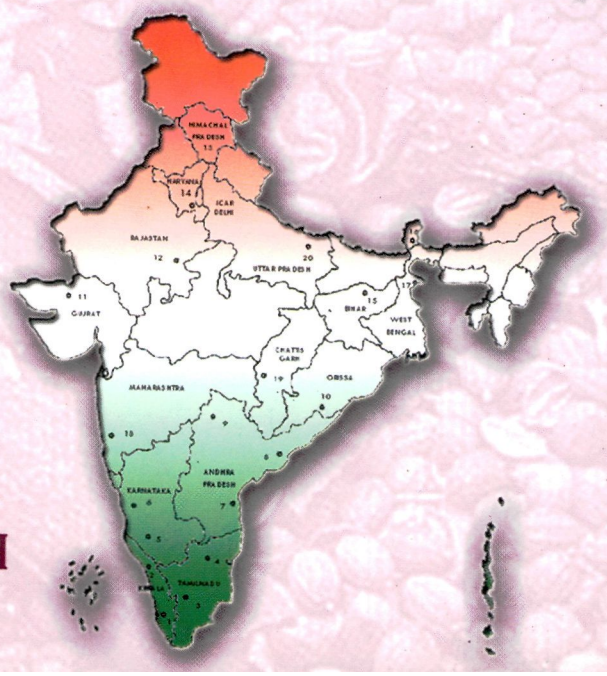
ANNUAL REPORT 2001 - 2002

All India Coordinated Research Project on Spices



INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

Calicut - 673 012, Kerala

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

ANNUAL REPORT 2001-2002

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

Published by:

Dr K V Ramana

Project Coordinator
All India Coordinated Research Project on Spices
Indian Institute of Spices Research
Calicut – 673 012, Kerala, India

Compiled and Edited by

K V Ramana
K N Shiva
Johny A Kallupurackal

Cover design by
A Sudhakaran

Correct citation

All India Coordinated Research Project on Spices, 2003
Annual Report 2001-2002
Indian Institute of Spices Research
Calicut, Kerala

September 2003

Printed at

Printers Castle
Cochin – 682 016.

CONTENTS

1. Project Coordinator's Report (Hindi) 1
2. Project Coordinator's Report 6
3. Technical Programmes 11
4. Progress of work and achievements
   - Black pepper 19
   - Cardamom 39
   - Ginger 48
   - Turmeric 63
   - Tree Spices 84
   - Coriander 88
   - Cumin 103
   - Fennel 106
   - Fenugreek 114
5. Germplasm holdings 125
6. ICAR Ad-hoc Research Schemes 128
7. Staff position 145
8. Budget details and expenditure 149
9. Publications 151
10. Meteorological data 156
11. AICRPS Centres 166

परियोजना समन्वयक की रिपोर्ट

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (AICRPS) भारतीय कृषि अनुसंधान परिषद की परियोजना रीति के अन्तर्गत आनेवाले 80 समन्वित अनुसंधान परियोजनाओं में एक होता है। इस अखिल भारतीय समन्वित मसाला अनुसंधान परियोजनाओं का लक्ष्य भारत में मसाले फसलों पर अनुसंधान आयोजित एवं समन्वित करना है। यह अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना मसाले एवं काजू के लिए सम्मिलित परियोजना के रूप में वर्ष 1971 में आरंभ किया । वर्ष 1985 में मसाला और काजू दोनों के लिए इसे दो अलग अलग परियोजनाओं के रूप में द्विभाजित किया और उसके बाद ही अखिल भारतीय समन्वित मसाला अनुसंधान परियोंजना भारतीय मसाला फसल अनुसंधान संस्थान, कालिकट के मुख्यालय में एक पूर्णकालिक समन्वयक के साथ कार्य किया जा रहा है।

अखिल भारतीय मसाला अनुसंधान परियोजना पहले चार फसलों (काली मिर्च, इलायची, अदरक एवं हल्दी) पर कार्य करने के लिए चार केन्द्रों सहित शुरू हुआ और बाद में 1995 में 12 मसाला फसलों के लिए 14 केन्द्र बनाकर विस्तृत किया। वर्ष 1996 में AICRPS का कार्य अन्य छः केन्द्रों नामतः धोली , हिसार, दापोली, पुंडिबारी, राईगढ और कुमारगंज को जोडकर और भी दृढ बना दिया। आज 15 राज्यों के 15 कृषि विश्व विद्यालयों पर आधारित 19 केन्द्र इस AICRPS के अन्तर्गत कार्यान्वित हो रहा है। इसके अलावा आठ सहकारी / स्वैच्छिक केन्द्र, जिसमें बडी इलायची के लिए आई सी ए आर रिसर्च काम्प्लक्स गौंगटोक भी शामिल है, भी इस परियोजना के साथ सहयोगी कार्य कर रहे हैं। AICRPS में 51 वैज्ञानिक और 32 तकनीकी / सहायक कर्मचारी सहित कुल 83 स्टाफ होता है। भारतीय कृषि अनुसंधान परिषद से इसके प्रत्येक केन्द्र को 75% व्यय दिया जाता है जबकि भूमि और 25% वार्षिक व्यय संबन्धित राज्य कृषि विश्वविद्यालय द्वारा भुगतान किया जाता है। परियोजना का वर्ष 2001-2002 का बजट 155.92 लाख रूपए है जिसमें 117.00 लाख रूपए भारतीय कृषि अनुसंधान परिषद का शेयर होता है।

इस परियोजना AICRPS का अधिदेश राज्य में मसालों का क्षेत्र, उत्पादन और उत्पादकता निम्नांकित द्वारा बढाना है।

i) विभिन्न कृषि परिस्थितिक दशा में कीटों व रोग सह्यता / प्रतिरोधक गुणवत्ता युक्त उच्च उपजवाली प्रजातियों को विसित करना।

ii) विभिन्न कृषि जलवायु स्थितियों के अन्दर मसाले फसलों के लिए कृषि प्रविधियँ मानकीकृत करना।

iii) मूल्य प्रभावित एवं कुशल कीट और रोग प्रबंन्धन पद्धतियों को विकसित करना।

iv) राज्य कृषि विश्व विद्यालय, आई आई एस आर एवं भारतीय कृषि अनुसंधान परिषद के बीच अन्तराफलक के रूप में कार्य करना।

AICRPS के अन्दर विभिन्न केन्द्रों में 12 मसाले फसलों की 120 अनुसंधान परियोजनाएँ चालू होती जा रही है। AICRPS की XVI वीं द्विवार्षिक कार्यशाला केरल कृषि विश्व विद्यालय त्रिचूर में 1-3 नवेंबर 2001 में संपन्न हुई। इस कार्यशाला में विभिन्न मसाला फसल जैसे PV-2 (इलायची) TCP-2 (हल्दी) हिसार सुगंध और UD-446 (धनिया), हिसार मुक्ता, हिसार माधवी और हिसार सुवर्णा (मेथी) की सात आशाजनक प्रजातियों को राज्य / केन्द्र

निर्मोचन के लिए सिफारिश किया गया। धनिया की इन दो प्रजातियों नामतः हिसार सुगन्ध और UD 446 और राष्ट्रीय निर्मोचन के लिए संस्तृत किया गया। इसके अतिरिक्त विकसित प्रविधियों पर आधारित चार सिफारिशें सामान्य अंगीकरण के लिए विस्तार अभिकरणों को उपलब्ध किया गया। एकीकृत पोषण प्रबन्धन, एकीकृत कीट एवं रोग नियन्त्रण तथा जैव कृषि पर जोर देकर नये कार्य्रक्रम का रूपांकन किया गया।

फसल सुधार

AICRPS केन्द्रों ने मसाले फसलों की जननिक संसाधनों को मजबूत बनाया और विभिन्न प्राचलों (parameters) के लिए जर्मप्लासम का मूल्यांकन कार्य भी चालू किया। अब AICRPS के केन्द्रों में उपलब्ध जर्मप्लासम की स्थिति ऐसी है कि उसमें काली मिर्च-461, इलायची-331, अदरक-547, हल्दी- 1221, वृक्ष मसाले-137 और बीज मसाले-3631 है और आशाजनक जर्मप्लासम अक्सशनों को पहचान कर सूचीबद्ध किया गया। इस काल में वर्तमान केन्द्रीय प्रजाति परीक्षण (CVTS) के अतिरिक्त नये केन्द्रीय प्रजाति परीक्षण शुरू किया। धनिया में DH 205 और DG-234 सौंफ में HF-107 और HF-116 और मेथी में HM-372 , 376 और HM-444 की पहचान की गयी और उन्हें केन्द्रीय प्रजाति परीक्षण में जोड भी दिया। मुडिगरे केन्द्र OP बीजपौधे संततियों (D-237, CL-730 और 8-4-D11) में आशाजनक इलायची जीनरूप और अन्य उच्चतम क्लोन (CL-692 और 7-24-D11) की पहचान की गयी। सूखा सह्यतावाले इलायची किस्मों (CL 746, P-6, D 237 और CL-746) की भी पहचान की गयी। सिरसी केन्द्र में काली मिर्च अक्सशन -239 को आशाजनक किस्म के रूप में पहचान की गयी। अदरक की किस्में V3 S1-8 और V1 E8-2 और हल्दी की किस्में PTS-59 PTS-43 और PTS-55 पोटांगी में आशाजनक देखा गया और ये निर्मोचन दशा पर पहूँच रहे है। धनिया की विजातीय किस्म EC- 232666 प्रर्णवाले प्रकार के वाणिज्यिक उत्पादन के लिए पहचान की गयी। निम्नलिखित प्रजातियाँ / किस्में विभिन्न गुणों के लिए पहचान की गयी।

केन्द्रीय प्रजाति परीक्षण के अन्दर पहचान किये आशाजनक प्रजातियाँ / किस्में ।

केन्द्र	फसल	प्रजाति/किस्म	उपज
कुमारगंज	हल्दी	एन डी एच-18	26.56 टन/हेक्टर
	धनिया	यु डी-743	2.67 टन/हेक्टर
	मेथी	जे.फेनु- 210	2.22 टन/हेक्टर
	सौंफ	आर एफ-115	2.27 टन/हेक्टर
सिरसी	काली मिर्च	पन्नियूर-5	3.97 कि.ग्राम/बेल(स्वच्छ)
कोयंबतोर	हल्दी	एल- 2 (बी एस आर- 2)	26.1 टन/हेक्टर
	धनिया	जे सी ओ 283	695.7 कि.ग्राम/हेक्टर
	मेथी	यू एम- 305	400 कि. ग्राम /हेक्टर
जगुदान	जीरा	जे सी-94-37	105.6 कि.ग्राम/हेक्टर
	सौंफ	जे एफ-192	248.9 कि. ग्राम /हेक्टर
		जे एफ- 332	220.1 कि. ग्राम /हेक्टर
	मेथी	जे फेनु- 270	180.8 कि. ग्राम /हेक्टर

पोटांगी	अदरक	वी१ई 8-1	28.53 टन/हेक्टर
		वी ३ एस 1-8	27.40 टन/हेक्टर
जगतियाल	हल्दी	आर एच-5	5.41 टन/हेक्टर
		टी.सी.पी-1	5.20 टन/हेक्टर(सूखा)
गुंटूर	धनिया	एल सी सी-128	596 कि.ग्राम/हेक्टर
		एल सी सी 133	565 कि. ग्राम/हेक्टर
	मेथी	जे एफ -210	625 कि.ग्राम/हेक्टर
		जे एफ -204	589 कि.ग्राम/हेक्टर
चिंतापल्ली	हल्दी	पी टी एस-11	24.8 टन / हेक्टर
	अदरक	आई आई एस आर वरदा	29.0 टन/हेक्टर
जोबनर	धनिया	डी एच- 246	1174 कि.ग्राम/हेक्टर
		आर सी आर- 41	1135 कि.ग्राम/हेक्टर
		यू डी-743	1120 कि.ग्राम/हेक्टर
	जीरा	यू सी- 310	236 कि.ग्राम/हेक्टर
		यू सी -231	226 कि.ग्राम/हेक्टर
		आर इजड-19	220 कि.ग्राम/हेक्टर
	मेथी	जे एफ-204	1397 कि.ग्राम/हेक्टर
		जे एफ- 195	1394 कि.ग्राम/हेक्टर
		आर एम टी- 1	1379 कि.ग्राम/हेक्टर
	सौफ	यू एफ -143	1204 कि.ग्राम/हेक्टर
		यू एफ-144	1021 कि.ग्राम/हेक्टर
हिसार	मेथी	एच एम- 346	2.19 टन/हेक्टर
		हिसार सोनाली	2.14 टन/हेक्टर
		जे एफ- 210	2.05 टन/हेक्टर
	धनिया	डी एच 246	2.18 टन/हेक्टर
		डी एच- 208	1.99 टन/हेक्टर
	सौंफ	एच एफ-33	2.19 टन/हेक्टर
		एच एफ-39	2.00 टन/हेक्टर

गुण विशेष के लिए पहचान किये आशाजनक किस्में

केन्द्र	फसल	किस्म	सूखे प्राप्ति (%)	कुरकुमिन अंश (%)	तेल अंश (%)	ओलिआरसिन (%)
कोयंबतोर	हल्दी	अक्स-360	-	5.10	-	-
		सी एल 115	-	5.92		
सोलन	अदरक	एस जी-882	22.4	-	1.80	7.00
		एस जी-699	21.0	-	1.50	6.50
जोबनर	धनिया	यूडी-744	-	-	0.45	-
		डी एच -246	-	-	0.40	-
	जीरा	जे सी-94-37	-	-	3.70	-
	सौंफ	यू डी-143	-	-	1.86	-
		यू एफ-144	-	-	1.85	-

फसल प्रबन्धन

सिरसी केन्द्र में काली मिर्च-सुपारी मिश्र फसलन रीति में उर्वरक एवं सिंचाई अपेक्षाओं को मानकीकृत किया। मुडिगरे में किये गये अध्ययन से इलायची की उपजता पर सूक्ष्म पोषणों (बोरोन और मोलिब्डिनम) का प्रभाव स्पष्ट होता है। सूक्ष्म पोषण जैसे Zn, Fe, Mn और Cu लगाने पर धनिया एवं सौंफ की उपजता और गुणवत्ता में बृद्वि हो गयी। चिंतापल्ली केन्द्र में अदरक एवं हल्दी के लिए पैकेज पद्वति मानकीकृत किया गया। येरकाड केन्द्र में लौंग और जायफल के लिए जैव उवैरक लगाने सहित एक उर्वरक पद्वति मानकीकृत किया। विभिन्न केन्द्रों की सूचना के अनुसार बीज मसालों की उपजता में जैव उर्वरक (अजोस्पिरिल्लम) का प्रभाव देखा गया।

फसल संरक्षण

पन्नियूर और सिरसी केन्द्रों द्धारा काली मिर्च के फाइटोफ्थोरा खुर गलन रोग प्रबन्धन के लिए एक पद्धति विकसित एवं संस्तुत किया । केरल की इडुक्की जिला में काली मिर्च में रोग एवं कीट प्रभाव का सर्वेक्षण करने पर एन्थ्राक्नोस रोग एवं सीमान्त पित्त कीट (Marginal gall thrips) का अस्तित्व देख लिया। इडुक्की जिला के उच्चतर प्रदेशों में काली मिर्च पर बाधित मसल शल्क को घटाने के लिए फल तोडने के बाद पाक्षिक अन्तराल में मोनोक्रोटोफास (0.05%) या डायमेतोयट (0.05%) दो बार छिडकना अत्यन्त प्रभावी दिखायी पडा। सिरसी केन्द्र में खेत में लगाने के लिए टाइकोडरमा को बडी मात्रा में उत्पादित करने हेतु कम लागतवाली प्रविधि विकसित की गयी।

संग्रहण में अदरक राइजोम की सडाई की रोक राइजोम को डीतैन एम- 45+ बाविस्टिन (5 ग्राम + 3 ग्राम / कि.ग्राम बीज) उपचार करके रेत परतवाले गड्ढों में संग्रहण करके किया जा सकता है, जिसके द्वारा राइजोम में कम रोग आपतन के साथ उच्चतम उपजता भी प्राप्त होता है। विभिन्न केन्द्रों में धनिया की म्लानी रोग एवं अदरक का राइजोम गलन के लिए नियन्त्रण उपाय विकसित किया गया। बिहार के विभिन्न भागों में आयोजित सर्वेक्षण से धनिया में तना पित्त रोग ज्यादा होते देखा गया। विभिन्न कीटों एवं रोगों के उन्मुक्त / प्रतिरोधक कई जर्मप्लासम अक्सशनों / प्रजातियों की पहचान की गयी।

कीटों एवं रोगों के प्रति जर्मप्लासम की प्रतिक्रिया

केन्द्र	फसल	कीट / रोग	प्रतियोगी / प्रजातियाँ	प्रतिक्रिया
जोबनर	धनिया	तना पित्त	आर सी आर- 41	उन्मुक्त
			आर सी आर-435	
			आर सी आर-436	
		मूल गांठ गोल कृमि	आर सी आर-435	
			आर सी आर-436	
			आर सी आर-684	प्रतिरोधक
			आर सी आर-685	
			आर सी आर-686 &	
			यू डी-446	
	जीरा	म्लानी	यू.सी-223	प्रतिरोधक
	मेथी	मूल गांठ गोल कृमि	यू एम-305	उन्मुक्त
			यू एम-32	
			यू एम-34	
			आर एम टी-303 &	
			यू एम-322	
		पाऊडरी मिल्डयू	यू एम- 305	उन्मुक्त
			यू एम -32, यू एम- 34	
			यू एम-143 & यू एम-103	प्रतिरोधक
जगुदान	जीरा	फुसेरियम म्लानी	जे सी- 2000-68	
			जे सी- 2000-71	संयत
			जे सी-2000-67	प्रतिरोधक
			जे सी- 2000-72 &	
			जे सी- 2000-69	
जगतियाल	हल्दी	पर्ण चित्त	जे टी एस -606 &	
			जे टी एस- 1	प्रतिरोधक
		पर्ण दाग	पी सी टी-14,	
			जे टी एस- 604 & टी एस -2	प्रतिरोधक

PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices (AICRPS) is one among the 80 Coordinated Research Projects operating under ICAR system. The aim of AICRPS is to conduct and coordinate research on spice crops in the country. The AICRP on Spices was started in 1971 (IV Plan) as a combined project on spices and cashew. It was bifurcated in to two separate projects one each for spices and cashew in 1985 and since then the AICRPS started functioning with a full time Coordinator with Headquarters at Indian Institute of Spices Research (IISR), Calicut.

The AICRPS initially started with four centres to work on four crops (black pepper, cardamom, ginger and turmeric) was extended to 14 centres, covering 12 spice crops during 1995. The activity of AICRPS was further strengthened in 1996 by adding six more centres namely, Dholi, Hisar, Dapoli, Pundibari, Raigarh and Kumarganj. At present 19 centres spread over in 15 states based at 15 Agricultural Universities are functioning under AICRPS. In addition, eight co-operating/voluntary centres including ICAR Research Complex, Gangtok for large cardamom are collaborating with this project. The total staff strength of AICRPS is 83, which includes 51 scientists and 32 technical/auxiliary staff. The ICAR is meeting 75% expenditure of each centre while the land and 25% of the expenditure are met by the respective State Agricultural Universities (SAUs). The budget of the project for the year 2001-2002 was Rs.155.92 lakhs with Rs.117.00 lakhs as ICAR share.

The mandate of the project is to increase area, production and productivity of spices in the country through:

i) Evolving high yielding varieties with quality attributes, tolerant/resistant to pests and diseases for various agro-ecological situations
ii) Standardizing agro-techniques for the spice crops under different agro-climatic conditions
iii) Evolving cost effective and efficient pest and disease management practices
iv) Working as interface between SAUs, IISR and ICAR.

About 120 research projects covering 12 spice crops are being operated at various centers under AICRPS. The XVI Biennial Workshop of AICRPS was held at Kerala Agricultural University, Thrissur during 1-3 November 2001. In this workshop, seven promising varieties of different spice crops viz., PV - 2 (cardamom), TCP - 2 (turmeric), Hisar Sugandh and UD - 446 (coriander), Hisar Mukta, Hisar Madhavi and Hisar Suvarna (fenugreek) were recommended for State/Central release. Among these, two coriander varieties namely, Hisar Sugandh and UD - 446 were recommended for national release. Besides, four recommendations (3 for crop production and one for crop protection) based on the technologies developed were also made available to the extension agencies for general adoption. New programmes were also formulated giving emphasis on Integrated Nutrient Management, Integrated Pest and Disease Management and Organic Farming.

CROP IMPROVEMENT

The AICRPS centres strengthened the

genetic resources of spice crops and evaluation of the germplasm for different parameters was carried out. At present, the germplasm holdings of AICRPS centres consist of black pepper-461, cardamom-331, ginger-547, turmeric-1221, tree spices-137 and seed spices-3631 and promising germplasm accessions were identified and short-listed. New CVTs were initiated during the period in addition to the existing CVTs. In coriander DH - 205 and DG - 234; in fennel HF - 107 and HF - 116 and in fenugreek HM - 372, 376 and HM - 444 were identified and included in CVTs. Promising cardamom genotypes in OP seedling progenies (D - 237, CL – 730 and 8-4-D11) and other superior clones (CL - 692 and 7-24-D11) were identified by the Mudigere centre. Cardamom lines tolerant to drought (CL - 746, P - 6, D - 237 and CL - 746) were also identified. Black pepper Acc - 239 was identified as a promising line at Sirsi centre. Ginger varieties, V_3S_1 - 8 and V_1E_8 - 2 and turmeric varieties, PTS - 59, PTS - 43 and PTS - 55 were found promising at Pottangi and are in the process of release. Exotic line of coriander, EC - 232666 for leafy type was identified for commercial cultivation. The following varieties/lines were identified for various attributes.

Promising varieties/lines identified for yield under CVT

Centre	Crop	Variety/line	Yield
Kumarganj	Turmeric	NDH - 18	26.56 t ha^{-1}
	Coriander	UD - 743	2.67 t ha^{-1}
	Fenugreek	J. Fenu - 210	2.22 t ha^{-1}
	Fennel	RF - 115	2.27 t ha^{-1}
Sirsi	Black Pepper	Panniyur – 5	3.97 kg $vine^{-1}$ (fresh)
Coimbatore	Turmeric	CL - 2 (BSR - 2)	26.1 t ha^{-1}
	Coriander	JCO - 283	695.7 kg ha^{-1}
	Fenugreek	UM - 305	400 kg ha^{-1}
Jagudan	Cumin	JC - 94-37	105.6 kg ha^{-1}
	Fennel	JF - 192	248.9 kg ha^{-1}
		JF - 332	220.1 kg ha^{-1}
	Fenugreek	J. Fenu - 270	180.8 kg ha^{-1}
Pottangi	Ginger	V_1E_8 - 1	28.53 t ha^{-1}
		V_3S_1 - 8	27.40 t ha^{-1}
	Turmeric	RH - 5	37.28 t ha^{-1}
		PTS - 52	29.55 t ha^{-1}
Jagtial	Turmeric	RH - 5	5.41 t ha^{-1} (dry)
		TCP - 1	5.20 t ha^{-1} (dry)
Guntur	Coriander	LCC - 128	596 kg ha^{-1}
		LCC - 133	565 kg ha^{-1}

	Fenugreek	JF - 210	625 kg ha^{-1}
		JF - 204	589 kg ha^{-1}
Chintapalli	Turmeric	PTS - 11	24.8 t ha^{-1}
	Ginger	IISR Varada	29.0 t ha^{-1}
Jobner	Coriander	DH - 246	1174 kg ha^{-1}
		RCr - 41	1135 kg ha^{-1}
		UD - 743	1120 kg ha^{-1}
	Cumin	UC - 310	236 kg ha^{-1}
		UC - 231	226 kg ha^{-1}
		RZ - 19	220 kg ha^{-1}
	Fenugreek	JF - 204	1397 kg ha^{-1}
		JF - 195	1394 kg ha^{-1}
		RMt - 1	1379 kg ha^{-1}
	Fennel	UF - 143	1204 kg ha^{-1}
		UF - 144	1021 kg ha^{-1}
Hisar	Fenugreek	HM - 346	2.19 t ha^{-1}
		Hisar Sonali	2.14 t ha^{-1}
		JF - 210	2.05 t ha^{-1}
	Coriander	DH - 246	2.18 t ha^{-1}
		DH - 208	1.99 t ha^{-1}
	Fennel	HF - 33	2.19 t ha^{-1}
		HF - 39	2.00 t ha^{-1}

Promising lines identified for quality attributes

Centre	Crop	Line	Dry matter (%)	Curcumin content (%)	Oil content (%)	Oleoresin (%)
Coimbatore	Turmeric	Acc - 360	-	5.10	-	-
		CL - 115	-	5.92	-	-
Solan	Ginger	SG - 882	22.4	-	1.80	7.00
		SG - 699	21.0	-	1.50	6.50
Jobner	Coriander	UD - 744	-	-	0.45	-
		DH - 246	-	-	0.40	-
	Cumin	JC - 94-37	-	-	3.70	-
	Fennel	UD - 143	-	-	1.86	-
		UF - 144	-	-	1.85	-

CROP MANAGEMENT

Fertilizer and irrigation requirements of black pepper-arecanut mixed cropping system were standardized at Sirsi centre. Studies at Mudigere revealed the influence of micronutrients (boron and molybdenum), on the yield of cardamom. Yield and quality of coriander and fennel also increased by application of micronutrients like Zn, Fe, Mn & Cu. Package of practices for ginger and turmeric were standardized at Chintapalli centre. A fertilizer package, including the application of biofertilizer was standardized for clove and nutmeg at Yercaud centre. In seed spices, biofertilizer (*Azospirillum*) was found to influence the yield.

CROP PROTECTION

Several germplasm accessions/varieties, immune/resistant to various pests and diseases were identified. A package for the management of *Phytophthora* foot rot disease of black pepper was developed and recommended by Panniyur and Sirsi centres. Survey for the in-

Source of resistance to pests and diseases

Centre	Crop	Pest/disease	Entries/varieties	Reaction
Jobner	Coriander	Stemgall	RCr - 41, RCr - 435, RCr - 436	Immune
		Root knot nematode	RCr - 435, RCr - 436, RCr - 684, RCr - 685, RCr - 686 & UD - 446	Resistant
	Cumin	Wilt	UC - 223	Resistant
	Fenugreek	Root knot nematode	UM - 305	Immune
			UM - 32, UM - 34, RMt - 303 & UM - 322	Resistant
		Powdery mildew	UM - 305	Immune
			UM - 32, UM - 34, UM - 143 & UM - 103	Resistant
Jagudan	Cumin	*Fusarium* wilt	JC - 2000 - 68 JC - 2000 - 71 JC - 2000 - 67 JC - 2000 - 72 & JC - 2000 – 69	Moderately resistant
Jagtial	Turmeric	Leaf spot	JTS - 606 & JTS - 1	Resistant
		Leaf blotch	PCT – 14, JTS - 604 & TC – 2	Resistant

cidence of diseases and pests in black pepper showed the occurrence of anthracnose disease and marginal gall thrips in Idukki District, Kerala. In black pepper, two sprayings, either monocrotophos (0.05%) or dimethoate (0.05%) at fortnightly interval after the harvest of berries are very effective in reducing the mussel scale (*Lepidosaphes piperis*) at high ranges of Idukki District. A low cost technology for mass multiplication of *Trichoderma* sp. for field application has been developed at Sirsi.

Rotting of ginger rhizomes in storage can be checked by storing the rhizomes treated with Dithane M - 45 + Bavistin (5 g + 3 g/kg seed) in pits containing sand in layers, which gave highest recovery of rhizomes with lowest disease incidence. Control measures for wilt disease in coriander and rhizome rot in ginger were evolved by various centres. Survey conducted, indicated the severity of stemgall disease in coriander in different parts of Bihar.

TECHNICAL PROGRAMMES

Project Code	Title	Centers
a) Ongoing projects		
BLACK PEPPER		
PEP/CI/1	**Genetic Resources**	
PEP/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Panniyur, Sirsi, Yercaud, Pechiparai, Chintapalli, Pundibari and Dapoli
PEP/CI/2	**Hybridization Trial**	
PEP/CI/2.1	Inter-varietal hybridization to evolve high yielding varieties	Panniyur
PEP/CI/3	**Coordinated Varietal Trial (CVT)**	
PEP/CI/3.1	CVT 1987 – Series III	Dapoli and Sirsi
PEP/CI/3.2	CVT 1991 – Series IV	Panniyur, Yercaud, Chintapalli and Ambalavayal
PEP/CI/3.3	CVT 2000 – Series V	Pampadumpara, Panniyur, Sirsi, Chintapalli and Ambalavayal
PEP/CM/1	**Irrigation Trial**	
PEP/CM/1.1	Irrigation-cum-fertilizer requirements for 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	Panniyur, Yercaud, Sirsi, Thadiyankudisai and Ambalavayal
PEP/CM/2.2	Efficacy of biofertilizer using P-solubilizer on black pepper	Panniyur, Sirsi, Yercaud, Thadiyankudisai and Ambalavayal
PEP/CM/2.3	Organic farming in black pepper	Panniyur, Sirsi, Yercaud, Thadiyankudisai and Ambalavayal
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	Control of *Phytophthora* foot rot disease of black pepper	Sirsi
PEP/CP/1.2	Biological control of *Phytophthora* foot rot of black pepper – nursery trial	Pampadumpara, Chintapalli and Ambalavayal
PEP/CP/1.4	Control of *Phytophthora* disease of black pepper in farmers' field – observational trial	Panniyur, Mudigere, Sirsi and Ambalavayal
PEP/CP/1.5	*Phytophthora* foot rot incidence in black pepper under different densities in an arecanut garden	Panniyur and Sirsi
PEP/CP/1.6	Incidence, epidemiology and management of anthracnose disease of black pepper	Pampadumpara, Mudigere, Chintapalli and Dapoli
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	Pampadumpara and Mudigere
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 (Relay out of CVT 1991 - Series)	Pampadumpara
CAR/CI/3.2	CVT 1991/1998 –Series III with Malabar Types	Mudigere and Sakleshpur
CAR/CI/3.3	CVT 1991/1998 –Series III with Mysore Types	Mudigere, Sakleshpur and Myladumpara
CAR/C1/3.4	CVT 2000- Series IV	Pampadumpara, Mudigere, Myladumpara and Sakleshpur.
CAR/CI/4	**Varietal Evaluation Trial (VET)**	
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	**Quality Evaluation Trial**	
CAR/CI/5.1	Screening cardamom clones for abiotic stress	Mudigere
CAR/CM/1	**Nutrient Management Trial**	
CAR/CM/1.3	Integrated nutrient management in cardamom	Mudigere and Pampadumpara
CAR/CM/1.4	Efficiency of bio-fertilizer using *Azospirillum* on cardamom	Pampadumpara, Mudigere, Myladumpara, and Sakleshpur
CAR/CM/1.5	Efficiency of biofertilizer using P. solubilizers on cardamom	Pampadumpara, Mudigere, Myladumpara and Sakleshpur
CAR/CP/2	**Pest Management Trial**	
CAR/CP/2.1	Evaluation of plant based insecticides for the control of thrips and fruit borers in cardamom	Mudigere
CAR/CP/2.2	Management of root grub of cardamom	Pampadumpara and Mudigere
CAR/CP/2.3	Bioecology of natural enemies of major pests of cardamom	Pampadumpara and Mudigere
CAR/CP/2.4	Estimation of quantitative and qualitative losses due to thrips damage in cardamom	Mudigere
GINGER		
GIN/CI/1	**Genetic Resources**	
GIN/CI/1.1	Germplasm collection, characterization, evaluation and conservation	Solan, Pottangi, Dholi, Kumarganj, Pundibari and Raigarh
GIN/CI/2	**Coordinated Varietal Trial**	
GIN/CI/2.2	CVT 2000 – Series V	Chintapalli, Solan, Pottangi, Pundibari and Raigarh
GIN/CI/3	**Varietal Evaluation Trial**	
GIN/CI/3.1	Comparative yield trial (CYT-I & II)	Solan, Pottangi and Raigarh
GIN/CI/3.2	Initial evaluation trial (IET)	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	Effect of biofertilizer using *Azospirillum* on ginger	Solan, Pottangi, Pundibari, Ambalavayal and Raigarh

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

TUR/CP/1.2	Chemical control measures against leaf blotch disease of turmeric	Pundibari
TUR/CP/1.3	Effect of seed treatment on leaf spot and leaf blotch diseases of turmeric	Dholi, Kumarganj, Raigarh and Pundibari
TUR/CP/1.4	Investigations on the causal organism of rhizome rot of turmeric and screening of biocontrol agents for its management	Coimbatore, Jagtial and Pundibari

TREE SPICES

TSP/CI/1	**Genetic Resources**	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Yercaud/Pechiparai and Dapoli
TSP/CI/2	**Coordinated Varietal Trial**	
TSP/CI/2.1	CVT 1992 in clove	Yercaud/Pechiparai and Dapoli
TSP/CI/2.2	CVT 1992 in cinnamon	Yercaud/Pechiparai and Ambalavayal
TSP/CM/1	**Propagation/Multiplication Trial**	
TSP/CM/1.1	Vegetative propagation in nutmeg, clove and cinnamon	Yercaud/Pechiparai and Dapoli
TSP/CM/2	**Irrigation Trial**	
TSP/CM/2.1	Drip irrigation in clove and nutmeg	Yercaud/Pechiparai
TSP/CP/1	**Disease Management Trial**	
TSP/CP/1.1	Survey for disease incidence in tree spices	Yercaud/Pechiparai, Dapoli and Ambalavayal

CORIANDER

COR/CI/1	**Genetic Resources**	
COR/CI/1.1	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases	Coimbatore, Guntur, Jobner, Jagudan, Hisar, Dholi and Kumarganj
COR/CI/2	**Coordinated Varietal Trial**	
COR/CI/2.1	CVT 1993 – Series II	Kumarganj and Raigarh
COR/CI/2.2	CVT 1996 – Series III	Hisar, Dholi and Kumarganj
COR/CI/2.3	CVT 1998 – Series IV	Guntur, Jobner, Jagudan, Hisar, Dholi and Kumarganj
COR/CI/3	**Varietal Evaluation Trial**	
COR/CI/3.2	Initial evaluation trial	Guntur, Jobner, Jagudan and Hisar

COR/CI/4	**Quality Evaluation Trial**	
COR/CI/4.1	Quality evaluation in coriander	Jobner
COR/CM/1	**Nutrient Management Trial**	
COR/CM/1.1	Response of coriander to micronutrients	Kumarganj
COR/CM/1.2	Efficacy of biofertilizer using *Azospirillum* on coriander	Coimbatore, Guntur, Jobner and Kumarganj
COR/CP/1	**Disease Management Trial**	
COR/CP/1.1	Survey to identify the disease incidence, collection and identification of causal organisms	Dholi
COR/CP/1.2	Management of wilt and powdery mildew diseases in coriander.	Coimbatore, Jobner, Jagudan, Dholi, Raigarh and Kumarganj

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/3.2	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/CM/1	**Nutrient Management Trial**	
CUM/CM/1.1	Efficacy of biofertilizer using *Azospirillum* on cumin	Jobner and Jagudan
CUM/CP/1	**Disease Management Trial**	
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	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Jobner, Jagudan, Hisar, Kumarganj and Dholi
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 and Hisar
FNL/CI/3.2	CVT 2001– Series –IV	Jobner, Jagudan and Hisar
FNL/CI/4	**Varietal Evaluation Trial**	
FNL/CI/4.1	Initial evaluation trial	Jagudan , Hisar and Jobner
FNL/CI/4.2	Comparative yield trial	Dholi
FNL/CI/5	**Quality evaluation trial**	
FNL/CI/5.1	Quality evaluation in fennel	Jobner
FNL/CM/1	**Nutrient Management Trial**	
FNL/CM/1.2	Efficacy of biofertilizer using *Azospirillum* on fennel	Jobner, Jagudan and Kumarganj

FENUGREEK

FGK/CI/1	**Genetic Resources**	
FGK/CI/1.1	Germplasm collection, characterization, evaluation conservation and screening against diseases	Guntur, Jobner, Jagudan, Hisar, Dholi and Kumarganj
FGK/CI/2	**Hybridization Trial**	
FGK/CI/2.1	Evolving varieties resistant to powdery mildew	Jagudan
FGK/CI/3	**Coordinated Varietal Trial**	
FGK/CI/3.1	CVT 1995 – Series III	Guntur and Kumarganj
FGK/CI/3.2	CVT 1999 – Series IV	Coimbatore, Jobner, Hisar, Jagudan, Kumarganj and Dholi
FGK/CI/4	**Varietal Evaluation Trial**	
FGK/CI/4.1	Comparative yield trial	Dholi
FGK/CI/4.2	Initial evaluation trial	Hisar, Jobner and Jagudan
FGK/CI/5	**Quality Evaluation Trial**	
FGK/CI/5.1	Quality evaluation in fenugreek	Coimbatore, Jobner, Guntur, Jagudan, Hisar, Dholi and Kumarganj

FGK/CM/2	**Nutrient Management Trial**	
FGK/CM/2.2	Efficacy of biofertilizers using *Azospirillum* *Rhizobium* on fenugreek	Coimbatore, Guntur, Jagudan, Kumarganj and Jobner
FGK/CP/1	**Disease Management Trial**	
FGK/CP/1.1	Biocontrol of root rot in fenugreek	Coimbatore

b) Closed projects

BLACK PEPPER

PEP/CI/3.2	CVT 1991-Series IV	Pampadumpara

GINGER

GIN/CI/2.1	CVT 1996 – Series IV	Pundibari
TUR/CI/2.1	CVT 1996 – Series IV	Pundibari

CORIANDER

COR/CI/2.1	CVT 1993 – Series II	Coimbatore
COR/CI/2.2	CVT 1996 – Series III	Coimbatore
COR/CI/3.1	Comparative yield trial	Coimbatore

FENUGREEK

FGK/CI/3.1	CVT 1995 – Series III	Coimbatore
FGK/CI/4.1	Comparative yield trial	Coimbatore

ACRONYMS

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

PROGRESS OF WORK AND ACHIEVEMENTS

BLACK PEPPER

PEP/CI/1 Genetic Resources

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

(*Panniyur, Sirsi, Chintapalli, Dapoli, Yercaud* and *Pundibari*)

Panniyur

Survey for collection of germplasm was carried out in northern most regions of Kerala - Karnataka border. Twenty four black pepper genotypes were collected from northern most areas of Kannur District, Kerala and 29 from Kanamvayal forest areas of Karnataka state. At present 137 accessions of cultivated types and 10 wild types are being maintained at Panniyur centre.

The germplasm accessions were evaluated for their yield and yield attributing characters. In the germplasm collections, 72 accessions flowered during the period and the data of a few promising accessions are given in Table 1.

Table 1. Yield and yield attributing characters of promising germplasm lines (2001-2002) - Panniyur

Cultivar	Green berry weight (g vine^{-1})	Dry recovery (%)	No. of spikes vine^{-1}	Spike length (cm)	No. of developed berries spike^{-1}	100 berry wt. (g) (dry)
TMB IV	1350.0	29.5	600.0	10.75	34.9	12.69
Chendayar	1300.0	28.5	345.0	8.74	36.1	12.23
Karimunda III	1128.6	34.9	599.9	7.84	13.5	12.44
Perumkodi	1070.0	34.1	480.0	11.40	24.3	11.53
Mundi	680.0	42.0	238.5	8.50	18.8	9.76
Karimunda IV	650.0	37.2	470.0	7.92	16.8	11.40
Chumala	615.0	42.6	220.0	12.17	32.9	13.16
Valiyaramundi	550.0	29.8	273.8	5.41	43.7	10.93
Thulakodi	542.5	30.8	235.5	9.06	17.8	14.99
Kalluvally I	493.3	40.0	171.7	7.92	39.5	12.64
Karivilanchi	485.0	34.2	295.0	9.76	24.6	11.83
Angamali	425.0	33.5	224.0	7.85	17.5	10.79
Uthirankotta II	32.5	46.2	35.5	15.74	15.5	15.62
Panniyur-1	300.0	33.3	111.8	14.87	52.7	12.19
Balankotta I	323.3	29.6	120.7	10.65	44.1	14.43
Nilgiris	65.0	46. 2	52.5	9.95	11.9	17.62

The variety TMB - IV recorded the maximum green berry yield vine^{-1} (1350 g) followed by Chendayar (1300 g) and Karimunda - III (1128 g). Maximum number of spikes vine^{-1} was recorded in TMB - IV (600) followed by Karimunda - III, Perumkodi and Karimunda - IV. The higher yield recorded in the variety TMB - IV is attributed to more number of spikes vine^{-1}. Uthirankotta - II had the maximum spike length (15.74 cm) followed by Panniyur - 1 (14.87 cm). Maximum number of developed berries per spike was recorded in Panniyur - 1 (52.7) followed by Balankotta - I (44.1), Valiyaramundi (43.7). The variety Nilgiris recorded the maximum weight for 100 berries (17.62 g) followed by Uthirankotta - II (15.62 g) (Table 1).

Further all the accessions were evaluated for their reaction to 'pollu disease' caused by fungus and also 'pollu' due to infestation by pollu beetle. 'Pollu disease' was observed in 13 accessions and it was least in Karimunda followed by Cul - 406, TMB -X and Kalluvally -V.

Sirsi

During the year, 5 accessions were added to the collections of black pepper at Sirsi and the total germplasm consists of 80 cultivated and 20 wild types. Local varieties of the district viz., Karimalligesara and Uddakare, which are showing promise for higher yield were collected and are being maintained. Among the promising accessions, Panniyur - 1 recorded the highest fresh berry yield (3.25 kg vine^{-1}), followed by Panniyur - 5 (2.97 kg vine^{-1}) and Munda (2.86 kg vine^{-1}). Karimunda and Karimalligesara are highly susceptible to *Phytophthora* foot rot disease.

Chintapalli

Ten accessions (cultivated types) namely, Kuthiravally, Punjarmunda, Bilimalligesara, Perimunda, Marampadathi, Wynadan, Doddiga, Valiyakaniyakadan, Cheruvalli and Cheppakulamunda were added to the germplasm collections during 2001-2002. A total of 47 cultivated types and 9 wild related species are being maintained at this centre.

In the germplasm evaluation, maximum yield (fresh - 8.0 kg and dry - 2.5 kg vine^{-1}) was recorded in Panniyur - 1 with 1680 spikes vine^{-1}, followed by Malamundi which recorded 6.4 kg (green) and 2.0 kg (dry) vine^{-1} (Table 2).

Dapoli

At Dapoli, the germplasm of black pepper consists of eleven varieties of which Panniyur - 1 and Panniyur - 3 started flowering.

Yercaud

Out of 106 germplasm accessions, 78 accessions started yielding. Among these accessions, Panniyur - 2 collected from Guddalore, Nilgiris District performed well for the last four years (Table 3).

Pundibari

Nine improved varieties of black pepper (Panniyur - 1, 2, 3, 4 and 5, Sreekara, Subhakara, Pournami and Panchami) collected from IISR Calicut and Kottanadan collected from CPCRI, Mohitnagar were added to the germplasm and are being multiplied.

PEP/CI/2 Hybridization Trial

PEP/CI/2.1 Inter-varietal hybridization to evolve high yielding varieties (*Panniyur*)

Panniyur

Sixteen crosses were made during 2001-2002 and the hybrid seeds were sown in pots.

Table 2. Yield and yield attributing characters of black pepper cultivars (2001-2002) - Chintapalli

Cultivar	No. of spikes vine^{-1}	Spike length (cm)	No. of berries spike^{-1}	Berry girth (mm)	Wet weight of berries (kg vine^{-1})	Dry weight (kg vine^{-1})	Recovery (%)
Neelamundi	685	9.0	60.7	5.1	2.54	0.70	27.5
Thevarmundi	329	9.2	97.0	4.8	2.85	0.80	28.0
Aimpiryan	820	9.9	59.5	4.8	3.87	1.20	31.0
Vellanamban	463	12.1	75.2	4.0	1.90	0.60	31.5
Narayakkodi	754	9.3	55.7	5.1	5.80	1.80	31.0
Uddaghere	700	10.2	60.7	5.1	5.00	1.50	30.0
Kureilmundi	190	12.0	54.5	5.3	1.05	0.30	28.5
Permabramundi	522	12.8	87.5	5.9	2.15	0.70	32.5
Malamundi	612	10.9	47.0	5.1	6.45	2.00	31.0
Kottanadan	566	10.8	96.2	5.1	3.33	1.20	36.0
Panniyur-1	1680	15.8	118.7	5.1	8.06	2.50	31.0
Karimunda	348	8.7	58.2	4.8	1.78	0.50	28.0
Kuthirvally	406	8.8	59.5	5.1	1.80	0.60	33.0
Arakulmundi	280	8.0	48.7	6.1	1.40	0.40	28.5
Balankottai	414	11.0	47.0	6.1	2.02	0.70	34.5
Kalluvally	203	9.3	65.0	5.1	1.32	0.35	26.5
Punjarimunda	499	8.0	49.2	5.0	2.39	0.55	23.0

Table 3. Yield and yield attributing characters of black pepper variety Panniyur - 2 (2001-2002) – Yercaud

Character	1997-98 (8 YAP)	1998-99 (9 YAP)	1999-2000 (10 YAP)	2000-2001 (11 YAP)	2001-2002 (12 YAP)
Spike length (cm)	13.00	13.93	11.82	7.760	10.86
No. of berries spike^{-1}	39.50	85.50	52.29	49.000	68.40
No. of spikes (m^2)$^{-1}$	11.00	11.50	60.17	8.000	26.50
Green berry yield (kg vine^{-1})	0.72	0.98	8.25	2.300	10.50
Dry berry yield (kg vine^{-1})	-	-	4.35	1.138	2.58

YAP - Year after planting

The details of the crosses made are listed in Table 4.

