latitude : Longitude :
Altitude : Soil type :

Month	Rainfall (mm)	No.of rainy days	Temperature (^{0}C) Max	Min
January	-	-	28.1	12.8
February	4	4	31.1	15.9
March	-	-	35.4	17.6
April	-	-	40.7	-
May	-	-	41.7	-
June	222	4	38.7	-
July	130	6	35.8	-
August	7	1	33.9	-
September	39	1	37.1	-
October	98	5	34.6	-
November	-	-	33.7	-
December	-	-	30.0	-
Total	**500**	**17**		

Chintapalle

Month	Temperatures °C		Rainfall	No. of rainy	Relative Humidity (%)
	Max.	Min.	(mm)	days	Forenoon
January, 2000	27.8	9.6	—	—	76.8
February, 2000	26.8	16.0	14.4	2	85.7
March, 2000	30.0	12.4	—	—	76.9
Month & Year	31.0	19.6	38.3	2	81.4
May, 2000	32.5	21.7	103.5	7	75.2
June, 2000	30.5	21.5	214.5	14	85.5
July, 2000	27.7	20.0	199.2	15	85.7
August, 2000	27.2	20.3	235.9	14	91.5
September, 2000	29.4	19.9	40.9	5	91.0
October, 2000	28.7	17.9	76.2	4	90.3
November, 2000	28.1	12.7	5.6	1	84.1
December, 2000	27.8	6.6	13.0	2	81.7
January, 2001	27.9	10.5	3.1	1	84.9
February, 2001	31.6	10.2	—	—	81.7
March, 2001	31.2	17.1	36	3	78.8
Total	347.5	198.2	941.5	66	1005.8
Mean	28.9	16.5	78.4	5.5	83.8
Decennial mean	27.7	15.7	1235.0	86	88.1

Jobner

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

Month & Year	Temperatures °C		R.H.%	Rainfall (mm)	No. of rainy days
	Max.	Min.			
January, 2000	23.0	3.5	65	-	-
February, 2000	26.3	8.1	56	-	-
March, 2000	30.8	10.3	49	5.3	1
April, 2000	40.2	21.1	34	-	-
May, 2000	39.3	27.3	46	13.2	1
June, 2000	39.6	27.3	47	-	-
July, 2000	33.6	25.6	70	13.5	1
August, 2000	33.5	24.7	71	27.6	4
September, 2000	35.1	21.4	60	18.0	3
October, 2000	35.9	14.6	49	0.5	-
November, 2000	29.3	8.3	51	-	-
December, 2000	25.0	4.2	52	-	-

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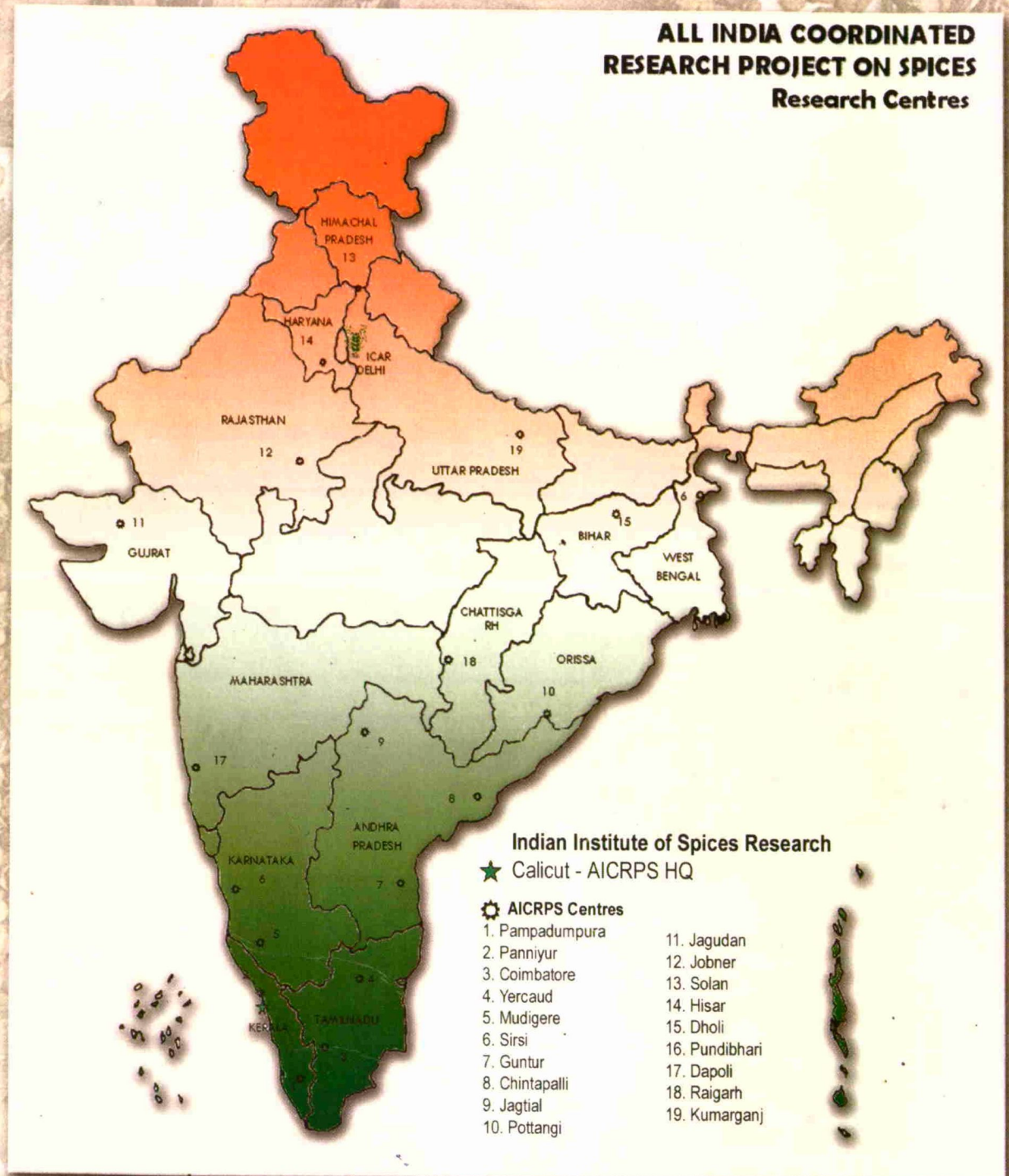
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