Table 4. Inter-varietal hybridization (2001–2002) - Panniyur

Cross			No. of hybrid seeds obtained
Karimunda - III	x	Panniyur-3	8
Panniyur - 3	x	Balankotta	19
Panniyur - 7	x	Panniyur-3	13
Karimunda - III	x	Balankotta	3
Panniyur - 5	x	Panniyur-3	15
Balankotta	x	Kalluvally	2
Balankotta	x	Panniyur-3	20
Kottanadan	x	Kalluvally	7
Kalluvally	x	Balankotta	5
Panniyur - 5	x	Balankotta	22
Panniyur - 2	x	Balankotta	2
Narayakodi	x	Panniyur – 1	1
Uthirankotta	x	Narayakodi	5
Narayakodi	x	Balankotta	4
Panniyur - 1	x	Balankotta	40
Panniyur - 4	x	Panniyur - 3	5
Total			171

Open pollinated progenies of 11 varieties were also raised during this period. The performance of seedlings of inter-species hybridization between *P. nigrum* x *P. colubrinum* and *P. nigrum* x *P. attenuatum* is being evaluated.

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.1 CVT-1987-Series – III (*Sirsi* and *Dapoli*)

Sirsi

Among eleven cultivars evaluated, Panniyur - 5 has recorded the highest yield (3.97 kg fresh berries vine^{-1}) followed by Panniyur - 1 (3.45 kg fresh berries vine^{-1}). Dry recovery was more in the variety Subhakara (34.28%) followed by KS - 88 (34.10%) (Table 5).

Dapoli

Report not received.

PEP/CI/3.2 CVT-1991- Series IV (*Panniyur, Pampadumpara, Ambalavayal, Chintapalli* and *Yercaud*)

Panniyur

In the coordinated varietal trial, out of 14 varieties/cultures evaluated, Panniyur - 3 recorded the highest green berry yield (1.920 kg vine^{-1}) and was on par with the Subhakara, Panniyur - 4 and Karimunda. The number of spikes was maximum in Karimunda (659.5 vine^{-1}) and Subhakara (634.5 vine^{-1}) and these two varieties were on par. The number of developed berries spike^{-1} was maximum in Panniyur - 5 (51.12). Cul - 5128, Cul - 1558, Panchami and Kottanadan (Acc - 2426) were on par for number of developed berries spike^{-1}. Panniyur - 1, Panniyur - 3, Cul - 1558, Cul - 5128, Cul - 239 and Subhakara were having longer spikes (>10 cm) and were significantly superior to all other varieties. The 100 berry weight was maximum in Cul - 5128 (18 g) and this culture was significantly superior to all other varieties (Table 6).

Pampadumpara

The experiment started in the year 1992, with the objective of evaluating the performance of the released varieties and promising

Table 5. Performance of promising black pepper cultivars (2001-02) - Sirsi

Entry	Average spike length (cm)	No. of developed berries spike^{-1}	Mean fresh berry yield (kg vine^{-1})	Dry recovery (%)
Karimalligesara	7.65	56.20	2.52	33.58
Uddakare	8.84	76.37	2.46	31.25
Pannniyur - 1	12.13	92.56	3.45	28.20
Culture - 812	10.17	74.50	2.70	30.08
Culture - 331	11.64	84.37	2.73	33.45
Culture - 239	11.68	88.65	3.97	33.23
Culture - 856	9.16	62.17	2.45	31.37
KS - 88	6.75	46.30	2.37	34.10
KS - 14 (Sreekara)	7.05	49.37	2.77	33.48
KS - 27 (Subhakara)	7.25	52.16	2.13	34.28
Culture – 141	8.02	52.10	2.45	32.82

Table 6. Yield and yield attributing characters of black pepper varieties under CVT (2001-02) - Panniyur

Entry	Yield (fresh, kg vine^{-1})	No. of spikes vine^{-1}	No. of developed berries spike^{-1}	Spike length (cm)	100 berry wt. (g)
Sreekara	406.00	223.50	20.79	6.58	11.00
Subhakara	1835.00	634.50	27.13	10.34	11.50
Panchami	1045.00	306.50	35.88	7.79	10.00
Pournami	150.00	87.25	25.24	7.87	11.00
Kottanadan (Acc - 2426)	1171.50	329.50	35.58	9.17	12.00
Kottanadan (Acc - 2445)	1016.00	279.20	32.92	8.45	11.50
Panniyur – 1	442.50	121.80	20.50	15.42	13.00
Panniyur – 2	575.00	185.20	24.38	9.05	12.00
Panniyur – 3	1920.00	566.00	25.42	14.23	13.00
Panniyur – 4	1665.00	370.30	31.74	9.95	11.00
Cul – 1558	658.50	201.00	39.84	14.44	13.50
Cul – 5128	970.00	200.90	46.96	13.49	18.00
Panniyur – 5 (Cul - 239)	681.00	515.80	51.12	11.81	11.00
Karimunda	1515.00	669.50	24.96	7.58	11.50
CD (5%)	498.74	106.32	16.89	5.25	2.57

selections of black pepper in the high ranges of Idukki District was concluded during this year. Fourteen accessions including the local cultivar Vellanamban were tested in RBD having three replications and six plants per plot. *Erythrina indica* was used as the standard. All varieties differed significantly in fresh and dry yield and volatile oil content. Panniyur - 5 registered maximum fresh (906.5 g) and dry (301.1 g) yield plant^{-1} and found to be significantly superior to all other varieties. Acc - 2445 (Kottanadan) recorded the second highest yield of 676.8 g plant^{-1} and 273.1 g plant^{-1} of fresh and dry berries, respectively. Subhakara recorded the lowest yield of green (88.5 g plant^{-1}) and dry (39.9 g plant^{-1}) berries. Panniyur - 5 was also found to be tolerant to *Phytophthora* foot rot disease. The other three varieties showing tolerance to this disease are Panniyur - 7, Panniyur - 4 and Panniyur - 2. All the varieties were found susceptible to leaf spot caused by *Colletotrichum gloeosporioides*. But the infestation was highest in Kottanadan (Acc - 2426) and lowest in Subhakara. Volatile oil content in dry berries was highest in Cul - 5128 (5.06% v/w), which was significantly higher than all other varieties, followed by Kottanadan (Acc - 2426) and it was lowest in Panniyur – 3. The oleoresin content was maximum (9.4% w/w) in Panniyur - 1 and minimum (7.4% w/ w) in Panniyur – 2, though the differences were not significant (Table 7).

Ambalavayal

The trial was started during 1992 with 14 entries. Biometric observations and yield data for the year 2002 are presented in Table 8.

Cul - 5128 recorded maximum yield (0.812 kg fresh and 0.180 dry berries standard^{-1}). Subhakara, Panchami and Cul - 1558 were affected by *Phytophthora* foot rot disease and hence no yield could be obtained from these cultivars.

Chintapalli

Final report not received.

Yercaud

Report not received.

PEP/CI/3.3 CVT 2000 – Series V (*Pampadumpara, Sirsi, Panniyur, Chintapalli* and *Ambalavayal*)

Pampadumpara

Thirteen accessions were collected from Pepper Research Station, Panniyur and IISR, Calicut and will be planted in the field during June 2002.

Sirsi

The planting material will be collected and the trial will be initiated during June, 2002.

Panniyur

The trial has been initiated in 2001 with 14 entries.

Ambalavayal

The trial has been initiated with 12 entries in 2001.

Chintapalli

Report not received.

PEP/CM/1 Irrigation Trial

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

Sirsi

The trial was laid out during 1992-1993 in arecanut - black pepper mixed cropping system to study the effect of 3 levels of irrigation

Table 7. Performance of promising varieties of black pepper (1998 to 2000) – Pooled data - Pampadumpara

Entry	Yield (g plant^{-1})		Foot rot disease	No. of leaves affected by anthracnose (%)	Volatile oil (%)	Oleoresin (%)
	Fresh	Dry				
Sreekara	143.2^{fg}	59.3^{c}	+	10.0	3.46^{def}	7.8
Subhakara	88.5^{g}	39.9^{c}	+	8.2	3.46^{def}	8.0
Panchami	419.4^{cd}	150.6^{bc}	+	12.1	3.99^{bed}	8.9
Pournami	411.7^{cd}	162.0^{bc}	+	15.4	4.26^{bc}	9.0
Kottanadan (Acc - 2426)	457.1^{c}	151.2^{bc}	+	20.1	4.52^{ab}	8.8
Kottanadan (Acc - 2445)	676.8^{b}	237.1^{ab}	+	15.8	3.46^{def}	8.0
Panniyur - 1	371.9^{cde}	142.1^{bc}	+	14.2	3.06^{efg}	9.4
Panniyur - 2	157.6^{fg}	57.9^{c}	_	17.6	3.72^{cde}	7.6
Panniyur - 3	229.8^{defg}	127.0^{bc}	+	19.6	2.66^{g}	8.1
Panniyur - 4	326.8^{cdef}	99.6^{bc}	_	15.9	4.66^{ab}	8.0
Panniyur - 7 (Cul - 1558)	233.3^{defg}	96.0^{c}	_	8.4	3.59^{cdef}	7.8
Cul - 5128	132.5^{fg}	46.9^{c}	+	13.3	5.06^{a}	8.9
Panniyur - 5 (Cul - 239)	906.5^{a}	310.1^{a}	_	18.7	3.19^{efg}	8.3
Vellanamban (local check)	190.4^{efg}	87.7^{c}	+	19.3	2.92^{fg}	7.8
CD (5%)	201.5	138.1		NS	0.75	NS

+ = present ; - = absent

on the productivity of black pepper variety, Panniyur - 1, which received the recommended dose of fertilizer (NPK @ 100:40:140 g vine^{-1}). During the year 1999-2000, irrigation of pepper vines significantly increased the yield. During 2000-2001, many pepper vines died due to severe incidence of *Phytophthora* foot rot disease and hence replanting was taken up.

PEP/CM/1.2 Drip irrigation in black pepper (*Panniyur*)

Panniyur

The trial was laid out during 1996 in a factorial RBD with three levels of irrigation (I_0, I_1, I_2) and three varieties (Panniyur - 1, 3 and 5). Irrigation was given from December to April. During the year 2000-2001 though,

Table 8. Biometric and yield characteristics of black pepper cultivars (2002) - Ambalavayal

Entry	Yield (kg standard^{-1})		No. of spikes standard^{-1}	Spike length (cm)	No. of berries spike^{-1}	1000 berry weigh (g)	1000 berry volume (cc)
	Fresh	Dry					
Sreekara	0.125	0.055	62.00	5.30	24.30	121.00	105.00
Subhakara	-	-	-	-	-	-	-
Panchami	-	-	-	-	-	-	-
Pournami	0.065	0.020	40.00	6.70	29.20	125.00	110.00
Kottanadan (Acc – 2426)	0.215	0.065	93.00	6.30	34.30	143.00	120.00
Kottanadan (Acc – 2445)	0.310	0.113	108.00	8.70	50.50	180.00	128.00
Panniyur-1	0.145	0.050	59.50	7.50	28.80	165.00	112.00
Panniyur-2	0.138	0.050	79.00	6.70	25.20	115.00	110.00
Panniyur-3	0.261	0.070	59.50	9.10	58.10	104.23	98.00
Panniyur-4	0.295	0.135	93.50	6.30	40.30	112.00	105.00
Cul – 1558	-	-	-	-	-	-	-
Cul – 5128	0.812	0.180	146.00	8.25	44.95	167.38	120.00
Panniyur-5	0.145	0.047	90.00	7.40	26.80	125.00	114.00
Karimunda	0.180	0.055	78.00	5.10	32.50	102.25	75.00

there was no significant difference among the treatments, irrigation at 2 l day^{-1} contributed more towards spike number, spike length and green berry yield. The maximum yield of 1.707 kg (green) vine^{-1} was recorded in the treatment I_1. The highest number of spikes, number of developed berries spike^{-1} and spike length were recorded in the treatment, irrigation at 2 l day^{-1}. Among the varieties, Panniyur - 5 recorded the maximum number of spikes (470.8 vine^{-1}), green berry weight (2.203 kg vine^{-1}) and spike length (11.48 cm) (Table 9).

PEP/CM/2 Nutrient Management Trial

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

(*Panniyur, Sirsi, Yercaud, Thdiyankudisai* and *Ambalavayal*)

Panniyur

The trial was laid out in RBD with four replications in two locations at Mattannur, Kannur District to study the efficacy of *Azospirillum* as nitrogen fixer. Treatments were imposed and initial morphological observations were recorded.

Sirsi

Yields recorded for the last two years were not statistically significant indicating no positive affect of biofertilizer towards yield (Table 10).

Table 9. Effect of different levels of irrigation on the productivity of black pepper varieties (2001-2002) - Panniyur

Treatment	No. of spikes vine^{-1}	Green berry yield (kg vine^{-1})	Spike length (cm)
$I_0 V_1$	161.43	0.705	10.96
$I_0 V_2$	115.17	0.843	9.83
$I_0 V_3$	415.80	2.440	10.04
$I_1 V_1$	152.50	1.603	11.97
$I_1 V_2$	158.17	0.960	11.10
$I_1 V_3$	598.83	2.558	11.77
$I_2 V_1$	182.87	1.069	11.00
$I_2 V_2$	69.67	0.487	10.00
$I_2 V_3$	397.77	1.612	12.63
CD (5%)	NS	NS	NS
Levels of irrigation			
I_0	230.80	1.329	10.28
I_1	303.17	1.707	11.61
I_2	216.77	1.056	11.21
CD (5%)	NS	NS	NS
Varieties			
V_1 Panniyur 3	114.33	1.126	10.31
V_2 Panniyur 5	470.80	0.763	11.48
V_3 Panniyur 1	165.60	2.203	11.31
CD (5%)	NS	NS	NS

Yercaud

The trial was laid out in the year 2000. The shade trees (*Erythrina lithosperma)* were planted in the month of April and the pepper plants were planted in the month of August 2000. Observations on vine length, number of leaves and leaf area were recorded. The vine length was maximum (65.5 cm) in the treatment T2 (inorganic N 75% + *Azospirillum* 50 g + FYM 10 kg). The number of leaves vine^{-1} (12.5) and the leaf area (57.58 cm^2) were higher in the treatment T3 (inorganic N 50% + *Azospirillum* 50 g + FYM 10 kg).

Ambalavayal

The plot which received inorganic nitrogen 50% + *Azospirillum* + FYM (T3) recorded the highest yield of 22.250 t ha^{-1} followed by the treatment T2, T1 and T6. The lowest yield was recorded in plot, which received FYM alone (7.792 t ha^{-1}) (Table 11).

Thadiyankudisai

Report not received.

Table 10. Efficacy of biofertilizer, *Azospirillum* on the yield in black pepper – Sirsi

Treatment	Mean yield (fresh, kg vine^{-1})		
	2000-01	2001-02	Pooled
Inorganic N 100% + *Azospirillum* 50 g + FYM 10 kg	6.49	6.20	6.35
Inorganic N 75% + *Azospirillum* 50 g + FYM 10 kg	6.23	6.35	6.29
Inorganic N 50% + *Azospirillum* 50 g + FYM 10 kg	6.49	6.32	6.41
FYM 10 kg + *Azospirillum* 50 g	6.40	6.08	6.24
FYM 10 kg alone	6.83	5.67	6.25
Recommended dose of fertilizer	5.91	6.19	6.05
SEm ±	0.46	0.27	0.24
CD (5 %)	NS	NS	NS

Table 11. Efficacy of biofertilizer, *Azospirillum* on the yield of black pepper (2001-2002) - Ambalavayal

Treatment	Yield (t ha^{-1})
T1 –Inorganic N 100% + *Azospirillum* 50 g + FYM 5 kg	21.333
T2 -Inorganic N 75% + *Azospirillum* 50 g + FYM 5 kg	21.917
T3 -Inorganic N 50% + *Azospirillum* 50 g + FYM 5 kg	22.250
T4 – FYM 5 kg + *Azospirillum* 50 g	16.083
T5 - FYM 5 kg alone	7.792
T6 - FYM 10 kg + *Azospirillum* 50 g	21.250
T7 - FYM 10 kg alone	11.750

PEP/CM/2.2 Efficacy of biofertilizers using P-solubilizer (Phosphobacteria) on black pepper (*Panniyur, Sirsi, Yercaud Ambalavayal* and *Thadiyankudisai*)

Panniyur

The trial was laid out in RBD with four replications in two locations at Mattannur, Kannur District to study the efficacy of P-solubilizers for increasing the yield of black pepper. Treatments were imposed and initial morphological observations were recorded.

Sirsi

No significant differences in the yield were observed for the last two years due to P-solubilizers (Table 12).

Yercaud

This trial was laid out in the year 2000. The shade trees (*Erythrina lithosperma)* were planted in the month of April and the pepper plants were planted in the month of August 2000. Observations on vine length, number of leaves and leaf area were recorded. Vine length was maximum (68.7 cm) in the treat-

Table 12. Efficacy of biofertilizer, P-solubilizer in increasing the yield of black pepper - Sirsi

Treatment	Mean fresh yield (kg vine^{-1})		
	2000-01	2001-02	Pooled
Inorganic P 100% + P-solubilizer 50 g + FYM 10 kg	6.68	6.27	6.48
Inorganic P 75% + P-solubilizer 50 g + FYM 10 kg	5.74	6.20	5.76
Inorganic P 50% + P-solubilizer 50 g + FYM 10 kg	6.31	6.00	6.16
FYM 10 kg + P-solubilizer 50 g	6.00	6.31	6.16
FYM 10 kg alone	5.73	5.71	5.72
Recommended dose of fertilizer	6.27	6.06	6.17
Sem ±	0.37	0.35	0.26
CD (5 %)	NS	NS	NS

ment T4 (FYM 10 kg + phosphobacteria 50 g). Number of leaves per vine was higher (16.2) in the treatment T2 (inorganic P 75% + phosphobacteria 50 g + FYM 10 kg), whereas the leaf area was high (76.6 cm^2) in the treatment T1 (inorganic P 100% + phosphobacteria 50 g + FYM 10 kg).

Ambalavayal

The trial has to be initiated.

Thadiyankudisai

Report not received.

PEP/CM/2.3 Organic farming in black pepper

(Panniyur, Sirsi, Ambalavayal, Yercaud and Thadiyandudisai)

Sirsi

Application of burnt earth to black pepper vines significantly increased the yield (6.74 kg vine^{-1}) as compared to other treatments (Table 13).

Table 13. Performance of organic farming in black pepper – Sirsi

Treatment	Mean yield (fresh, kg vine^{-1})		
	2000-01	2001-02	Pooled
FYM 10 kg vine^{-1} + P 40 g + wood ash 2 kg	5.36	5.84	5.60
FYM 10 kg vine^{-1} + P 40 g + wood ash 2 kg	5.06	5.40	5.24
FYM 10 kg + Burnt earth 10 kg	6.74	6.32	6.63
FYM 10 kg + *Azospirillum* 50 g vine^{-1} + wood ash 2 kg	5.05	5.62	5.33
FYM 10 kg + Leaf manure 10 kg (local practice) + wood ash 2 kg	5.61	5.82	5.70
SEm ±	0.27	0.16	0.20
CD (5 %)	0.85	0.49	0.61

Panniyur, Ambalavayal, Yercaud and *Thadiyandudisai*

Reports were not received.

PEP/CM/3 Multiplication Trial

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

(*Dapoli*)

Dapoli

The vine length, number of roots and the number of branches produced per vine were not influenced significantly by different spacings (Table 14). However, the number of rooted cuttings per vine in different spacings was statistically significant. Closer spacing i.e. vines planted at 15.0 cm, produced highest number of rooted cuttings (262.83) per hill year^{-1} (in three harvests). In all the treatments the survival of rooted cuttings two months after planting, was above 82.93%.

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

(*Chintapalli, Pampadumpara* and *Ambalavayal*)

Chintapalli

The trial was not taken up so far.

Pampadumpara

The experiment was initiated during April 2002 and observations are being recorded.

Ambalavayal

The trial was conducted with Panniyur - 1 as test variety. The results showed that sprouting of the cuttings was maximum in solarized soil (65.70%) compared to non-solarized soil (61.26%). Among different treatments, application of biocontrol agents, *T. harizanium* and VAM recorded maximum sprouting of the pepper cuttings (69.07%) (Table 15)

Table 14. Effect of spacing on the growth and production of rooted cuttings – Dapoli

Spacing (cm)	Vine length (m)	No. of cuttings	Av. no. of roots	Survival (%)	No. of branches
S_1- 15.0	2.67	262.83	5.16	94.35	13.50
S_2- 22.5	2.30	213.16	4.33	88.19	9.16
S_3- 30.0	2.20	168.80	4.16	82.93	11.66
S_4- 37.5	2.68	209.83	5.50	97.69	14.83

PEP/CP/1 Disease Management Trial

PEP/CP/1.1 Control of *Phytophthora* foot rot disease of black pepper

(*Sirsi*)

Sirsi

The project in operation at Sirsi from 1991-92 was closed during 1996-97.

Disease incidence was maximum in non-solarized soil (24.00%) compared to the solarized soil (21.26%) (Table 16). Thus, there was a reduction (13.00%) in the disease intensity due to soil solarization. The reduction in disease incidence in chemical and biocontrol treatments ranged from 15.54% to 24.33%. Maximum reduction of disease inci-

Table 15. Effect of different treatments on sprouting of black pepper cuttings (2001) - Ambalavayal

Treatment	Sprouting (%)		
	Solarized soil	Non-solarized soil	Mean
Control	55.56 (48.200)	52.96 (46.703)	54.26 (47.452)
Trichoderma harzianum + VAM	71.85 (57.963)	66.29 (54.570)	69.07 (56.267)
Ridomil spray and drench	67.04 (54.950)	62.96 (52.523)	65.00 (53.737)
COC drench	66.66 (54.747)	61.48 (51.663)	64.07 (53.205)
Akomin drench	67.41 (55.213)	62.59 (52.283)	65.00 (53.748)
Mean	65.70 (54.215)	61.26 (51.549)	
CD Factor A	1.937**		
CD Factor B	3.063**		
AB	NS		

Figures in parentheses are the arcsine transformed values.

dence (24.33%) was observed in *Trichoderma harzianum* + VAM and Akomin drenched plots compared to control.

PEP/CP/1.4 Control of *Phytophthora* foot rot disease of black pepper in farmers field - observational trial

(*Sirsi, Panniyur, Mudigere* and *Ambalavayal*)

Sirsi

The trial was conducted in arecanut based mixed cropping system in two locations (Edahalli and Hosable villages) in farmers gardens around Sirsi.

Black pepper vines treated with Metalaxyl gold MZ 68 WP (Ridomil gold) @ 2.5 g l^{-1} as spray (2 l $vine^{-1}$) and drench (3 l $vine^{-1}$) alone and in combination with bioagent i.e., *Trichoderma harzianum* 50 g (10^7 cfu $vine^{-1}$) or Potassium phosphonate 5 ml l^{-1} as spray and drench in combination with bioagent i.e., *T. harzianum* 50 g twice in the season (June and August) showed least incidence of *Phytophthora* foot rot disease (15.00%). The disease incidence was highest in the untreated vines (62.50%) (Table 17).

Panniyur

The trial was laid out in two locations (Padiyoor and Valiampara) in Kannur District, Kerala. The results are presented in Tables 18 and 19.

Table 16. Effect of different treatments on disease incidence in black pepper rooted cuttings (2001) - Ambalavayal

Treatment	Sprouting (%)		
	Solarized soil	Non-solarized soil	Mean
Control	26.66 (30.960)	28.15 (32.047)	27.41 (31.503)
Trichoderma harzianum + VAM	18.52 (25.353)	22.96 (28.577)	20.74 (26.965)
Ridomil spray and drench	19.63 (26.297)	22.59 (28.357)	21.11 (27.327)
COC drench	21.85 (27.857)	24.44 (29.590)	23.15 (28.723)
Akomin drench	19.63 (26.250)	21.85 (27.803)	20.74 (27.027)
Mean	21.26 (27.343)	24.00 (29.275)	
CD Factor A	NS		
CD Factor B	3.148*		
AB	NS		

Figures in parentheses are the arcsine transformed values.

Application of Metalaxyl gold and *Trichoderma* was found effective in controlling the foot rot disease followed by the application of Akomin and *Trichoderma*. The disease incidence was very low, when the vines were sprayed with Metalaxyl gold combined with soil application of *Trichoderma*.

Mudigere

Spraying and drenching with Ridomil MZ 72 WP (1.25 g l^{-1}) 5 l $vine^{-1}$ (T2) and combination with *Trichoderma harzianum* (50 g) with 1 kg neem oil cake $vine^{-1}$ (T5) during the first week of June and September was found highly effective in checking the disease, followed by the combined application of Akomin (5 ml l^{-1}) and biocontrol agent (T4). The treatments T1 and T3 were on par and they were significantly superior over the check T7 (Table 20).

Ambalavayal

As per the decision taken in the XV Workshop, the trial has to be taken up at 2 locations. The center has not laid out the experiment.

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

(*Panniyur* and *Sirsi*)

Panniyur

The trial was laid out during 2001 at

Table 17. Effect of different treatments on the management of *Phytophthora* foot rot disease in black pepper – Sirsi

Treatment	Disease incidence (%)	
	2000-01	2001-02
Metalaxyl gold MZ 68 WP (100 ppm, 2.5 g l^{-1}) as spray (2 l $vine^{-1}$) and drench (3 l $vine^{-1}$) twice	17.50 (24.16)	15.00 (22.48)
Potassium phosphonate (Akomin, 0. 5 %) as spray and drench, twice	17.50 (24.16)	17.50 (24.53)
Soil application of *Trichoderma harzianum* (10^7 cfu, 50 g $vine^{-1}$) with 1 kg of neem cake, twice	27.50 (30.87)	50.00 (45.00)
Metalaxyl gold MZ 68 WP (100 ppm, 2.5 g l^{-1}) as spray (2 l $vine^{-1}$) and drench (3 l $vine^{-1}$) twice + soil application of *Trichoderma harzianum* (10^7 cfu, @ 50 g $vine^{-1}$) with 1 kg of neem cake twice	17.50 (24.53)	15.00 (22.50)
Potassium phosphonate (Akomin, 0.5 %) as spray and drench twice + soil application of *Trichoderma harzianum* (10^7 cfu, 50 g $vine^{-1}$) with 1 kg of neem cake, twice	15.00 (22.13)	15.00 (22.50)
Neem cake 1 kg $vine^{-1}$	37.50 (37.72)	55.00 (47.89)
Untreated control	52.50 (46.50)	62.50 (52.34)
SEm ±	3.12	2.20
CD (5%)	9.30	6.54

Figures in parentheses are angular transformed values

Table 18. Effect of different treatment on the management of *Phytophthora* foot rot disease in black pepper (Padiyoor) - Panniyur

Treatment	Disease incidence (%) on		
	Leaf	Branch	Stem
Metalaxyl gold MZ 68 WP (Spraying and drenching)	2.02	2.18	0.00
Akomin	3.18	3.50	0.00
Trichoderma harzianum	2.99	3.05	0.00
Metalaxyl gold MZ + *Trichoderma*	1.15	1.15	0.00
Akomin + *Trichoderma harzianum*	1.98	2.09	0.00
Neem cake - 1kg	5.22	3.94	0.66
Control	8.17	4.85	2.00
CD (5%)	0.42	0.55	0.76

Table 19. Effect of different treatments on the management of *Phytophthora* foot rot disease in black pepper (Valiampara) - Panniyur

Treatment	Disease incidence (%) on		
	Leaf	Branch	Stem
Metalaxyl gold MZ 68 WP (Spraying and drenching)	1.96	2.07	0.00
Akomin	3.16	3.48	0.00
Trichoderma harzianum	2.96	3.01	0.00
Metalaxyl gold MZ + *Trichoderma*	1.13	1.11	0.00
Akomin + *Trichoderma harzianum*	1.93	2.01	0.00
Neem cake 1kg	5.19	3.91	0.66
Control	8.22	5.36	2.00
CD (5%)	0.95	0.45	0.89

Panniyur and pepper cuttings were planted as an intercrop in an arecanut garden at four levels of population using arecanut palm as standard. The incidence of *Phytophthora* disease on black pepper was very less. All the pepper plants established under arecanut system. The maximum vine length of 88 cm was observed in 25% population of pepper vines in the arecanut garden.

Sirsi

Establishment and growth of black pepper vines were better in 50% and 25% population density under arecanut cropping system (Table 21).

Table 20. Incidence of foot rot disease in black pepper under coffee based cropping system - Mudigere

Treatment	Yellowing (mean)	Defoliation (mean)
T1- Akomin 5 ml l^{-1}, 5 l $vine^{-1}$ both as spray and drench	25.00	25.00
T2- Ridomil MZ 72 WP (1.25 g l^{-1})	0.00	0.00
T3- Bioagent (*Trichoderma harzianum*) 50 g $vine^{-1}$	25.00	25.00
T4- $T_3 + T_1$	0.00	25.00
T5- $T_3 + T_2$	0.00	0.00
T6- Neem oil cake 1kg $vine^{-1}$	32.67	26.67
T7- Control	37.67	30.00
CD (5%)	1.43	2.06
CV %	4.48	5.84

Table 21. Management of *Phytophthora* foot rot of black pepper in areca – pepper cropping system - Sirsi

Population of black pepper (% of arecanut population)	Establishment (%)	Plant height (cm)
25	90	201.60
50	90	195.00
75	80	193.40
100	75	196.40

PEP/CP/1.6 Incidence, epidemiology and management of anthracnose disease of black pepper (Survey for the occurrence of disease in black pepper)
(*Pampadumpara, Mudigere, Dapoli* and *Chintapalli*)

Pampadumpara

Twelve panchayats were surveyed for the incidence of anthracnose disease. Infection on spikes was not seen during this period, except in one or two vines in Chakupallom panchayat. Leaf spots were observed only on older leaves. The disease incidence on the leaves was the highest in Chakupallom panchayat (50.4%) followed by Vandanmedu panchayat (36.4%). It was least in the Vellathooval panchayat (2.1%) (Table 22).

Table 22. Incidence of various diseases of black pepper in the high ranges of Idukki District, Kerala

Panchayat	Incidence					
	Anthracnose (%)		*Phytophthora* (%)		Stunted disease	Slow wilt
	Leaves	Spikes	Leaves	Plants	(No. of plants)	(No. of plants)
Kamakshi	15.8	-	5.5	-	-	-
Vathikkudy	18.4	-	0.9	17.3	6.7	-
Konnathadi	13.8	-	1.6	33.7	10.0	-
Mannamkandam	7.9	-	-	22.4	7.1	3.03
Vellathooval	2.1	-	1.6	46.7	4.5	2.23
Bisonvalley	18.8	-	0.2	30.9	3.5	-
Pallivasal	15.3	-	0.3	13.3	12.8	-
Karunapuram	29.2	-	-	-	-	-
Vandanmedu	36.4	-	-	-	-	-
Vandiperiyar	14.7	-	8.7	-	15.3	-
Kumily	21.8	-	2.2	-	11.7	-
Chackupallom	50.4	0.1	4.8	-	-	-

Dapoli

Survey conducted during 2001-2002 showed that the incidence of anthracnose ranged form 0.95 to 18.09% and *Phytophthora* foot rot disease was the most important disease of black pepper of this region. The intensity of the disease ranged form 0.33 to 19.67% and it was maximum in coconut - black pepper mixed plantations.

Mudigere

Maximum leaf and spike damage due to anthracnose disease in black pepper (9.67% and 2.48%, respectively) was recorded during the first fortnight of July under coffee based cropping system (Table 23).

Chintapalli

The trial was started in 2002.

PEP/CP/2 Pest Management Trial

PEP/CP/2.1 Control of scale insects in black pepper (*Pampadumpara*)

Pampadumpara

The results of the study showed that two sprayings of either monocrotophos (0.05%) or dimethoate (0.05%) at fortnightly interval after the harvest of berries are very effective in reducing the black pepper mussel scale (*Lepidosaphes piperis*) at high ranges of Idukki District.

Table 23. Incidence of anthracnose disease in black pepper under coffee based cropping system – Mudigere

Location	Incidence of the disease (%) during different months (2001)									
	May		June		July		August		Average	
	L	S	L	S	L	S	L	S	L	S
Kadumane	6.40	0.00	8.37	3.22	10.30	2.80	8.00	2.00	8.27	2.67
Hoysalalu	3.00	0.00	14.11	10.13	8.60	5.38	11.50	3.82	9.30	3.44
Gabgal	3.21	0.00	7.32	0.56	9.24	1.70	7.12	1.00	6.72	1.10
Daradahalli	2.60	0.00	4.39	0.39	8.70	0.27	4.00	0.00	4.92	0.33
Ousana	5.80	0.00	12.64	4.00	11.20	3.61	10.08	2.69	9.93	3.43
B.Hosahalli	5.50	0.00	10.00	4.41	6.17	1.12	5.66	0.00	6.83	2.77
Average PDI	4.42	0.00	8.83	2.29	9.67	2.48	7.73	2.38	7.66	2.29

L - leaf, S - spike

Maximum loss of berries was 2.48% during July and the minimum loss was in June (2.29%). However, overall loss in the six locations surveyed was estimated to be 2.29% (0.79 kg vine^{-1}) and in terms of value the loss was Rs. 21.84 vine^{-1}, which is not significant compared to the total yield of 12.9 kg vine^{-1} (Table 24).

PEP/CP/2.2 Survey for the incidence of insect-pests on black pepper at high altitudes (*Pampadumpara*)

Pampadumpara

Twelve panchayats representing three taluks were surveyed for the occurrence and distribution of insect pests in black pepper at

Table 24. Crop loss due to anthracnose disease at the time of spiking in black pepper - Mudigere

Location	PDI	No. of spikes vine^{-1}	No. of berries spike^{-1}	1000 berries wt (g)		Total wet yield vine^{-1} (kg)	Loss of berries vine^{-1} (kg)		Total yield vine^{-1} (kg)	% loss vine^{-1}
				Wet	Dry		Wet	Dry		
Kadumane	2.67	5680	69	10.20	3.36	39.98	1.07	0.36	13.33	2.67
Hoysalalu	3.44	3160	90	10.03	3.20	28.53	0.98	0.33	9.51	3.44
Gabgal	1.10	7480	84	8.27	2.89	51.96	0.57	0.19	17.32	1.10
Daradahalli	0.33	8428	60	9.68	3.09	48.94	0.16	0.05	16.31	0.33
Ousana	3.43	3317	87	10.74	3.54	30.99	1.06	0.35	10.33	3.43
B.Hosahalli	2.77	4422	72	10.00	3.03	31.84	0.88	0.29	10.61	2.77
Average PDI	2.29	5415	77	9.82	3.19	38.71	0.79	0.26	12.90	2.29

PDI- Percentage Disease Incidence

high ranges of Idukki District (Table 25). Marginal gall thrips (*Liothrips karnyi*) was the most predominant insect pest recorded in all panchayats surveyed, the maximum being in Chakupallom (16.27%). Besides Chakupallom other eleven panchayats had a meager inci-

Table 25. Incidence (%) of insect pests on black pepper in high ranges of Idukki District

Panchayat	Gall thrips	Leaf miner	Scale insects	Leaf gall	Mealy bug	Pollu beetle
Kamakshi	10.24	1.07	1.01	—	—	—
Vathukudy	8.11	—	1.12	0.16	—	—
Kunnathady	11.20	—	0.96	—	1.81	—
Adimali	12.53	0.26	2.08	—	—	—
Vellathoval	14.03	0.11	1.39	—	0.16	—
Bison valley	15.15	—	1.60	—	—	—
Pallivasal	15.89	0.43	1.07	—	—	—
Vandiperiyar	11.63	—	0.48	1.76	—	0.42
Kumily	16.21	—	1.33	0.27	—	1.17
Chakupallom	16.27	—	—	—	—	0.64
Vandenmedu	13.81	0.11	0.75	—	—	—
Karunapuram	11.57	—	0.21	—	—	0.11
Mean	13.05	0.17	1.00	0.18	0.16	0.19

dence of scale insects ranging from 0.21% to 2.08%. There is a slight increase in the infestation by scale insects during this year compared to previous years. Three species of scale insects *viz., Lepidosaphes piperis* (mussel scale), *Marsipococcus marsupiale* (soft scale) and *Aspidiotus destructor* (coconut scale) are observed in most of the gardens of which mussel scale is widely prevalent. Leaf miner was noticed in five panchayats and the population was highest in Kamakshi panchayat (1.07%). The occurrence of leaf gall is on the rise in Vandiperiyar panchayat (1.76%). Two tailed mealy bug *Ferrisia virgata* was recorded in two panchayats and the infestation of which is confined to leaves and left out berries. It is for the first time pollu beetle (*Longitarsus nigripennis*) was observed in four panchayats at high ranges. In the preceding three years it was reported from only one garden at Vazhathoppu. Rooted cuttings planted in this garden were brought from endemic plains and the pest got introduced in the high ranges.

CARDAMOM

CAR/CI/1 Genetic Resources

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

(*Mudigere* and *Pampadumpara*)

Mudigere

The entire germplasm collections (245) are being replanted for further evaluation, since the plants have become 12 year old.

Pampadumpara

Eighty six accessions of cardamom germplasm are being maintained in the field gene bank. During 2001-2002 four super clones were collected from farmer's field at Pallivasal, Erratayar panchyath and added to the germplasm. A survey was conducted in Mehamalai Hills, Theni District, Tamil Nadu to collect biotic and abiotic stress tolerant lines. Among the twelve lines collected, five were found to be tolerant to thrips. Accessions, BEP - 1, BEP - 2, PPK - 1, PPK - 2, PS - 3, PS - 9, PV - 12, AEP - 1 and PS - 27 gave higher yield compared to the local ruling cultivar, Green gold and these lines were included in the comparative yield trial.

CAR/CI/2 Hybridization and selection

CAR/CI/2.1 Evaluation of synthetics and OP progenies

(*Mudigere*)

Mudigere

Eight promising cardamom clones viz., Mudigere - 1, Mudigere - 2, CL - 692, HS – 1, SKP - 14, Sel - 98, CCS - 800, CL - 691, which were found to be better general combiners, were planted during 1995-96 with closer spacing (6'x 3') in ordered to collect the crossed seeds. A total of 61 open pollinated seedlings were selected and planted in the field during 2000. Gap filling was done during 2001 and observations are being recorded.

CAR/CI/3 Coordinated Varietal Trial (CVT)

CAR/CI/3.1 CVT 1998 - Series II

(*Pampadumpara*)

Pampadumpara

The trial (CVT 1991 - Series II), relaid during 1999 with 10 accessions as per the decision of the XII AICRPS Workshop was concluded. Among ten entries tested, significant differences were observed for dry yield per plant during all the years under the study except 1996 and 1998 (Table 26). All the accessions recorded low yield during 1998, which is attributed to severe drought coinciding the critical panicle initiation stage. M - 1 registered the highest yield consistently for four consecutive years (1997 to 2000) followed by PV - 1 for three years in succession (1998-2000). The highest pooled yield (dry) 373.98 kg ha^{-1} was recorded in M - 1 followed by PV - 1 (321.78 kg ha^{-1}).

Out of ten characters studied, number of tillers and panicles, panicle length, 100 capsule weight, itch and borer percentage and fresh yield differed significantly among the accessions. M - 1 and PV - 1 are found to be the suitable varieties for Idukki District. M - 1 also recorded maximum number of tillers and panicles, lengthy panicle and least infestation by thrips. Hence these varieties can be utilized for further breeding programme to

develop high yielding varieties suitable for cardamom hill reserve.

726, HS - 1 and SPK - 14 were found significantly superior over the M - 1 for panicle

Table 26. Pooled analysis of yield (dry) of small cardamom under CVT - Pampadumpara

Entry	Yield (dry, g plant $^{-1}$)					
	1996	1997	1998	1999	2000	Mean
Cl – 679	286.00	104.80	36.20	90.70	355.20	174.58
Sel – 800	311.60	146.20	33.50	117.90	390.80	200.05
M – 1	244.40	175.60	60.00	189.60	578.00	249.32
Sel – 112	72.00	52.40	30.40	76.30	279.10	102.04
Sel – 262	231.60	90.50	42.90	124.00	292.20	156.24
Cl – 276	162.40	53.10	43.20	98.60	338.80	139.22
Cl – 683	87.50	20.20	22.90	75.20	232.50	87.66
SKP – 51	116.50	36.30	15.08	37.60	285.60	98.20
SKP – 14	280.70	155.70	25.80	94.60	222.00	155.76
PV – 1	257.50	116.80	43.80	164.20	490.30	214.52
CD (5%)	NS	96.20	NS	90.23	30.18	48.70

CAR/CI/3.2 CVT 1991/1998 - Series III with Malabar Types
(*Mudigere* and *Sakleshpur*)

Mudigere

The data on yield and plant growth characters of the promising clones are presented in Table 27. Out of 15 promising clones selected for yield trial, SKP - 72 recorded maximum height (313.5 cm), followed by CL - 683, (307.7 cm), SKP - 21 (297.0 cm), CL - 692 (291.9 cm). SKP – 14 recorded lowest height (178.6 cm). CL - 683 (28.10) and CL - 726 (28.00) found significantly superior over the local check M - 1 in the production of number of panicles per clump followed by SPK - 14, CL - 692, CL - 679, whereas PV - 1 produced lowest number of panicles per clump (12.90). SPK - 72, CL - 683, CL - 679, CL - length and PV - 1 has produced shortest panicles (24.0 cm). CLK - 683, SPK - 72, MCC - 34, CL – 726 and CL - 692 produced more number of capsules/panicle over the M - 1 and CCS - 800 has produced very few capsules/ panicle (17.20). CL - 683, MS - 1, SPK - 14, CL - 679 and SPK - 72 produced more number of racemes per panicle compared to M - 1, whereas PV - 1 has produced least number of racemes per panicle. Regarding the yield per hectare (dry capsules), SPK - 14, CL - 683, CCS - 872, HS - 1, CL - 676 and SPK - 72 were found promising over the local check M - 1 (Table 28).

However, during the last two years, CL - 692 produced consistently more yield (185.9 kg ha^{-1}) followed by CL - 679 (174.4 kg ha^{-1}), CL - 726 (164.20 kg ha^{-1}) compared to the local check M - 1 (141.0 kg ha^{-1}).

Table 27. Performance of promising clones (Malabar types) (2000-01) - Mudigere

Genotype	Height (cm)	No.of tillers plant^{-1}	No.of productive tillers plant^{-1}	No. of panicles plant^{-1}	Panicle length (cm)	No. of capsules panicle^{-1}	No.of racemes panicle^{-1}	Yield (dry, kg ha^{-1})
CL – 679	206.90	17.30	9.60	22.70	43.60	26.60	14.80	89.00
CL – 683	307.70	27.30	11.30	28.10	50.00	35.00	16.70	117.20
CL – 692	291.90	21.30	9.70	23.80	36.70	28.50	13.40	90.00
CL – 726	232.10	24.00	10.70	28.00	41.70	29.20	13.20	103.40
CCS - 800	202.30	16.20	7.50	15.60	32.70	17.20	11.60	56.40
CCS - 872	193.90	15.10	6.30	14.80	33.60	25.00	12.30	109.00
CCS - 893	223.30	13.70	6.60	14.70	34.30	24.50	12.60	91.00
HS - 1	248.10	13.90	7.30	18.40	42.90	26.60	16.00	103.50
M - 1	220.00	19.20	8.00	19.00	30.30	26.50	12.00	99.60
MCC - 34	268.30	21.40	7.50	14.40	26.20	30.00	11.00	60.30
PV - 1	233.70	18.30	6.25	12.90	24.30	25.00	10.00	58.00
SKP - 14	178.60	19.30	8.00	26.00	44.30	29.30	15.40	127.50
SKP - 21	297.00	15.60	5.60	11.00	32.80	23.80	13.30	63.40
SKP - 72	313.50	24.80	8.30	18.40	51.70	30.50	14.70	103.00
SKP - 100	212.50	18.30	8.10	17.70	40.80	24.90	13.40	67.00
CD (5%)	76.85	5.86	2.42	9.02	11.00	9.35	2.81	51.44
CV %	19.00	8.40	18.00	28.30	17.43	20.82	12.60	34.13

Sakleshpur

Out of the 13 promising clones, SKP - 169 recorded the highest yield (282.7 kg ha^{-1}) followed by ICRI - 3 (252.2 kg ha^{-1}) during 2001-2002 (Table 29).

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

(*Mudigere, Sakleshpur* and *Myladumpara*)

Mudigere

MCC - 61 produced highest yield of 36.40 kg ha^{-1} followed by MCC - 81 (25.80 kg ha^{-1}) and lowest yield was in SPK - 51 (14.4 kg ha^{-1}) during 2000-01 (Table 30).

Sakleshpur

Out of five germplasm accessions tested, MCC - 85 produced the highest yield of 71.3 kg ha^{-1} followed by GM (60.6 kg ha^{-1}) during 2001-2002 (Table 31).

Myladumpara

Report was not received

CAR/CI/3.4 CVT 2000 Series - IV

(*Pampadumpara, Mudigere, Myladumpara* and *Sakleshpur*)

Pampadumpara

The experiment was laid out during 2001 with 12 accessions in three replications.

Table 28. Mean yield of promising clones – (Malabar types) – Mudigere

Entry	Yield (dry, kg ha^{-1})		Average
	2000	2001	
CL - 679	259.80	89.0	174.400
CL - 683	228.10	117.2	172.130
CL - 692	282.60	90.0	185.850
CL - 726	225.10	103.4	164.150
CCS - 800	182.10	56.4	117.250
CCS - 872	154.50	109.0	131.700
CCS - 893	154.10	91.0	122.175
HS - 1	138.10	103.5	120.650
M - 1	180.10	99.6	140.970
MCC - 34	150.30	60.3	105.500
PV - 1	80.80	58.0	69.300
SKP - 14	207.50	127.5	155.100
SKP - 21	130.30	63.4	96.730
SKP - 72	207.80	103.0	155.100
SKP - 100	168.50	67.0	117.430
CD (5%)	84.30	51.44	
CV %	27.48	34.13	

Table 30. Performance of cardamom accessions under CVT (Mysore types) - Mudigere

Clone	Yield (dry, kg ha^{-1})		Average
	2000	2001	
SKP – 51	22.08	14.40	18.70
MCC – 12	45.92	22.80	39.40
MCC – 21	35.28	18.60	26.90
MCC – 61	31.44	36.40	28.90
MCC – 81	36.48	25.80	31.10
CD (5%)	-	13.63	
CV %	-	17.28	

Initial growth of tillers was recorded. The yield and other biometrical data will be recorded in the forthcoming years.

Mudigere

A new CVT with 12 entries (CL – 692, MCC – 13, MCC – 10, MCC – 200, MCC – 18, PS – 44, S – 1, SKP – 165, SKP – 170, APG – 1, APG – 2, and M – 2 as local check) was laid out during 2001-02.

Table 29. Performance of cardamom accessions (Malabar types) - Sakleshpur

Genotype	Plant height (cm)	No. of tillers	No. of bearing tillers	No. of panicles	Racemes/ panicle	Capsules/ raceme	Yield (kg ha^{-1})
CCS - 872	205.2	21.1	9.1	17.5	12.7	2.80	113.6
CCS - 893	197.7	16.6	7.1	13.6	12.5	2.50	66.1
CCS - 800	211.2	15.7	6.50	12.3	13.7	2.40	84.7
PV - 1	242.7	14.7	6.30	11.9	11.7	3.20	142.5
CL - 679	228.9	20.3	10.40	20.0	13.8	2.80	172.1
CL - 683	215.1	20.1	10.40	19.9	12.1	2.50	140.6
CL - 726	216.5	21.6	10.80	22.3	12.5	2.60	216.1
MUD - 1	243.4	18.7	6.90	14.9	13.5	2.40	120.1
MCC - 34	209.0	20.5	6.80	11.9	10.6	2.80	82.3
ICRI - 3	247.5	15.3	8.90	20.5	15.8	3.30	252.2
SKP - 72	236.2	16.0	5.90	10.9	13.0	3.30	116.7
SKP - 169	242.0	15.8	9.30	19.5	16.0	2.70	282.7
SKP - 170	242.8	18.5	8.30	18.3	13.1	2.60	215.8
GM	226.0	18.1	8.20	16.4	13.2	2.90	154.3
CD (5%)	0	0	2.51	6.0	0	0.67	74.7

Table 31. Performance of cardamom accessions under CVT (Mysore types) - Sakleshpur

Genotype	Plant height (cm)	No. of tillers	No. of bearing tillers	No. of panicles	Racemes/ panicle	Capsules/ raceme	Yield (kg ha^{-1})
MCC 12	223.3	19.2	6.6	11.1	15.2	2.7	52.4
MCC 21	255.9	19.9	6.6	10.8	17.2	2.6	54.5
MCC 61	227.3	17.5	6.2	9.8	14.8	2.4	75.0
MCC 85	268.9	14.4	5.1	8.8	12.2	2.7	71.3
SKP 51	229.5	20.1	6.5	10.6	17.2	2.6	49.9
GM	241.0	18.2	6.2	10.2	15.3	2.6	60.6
CD (5%)	31.7	NS	NS	NS	2.8	NS	14.6

Myladumpara and Sakleshpur

Reports not received.

CAR/CI/4 Varietal Evaluation Trial (VET)

CAR/CI/4.1 Yield evaluation of OP seedling progenies of promising cardamom selection (VET-I)

(Mudigere)

Mudigere

The experiment was started in 1997 and data on yield for 1999-2000 were recorded. The experiment could not be continued in the same plot because of overlapping of plant population of another experiment in the same plot. However, a few superior plants were identified and the same will be replanted in a separate plot for further evaluation.

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

(Mudigere)

Mudigere

Replanting of cardamom seedlings under VET-II has been taken up.

CAR/CI/4.3 Yield evaluation of OP seedling progenies of promising cardamom selections (VET-III)

(Mudigere)

Mudigere

The progenies of open pollinated seedlings were multiplied and their suckers were planted during 1999. Among the 29 genotypes tested against local checks, M - 1 and M - 2, CL - 24-17-D10, CL - 7-10-D11, CL - 7-24-D11 and CL - 722 are found promising which gave higher number of tillers per clump (31, 28, 28 and 27, respectively) compared to M - 1 (25) and M - 2 (26).

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

(Mudigere)

Mudigere

Based on the yield, 11 promising accessions from the open pollinated seedling progenies (MCC - 34, CCS – 800, SKP – 14, Sel - 800, CL – 668, CL - 726, HS - 1, CL – 691, CL – 692, Sel - 98, CL–722) were selected and planted along with M – 1 and M – 2 as local checks during 2001.

CAR/CI/5 Screening cardamom clones for abiotic stress

(Mudigere)

Mudigere

Seventy seven cardamom clones were selected from the germplasm collections (55) and from open pollinated seedling progenies (22) to study their tolerance to drought under purely rainfed conditions. The survival of these genotypes is given in Table 32.

CAR/CM/1 Nutrient Management Trial

CAR/CM/1.3 Integrated nutrient management in cardamom

(*Pampadumpara* and *Mudigere*)

Pampadumpara

Application of NPK @ 100:100:175 kg ha^{-1} gave the highest number of panicles, fresh yield as well as dry yield of cardamom. Neem cake application could not influence the cardamom yield to a greater extent.

Mudigere

The experiment was relaid during the year 2000. The growth of the crop is satisfactory and expected to bear next year.

CAR/ CM/ 1.4 Efficacy of bio-fertilizer using *Azospirillum* on cardamom

(*Mudigere, Pampadumpara, Myladumpara* and *Sakleshpur*)

Table 32. Screening cardamom genotypes for drought tolerance - Mudigere

Survival (%)	Genotypes	Number
100	Nil	0
80	CL - 746, CL - 258, D - 237, 7-6-D11, P - 6, 22-16-D11, 24-17-D10, 2-2-D11 M - 1, M - 2	9
60	CL - 676, CL - 691, CL - 668, 7-6-D11, 14-7-D11, CL - 722, 2-4-D4	8
40	Compact panicle, CL - 38, D - 235, D - 509, V - 179, D - 575, D - 269, D -148, D - 527, 2-26-D11, CL - 726, 19-18-D11, 2-5-D4	13
20	EB - 1289-55, CL - 699, Silent valley, CL - 652, CL - 696, CL - 656, CL - 731, R.C. Pubescent, CL - 671, CL - 654, CL - 730, D - 287, HS - 1, SKP - 14, MCC – 34, 7-24-D11, 22-9-D11, 10-5-D11, 8-4-D11.	19
0	CL - 680, CL - 720, CL - 687, CL - 757, BR, P - 8, P - 12, Burlior - 1, P - 17, CL - 692, EB - 1277-7, EB - 1271-4, CL – 668, P - 20, HS - 3, HS - 2, CCS - 800, 10-6-D10, D - 163, Sel - 98, 2-25-D11, 7-10-D11, 7-12-D11, 12-7-D11, 23-8-D4, CL - 726, CL - 729, CL - 681.	28

Mudigere

The experiment was initiated during the year 2000. The crop condition is satisfactory and is expected to bear during the next year.

Pampadumpara

There was no significant difference among the treatments. However, the highest yield was recorded in the plants applied with FYM 5 kg.

Myladumpara and *Sakleshpur*

Reports not received.

CAR/CM/1.5 Efficacy of bio-fertilizer using P-solubilizers on cardamom

(*Mudigere, Pampadumpara, Myladumpara* and *Sakleshpur*)

Mudigere

The experiment was initiated during the year 2000. The crop condition is satisfactory and is expected to bear during the next year.

Pampadumpara, Myladumpara and *Sakleshpur*

Reports not received.

CAR/CP/2 Pest Management Trial

CAR/CP/2.1 Evaluation of plant based insecticides for the control of thrips and fruit borers in cardamom

(Mudigere)

Mudigere

Four commercially available neem based insecticides viz., Neem gold 3%, Neem oil 3%, NSKE 4% and neem oil cake were evaluated against thrips and capsule borer along with recommended chemicals (spraying monocrotophos 36% S.L. @ 1.5 ml l^{-1} followed by phosalone @ 2.0 ml l^{-1}, three times at an interval of 25 to 30 days). Observations revealed that none of the neem based insecticides proved effective for the control of thrips and capsule borer compared to chemical treatment. The recommended spray schedule of chemical insecticides was proved effective and significantly superior over the botanicals in controlling both thrips and borers. Interestingly in the neem cake treated plots, the damage was higher compared to control (Table 33).

Table 33. Effect of neem based insecticides against thrips and capsule borer of cardamom – Mudigere

Treatment	Damage* (%)		
	Thrips	Capsules	Shoot
T1 - Neem gold 3%	23.55	5.55	10.00
T2 - Neem oil cake (0.5 kg plant^{-1})	31.35	6.55	12.65
T3 - NSKE 4 %	20.99	7.55	11.55
T4 - Neem oil 3 %	21.55	5.20	10.65
T5 - Monocrotophos 36 % S.L. +Phosalone	6.59	2.50	7.05
T6 - Control (no spray)	29.55	7.50	11.99
CD (5%)	5.74	1.86	2.00

*Mean of 1000 capsules from 7 harvests from 100 randomly selected clumps

CAR/CP/2.2 Management of root grub of cardamom

(*Pampadumpara* and *Mudigere*)

Pampadumpara

The initial root grub population before subjecting the treatments was 16.03 in one cubic foot of soil. Maximum reduction of grub population was observed in T2, T4 and T6 followed by T1, T3 and T5. At higher dosage, all the three insecticides tested were very effective in suppressing the grub population (80.57% in T6, 79.93% in T2 and 79.40% in T4). T6 and T2 produced the highest yield of more than 300 g plant^{-1}. The yield data evinced that carbofuran @ 150 g plant^{-1} could not enhance the yield of cardamom, though there was a significant reduction in the grubs population. Control plots registered the lowest yield (Table 34).

Mudigere

Report not received.

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

(*Pampadumpara* and *Mudigere*)

Pampadumpara

Two ichneumonid larval and pupal parasitoids and one dipteran parasitoid were recorded on cardamom stem borer, *Conogethes punctiferalis*. The two ichneumonids were identified as *Agrypon* sp. and *Temelucha* sp. The dipteran mosquito like parasitoid is gregarious in nature that deforms the parasatized pupae of *C. punctiferalis*, typical to that of puparium. The antennae resemble to that of male mosquito (plumose type).

Against cardamom whitefly,

Table 34. Effect of insecticides on root grub and yield of cardamom - Pampadumpara

Treatment	Grub population (No.)		Reduction after treatment** (%)	Yield (g plant $^{-1}$)
	Before treatment*	After treatment*		
T_1 Chlorpyrifos 0.05%	15.78 (3.97)	8.56 (2.92)^{b}	45.50 (42.42)^{b}	258.00^{bc}
T_2 Chlorpyrifos 0.07%	16.00 (4.00)	3.22 (1.79)^{a}	79.93 (63.42)^{a}	310.30^{a}
T_3 Carbofuran 100 g plant $^{-1}$	16.00 (4.00)	8.33 (2.89)^{b}	47.73 (43.70)^{b}	277.00^{b}
T_4 Carbofuran 150 g plant $^{-1}$	15.56 (3.94)	3.22 (1.79)^{a}	79.40 (63.03)^{a}	250.30^{c}
T_5 Imidacloprid 0.5 ml per litre	16.22 (4.02)	8.56 (2.92)^{b}	47.13 (43.36)^{b}	212.70^{d}
T_6 Imidacloprid 0.75 ml per litre	15.89 (3.99)	3.00 (1.73)^{a}	80.57 (63.89)^{a}	326.70^{a}
T_7 Control	16.78 (4.09)	14.89 (3.86)^{c}	11.33 (19.67)^{c}	163.00^{e}
CD (5%)	N.S.	0.126	2.02	26.61

* Values in parentheses are square root transformed

** Values in parentheses are arcsine transformed

Values followed by the same alphabet are not significantly different

Kanakarajiella cardamomi three entomopathogenic fungi were isolated viz., orange coloured *Aschersonia placenta,* white coloured *Verticillium* sp. and black coloured unidentified fungus. When sporulated, *Verticillium* sp. produced two different types of spores one smaller and darker and other bigger and pale in colour.

Metarrhizium anisopliae was isolated from mummified green coloured cardamom root grub, *Basilepta fulvicorne* whereas a white coloured fungus was found infecting adult beetles. No natural enemy was recorded from cardamom thrips.

Mudigere

Report not received.

CAR/CP/2.4 Estimation of quantitative and qualitative losses due to thrips damage in cardamom

(*Mudigere*)

Mudigere

Report not received.

GINGER

GIN/CI/1 Genetic Resources

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

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

Solan

The yield of different germplasm accessions (10) ranged from 6.20 kg to 10.35 kg $3m^2$ $plot^{-1}$. In general, the performance of different collections was poor compared to last year. However, one collection SG - 882 performed best during 2001 (Table 35).

Pottangi

Two new collections were added to the germplasm this year making the total to 172. During the year, 141 accessions were evaluated and only 12 accessions yielded more than 4.5 kg $3m^2$ bed^{-1} with a range 0.35 to 7.5 kg $3m^2$ bed^{-1}. The highest fresh rhizome yield was recorded in V_1E_4 - 5 (7.64 kg $3m^2$ bed^{-1}) followed by PGS - 9 (7.0 kg $3m^2$ bed^{-1}) and PGS - 12 (6.82 kg $3m^2$ bed^{-1}). Characterization, documentation and passport data of the accessions collected are being continued.

Pundibari

Terai, a hill zone, being a part of the centre of diversity for ginger, a large amount of variations can be found in the adjoining foot hills of Himalayan range. Different genotypes are being collected through survey at different places of Terai zone and adjoining areas.

Twenty one germplasm accessions are being maintained and were evaluated during 2001-2002. Considering mean values for different characters, it was observed that GCP - 12 produced highest plant height (72.97 cm), followed by GCP - 17. Highest number of tillers (15.97) and yield $plant^{-1}$ (288.93 g) was observed in GCP- 21. GCP - 1 produced maximum number of leaves (19.33) (Table 36).

The reaction of ginger germplasm to leaf spot disease (*Phyllosticta zingiberi*) is presented in Table 37.

Table 35. Performance of promising lines of ginger - Solan

Entry	Yield (kg $3m^2$ bed^{-1})	Converted yield (t ha^{-1})	Dry matter (%)	Oleoresin (%)	Essential oil (%)
SG – 709	10.35	20.803	18.3	4.90	1.00
SG – 713	9.00	18.090	18.5	6.79	1.75
SG – 882	8.70	17.487	22.4	7.72	1.50
SG – 213	8.40	16.884	15.8	5.72	1.25
SG – 701	8.35	16.783	17.1	4.36	1.00
BDJR – 1074	8.20	16.482	19.2	6.00	1.50
SG – 827	8.20	16.482	21.0	6.30	1.50
SG – 878	7.50	15.075	20.0	6.30	1.50
SG – 53	6.50	13.065	18.6	5.42	1.50
SG – 821	6.20	12.462	18.5	6.00	1.50

Table 36. Performance of ginger germplasm (1999-2000 to 2001-2002) - Pundibari

Entry	Yield (g plant^{-1})			
	1999-2000	2000-2001	2001-2002	Mean
GCP – 1	275.1	272.10	270.9	272.70
GCP – 3	261.3	267.20	260.1	262.87
GCP – 4	242.4	258.40	237.4	246.07
GCP – 5	230.7	247.40	238.2	238.77
GCP – 7	196.1	200.45	202.1	199.57
GCP – 8	280.3	282.60	276.4	279.77
GCP – 9	235.3	241.20	231.2	235.90
GCP – 12	295.2	298.90	278.6	290.90
GCP – 13	273.5	281.40	270.1	275.00
GCP – 14	255.6	267.30	242.6	255.17
GCP – 15	258.1	262.40	241.6	254.03
GCP – 16	-	271.10	259.4	265.27
GCP – 17	-	298.20	276.4	287.30
GCP – 18	-	252.50	241.7	247.10
GCP – 19	-	260.60	258.2	259.40
GCP – 20	-	272.50	251.2	261.83
GCP – 21	-	300.10	277.8	288.93
SEm ±				2.82
CD (5%)				8.13
CV %				1.88

Table 37. Reaction of ginger germplasm to *Phyllosticta zingiberi* under glasshouse conditions - Pundibari

Disease incidence (%)	Germplasm	Reaction
00.1 – 10.0	Lajhan, SG 503, Kali Chanog, Kindi	Resistant
10.1 – 25.0	BDJR 1030, BDS 9/ 93, Shilli Bangi Keral Local, Erand, V1 S1-8	Moderately resistant
25.1 – 50.0	SG 880, Juggijan, V1 S1-8, Jamaica, Himgiri	Moderately susceptible
50.1 – 75.0	Panesh 1, Taffingiva	Susceptible
75.1 – 100.0	Awocho	Highly susceptible

Kumarganj

During 2001-2002, two collections were made from eastern part of U.P and added to the germplasm. Altogether 21 germplasm accessions were evaluated for their agronomic traits. Maximum rhizome yield (0.102 kg plant^{-1}) was obtained in NDG – 6, followed by NDG – 9 (0.064 kg plant^{-1}) (Table 38). Rhizome rot disease was observed in almost all the cultures.

Table 38. Performance of ginger germplasm (2001-2002) - Kumarganj

Germplasm	Yield (t ha^{-1})
NDG – 1	2.767
NDG – 2	3.900
NDG – 3	1.833
NDG – 4	1.800
NDG – 5	6.600
NDG – 6	10.200
NDG – 7	2.767
NDG – 8	1.900
NDG – 9	6.400
NDG – 10	1.967
NDG – 11	4.033
NDG – 12	1.633
NDG – 13	2.833
NDG – 14	2.567
NDG – 15	4.033
NDG – 16	1.600
NDG – 17	6.333
NDG – 18	2.767
NDG – 19	2.100
NDG – 20	2.967
NDG – 21	1.800
NDG – 22	4.700
CD (5%)	0.277
CV %	0.476

Raigarh

Thirty five germplasm accessions were maintained and evaluated for different yield and yield attributing characters. Among them, IG - 01-01, IG - 01-02, IG - 01-03, IG - 01-04 were found to be superior with respect to yield.

Dholi

Forty two germplasm accessions were collected from East Champaran District of Bihar during the year 2002. Their morphological characters will be recorded during 2002-2003.

GIN/CI/2 Coordinated varietal trial (CVT)

GIN/CI/2.1 CVT 1996 - Series IV *(Pundibari)*

Pundibari

This trial has to be concluded as per the XIV Workshop decision. Final report was not received.

GIN/CI/2.2 CVT 2000 - 7 Series V *(Solan, Chintapalli, Pottangi, Pundibari* and *Raigarh)*

Solan

A new CVT was laid out at Solan during the year with 6 entries, two from Calicut (Acc - 35 & Acc - 117) and four from Solan (SG - 682 and SG - 692, Himgiri and SG - 54 as a local check). Significant differences for yield among the lines was observed. However, the local entries performed better over Acc - 35 and Acc - 117. Among these two, Acc - 117 performed better compared to Acc - 35 (Table 39).

Table 39. Performance of ginger varieties under CVT - Solan

Entry	Mean yield (kg/3m^2)	Converted yield (t ha^{-1})
SG – 682	5.43	10.91
SG – 692	5.60	11.25
Acc – 35	3.26	5.22
Acc – 117	3.26	6.55
SG – 54	5.80	11.65
Himgiri	6.80	13.66
Mean	4.91	9.87
SEm ±	0.29	
CD (5%)	0.65	

Chintapalli

The trial was started during 2001-2002 with eight entries collected from different co-ordinating centres (Acc - 35, Acc - 117, V_1S_1 - 2, V_1E_1 - 8, IISR Varada, Jaheerabad local, Suprabha and Chintapalli local). Among eight varieties tested, significantly higher plant height was recorded in IISR Varada and Jaheerabad local, whereas number of tillers per plant was maximum in V_1S_1 - 2, IISR Varada and Jaheerabad local. The variety IISR Varada recorded highest yield of 29 t ha^{-1}, which is significantly superior to other varieties (Table 40).

Pundibari

The coordinated varietal trial with seven entries was conducted in the year 2001-2002. Maximum number of leaves and tillers were found in Gorubathan followed by Acc - 117 and V_1S_1 - 8. Fresh rhizome yield 3m^2 bed^{-1} was highest in Gorubathan (19.17 kg) followed by SG - 692 (8.56 kg) (Table 41).

Pottangi

Eight entries were evaluated under this trial. Significant difference among the varieties in rhizome yield was recorded. The highest fresh rhizome yield was recorded in V_1E_8 - 2 (28.53 t ha^{-1}), followed by V_3S_1 - 8 (27.40 t ha^{-1}) (Table 42).

Table 40. Performance of ginger varieties under CVT - Chintapalli

Variety	Plant height (cm)	No. of tillers plant^{-1}	No. of leaves plant^{-1}	Leaf length (cm)	Leaf width (cm)	Yield (kg plant^{-1})	Yield (kg plot^{-1})	Yield (t ha^{-1})
Acc – 35	41.2	4.2	39.2	15.8	2.5	0.13	1.5	15
Acc – 117	51.7	5.8	55.3	15.2	2.5	0.17	1.8	18
V_1S_1 – 2	51.0	9.2	66.2	17.5	1.9	0.17	1.9	19
V_1E_1 – 8	47.7	7.0	53.6	15.9	2.1	0.13	1.6	16
IISR Varada	62.8	8.1	83.2	18.5	2.5	0.23	2.9	29
Jaheerabad local	57.8	8.4	72.7	18.8	2.5	0.13	1.8	18
Suprabha	39.2	5.0	55.4	18.7	2.2	0.14	1.5	15
Chintapalli local	47.3	6.0	47.6	17.3	2.3	0.16	1.5	15
SEm ±	49.8	6.7	59.2	17.2	2.3	0.18	1.8	18
CV %	17.5	28.0	30.7	14.7	18.0	25.00	30.0	30
CD (5%)	8.7	1.7	18.3	NS	NS	0.05	0.7	7

Table 41. Performance of ginger varieties under CVT - Pundibari

Variety	Plant height (cm)	No. of tillers	No. of leaves	Leaf length (cm)	Leaf breadth (cm)	Rhizome yield (kg $3m^2$ bed^{-1})
Acc - 35	64.47	11.700	17.370	18.00	2.53	8.13
Acc - 117	61.47	12.340	17.970	19.23	2.56	7.81
Gorubathan	65.07	12.560	19.470	21.83	2.50	19.17
SG - 682	62.43	11.200	16.630	21.43	2.53	8.53
SG - 692	55.23	11.400	17.270	19.27	2.60	8.56
V_1S_1 - 2	61.13	11.400	17.930	20.57	2.47	7.89
V_1E_1 - 8	62.77	12.030	16.500	20.76	2.30	7.59
SEm ±	NS	0.195	0.380	NS	NS	1.58
CD (5%)	-	0.365	2.105	-	-	3.32

Table 42. Performance of ginger varieties under CVT - Pottangi

Variety	Fresh rhizome yield (kg $3m^2$ bed^{-1})			Projected yield
	2000	2001	Mean	(t ha^{-1})
V_1E_8 – 2	11.68	11.13	11.41	28.53
V_3S_1 – 8	10.49	11.43	10.96	27.40
V_1E_1 – 8	9.47	10.86	10.67	26.68
Acc – 35	7.70	7.84	7.77	19.43
Suprabha	8.20	8.68	8.44	21.10
Acc – 117	6.50	8.80	7.65	19.13
V_1S_1 – 2	7.50	9.06	8.28	20.70
SG – 666	6.10	8.46	7.28	18.20
CD (5%)	NS	1.14	-	2.85

Raigarh

A CVT with five entries was laid out during 2001 along with Acc - 35, Acc - 117, V_1E_1 - 8 and V_1S_1 - 2. Significant differences were observed in IG - 01-1 and IG - 01-02, which gave significantly superior yield over the rest of the entries.

GIN/CI/3 Varietal Evaluation Trial

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

(Solan, Pottangi and *Raigarh)*

Pottangi

Eight entries were evaluated and signifi-

Table 43. Performance of ginger cultivars under CYT – Pottangi

Entry	Fresh rhizome yield (kg $3m^2$ bed^{-1})			Projected yield
	2000	2001	Mean	(t ha^{-1})
S - 646	10.60	8.63	9.62	24.05
V_2E_5 - 2	8.90	10.90	9.90	24.75
Z0 - 17	8.10	9.05	8.58	21.45
V_3S_1 - 8	6.20	9.88	8.04	20.10
S - 641	5.23	7.63	6.43	16.08
Singhjhara	5.51	9.03	7.27	18.18
Vengara	4.56	8.10	6.33	15.83
Suprabha	6.30	8.13	7.22	18.05
CD (5%)	1.64	1.99	1.82	4.97

cant difference for yield among the entries was observed. Highest fresh rhizome yield was recorded in V_2E_5 - 2 (24.75 t ha^{-1}), followed by S - 646 (24.05 t ha^{-1}) (Table 43).

Raigarh

Comparative yield trial was started in 2001 with five entries along with Acc - 64, SG - 554 in RBD. Significantly higher yields were observed in IG - 01-1 and IG - 01-2 (Table 44).

Table 44. Performance of ginger in CYT - Raigarh

Entry	Yield (kg/$3m^2$)	Converted yield (q/ha)
IG – 01-1	15.93	362.60
IG – 01-2	14.56	332.00
IG – 01-3	11.90	239.00
IG – 01-4	12.63	254.00
IG – 01-4	9.53	192.00
Acc – 35	2.90	58.30
Acc – 177	7.90	160.00
V_1S_1 – 2	1.75	35.17
V_1C – 8	0.80	16.08

$\overline{X}$ = 183.14, CD = 5.73, CV % = 14.35

Solan

Six collections along with check Himgiri were evaluated for yield. No significant difference among collections was observed for yield during 2000 (Table 45). These collections were tested again during 2001. Though significant differences were observed for yield, none of the collections out yielded the check (Himgiri) (Table 46).

Table 45. Performance of ginger under CYT (2000) - Solan

Name	Yield (kg/$3m^2$)	Converted yield (q/ha)
SG - 718	6.3	126.63
Juggijan	6.2	124.62
SG - 869	6.3	126.63
47/95	6.2	124.62
SG - 868	6.1	122.61
Himgiri (check)	6.52	130.65
Mean	6.26	125.87
SEm ±	1.82	
CD (5%)	NS	

Table 46. Performance of ginger under CYT (2001) - Solan

Name	Yield (kg/3m²)	Converted yield (q/ha)
SG - 785	6.20	124.62
Jamaica	5.85	117.60
SG - 709	6.35	127.63
BLP - 6	5.82	117.00
SG - 723	6.05	121.60
Himgiri (check)	6.52	131.00
Mean	6.13	123.20
SEm ±	0.18	
CD (5%)	0.39	

GIN/CI/3.2 Initial evaluation trial (IET) *(Solan and Pottangi)*

Solan

Eighteen collections along with check (Himgiri) were evaluated during 2001. Non-significant differences were observed for yield and none of the collections out yielded the check, Himgiri (125.62 q ha^{-1}).

Pottangi

Significant difference among the cultivars for fresh rhizome yield was recorded. Highest fresh rhizome yield was recorded in V3S1 - 8 (28.25 t ha^{-1}) followed by Raigarh (25.38 t ha^{-1}) (Table 47).

Table 47. Performance of ginger cultivars under IET - Pottangi

Cultivar	Fresh rhizome yield (kg/3m²)			Projected yield
	2000-01	2001-02	Mean	(t ha^{-1})
S - 558	9.44	10.33	9.89	24.73
Z0 - 17	6.92	8.65	7.79	19.48
Vengara	7.16	7.65	7.41	18.53
Rajgarh	11.43	8.86	10.15	25.38
V_2E_5 - 2	8.67	9.85	9.26	23.15
Anamica	10.22	8.57	9.40	23.50
SS - 1	9.41	7.35	8.38	20.95
V_1S_1 - 8	7.30	9.87	8.59	21.48
V_3S_1 - 8	11.64	10.96	11.30	28.25
Jugijan	7.52	7.60	7.56	18.9
Z0 - 2	9.81	6.71	8.26	20.65
S - 646	10.76	8.09	9.43	23.58
Nadia	8.63	6.98	7.81	19.53
S - 666	9.62	7.33	8.48	21.20
Suprabha	10.78	9.27	10.03	25.08
CD (5%)	1.94	2.54	2.24	5.60

GIN/CI/4 Quality Evaluation Trial
GIN/CI/4.1 Evaluation of germplasm for quality
(Solan)

Solan

Fifty collections of ginger found to be superior in quality attributes during 2000-01 were again analyzed for quality parameters during 2002. The dry matter and oleoresin content varied from 13.8 to 22.4% and 4.30 to 7.72%, respectively, whereas essential oil ranged between 1.0 to 2.0%. Among these collections, SG - 882 exhibited best quality followed by SG - 699, SG - 864 and SG - 681.

GIN/CM/1 Nutrient Management Trial
GIN /CM/1.1 Efficacy of biofertilizer using *Azospirillum* on ginger
(Solan, Pottangi, Ambalavayal, Pundibari and *Raigarh)*

Pottangi

Significant differences among the treatments for fresh rhizome yield were observed. Highest fresh rhizome yield was recorded in the treatment T 1 (20. 58 t ha^{-1}), followed by the recommended dose of inorganic fertilizers (18.88 t ha^{-1}) (Table 48).

Solan

The experiment was repeated during 2001. Non-significant differences were observed for yield in both the years.

Raigarh

At Raigarh the trial was laid out during 2001 and maximum fresh rhizome yield (24.30 t ha^{-1}) was recorded with the application of inorganic nitrogen 100% + *Azospirillum* 50 g + FYM 5 kg ha^{-1} (T1), closely followed by T8 (23.11 t ha^{-1}) and T2 (21.62 t ha^{-1}), which are at par. Treatments T4, T5, T6 and T7 also showed non-significant differences (Table 49).

Table 48. Efficacy of *Azospirillum* in ginger var. Suprabha - Pottangi

Treatment	Fresh rhizome yield (kg/3m²)			Projected
	2000-01	2001-02	Mean	(t/ha)
T1 - Inorganic N 100% + *Azospirillum* 50 g + 5 k FYM	7.23	9.23	8.23	20.58
T2 - Inorganic N 75% + *Azospirillum* 50 g + 5 kg FYM	6.81	6.80	6.81	17.03
T3 - Inorganic N 30% + *Azospirillum* 50 g + 5 kg FYM	6.68	5.76	6.22	15.55
T4 - 0 N+ 0+ 5 kg FYM	5.53	4.87	5.20	13.00
T5 - 0 N+ *Azospirillum* 50 g + 10 kg FYM	5.45	4.93	5.19	12.98
T6 - 0 N+ *Azospirillum* 50 g + 10 kg FYM	5.84	6.10	5.97	14.93
T7 - 0 N+ 0	5.22	4.76	4.99	12.48
T8 - 125 kg N + 100 kg P2O5 + 100 kg MOP (Recommended dose of fertilizer)	7.14	7.96	7.55	18.88
CD (5%)	NS	1.20	-	3.0

P and K are applied as SSP and MOP, respectively.

Table 49. Effect of biofertilizer, *Azospirillum* on the yield and economics of ginger - Raigarh

Treatment	Plot Yield (kg)	Yield (t ha^{-1})	Cost (Rs.in lakhs)	Gross return (Rs. in lakhs)	Net return (Rs. in lakhs)
T1- Inorganic nitrogen 100% + *Azospirillum* 50 g + FYM 5 kg.	12.1	24.30	1.12	1.94	0.82
T2- Inorganic nitrogen 75% + *Azospirillum* 50 g + FYM 5 kg.	10.76	21.62	1.10	1.73	0.63
T3- Inorganic nitrogen 50% + *Azospirillum* 50 g + FYM 5 kg.	9.83	19.76	1.08	1.58	0.50
T4- FYM 5 Kg. + *Azospirillum* 50 g.	7.00	14.03	1.00	1.12	0.12
T5- FYM 5 kg alone	6.76	13.60	0.98	1.09	0.11
T6- FYM 10 kg. + *Azospirillum* 50 g.	7.76	15.61	1.02	1.24	0.22
T7- FYM 10 kg alone	7.43	14.94	1.01	1.20	0.19
T8- Recommended dose of fertilizer (150,100, 120 NPK)	11.50	23.11	1.11	1.84	0.73
CD (5%)	0.84	1.69	-	-	-

The minimum yield (13.60 t ha^{-1}) was recorded with application of FYM 5 kg alone (T5).

Ambalavayal and *Pundibari*

Reports not received.

GIN/CM/ 1.2 Organic farming in ginger

(Solan, Pottangi, Ambalavayal, Dholi and *Raigarh)*

Pottangi

There was significant difference among different treatments for fresh rhizome yield. Highest fresh rhizome yield was recorded in T8 (20.80 t ha^{-1}) followed by T1 (17.63 t ha^{-1}) (Table 50).

Raigarh

Maximum yield of 22.3 t ha^{-1} was obtained with the application of recommended dose of fertilizers i.e. farmers practice (NPK 150 : 100 : 120 kg ha^{-1}), closely followed by T1 (18.96 t ha^{-1}) and T5 (18.76 t ha^{-1}), which are at par. The minimum yield (9.78 t ha^{-1}) was recorded with application of wood ash alone (Table 51).

Solan

The experiment was conducted during 2001 and 2002 at Solan. No significant differences were observed for yield among the treatments in both the years.

Dholi and *Ambalavayal*

Reports not received.

Table 50. Performance of ginger var. Suprabha under organic farming – Pottangi

Treatment	Fresh rhizome yield (kg^3/m^2)			Projected yield
	2000-01	2001-02	Mean	(t ha^{-1})
T1 - A +B+C+D+E+F	7.48	6.61	7.05	17.63
T2 - O+B +C+D+E+F	5.43	5.20	5.32	13.30
T3 - O +A+C+D+E+F	5.47	5.09	5.28	13.20
T4 - O+A+B+D+E+F	5.41	4.28	4.85	12.13
T5 - O+A+B+C+E+F	5.89	4.48	5.19	12.98
T6 - O+A+B+C+D+E+F	4.69	4.78	4.74	11.85
T7 - O + A+B+C+D+F	5.21	4.35	4.78	11.95
T8 - Recommend dose of fertilizer	8.13	8.50	8.32	20.80
CD (5%)		1.32		3.30

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

Table 51. Effect of organic inputs on yield and economics of ginger - Raigarh

Treatment	Fresh yield		Cost (Rs. in lakhs)	Gross return (Rs. in lakhs)	Net return (Rs. in lakhs)
	(kg $plot^{-1}$)	(t ha^{-1})			
T1 - FYM + rock phosphate + wood ash	9.43	18.96	1.07	1.51	0.44
T2 - Rock phosphate 500 g $plot^{-1}$ alone	4.93	9.91	0.75	0.79	0.04
T3 - Wood ash 2 kg $plot^{-1}$ alone	4.86	9.78	0.75	0.78	0.03
T4 - *Azospirillum* alone 50 g $plot^{-1}$ alone	5.23	10.51	0.78	0.84	0.06
T5 - Neem cake + rock phosphate + wood ash	9.33	18.76	1.07	1.50	0.43
T6 - Neem cake 250 g $plot^{-1}$ alone	5.63	11.32	0.85	0.90	0.05
T7 - FYM 5 kg $plot^{-1}$ alone	6.00	12.06	0.90	0.96	0.06
T8 - Recommended dose of fertilizer 150 + 100 + 120 kg NPK ha^{-1}	11.10	22.31	1.10	1.78	0.68
CD (5%)	0.98	1.97			

GIN/CM/1.3 Micronutrient on ginger
(Dholi)

Dholi

An experiment was conducted to study the effect of micronutrients on the yield of ginger during 2001-02 in a randomized block design. Application of micronutrients significantly increased the yield of ginger compared to control. Among the micronutrients, ferrous sulphate 1%, two foliar sprays at 45 and 55 days after planting produced maximum yield (176.30 q ha^{-1}), which was statistically at par with zinc sulphate @ 10 kg ha^{-1} as soil application (T4), three foliar sprays of ferrous sulphate 1% (T12) and zinc sulphate 0.5% at 45, 55 and 65 days after sowing (T10) (Table 52).

GIN/CP/1 Disease Management Trial
GIN/CP/1.1 Integrated management on rhizome rot of ginger
(Solan, Dholi and *Pundibari)*

Pundibari

Survey conducted in the northern districts of West Bengal i.e. Cooch Behar, Jalpaiguri and Darjeeling during July and September 2001 indicated that leaf spot and rhizome rot were

Table 52. Effect of micronutrients on yield and yield parameters in ginger (2001-2002) - Dholi

Treatment	Plant height (cm)	No. of tillers $plant^{-1}$	Yield $plot^{-1}$ (kg)	Yield (q ha^{-1})
T1 - Control	37.35	10.25	1.000	34.01
T2 - Zn @ 2.5 kg ha^{-1}	45.00	16.85	2.733	92.97
T3 - Zn @ 5.0 kg ha^{-1}	45.50	18.75	3.100	105.44
T4 - Zn @ 10.0 kg ha^{-1}	54.50	24.50	4.700	159.87
T5 - B @ 0.50 kg ha^{-1}	40.45	13.75	1.667	56.69
T6 - B @ 1.00 kg ha^{-1}	43.55	15.60	2.117	71.99
T7 - B @ 1.50 kg ha^{-1}	43.80	15.90	2.400	81.63
T8 - B @ 2.00 kg ha^{-1}	47.75	19.00	3.283	111.68
T9 - Two spraying of 0.5% $ZNSO_4$ solution at 45 and 55 days after sowing	50.00	19.30	3.350	113.95
T10 - Three spraying of 0.5% $ZNSO_4$ solution at 45, 55 and 65 days after sowing	53.00	21.80	4.367	148.52
T11 - Two spraying with 1% ferrous sulphate solution at 45 and 55 days after sowing	55.00	27.90	5.183	176.30
T12 - Three spraying with 1% ferrous sulphate solution at 45, 55 and 65 days after sowing	54.00	22.50	4.416	150.22
CD (5%)	4.75	3.49	0.718	24.40
CV %	5.89	10.90	13.287	13.27

predominant diseases in Cooch Behar and Jalpaiguri but in Darjeeling district a complex symptom of rotting, yellowing and wilting were observed. The incidence of the disease was moderate to heavy in all locations surveyed. Among the varieties grown, Gorubathan and Vaisi were dominant and farmers generally do not apply any plant protection chemicals.

Solan and *Dholi*

Reports not received.

GIN/CP/1.2 Biocontrol studies on rhizome rot of ginger

(*Pundibari, Raigarh, Kumarganj, Solan, Pottangi, Dholi* and *Ambalavayal*)

Raigarh

Among different treatments, T6 was found superior to all other treatments with maximum fresh rhizome yield closely followed by T7 and T4 (Table 53).

Pundibari

This experiment was initiated in the year 2000–2001 with following eight treatments.

T1 - No seed treatment

T2 - Seed treatment with hot water at 51°C for 10 minutes

T3 - Seed treatment with mancozeb (3 g l^{-1}) for 30 minutes

T4 - Seed treatment with biocontrol inoculum 100 g 5 l^{-1} (10^7 c.f.u) of water for 30 minutes.

T5 - Seed treatment with hot water at

Table 53. Management of rhizome rot of ginger - Raigarh

Treatment	Germination (%)	Survival (%)	Rhizome yield (kg $plot^{-1}$)
T1 – Healthy looking seed sown directly - no treatment	85.3	78.0	5.07
T2 - Seed treatment with hot water 51°C for 10 min.	59.7	79.3	5.83
T3 - Seed treatment with mancozeb (3 g/l) 30 min	91.3	77.3	5.43
T4 - Seed treatment with bioagent 100 g/5 l of water for 30 min.	90.7	87.3	6.90
T5 - Seed treatment with hot water 51°C for 10 min + T3	84.7	75.3	5.70
T6 - Seed treatment with hot water + 100 g bio agent in 1 kg neem cake at sowing	88.7	84.0	8.63
T7 – Application of neem cake 1 kg in soil at the time of sowing.	92.0	84.7	6.90
T8 – Neem cake 1 kg + 100 g bioagent in 3 kg FYM (mixed 7 days before sowing and watering regularly)	94.7	94.0	8.93
CD (5%)	NS	6.72	0.79
CV %	-	8.05	20.2

Note -T8 is additional treatment.

51^0 C for 10 minutes + mancozeb treatment for 30 minutes

T6 - Seed treatment with hot water at 51^0 C for 10 minutes + biocontrol inoculum mixed with 1 kg of neem cake at the time of planting.

T7 - Soil application of neem cake

T8 - Soil treatment with *Aspergillus* sp.

Seed treatment with hot water and *Trichoderma harzianum* mixed with neem cake was the most effective treatment in reducing the disease incidence at different phases of crop growth. This treatment recorded 57% less disease incidence as compared to that of untreated check. The next best treatment was seed treatment with *T. harziamum* alone (Table 54).

Kumarganj

The results showed that minimum rhizome rotting (35.55%) was in T6 (seed treatment with hot water at 51^0C for 10 min + mancozeb treatment for 30 min with rhizome yield of 90.74 q ha^{-1} (Table 55). However, maximum disease was observed in T5 (seed treatment with hot water at 51^0C for 10 min + mancozeb treatment for 30 min).

Solan

The studies conducted for the management of rhizome rot disease of ginger showed no significant differences among the treatments in reducing the disease incidence (Table 56).

Pottangi, *Dholi* and *Ambalavayal*

Reports not received.

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

(Dholi and *Pundibari)*

Dholi

Metalaxyl mancozeb (Ridomil – MZ, 200-300 ppm) as seed treatment proved better in controlling the disease giving the maximum yield of 44.97 q ha^{-1} and less disease incidence of 18.65% (Table 57).

Pundibari

This experiment was laid with 3 treatments, namely mixture of mancozeb and

Table 54. Efficacy of biocontrol agents for the control of rhizome rot of ginger – Pundibari

Treatment	Germination (%)	Disease incidence (%)			Rhizome yield (kg $plot^{-1}$)
		1st observation	2nd observation	3rd observation	
T1	88.9	27.74	39.69	49.95	4.00
T2	91.1	23.19	34.68	38.30	5.15
T3	91.1	21.53	27.41	35.52	4.83
T4	92.0	12.57	25.59	29.97	5.07
T5	92.0	20.22	29.50	33.78	5.23
T6	92.0	14.76	25.73	27.97	6.23
T7	88.9	23.11	36.43	39.50	4.07
T8	91.1	16.92	28.02	34.76	4.95
SEm ±		1.46	0.98	1.28	0.20
CD (5%)		4.43	1.65	3.89	0.62

Table 55. Efficacy of bioagent for the management of rhizome rot of ginger - Kumarganj

Treatment	Germination (%)	Rhizome rot incidence (%)	Yield (q ha^{-1})
T1 - Seed sown directly (Control)	75.55	66.66	45.37
T2 - Seed treatment with hot water at 51° C for 10 min	88.88	48.88	35.18
T3 - Seed treatment with mancozeb (3 gl^{-1}) for 30 min	84.44	51.11	30.55
T4 - Seed treatment with biocontrol agent (*T. harzianum)* 100 g inoculum (5 gl^{-1}) of water for 30 min	82.21	48.88	59.25
T5 - Seed treatment with hot water at 51°C for 10 min + mancozeb treatment for 30 min.	82.22	53.33	63.88
T6 - Seed treatment with hot water at 51°C for 10 min + biocontrol inoculum (*T. harzianum*) mixed with neem cake.	93.33	35.55	90.74
T7 - Soil application of neem cake at the time of sowing & planting	88.86	48.88	63.88
CD (5%)	19.04	9.09	16.02
CV %	12.04	10.45	14.10

Table 56. Efficacy of bioagent for the management of rhizome rot of ginger - Solan

Treatment	Germination (%)	Disease Incidence (%)	Mean yield (kg/3 m^2)	
			Fresh	Dry
T1 - Sanjeevani seed and soil treatment	90	7.5	11.10	1.83
T2 - Sanjeevani soil treatment	91	8.0	8.92	1.50
T3 - *Trichoderma harzianum* seed and soil Treatment	90	6.0	11.65	1.55
T4 - FYM furrow application at rhizome planting time	89	8.5	10.75	2.10
T5 - Rhizome treatment with mancozeb 0.25 % + carbendazim 0.1% + chlorpyriphos 0.2% + soil application of Thimet 10 G @ 10 kg ha^{-1}.	90	5.0	8.66	2.10
T6 - *T. harzianum* vermi compost treatment	91	9.0	9.70	1.66
T7 - Control 1	90	9.5	9.75	1.33
T8 - Control 2	88	10.0	10.66	1.81
CD (5%)	NS	NS	NS	NS

Table 57. Effect of seed treatment on soft rot disease of ginger (2000-2001) - Dholi

Treatment	Disease incidence (%)	Yield (q ha^{-1})
T1 - Metalaxyl mancozeb @ 200-300 ppm (Ridomil MZ) as seed treatment	18.65	44.97
T2 - Biocontrol as seed treatment (*Trichoderma viride)*	21.90	36.46
T3 - Biocontrol as soil application and seed treatment	25.85	28.13
T4 - Metalaxyl as seed treatment and soil application of bio-control agent	21.35	40.45
T5 - Control (untreated)	32.19	22.22
CD (5%)	3.94	5.45
CV %	10.68	10.26

carbendazim (SAAF) @ 0.2% with monocrotophos @ 0.25%, SAAF + *Trichoderma harzianum* and control (Table 58). The disease incidence was low (13.0%) in rhizomes treated with SAAF + *T. harzianum*, which resulted in highest recovery (84.5%) of healthy rhizomes.

Table 58. Effect of pre-treatment on storage rot of ginger - Pundibari

Treatment	Disease incidence (%)	Recovery (%)
SAAF + monocrotophos	17.5	81.4
SAAF + *T. harzianum*	13.0	84.5
Control	25.0	71.0

TURMERIC

TUR/CI/1 Genetic Resources

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

(*Coimbatore, Jagtial, Dholi, Pottangi, Raigarh, Pundibari, Solan* and *Kumarganj*)

Coimbatore

Morphological and yield characters of turmeric germplasm (224 indigenous and 6 exotic types) were recorded. The highest yield, 40 t ha^{-1} was recorded in the turmeric accessions CL - 18, CL - 48 and CL - 169, while the lowest yield was 10 t ha^{-1}.

Jagtial

At present, 189 genotypes/germplasm collections are being maintained. Germplasm has been collected from Adilabad, Kovvuru, Chintapally, Anantharajpeta. Based on duration of the crop, the cultures are grouped into long duration (8 to 9 months), medium duration (7 to 8 months), short duration (6 to 5 months) types (Table 59). Wide variability was observed for growth and yield characters, especially with respect to number and length of primary fingers, number of secondaries, length and diameter of mother rhizome, curing per cent and curcumin content. Variability was also observed in their reaction to diseases like rhizome rot, leaf spot and leaf blotch.

Dholi

Sixty germplasm accessions comprising of local as well as promising varieties of different states of India are being maintained. Out of 58 genotypes, eight genotypes namely, RH - 16, RH - 5, RH - 9/90, RH - 24, RH - 14, RH - 13/90, RH - 80 and RH - 17 were selected for initial evaluation trial (IET).

Pottangi

At Pottangi, out of 191 turmeric accessions, 173 were evaluated during the year. Among these accessions 155 were *Curcuma longa*, 17 were *Curcuma aromatica* and 3

Table 59. Plant characters and yield of few promising turmeric germplasm (2001-2002) - Jagtial

Culture	Plant height (cm)	No. of leaves $plant^{-1}$	Stem girth (cm)	Fingers No.	Fingers Length (cm)	Fresh rhizome yield (kg/3m^2)
A. Long duration						
Turmeric local	67.6	9.0	3.3	6.8	6.0	13.8
GS	76.0	9.0	3.6	6.0	5.8	13.2
B. Medium duration						
CLI – 330	67.0	8.0	3.6	6.2	5.6	14.0
JTS – 303	72.3	8.0	4.0	6.4	5.4	12.2
C. Short duration						
JTS – 606	66.3	8.0	4.0	5.8	5.8	13.4
PCT – 19	66.3	7.8	3.6	8.4	5.6	8.3

were *Curcuma amada*. The range in fresh rhizome yield plot^{-1} (3 m^2) in *C. longa* varied from 3.31 kg to 11.5 kg and 35 accessions gave yield more than 6 kg.

In *Curcuma aromatica,* the range in fresh rhizome yield/3 m^2 varied from 2.5 kg to 10.5 kg and 7 accessions gave more than 5 kg. In *C. amada*, the range in yield was 6.1 kg to 11.4 kg/3 m^2 bed. Two new accessions of *C. longa* were added making the total to 155. Cataloguing, characterization and passport data are being done.

Raigarh

Seventy germplasm accessions consisting of indigenous (collected locally from Bastar region) and exotic types are being maintained. These lines were evaluated for different yield characters. Among them, IT - 01-1, IT - 01-2, IT - 01-3, IT - 01-4, IT - 01-5 (yield), IT - 01-15, IT - 01-14, IT - 01-1, IT - 01-4 and IT - 01-12 (weight of clump) IT - 01-3, IT - 01-14, IT - 01-15, IT - 01-19 and IT - 01-17 (weight of mother rhizome), IT - 01-12, IT - 01-15 and IT - 01-17 were identified for various yield attributing characters.

Pundibari

Eighty two accessions of turmeric are being maintained and evaluated. Considering plant height for all the three years (1999-2002), it was observed that the TCP - 42 recorded maximum plant height (183.63 cm), while tiller number, leaf length, leaf number, leaf breadth and yield per clump were high in accessions TCP - 68 (4.1), TCP - 42 (68.53 cm), TCP - 13 (12.53), TCP - 14 (18.5 cm) and TCP - 56 (894.53 g), respectively.

Solan

At Solan, 171 collections were evaluated for yield and other characters. The yield per plot (3 m^2) varied from 0.75 to 7.20 kg. The yield of promising lines ranged from 5.8 to 7.5 kg/3m^2. ST - 691 performed best (7.5 kg/3m^2), followed by CL - 21 (6.8 kg/3m^2).

Kumarganj

During kharif season of 2001-2002 thirty germplasm accessions of turmeric were collected from neighboring districts in eastern U.P. Altogether 96 germplasm accessions were evaluated for their agronomic traits. Rajendra Sonia was used as standard check. Among the germplasm, maximum fresh rhizome yield was obtained in NDH - 18 (578.89 q ha^{-1}), followed by NDH - 14 (573.33 q ha^{-1}). The yield varied from 90.27 q ha^{-1} to 578.89 q ha^{-1}. However, maximum yield of fresh rhizomes was recorded in early maturing type NDH – 5 (568.51 q ha^{-1}), medium maturing type NDH – 14 (573.33 q ha^{-1}) and late maturing type NDH - 9 (565.55 q ha^{-1}). A mild incidence of *Taphrina* leaf blotch and leaf spot diseases were observed in almost all the germplasm accessions.

TUR/CI/2 Coordinated Varietal Trial
TUR/CI/2.2 CVT 2000 Series V

(*Pottangi, Dholi, Pundibari, Raigarh, Jagtial, Kumarganj, Coimbatore* and *Chintapalli*)

Pottangi

Out of 15 entries evaluated significant difference for fresh rhizome yield among the entries was recorded. Highest fresh rhizome yield was recorded in RH - 5 (37.28 t ha^{-1}), followed by PTS - 52 (29.55 t ha^{-1}) and PTS - 11 (28.89 t ha^{-1}) (Table 60).

Chintapalli

The trial was initiated during 2000-2001 with 12 entries collected from different coor-

Table 60. Performance of turmeric accessions under CVT - Pottangi

Cultivar	Fresh rhizome yield (kg/3 m^2)			Projected yield (t ha^{-1})
	2000-01	2001-02	Mean	
RH – 5	8.99	11.83	14.91	37.28
PTS – 52	10.24	13.39	11.82	29.55
PTS – 55	8.46	11.93	10.20	25.50
PTS – 11	11.33	11.74	11.54	28.89
PTS – 59	9.32	11.62	10.47	26.18
NDH –18	5.81	9.62	7.72	18.00
TCP – 1	7.89	7.24	7.57	18.93
TCP – 2	6.25	7.08	6.67	16.68
Acc – 585	7.29	8.83	8.06	20.15
Acc – 5840	6.08	7.66	6.87	17.18
TCC No.1	7.10	12.78	9.94	24.85
Surama	9.21	11.69	10.45	26.13
Roma	8.13	11.15	9.64	24.10
PTS – 15	7.32	10.64	8.98	22.45
PCT – 8	7.96	9.67	8.85	22.05
CD (5%)	1.96	1.99	1.98	4.95

dinating centers. Among twelve varieties/selections, maximum plant height was recorded in Acc - 585 (116.8 cm) and PTS - 55 (113.4 cm), which are on par, whereas number of tillers is high in TCP - 2, Acc - 126, Acc - 585, PTS - 52, PTS - 15, PTS - 55, PTS - 59 and NDH - 18. However, there is no significant difference among the varieties/selections, PTS - 55, PTS - 11, PTS - 15, TU - 1, Acc - 126, Acc - 585, PTS - 52 and TCP - 2 in respect of number of leaves $plant^{-1}$. Maximum fresh rhizome yield per plant was recorded in NDH - 18 (466 g) and PTS - 11 (386 g), which are significantly to superior to other varieties. The fresh rhizome yield ranged from 4.6 t ha^{-1} to 24.8 t ha^{-1}. The varieties/selections viz., PTS - 11, TU - 1 and PTS - 55 recorded highest yield of 24.8 t ha^{-1}, 18.6 t ha^{-1} and 18.5 t ha^{-1}, respectively which are significantly superior to other varieties (Table 61).

Jagtial

Out of 14 cultures tested at Jagtial, RH - 5 gave more yield of cured rhizomes (5.41 t ha^{-1}), followed by TCP - 1 (5.20 t ha^{-1}) and TCP - 2 (4.25 t ha^{-1}). The highest curing percentage was observed in PTS - 55 (28%) in comparison to check variety Duggirala Red (20%) (Table 62).

Raigarh

Fifteen entries were tested under CVT, including three local checks during 2001. The results showed that the entries from Raigarh (IT - 01-1, IT - 01-2), Pundibari (IT - 01-5 and TCP - 2) showed excellent performance compared to the rest of the entries, with respect to yield (Table 63).

Table 61. Performance of turmeric varieties under CVT (2001-2002) - Chintapalli

Variety	Plant height (cm)	No. of tillers plant^{-1}	No. of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Weight of rhizomes clump^{-1} (g)	Fresh rhizome yield t ha^{-1}
NDH -18	101.7	3.7	17.0	19.7	6.0	466.6	14.7
BSR - 1	100.3	1.8	10.1	20.4	5.5	280.0	17.1
PTS - 59	99.5	3.2	12.0	18.8	5.7	200.0	12.7
PTS - 55	113.4	2.9	14.7	21.1	5.9	186.6	18.5
PTS - 11	106.4	2.6	13.6	18.9	5.6	386.6	24.8
PTS - 15	97.2	3.8	16.1	18.8	5.0	200.0	14.5
TU - 1	110.6	2.6	14.3	22.0	6.0	280.0	18.6
PTS - 52	101.8	3.2	14.7	20.4	6.1	340.0	15.8
TCP - 2	86.2	4.0	17.7	18.2	5.7	326.6	9.2
TCP - 1	86.0	2.8	12.7	18.2	5.6	240.0	4.6
Acc - 126	112.1	4.1	15.4	20.4	5.2	200.0	15.8
Acc - 585	116.8	3.6	17.6	20.2	5.2	233.3	16.8
SEm ±	4.9	0.3	1.5	1.2	0.3	35.2	2.2
CV %	8.2	20.5	17.9	10.9	9.8	21.9	24.9
CD (5%)	14.3	1.1	4.4	3.6	0.9	103.4	6.4

Table 62. Performance of turmeric varieties under CVT (2001-2002) - Jagtial

Culture	Fresh rhizome yield		Cured yield (t ha^{-1})	Curing (%)
	kg/3 m^2	t ha^{-1}		
TCP – 1	7.80	26.0	5.20	20.0
TCP – 2	6.90	23.0	4.25	18.4
Acc – 584	0.58	1.9	0.38	20.0
PTS – 59	5.10	17.0	4.25	25.0
PTS – 11	3.90	13.0	3.38	26.0
PTS – 55	3.60	12.0	3.36	28.0
PTS – 52	3.70	12.3	2.70	21.9
Acc – 593	1.20	4.2	1.13	26.9
Acc – 585	0.62	2.0	0.48	24.0
Acc – 657	1.41	4.6	0.92	20.0
RH – 5	7.40	24.6	5.41	21.9
PTS – 15	4.30	14.3	3.71	25.9
NDH – 18	5.75	19.0	4.18	22.0
Duggirala Red	5.80	19.3	3.86	20.0

Table 63. Performance of turmeric varieties under CVT - Raigarh

Entry	Mean yield (kg/3m^2)	Projected yield (q ha^{-1})
TCP – 2	19.00	381.90
TCP – 1	16.35	328.63
PTS – 55	4.10	82.40
TU – 11	5.25	105.50
PTS – 15	3.60	71.40
PTS – 11	5.20	104.60
PTS – 52	5.20	104.60
PTS – 59	3.90	77.40
RH – 5	10.50	211.00
Acc - 593	2.50	50.25
Acc - 584	3.25	65.40
Acc - 585	4.75	95.50
IT - 01-1	19.50	392.00
IT - 01-2	18.30	368.25
IT - 01-5	18.00	355.00

X = 186.21, CD (5%) = 45.58, CV% =11.41

Pundibari

A CVT on turmeric was initiated during 2000-2001 crop season with 15 entries and one cheek (Acc - 126). The highest mean yield was recorded in TCP - 2 (33.15 t ha^{-1}). All other genotypes except, TCP - 59 gave significantly less yield. It may be observed that TCP - 2 had also the highest values for characters like length of primary and secondary fingers, number of secondary fingers and weight of primary fingers. Other characters like weight of clump and number of primary fingers are also high (Table 64).

Dholi

The experiment was conducted during 2001-2002. Out of 16 promising genotypes, RH - 5 produced the highest yield of fresh rhizomes (515.87 q ha^{-1}), which is an early maturing (196 days) and dwarf type (71.40 cm) compared to other genotypes (Table 65).

Table 64. Performance of turmeric varieties under CVT – Pundibari

Variety	No. of secondary fingers	Length of secondary finger (cm)	Weight of secondary fingers (g)	Weight of clump (g)	Projected yield (t ha^{-1})
PTS – 59	16.77	4.387	108.170	471.57	31.170
PTS – 55	13.44	3.747	90.270	346.67	27.187
PTS – 15	10.17	3.033	88.300	253.33	21.827
PTS – 11	16.32	3.607	86.100	361.67	22.160
PTS – 52	14.11	4.240	103.770	367.23	23.113
RH – 5	16.33	4.347	117.270	361.10	25.207
TU – 1	18.00	3.793	96.430	417.23	25.520
Acc – 584	15.00	4.247	110.900	471.40	24.150
Acc – 126	14.84	3.337	114.330	351.20	29.240
Acc – 585	15.34	4.093	99.170	327.23	20.250
TCP – 1	15.50	4.913	107.430	292.77	29.030
TCP – 2	21.67	6.847	111.200	456.57	33.147
Prabha	15.83	3.920	42.300	239.43	27.360
Pratibha	9.50	2.673	100.570	234.43	23.060
SEm ±	1.02	0.234	2.800	13.30	1.307
CD (5%)	2.93	0.682	8.973	38.65	3.799
CV %	4.89	9.940	4.940	6.51	9.110

Table 65. Performance of turmeric genotypes under CVT (2001-2002) - Dholi

Genotype	Plant height (cm)	No. of tillers plant^{-1}	No. of days to maturity	Yield	
				kg plot^{-1}	q ha^{-1}
Acc - 584	88.40	3.73	225.67	4.783	162.69
Acc - 585	119.53	3.20	236.00	6.667	226.75
Acc - 593	106.20	3.67	226.00	6.567	223.35
Acc - 657	117.80	2.87	273.33	5.033	171.20
TCP – 1	59.20	3.07	200.00	8.333	283.44
TCP – 2	58.20	3.47	198.33	6.233	212.01
TCP – 11	94.13	4.00	231.67	8.900	302.71
PTS – 15	82.40	4.07	224.33	7.800	265.30
PTS – 52	92.33	3.27	234.00	9.400	319.72
PTS – 55	89.40	3.73	230.00	8.850	301.02
PTS – 59	94.67	3.53	234.33	8.217	279.47
TU – 1	100.00	2.80	234.67	5.500	187.07
NDH – 18	78.93	3.60	202.67	9.433	320.85
RH – 5	71.40	4.20	196.00	15.167	515.87
Kerala	86.67	3.07	222.67	4.417	150.22
R. Sonia (check)	75.67	4.07	201.67	13.533	460.31
CD (5%)	13.46	0.78	6.56	1.540	63.73
CV %	9.12	12.98	1.78	11.477	13.96

Kumarganj

Under CVT, 15 entries were evaluated including two cultivars as standard check. Among the cultivars, maximum fresh rhizome yield (265.56 q ha^{-1}) was obtained with NDH – 18, followed by Rajendra Sonia (253.33 q ha^{-1}) (Table 66). Incidence of leaf blotch was lowest in Acc - 585 and it was 40% in Rajendra Sonia, whereas minimum leaf spot disease was in Acc - 585 and maximum disease incidence of 41.67% was observed in NDH – 18.

Coimbatore

Report not received.

TUR/CI/3 Varietal Evaluation Trial

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

(*Pottangi, Dholi, Pundibari, Jagtial* and *Raigarh*)

Jagtial

Out of seven long duration varieties tested during 2001-2002, JTS - 12 has given higher yield of cured turmeric and curing percentage (4.25 t ha^{-1} and 25%), followed by JTS - 15 (4 t ha^{-1} and 25%, respectively) in comparison to check Duggirala Red (2.72 t ha^{-1} and 20%, respectively). Among medium duration varieties tested, JTS - 318 has given more cured yield (5.21 t ha^{-1}), followed by JTS - 324 (5.20 t ha^{-1}). In check variety CLI –

317, the cured yield was 3.91 t ha^{-1} and the curing percentage in JTS - 324 was 27.9%. Out of seven short duration varieties tested, JTS -612 gave high cured yield (6.00 t ha^{-1}), followed by JTS - 608 (5.75 t ha^{-1}). Check variety (PCT - 13) recorded 0.09 t ha^{-1} of cured yield. Highest curing percentage was observed with JTS - 11 (26%).

Dholi

The experiment was conducted during 2001-2002 in a randomized block design with three replications. Out of eight genotypes, RH – 5, an early maturing variety and dwarf type (87.33 cm) produced maximum yield (43.38 t ha^{-1}) compared to other genotypes (Table 67).

Table 66. Performance of turmeric varieties under CVT - Kumarganj

Entry	Duration of the crop (days)	Yield (q ha^{-1})	Disease incidence (%)	
			Leaf blotch	Leaf spot
Acc - 585	213.67	134.22	20.00	11.67
TCP - 1	206.67	130.56	26.67	18.33
PTS - 55	216.33	169.44	30.00	30.00
TU - 1	206.33	157.78	28.33	21.67
Acc - 657	215.00	207.78	23.33	23.33
Acc - 593	216.67	200.00	28.33	18.33
PTS - 11	215.00	190.00	31.67	21.67
PTS - 59	213.33	207.78	31.67	26.67
Acc - 584	214.00	149.44	35.00	31.67
TC P- 2	206.00	242.78	31.67	25.00
RH - 5	199.33	245.56	41.67	40.00
R. Sonia	200.00	253.33	40.00	35.00
NDH - 18	204.33	265.56	38.33	41.67
PTS - 15	212.33	232.78	31.70	30.00
PTS - 52	210.00	208.33	30.00	30.00
CD (5%)	5.05	36.85	7.92	9.32
CV %	1.44	11.04	15.17	20.14

Table 67. Performance of turmeric under CYT - Dholi

Genotype	Plant height (cm)	No.of tillers $plant^{-1}$	No.of days to maturity	Yield (kg $plot^{-1}$)	Yield (q ha^{-1})
PCT – 8	106.13	2.40	224.00	8.000	111.11
PCT– 8	106.20	2.33	231.67	8.708	120.95
Acc – 360	92.93	4.07	232.67	8.933	124.07
Acc – 361	114.00	3.27	233.67	11.250	156.25
JTS – 1	100.86	2.60	222.67	9.667	134.26
RH – 5	87.33	4.53	187.33	31.233	433.80
Sugandhum	75.80	2.47	220.67	8.133	113.13
Rajendra Sonia (check)	87.60	4.40	194.33	28.333	393.52
CD (5%)	18.48	0.93	4.22	1.908	26.43
CV %	8.89	13.01	13.01	6.192	7.83

Pottangi

Out of 8 entries evaluated, no significant difference for rhizome yield among the varieties was recorded. However, highest rhizome yield was recorded in PTS - 34 (25.38 t ha^{-1}), followed by PTS - 39 (24.93 t ha^{-1}) (Table 68).

Raigarh

The experiment was laid out with five entries along with six local varieties during 2001. The results showed that the local entries, IT - 01-1, IT - 01-2, IT - 01-03 and IT - 01-5 were found to be significantly superior to rest of the entries, with respect to yield (Table 69).

Table 68. Performance of turmeric varieties under CYT - Pottangi

Entry	Fresh rhizome yield (kg /3 m^2)			Projected yield (t ha^{-1})
	2000-01	2001-02	Mean	
PTS – 51	7.26	11.07	9.17	22.93
PTS – 50	8.43	11.09	9.76	24.40
TU – 6	6.24	11.81	9.03	22.58
PTS – 34	8.91	11.38	10.15	25.38
PTS – 39	8.67	11.27	9.97	24.93
PTS – 4	6.88	10.47	8.68	21.70
PTS – 16	6.57	9.72	8.15	20.38
Roma	7.92	10.10	9.01	22.53
CD (5%)	NS	NS	-	-

Table 69. Performance of turmeric entries under CYT - Raigarh

Entry	Yield (kg/3m^2)	Projected yield (q ha^{-1})			
		2001-02	2000-01	1999-00	Mean
Prabha	6.15	123.01	123.23	236.50	160.91
Pratibha	10.00	201.00	113.36	221.70	178.68
Acc - 584	3.25	65.32	106.70	220.00	130.67
Acc - 126	3.05	61.31	112.60	206.00	126.63
Acc - 585	6.05	121.60	127.04	204.70	151.11
IT - 01-1	19.50	392.00			
IT - 01-2	18.30	368.00			
IT - 01-3	17.50	344.71			
IT - 01-4	16.10	323.61			
IT - 01-5	17.62	354.26			
IT - 01-6	14.42	289.94			

X = 240.46, CD (5%)= 49.08, CV% = 9.16

TUR/CI/3.2 Initial Evaluation Trial (IET)

(Pottangi and *Solan)*

Pottangi

Among the 15 entries evaluated for the last two years, significant differences for fresh rhizome yield were recorded. Highest fresh rhizome yield was recorded in PTS - 39 (27.80 t ha^{-1}, followed by PTS - 34 (26.80 t ha)$^{-1}$.

Solan

Report not received.

TUR/CI/4 Quality Evaluation Trial

TUR/CI/4.1 Quality Evaluation of germplasm

(Solan and *Coimbatore)*

Solan

During the year 165 germplasm accessions were analysed for various quality parameters. The ranges of various parameters in the accessions are dry matter - 14.4 to 29.6%, essential oil - 2.0 to 6.2%, oleoresin - 5.6 to 14.4% and curcumin - 1.00 to 4.69%. Based on quality, BDJR - 1260, TN - 262, CLS - 21, BDJR - 1235, TN - 201 and DKH - 26 are found promising.

Coimbatore

The curcumin content of 224 accessions of turmeric was analysed. The highest curcumin content (6.16%) was recorded in CL – 67, followed by CL - 146 (6.00%), while the lowest curcumin content was recorded in CL - 36 (1.68%).

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

(*Pottangi* and *Coimbatore*)

Coimbatore

Six promising accessions of turmeric were evaluated for both qualitative and quantitative characters. Rhizome number was high in Acc - 133 (8.9), rhizome weight was highest in Acc - 151 and girth was highest in Acc - 141. The yield was highest in Acc - 2, followed by Acc - 151 and the lowest yield (18.3 kg ha^{-1}) was recorded in Acc - 131. The yield was significantly high in Acc - 2 (26.1 t ha^{-1}), followed by Acc - 151 (Table 70).

Table 70. Yield and yield attributing characters and curcumin content of turmeric accessions (CVT) - Coimbatore

Accession	Mother rhizome			Primary rhizome			Secondary rhizome			Yield (t ha^{-1})	Curcumin (%)
	No	Wt. (g)	Gr.	No.	Wt. (g)	Gr.	No.	Wt. (g)	Gr.		
131 (Suguna)	1.8	65.5	9.5	5.4	141.6	8.2	6.6	57.1	5.9	18.3	4.6
360 (151)	1.8	64.9	9.9	5.7	131.6	7.5	8.4	57.7	5.8	23.8	5.1
140 (JTS - 2)	1.7	64.9	9.3	5.4	131.6	7.6	8.2	46.6	5.3	20.0	3.9
133 (Roma)	1.7	49.9	9.6	5.7	131.0	9.2	8.9	53.8	5.8	20.6	4.7
2 (BSR - 2)	1.3	51.1	9.9	5.7	140.0	7.8	7.6	46.8	5.4	26.1	4.7
141 (Rajendra Sonia)	1.6	48.9	11.6	4.6	122.7	8.8	6.7	49.4	5.1	19.4	4.5
CD (5%)	0.6	23.8	1.3	1.6	50.6	1.4	2.8	15.9	1.0	6.7	

Pottangi

Out of six promising entries evaluated for quality and fresh rhizome yield over last three years no significant differences among different varieties were observed. However, the highest yield was recorded in Rajendra Sonia (23.28 t ha^{-1}) with 14% dry recovery, followed by JTS -2 (23.28 t ha^{-1}) with 14% dry recovery. Highest dry recovery was in cultivar Roma (26%) and Acc - 360 (21%) (Table 71).

Coimbatore

The trial was conducted with organic and inorganic fertilizers along with *Azospirillum*. It was observed that the treatment T5 (FYM 5 kg) alone gave the highest yield of 12.53 t ha^{-1}, followed by FYM (5 kg) + *Azospirillum* (50 g) (12.42 t ha^{-1}) (Table 73).

Raigarh

The maximum fresh rhizome yield of 39.65 t ha^{-1} was recorded with application of inorganic N (100%) + *Azospirillum* 50 g +

Table 71. Yield of turmeric cultivars - Pottangi

Cultivar	Fresh rhizome yield (kg/3 m^2)					Projected yield (t ha^{-1})	Dry recovery (%)	Dry yield (t ha^{-1})
	1998-1999	1999-2000	2000-2001	2001-2002	Mean			
Roma	8.76	5.50	9.50	11.29	8.76	21.90	26.0	5.69
Rajendra Sonia	12.66	5.37	7.80	11.39	9.31	23.28	14.0	3.26
Alleppey	10.77	5.67	8.21	11.05	8.93	22.33	20.0	4.47
JTS - 2	13.28	6.95	6.71	10.29	9.31	23.28	14.0	3.26
Acc - 360	8.12	3.80	7.42	10.13	7.37	18.43	21.0	3.87
BSR - 2	9.30	4.79	6.84	10.71	7.91	19.78	19.0	3.76
CD (5%)	NS	2.38	NS	NS				

TUR/CM/1 Nutrient Management Trial

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

(*Coimbatore, Pottangi, Raigarh, Kumarganj, Solan, Pundibari* and *Ambalavayal*)

Kumarganj

Use of *Azospirillum* along with recommended dose of inorganic N (100%) and FYM 5 t ha^{-1} produced maximum fresh rhizome yield (394.44 q ha^{-1}). However, FYM 10 t ha^{-1} yielded 375.00 q ha^{-1}, followed by FYM 10 t ha^{-1} + *Azospirillum* (357.22 q ha^{-1}) (Table 72). FYM 5 kg (T1) closely followed by T8 (37.84 t ha^{-1}). Lowest yield 21.30 t ha^{-1} was recorded with the application FYM 5 kg alone (T5) (Table 74).

Pottangi

Significant difference among the treatments for fresh rhizome yield was observed. Highest fresh rhizome yield was recorded in T_8 (21.13 t ha^{-1}), followed by T_1 (20.88 t ha^{-1}) and T_2 (17.33 t ha^{-1}) (Table 75).

Ambalavayal, Solan and *Pundibari*

Reports not received.

Table 72. Effect of biofertilizer, *Azospirillum* on the yield of turmeric - Kumarganj

Treatment	Weight of fresh rhizome clump^{-1} (g)	Weight of mother rhizome (g)	No. of primary fingers	Weight of primary fingers (g)	Weight of secondary fingers (g)	Yield (q ha^{-1})
T1 - Inorganic N(100% + *Azospirillum* (50 g) + FYM 5kg	230.00	26.33	1.93	44.00	96.00	394.44
T2 - Inorganic N(75%) + *Azospirillum* (50 g) + FYM 5 kg	356.23	34.67	2.87	78.33	100.00	345.56
T3 - Inorganic N(50%) + *Azospirillum* (50 g) + FYM 5 kg	237.77	35.67	2.33	76.33	106.67	338.89
T4 - FYM 5 kg + *Azospirillum* (50 g)	355.67	33.33	2.60	81.04	121.00	309.44
T5 - FYM (5 kg) alone	316.67	30.00	2.73	76.67	106.00	353.89
T6 - FYM (10 kg) + *Azospirillum* (50 g)	361.67	51.33	2.60	75.33	173.00	357.22
T7 - FYM (10 kg) alone	222.67	34.67	2.60	59.33	88.67	375.00
CD (5%)	38.21	9.23	0.47	8.21	24.00	42.36
CV (%)	9.65	14.96	10.18	7.77	15.22	6.35

Table 73. Efficacy of biofertilizer, *Azospirillum* on turmeric - Coimbatore

Treatment	Yield (t ha^{-1})
T1 - Inorganic N 100% + *Azospirillum* 50 g + FYM 5 kg	8.76
T2 - Inorganic N 75% + *Azospirillum* 50 g + FYM 5 kg	6.64
T3 - Inorganic N 50% + *Azospirillum* 50 g + FYM 5 kg	10.94
T4 - FYM 5 kg + *Azospirillum* 50 g	12.42
T5 - FYM 5 kg	12.53
T6 - FYM 10 kg + *Azospirillum* 50 g	6.76
T7 - FYM 10 kg	6.82
T8 - Recommended dose of fertilizers	6.36
CD (5%)	4.42

Table 74. Effect of biofertilizer, *Azospirillum* on the yield of turmeric - Raigarh

Treatment	Yield (kg plot^{-1})	Yield (t ha^{-1})	Cost (Rs. in lakhs)	Gross return (Rs. in lakhs)	Net Return (Rs.in lakhs)
T1 - Inorganic N 100% + *Azospirillum* (50 g) + FYM 5 kg	19.73	39.65	0.92	1.98	1.06
T2 - Inorganic N 75% + *Azospirillum* (50 g) + FYM 5 kg	16.13	32.42	0.91	1.62	0.71
T3 - Inorganic N 50% + *Azospirillum* (50 g) + FYM 5 kg	14.93	30.50	0.89	1.50	0.61
T4 - FYM 5 kg + *Azospirillum* (50 g)	12.10	24.32	0.88	1.21	0.33
T5 - FYM (5 kg)	10.60	21.30	0.86	1.06	0.20
T6 - FYM (10 kg) + *Azospirillum* (50 g)	13.70	27.53	0.87	1.37	0.50
T7 - FYM 10 kg	11.36	22.83	0.87	1.14	0.27
T8 - Recommended dose of fertilizer	18.03	37.84	0.91	1.89	0.98
CD (5%)	1.32	2.65			

Table 75. Effect of bio-fertilizer, *Azospirillum* on the yield of turmeric - Pottangi

Treatment	Fresh rhizome yield (kg/3 m^2)			Projected (t ha^{-1})
	2000-01	2001-02	Mean	
T1 - N (100%) + *Azospirillum* + 5 kg FYM	8.41	8.29	8.35	20.88
T2 - N (75%) + *Azospirillum* + 5 kg FYM	7.10	6.76	6.93	17.33
T3 - N (50%) +*Azospirillum* + 5 kg FYM	6.64	5.93	6.29	15.70
T4 - *Azospirillum* + FYM 5 kg	5.44	4.95	5.20	13.00
T5 - *Azospirillum* + FYM 5 kg	6.21	4.80	5.55	13.88
T6 - *Azospirillum* + FYM 10 kg	6.42	5.27	5.85	14.63
T7 - FYM 10 kg	6.21	5.30	5.76	14.40
T8 - Recommended dose of inorganic fertilizer	7.34	9.56	8.45	21.13
CD (5%)	NS	0.967		2.40

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

(Pottangi, Raigarh, Pundibari and Bhavanisagar)

Pottangi

Significant difference in fresh rhizome yield among different treatments was observed. Highest fresh rhizome yield was recorded in T_8 (21.75 t ha^{-1}) followed by T_6 (19.95 t ha^{-1}) and T_7 (18.13 t ha^{-1}) (Table 76).

Raigarh

All the organic inputs significantly increased the yield except in T2 and T3. The

Table 76. Effect of organic inputs on the yield of turmeric variety Roma - Pottangi

Treatment	Fresh rhizome yield (kg/3 m^2)			Projected (t ha^{-1})
	2000-01	2001-02	Mean	
T1 - a+b+c+d+e+f	8.00	7.56	7.78	19.45
T2 - a+c+d+e+f	6.32	6.04	6.18	15.45
T3 - a+c+d+e+f	6.54	6.36	6.45	16.13
T4 - a+b+d+e+f	8.56	5.67	7.15	17.79
T5 - a+b+c+e+f	8.47	5.28	6.88	17.20
T6 - a+b+c+d+f	9.75	6.20	7.98	19.95
T7 - a+b+c+d+e	9.71	5.27	7.49	18.73
T8 - Inorganics	8.54	8.90	8.70	21.75
CD (5%)	NS	1.65		4.15

a = Pongamia cake 250 g/3 m^2 d = Sterameal 250 g/3 m^2
b = FYM 10 kg/3 m^2 e = Rock phosphate 500 g/3 m^2
c = Neem oil cake 250 g/ 3 m^2 f = Wood ash 250 g plot^{-1}

maximum yield of 31.15 t ha^{-1} was recorded in case of conventional farming i.e. farmers practice (T8) closely followed by T1 (24.99 t ha^{-1}) and T5 (21.64 t ha^{-1}) and minimum yield of 11.39 t ha^{-1} was recorded in T3 which was at par with T2 (Table 77).

Pundibari and *Bhavanisagar*

Reports not received.

Table 77. Effect of organic inputs on the yield of turmeric - Raigarh

Treatment	Fresh yield (kg plot^{-1})	Rhizome yield (t ha^{-1})	Cost (Rs. in lakhs)	Gross return (Rs. in lakhs)	Net return (Rs. in lakhs)
T1 - FYM + rock phosphate + wood ash	12.43	24.99	0.89	1.24	+ 0.35
T2 - Rock phosphate alone 500 g plot^{-1}	6.20	12.46	0.85	0.62	- 0.23
T3 - Wood ash alone 2 kg plot^{-1}	5.66	11.39	0.86	0.57	- 0.29
T4 - *Azospirillum* alone 50g plot^{-1}	7.30	14.67	0.85	0.73	- 0.12
T5 - Neem Cake + rock phosphate + wood ash	10.76	21.64	0.88	1.08	+ 0.20
T6 - Neem cake alone	7.76	15.61	0.86	0.78	- 0.08
T7 - FYM alone	9.73	19.55	0.88	0.98	+ 0.10
T8 - Recommended dose of inorganic fertilizer	15.50	31.15	0.91	1.55	+ 0.64
CD (5%)	0.70	1.41			

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, Pundibari* and *Coimbatore*)

Jagtial

The studies were conducted for five years (1997-2001). Out of 50 accessions tested, 34 (68%) were found resistant to rhizome rot disease. JTS - 606 and JTS - 1 were found resistant to leaf spot caused by *Colletotrichum capsici*. Three varieties viz., PCT - 14, JTS - 604, TC - 2 were found resistant to leaf blotch caused by *Taphirana maculans* (Tables 78, 79 & 80).

Coimbatore

The reaction of the turmeric accessions to leaf spot and leaf blotch diseases were assessed using the following scale.

Disease incidence	Rating
Upto 5%	Highly resistant (HR)
5-10%	Resistant (R)
10-25%	Moderately Resistant (MR)
25-50%	Susceptible (S)
>50%	Highly susceptible (HS)

Out of 224 accessions screened for leaf spot and leaf blotch diseases, accessions, CL - 6, CL - 10, CL - 42, CL - 44, CL - 52, CL - 54, CL - 57,

Table 78. Reaction of turmeric accessions to rhizome rot disease - Jagtial

Disease index	Accessions
0–20 = Resistant (R)	JTS 605, PCT 10, GS, PCT 14, JTS 306, JTS 308, PTS 19, CLI 320, JTS 302, PTS 38, CLI 38, PTS 9, CLI 367/11, JTS 311, JTS 303, JTS 313, JTS 301, JTS 312, JTS 304, JTS 309, CLI 370, CLI 325, JTS 310, PTS 10, PTS 24, T 5, TC 4, BSR 1, ST 510, TC 2, JTS 3, JTS 8, ST 365, 361
20–40 Moderately Resistant (MR)	JTS 606, JTS 604, JTS 602, JTS 601, JTS 307, JTS 305, CLI 330, CLI 317, 15 B, JTS 6, JTS 9
40-60 Moderately Susceptible (MS)	JTS 7 = (1/50)
>60 Susceptible (S)	JTS 1, JTS 2, Duggirala Telupu, Armoor local

Table 79. Reaction of turmeric accessions to leaf spot disease - Jagtial

Disease incidence	Rating	Accessions
0-20%	Resistant (R)	JTS 606, JTS 1
20-40%	Moderately Resistant (MR)	JTS 605, JTS 2, Armoor local
40-60%	Moderately Susceptible (MS)	Duggirala Telupu
>60%	Susceptible (S)	- Nil -

Table 80. Reaction of turmeric accessions to leaf blotch disease - Jagtial

Disease incidence	Rating	Accessions
0–20%	Resistant (R)	PCT 14, JTS 604, TC 2 = (3/44) 6.8%
20–40%	Moderately Resistant (MR)	PCT 10
40-60%	Moderately Susceptible (MS)	JTS 602, JTS 601, JTS 306, PTS 38, PTS 9, CLI 330, CLI 325, T 5, 361, JTS 7
>60%	Susceptible (S)	GS, JTS 308, PTS 19, CLI 320, JTS 307, JTS 305, JTS 302, CLI 38, CLI 367-11, JTS 311, JTS 303, JTS 313, JTS 301, JTS 312, JTS 304, JTS 309, JTS 310, PTS 10, PTS 24, CLI 317, TC 4, BSR 1, ST 510, JTS 3, JTS 8, ST 365, 361, 15 B, JTS 6, JTS 9

CL - 83, CL - 90, CL - 122, CL - 151, CL - 193, CL -206, CL - 212, CL - 218, CL - 223 and CL - 224 were totally free from leaf spot disease. Accessions, CL - 1, CL - 2, CL - 4, CL - 7, CL - 8, CL - 9, CL - 12, CL - 18, CL - 107, CL - 112, CL - 119, CL - 121, CL - 132, CL - 151, CL - 156, CL - 161, CL - 168, CL - 193, CL - 201, CL - 217, CL - 221 and CL - 223 recorded least incidence of leaf blotch disease and are graded as highly resistant.

Raigarh

Fifty eight germplasm accessions were screened against leaf blotch and leaf spot diseases using the following scale:

Disease incidence	Rating
0 - 1%	Highly resistant (HR)
1 - 10%	Resistant (R)
10 - 20%	Moderately resistant (MR)
20 - 50%	Susceptible (S)
>50%	Highly Susceptible (HS)

The results showed that Acc - 360, Acc - 361, Acc - 585, Acc - 126 and T4 - 11 are resistant to *Taphrina* leaf blotch disease.

None of germplasm entries was found to be highly resistant to the leaf spot disease, while Sudarshana and RTS - 1 showed resistant reaction to the disease.

Dholi

A survey was conducted in turmeric growing areas of North Bihar viz. Sitamarhi, East Champaran and West Champaran. It was observed that leaf blotch disease was more severe compared to leaf spot disease. In some areas of East Champaran District, rhizome rot disease was also found. In comparison to previous year, leaf blotch disease incidence was low during the year 2001, may be due to low rainfall.

Out of 39 germplasm accessions tested, only Kohinoor was rated as highly resistant while G.L. Puram, Rajendra Sonia, RH - 5, and RH - 24, were rated as resistant to leaf blotch disease.

Pundibari

Report not received.

TUR/CP/1.2 Chemical control measures against leaf blotch disease of turmeric (*Pundibari*)

Report not received.

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

(*Dholi, Pundibari, Raigarh* and *Kumarganj*)

Pundibari

This experiment was laid out with 7 treatments and 3 replications in RBD (plot size of 3 m x 1 m, spacing of 30 cm x 20 cm). FYM 20-25 kg and N: P: K @ 60 : 60 : 60 kg ha^{-1} were applied. The test varieties were Rajendra Sonia and RH - 5. Three sprays of fungicides as per the treatments were given starting from first appearance of the disease at 20 days interval.

Minimum disease incidence was recorded in the treatment T3 (mancozeb and carbendazim applied as foliar spray). This treatment reduced the disease incidence by 58% and 57% in Rajendra Sonia and RH - 5, respectively. The biocontrol agent had no effect on the disease (Tables 81 & 82).

Raigarh

Treatments T4, T5, T6 were statistically at par with control (T7) regarding disease se-

Table 81. Effect of fungicides and bio-control agents on leaf blotch and leaf spot diseases in turmeric cv. Rajendra Sonia - Pundibari

Treatment	Disease index (%) (150 days)	Percent reduction over control	Fresh rhizome yield ($kg/3m^2$ plot)
T1 - Spray with mancozeb (0.2%)	36.670	35.96	7.930
T2 - Spray with carbendazim (02%)	37.040	36.45	8.190
T3 - Spray with mancozeb and carbendazim (0.2%)	24.020	58.14	9.400
T4 - Seed and soil treatment with *Trichoderma viride*	56.280	1.93	7.400
T5 - Seed Treatment with mancozeb (0.25%) and *Trichoderma viride* as soil application (20 kg ha^{-1})	50.340	12.28	7.300
T6 - Seed treatment with carbendazim (0.2%) and *Trichoderma viride* as soil Application (20 kg ha^{-1})	56.360	1.79	7.330
T7 - Untreated check	57.390		7.270
SEm ±	3.280		0.437
CD (5%)	10.107		1.346

Table 82. Effect of fungicides and bio-control agents on leaf blotch and leaf spot diseases in turmeric cv RH - 5) – Pundibari

Treatment	Disease index (%) (150 days)	Percent reduction over control	Fresh rhizome yield (kg/3m^2 plot)
T1 - Spray with mancozeb (0.2%)	43.35	41.29	7.43
T2 - Spray with carbendazim (02%)	45.41	38.50	7.30
T3 - Spray with mancozeb and carbendazim (0.2%)	31.35	57.54	8.60
T4 - Seed and soil treatment with *Trichoderma viride*	69.75	5.53	6.57
T5 - Seed Treatment with mancozeb (0.25%) and *Trichoderma viride* as soil application (20 kg ha^{-1})	69.95	5.53	6.90
T6 - Seed treatment with carbendazim (0.2%) and *Trichoderma viride* as soil application (20 kg ha^{-1})	68.43	7.32	6.77
T7 - Untreated check	73.840		6.17
SEm ±	1.590		0.497
CD (5%)	4.899		1.531

verity, while T1, T2 and T3 reduced disease severity significantly over control (T7) with maximum reduction in treatment T3. Fresh rhizome yield was also significantly more in treatment T1, T2 and T3 with maximum in T3 over control (Table 83).

Table 83. Effect of fungicides and bio-control agents on leaf blotch disease in turmeric - Raigarh

Treatment	Leaf blotch (disease severity)	Rhizome yield (kg/3 m^2 plot)	Yield (q ha^{-1})
T1 - Spray with mancozeb (0.2%)	42.7	4.90	163.33
T2 - Spray with carbendazim (02%)	33.0	5.70	190.00
T3 - Spray with mancozeb and carbendazim (0.2%)	28.7	6.40	213.33
T4 - Seed and soil treatment with *Trichoderma viride*	67.5	6.00	200.00
T5 - Seed treatment with mancozeb (0.25%) and *Trichoderma viride* as soil application (20 kg ha^{-1})	65.3	4.10	136.67
T6 - Seed treatment with carbendazim (0.2%) and *Trichoderma viride* as soil application (20 kg ha^{-1})	62.5	2.30	76.66
T7 - Untreated check	66.8	2.60	86.67
CD (5%)	17.49	2.07	-
CV %	33.67	38.7	-

Dholi

Application of mancozeb + carbendazim (0.2%) proved effective in controlling the disease giving maximum yield of 189.81 q ha^{-1} with less incidence of leaf spot (25.85%) and leaf blotch (29.72%) diseases, whereas in control the yield was 110.74 q ha^{-1} with high incidence of diseases (leaf spot 44.00% and leaf blotch 45.95%) (Table 84).

Kumarganj

Studies conducted for the management of leaf blotch and leaf spot disease in turmeric indicated that maximum PDI of leaf blotch disease 71.13, 68.93 and leaf spot disease 65.81, 61.40 were observed in T_4 (seed treatment with *T. harzianum*), with fresh rhizome yield of 311.66 and 228.61 q ha^{-1} in Rajendra Sonia and RH – 5 respectively. However, seed treatment with mancozeb and carbendazim 0.2% as foliar spray had lowest incidence of diseases in both the varieties (Table 85).

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

(Jagtial, Coimbatore and *Pundibari)*

Jagtial

Fusarium solani was consistently isolated from the samples of roots and rhizomes showing discolouration and rotting from the plants exhibiting yellowing of leaves from top to downwards along the leaf margin, typical symptoms of rhizome rot disease of turmeric varieties Duggirala White, Duggirala Red, Armoor, JST - 1 and JST – 2. The identity of the fungus was confirmed by IARI, New Delhi. Further, the pathogenicity of the fungus was established under green house conditions. Hence, *F. solani* is the causal organism of rhizome rot of turmeric in Andhra Pradesh.

Experiment conducted during the year

Table 84. Effect of fungicides and biocontrol agent on leaf spot and leaf blotch diseases of turmeric - Dholi

Treatment	Leaf spot disease (%)	Leaf blotch disease (%)	Yield (q ha^{-1})
T1 - Mancozeb (0.2%) (Endophil M-45) (@ 2 g l^{-1} water)	29.35	31.38	150.46
T2 - Carbendazim (0.2%) (Bavistin) (@ 2 g l^{-1} water)	31.17	33.85	143.52
T3 - Mancozeb + carbendazim (0.2%)	25.85	29.72	189.81
T4 - Biocontrol agent (*Trichoderma viride*)	39.30	31.20	166.66
T5 - Mancozeb as seed treatment and biocontrol as soil application	33.30	34.90	136.57
T6 - Carbendazim as seed treatment and biocontrol agent as soil application	27.45	30.68	175.93
T7 - Control (untreated)	44.00	45.95	110.74
CD (5%)	4.96	5.18	18.52
CV %	8.33	8.59	6.78

Table 85. Effect of fungicides and bioagent on leaf blotch and leaf spot diseases in turmeric - Kumarganj

Treatment	Yield of rhizome (q ha^{-1})		PDI			
			Leaf blotch		Leaf spot	
	RH-5	R. Sonia	R. Sonia	RH-5	R. Sonia	RH-5
T1 - Mancozeb 0.2% (seed treatment + spray)	290.55	330.27	68.10	62.59	57.62	56.36
T2 - Carbendazim 0.2% (seed treatment + spray)	328.22	329.16	65.62	56.27	55.31	54.15
T3 - Mancozeb + Carbendazim 0.2% (seed treatment + spray)	382.53	333.05	60.50	51.33	51.20	44.90
T4 - Biocontrol agent (seed treatment with *T. harzianum*)	228.61	311.66	71.13	68.93	65.81	61.40
T5 - Mancozeb 0.2% (seed treatment) + *T. harzianum* as soil application)	244.44	325.00	70.62	67.57	60.51	62.89
T6 - Carbendazim 0.2% (seed treatment) + *T. harzianum* soil as application)	342.77	347.05	61.52	54.43	54.41	49.67
T7 - Control	219.77	199.95	76.81	73.28	71.05	66.76
CD (5%)	75.14	52.05	15.83	10.18	7.39	11.02
CV %	19.22	14.63	11.59	7.81	5.85	9.28

2001-2002 in farmers field in Perkit village, Armoor, Nizamabad District with Duggirala Red variety, revealed that seed treatment with mancozeb 0.2%, carbendazim 0.2%, mancozeb 0.2% + carbendazim 0.2%, bio-earth as seed treatment and soil application, bio-earth as seed treatment and soil application along with neem cake as soil application with proper earthing up of turmeric plants, no incidence of rhizome rot disease till harvest of the crop (Table 86).

Coimbatore

A new trial on biocontrol of rhizome rot disease of turmeric was laid out with eight treatment combinations including control. The variety BSR - 2 was used for this trial. Among the eight treatments, T_7 was found to be significantly effective in reducing the rhizome rot incidence to 5.33% and significantly increasing the yield to 23.17 t ha^{-1}. The next effective treatment was T_6, which recorded the rhizome rot incidence of 9.33% and a yield of 17.83 t ha^{-1}. Control registered 24.00% disease incidence with an yield of 7.33 t ha^{-1} (Table 87).

Pundibari

A new trial for the management of rhizome rot disease of turmeric was initiated at Pundibari during 2001-2002 using different biocontrol agents.

The data on disease incidence, germination and yield indicate that the disease incidence was low in general. However, the best treatment was T5 (seed treatment with *Trichoderma viride* and *P. fluorescence* with application of recommended NPK and FYM), closely followed by T6 and T7. Rhizome yield was highest in T7 followed by T6 (Table 88).

Table 86. Control of rhizome rot disease of turmeric (2001-2002) - Jagtial

Treatment	Rhizome rot incidence (%)		Fresh rhizome yield (kg)	
	Pre	Post	Plot (13.5 m^2)	Hectare
T1 - Recommended NPK + Seed treatment with Mancozeb 0.2%	0	0	28.330	20985.2
T2 - Recommended NPK + Seed treatment with Carbendazim 0.2	0	0	24.580	18207.4
T3 - Recommended NPK + T1 + T2	0	0	22.080	16355.5
T4 - Recommended NPK + Seed treatment with Bio-earth 4 g kg + soil application of bio-earth 10 t ha^{-1}	0	0	26.250	19444.4
T5 - Recommended NPK + T4 + T1	0	0	26.250	19444.4
T6 - Recommended NPK + T4 + T2	7.76	0	21.250	15740.7
T7 - Recommended NPK + T4 + Neem cake @ 10 t ha^{-1}	4.88	0	29.160	21600.0
T8 - Recommended NPK + Untreated rhizomes	0.22	0.02	25.830	19133.3
SEm ±	4.265		2.158	
CD (5%)	9.14		4.628	
CV %	3.243		0.104	
	NS		S	

Table 87. Effect of biocontrol agents for the management on rhizome rot disease of turmeric - Coimbatore

Treatment	Disease incidence (%)	Yield (t ha^{-1})
T1 - Recommended NPK (Control)	24.00	7.33
T2 - Recommended NPK + FYM	21.33	9.58
T3 - Recommended NPK + T. viride + Pseudomonas fluorescens @ 4g/kg seed as seed treatment	16.67	16.00
T4 - Recommended NPK + T. viride + Pseudomonas fluorescens to be applied to soil @ 12.5 kg/ha and 25.0 kg/ha as basal and top dressing respectively.	13.33	19.50
T5 - $T_2 + T_3$	10.67	14.42
T6 - $T_2 + T_4$	9.33	17.83
T7 - $T_2 + T_3 + T_4$	5.33	23.17
T8 - T_2 + Bacillus subtilus (Biostat) @ 1 ml/litre of water	10.67	13.00
CD (5%)	3.18	4.58

Table 88. Effect of biocontrol agents on rhizome rot disease of turmeric - Pundibari

Treatment	Germination (%)	Disease incidence (%)		Rhizome yield (kg $plot^{-1}$)
		1st Observation	2nd Observation	
T1 - (Recommended NPK) Control	91.11	17.500	19.780	7.750
T2 - (Recommended NPK + FYM)	88.88	15.720	16.670	8.330
T3 - Recommended NPK + *T. viride* + *Pseudomonas fluorescence* @ 4g/kg seed as seed treatment	95.56	5.570	10.550	8.830
T4 - Recommended NPK + *T. viride* + *Pseudomonas fluorescence* to be applied to soil @ 12.5 kg/ha and 25.0 kg/ha as basal and top dressing respectively.	93.33	7.230	8.690	8.750
T5 - $T_2 + T_3$	93.33	5.620	7.190	8.800
T6 - $T_2 + T_4$	95.56	7.230	7.230	9.000
T7 - $T_2 + T_3 + T_4$	95.56	5.620	7.230	9.250
T8 - T_2 + *Bacillus subtilus* (Biostat) @ 1 ml/litre of water.	91.11	15.580	17.500	8.200
SEm ±		1.559	1.478	0.408
CD (5%)		4.720	4.480	1.240

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)*

Dapoli

A survey was conducted to locate the elite types of nutmeg in Ratnagiri, Sindhudurg, Raigad and Thane districts of Maharashtra covering 19 orchards. The bud sticks of selected types were collected and soft wood grafts were prepared. In all 32 grafts of 16 different selected elite types were prepared and maintained in the nursery. Five types of cinnamon were collected and maintained in the nursery.

The germplasm of nutmeg (grafted types) consists of six collections. AG - 71 recorded maximum height (1.40 m), followed by AG - 20 (1.30 m), B - 72 (1.20 m) and V - 26 (1.0 m). Maximum plant spread was found in AG - 20 (2.70 m). Eight elite types of nutmeg were collected from IISR, Calicut and planted in the coconut orchard. Accessions A - 9/12, A - 9/20, A - 9/22, A - 9/70, A - 9/79 and bulk started flowering in the third year.

Nine elite cinnamon types have been procured from IISR, Calicut and planted in germplasm block. It is evident from the data that A - 5 recorded the maximum plant height (4.27 m), stem girth (14.67 cm), fresh weight of leaves (2.63 kg) and dry weight of leaves (1.61 kg). Similarly, A - 189 recorded the maximum number of shoots (24.66). A - 63 recorded maximum plant spread (2.53 m), compared to all other accessions (Table 89).

Two accessions of clove were planted during 1997 and the growth of the seedlings is satisfactory (Table 90).

Table 89. Performance of cinnamon accessions - Dapoli

Accession	Plant height (m)	Stem girth (cm)	Plant spread (m)	No. of shoots	Bark yield (g plant^{-1})		Leaf yield (kg plant^{-1})	
					Fresh	Dry	Fresh	Dry
A - 5	4.270	14.670	2.350	12.330	285.00	179.660	2.620	1.610
A - 44	3.650	10.470	1.960	18.000	268.33	132.330	1.930	1.370
A - 53	3.670	13.670	2.400	23.000	308.33	178.330	2.160	1.150
A - 63	2.880	7.770	2.530	18.330	193.00	112.330	1.690	1.090
A - 65	2.970	12.670	1.830	14.330	285.00	102.330	1.560	1.560
A - 189	3.650	12.660	2.180	24.660	250.66	148.330	2.410	1.240
A - 203	2.600	10.760	1.800	19.000	228.33	99.660	1.560	0.900
A - 310	3.350	10.160	2.300	23.000	295.00	160.000	1.300	0.800
A - 312	2.760	11.860	1.730	18.000	205.00	109.660	1.560	1.100
SEm ±	0.201	0.348	0.109	0.860	5.866	3.381	0.055	0.048
CD (5%)	0.603	1.037	0.325	2.576	17.597	10.133	0.165	0.143

Table 90. Performance of clove - Dapoli

Entry	Height (m)	Girth (cm)	Plant Spread (m)	No. of shoots	No. of plants	Remarks
IISR Calicut	2.27	9.64	2.10	31.39	43	Two plants started flowering
Kallar type	1.25	4.30	0.78	8.03	—	—

Yercaud

Among the 12 nutmeg selections, IISR selection MF - 2 recorded maximum height (6.2 m) with 0.29 m stem girth and yielded 12 fruits/tree. Among the local collections, MF - 6 recorded the maximum height of 4.7 m with the stem girth of 0.27 m.

Among the 13 accessions of clove, accession SA - 1 recorded a height of 230 cm with 24 branches.

Among the 11 accessions of cinnamon, CV - 9 recorded a height of 3.50 m with 15 primary branches.

Pechiparai

In the clove germplasm, among the IISR collections, Selection 7 registered the maximum height of 7.96 m with stem girth of 0.48 m. Among the local types, Selection 13 recorded the maximum height of 8.52 m and stem girth of 0.39 m (Table 91).

Table 91. Growth of clove - Pechiparai

Entry	Stem height (m)	Stem girth (m)	No. of branches
Sel - 1	5.96	0.34	38.30
Sel - 2	6.23	0.38	41.50
Sel - 3	5.66	0.30	32.40
Sel - 4	4.60	0.28	27.20
Sel - 5	5.73	0.36	36.80
Sel - 6	6.87	0.47	38.30
Sel - 7	7.96	0.48	43.20
Sel - 8	7.20	0.42	38.10
Sel - 9	5.90	0.37	33.10
Sel - 10	5.93	0.32	33.20
Sel - 11	6.10	0.27	35.30
Sel - 12	65.3	0.32	36.70
Sel - 13	8.52	0.39	39.20
Sel - 14	6.12	0.37	23.50
Sel - 15	6.21	0.29	24.50
Sel - 16	6.12	0.28	24.10
Sel - 17	4.30	0.26	20.20
Sel - 18	4.23	0.27	20.20
Sel - 19	3.71	0.26	13.50

Among the 12 nutmeg selections, the IISR selection MF - 2 recorded maximum height of 6.2 m with 0.29 m stem girth and yielded 12 fruits tree^{-1}. Among the local collections, MF - 6 recorded the maximum height of 4.7 m with the stem girth of 0.27 m (Table 92).

TSP/CI/2 Coordinated Varietal Trial (CVT)

TSP/CI/2.1 CVT 1992 in clove

(Yercaud/Pechiparai and *Dapoli)*

Yercaud/Pechiparai

Among the 6 accessions of clove maintained, Sel - 1 recorded a plant height of 240 cm with 39 branches.

Dapoli

Report not received.

TSP/CI/2.2 CVT 1992 in cinnamon

(*Yercaud/Pechiparai* and *Ambalavayal*)

Yercaud/Pechiparai

Among the 9 selections of cinnamon, CV - 203 recorded the maximum number of shoots (48.5), height (4.2 m), girth (10.7 cm) and number of leaves (720) (Table 93).

At Yercaud, 5 accessions are being maintained and coppicing will be done in the ensuing season.

Ambalavayal

Among the nine accessions/types, SL - 189 and SL - 53 were found promising.

TSP/CM /1 Propagation/Multiplication Trial

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

(Yercaud/Pechiparai and *Dapoli)*

Dapoli

Maximum success (60%) of soft wood grafting in nutmeg was recorded during the months of October and November. Maximum

Table 92. Growth of nutmeg selections - Pechiparai

Entry	Stem height (m)	Stem girth (m)	No. of branches	No. of fruits tree^{-1}
MF – 1	5.70	0.28	34.70	-
MF - 2	6.20	0.29	41.27	12.00
MF - 3	5.15	0.32	32.00	7.50
MF - 4	5.20	0.23	27.25	-
MF - 5	5.75	0.24	32.00	-
MF - 6	4.70	0.27	28.25	-
MF - 7	4.23	0.30	22.50	-
MF - 8	3.20	0.21	21.20	-
MF - 9	3.25	0.23	22.25	-
MF - 10	2.96	0.18	26.25	-
MF - 11	2.15	0.17	13.25	-
MF - 12	3.25	0.18	23.00	-

Table 93. Growth of cinnamon after coppicing - Pechiparai

Entry	No. of shoots	Height of the stem (cm)	Girth (cm)	No. of leaves
CV – 5	32.00	2.80	10.20	492.30
CV - 44	35.00	2.95	9.30	482.30
CV - 53	41.50	4.10	8.70	565.30
CV - 63	26.00	3.60	9.60	525.30
CV - 89	27.00	3.50	10.20	625.00
CV - 203	45.00	4.20	10.70	720.00
CV - 310	38.50	3.70	10.00	650.00
CV - 312	47.15	4.20	7.30	623.00
CV - 65	38.15	3.70	8.20	575.00

success of soft wood grafting in clove was recorded during the month of September.

Yercaud/Pechiparai

Hardwood and terminal cuttings, ground and air layering, approach, soft wood and epicotyl grafting and T-budding were tried in clove. In air layering 30% success was recorded and in approach grafting the success was 10%. Epicotyl and approach grafting were tried in nutmeg and the success was 70% in epicotyl grafting and 90% in approach grafting.

TSP/CM/2 Irrigation Trial

TSP/CM/2.1 Drip irrigation in clove and nutmeg

(*Yercaud*)

Report not received.

TSP/CP/1 Disease Management Trial

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

(Dapoli, Yercaud/Pechiparai and *Ambalavayal)*

Dapoli

A survey was conducted in Sindhudurg, Ratnagiri, Raigad and Thane districts covering 29 orchards to study the incidence of various diseases in tree spices. Short hole diseases in nutmeg was observed in all the orchards visited. Low to moderate incidence of dieback and fruit rot diseases were also observed in some of the orchards. Sudden wilt was noticed at Dapoli and Khanoli villages. Leaf rot of clove is a serious disease at Dapoli. In other locations the disease intensity was low to moderate. A low to moderate incidence of pink disease in cinnamon was noticed. The incidence of leaf spot and leaf blight was low.

Yercaud/Pechiparai and *Ambalavayal*

Reports not received.

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*)

Coimbatore

Among the 224 accessions of coriander evaluated, the highest yield was recorded in CS - 76, CS - 104, CS - 116 (1100 kg ha^{-1}), followed by CS – 8 9, CS - 119, CS - 120, CS - 181, CS - 192, CS - 219 (1050 kg ha^{-1}).

Jagudan

During rabi 2001-2002, 92 entries of coriander were raised, evaluated and maintained. A total 21 entries were screened for resistance against powdery mildew disease. None of the entries was found resistant against the disease under natural condition. Minimum incidence of the disease was recorded in recommended variety G.Co - 1 (35%), followed by J.Co - 328 (38.75%) and LCC - 133 (38.75%).

Hisar

Seventy six accessions of coriander were evaluated using Pant Haritima, DH - 5, and Narnaul Selection as checks during 1997-98 to 2000-2001. The mean seed yield ranged from 285 g (DH - 215) to 522 g (DH - 234). Forty three lines gave higher seed yield than Hisar Anand, 59 lines higher than Narnaul Selection and 65 out yielded Pant Haritima. The most promising lines for seed yield are DH - 202, DH - 205, DH - 206, DH - 209, DH - 241, DH - 234.

Guntur

During 2001-2002 rabi season, 110 coriander accessions were evaluated in simple observational plots. Among the accessions evaluated, LCC - 226 recorded highest yield of (760 kg ha^{-1}), followed by LCC - 228, LCC - 144, LCC - 175 and LCC - 173 with 720, 710, 690 and 680 kg ha^{-1}, respectively. The check Sadhana recorded an yield of 420 kg ha^{-1}.

Jobner

At Jobner, 196 accessions with seven check varieties were evaluated in Augment Randomized Block Design. One meter uniform section of each row of a plot was maintained by bagging with muslin cloth and matured seeds were harvested separately as a self seed to raise the crop in the next season.

The yield was recorded on per plant basis. The superior accessions, which were better than best check variety (RCr - 684), were UD - 310 (8.12 g), UD - 426 (7.51 g), CS - 287 (6.37 g), UD - 92 (6.25 g), UD - 42 (6.01 g), UD - 380 (5.62 g), UD - 207 (5.54 g), UD - 411 (5.25 g), UD - 744 (5.12 g), UD - 20-93 (5.10 g) and UD - 317 (5.08 g).

A total of 35 germplasm entries were screened against stemgall disease (*Protomyces macrosporus*) in farmer's field in Danta and the data are given in Table 94.

Out of thirty five varieties tested, RCr - 41, RCr - 435 and RCr - 436 were found immune to the disease. The reaction of coriander lines to root knot nematodes is given in Table 95.

Kumarganj

During rabi season of 2001-2002, ten germplasm accessions were collected from

Table 94. Evaluation of coriander entries against stemgall disease (2000-2001) - Jobner

Disease reaction	Entries
0=Immune (I)	RCr-41, RCr-435, RCr-436
1= Resistant (R)	UD-262, UD-446, UD-684, UD-685 and UD-686
2=Moderately resistant (MR)	UD-20, UD-447 and UD-743
3= Susceptible (S)	UD-30, UD-35, UD-61, UD-75, UD-171, UD-257, UD-311, UD-393, UD-407 and UD-457
4= Highly susceptible (HS)	UD-463, UD-469, UD-512, UD-537, UD-540, UD-546, UD-552, UD-568, UD-638, UD-666, UD-742, CS-2, CS-6 and local.

Table 95. Reaction of coriander genotype to root knot nematodes - Jobner

Reaction	No. of galls	Genotypes
Immune (I)	No galls	Nil
Resistant (R	3-10	RCr-435, RCr-436, RCr-684, RCr-685 and UD-446
Moderately (MR) resistant	11-30	RCr-20, RCr-41, UD-469 and UD-478
Susceptible (S)	31-100	UD-30, UD-35, UD-61, UD-75, UD-171, UDd-257, UD-262, UD-311, UD-340, UD-358, UD-393, UD-546, UD-552, UD-568, UD-638, UD-666, UD-686, UD-743, UD-744, UD-746, UD-747, UD-749, UD-751, UD-753, CS-2 and CS-6
Highly susceptible (HS)	Above 100	UD-88, UD-443, UD-447, UD-512, UD-537, UD-540, UD-743, UD-753 and Local

neighbouring district of Faizabad. Altogether fifty germplasm accessions were evaluated for their growth and yield. Pant Haritima and Kumarganj selection were used as standard check. Among the germplasm, K-selection produced 20.00 q ha^{-1} followed by ND Cor - 2 (19.73 q ha^{-1}). Maximum seed infection of stem gall disease was observed in ND Cor - 44 (8.2 %) and minimum in ND Cor – 48 (1.6 %). K-selection showed 3.8% of seed infection.

Dholi

Altogether 77 germplasm accessions are being maintained, which comprised of local as well as reputed genotypes of different states of India. Their morphological characters were studied and some promising lines have been identified based on their yield, quality and disease resistance. UD - 435, UD - 190, UD - 684, JCO - 64, JCO - 31, RD - 20, UD - 357, RD - 121, UD - 217, Composite 1 recorded seed yield of 400 g $plot^{-1}$.

COR/CI/2 Coordinated Varietal Trial (CVT)

COR/CI/2.1 CVT 1993 series II

(*Kumarganj* and *Raigarh*)

Raigarh

Trial was conducted with ten entries including two local entries as a check. None of the entries was found significantly superior to both the local entries. The trial was concluded and the data are given in Table 96.

Kumarganj

Final report not received.

COR/CI/2.2 CVT 1996 Series III

(*Kumarganj, Dholi* and *Hisar*)

Kumarganj, Dholi and *Hisar*

Final reports not received.

COR/CI/2.3 CVT 1998 Series IV

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

Coimbatore

The trial was conducted to study the performance of nine varietal cultures of coriander. The yield of seed was the highest in JCO - 283 (695.7 kg ha^{-1}), followed by JCO - 387 (541.7 kg ha^{-1}) and the cultures DH - 208, LCC - 128, LCC - 133 are on par for yield. The lowest yield was recorded in UD - 744 (304.7 kg ha^{-1}) (Table 97).

Jagudan

Among the entries, the yield differences were found significant, but none of the entries was found significantly superior to control. However, LCC - 133 had given higher yield (16.29 q ha^{-1}) than control. It was 5.78% higher over control.

Table 96. Performance of coriander entries under CVT - Raigarh

Entry	Plot yield ($g/3\ m^2$) (2001)	Converted yield (q ha^{-1})				
		2001	2000	1999	1998	Mean
JCO - 283	295.00	5.93	4.53	12.00	-	7.48
LCC - 133	216.91	4.36	6.77	9.11	8.7	7.23
JCO - 387	302.98	6.09	16.44	11.44	-	11.32
LCC - 128	117.91	2.37	3.71	9.00	8.1	5.77
UD - 744	169.65	3.41	14.88	10.00	-	9.43
DH - 208	234.32	4.71	5.88	9.88	4.6	6.26
DH - 246	265.07	5.34	7.33	14.16	9.0	8.96
UD- 743	149.75	3.01	12.55	10.80	-	8.78
IC – 01-1	405.97	8.16				
IC – 01-2	513.43	10.32				

$\overline{X}$ = 5.37, CD (5%) = 2.45, CV% = 21.71

Table 97. Performance of coriander accessions - Coimbatore

Acc. No.	Plant ht. (cm)	No. of primary branches	No. of secondary branches	No. of umbles	Umbelets umbel^{-1}	No. of seeds umblet^{-1}	Yield (kg ha^{-1})
JCO – 387	44.1	4.9	10.3	18.1	5.8	4.9	541.7
JCO – 283	44.8	6.0	12.4	20.9	5.7	4.9	695.7
LCC – 128	63.4	4.1	8.0	21.1	5.4	4.5	495.8
UD – 743	54.3	6.8	16.4	22.6	5.0	5.0	445.8
DH – 246	58.4	6.5	10.9	15.4	5.0	4.9	375.0
UD – 744	51.6	5.4	10.1	17.8	5.9	4.9	304.7
LCC –133	61.7	7.7	14.8	21.5	5.1	5.1	458.3
DH – 208	47.5	5.3	12.8	22.4	5.6	5.2	491.7
CO – 3	56.0	3.8	10.6	22.6	5.6	5.1	375.0
CD (5%)	13.0	1.9	3.3	4.0	1.0	0.4	182.9

The pooled data for two years showed significant yield difference among entries. But none of the entries was found significantly superior over control. However, J. Cori - 283 had given higher yield (17.34 q ha^{-1}). It was 8.85% higher over control (Table 98).

Hisar

Ten entries were evaluated along with Hisar Anand and Narnaul selection as check. Significant differences were observed for all the parameters. Maximum seed yield was recorded in DH - 246 (21.8 q ha^{-1}), which was

Table 98. Performance of coriander accessions – Jagudan

Entry	Yield (q ha^{-1})				Increase over control (%)
	1999-00	2000-01	2001-02	Average	
DH – 208	16.34	16.23	14.65	15.74	-
DH – 246	14.81	14.60	11.76	13.72	-
J.Cori – 283	18.68	17.13	16.20	17.34	8.85
J.Cori – 387	19.23	15.47	15.14	16.61	4.27
LCC – 128	17.27	14.76	14.57	15.53	-
LCC – 133	16.29	16.53	16.29	16.37	2.76
UD – 743	13.07	11.52	11.33	11.97	-
UD – 744	16.34	11.71	12.69	13.58	-
G.Cori - 2 (check)	16.78	15.28	15.74	15.93	-
SEm ±	0.66	1.15	0.81	0.53	
CD (5%)	1.97	3.46	2.44	1.50	
CV %	6.88	13.48	9.87	10.23	

closely followed by DH - 208 (19.9 q ha^{-1}) and UD - 744 (16.7 q ha^{-1}). The range for plant height was from 38.3 to 73.4 cm; for number of branches from 5.1 to 7.1; for umbels per plant from 47.4 to 92.5 and for seeds per umbel from 22.3 to 34.2.

Guntur

During 2001-2002 rabi season, 9 entries from different Coordinating centres were tested with Sadhana as check. Among the entries tested, LCC - 128 recorded significantly higher yield (596 kg ha^{-1}), followed by LCC - 133 (565 kg ha^{-1}). The check variety Sadhana recorded an yield of 451 kg ha^{-1}. Except JCO - 283, all other entries recorded significantly lower yields than check. (Table 99)

Jobner

Twelve entries with 3 checks namely, RCr - 41, RCr - 684 and local were evaluated in RBD with 3 replications with a plot size of 4 x 2.4 m. The entry RCr - 684 (check) recorded maximum seed yield (9.73 q ha^{-1}), followed by RCr - 41 (check 9.62 q ha^{-1}), JCO - 283 (8.75 q ha^{-1}), UD - 743 (8.19 q ha^{-1}) and UD - 262 (8.05 q ha^{-1}), while lowest yield of 1.91 q ha^{-1} was recorded in LCC - 133.

The mean performance of the entries evaluated in CVT during 1999-2000 and 2000-2001 indicated superior performance of DH-246 with a mean seed yield of 11.74 q ha^{-1}, followed by RCr - 41 (check, 11.35 q ha^{-1}) and UD - 743 (11.20 q ha^{-1}), while lowest mean yield of 3.37 q ha^{-1} was recorded in LCC - 133 (Table 100).

Kumarganj

Eleven cultivars were evaluated including Kumarganj selection as a local check. Out of these cultivars, maximum yield (26.68 q ha^{-1}) was obtained with UD –743, followed by RCr - 41 and Kumarganj selection (Table 101).

Dholi

The genotype DH - 208 recorded the maximum yield (16.54 q ha^{-1}) which took 135 days for maturity. All genotypes were severely affected by stemgall disease (Table 102).

Table 99. Performance of coriander (2001-2002) - Guntur

Entry	Plant height	No. of primary branches	No. of secondary branches	No. of umbels $plant^{-1}$	No. of umbelets $umbel^{-1}$	Yield $plot^{-1}$ (g)	Yield ha^{-1} (kg)
LCC - 128	53.3	6.2	8.5	18	6.9	356.7	595.7
LCC - 133	50.8	5.8	8.1	17.3	6.6	336.7	565.0
DH - 208	42.1	3.9	5.4	11.1	5.7	151.7	253.3
DH - 246	43.0	3.1	5.1	10.1	4.8	115.0	192.0
JCO - 283	63.5	4.7	7.1	15.7	5.5	216.0	360.7
JCO - 387	60.9	4.2	6.5	15.1	5.5	200.0	340.0
UD - 743	37.8	2.8	4.8	9.8	4.1	76.7	128.0
UD - 744	40.0	2.6	4.4	9.3	4.5	94.0	157.3
Sadhana (c)	46.5	4.8	7.6	15.8	5.5	270.0	451.0
CD (5%)	6.0	1.0	0.8	3.5	0.9	51.0	83.9

Table 100. Performance of coriander accessions (1999-2000 and 2000-2001) – Jobner

Entry	Yield (q ha^{-1})		
	1999-00	2000-01	Mean
UD – 744	16.41	4.17	10.29
DH – 246	15.76	7.72	11.74
UD – 743	14.20	8.19	11.20
RCr – 41C	13.08	9.62	11.35
DH – 208	12.04	7.55	9.80
Local (check)	9.05	2.78	5.92
LCC – 128	4.82	2.43	3.63
LCC – 133	4.82	1.91	3.37
CD (5%)	3.63	0.71	
CV %	21.91	6.90	

COR/CI/3.2 Initial Evaluation Trial

(Jobner, Guntur, Hisar and *Jagudan)*

Hisar

The initial evaluation trial (IET) in coriander was conducted with nine accessions along with Hisar Anand as check during 1999-2000 and 2000-2001 in plots measuring 3.0 x 1.5 m. The result indicated that DH - 205, DH - 234, DH - 242 and DH - 256 were found significantly superior over check during both the years (Table 103).

Jagudan

Though, non-significant differences in yield were observed among the entries, J. Cori - 328 gave maximum yield (16.15 q ha^{-1}) than

Table 101. Performance of coriander accessions - Kumarganj

Entry	Days to 50% flowering	Plant height (cm)	No. of branches plant^{-1}	No. of umbel plant^{-1}	No. of umbellets umbel^{-1}	No. of seeds umbellet^{-1}	Days to maturity	Yield (q ha^{-1})
RCr – 41	74.33	121.76	13.13	110.00	5.27	44.93	116.33	22.78
JCO – 387	63.67	108.04	14.70	75.67	6.53	53.73	116.67	22.45
LCC – 133	48.67	101.41	8.23	53.67	5.33	56.13	115.67	14.12
LCC – 128	50.00	99.49	8.47	98.80	5.33	42.73	111.33	12.96
JCO – 283	64.00	127.55	6.93	54.53	5.73	41.53	112.00	22.45
UD – 744	62.00	109.31	9.07	64.13	5.67	42.07	113.00	20.16
DH – 208	70.67	111.04	8.73	70.93	6.27	45.87	113.00	20.83
DH – 246	71.33	143.35	12.20	121.70	5.93	50.87	111.67	15.24
UD – 743	66.67	127.42	7.40	63.40	6.00	44.07	114.33	26.68
K. selection (check)	70.33	118.05	10.13	77.30	6.87	65.67	113.33	22.68
UD – 262	69.33	116.73	9.27	77.73	6.93	56.73	108.67	15.04
CD (5%)	5.03	15.04	2.78	18.57	1.76	15.22	7.07	4.11
CV %	4.26	7.58	17.61	14.02	14.87	15.75	3.82	16.05

Table 102. Performance of coriander entries under CVT (2001-2002) – Dholi

Genotype	Height of the plant (cm)	No. of branches plant^{-1}	No. of umbels plant^{-1}	Days to maturity	Grain (kg plot^{-1})	Yield (q ha^{-1})
JCO – 283	127.27	8.27	33.93	115.00	0.993	13.41
JCO – 387	128.07	7.20	26.80	128.00	0.756	10.22
LCC – 128	98.33	6.47	23.10	118.00	0.754	10.88
LCC – 133	98.67	8.07	31.00	119.00	0.754	10.18
DH - 208	130.33	8.33	42.27	135.00	1.224	16.54
DH- 2 46	139.07	8.33	40.40	128.00	1.185	16.02
R. Swati	124.13	6.80	30.00	127.00	0.799	10.79
CD (5%)	17.38	NS	11.96	5.39	0.210	2.84
CV %	8.09	10.87	20.68	2.44	12.681	12.66

Table 103. Initial Evaluation of coriander accessions (1999-2000 and 2000-2001) – Hisar

Accession	Seed yield (q ha^{-1})		
	1999-2000	2000-2001	Mean
DH – 205	18.4	19.4	19.1
DH – 211	15.9	19.1	17.5
DH – 218	13.9	18.9	16.4
DH – 229	16.0	16.5	16.3
DH – 234	19.4	20.6	20.0
DH – 242	17.8	19.3	18.6
DH – 245	15.7	17.2	16.5
DH – 256	16.9	17.9	17.4
DH – 267	14.8	17.6	16.2
Hisar Anand	14.4	16.8	15.6
CD (5%)	2.4	2.1	—

control. However, in pooled analysis, yield differences were found significant and the entries J. Cori - 360, 328 and Dhana-25 gave higher yield (15.97, 15.79 and 15.77 q ha^{-1}, respectively) (Table 104).

Guntur

During 2001-2002, ten promising coriander accessions selected from the germplasm were tested with Sadhana as check in RBD, replicated thrice. Among these accessions, LCC - 174 recorded significantly highest yield (585 kg ha^{-1}) followed by LCC - 225 and LCC - 176 with 535 and 501 kg ha^{-1}, respectively. The check variety Sadhana recorded a yield of 418 kg ha^{-1}. This trial on coriander was concluded during 2001-2002 season as it completed three years of experimentation at RARS, Lam. During 1999-2000, among the eleven genotypes evaluated LCC-174 recorded significantly highest yield (567 kg ha^{-1}), followed by LCC - 176 (517 kg ha^{-1}) and LCC - 225 (500 kg ha^{-1}). During 2000-2001 and 2001-2002 LCC - 174 recorded significantly highest yield followed by LCC - 225 and LCC - 175. The pooled data of three years indicated that among the eleven genotypes LCC - 174 was significantly superior (695 kg ha^{-1}) than the check Sadhana (506 kg ha^{-1}) but on

Table 104. Performance of coriander accessions - Jagudan

Entry	Yield (q ha^{-1})				Increase over control (%)
	1999-00	2000-01	2001-02	Average	
J.Cori - 328	17.97	13.21	16.18	15.79	7.20
J.Cori - 344	14.43	15.47	14.05	14.65	-
J.Cori - 360	16.67	15.50	15.74	15.97	8.42
J.Cori - 372	16.83	14.35	13.16	14.78	0.34
J.Cori - 380	11.98	12.64	11.87	12.16	-
Dhana - 25	17.76	15.80	13.75	15.77	7.06
Dhana - 89	15.52	15.90	14.76	15.39	4.48
G.Cori - 2	15.80	14.57	13.83	14.73	-
SEm ±	1.06	1.18	1.03	0.64	
CD (5%)	3.21	NS	NS	1.82	
CV %	11.54	13.95	12.64	12.70	

par with LCC - 225 (645 kg ha^{-1}) (Table 105).

Jobner

Twenty entries including four checks namely, RCr - 20, RCr-41, RCr - 436 and a local variety were evaluated in RBD. The entry UD - 358 recorded maximum seed yield of 8.58 q ha^{-1} followed by UD - 748 (7.01 q ha^{-1}), UD - 751 (6.11 q ha^{-1}) and UD -742 and RCr - 436 (check, 5.76 q ha^{-1}), while lowest

Table 105. Performance of coriander accessions under IET (Pooled analysis of yield, 1999-2000 to 2001-02) - Guntur

Entry	Yield (kg ha^{-1})			
	1999-2000	2000-2001	2001-2002	Pooled
LCC – 174	567.00	933.0	585.0	695.0
LCC – 175	400.00	783.0	434.0	539.0
LCC – 176	517.00	867.0	501.0	628.0
LCC - 195	383.00	750.0	418.0	517.0
LCC - 197	433.00	783.0	434.0	550.0
LCC - 215	367.00	700.0	301.0	456.0
LCC - 222	317.00	683.0	267.0	422.0
LCC - 224	400.00	750.0	451.0	534.0
LCC - 225	500.00	900.0	535.0	645.0
LCC – 227	467.00	817.0	468.0	584.0
Sadhana (check)	367.00	733.0	418.0	506.0
CD (5%)	116.28	94.9	64.6	554.0

yield of 2.06 q ha^{-1} was recorded in RCr - 41 (check). Mean performance of entries evaluated in IET during 1998-99, 1999-200 and 2000–2001 indicated superior performance of UD – 743, with a mean seed yield of 10.33 q ha^{-1} (22.39% higher than RCr - 20 and 15.29% higher than RCr - 41). Other promising entries identified were UD - 480, UD -118, UD - 358 and UD - 745 (Table 106).

COR/CI/4 Quality Evaluation Trial

COR/CI/4.1 Quality evaluation in coriander

(*Jobner*)

Jobner

Volatile oil content of the entries evaluated at Jobner under CVT over two years (1999-2000 & 2000-2001) indicated that the highest mean volatile oil yield (4.69 l ha^{-1})

Table 106. Performance of coriander entries evaluated under IET (Pooled analysis of yield, 1998-99 to 2000-2001) - Jobner

Entry	Yield (q ha^{-1})			
	1998-99	1999-2000	2000-2001	Mean
UD – 745	7.98	12.67	5.07	8.57
UD – 743	9.73	17.71	3.54	10.33
UD – 88	7.29	10.25	4.37	7.30
UD –118	8.33	14.58	3.54	8.82
UD –262	7.29	10.25	3.12	6.89
UD – 340	6.60	12.14	3.61	7.45
UD – 358	5.56	12.67	8.58	7.93
UD – 753	5.90	11.81	3.61	7.11
UD – 480	9.73	15.79	5.28	10.27
UD – 746	6.60	14.75	4.24	8.53
UD – 747	3.82	12.14	4.65	6.87
UD – 748	5.04	11.45	7.01	7.83
UD – 749	5.21	12.14	4.49	7.28
UD – 751	3.82	7.29	6.11	5.74
UD – 752	4.69	14.06	3.40	7.38
RCr – 436	5.21	8.69	5.76	6.55
RCr – 20	9.38	12.33	3.61	8.44
RCr – 41	8.33	16.50	2.06	8.96
CD (5%)	2.05	2.92	0.91	
CV %	17.93	13.61	11.90	

was in DH – 246, followed by (4.63 l ha^{-1}) in UD - 744 and 3.68 l ha^{-1} in RCr - 41.

The mean volatile oil content of the entries evaluated at Jobner under IET over three years (1998-99 to 2000-2001) indicated that UD - 751 (0.475%), UD - 88, UD - 262 (0.40% each) and UD - 745, UD - 480 (0.366% each) with respect to volatile oil content and UD - 480 (3.758 l ha^{-1}), UD - 743 (3.615 l ha^{-1}), UD - 745 (3.13 l ha^{-1}), UD - 88 (2.92 l ha^{-1}), UD - 118 (2.86 l ha^{-1}) and UD - 262 (2.75 l ha^{-1}) with respect to volatile oil yield were found promising (Table 107).

There is no effect of biofertilizer on the volatile oil content. However, the volatile oil yield depends on the grain yield.

COR/CM/1 Nutrient Management Trial

COR/CM/1.1 Response of coriander to micronutrients

(Kumarganj)

Kumarganj

Maximum yield (27.54 q ha^{-1}) was obtained with the application of ferrous sulphate 5 kg ha^{-1} + 0.125% as foliar spray, followed by copper sulphate 12.5 kg ha^{-1} + 0.25% as foliar spray (Table 108).

Table 107. Mean volatile oil content of coriander entries evaluated in IET - Jobner

Entry	Mean yield (q ha^{-1})	Volatile oil (%)				Mean oil yield (l ha^{-1})
		1988-99	1999-00	2000-01	Mean (%)	
UD - 745	8.57	0.30	0.40	0.400	0.366	3.136
UD - 743	10.33	0.30	0.35	0.400	0.350	3.615
UD - 88	7.30	0.35	0.45	0.400	0.400	2.920
UD - 118	8.82	-	0.35	0.300	0.325	2.866
UD - 262	6.89	0.40	0.35	0.450	0.400	2.756
UD - 340	7.45	0.25	0.35	0.300	0.300	2.235
UD - 358	7.93	0.20	0.30	0.400	0.300	2.379
UD - 753	7.11	-	0.30	0.275	0.282	2.000
UD - 480	10.27	0.35	0.35	0.400	0.366	3.758
UD - 746	8.53	0.20	0.15	0.325	0.225	1.919
UD - 747	6.87	0.25	0.25	0.350	0.283	1.944
UD - 748	7.83	0.30	0.30	0.300	0.300	2.349
UD - 749	7.28	0.20	0.15	0.300	0.216	1.572
UD - 751	5.74	0.40	0.60	0.425	0.475	2.720
UD - 752	7.38	0.30	0.25	0.250	0.266	1.960
RCr - 436	6.55	0.30	0.40	0 .300	0.330	2.160
RCr - 20	8.44	-	0.20	0 .250	0.225	1.899
RCr - 41	8.96	0.30	0.30	0.300	0.300	2.688

Table 108. Effect of micronutrients on coriander - Kumarganj

Treatment	No. of seeds umbel^{-1}	Days to maturity	Yield (q ha^{-1})	Disease incidence (%)	
				Powdery mildew	Stem gall (seeds)
T1 - Control	61.87	145.00	19.76	58.33	15.00
T2 - Zinc sulphate 20 kg ha^{-1} as soil application	64.47	147.33	17.45	53.33	10.00
T3 - Zinc sulphate (0.5 %) as foliar spray	62.20	147.00	19.53	51.67	15.00
T4 - Zinc sulphate 10 kg ha^{-1} + 0.25% as foliar application	59.73	145.33	18.61	48.33	33.33
T5 - Ferrous sulphate 10 kg ha^{-1} as soil application	67.00	145.67	19.30	45.00	16.67
T6 - Ferrous sulphate 0.25% as foliar application	59.67	146.00	19.07	41.67	11.67
T7 - Ferrous sulphate 5 kg ha^{-1} + 0.125% as foliar application	63.80	145.33	22.54	55.00	13.33
T8 - Magnese sulphate 25 kg ha^{-1} as soil application	55.33	145.33	22.08	51.67	15.00
T9 - Magnese sulphate 0.5% as Foliar application	54.67	142.67	21.85	63.33	11.67
T10 - Magnese sulphate 12.5 kg ha^{-1} + 0.25% as foliar application	62.00	144.67	19.53	55.00	15.00
T11 - Copper sulphate 25 kg ha^{-1} as soil application	71.47	144.00	20.92	51.67	11.67
T12 - Copper sulphate 0.5% as foliar application	65.33	147.33	19.53	51.67	8.33
T13 - Copper sulphate 12.5kg ha^{-1} + 0.25% as foliar application	62.87	146.33	22.20	46.67	8.33
CD (5%)	8.62	3.25	3.96	10.94	2.68
CV %	8.14	1.32	10.68	13.91	19.00

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

(*Coimbatore, Jobner, Kumarganj* and *Guntur*)

Jobner

Application of 100, 75 and 50% of the recommended dose of inorganic N + *Azospirillum* 1.5 kg ha^{-1} + FYM 5 t ha^{-1}; *Azospirillum* + FYM 10 t ha^{-1}; FYM 10 t ha^{-1} alone and 100% inorganic N alone produced significantly higher number of umbels plant^{-1}, number of seeds umbel^{-1} and seed yield ha^{-1}

over control. Maximum seed yield (6.62 q ha^{-1}) was obtained with the application of inorganic N (100%) + *Azospirillum* + FYM 5 t ha^{-1} and was at par with inorganic N (75%) + *Azospirillum* + FYM 5 t ha^{-1} (5.86 q ha^{-1}), *Azospirillium* + FYM 10 t ha^{-1} (6.01 q ha^{-1}) and inorganic N (100%) (6.23 q ha^{-1}) and significantly higher over rest of the treatments.

Coimbatore

The experiment was laid out with organic and inorganic fertilizers using coriander variety, CO - 3 and the results of the study are given in Table 109. The yield of coriander was highest (1083.3 kg ha^{-1}) with FYM (5 kg) + *Azospirillum* (50 g).

Kumarganj

Maximum yield of coriander (25.50 q ha^{-1}) was obtained in the treatment FYM 10 t ha^{-1} alone. However, use of *Azospirillum* with FYM 10 t ha^{-1} reduced the yield to 19.90 q ha^{-1} (Table 110).

Guntur

During 2001-2002 rabi season, among the ten different treatments tried in RBD with three replications, T1 (N 100% + *Azospirillum* + FYM 5 t ha^{-1}) recorded significantly higher yield (475 kg ha^{-1}), closely followed by T2 (N 75% + *Azospirillum* + FYM 5t ha^{-1}) with 467 kg ha^{-1} and T3 (N 50% + *Azospirillum* + 5 tonnes of FYM ha^{-1}) with 431 kg ha^{-1}. The Check (T10) recorded a yield of 250 kg ha^{-1} (Table 111).

COR/CP/1 Disease Management Trial

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

(Dholi)

Dholi

A survey was conducted during 2001-2002 to find out the severity of stemgall disease in different areas of Bihar. The crop was severely affected by stemgall disease in many districts of Bihar. M-1, UD-1, and Pant Haritima were found highly resistant to the disease.

Table 109. Effect of biofertilizer, *Azospirillum* on the yield of coriander - Coimbatore

Treatment		Yield (kg ha^{-1})
T0	Inorganic N (100%)	712.5
T1	Inorganic N (100%) + *Azospirillum* (50 g) + 5 kg FYM	833.3
T2	Inorganic N (75%) + *Azospirillum* (50 g) + 5 kg FYM	920.8
T3	Inorganic N (50%) + *Azospirillum* (50 g) + 5 kg FYM	816.6
T4	FYM (5 kg) + *Azospirillum* (50 g)	1083.3
T5	FYM (5 kg) alone	975.0
T6	FYM (10 kg) + *Azospirillum* (50 g)	700.0
T7	FYM (10 kg) alone	833.0
T8	*Azospirillum* (50 g) alone	900.0
T9	Control	650.0
	CD (5%)	125.6

Table 110. Effect of biofertilizer *Azospirillum* on the yield and yield attributing characters in coriander - Kumarganj

Treatment	Days to 50% flowering	Plant height (cm)	No. of branches plant^{-1}	No. of umbels plant^{-1}	No. of umbellets umbel^{-1}	Yield of seeds plant^{-1}	Days to maturity	Yield (q ha^{-1})
T1 - Inorganic N(100%) + *Azospirillum* (50g) + 5kg FYM	92.67	129.35	12.60	109.60	7.70	64.13	149.67	12.96
T2 - Inorganic N(75%) + *Azospirillum* (50g) + 5kg FYM	93.00	125.82	8.47	80.87	6.40	60.93	149.00	10.88
T3 - Inorganic N(50%) + *Azospirillum* (50g) + 5kg FYM	91.00	135.38	13.47	146.07	6.20	59.60	148.00	17.59
T4 - 5kg FYM + *Azospirillum* (50g)	95.00	128.56	16.10	135.13	6.07	54.00	149.67	18.98
T5 - 5kg FYM alone	94.00	119.12	9.73	107.93	6.63	60.40	150.33	15.74
T6 - 10kg FYM + *Azospirillum* (50g)	93.67	115.19	11.87	100.00	6.73	56.20	148.67	19.90
T7 FYM (10kg) alone	90.67	134.22	8.04	94.53	6.60	53.13	148.33	25.55
CD (5%)	2.77	8.66	2.33	22.76	0.93	6.94	6.87	4.32
CV %	1.72	3.63	16.24	13.53	7.92	7.34	2.60	9.50

Table 111. Effect of biofertiliser, *Azospirillum* on the yield of coriander - Guntur

Treatment	Yield (kg ha^{-1})
T1 - N 100% + *Azospirillum* + FYM 5 t ha^{-1}	475
T2 - N 75% + *Azospirillum* + FYM 5 t ha^{-1}	467
T3 - N 50% + *Azospirillum* + FYM 5 t ha^{-1}	431
T4 - FYM 5 t ha^{-1} *Azospirillum*	383
T5 - FYM 5 t ha^{-1} alone	350
T6 - FYM 10 t ha^{-1} + *Azospirillum*	416
T7 - FYM 10 t ha^{-1} alone	367
T8 - Inorganic N (100%).	375
T9 - *Azospirillum* alone	261
T10 – Control	250
CD (5%)	58.7

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

(*Coimbatore, Kumarganj, Dholi, Jagudan, Raigarh* and *Jobner*)

Coimbatore

The trial was conducted with seven treatments during rabi 2001 in RBD with three replications. The treatments showed significantly differential efficacy in the control of wilt disease in coriander. Among the treatments, the lowest wilt incidence of 6.00% and the highest yield of 640.74 kg ha^{-1} were recorded in seed treatment with *Trichoderma viride* and soil application. The next effective treatment was seed treatment with *T. harzianum* and soil application, which recorded the wilt incidence of 7.33% and yield of 607.41 kg ha^{-1}. The control treatment registered the highest wilt incidence of 26.67% with lowest yield of 351.85 kg ha^{-1} (Table 112).

Kumarganj

Lowest incidence of wilt disease (2.50%) was observed in seed treatment and soil drenching with carbendazim with highest seed yield (19.21 q ha^{-1}). Highest incidence of powdery mildew (83.33%) and stem gall disease (58.33% & 13.08%) were observed in untreated control (Table 113).

Jobner

Out of the seven treatments, minimum wilt incidence (10.67%) with the maximum grain yield (6.88 q ha^{-1}) were observed in the treatment where *Trichoderma harzianum* applied as seed treatment and as soil application, followed by seed treatment with carbendazim and soil application of carbendazim with 13.33% wilt incidence and grain yield of 6.88 q ha^{-1}. Maximum disease incidence (28.73%) and lowest yield (3.55 q ha^{-1}) were in control compared to all other treatments (Table 114).

Dholi, Jagudan and *Raigarh*

Reports not received.

Table 112. Management of wilt disease in coriander - Coimbatore

Treatment	Wilt incidence (%)	Yield (kg ha^{-1})
Seed treatment with carbendazim	11.33	470.36
Seed treatment with *Trichoderma viride* + soil application	6.00	640.74
Seed treatment with *T. harzianum* + soil application	7.33	607.41
Seed treatment with *Bacillus subtilis* + soil application	11.33	479.63
Seed treatment with *Pseudomonas fluorescence* + soil application	8.66	348.15
Seed treatment and soil drenching with carbendazim	9.33	503.70
Control	26.67	351.85
CD (5%)	0.97	53.72

Table 113. Management of diseases in coriander - Kumarganj

Treatment	Yield (q ha^{-1})	Wilt (%)	Powdery mildew (%)	Stem gall disease (%)	
				Plant	Seed
Seed treatment with carbendazim (0.2 %)	18.75	6.00	46.67	35.00	11.62
Seed treatment *Trichoderma viridae* and soil application	18.75	7.80	80.00	50.00	13.43
Seed treatment with *Trichoderma harzianum* and soil application	18.29	8.10	63.33	40.00	15.05
Seed treatment with *Bacillus subtilis* and soil application	16.90	9.20	53.33	41.67	11.94
Seed treatment with *Psedumonas flourescence* and soil application	15.91	10.00	46.67	46.67	12.19
Seed treatment with carbendazim (0.2 %) and soil drenching	19.21	2.50	43.33	33.33	9.24
Control	13.20	15.40	83.33	58.33	13.08
CD (5%)	3.03	3.28	15.33	11.09	2.95
CV %	12.88	11.98	10.34	10.69	2.70

Table 114. Biocontrol of wilt of coriander - Jobner

Treatment	Disease (%)	Yield (q ha^{-1})
Seed treatment with carbendazim	16.33	6.25
Seed treatment with *T. Viride* + Soil application	14.67	6.45
Seed treatment with *T. harzianum*_+ soil application	10.67	6.88
Seed treatment with *B. subtilis* + soil application	21.67	4.80
Seed treatment with *P. fluorescence* + soil application	23.33	4.80
Seed treatment and soil drenching of carbendazim	13.33	6.68
Control	28.33	3.55
CD (5%)	3.06	0.36
CV %	11.00	8.70

CUMIN

CUM/CI/1 Genetic Resources

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

(*Jobner* and *Jagudan*)

Jagudan

A total of 149 germplasm accessions (exotic – 9 and indigenous – 140) were maintained, including 30 new accessions collected during 2001-2002.

Out of 48 entries screened for their reaction to wilt disease under wilt sick plot conditions during the year, only JC - 2000 - 68, JC – 2000-71, JC - 2000-67, JC - 2000-72, GC - 3 and JC - 2000-69 were found moderately resistant, while all other entries were found highly susceptible.

A total of 48 entries were also screened for their reaction to blight disease. ACC - 1123 showed minimum incidence of the disease (11.00%), followed by ACC - 1205, JC - 96-47 and EC -Turkey. ACC - 1149, ACC - 1150 and ACC - 1151 recorded maximum incidence of blight disease under natural condition. Overall, the incidence of blight disease was moderate.

None of the entries was found resistant to powdery mildew disease. Minimum incidence of powdery mildew was recorded in JC - 94-37 (23.8%), followed by ACC - 1196 (27.5%), ACC - 1185 (31.2%), ACC - 1131 (32.5%) and ACC - 1186 (33.8 %). While other entries showed higher incidence of powdery mildew disease.

Jobner

Germplasm accessions (480) were sown in Augmented Randomized Complete Block Design. Only 180 accessions had uniform plant stand and hence observations were recorded only for these accessions.

Forty accessions recorded higher yield over the best check (UC - 223). The superior accessions were UC - 19 W - 9 (11.82 g), JC - 95-11 (10.72 g), SP - 12 (10.43 g), Wt - 7 (9.93 g), JC - 96-48 (9.84 g), JC - 95-104 (9.69 g), UC - 19W-2 (9.23 g), UC - 19W-5 (8.90g), JC - 95-37 (8.79 g), JC - 95-12 (8.41) and UC - 264 (7.85 g).

Screening of 10 lines for wilt disease was carried out in RBD in the field as well as in the disease sick pot. In field condition, of the ten entries evaluated, minimum wilt incidence (5.00%) with the maximum grain yield (2.55 q ha^{-1}) was observed in UC - 223 (check), followed by RZ - 19 with the 11.25% wilt incidence and grain yield of 1.74 q ha^{-1}, where as in local check the wilt incidence was maximum (30.0%) with lowest grain yield (1.02 q ha^{-1}) (Table 115).

Table 115. Screening of cumin lines against wilt disease under field conditions - Jobner

Entry	Disease incidence (%)	Yield (q ha^{-1})
UC – 223	5.00	2.55
RZ - 19 C	11.25	1.74
UC – 231	16.25	1.67
JC - 94-148	17.50	1.58
RZ - 209 C	22.50	1.51
UC - 310	22.50	1.43
JC - 95-128	25.00	1.25
JC - 94-37	25.00	1.19
JC - 94-262	27.50	1.13
Local check	30.00	1.02
CD (5%)	5.91	0.39
CV %	20.10	17.70

CUM/CI/2 Hybridization Trial

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

(Jagudan)

Jagudan

Optimum time of pollination (GC - 2 X Hairy cumin): F2 : Hairy plants in F1 were segregated in to hairy and non-hairy characters of parent. (GC-2 X Hairy cumin).

Optimum day of pollination (GC-2 X Hairy cumin): None of the F1 seeds germinated in the laboratory.

CUM/CI/3 Coordinated Varietal Trial

CUM/CI/3.2 CVT 1999 Series IV

(Jagudan and *Jobner)*

Jagudan

The yield differences among entries were found significant. JC - 94-37 recorded significantly higher yield (10.56 q ha^{-1}) than the most popular variety GC - 2. It was 18.78 % more than the yield of GC - 2. But JC - 94-37 was at par with latest released wilt resistant variety GC – 3, with 10.81% higher yield.

Pooled data for 3 years showed non-significant differences in the yield among the entries. However, JC - 94-37 gave 16.62% and 6.56% higher yield than GC - 2 and GC - 3 (W), respectively (Table 116).

Jobner

The variety UC - 223 (check) recorded maximum seed yield of 2.55 q ha^{-1} followed by RZ - 19 (check, 1.74 q ha^{-1}), UC - 231 (1.67 q ha^{-1}), JC - 94-148 (1.58 q ha^{-1}), and RZ - 209 (1.51 q ha^{-1}), while local check recorded lowest seed yield of 1.02 q ha^{-1}.

Performance of the entries during 1999-2000 and 2000-2001 revealed superior performance of UC - 310 yielding 2.36 q ha^{-1}, followed by UC - 231 (2.26 q ha^{-1}), RZ - 19 (2.20 q ha^{-1}), while lowest mean yield of 1.41 q ha^{-1} was recorded in JC - 94-262 (Table 117).

Table 116. Performance of cumin varieties under CVT - Jagudan

Entry	Yield (q ha^{-1})				Increase over control (%)	
	99-2000	2000-01	2001-02	Average	GC-2	GC-3
JC - 94-37	5.57	11.65	10.56	9.26	16.62	6.56
JC - 94-128	5.03	11.24	8.50	8.26	4.03	-
JC - 94-148	4.73	9.94	9.22	7.96	-	-
JC - 94-262	5.35	8.24	7.41	7.00	-	-
UC - 231	4.20	10.84	8.83	7.96	-	-
UC - 310	5.41	10.56	8.55	8.17	2.90	-
JGC - 2(check)	4.36	10.58	8.89	7.94	-	-
GC - 3(check)	4.76	11.77	9.53	8.69	9.45	-
SEm ±	0.30	0.64	0.43	0.42		
CD (5%)	0.87	1.88	1.28	-		
CV %	12.03	12.08	9.73	11.73		

Table 117. Performance of cumin entries – Jobner

Entry	Yield (q ha^{-1})		
	1999-2000	2000-2001	Mean
UC - 310	3.28	1.43	2.36
UC - 231	2.85	1.67	2.26
Local check	2.71	1.02	1.87
RZ - 19	2.65	1.74	2.20
JC - 94-148	2.42	1.58	2.00
JC - 94-37	2.36	1.19	1.78
JC - 94-128	1.81	1.25	1.53
JC - 94-262	1.68	1.13	1.41
CD (5%)	0.55	0.39	
CV %	15.21	17.7	

CUM/CI/4 Varietal Evaluation Trial
CUM/CI/4.1 Initial evaluation trial
(Jagudan)

Jagudan

Ten non-splitting and wilt resistant entries were tested for yield with GC - 2 and GC - 3 as check. The data revealed that the yield differences among various entries were significant. The entries JC - 2000-72 (12.27 q ha^{-1}), JC - 2000-28 (12.07 q ha^{-1}) and JC - 2000-27 (11.80 q ha^{-1}) gave 27.55%, 25.47% and 22.66% higher yield over GC - 3, respectively. Nine entries recorded significantly higher yield over GC - 2.

CUM/CI/5 Quality Evaluation Trial
CUM/CI/5.1 Quality evaluation in cumin
(Jobner)

Jobner

The volatile oil content of cumin entries evaluated in CVT over two years (1999-2000 and 2000-2001) indicated that the volatile oil content ranged from 2.75% to 3.7%. The highest volatile oil content was found in JC - 94-37 (3.7%), followed by JC - 94-148 (3.4%), JC - 94-128 (3.25%) and UC - 310 (3.2%) and minimum of 2.75% in JC - 94-262 (Table 118).

Table 118. Volatile oil content of cumin entries evaluated in CVT during 1999-2000 and 2000-2001 - Jobner

Entry	Grain yield (q ha^{-1})	Volatile oil (%)			Mean oil yield (l ha^{-1})
		1999-00	2000-01	Mean	
UC - 310	2.36	3.6	2.8	3.20	7.551
UC - 231	2.26	3.5	2.6	3.05	6.893
Local check	1.87	3.4	2.6	3.00	5.610
RZ - 19	2.20	3.6	2.4	3.00	6.600
JC - 94-148	2.00	4.2	2.6	3.40	6.800
JC - 94-37	1.78	4.4	3.0	3.70	6.586
JC - 94-128	1.53	3.7	2.8	3.25	4.972
JC - 94-262	1.41	3.1	2.4	2.75	3.877

CUM/CM/1 Nutrient Management Trial
CUM/CM/1.1 Efficacy of biofertilizer using *Azospirillum* on cumin
(*Jobner* and *Jagudan*)

Jobner

Significantly higher number of umbels plant^{-1}, seeds umbel^{-1}, biological and seed yield ha^{-1} over control were recorded with the application of 100, 75 and 50% of recommended inorganic N + *Azospirillum* 1.5 kg ha^{-1} + FYM 5 t ha^{-1}, inorganic N 100% and *Azospirillum* 1.5 kg ha^{-1} alone. However these treatments were at par in their effect on seed yield. The seed yield recorded under these treatments were 1.96, 1.83, 1.78 and 1.98 q ha^{-1}, respectively.

Jagudan

Report not received.

CUM/CP/1 Disease Management Trial
CUM/CP/1.2 Epidemiological study of *Alternaria* blight of cumin
(*Jobner*)

Final report not received.

CUM/CP/2 Pest Management Trial
CUM/CP/2.1 Integrated Management of Pests and Disease of cumin
(*Jagudan* and *Jobner*)

Jagudan

The incidence of blight and wilt diseases was very high during the season. Soil and seed treatment with *Trichoderma harzianum* could not significantly reduce the incidence of both the diseases. Among the spraying treatments, none of the treatments was found effective to manage both the diseases. The infestation of aphid before spraying was found non-significant in all the treatments. After second spray, all the treatments were found effective over control. Among the spraying treatments, hexaconazole + monocrotophos was found superior, but it was at par with T4, (mancozeb + acephate), T8 (hexaconazole + acephate) and T3 (mancozeb + monocrotophos) treatments (Table 119).

Due to the heavy incidences of wilt and blight diseases, the grain yield was very low and the grains became black and shriveled and hence the results were non-significant. The data pertaining to powdery mildew were not recorded during the season as there was no incidence of the disease.

Jobner

Report not received.

FENNEL

FNL/CI/1 Genetic Resources
FNL/CI/1.1 Germplasm collection, characterization, evaluation, conservation and screening against diseases
(*Jobner, Jagudan, Hisar, Kumarganj* and *Dholi*)

Kumarganj

Out of 18 germplasm accessions, maximum yield was recorded in NDF – 6 (22.92 q ha^{-1}), followed by NDF – 5 (20.83 q ha^{-1}). Maximum incidence of powdery mildew disease was observed in NDF – 15 (66.67 %) and minimum in NDF – 8, NDF – 10 (3.33 %) (Table 120).

Table 119. Effects of agrochemicals and bio control agent on blight and wilt diseases, aphid infestation and yield of cumin - Jagudan

Treatment	PDI blight	Unit (%)	Aphid index at second spray Before	Aphid index at second spray After	Yield (kg ha^{-1})
(A) Main treatments					
S1 Seed treatment and soil application of *Trichoderma harzianum*	25.15	33.75	1.700	1.340	55.80
S2 Seed treatment of carbendazim 0.1% + soil application of *Trichoderma harzianum*	33.09	38.53	1.690	1.360	53.90
S3 Control	32.24	35.72	1.550	1.470	89.09
SEm ±	2.55	9.02	0.084	0.058	23.94
CD (5%)	NS	NS	NS	NS	NS
(B) Sub treatments					
T1 Mancozeb 0.3%	28.67	39.24	1.580	1.440	64.58
T2 Mancozeb 0.3% + Neem Oil 1% + Tipol 1%	27.11	41.40	1.750	1.540	52.78
T3 Mancozeb 0.3% + Monocrotophos 0.04%	26.44	43.59	1.850	1.180	68.47
T4 Mancozeb 0.3% + Acephate 0.075 %	33.11	38.34	1.900	1.080	103.47
T5 Hexaconazole 0.05%	31.33	24.56	1.760	1.730	70.83
T6 Hexaconazole 0.05% + Neem Oil 1 % + Tipol 1%	27.56	31.46	1.400	1.330	70.14
T7 Hexaconazole 0.05% + Monocrotophos 0.04%	33.33	16.63	1.330	0.750	60.00
T8 Hexaconazole 0.05% + Acephate 0.075%	33.11	27.46	1.630	1.120	71.39
T9 Thiophenate methyl 0.07%	31.11	37.67	1.550	1.630	47.22
T10 Thiophenate methyl 0.07% + Monocrotophos 0.04%	29.33	36.80	1.770	1.380	59.58
T11 Control (no spraying)	30.67	58.85	1.620	2.170	80.42
SEm ±	3.97	9.01	0.156	0.152	20.80
CD (5%)	NS	NS	NS	0.431	NS
S x T NS	NS	NS	NS	NS	
CV %	39.46	75.11	28.440	32.77	94.18

Table 120. Performance of fennel germplasm – Kumarganj

Entry	Yield (q ha^{-1})	Incidence of powdery mildew (%)
NDF - 1	12.92	25.00
NDF - 2	17.50	56.67
NDF - 3	16.25	65.00
NDF - 4	8.75	30.00
NDF - 5	22.92	31.67
NDF - 6	20.83	23.33
NDF - 7	13.33	28.33
NDF - 8	16.25	3.33
NDF - 9	11.25	31.67
NDF - 10	20.42	3.33
NDF - 11	14.17	35.00
NDF - 12	12.08	30.00
NDF - 13	16.67	28.33
NDF - 14	15.42	58.33
NDF - 15	12.92	66.67
NDF - 16	15.42	31.67
NDF - 17	9.58	26.67
NDF - 18	8.75	26.67
CD (5%)	5.56	10.09
CV %	18.86	15.09

Jagudan

In fennel, 57 new accessions were collected during the year for different characters as given below. Among them, 41 entries were selected for good characters and were maintained.

Character	No. of collections
Early type	17
Dwarf type	9
Erect plant habit	6
Bloomless type	2
Big umbels type	1
Long seed type	1
Compact seed inumbellate	8
Less bloom type	1
Sterile habit	1
Less leafy type	6
Sweet in taste	5
Total	57

Out of 20 entries tested, the minimum incidence of powdery mildew disease was observed in JF - 203 (21.25), followed by JF - 187 (22.50 %), JF - 259 (25%), C - 1 (25%) and JF - 204 (28.75%). Other entries showed moderate incidence of the disease. *Ramularia* blight was not observed during rabi season in the field.

Hisar

At Hisar, 64 accessions of fennel were evaluated in two row plots of 2.5 m length (2.5 sq m) along with PF - 35, GF - 1 and local variety as checks during 1996-97 to 1998-99. The mean seed yield of the germplasm ranged from 360 g (HF - 159) to 740 g (HF - 127) per plot. Thirty four lines gave higher seed yield than the highest yielding check (PF – 35). The most promising lines are HF - 107, HF - 113, HF - 116, HF - 117, HF - 118, HF - 122, HF - 125, HF - 127, HF - 129 and HF - 175. The initial evaluation trial (IET) in fennel was conducted at Hisar, with ten accessions along with PF - 35 as check during 1998-1999 to 2000-2001. The results indicated that HF - 107 and HF - 116 gave significantly better yield over PF - 35. Hence, both these lines were included in co-ordinated varietal trial for further evaluation during 2001-2002.

Jobner

At Jobner, 122 accessions were sown in Augmented Randomized Complete Block Design. Out of 122 accessions, 40 accessions recorded better yield than check varieties. The superior accessions that were better than best check varieties were NS - 4 (400 g), UF - 151 (340 g), NS - 5 (325 g), NS - 25 & NS - 26 (300 g), NS - 20 & NS - 21 (250 g), NS - 2, NS - 15, JF - 25 & UF - 133 (225 g), UF - 148, UF - 152 & NS - 28 (220 g), UF - 158 (215 g).

Dholi

Thirty six germplasm accessions of fennel, comprising of local as well as reputed genotypes of different states of India are being maintained. Their morphological characters were studied and a few promising lines, RF - 31 (500 g plot^{-1}), RF - 4 and 21 (900 g plot^{-1}) have been identified based on their yield, quality and resistance to disease.

FNL/CI/2 Hybridization trial

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

(Jagudan)

Jagudan

F_1 seeds of the crosses JF - 399-1 X GF - 2, JF - 413-1 X GF - 2 and JF - 427-3 X GF - 2 collected from previous years did not germinate.

With a view to find out cytoplasmic male sterile line, 14 lines selected during last years were sown and critically examined for fruit setting in primary and higher order umbels. Among them, 6 lines JF - 399-2, JF - 427-2, GF - 2-1, GF - 2-2, GF - 2-3 & GF - 2-4 showed less seed setting habit. Among them three entries were crossed with elite line GF - 2 and F_1 seeds were harvested.

FNL/CI/3 Coordinated Varietal Trial

FNL/CI/3.1 CVT 1994-Series III

(Jobner, Jagudan and *Hisar)*

Jagudan

Significant differences were observed among the entries for yield. JF - 192 recorded significantly higher yield (21.53 q ha^{-1}) than control. It was 14.58% higher over control. Pooled data for five years showed significant yield differences among the entries. JF - 192 gave significantly superior yield (24.89 q ha^{-1}), which was 12.17% higher over control (Table 121).

Jobner

The accession UF - 143 recorded maximum seed yield (13.67 q ha^{-1}), followed by UF - 144 (10.27 q ha^{-1}), JF - 200 (9.50 q ha^{-1}), RF - 125 check (9.33 qha^{-1}) and RF - 101 (check, 9.17 q ha^{-1}), while lowest yield (7.33 q ha^{-1}) was recorded in JF - 192.

Mean performance of the entries evaluated in CVT during 1998-99, 1999-2000 and 2000-2001 revealed superior performance of UF - 143 yielding 12.04 q ha^{-1} followed by UF - 144 (10.21 q ha^{-1}), JF - 186 (9.73 q ha^{-1}) and JF - 200 (9.27 q ha^{-1}), while lowest mean yield of 6.60 q ha^{-1} was recorded in HF - 39 (Table 122).

Hisar

Ten entries were evaluated for their performance during 1997-98 to 2000-2001. On the basis of average yield for three years (Table 123), the maximum seed yield was recorded in HF-33 (21.9 q ha^{-1}) which was 31.9% higher

Table 121. Yield performance of fennel entries - Jagudan

Entry	Yield (q ha^{-1})						Increase over control (%)
	1997-98	1998-99	1999-00	2000-01	2001-02	Average	
JF - 186	27.66	26.06	21.81	19.25	16.19	22.19	-
JF - 192	26.18	27.43	26.45	22.87	21.53	24.89	12.17
JF - 200	28.33	26.06	24.89	20.38	17.88	23.51	5.95
UF - 143	23.60	23.07	21.81	21.83	17.40	21.54	-
UF - 144	26.50	24.02	17.90	20.77	19.66	21.77	-
HF - 33	17.37	20.79	18.38	16.51	16.75	17.96	-
HF - 39	21.40	19.47	22.85	16.08	17.19	19.40	-
GF - 2 (Ch)	25.39	25.54	21.85	19.40	18.79	22.19	-
SEm ±	1.96	1.07	2.06	1.12	0.82	0.85	
CD (5%)	5.77	3.16	NS	3.30	2.43	2.47	
CV %	15.97	8.92	18.72	11.41	9.10	13.79	

Table 122. Performance of fennel genotypes (1998-99, 1999-2000 and 2000-2001) - Jobner

Entry	Yield (q ha^{-1})			
	1998-1999	1999-2000	2000-2001	Mean
UF – 143	10.02	12.44	13.67	12.04
UF – 144	9.85	10.50	10.27	10.21
JF – 186	8.13	12.06	9.00	9.73
JF – 200	8.50	9.81	9.50	9.27
Local check	8.30	9.31	7.83	8.48
JF – 192	7.78	9.56	7.33	8.22
HF – 33	6.14	9.94	7.83	7.97
HF – 39	3.69	7.94	8.17	6.60
CD (5%)	2.33	NS	0.16	
CV %	20.23	22.26	10.00	

over local check, followed by HF-39 (20.5%), PF-35 (16.9 %) and JF-200 (12.6%).

FNL/CI/3.2 CVT 2001 – Series IV
(*Jagudan, Jobner, Hisar* and *Kumarganj)*

Jagudan

Significant differences were observed among the entries for yield. JF - 332 recorded maximum yield (22.01 q ha^{-1}), which was 17.39% higher over control.

Table 123. Performance of fennel genotypes – Hisar

Entry	Seed yield (q ha^{-1})					Increase over local check (%)
	1997-98	1998-99	1999-00	2000-01	Mean	
HF – 33	15.6	24.3	22.1	19.3	21.9	31.9
HF - 39	13.3	21.5	20.9	17.7	20.0	20.5
JF - 186	15.0	18.3	18.7	17.0	18.0	8.4
JF - 192	13.1	15.2	20.0	20.3	18.5	11.4
JF - 200	12.7	16.8	21.1	18.3	18.7	12.6
UF - 143	14.0	16.2	14.7	16.7	15.9	4.2
UF - 144	13.1	18.2	16.9	20.3	18.5	11.4
Local check	14.2	17.5	16.5	15.7	16.6	—
PF - 35	16.0	22.8	19.0	16.3	19.4	16.9
GF - 1	14.4	20.0	18.4	17.3	18.0	12.0
CD (5%)	1.7	2.2	2.5	3.1	—	—

Kumarganj

Six cultivars of fennel including local check NDF - 5 were evaluated. Out of six cultivars RF – 15 gave highest yield (22.70 q ha^{-1}), followed by NDF - 5 (20.76 q ha^{-1}) (Table 124).

Jobne and *Hisar*

Reports not received.

FNL/CI/4 Varietal Evaluation Trial

FNL/CI/4.1 Initial evaluation trial

(*Hisar, Jobner* and *Jagudan*)

Hisar

The initial evaluation trial in fennel was conducted with ten accessions along with PF - 35 as check during 1998-99 to 2000-01. The

Table 124. Performance of fennel genotypes - Kumarganj

Entry	Plant height (cm)	No. of branches plant^{-1}	No. of umbel plant^{-1}	No. of umbelts umbel^{-1}	No. of umbelt^{-1} grains	Days taken to maturity	Yield (q ha^{-1})
RF - 15	133.15	11.40	45.67	26.67	27.27	155.67	22.70
RRF - 16	109.13	11.00	38.07	25.00	29.53	159.33	19.44
RF - 21	106.80	8.20	30.20	23.40	25.67	157.67	6.59
RF - 31	109.03	7.57	32.43	24.12	25.62	160.00	9.02
J.F - 192	108.80	9.13	34.73	21.87	22.13	158.00	9.72
NDF - 5 (check)	117.07	12.00	35.73	26.80	26.70	159.67	20.76
CD (5%)	7.34	1.89	6.97	3.27	3.78	5.06	2.60
CV %	3.44	8.65	10.72	6.70	7.79	1.74	6.89

results indicated that HF - 107 and HF - 116 gave significantly higher yield over PF - 35 (Table 125).

Table 125. Initial Evaluation of fennel accessions - Hisar

Entry	Seed yield (q ha^{-1})		
	1998-99	2000-2001	Mean
HF - 107	19.5	21.2	20.3
HF - 113	16.5	13.5	15.0
HF - 116	19.2	20.0	19.6
HF - 117	22.0	17.0	19.5
HF - 118	17.0	13.0	15.0
HF - 122	20.2	13.5	16.9
HF - 125	18.2	17.0	17.6
HF - 127	21.0	16.0	18.5
HF - 129	15.0	16.2	15.6
HF - 175	16.0	17.5	16.8
PF - 35 (check)	16.7	13.6	15.1
CD (5%)	2.4	3.2	

Jobner

Ten entries including two checks namely, RF - 101 and local variety were evaluated in RBD. The entry UF - 136 recorded maximum seed yield (19.79 q ha^{-1}) followed by UF - 119 (19.44 q ha), UF - 33 (16.86 q ha^{-1}) and RF - 101 (13.40 q ha^{-1}), while lowest yield of 8.19 q ha^{-1} was recorded in UF - 145.

Jagudan

A new IET was initiated during 2001-02. The yield differences were found non significant among the entries. However, the entries, JF - 444-1, JF - 376 and JF - 421 gave more yield of 30.38, 29.28 and 28.76 q ha^{-1}, respectively.

FNL/CI/4.2 Comparative yield trial (CYT) (*Dholi*)

Dholi

A new CYT in fennel was laid out during 2001-2002 in a randomized block design with ten entries, received from other centres of AICRPS to study their relative growth and yield parameters.

FNL/CI/5 Quality Evaluation Trial

FNL/CI/5.1 Quality evaluation in fennel (*Jobner*)

Jobner

The volatile oil content of the entries being evaluated under CVT for three years (1998-99 to 2000-2001) indicated that the volatile oil yield was maximum in UF - 143 (22.4 l ha^{-1}), followed by UF - 144 (18.9 l ha^{-1}) and JF - 200 (16.68 l ha^{-1}) (Table 126).

Forty nine accessions of fennel along with 4 checks (local check, RF - 101, RF - 125 and UF - 134) were evaluated for volatile oil content. The volatile oil content ranged from 0.6% to 2.6%. The promising entries are UF - 133 X HF - 71 (2.6%), RF - 125, RF - 125 X HF - 71, HF - 71 X HF - 104, DFM - 1.

The volatile oil content of fennel was found to be highest (2.6%) with the application of N 100% + *Azospirillum* + FYM 5 t ha^{-1} followed by 2.55% with FYM 5 t ha^{-1}; 2.50% with *Azospirillum* + FYM 10 t ha^{-1} or FYM 10 t ha^{-1} as compared to control (2.3%).

FNL/CM/1 Nutrient Management Trial

FNL/CM/1.2 Efficacy of biofertilizer using *Azospirillum* and P solubiliser on fennel (*Kumarganj, Jobner* and *Jagudan*)

Table 126. Volatile oil content of fennel entries evaluated under CVT - Jobner

Entry	Mean yield (q ha^{-1})	Volatile oil (%)				Mean oil yield (l ha^{-1})
		1998-99	1999-00	2000-01	Mean	
UF – 143	12.04	1.80	2.00	1.80	1.86	22.394
UF – 144	10.21	1.75	2.10	1.70	1.85	18.888
JF – 186	9.73	1.55	1.80	1.70	1.68	16.346
JF – 192	8.22	1.65	1.90	1.70	1.75	14.385
JF – 200	9.27	1.50	2.00	1.90	1.80	16.686
HF – 33	7.97	1.60	2.00	1.80	1.80	14.346
HF – 39	6.60	1.80	1.60	1.90	1.76	11.616
Local	8.48	1.50	1.90	1.60	1.66	14.076

Kumarganj

The trial was initiated during 2000-01. During 2001-02, maximum yield (10.06 q ha^{-1}) was obtained by application of inorganic N (100%) along with *Azospirillum* 50 g + FYM 5 kg (Table 127).

Jobner

Significantly higher number of branches and umbels plant^{-1}, seeds umbel^{-1} biological and seed yield ha^{-1} over control were recorded with the application of recommended inorganic N (100, 75 & 50%) + *Azospirillum* 1.5

Table 127. Effect of *Azospirillum* on yield and yield attributes of fennel - Kumarganj

Treatment	Plant height (cm)	No. of umbel plant^{-1}	No. of seeds umbellet^{-1}	Yield (q ha^{-1})
T1 - Inorganic N (100%) + *Azospirillum* (50g) + FYM 5 t ha^{-1}	116.20	41.53	28.27	10.06
T2 - Inorganic N (75%) + *Azospirillum* (50g) + FYM 5 t ha^{-1}	104.13	45.07	25.13	8.19
T3 - Inorganic N (50%) + *Azospirillum* (50g) + FYM 5 t ha^{-1}	109.80	41.40	29.73	9.37
T4 - FYM (50g) 5 t ha^{-1} + *Azospirillum*	104.53	57.00	26.47	8.54
T5 - FYM 5 t ha^{-1} alone	83.15	43.33	23.27	6.25
T6 - FYM 10 t ha^{-1} + *Azospirillum* (50 g)	74.07	28.93	23.33	5.55
T7 - FYM 10 t ha^{-1}alone	96.47	28.53	23.60	5.20
CD (5%)	20.96	6.65	4.38	1.89
CV %	12.21	13.10	10.44	20.29

kg ha^{-1} + FYM 5 t ha^{-1}. Maximum seed yield (11.88 q ha^{-1}) was recorded with *Azospirillum* 1.5 kg ha^{-1} + FYM 10 t ha^{-1}, followed by inorganic N (100%) + *Azospirillum* 1.5 kg ha^{-1} + FYM 5 t ha^{-1} (11.41 q ha^{-1}).

Jagudan

Report not received

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*)

Hisar

Sixty five accessions of fenugreek were evaluated in 4 rows plot of 3 meter long, spaced at 30 cm using Hisar Sonali and Pusa Early Bunching as check during 1997-98 to 2000-01. The results indicated that 9 accessions gave higher seed yield than Hisar Sonali and 52 accessions out yielded Pusa Early Bunching. The mean seed yield ranged from 15.71 q ha^{-1} (HM - 267-7) to 24.14 q ha^{-1} (HM - 273). The most promising lines were HM - 242, HM - 273, HM - 281-6, HM - 292-6, HM - 293-1, HM - 299, HM - 305, HM - 348 and HM - 355.

Guntur

During 2001-2002 rabi season, fifty four accessions were evaluated in simple observational plots. Among the accessions evaluated LFC - 92 recorded highest yield (980 kg ha^{-1}), followed by LFC - 101, LFC - 99, LFC - 90 and LFC - 100 with 950, 940, 920 and 900 kg ha^{-1} respectively. The check variety, Lam Selection-1 recorded an yield of 460 kg ha^{-1}.

Kumarganj

Eight germplasm accessions were collected from Uttar Pradesh and altogether 38 germplasm accessions were evaluated during rabi season 2001–2002 for their agronomic traits and yield attributes. NDM - 21 (28.44 q ha^{-1}), followed by NDM - 5 (27.13 q ha^{-1}) gave maximum yield.

Jobner

During 2001-2002, 352 accessions of fenugreek were maintained and the germplasm was not evaluated for yield performance during the year.

Out of twenty eight entries screened for the reaction to powdery mildew disease in the farmers field at Danta (Sikar), variety UM - 305 was found free from disease and rest others were found resistant to highly susceptible (Table 128).

Twenty eight entries of fenugreek were screened against root knot nematode (*Meleiodogyne incognita*) under field conditions in collaboration with the department of Nematology, Agricultural Research Station, Durgapura, Jaipur (Table 129).

Dholi

Altogether 89 germplasm accessions of fenugreek are being maintained comprising of local as well as reputed genotypes of different states of India. Their morphological characters were studied and some promising lines (HM - 101, RM - 15, HM - 346 with highest yield of 800 g plot^{-1}) have been identified based on their yield, quality and disease resistance.

In screening of germplasm against *Cercospora* leaf spot, the accessions, J. Fenu - 115, HM - 302, UM - 322, HM - 346, J.

Table 128. Reaction of fenugreek entries to powdery mildew disease at farmer's field in Danta (Sikar) (2000-2001) - Jobner

Score	Nature of infection	Entry
0	No disease observed	UM-305
1	A few Scattered plants mildewed: no more than 1 or 2 patches per plant	UM-32, UM-34, UM-143 and UM-303
2	Up to 10 patches/ plant	UM-304 and UM-321
3	Nearly every leaflet infected	UM-15, UM-44, UM-52 and RMt-1
4	Nearly all leaflet infected	UM-56,UM-68,UM-118, UM-175 and UM-193
5	Every plant affected field appears green flecked with brown	UM-322, UM-323 and UM-324
6	About 75% plants infected	UM-117, UM-127 and UM-128
7	Only some leaves on plants not infected but stems are green	UM-129 and Local
8	Leaves, leaflets and stem are infected	UM-138, UM-142
9	All plants infected with mildew	UM-231 and UM-321

Table 129. Reaction of fenugreek entries to root knot nematodes

Reaction	No.of galls	Accessions
Immune (I)	No galls	UM-305
Resistant (R)	3-10	UM-32, UM-34, and RMt-303, UM-322
Moderately resistant (MR)	11-30	UM-52, UM-56, UM-68, UM-116, UM-117, UM-127, UM-128, UM-143, UM-175, Um-193, UM-231, UM-301, UM-321, UM-322 and RMt-1
Susceptible (S)	31-100	UM-44, UM0118, UM-138, UM-142, UM-323
Highly susceptible (HS)	Above 100	UM-12, UM-15, UM-47, UM-94, UM-96, UM-137, UM-249 and Local

Fenu - 195, Rajendra Kanti, Sel - 6, UM - 66, UM - 302, RM - 1, J. Fenu - 58, Sel - 5, UM - 109, CF - 390, UM - 29, Sel - 9, UM - 14, UM - 69 and UM - 21 were found to be resistant.

Jagudan

This centre maintained and evaluated 42 accessions of fenugreek during 2001-2002.

Out of 20 entries, the minimum incidence powdery mildew was observed in JF -

203 (21.25%) followed by JF - 187 (22.50%), JF - 259 (25.00%), C - 1 (25%) and JF - 204 (28.75%). Other entries showed moderate incidence of powdery mildew disease.

FGK/CI/2 Hybridization Trial

FGK/CI/2.1 Evolving varieties resistant to powdery mildew

(Jagudan)

Jagudan

In fenugreek, all F_1 seeds collected during 2000-2001 were sown and none of the seeds germinated. For F_2 study, 210 seeds were sown during the year and segregation was not observed. During 2000-2001, crosses GM - 1 X UM-305 and UM - 305 X GM-1 were made and seeds harvested.

FGK/CI/3 Coordinated Varietal Trial

FGK/CI/3.1 CVT - 1995 Series III

(Guntur and *Kumarganj)*

Guntur

During 1998-99, among the twelve entries from different coordinating centres tested, JF - 210 recorded significantly higher grain yield of 1417 kg ha^{-1} followed by JF - 204 with 1300 kg ha^{-1}. During 1999-2000 also, JF - 210 repeated its performance by recording significantly higher yield of 967 kg ha^{-1}. The genotype, JF - 204 was on par with check, Lam selection-1. During 2000-2001, significantly higher grain yield was recorded by JF - 210 with 1354 kg ha^{-1} followed by JF - 204 with 1271 kg ha^{-1}. During 2001-2002 also the same trend continued, but the yield in general was low due to the incidence of *Spodoptera exigua*. JF - 210 recorded significantly higher yield of 625 kg ha^{-1} and was on par with JF - 204 (589 kg ha^{-1}). The pooled data over four years indicated the superiority of JF - 210 in grain yield with 1091 kg ha^{-1} followed by JF - 204 with 1011 kg ha^{-1} while JF - 195 (789 kg ha^{-1}) and UM - 321 (787 kg ha^{-1}) were on par with check, Lam selection-1 (823 kg ha^{-1}) (Table 130).

Kumarganj

Final report not received.

FGK/CI/3.2 CVT 1999 Series IV

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

Coimbatore

A new CVT was started during 2001-2002. Among the 10 cultures of fenugreek evaluated, the number of seeds per pod was highest in UM - 351 (13.6) followed by CO - 2 (13.3). The yield was highest in UM - 305 (400 kg ha^{-1}), followed by J - 270 (383.3 kg ha^{-1}) and the cultures HM - 346, UM - 321, UM - 322 and CO - 2 were on par.

Hisar

Thirteen entries including two from Dholi (RM - 1 and RM – 5), two from Hisar (HM - 346 and HM – 350) three from Jagudan (JF - 195, JF - 204 and JF – 210) three from Jobner (UM - 305, UM - 321 and UM – 322) along with Pusa Early Bunching, Hisar Sonali and local check were tested during 2000-01.

Significant differences were observed for all the parameters. Maximum seed yield was recorded in HM - 346 (20.1 q ha^{-1}), which was statistically at par with Hisar Sonali (19.4 q ha^{-1}). Both the entries significantly increased yield over local check. Plant height ranged from 52.6 to 89.5 cm, number of branches

Table 130. Performance of fenugreek accessions under CVT (1998-99 to 2001-02) - Guntur

Entry	Yield (kg ha^{-1})				
	1998-1999	1999-2000	2000-2001	2001-2002	Pooled
RM – 1	850.00	650.0	875.0	437.00	703.00
HM – 305	811.00	600.0	854.0	385.00	663.00
HM – 346	700.00	517.0	750.0	344.00	578.00
HM – 350	833.00	633.0	865.0	406.00	684.00
JF – 195	1000.00	750.0	979.0	427.00	789.00
JF – 204	1300.00	883.0	1271.0	589.00	1011.00
JF – 210	1417.00	967.0	1354.0	625.00	1091.00
UM – 321	983.00	717.0	979.0	469.00	787.00
UM – 322	783.00	600.0	813.0	365.00	640.00
UM – 323	650.00	550.0	677.0	302.00	545.00
UM – 324	916.00	667.0	948.0	452.00	746.00
Lam Sel –1 (check)	1017.00	783.0	1031.0	458.00	823.00
CD (5%)	131.60	115.9	134.3	102.34	38.25

from 4.8 to 6.6, number of pods per plant 52.2 to 81.6, length of pods 8.0 to 9.4 and number of seeds per pod from 14.0 to 15.8.

Jobner

The entry UM - 305 recorded maximum seed yield of 9.97 q ha^{-1} followed by UM - 321 (9.38 q ha^{-1}), J. Fenu - 195 (9.13 q ha^{-1}), RMt - 303 (8.68 a ha^{-1}), while lowest yield of 5.38 q ha^{-1} was recorded in local check.

Performance of entries evaluated in CVT during 1998-99, 1999-2000 and 2000-2001 revealed superior performance of JF - 204 with an yield of 13.97 q ha^{-1} followed by JF - 195 (13.94 q ha^{-1}), RMt - 1 (13.79 q ha^{-1}), UM - 321 (13.42 q ha^{-1}) and HM - 350 (13.34 q ha^{-1}), while lowest mean yield of 10. q ha^{-1} was recorded in UM - 322. The trial will be repeated since the yield was poor in 2000-2001 (Table 131).

Kumarganj

Eleven cultivars including local check (Kumarganj selection) were evaluated. J. Fenu - 210 produced maximum yield (22.22 q ha^{-1}) (Table 132).

Dholi

The trial was conducted during 1999-2000, 2000-2001 and 2001-2002. The pooled analysis of the data is given in Table 133. Maximum number of pods (57.18) was recorded in genotype UM - 305, which was significantly superior to other prominent genotypes and check. In case of yield component, maximum yield was recorded in genotypes HM - 350 and UM - 305 (19.61 and 19.36 q ha^{-1}, respectively), which was statistically at par with UM - 321, UM - 322, HM - 346, J. Fenu - 204 and check (Rajendra Kanti).

Table 131. Performance of fenugreek entries - Jobner

Entry	Yield (q ha^{-1})			
	1998-1999	1999-2000	2000-2001	Mean
JF – 204	18.10	16.02	7.80	13.97
JF – 195	16.80	15.88	9.13	13.94
RMt – 1	18.75	15.68	6.94	13.79
UM – 321	15.63	15.24	9.38	13.42
HM – 350	16.08	16.20	7.81	13.34
HM – 346	16.28	15.50	7.47	13.08
JF – 210	15.36	15.52	8.05	12.98
UM – 305	14.98	13.42	9.97	12.79
Local check	14.32	15.43	5.38	11.71
UM – 322	10.68	12.55	7.71	10.31
CD (5%)	3.71	NS	1.91	
CV %	17.42	16.40	14.30	

Table 132. Performance of fenugreek germplasm under CVT - Kumarganj

Entry	No. of pods plant^{-1}	No. of grains pod^{-1}	Days taken to maturity	Yield (q ha^{-1})
HM – 350	125.18	16.53	147.33	17.71
J.Fenu – 204	111.87	16.53	147.33	14.93
J.Fenu – 244	118.20	18.20	146.00	19.44
RMT – 1	122.40	17.47	139.33	16.67
J.Fenu – 210	98.93	17.67	143.33	22.22
J.Fenu – 270	92.13	18.67	146.00	12.85
UM – 352	75.80	17.73	144.67	15.83
HM – 346	112.60	17.27	145.67	20.83
UM – 351	89.73	16.27	145.00	18.06
J.Fenu – 195	90.20	17.67	145.00	18.40
K.Selection (check)	99.13	17.40	149.67	13.19
CD (5%)	14.46	3.52	3.03	4.23
CV %	8.56	11.80	1.19	18.84

Table 133. Performance of fenugreek genotypes under CVT – Dholi

Genotype	Pooled mean	No. of days to maturity			Pooled mean	Yield (q ha^{-1})			Pooled mean
		1999-2000	2000-2001	2001-2002		1999-2000	2000-2001	2001-2002	
UM – 305	57.18	13.19	25.00	19.90	19.36	121.33	124.00	126.00	123.78
UM – 321	44.58	14.49	20.84	15.97	17.10	120.00	128.00	130.00	126.00
UM – 322	43.87	14.93	20.83	15.04	16.93	124.67	129.00	130.00	127.89
HM – 346	41.40	15.33	20.83	14.44	16.87	129.00	125.00	124.00	126.00
HM – 350	46.89	16.01	25.46	17.36	19.61	131.33	135.00	138.00	134.78
J. Fenu – 195	34.65	12.70	12.50	9.95	11.72	125.00	124.00	124.00	124.33
J. Fenu – 204	40.73	14.76	20.37	13.43	16.19	128.00	132.00	135.00	131.67
J. Fenu – 210	37.80	13.61	12.82	12.96	13.13	127.33	135.00	139.00	133.78
R. Kanti (check)	44.44	17.63	21.76	17.08	18.82	125.00	126.00	125.00	125.33
CD (5%)	7.84	1.35	7.88	1.59	3.84	21.83	7.43	4.77	NS
CV %	11.04	5.01	19.26	6.02	13.36	10.03	2.83	2.12	4.67

Jagudan

A new CVT was initiated during 2001-2002. The yield differences were found significant among the entries. J. Fenu - 270 gave significantly higher yield (18.08 q ha^{-1}) than control. It was 18.00% higher over control.

FGK/CI/4 Varietal Evaluation Trial

FGK/CI/4.1 Comparative yield trial

(*Dholi*)

Dholi

The experiment was conducted for three years during 1999-2000, 2000-2001 and 2001-2002 in a randomized block design. The pooled analysis of the data (Table 134) showed that maximum grain yield was in the genotypes HM - 291 and RM – 5/90 (18.63 and 18.62 q ha^{-1}, respectively) as compared to other entries in which HM - 291 is a late maturing type (131.33 days) while RM - 5/90 is early maturing type (125.33 days).

FGK/CI/4.2 Initial evaluation trial

(*Jobner, Jagudan* and *Hisar)*

Hisar

Two initial evaluation trials, one on green seed coat mutant lines and another on yellow seed coat of fenugreek were conducted with nine accessions along with Hisar Sonali as check during 1999-2000 and 2000-2001. The results indicated that HM - 444 (23.9 q ha^{-1}) a green seed coat mutant and HM - 372 and HM - 376 (33.85 and 32.65 q ha^{1}, respectively), yellow seed coat mutants gave highest seed yield during both the years (Tables 135 and 136). These three lines (HM - 372,

Table 134. Performance of fenugreek entries under CYT (Pooled data) - Dholi

Genotype	No. of days to maturity			Pooled mean	Yield (q ha^{-1})			Pooled mean
	1999-2000	2000-2001	2001-2002		1999-2000	2000-2001	2001-2002	
HM - 110	125.00	132.00	134.00	130.33	15.55	19.91	15.76	17.07
HM - 114	105.33	130.00	133.00	122.78	15.00	17.13	15.04	15.72
HM - 291	135.00	129.00	130.00	131.33	16.11	22.22	17.57	18.63
HM - 305	130.67	128.00	129.00	129.22	15.27	17.59	14.59	15.82
J. Fenu - 58	125.00	127.00	129.00	127.00	13.61	12.67	9.91	11.90
J. Fenu - 102	127.67	125.00	124.00	125.56	14.16	16.20	11.35	13.90
UM - 301	125.00	135.00	138.00	132.67	13.05	12.50	10.36	11.97
UM - 302	126.67	133.00	135.00	131.56	15.46	18.98	15.32	16.59
UM - 303	119.00	130.00	130.00	126.33	15.97	20.37	16.22	17.42
UM - 304	125.00	133.00	135.00	131.00	15.00	15.74	14.87	15.20
RM - 1/90	115.33	125.00	127.00	122.44	13.19	18.52	13.96	15.22
RM - 5/90	125.00	125.00	126.00	125.33	15.27	18.98	21.62	18.62
R. Kanti (check)	124.67	128.00	128.00	126.89	17.77	21.76	16.22	18.38
CD (5%)	15.69	4.90	3.33	3.96	2.05	5.67	4.06	2.78
CV %	7.55	2.13	1.51	190.00	5.80	17.85	16.21	10.29

Table 135. Initial evaluation trial (IET) of green tan and green seed lines of fenugreek - Hisar

Accession	Seed yield (q ha^{-1})			Disease %	
	1999-2000	2000-2001	Mean	DM	PM
HM - 338	22.0	22.3	22.15	0.0	60.0
HM - 342	23.0	22.5	22.75	0.0	47.0
HM - 345	21.2	23.0	22.10	0.0	50.5
HM - 354	22.0	20.5	21.25	0.0	45.0
HM - 361	22.3	22.7	22.50	0.0	50.5
HM - 365	21.5	21.8	21.65	0.0	65.0
HM - 369	22.0	23.0	22.50	0.0	60.0
HM - 444	23.5	24.3	23.90	4.5	05.0
HM - 346 (check)	23.2	23.8	23.50	0.0	60.5
Hisar Sonali	21.7	23.2	21.95	30.0	45.0
CD (5%)	1.7	2.0	—	—	—

DM – Downy mildew, PM – Powdery mildew

Table 136. Initial evaluation trial (IET) in fenugreek- Hisar

Accession	Seed yield (q ha^{-1})		
	1999-00	2000-01	Mean
HM - 202	30.20	29.00	29.60
HM - 205	30.50	29.00	29.75
HM - 213	28.85	30.00	29.43
HM - 232	30.90	32.00	31.45
HM - 360	31.40	30.00	30.70
HM - 371	27.60	28.00	27.80
HM - 372	32.70	35.00	33.85
HM - 373	30.40	32.00	31.20
HM - 376	32.80	32.50	32.65
Hisar Sonali (check)	22.50	21.00	21.75
CD (5%)	2.10	2.23	—

HM - 376 and HM – 444) have been included in the coordinated varietal trial for further evaluation.

HM – 444, a pure green seed line is resistant to both downy and powdery mildew diseases.

Jobner

The IET of fenugreek was started in rabi 2000. Thirty six entries including five checks namely, RMt - 1, RMt - 143, RMt - 303, UM - 305 and local were evaluated in RBD. The entry RTP - 9 recorded maximum seed yield of 14.42 q ha^{-1} followed by AL - 18 (12.18 q ha^{-1}), AL - 1 (11.69 q ha^{-1}), RTP - 8 (11.0 q ha^{-1}), RMt - 303 (check, 10.5 q ha^{-1}) and RTP - 4 (10.1 q ha^{-1}), while lowest yield of 3.78 q ha^{-1} was recorded in NS - 6.

Jagudan

A new IET was initiated during 2001-02. The yield differences were found significant among the entries. J. Fenu - 211 gave significantly higher yield (13.05 q ha^{-1}) than control. It was 25.8 % higher over control. The pooled data over three years showed non-significant yield differences. But the entries J. Fenu - 204 and J.Fenu - 2311 gave 6.7% and 5.7% higher yield, respectively over GM - 1 (control).

FGK/CI/5 Quality Evaluation Trial

FGK/CI/5.1 Quality evaluation in fenugreek

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

None of the centres analysed the quality parameters.

FGK/CM/2 Nutrient Management Trial

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

(Jobner, Guntur, Coimbatore, Kumarganj, Jagudan)

Jobner

Significantly more number of pods plant^{-1}, higher yield of straw and seed over control were recorded with the application of 100, 75 and 50% of recommended dose of N + *Rhizobium* + FYM 5 t ha^{-1}, 5 and FYM 10 t ha^{-1} each and inoculated with *Rhizobium*, FYM 10 t and 100% inorganic N alone. The maximum seed yield (8.70 q ha^{-1}) recorded under 50%

Table 137. Effect of biofertilizers, *Azospirillum* on growth and yield attributes of fenugreek – Jobner

Treatment	Plant height	Biological yield (q ha^{-1})	Straw yield (q ha^{-1})	Seed yield (q ha^{-1})
Inorganic N (100%) + Rhizobium + FYM 5 t ha^{-1}	34.7	49.39	41.36	8.01
Inorganic N (75%) + Rhizobium + FYM 5 t ha^{-1}	37.3	53.01	45.13	7.96
Inorganic N (50%) + Rhizobium + FYM 5 t ha^{-1}	36.5	52.47	43.76	8.70
Rhizobium + 5 t FYM ha^{-1}	36.3	43.84	36.98	6.85
FYM 5 t ha^{-1} alone	38.1	39.50	33.10	6.33
Rhizobium + FYM 10 t ha^{-1}	37.8	48.76	40.43	8.33
FYM 10 t ha^{-1}	38.7	43.21	36.43	6.79
Inorganic N (100%) alone	39.5	45.69	37.65	8.01
Rhizobium 1.5 kg ha^{-1} alone	37.3	39.50	32.97	6.48
Control	34.9	33.34	27.72	5.55
SEm ±	1.5	2.74	2.87	0.34
CD (5%)	NS	8.13	8.52	1.02
CV %	7.1	10.57	13.02	8.04

inorganic N + *Rhizobium* + FYM 5 t ha^{-1}, which was at par with 100% N + *Rhizobium* + FYM 5 t ha^{-1} (8.01 q ha^{-1}), 75% N + *Rhizobium* FYM 5 t ha^{-1} (7.96 q ha^{-1}), *Rhizobium* + FYM 10 t ha^{-1} (8.33 q ha^{-1}) and 100% inorganic N alone (8.01 q ha^{-1}) and significantly higher over rest of the treatments (Table 137).

Guntur

During 2001-2002 rabi season, *Rhizobium* with different levels of inorganic N and FYM were tried in RBD. Among the treatments tried, T1 (N 100% + Rhizobium + FYM 5 t ha^{-1}) recorded significantly higher yield (718 kg ha^{-1}) closely followed by T2 (N 75% + Rhizobium + FYM 5 t ha^{-1}) with 697 kg ha^{-1} and T3 (N 50% + Rhizobium + FYM 5 t ha^{-1}) with 686 kg ha^{-1}. The T10 (control) recorded a yield of 395 kg ha^{-1} (Table 138).

Coimbatore

The yield of seeds (g plot^{-1}) was highest in T2 (93.30) followed by T5 & T9, which are on par. Similarly the yield hectare^{-1} was the highest in T6 (Table 139).

Kumarganj

Maximum yield of 16.32 q ha^{-1} was obtained with FYM 10t ha^{-1} + *Azospirillum* (50g) followed by 14.58 q ha^{-1} with FYM 5 t ha^{-1} + *Azospirillum* (50 g).

Jagudan

Report not received.

Table 138. Efficacy of *Rhizobium* on fenugreek - Guntur

Treatment	Yield (kg ha^{-1})
T1- N 100% + *Rhizobium* + FYM 5 t ha^{-1}	718.0
T2- N 75% + *Rhizobium* + FYM 5 t ha^{-1}	697.0
T3- N 50% + *Rhizobium* + FYM 5 t ha^{-1}	686.0
T4- FYM 5 t ha^{-1} + *Rhizobium*	482.0
T5- FYM 5t ha^{-1} alone	437.0
T6- FYM 10 t ha^{-1} + *Rhizobium*	489.0
T7- FYM 10 t ha^{-1} alone	447.0
T8- Inorganic N 100%	478.0
T9- *Rhizobium* alone	416.0
T10-Control	395.0
CD (5%)	103.7

Table 139. Effect of biofertilizer, *Azospirillum* on the yield of fenugreek – Coimbatore

Treatment		Yield (kg ha^{-1})
T1	Inorganic N (100%)	266.6
T2	Inorganic N (100%) + *Azospirillum* (50 g) + FYM 5 kg	313.1
T3	Inorganic N (75%) + *Azospirillum* (50 g) + FYM 5 kg	273.0
T4	Inorganic N (50%) + *Azospirillum* (50 g) + FYM 5 kg	296.2
T5	FYM 5 kg + *Azospirillum* (50 g)	325.9
T6	FYM 5 kg alone.	340.7
T7	FYM 10 kg + *Azospirillum* (50 g)	318.5
T8	FYM 10 kg alone.	303.6
T9	*Azospirillum* (50 g) alone	333.3
T10	Control	259.2
CD (5%)		128.2

FGK/CP/1 Disease Management Trial

FGK/CP/1.1 Biocontrol of root rot in fenugreek

(Coimbatore)

Coimbatore

To evolve an effective biocontrol measure for root rot of fenugreek an experiment comprising eight treatment combinations was laid out during rabi 2001–2002. Among the treatments, *Trichoderma* either as seed treatment or as soil application along with neem cake was found to be highly effective in reducing the disease incidence and increasing the yield significantly. Highest root rot incidence and lowest yield were recorded in control (Table 140).

Table 140. Biocontrol of root rot in fenugreek - Coimbatore

Treatment	Root rot incidence (%)	Yield (kg ha^{-1})
S.T with carbendazim (2 g kg^{-1} seed) + soil drenching (0.1%)	9.33	410.03
S.T with *Trichoderma viride* (4 g kg^{-1} seed)	8.67	420.04
S.A. of *Trichoderma viride* (20 DBS).	6.00	380.30
S.A. of neem cake (150 kg ha^{-1})	13.33	360.30
S.T with *Trichoderma viride* + S.A. of neem cake.	4.67	460.10
S.A of *Trichoderma viride* + S.A. of neem cake	5.33	465.24
S.T with carbendazim, soil drenching + S.A. of neem cake	6.67	440.40
Control	31.33	310.13
CD (5%)	3.72	15.23

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

GENETIC RESOURCES OF SPICES AT AICRPS CENTRES

(As on 31- 3-2002)

Crop/Centre	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Black pepper				
Panniyur	138	—	—	138
Sirsi	80	20	—	100
Chintapalli	47	29	—	76
Yercaud	106	—	—	106
Pundibari	18	—	—	18
Dapoli	16	—	—	16
Dholi	7	—	—	7
Total				**461**
Cardamom				
Pampadumpara	86	—	—	86
Mudigere	245	—	—	245
Total				**331**
Ginger				
Pottangi	167	2	3	172
Solan	221	—	—	221
Dholi	61	—	—	61
Kumarganj	22	—	—	22
Pundibari	33	—	—	33
Raigarh	35	—	—	35
Dapoli	3	—	—	3
Total				**547**
Turmeric				
Dapoli	8	—	—	8
Pottangi	169	22	—	191
Jagtial	189	—	—	189
Dholi	60	—	—	60
Bhavanisagar				
Raigarh	70	—	—	70
Kumarganj	96	—	—	96
Pundibari	82	—	—	82

Solan	171	—	—	171
Coimbatore	224	—	6	230
Guntur	124	—	—	124
Total				**1221**
Clove				
Yercaud	13	—	—	13
Thadiyankudisai	1	—	—	1
Pechiparai	19	—	—	19
Dapoli	3	—	—	3
Total				**36**
Nutmeg				
Yercaud	15	—	—	15
Thadiyankudisai	1	—	—	1
Pechiparai	12	—	—	12
Dapoli	30	—	—	30
Total				**58**
Cinnamon				
Yercaud	11	—	—	11
Thadiyankudisai	6	—	—	6
Pechiparai	9	—	—	9
Dapoli	17	—	—	17
Total				**43**
Coriander				
Jobner	780	—	—	780
Jagudan	70	—	22	92
Coimbatore	224	—	—	224
Guntur	230	—	—	230
Hisar	76	—	—	76
Dholi	77	—	—	77
Raigarh	20	—	—	20
Kumarganj	50	—	—	50
Total				**1549**
Cumin				
Jobner	340	—	—	340
Jagudan	140	—	9	149
Kumarganj	19	—	—	19
Total				**508**

Fennel				
Jobner	189	——	——	189
Jagudan	261	——	20	281
Hisar	65	——	——	65
Dholi	36	——	——	36
Kumarganj	18	——	——	18
Total				**589**
Fenugreek				
Jobner	352	——	——	352
Jagudan	42	——	——	42
Coimbatore	262	——	——	262
Guntur	124	——	——	124
Hisar	65	——	——	65
Dholi	89	——	——	89
Raigarh	13	——	——	13
Kumarganj	38	——	——	38
Total				**985**
Total (Overall)				**6328**

Spice crops	**No.of accessions**
Black pepper	461
Cardamom	331
Ginger	547
Turmeric	1221
Clove	36
Nutmeg	58
Cinnamon	43
Tree spices	137
Coriander	1549
Cumin	508
Fennel	589
Fenugreek	985
Seed spices	3631

ICAR – ADHOC PROJECTS

1. Identification and evaluation of bioactive peptides: a biotechnological approach towards controlling the fungal pathogen of the quick wilt disease of black pepper

George Thomas
Plant Molecular Biology Group, Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram – 695 014.

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.

Progress of work

Optimum concentrations of mycelial fragments, and their growth conditions were standardized in microtitre plates, for assaying the fungus with peptides. Inoculum concentration, ranging from $5x10^3$ to $5x10^4$, showed balanced growth conditions and less optical variability. The protocols for the production of peptides were standardized and two hexamer peptides with known antifungal properties were synthesized.

2. Hybridization in ginger (*Zingiber officinale* Rosc.) through *in vitro* pollination

P.A. Valsala, E.V. Nybe, P.A. Nazeem and Lissamma Joseph
Department of Plantation Crops & Spices College of Horticulture, Kerala Agricultural University, Thrissur.

Objectives

1. Embryo rescue and germination studies of *in vitro* produced seeds of ginger.
2. Production of hybrid population through appropriate crosses by *in vitro* pollination.
3. Establishment of hybrid population by *in vitro* cloning.
4. Field establishment and evaluation of hybrid population.

Progress of work

During first year emphasis was given to identify conditions required for the germination of ginger seeds. Mature seeds (40 to 80 days after pollination) were used for embryo rescue and germination studies. Rescuing embryo along with endosperm and incubating in various media under different constituents did not induce germination. Various primary treatments like water soaking, incubating on moist filter paper, moist sand or basal medium did not favour germination. Incubating the seeds in various combinations of hormones like auxins, cytominins GA_3 and ethylene also did not favour germination.

The influence of sucrose concentration (3-12%) on encosperm filling was examined. In ½ MS and full MS media sucrose concentration 3-12% along with cytokinin and auxin did not result in complete endosperm filling in the central cavity of the seeds. Germination studies with seeds of 20 days after planting was repeated during second year and no seed germination was obtained.

Hence, during third year, one seed germinated 50 days after pollination in the medium of ½ MS + 6% sucrose+ NAA 0.5 mgl^{-1} +15% CW when incubated in dark. The ob-

tained seedling is multiplied. Seeds showed radicle emergence in two more media i.e. ½ MS + 6% sucrose + BAP mgl^{-1} + NAA 0.2 mgl^{-1} + GA_3 2.0 mgl^{-1} + CW 15% and ½ MS + 6% sucrose + 2, 4-D 0.2 mgl^{-1} + BAP 5.0 mgl^{-1} +CW 15%.

3. Enhancement of yield and quality of spices by secondary and micronutrients in soils

C. Chatterjee
Botany Department, Lucknow University, Lucknow

Objectives

To find out the critical requirement of sulphur in certain spices, coriander, fennel and black cumin were grown in alluvial soils of district Lucknow, Uttar Pradesh as test crops.

Progress of work

Coriander, fennel and black cumin when grown in Alluvial soils from Lucknow district showed better growth, development and higher economic yield with an addition of boron at 0.5,1 and 2 kg B/ha. Most of the parameters were increased considerably when B was applied at 1 kg/ha followed by 0.5 kg B/ha. In certain cases 2 kg B/ha was found to be toxic, because reduction was observed not only in biomass and economic yield but also in metabolic parameters. These responses were pronounced in all three crops. Hence, it could be inferred that soil application of B @ 1kg/ha can be recommended to supplement the fields specially when spices are grown.

4. Characterization of nutmeg germplasm for quality

B. Krishnamoorthy, T. John Zachariah and K.M. Maya
Indian Institute of Spices Research, Calicut.

Objectives

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

Progress of work

The essential oil content in nutmeg ranged from 3.9 to 16.5 % (v/w) and that in mace, it ranged from 6 to 22.33 %. The major components of significance in both the essential oils are á- pinene, sabinene, myrcene, safrole, myristicin and elemicin. Sabinene and myrcene have a sweet and pleasant odour that enhances the sweetness of the product to which it is added. Myristicin and elemicin, on the other hand are the hallucinogenic principles of nutmeg. Accessions with high sabinene and myrcene coupled with low myristicin and elemicin are highly desirable for confectionery and perfume industry. Myristicin has now been identified as an active principle in cancer prevention.

Accessions, which are rich in myristicin have application in pharmaceutical industry. A9/18, A9/4 and its progenies, have high myristicin content in both nutmeg & mace. A9/79 and A9/18 accessions have high myristicin, coupled with low elemicin in both nutmeg and mace.

Among the thirty-six nutmeg samples evaluated, the essential oil content in nutmeg ranged from 3.9 to 16.5% (v/w). The highest nutmeg oil was found in A9/18. Other accessions with high nutmeg oil are A4/5 and A11/12. In mace, the oil content ranged from 6 to 22.33% and the highest was in A9/18. It was observed that accessions A9/18 & A4/5 are relatively rich in both nutmeg and mace oils.

Myristicin content ranged from 0.6 to 16.4% in nutmeg and from 0.8 to 24%in mace.

Similarly, the elemicin content in nutmeg ranged from 0.52 to 17.3% and in mace, from 0.4 to 21%. It is interesting to observe that A9/18, which has the highest oil content among the accessions, also possesses high myristicin in nutmeg and mace oils (15.1% & 24.0% respectively).

Sabinene and myrcene are the two components that contribute to the sweetness and hence accessions with high sabinene and myrcene are suitable for preparing confectionery. Among the accessions evaluated, six accessions in the A9 series possess high sabinene and myrcene in the nutmeg oil, with the highest content (51%) in A9/20. A4/22 is an accession, which possesses a very low myristicin and elemicin in nutmeg oil (0.63% & 0.97% respectively) with 38.2% of sabinene and myrcene. Five mace samples with high sabinene and myrcene levels were also identified and it was highest in A9/71 (41.9%).

Very good potential is available in the nutmeg germplasm with regard to oil content, myristicin, elemicin, sabinene and myrcene levels. Considering the vast application, these accessions can be exploited for confectionery, nutraceutical and pharmaceutical industries

Lycopene is the pigment responsible for the attractive red colour of mace. The pigment is unstable when mace is stored in the powdered form. This degradation was followed for one month and it was observed that 75% of the original colour was lost when the sample was stored for 27 days. However, the types of container had no effect on the rate of degradation.

However, the percentage of volatile oil content of powdered mace was reduced in only 15% during one month of shortage.

5. Organization of ginger and turmeric germplasm based on molecular characterization

B. Sasikumar
Indian Institute of Spices Research, Calicut.

Objectives

1. Characterization of ginger and turmeric germplasm using molecular markers.
2. Build up a core collection of ginger and 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

The various protocols of DNA extraction from ginger and turmeric were tried. Among different methods tested the one developed by Saghai - Maroof *et al.* (1984) with slight modification was found most suitable.

The amplification condition found suitable for ginger and turmeric leaf DNA is

Denaturation - At 94°C for 5 minutes 1 cycle
Denaturation - At 94°C for 1 minute 40 cycles
Annealing – At 35°C for 1 minute 40 cycles
Extension - At 72°C for 2 minutes 40 cycles
Final extension - At 72°C for 10 minutes 1 cycle.

The concentration of template DNA, primer, magnesium concentration, PH of the buffer, amplification conditions etc. affects the PCR performance. Varying concentrations of these components in the PCR mixture were experimented. Final concentration of 0.15-0.25 mM dNTPs along with 2.5mM MgCl2, 0.5 U of Taq DNA polymerase, 10 ng genomic DNA and O.2mM primer in 25ml reaction volume were found suitable for good amplification.

RAPD profiling was done for *Zingiber zernum ,Zingiber casumunnar,Zingiber nimmoni, Zingiber zerumbet* and turmeric accessions/varieties, ACC.75, Prathibha, ACC 44, ACC116, ACC 105, ACC.101,ACC 69,ACC 34 ,ACC 63, ACC 202, Sudarsana, Prabha, Suvarna , ACC 194

6. Intensification of research on vanilla (*Vanilla planifolia* andrews)

N. Kumar

Horticultural Research Station, Thadiyankudisai, Perumbarai – 624 212.

Objectives :

1. Identification of ideal genotypes for Pulney hills.
2. Formulation of integrated production technologies for higher yield and quality of vanilla including processing.
3. Mass multiplication of selected genotypes
4. Study the effect of growth regulators on pod set, pod growth and maturity.

Progress of work (Final report)

The entire vanilla growing zones in South India were surveyed and a total of 11 genotypes were collected. These were raised at Horticultural Research Station, Thadiyankudisai.

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 during 2001-2002. Pod yield and pod characters are being recorded.

Observations on vegetative growth revealed that the length of vine, internodal length and number of leaves were maximum in the treatment 100 g of NPK/vine/year along with 25 g each of VAM, *Azospirillum* and Phosphobacterium/vine/year. The crop has come to flowering during 2001-2002.

Among the various types of cutting tried, one metre long cuttings registered the highest rooting (100%) followed by four, three, two and single nodal cuttings. The one metre length cutting also resulted in more plant growth and root length compared to other 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.

Observations on vegetable growth revealed that the length of vine, internodal length and number of leaves were maximum in the treatment 100g of NPK/Vine/year along with 25g each of VAM, *Azospirillum* and Phosphobacterium/vine/year recorded maximum number of laterals.

7. Studies on the compatibility of *Azospirillum* and biocontrol agents in turmeric

R. Sridar

Centre of Advanced Studies in Agricultural Microbiology, Dept. of Agricultural Microbiology, TNAU, Coimbatore – 641 003.

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 inocula-

tion 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.

Progress of work

Thirty strains of *Azospirillum* for turmeric growing areas in Tamil Nadu were isolated, characterized and maintained as a slant cultures for further studies.

Pythium, the causal organism of rhizome rot of turmeric was isolated from the infected turmeric rhizome samples collected from Gobichettipalayam. Two *Pythium* strains were isolated, characterized and stored as slant cultures. An antagonistic soil borne bacterium *Bacillus subtilis* was isolated from turmeric grown soil at Coimbatore and the same was purified and stored as slant cultures.

Antagonistic effect of *Bacillus subtilis*, *Pseudomonas fluorescens* and *Trichoderma viride* against *Pythium* were tested. The results revealed that among the three biocontrol agents, *Bacillus subtilis* was highly inhibitory to the pathogen.

A cross streak assay was conducted to study the compatibility of *Azospirillum* and biocontrol agents. The results revealed that the *Azospirillum* isolates OS_3 and ER_2 were highly compatible with bio control agent.

The potential nitrogen fixer *Azospirillum* and the biocontrol agents were mixed together and the new pellet formulation was prepared.

Inoculation of *Azospirillum* either alone or in combination with biocontrol agents like *Pseudomonas fluorescens*, *Trichoderma viride* and *Bacillus subtilis* enhanced the plant height significantly compared to uninoculated control. The highest plant height were recorded in *Azospirillum* with *Bacillus subtilis* combination.

However, there was no significant difference among the treatment with regard to leaf number.

The combined inoculation of *Azospirillum* with *Bacillus subtilis* recorded the higher population (3.49 CFU / g on dry wt basis) at active vegetative stage.

The highest population 25.41 CFU / g on dry weight basis of *Pseudomononas florescences* on dry weight basis was recorded in dual inoculation of *Azospirillum* and *Pseudomonas fluorescens.*

At the active vegetative stage, *Azospirillum* and *Trichoderma viride* combination was recorded the highest population of *Trichoderma viride* (15.66 CFU / g on dry weight basis).

Azospirillum plus *Bacillus subtilis* combination recorded higher population of *Bacillus subtilis* (39.82 CFU / g on dry wt basis) when compared to the other treatments.

The highest yield of rhizome was recorded in plants inoculated with *Azospirillum* and *Bacillus subtilis.*

In the field experiment, maximum plant height was recorded with the application of *Azospirillum* along with *Bacillus subtilis.* However statistically no significant difference was observed at 45 and 90 DAS.

In general the leaf length and leaf breadth of the inoculated plants were significantly higher than the uninoculated control at all stages.

The effect of combined inoculation on the population dynamics of *Azospirillum,*

Pseudomonas fluorescens, Trichoderma viride, Bacillus subtilis was studied under field condition. There was a statistically significant reduction in population of *Azospirillum* and biocontrol agents over a period of time. A significant increase in the population of *Azospirillum* and biocontrol agents was observed when circulated individually when circulated compared to combined inoculation over a period of time. In all the treatments there was a decrease in the population of these microorganism at 180 days after sowing these crop.

A cumulative effect of *Azospirillum* and *Bacillus subtilis* in disease reduction was observed. *Azospirillum* alone recorded 30.25 percent disease while in combination with *Bacillus subtilis*, it was reduced to 19.42 percent.

8. Micropropagation and development of seedless malabar tarmarind through *in vitro* techniques

P.C. Rajendran and A. Augustin
Centre for Plant Biotechnology and molecular Biology, College of Horticulture, Kerala Agricultural University
Vellanikkara, Thrissur-680 656

Objectives

1. To standardised the culture conditions for large scale multiplication through *in vitro* techniques.
2. Standardisation of protocol for developing triploid plantlets through *in vitro* endosperm culture.
3. To develop haploids through anther culture from male trees of *Garcinia gummigutta.*
4. To compare the Hydroxy Citric Acid (HCA) content in callus cultures and fleshy fruit rind (fresh and dry) of Malabar tarmarind fruit through Gas chromatography.
5. Isozyme studies, protein patterns and ribosomal DNA banding patterns in haploid, diploid and triploid plantlets.
6. Induction of somatic embryogenesis from triploid calli cultures and development of synthetic seeds.
7. To isolate and purify the protoplasts from haploids and diploid females.
8. To fuse the protoplasts of haploid and diploid females for the development of triploid plantlets.

Progress of work

Standardisation of micro-propagation in this dioecious allogamous tree spices (*Garcinia gummigutta* var. *gummigutta*) is the primary mandate of the project. The yielding female trees were identified from the campus of the College of Horticulture, Vellanikkara for excising the explants such as shoot tips, nodal segments, internodal segments, leaf bits etc. Since there is only limited number of female trees for excising explants, grafted plants also planted in the field. In general, the explants collected from field grown plants caused more contamination in inoculated cultures. Hence the grafted plants are also maintained under glass house for excising explants from vegetative part.

Surface sterlization, pre-treatment establishment media and the regeneration from shoot tip and nodal segments were standardised. Pre-treatment of explants by 0.1% Bavistin for 20-30 minutes and wiping with alcohol resulted in maximum percentage survival. Surface sterilization with 0.1% Mercuric chloride for 3-4 minutes had shown

maximum survival rate.

Direct and indirect organogenesis for micropropagation has been attempted for getting positive response. Direct organogenesis for micropropagation using shoot tips and nodal segments was tried. Regeneration from shoot tip cultures was best in ½ MS medium fortified with 5.0 mg/l IBA + 0.5 - 1.0 mg/l BA. Nodal segments put-forth multiple shoots in MS medium supplemented with 0.5 mg/l NAA.

Initiation of callus from anthers for inducing haploids through indirect organogenesis was also attempted. No response of callusing from leaf segments and anthers was exhibited during the period of this report.

Remarkable response of indirect organogenesis was observed from endosperm. The profuse callusing and subsequent, initiation of regenerants are noticed in some of the callus cultures. Indirect regeneration of plantlets from triploid endosperm callus may be the easiest way of producing triploid plantlets and seedless fruits of Malabar tarmarind (*Garcinia gummigutta* var. *gummigutta*).

9. Clonal propagation of tamarind (*Tamarindus indica* L.) through *in vitro* culture

G. Balakrishnamurthy and M. Ganga Sivakumar

Department of Pomology, Horticultural College of Research Institute,
TNAU, Coimbatore

Objectives

1. Standardization of pre-culture techniques for establishment of aseptic responsible explants under *in vitro* conditions.
2. To develop a protocol for mass multiplication of plantlets under ***in vitro*** conditions and to develop a hardening technology.
3. Evaluation of *in vitro* derived plants in comparison with grafts under field conditions.

Progress of work (Final report)

Plants of the genotypes Unigam and Asanoor H-1 maintained at the Institute of Forest Genetic and Tree Breeding, Coimbatore served as the source of explants for the present investigations. These mother plants were subjected to regular pruning.

The contamination was reduced with increase in the time of exposure of the explants to the surface sterilants. Exposure of the explants to 70% ethyl alcohol for 45 seconds followed by exposure to 0.1% mercuric chloride for five minutes resulted in the highest survival percentage (33.46).

The highest percentage of contaminant free culture (46.37) of axillary bud explants of the genotype Asanoor H-1 was achieved by exposing the explants to 70% ethyl alcohol for 60 seconds followed by exposure to 0.1% mercuric chloride for three minutes.

The studies on the influence of pre-soaking treatment with citric acid and ascorbic acid on browning of axillary buds in the primary culture showed that the maximum survival percentage (95.02) was obtained with 200 mgl^{-1} citric acid + 200 mgl^{-1} ascorbic acid. Control recorded the minimum survival percentage. The bud break percentage was maximum (94.67) with 100 mgl^{-1} citric acid + 100 mgl^{-1} ascorbic acid.

The response of axillary buds to multiple shoot production was observed. Few number of axillary buds produced multiple shoots in the primary culture while majority of them produced only single shoots. Among the different treatments tried, the highest per

cent bud break (82.50), the earliest bud break (9.33 days), highest per cent response to multiple shoot induction (22.50), the maximum number of shoots per culture (6.40) and the longest shoot (6.72) were recorded in the explants cultured in MS medium supplemented with 5.0 mgl^{-1} BA and 0.5 mgl^{-1} GA.

Among the five concentrations of BA and with GA at 0.5 mgl^{-1}, the growth regulator combination 3.0 mgl^{-1} and 0.5 mgl^{-1}GA induced the highest per cent response to multiple shoot induction (53.33), the maximum number of shoots per culture (7.50) and the longest shoots (6.69 cm) in the secondary culture.

The concentration of BA and the response to multiple shoot induction were found to be positively correlated upto a certain level. The percent response to multiple shoot induction reached the peak at 3.0 mgl^{-1} BA, after which further increase in the concentration of BA caused a decline in the percent response.

The lowest response to multiple shoot induction (6.66%), the minimum number of shoots per culture (2.00) and the shortest shoots (1.50 cm) were recorded in the culture transferred to MS medium supplemented with GA alone.

The axillary buds collected and cultured during the month of May gave the best results with respect to the bud break, number of days taken for bud break, response to multiple shoot induction, number of shoots per culture and length of shoots. This was followed by the axillary buds collected and cultured during the month of November.

The influence of various strengths of MS medium and various concentration of GA on elongation of the microshoots was studied.

The micro-shoots transferred to half strength MS medium recorded the maximum response (76.00%) to elongation and the maximum shoot length (10.86 cm). Those transferred to full strength MS medium recorded the least response to elongation and the minimum shoot length.

Microshoots transferred to medium fortified with 1.0 mgl^{-1} GA recorded the maximum response (88.00%) to elongation and the maximum shoot length (11.25 cm). Those cultured on medium with 0.25 mgl^{-1}GA recorded the minimum response to elongation.

The microshoots produced by axillary bud explants were transferred to rooting medium to induce roots. Experiments were carried out to standardize the medium strength, sucrose concentration and growth regulator combination for *in vitro* rooting of the microshoots.

The maximum response (53.33%) to rooting in the shortest duration of 21.60 days was recorded by the microshoots transferred to half strength MS medium. These microshoots produced the maximum number of roots per culture (7.70) and the longest root of length 3.31 cm.

Micoshoots transferred to¼ to ¾ strength and full strength was found to have a negative correlation with response to rooting, number of roots produced per culture and length of the roots.

The microshoots transferred to the medium with three per cent sucrose recorded the maximum response (46.67%) to rooting in the shortest duration of 20.70 days. Further, these cultures also produced the maximum number of roots per culture (7.10) and the longest root (3.01cm).

Microshoots transferred to media with 6% and 7% sucrose did not respond to rhizogenesis. These microshoots developed callus at the base followed by withering of leaves and wilting.

The maximum response to rooting (50.00%) in the shortest period of 21.67 days and the maximum number and length of roots (6.67 and 4.43cm respectively) were recorded by microshoots transferred to medium supplemented with 0.5 mgl^{-1} IAA and 0.5 mgl^{-1} IBA.

Charcoal when added to the rooting medium at a concentration of 2.5 mgl^{-1} induced 13.3% rooting. The number of roots produced was 6.33 and the longest root measured 2.65 cm. The other concentrations of charcoal did not record any response.

Response to root growth and development (37.50%) was recorded only in the cultures transferred to half strength hormone free MS medium. The number of roots produced per culture after transfer to hormone free medium was 4.23 and the increase in root length was 4.36 cm. The fully developed plantlet had an average of 11.93 roots per plantlet and the longest root measured 7.67 cm.

The *in vitro* derived rooted plantlets were transferred to *in vitro* conditions for hardening. Plantlets with well developed roots were removed from the culture tubes and washed free of agar. These plantlets were placed inside the culture room for two days with their roots immersed in distilled water after which they were transplanted in micropots filled with sterilized potting media and transferred to the mist chamber.

The survival percentage *in vitro* was nil one week after transfer of the plantlets.

Stem segments of about 1cm length collected from *in vitro* germinated seedlings and cultured in MS medium supplemented with BA at 0.5, 1.0, 1.5, 2.0 and 2.5 mg^{-1} BA and 0.5 mg^{-1} GA recorded maximum response (80.00%) to shoot bud differentiation. The longest shoot (6.14 cm) was produced by stem bits cultured in medium supplemented with 2.0 mg^{-1} BA + 0.5 mg^{-1} GA.

The stem bits cultured in medium supplemented with 0.5 mg^{-1} BA + 0.5 mg^{-1} GA and 1.0 mg^{-1} BA + 0.5 mg^{-1} GA did not respond to shoot differentiation. These cultures turned brown and died in about 2-3 weeks after culture.

For *in vitro* germination the sterilized seeds were cultured in liquid MS medium supported by filter paper bridges. The medium was fortified with the growth regulators BA and GA. The response to germination and the time taken for germination were recorded.

The highest percentage of survival (95) was achieved by exposing the non-scarified seeds to 70% ethanol for 60 seconds followed by exposure to 0.1% mercuric chloride for 20 minutes. Moreover, this treatment resulted in the lowest contamination percentage (5.00) and no mortality.

The highest percentage of germination of non-scarified seeds (93.33) was achieved with MS medium supplemented with 0.4 mg^{-1} BA + 0.2 mg^{-1} GA. In the case of scarified seeds, the growth regulator combinations namely, 0.2 mg^{-1} BA + 0.2 mg^{-1} GA and 0.8 mg^{-1} BA + 0.2 mg^{-1} GA produced the highest percentage of germination (80.00).

Culturing of the non-scarified seeds in MS medium supplemented with 0.6 mg^{-1} BA and 0.2 mg^{-1} GA resulted in the earliest germination (33.33 days). In the case of scari-

fied seeds, the earliest germination (11.33 days) was achieved with MS medium with 0.8 mg^{-1} BA and 0.2 mg^{-1} GA.

Micrografting was attempted using *in vitro* germinated seedlings as the rootstocks under *in vitro* conditions. But the experiments were not successful.

10. Production of haploids of cardamom (*Elettaria cardamomum* Maton) through anther culture/ pollen culture

K Nirmal Babu, PN Ravindran and Benny Daniel

Indian Institute of Spices Research, Calicut

Objectives

1. The anther/microspore culture technology and subsequent production of dihaploids is an important means by which homozygous lines could be achieved for the subsequent production of high yielding hybrids exhibiting maximum heterosis.
2. Production of haploids the 'microspore callus' is a sure way of introducing variation in the crop. The variations obtained may be useful in breeding, especially for developing disease tolerant lines.
3. In cardamom, resistance to the katte virus seems to be a recessive character or a character controlled by cytoplasmic factors. Through anther/microspore culture, it is possible to fix the recessive genes in homozygous condition.
4. Cardamom is a naturally cross pollinated crop and the dihaploids from such hybrid plants are recombinant homozygous products useful in the fixation of gene loci. Additive effects are fixed in dihaploids.
5. The ultimate aim of the project is to evolve high yielding disease resistant cardamom lines through crossing of dihaploids.

Progress of work (Final report)

In the present study the primary requisites of anther culture such as optimum age of panicle and anther suitable for culture, cold treatment procedure, sterilization and inoculation procedure, photoperiod and light conditions were standardized.

Callus could be induced and proliferated by culturing cardamom anthers initially in MS medium containing 0.1 mgl^{-1} TDZ and thereafter the swollen anthers on MS medium containing 0.5 mgl^{-1} 2, 4-D and 0.1 mgl^{-1}TDZ.

Pollen derived callus gave plant regeneration in MS medium 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. These plantlets were multiplied on continuous culture in the same medium. Multiple shoots as well as rooting was achieved in the same medium. These androgenic plantlets have to be cytologically indexed for their ploidy level to determine their origin and this work is in progress.

However, consistency in development of androgenic plantlets could not be achieved irrespective of large number of (over 500) media combinations tested.

Production of diploid homozygous pure lines is a very important step in hybrid breeding. 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. Thus the anther / microspore culture technology and subsequent production of dihaploids through microspore callus, is a sure way for production of hybrids

exhibiting maximum heterosis and introduction of variations into the crop.

11. Elucidation of biosynthetic pathways of curcumin in turmeric

B. Chempakam, N.K. Leela, *K. Vasu
Indian Institute of Spices Research, Calicut
*CWRDM, Calicut

Objectives

1. To study the nature of precursors, intermediates and degradation products of curcumin so as to understand the biosynthetic pathway.
2. To assay and localize the key enzymes involved in the biogenesis, based on the established pathway.
3. 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.

Progress of work

PAL, the major enzyme, which initiates the series of reactions leading curcumin synthesis, was studied during the early germination phase. Leaves possessed highest activity among the vegetative parts analyzed. Least activity was observed in pseudostem. This gives an indication that leaves can be the site of synthesis of curcumin precursors, which are mainly phenolic acids. An earlier study on PAL activity after 3 months upto maturity also confirmed this trend.

Preliminary studies on the cell fractionation of turmeric leaf and localization of PAL in each fraction indicates higher activity in the mitochondria. However, chloroplast and microsomes too had considerable amount of activity.

Studies on incorporation of $^{14}CO_2$ are being followed up. This will give indication of the origin of carbon atoms of curcumin. The phenolic fractions will also be seen for incorporation, which will help in identifying the actual precursors of curcumin. Effect of light on PAL activity was undertaken to see how PAL could be manipulated under different environmental conditions. The study could confirm that light at different wavelengths has got varied and marked effect on PAL activity.

HPLC separation of curcuminoids in turmeric leaf, root and rhizome indicated variation in the proportions of the three forms during development, with curcumin III (natural form of curcumin) having the maximum percentage. Curcumin III also showed an increase at 180–210 DAS (Days After Sowing), which declined at subsequent stages. However, this decrease was compensated with a rise in the levels of curcumin I and II. In roots, curcuminoids could be detected only after 90 DAS.

12. Production of somaclones and somatic hybrids in cardamom (*Elettaria cardamomum* Maton) for high yield and resistance to diseases

K.V. Peter, P.N Ravindran, K Nirmal Babu, M.N. Venugopal, R. Mulge, Geetha S Pillai and Benny Daniel
Indian Institute of Spices Research, Calicut.

Objectives

1. Production of somaclonal variants through callus regeneration
2. Production of somatic hybrids through fusion of protoplasts of cardamom with that of other related taxa like *Alpinia* sp. and *Hedychium* sp.

3. Screening of somaclones and somatic hybrids against 'Katte' and evaluation for high yield and other desirable quality characters.

Progress of work (Final report)

Production of somaclonal variants through callus regeneration

Callus could be induced from sucker, rhizome, panicle, leaf sheath, pseudostem explants, *in vitro* derived leaf tissue and *in vitro* cultures could be established from high yielding lines of cardamom such as PV1 x CL 37, CCS 1, NKE 9, NKE 27 and NKE 30. Callus was induced in MS medium with different concentrations of 2,4-D alone or along with BA. The Proliferated embryogenic callus regenerated into plantlets. In MS medium fortified with 0.5 mgl^{-1} NAA and 1.0 mgl^{-1} BAP, maximum number of shoots regenerated from these callus cultures. The regenerating callus cultures were maintained in the callus-regenerating medium itself, which continued producing plantlets. The callus-regenerated plantlets exhibited 3 morphotypes in culture; they are (i) plants with short internodes and needle like leaves (ii) plants with short internodes and small but normal leaves (iii) and plants with normal internodes and normal leaves. In about 30% of the cultures, two of the morphotypes could be observed in the same culture itself. Some plants with variegated leaves were also obtained from culture. Regenerated plantlets with good root system got hardened successfully. The hardened plantlets were maintained in the nursery.

Thus very efficient plant regeneration system, via, both organogenesis and embryogenesis - was developed in many varieties of cardamom for the first time.

This is the fundamental requisite for any biotechnological tool for crop improvement.

Production of somatic hybrids through protoplast fusion

The second objective of the project was production of somatic hybrids of cardamom with that of other related taxa like *Alpinia* sp. and *Hedychium* sp, which are resistant to the serious diseases so as to produce a resistant hybrid.

Protoplasts were successfully isolated from young *in vitro* derived leaves in an enzyme mixture containing 0.5% macerozyme, 2% cellulase and 9% mannitol. Protoplast yield was 3.5 x 10^5 protoplasts per g leaf tissue and the viability was 72-75%. 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%. The yield of protoplasts was lesser from callus / cell suspension with 1 x 10^5 protoplasts per gram wt of callus, when compared to leaf, but the viability was higher.

The protoplasts were developed into microcalli in 50-70 days of culture. Plant regeneration from protoplast derived microcalli could not be achieved in the present study.

Thus a protocol for isolation and culture of viable protoplasts from young in vitro derived leaf and cell suspension cultures was standardized for the first time in cardamom. There were no earlier reports of protoplasts from cardamom tissues.

These protoplasts form the basis for utilization of advanced techniques such as somatic cell hybridization and genetic manipulation using direct or *Agrobacterium* mediated gene transfer for crop improvement in cardamom.

Evaluation of somaclones

The somaclones were hardened and transferred to ploy- bags with garden soil and maintained in nursery. Out of the three 3 morphotypes in culture, normal plantlets got established with 80-85% survival, whereas other two morphotypes with about 20-30% survival.

Hardened plants were transferred into polybags with garden soil and maintained in the green house for 60- 80 days till they are ready for transfer to field. Plants 50 -60 cm height was transferred to field at Cardamom Research Center, Appangala. The plants were planted in 2 x 2 m spacing. There were altogether 400 plants planted in this first stage. Morphological and yield data were collected from these plants in the 3rd, 4th and 5th year of planting. Another batch of 200 plants were planted in the third year of the project and another batch comprising of 300 plants were plants in the 4th year of the project. Somaclones planted in the field showed 60% survival. The data showed a range of variations in morphological and yield related characters.

This study revealed that somaclones are good source of variation with regard to important agronomic characters like plant height, vigour, fruit set, fruit size and shape, and hence can be exploited to develop more and more varieties.

Screening of somaclones for resistance to 'katte'

In cardamom the somaclones were screened for resistance to 'Katte' for three rounds and 67 somaclones were found free from virus infection. All the 6654 infected somaclones exhibited different degrees mosaic symptoms typical of local severe katte isolate. Un-infected somaclones were transferred to sick plot for further evaluation against natural infection of mosaic virus and also to assess their growth and yield characters. The maiden crop is expected only in 2003 cropping season.

A few 'katte' tolerant somaclones were identified. This form a source either for future breeding programmes through hybridization or direct selection of more high yielding lines and resistant varieties by further evaluation.

13. Biological control of plant parasitic nematodes of major spice crops

K.V. Ramana, S. J. Eapen and B. Beena

Indian Institute of Spices Research, Calicut.

Objectives

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

Progress of work (Final report)

Soil and root samples (121 numbers) were collected from the rhizosphere of different spice crops like black pepper (Piper *nigrum* L.), cardamom (*Eletteria cardamomum* Maton), ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* L.) through random

surveys undertaken in seven districts of Kerala. Besides six turmeric samples were collected from Andhra Pradesh. Bacteria (251isolates) and fungi (79 isolates) were isolated from these samples using standard methods.

Out of the 79 fungal biocontrol agents collected and maintained, 45 were identified based on the morphological characteristics in consultation with Centre for Advanced Studies in Botany, Guindy Campus, University of Madras. Among these, 22.22% were *Trichoderma* spp., 13.33% were *Aspergillus* spp., 11.11% were *Verticillium*, 8.88% were *Paecilomyces* spp., and 8.88% were *Fusarium* spp. *Scopulariopsis* and *Humicola* were obtained at 2.22% frequencies. The bacterial colonies were purified and stored in yeast extract glucose calcium carbonate agar slants. For long-term storage the bacterial isolates were kept at -80°C in 20 % glycerol. The fungal colonies were sub-cultured, purified and stored in PDA slants for further studies. For long-term storage of fungal cultures, Potato Carrot Agar medium or liquid paraffin was used.

Initial screening of fungal isolates was done *in vitro* to identify their potentiality, by standardized protocols viz. hatching suppression and egg parasitization. Out of the 79 isolates tested, 19 isolates caused more than 80% hatching suppression while 24 isolates showed good parasitization of nematode eggs. Seven isolates (*Fusarium oxysporum* (Is. 11), *Scopulariopsis* sp (Is.14), *Verticillium chlamydosporium* (Is 31,.32, & 34) *Verticillium lecanii* (Is.35) and *Paecilomyces lilacinus* (Is.36) have very high inhibitory effect (>90%) on the egg hatching while another ten isolates suppressed egg hatching by more than 80%. *Aspergillus* spp. (Is. 2, 7, 10 & 49), *Fusarium* spp. (Is. 11 & 13), *Scopulariopsis* sp. (Is. 14), *Scolicobasidium* (Is.15), *Trichoderma* spp. (Is. 16, 25, 33 & 56), *Verticillium chlamydosporium* (Is. 31, 32, 34 & 57), *Verticillium lecanii* (Is. 35), *Paecilomyces* spp. (Is. 20, 27 & 36), *Gliocladium* (Is. 40 & 41) and *Drechleria* sp. (Is. 44), showed good parasitization of root knot nematode eggs.

Thermo stable toxic metabolites in culture filtrates of two species of the genus *Verticillium* namely, *V. chlamydosporium* (four strains) and *V. lecanii* and one isolate of *Paecilomyces lilacinus* have shown significant effects on the egg hatching and mortality of the juveniles of root knot nematodes.

Similarly, bacterial isolates (99 numbers) were screened initially by employing the buffer method to assess their nematode suppressing ability. Except a few isolates, most of the bacterial isolates caused very less mortality of nematodes in this test. Based on their efficacy, 30 bacterial isolates were selected for further *in vitro* evaluation using different methods like culture filtrate assay, direct assay of bacterial suspension and assay of volatile and non-volatile metabolites.

Paecilomyces lilacinus (Is. No. 36), *Fusarium oxysporum* (Is. No. 11) and *Aspergillus tamarii* (Is. No. 2) were studied separately in three different experiments using tomato as the test plant. All the fungal isolates significantly suppressed the nematode population in both soil and roots and hence can be used as potential biocontrol agents. However, among the three fungi tested, *P. lilacinus* was noteworthy as it has profound effect on the growth of tomato plants.

In another greenhouse trial using four fungal biocontrol agents (*Fusarium oxysporum* - Is. 11, *Aspergillus tamarii* - Is. 2, *Verticillium chlamydosporium* - Is. 32 and *Trichoderma harzianum* - Is. 33) none of the isolates had any significant positive or negative effects on the growth and yield of root knot nematode infested ginger. However, *V. chlamydosporium* caused a slight improvement in the growth of ginger plants even in the presence of root knot nematodes.

Seventy-five bacteria were tested in four different experiments. In Experiment-1, out of the twelve bacterial isolates used, eight isolates caused significant increase in the height of the plants over controls, isolate No. 13 recorded maximum height. Seven isolates caused significant increase in the shoot weight. All the tested isolates resulted in significant nematode suppression and the maximum suppression was obtained with isolate No. 13. This isolate is very effective, both in promoting the growth of tomato plants and in nematode suppression. In Experiment-2 where 18 isolates were used, three isolates were effective in increasing the height of the plants significantly over the controls and none except in isolate No. 84 could induce significant increase in the total biomass. In Experiment-3 and 4, where nine and 21 isolates were used, respectively, none of them caused any improvement in plant growth characters. However, all the isolates caused significant reduction in nematode development and 100% nematode suppressions was obtained with three isolates (Is. No. 113, 117 and 123).

Finally, isolates of *V. chlamydosporium* (Is.31 & 32), *Trichoderma* spp. (Is. 25 & 56), *Penicillium* sp. (Is. 4), *V. lecanii* (Is. 35), *P. lilacinus* (Is. 36), *F. oxysporum* (Is.11), *Scopulariopsis* sp. (Is. 14) and *Aspergillus* sp. (Is.10) were selected and evaluated under field conditions using ginger and turmeric as the test crops. The biocontrol agents, multiplied on sorghum, were incorporated in the soil (@ 50 g/bed of 3 x 1 m) at the time of sowing. *V.chlamydosporium* (Is.31) was tried as a seed treatment as well as soil bed application. All the fungal biocontrol agents evaluated, except, *Penicillium, Scopulariopsis, Aspergillus* and one isolate of *Trichoderma,* have proved their efficiency significantly in suppressing of root knot nematode population. However, complete suppression of root knot nematodes could be achieved only by the application of *Fusarium oxysporum.*

Attempts were also made to mass multiply some of these promising bioagents on liquid as well as solid substrates. The highest mycelial production of *V.chlamydosporium* was observed on the starch medium followed by coconut water. Scaling up of this fungus was done through liquid fermentation too. Among various solid substrates evaluated, rice and ginger shoot powder supported very good sporulation and multiplication of *P. lilacinus* and *A. tamarii. A. tamarii* multiplied well on tea waste too.

The optimum pH for the growth of *Trichoderma* (Is. 33) was at pH 4 and for *Trichoderma* (Is. 56) was at pH 5. Is. 33 showed adaptation to a wide range of pH (4 - 7) while Is. 56 showed adaptability to pH ranging from 4 to 6. The fungus *Fusarium* has shown more adaptability to higher pH (>6). Similarly, maximum growth of *Fusarium* sp. (Is. 11) was at pH 6. pH 5 can be considered as the optimum pH for the growth of the fungus *V.*

chlamydosporium. Similarly, the optimum temperatures for growth and multiplication of *T. harzianum* (Is.33) and *P. lilacinus* (Is.36) were between 25°C and 30°C while that of *V. chlamydosporium* (Is. 34) was 25°C. Further studies showed that the maximum radial growth of *V. chlamydosporium* was observed in at 26° C. The chlamydospore production too was comparatively higher in the temperature range of 26°C to 28°C.

The compatibility of three fungal isolates viz. *Trichoderma* (Is33), *Verticillium* (Is. 34) and *Paecilomyces* (Is.36) were tested against metalaxyl mancozeb, potassium phosphonate, phorate and chlorpyriphos. Potassium phosphonate and insecticides like 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.

14. Establishing *in vitro* conservatory of spices germplasm

K Nirmal Babu, P N Ravindran, B Sasikumar and Geetha S Pillai

Indian Institute of Spices Research, Calicut.

Objectives

1. Standardization of ideal protocol for short to medium term and long term *in vitro* conservation of spices with following major studies.
2. Standardization of protocol for meristem culture.
3. Studies on growth at normal and minimal media.
4. Standardization of freeze thaw process.
5. Standardization of post thaw recovery and growth.
6. Studies in genetic stability in *in vitro* and cryopreserved material.
7. Conserving germplasm of spices such as black pepper, cardamom, ginger, turmeric, tree spices, vanilla and herbal spices in *in vitro* gene bank.

Progress of work (Final report)

Experiments were carried out to standardize minimal growth storage protocols in the species studied. Slow growth storage techniques was standardized in ginger, turmeric and vanilla. Microrhizomes were induced in ginger and turmeric. This technology can be exploited for their use in conservation and exchange of germplasm. Meristem isolation and culture is achieved in cardamom, ginger, turmeric and vanilla. Cryopreservation of black pepper zygotic embryos, cardamom shoots tips, ginger somatic embryos and shoot tips and vanilla shoot buds were achieved. Pollen cryopreservation was achieved in cardamom and vanilla. *In vitro* cultures under minimal growth storage conditions were multiplied and rooted normally and established in the soil. Studied the genetic fidelity analysis of the conserved material using RAPD markers.

The germplasm of spices such as black pepper, cardamom, ginger, turmeric, anilla, seed and herbal spices etc. are being conserved in the *in vitro* repository using slow growth method standardized. An *in vitro* gene bank is being established with more than 500 accessions of various spices in it. Initiated a DNA bank for important accessions, verities and related species of black pepper, cardamom, ginger, turmeric, vanilla, *Kaempferia* spp. etc.

Thus, development of efficient *in vitro* conservation strategies helps in collection and conservation of samples of spice crops that

are normally vegetatively propagated or those that produce recalcitrant seeds. This method offers a safe alternative or additive to field gene bank and can also be used for efficient pest and pathogen free germplasm exchange. This will form an important component in the overall strategy of genetic resources management and utilization in these crop species.

15. Development of resistant variety/lines of cumin to wilt caused by *fusarium oxysporum* using *in vitro* techniques

S. Gangopadhyay and S.N. Saxena
Plant Biotechnology Centre, Agricultural Research Station, Rajasthan Agricultural University, Bikaner –334 006

Objectives

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

Progress of work

Report not received.

STAFF

PROJECT COORDINATOR'S CELL

Project Coordinator	:	Dr K V Ramana
Scientist (Hort.)	:	Dr K N Shiva
Technical Information Officer	:	Dr Johny A Kallupurackal
Personal Assistant	:	Ms P V Sali
Peon	:	Mr K Chandran

COORDINATING CENTRES

1 Cardamom Research Station, KAU, Pampadumpara

1. Breeder (Posted at Ambalavayal)	:	Ms Susamma P. George
2. Asst. Professor (Agron./Hort.)	:	Vacant
3. Asst. Professor (Ag. Entomology)	:	Dr A Joseph Rajkumar
4. Farm Assistant Sel. Gr.	:	Mr C G Pradeep
5. Lab Assistant	:	Vacant
6. Peon	:	Mr Paulose Mathew

2 Regional Research Station, UAS (Bangalore), Mudigere

1. Breeder	:	Mr M Narayanaswamy
2. Agronomist (Hort.)	:	Mr M Dinesh Kumar
3. Pathologist	:	Mr L Arasumallaiah
4. Jr. Entomologist	:	Mr N E Thyagaraj
5. Jr. Technical Assistant	:	Mr Narayana
6. Jr. Technical Assistant	:	Mr Murthyunjaya
7. Messenger	:	Ms Savithri

3 Horticultural Research Station, TNAU, Yercaud/Pechiparai

1. Agronomist (Hort.)	:	Dr V Lakshmanan/Yercaud
2. Jr. Breeder (Hort.)	:	Dr Prem Jousha/Pechiparai
3. Lab Assistant	:	Mr M Ramaiah/Yercaud

4 Pepper Research Station, KAU, Panniyur

1. Assoc. Professor (Pl.Pathology)	:	Mr P K Unnikrishnan Nair (retired)
2. Asst. Professor (Pl.Pathology)	:	Dr G Sivakumar
3. Asst. Professor (Pl.Breeding)	:	Dr Neema V P
4. Asst. Professor (Agronomy)	:	Vacant
5. Farm Assistant	:	Mr N K Muralidharan
6. Farm Assistant	:	Mr P P Muralidharan
7. Farm Assistant	:	Vacant
8. Lab Assistant	:	Ms Nirmala Chellath
9. Peon	:	K Rajeevan

5 Regional Agricultural Research Station, APAU, Chintapalli

1. Horticulturist	:	Mr M M Naidu
2. Junior Pathologist	:	Smt V Prasanna Kumari
3. Technical Assistant	:	Vacant

6 Agricultural Research Station, UAS (Dharward), Sirsi

1. Jr. Pathologist (Assoc. Prof.)	:	Mr M S Lokesh
2. Jr. Horticulturist (Asst. Prof.)	:	Mr H G Hegde
3. Technical Assistant (Asst. Prof.)	:	Mr Nagesh Naik

7 Department of Vegetable Crops, Dr YSPUHF, Solan

1. Breeder (Olericulturist)	:	Dr B N Korla
2. Jr. Plant Pathologist	:	Dr N P Dohroo
3. Jr. Biochemist	:	Dr R K Goyal Dr (Mrs) Nirja Singh
4. Jr. Technical Assistant	:	Vacant

8 High Altitude Research Station, OUAT, Pottangi

1 Breeder (Olericulturist)	:	Dr A K Pattnaik
2 Jr. Breeder	:	Dr D K Dash
3 Jr. Technical Assistant	:	Mr R C Dash
4 Jr. Technical Assistant	:	Mr B N Sahoo

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

1	Sr. Breeder (Prof.)	:	Dr D L Singhania
2	Breeder	:	Dr Dhirendra Singh
3	Agronomist (Hort.)	:	Dr G R Chaudharay
4	Jr. Plant Pathologist	:	Mr M P Jain
5	Jr. Biochemist	:	Dr S Agarwal
6	Sr. Technical Assistant	:	Mr S S Rajput
7	Jr. Technical Assistant	:	Mr S R Kumawat

10 Regional Agricultural Research Station, APAU, Guntur

1	Horticulturist	:	Smt C Sarada
2	Jr. Breeder (Hort.)	:	Sri K Giridhar
3	Sub Assistant	:	Mr K Sivakumar

11 Spices Research Station, GAU, Jagudan

1	Sr. Plant Pathologist	:	Dr K D Patel
2	Jr. Breeder	:	Mr G M Patel
3	Technical Assistant	:	Mr S R Chaudhari

12 Department of Spices & Plantation Crops, TNAU, Coimbatore

1	Breeder (Horticulturist)	:	Ms G Jansi Rani
2	Jr. Pathologist	:	Dr P Muthulakshmi
3	Agricultural Assistant	:	Mr R Swaminathan

13 Regional Agricultural Research Station, ANGRAU, Jagtial

1	Jr. Pathologist	:	Mr C L Narasimha Chary
2	Jr. Horticulturist	:	Mr R Manohar Rao
3	Technical Asst./Sub Asst.	:	Vacant

14 Department of Vegetable Crops, CCS HAU, Hisar

1	Olericulturist /Horticulturist	:	Dr K K Thakral
2	Assistant Scientist (VC)	:	Dr S K Tehlan

15 Tirhut College of Agriculture, RAU, Dholi

1	Horticulturist	:	Mr S P Singh
2	Jr. Pathologist	:	Vacant
3	Technical Assistant	:	Vacant

16 Konkan Krishi Vidya Peeth, Dapoli

1	Horticulturist	:	Mr A G Desai
2	Jr. Pathologist	:	Dr V S Pande
3	Junior Spice Breeder	:	Prof R G Khandekar
4	Technical Assistant	:	Vacant
5	Technical Assistant	:	Vacant

17 Narendra Dev University of Agriculture and Technology, Kumarganj

1	Horticulturist	:	Dr J Dixit
2	Jr. Breeder	:	Dr V P Pandey
3	Jr. Pathologist	:	Dr R P Saxena
4	Technical Assistant	:	Mr V K Singh
5	Technical Assistant	:	Mr R K Gupta

18 Indira Gandhi Krishi Vishwa Vidhyalaya, Raigarh

1	Horticulturist	:	Dr C R Gupta
2	Jr. Breeder	:	Dr N S Tomar
3	Jr. Pathologist	:	Dr A K Singh
4	Technical Assistant	:	Mr G P Kashyap
5	Technical Assistant	:	Mr D S Kshatri

19 Uttar Banga Krishi Viswa Vidhyalaya, Pundibari

1	Horticulturist	:	Dr J C Jana
2	Jr. Breeder	:	Vacant
3	Jr. Pathologist	:	Dr A K Chowdhuri Dr P M Bhattacharya
4	Technical Assistant	:	Mr B Mahjumdar
5.	Technical Assistant	:	Vacant

RELEASE OF GRANTS DURING 2001-2002 (Rs. in lakhs)

Name of the centre	Allocation (2001-02)	First half	Second half	Total	Additional fund released**	Grand total released
Pampadumpara (KAU)	6.98	3.49	3.07	6.56		6.56
Panniyur (KAU)	9.60	4.80	4.80	9.60	2.586	12.186
Mudigere (UAS-B)	9.00	4.50	4.50	9.00		9.00
Sirsi (UAS-D)	3.75	1.88	1.87	3.75		3.75
Yercaud (TNAU)	4.51	2.26	2.01	4.27		4.27
Coimbatore (TNAU)	4.46	2.23	2.23	4.46	0.92	5.38
Chintapalli (APAU)	3.11	1.56	0.00	1.56		1.56
Jagtial (APAU)	3.93	1.97	1.03	3.00		3.00
Guntur (APAU)	3.93	1.97	0.00	1.97		1.97
Solan (YSPUHF)	5.82	2.91	2.91	5.82	2.00	7.82
Pottangi (OUAT)	5.12	2.56	2.56	5.12	0.96	6.08
Jobner(RAJAU)	11.93	5.97	5.96	11.93	2.00	13.93
Jagudan (GAU)	3.83	1.92	1.91	3.83	0.46	4.29
Hisar (HAU)	4.50	2.25	2.25	4.50	1.35	5.85
Dholi (RAU)	4.05	2.03	2.02	4.05		4.05
Kumarganj (NDUAT)	6.37	3.19	3.18	6.37		6.37
Pundibari (BCKVV)	6.37	3.19	3.18	6.37	0.12	6.49
Dapoli (KKV)	6.37	3.19	3.18	6.37	1.47	7.84
Raigarh (IGKVV)	6.37	3.19	3.18	6.37		6.37
Workshop				0.234		0.234
Total	**110.00**	**55.06**	**49.84**	***105.134**	**11.866**	**117.00**

* An amount of Rs. 4.866 lakhs obtained as savings from Pampadumpara (Rs. 0.42 lakhs), Yercaud (Rs.0.24 lakhs), Jagtial (Rs. 0.93 lakhs), Guntur Rs. 1.96 lakhs) and Chintapalli (Rs. 1.55 lakhs).

**The amount of Rs. 4.866 lakhs has been allotted to 3 centres as additional fund under pay and allowances from the over all savings obtained. An amount of Rs.7.00 lakhs has been received as additional fund and was released to 7 centres. An amount of Rs. 0.234 lakhs has been spent for XVI AICRPS Workshop.

BUDGET PROVISION -2001-2002 (Rs. in lakhs)

Name of the centre	Details of sanctioned provision for pay and allowances				Grand Total		
	Estt.	RC	TA	NRC (Equipments /works)	Total	ICAR share	State share
Pampadumparà (KAU)	7.25	1.20	0.30	Nil	8.75	6.56	2.19
Panniyur (KAU)	14.25	1.60	0.40	"	16.25	12.19	4.06
Mudigere (UAS-B)	10.00	1.60	0.40	"	12.00	9.00	3.00
Sirsi (UAS-D)	4.00	0.80	0.20	"	5.00	3.75	1.25
Yercaud (TNAU)	4.69	0.80	0.20	"	5.69	4.27	1.42
Coimbatore (TNAU)	6.17	0.80	0.20	"	7.17	5.38	1.79
Chintapalli (APAU)	1.08	0.80	0.20	"	2.08	1.56	0.52
Jagtial (APAU)	3.00	0.80	0.20	"	4.00	3.00	1.00
Guntur (APAU)	1.63	0.80	0.20	"	2.63	1.97	0.66
Solan (YSPUHF)	8.93	1.20	0.30	"	10.43	7.82	2.61
Pottangi (OUAT)	7.11	0.80	0.20	"	8.11	6.08	2.03
Jobner(RAJAU)	16.07	2.00	0.50	"	18.57	13.93	4.64
Jagudan (GAU)	4.72	0.80	0.20	"	5.72	4.29	1.43
Hisar (HAU)	6.80	0.80	0.20	"	7.80	5.85	1.95
Dholi (RAU)	4.40	0.80	0.20	"	5.40	4.05	1.35
Kumarganj (NDUAT)	6.99	1.20	0.30	"	8.49	6.37	2.12
Pundibari (BCKVV)	7.15	1.20	0.30	"	8.65	6.49	2.16
Dapoli (KKV)	8.95	1.20	0.30	"	10.45	7.84	2.61
Raigarh (IGKVV)	6.99	1.20	0.30	"	8.49	6.37	2.12
Workshop	0.234			"	0.234	0.234	
Total	**130.42**	**20.40**	**5.10**	"	**155.92**	**117.00**	**38.92**
ICAR share	97.82	15.30	3.83				
State share	32.60	5.10	1.27				

LIST OF PUBLICATIONS

Research papers

GUNTUR

Hari Prasada Rao, N. 2001. Performance of fenugreek genotypes under KG Agroclimatic conditions of AP. *Spice India* (2): 10-13.

Hari Prasada Rao, N. and Sreenivasarao, G. 2001. Performance of coriander genotypes in AP. *Andhra Agril. Journal* **48**(1&2): 145-188.

Hari Prasada Rao, N. and Sreenivasarao, G. 2001. Studies on the performance of exotic and indigenous genotypes of coriander (*Coriandrum sativum*) for greens. *Andhra Agril. Journal* **48** (3 & 4): 324-326.

JAGUDAN

Patel B.S., Patel, K.P. and Patel, M.I. 2001. Response of fennel (*Foeniculum vulgure* Mill.) to irrigation, nitrogen and phosphorus. *Indian J. Agronomy* **45**(2): 429-432.

JOBNER

Raje, R.S., Singh, D. and Dashora, S.L. 2001. Inheritance of determinant growth habit and multipodedness in fenugreek. *Indian J. Genet.* **61**(2) :183-184

SOLAN

Goyal, R.K. and Korla, B.N. 2001. Quality variation in ginger. *Veg. Sci.* **28** (1) : 45-47.

Kumar, M and Korla, B.N. 2000. Effect of cultural practices on growth and yield of ginger. *Haryana J. Hort. Sci.* **29** (1-2): 112-114.

Nath, B and Korla, B.N. 2001. Use of sprouts as seed materials and their effects on growth and yield of ginger. *Haryana J. Hort. Sci.* **30**

PAMPADUMPARA

Josephrajkumar, A., Backiyarani, S. and Murugan, M. 2002. PV-1, a psuedostem borer tolerant cardamom variety. *Insect Environment* **7**(4): 155-156.

Papers presented in Symposia/Seminar/ Workshop

AMBALAVAYAL

Radhakrishnan, N.V., Manomohan Das, T. P., Susamma. P. George and Aipe, K.C. 2002. Integrated management of wilt disease incited by *Phytophthora capsici* in black pepper nursery. National Seminar on Changing Scenario in the Production Systems of Hill Horticultural Crops, Ooty, Feb. 20-21, 2002.

COIMBATORE

Chezhiyan, N. and Jansi Rani, G. 2002. Breeding for quality improvement in Spices & Condiments. In: Short-term Training course at CPBG, TNAU, Coimbatore.

Selvarajan, M. and Chezhiyan, N. 2001. Effect of *Azospirillum* inoculation and nitrogen fertilization on growth and yield of coriander (*Coriandrum sativum* L.). National Seminar on Changing Scenario in the Production systems of Horticultural Crops, Ooty, 20-21 February 2002.

Selvarajan, M. and Chezhiyan, N. 2001. Effect of *Azospirillum* in combination with different levels of nitrogen on growth and yield of fenugreek (*Trigonella foenum–graecum*. L.). National Seminar on Changing Scenario in the Production systems of Horticultural Crops, Ooty, 20-21 February 2002.

Selvarajan, M. and Chezhiyan, N. 2001. Studies on the influence of *Azospirillum* and different levels of nitrogen on growth and yield of turmeric (*Curcuma longa* L.). National Seminar on Changing Scenario in the Production systems of Horticultural Crops, Ooty, 20-21 February 2002.

JOBNER

Dashora, A., Sharma, R.K., Sastry, EVD and Singh, D. 2001. Varietal diallel analysis in fennel (*Foeniculum vulgare* Mill.). In: Diamond Jubilee Symposium on Hundred years of post Mendelian Genetics and Plant Breeding. Retrospects and Prospects. Indian Society of Genetics and Plant Breeding, I.A.R.I., New Delhi.

Singh, D., Sastry, EVD., Sharma, R.K. and Dashora, A. 2001. Heterosis in fennel (*Foeniculum vulgare* Mill). In: Diamond Jubilee Symposium on Hundred years of post Mendelian Genetics and Plant Breeding. Retrospects and Prospects. Indian Society of Genetics and Plant Breeding, I.A.R.I., New Delhi.

Agrawal, S., Singh, D. and Singhania, D.L. 2001. Effect of stage of harvest on quality of coriander. In: International Conference on Globalization of Indian Essential oil, Agra, 21-23 Sept., 2001.A7 pp.66.

KUMARGANJ

Singh, T. and Pandey, V.P. 2001. Performance of different cultivars of turmeric at Faizabad under Eastern condions of U.P. International conference on Vegetables, Bangalore.

Saxena, R.P., Gupta., S., Singh., T., Pandey., V.P., Gupta, R.K. and Singh, V.K.. 2002. Screening of turmeric germplasm against Taphrina Leaf blotch. Indian Science Congress Association meet, Lucknow University, Lucknow, Jan 05-9, 2002.

SOLAN

Dohroo, NP and UK Kohli. 2001. *Adrak Ka Swasth Beej Bhandaran- Takniki Pustika.* Centre of Advanced Studies, Dept. of Vegetable Crops, Dr. Y. S Parmar University of Horticulture and foresty, Nauni, Solan, (H.P), 24 pp.

Dohroo, N.P, Bhardwaj, R.K. and Kohli, U.K. 2002. *Adrak utpaadan avam bhandaran.* Centre of Advanced Studies, Dept. of Vegetable Crops, Dr. Y. S Parmar University of horticulture and Forestry, Nauni, Solan (H.P), 67 pp.

Dohroo N.P. 2001. *Adrak ki unnat kheti ke liye krishi karyaa.* Masala Fasal Utpaadan, Takniki main Rajya Satariya Sangoshthi, Seed Production Centre Dr. Y. S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P).

Dohroo, N.P. 2002. *Adrak ke rog avam roktham.* In: Adrak utpaadan avam bhandaran. Centre of Advanced Studies, Dept. of Vegetable Crops, Dr. Y. S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P).pp. 28-33.

Sood, Ruchi and Dohroo, N.P. 2001. Effect of botanicals against *Phyllosticta zingiberi* Ramakr causing leaf spot of ginger. In: Ann. Meet (IPS), Symposium on "Current Trends in Teaching. Research and Extension of Plant Pathology", Dec. 12-13, 2001. Dept. of plant Pathology, CCS, HAU, Hiasr, p.50.

Sood, Ruchi and Dohroo, N.P. (2001). Viability of *Phyllosticta zingiberi* Ramakr. casual agent of leaf spot of ginger, In: Ann. Meet (IPS), "Symposium on Current Trends in Teaching, Research and Extension of Plant Pathology", Dec. 12-13 , 2001 Dept. Of lant Pathology, CCS, HAU, Hiasr, p.51.

MUDIGERE

Arasumallaiah, L. 2001. Management of foot rot (Quick wilt) of black pepper under coffee based cropping system. In: Proceedings of National Seminar on seed science and Technology in the new Millennium- Vistas and Vision, University of Mysore, August 6-8, 2001, p.67.

RAIGARH

Gupta, C.R. 2002. Prospect of ginger and seed spices production in Chhattisgarh. National Symposium on Horticultural Crops, Jan. 21 - 23, 2002, IGKV Raipur.

Tomar, N.S. 2002. Prospects of turmeric production in Chhattisgarh. National Symposium on Horticultural Crops, Jan. 21 - 23, 2002, IGKV Raipur.

YERCAUD

Balasubramanyan, S., J. Prem Joshua, T. Thangaselvabai and C.V. Rajalingam. 2002. Performance of cinnamon types under high rainfall zone of Tamil Nadu, National Seminar as Changing scenario in the production system of Horticultural crops, Ooty, Feb.2002.

Popular articles

COIMBATORE

Muthulakshmi, P., Chezhiyan, N. and Selvarajan, M. 2002. Katte disease of cardamom. *Udyaniki Jeevan*, March 2002.

DAPOLI

Khandekar, R.G. 2002. Masala pikanchi abhivrudhi chaya padhati. *Fal bag vreeta* Feb–Mar, 2002

Khandekar, R.G. 2002. Lavang lagwad *Fal bag vruta,* Feb–Mar, 2002

Khandekar, R.G. 2002. Bush pepper Kami Jaget lawayala yogya kalimiti. *Fal bag vruta*, 2002

Khandekar, R.G. 2002. Kalimiri kale sahe. *Fal bag vruta*, 2002

Khandekar, R.G. 2002. All spice eak navinyapurna masala pike. *Fal bag vruta*, 2002

Khandekar, R.G. 2002. Masala Pikanchi Niryat. *Shetkari*, 2002

Pande, V.S. 2002. Kalimiri varil rog ani tyanchie niyantran. *Kisan Shakti*, Jan. 2002

Pande, V.S. 2002. Masala pikanchi Niryat. *Shetkari*, Jan. 2002

Pande, V.S. 2002. Kalimiriche rog ani tyanche niyantran . *Fal bag vruta,* Feb. 2002

Pande, V.S. 2002. Masala pikanchya abhivrudhichya padhati. *Fal bag vruta,* Feb-March, 2002.

Pande, V.S. 2002. Bush Pepper Kami Jaget Lavayalas yogya. *Kalimiri*, Feb. 2002

Pande, V.S. 2002. Aushadhi vanaspalinchya sakayane Pikanche rog niyantran. *Kisan Shakti*, Oct. 2001

GUNTUR

Sarada, C., Giridhar, K. and Rosaiah, B. 2002. "Sugandhadravyalu-sagupaddathulu" Agricultural Information Series No. 64, January 2002, ANGRAU, RARS, Lam.

JAGUDAN

Patel, B.S., K.P. Patel, I.D. Patel and Madhu Patel. 2000. Vavani panchchi khala puri chchod ni sankhya jalvo. *Nitrogen Kisan Parivar Patra* (Gujarati) 16(12): 18-19.

Prajapati, D.B., Patel, B.S. and I.D. Patel (2000). Shiyalu rutuno rokadiyo pak suva. *Krushi Jivan* (Gujarati) 33(4): 16-17.

Patel, K.P., Patel, G.M., Patel, B.S. Jiru Ni Sukara Rog Pratikarak Jat-Gujarat Jiru-3. *Gujarat Kisan* (Gujarati) 2(14): 10-11.

JOBNER

Agarwal, S., Sharma, R.K. and Edison, S. 2001. Cumin wilt–Prospects and perspectives. *Spice India* 14: 17-20.

Singhania, D.L., Agrawal, S., Singh, D., Choudhary, G.R. Jain M.P. 2001. Research achievements of seed spices at Rajasthan Agricultural University. Indian Journal Arecanut, Spices & Medicinal Plants 3 (3): 157-160.

KUMARGANJ

Singh, T. and Singh, V.P. 2001. Masala utpadan Samasya aur Samadhan. Khad Patrika, New Delhi.

PAMPADUMPARA

Hari, Josephrajkumar, A., Sainamole Kurian, P., Backiyarani, S. 2001. Cardamom management in high ranges (Malayalam). *Karshakan*. 9(11): 30-33.

Josephrajkumar, A. 2001. Pollu disease – A threat to black pepper in high ranges. (In Malayalam). *Karshakashree* **7**(4): 28-30.

PANNIYUR

Sivakumar, G. Sudheesh, M.V. and Unnikrishnan Nair, P.K. 2001. Stunted disease of black Pepper - A report. *Spice India* XIV (4) : 5

Sivakumar, G., Sudheesh, M.V., Vanaja, T. Arya and Unnikrishnan Nair, P.K. 2001. A novel method of raising nursery in black pepper. *Spice India* XIV (4) : 5

Sivakumar, G., Mahapatro, G.K., Sudheesh, M.V., Neema, V.P. and Vanaja, T. 2001. Black pepper-Pollu beetle and disease complex in black pepper. *Kisan World* 28 (5) : 63

Sivakumar, G., Vanaja, T., Neema, V.P., Sudheesh, M.V. and Unnikrishnan Nair, P.K. 2001. Bush Pepper - A growing new technology in black pepper. *Kisan World* 28 (6) : 39

Sivakumar, G., Sudheesh, M.V., Neema, V.P., Vanaja, T. and Unnikrishnan Nair, P.K. 2001. Recent approaches for the management of foot rot disease of black pepper. *Spice India* XIV (9) : 13

Vanaja, T. 2001. "Vaevidhyamniranja kurumulak thandukal". *Kerala Karshakan* 46(17): 9-10.

RAIGARH

Gupta, C.R. 2001. *Chhatisgarh me Adrak Ki Kheti* 8(1)7-9.

Book chapters

JOBNER

Agarwal, S. 2001. Quality aspects and export potential in seed spices. In : Spice crops of India (ed. Prem Singh Arya), Kalyani Publishers, Ludhiana, pp.51-59.

SOLAN

Dohroo, NP and Nirupma Nag. 2001. Fungal diseases of ginger, turmeric and colocasia. In: Disease of Vegetable Crops (Eds. VK Gupta and YS Paul), Kalyani Publishers, pp. 124-141.

Dohroo, NP. 2001. Bacterial wilt of ginger. In : Disease of Vegetable Corps (Eds. VK Gupta and YS Paul), Kalyani Publishers, pp. 176- 178.

METEOROLOGICAL DATA 2001

Pampadumpara

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Min.	Max.	
January	9.4	3.0	16.6	22.3	7.26
February	15.2	3.0	16.9	25.9	9.16
March	38.4	4.0	17.7	29.9	8.57
April	245.0	15.0	19.6	28.1	6.63
May	70.6	11.0	18.4	27.0	6.60
June	382.6	25.0	18.8	22.3	4.05
July	385.9	26.0	17.0	22.3	4.85
August	233.8	25.0	17.8	22.6	4.05
September	125.0	15.0	17.7	25.5	5.30
October	291.3	26.0	17.8	23.7	5.25
November	272.8	14.0	17.4	25.0	5.50
December	27.1	7.0	15.4	22.2	5.45

Panniyur

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Min.	Max.	
January	-	-	34.7	19.9	92.0
February	4.8	1	35.0	21.9	89.8
March	-	-	35.6	22.2	81.9
April	155.8	12	35.5	23.9	84.3
May	276.3	12	33.8	24.0	90.3
June	1040.4	27	28.0	22.8	95.5
July	812.8	30	28.0	22.7	94.5
August	542.0	28	27.8	22.8	94.8
September	107.4	7	32.0	22.9	88.9
October	389.6	18	30.7	22.8	91.3
November	201.2	8	32.3	22.5	90.8
December	-	-	33.8	20.4	83.7

Mudigere

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Min.	Max.	AM	PM
January	-	-	14.20	28.38	68.83	31.61
February	-	-	15.80	31.04	76.50	35.46
March	-	-	18.04	31.79	72.84	50.03
April	131.30	7	19.40	31.00	83.40	58.16
May	73.30	10	19.20	28.25	83.03	62.52
June	522.00	22	17.90	23.02	88.83	77.76
July	429.20	26	17.80	22.00	90.06	83.38
August	346.30	28	17.70	21.00	92.70	87.58
September	194.10	14	17.80	24.12	90.53	74.50
October	86.80	6	18.70	24.88	88.38	78.54
November	89.90	3	17.60	26.25	78.60	60.63
December	2.40	1	15.80	25.98	70.96	56.71

Sirsi

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	0.00	0	34.04	14.19	77.87	71.48
February	16.40	1	34.04	15.82	76.93	66.04
March	0.00	0	35.94	16.26	80.82	49.45
April	126.40	7	36.13	21.06	76.43	59.60
May	32.70	7	33.81	21.42	81.58	63.39
June	527.70	25	28.53	21.07	86.20	83.20
July	450.00	30	27.23	21.13	86.74	86.77
August	304.00	29	27.48	21.13	88.19	86.54
September	68.00	4	30.33	20.33	88.53	86.73
October	56.90	10	30.17	20.87	87.93	85.43
November	2.20	1	31.43	18.10	83.57	74.33
December	0.00	0	31.03	14.06	80.51	74.06

Yercaud

Latitude : 11.4' N
Longitude : 78.5' E
Altitude : 1450 m MSL
Soil type : Clay loam

Month	Rainfall days (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	
January	4.0	1	Data is	Data is	Data is
February	-	-	not	not	not
March	4.0	1	available	available	available
April	72.6	7			
May	142.1	6			
June	64.0	10			
July	244.0	9			
August	143.0	11			
September	165.0	11			
October	149.4	13			
November	42.0	3			
December	60.0	5			

Coimbatore

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	-	5	30.3	19.7	87	44
February	-	-	33.5	20.0	87	37
March	-	-	35.3	22.1	80	35
April	96.0	5	34.7	23.6	87	42
May	6.5	1	35.0	23.5	82	44
June	52.6	5	31.2	22.1	78	52
July	19.9	3	31.2	22.7	80	54
August	22.8	4	31.4	22.1	85	53
September	96.6	4	32.7	22.3	89	50
October	286.7	6	31.0	22.1	90	61
November	136.6	10	29.5	21.6	92	63
December	16.1	2	28.2	18.7	90	55

Chintapalli

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	3.1	1	27.9	10.5	84	46
February	-	-	31.6	10.2	81	34
March	36	3	31.2	17.1	78	41
April	42.5	6	32.2	18.5	78	52
May	110.5	6	35.7	21.7	67	49
June	94.3	9	28.7	22.2	83	72
July	128.7	7	27.4	21.6	85	75
August	144.5	15	26.3	21.6	89	81
September	173.3	12	28.8	20.6	89	76
October	162.6	14	27.5	20.3	90	76
November	26.5	2	25.8	17.1	88	65
December	—	—	26.7	9.8	82	44

Guntur

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	0.00	-	30.80	15.36	90	56
February	0.00	-	34.24	18.43	87	49
March	0.00	-	36.26	24.41	85	66
April	30.20	1	36.40	25.61	88	66
May	0.00	-	42.66	29.10	78	60
June	131.00	5	37.51	26.46	74	62
July	155.00	6	34.24	24.90	80	64
August	278.80	12	33.32	24.08	89	83
September	104.00	7	34.57	24.61	90	82
October	153.90	8	32.50	23.98	92	80
November	64.70	3	31.73	21.52	89	78
December	1.40	-	30.14	16.96	89	80

Solan

Latitude : 30.5° N
Altitude : 1000 m MSL

Longitude : 77.8° E
Soil type : Loam

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	
January	25.8	2	19.8	50.0	1.8
February	5.0	1	22.5	41.0	4.3
March	56.5	3	24.5	45.0	7.4
April	59.4	5	28.8	47.7	12.7
May	100.8	5	31.7	55.7	17.2
June	306.6	12	-	75.3	18.5
July	144.6	13	28.4	85.3	20.7
August	191.0	7	28.7	79.2	20.1
September	-	-	29.7	79.5	15.2
October	-	-	28.2	54.5	11.8
November	-	-	24.5	57.5	6.5
December	-	-	20.2	668.4	4.3

Pottangi

Latitude : 18°34 N
Altitude : 917 m MSL

Longitude : 82°C 52 E
Soil type : Sandy Loam

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	
January	Nil	Nil	24.6	10.4	81.0
February	Nil	Nil	28.0	11.0	84.0
March	49.50	5	30.0	18.0	82.0
April	79.20	6	32.6	21.6	81.0
May	114.50	7	39.0	24.10	81.0
June	498.40	21	31.2	20.6	81.0
July	403.00	21	26.8	18.0	94.0
August	214.00	26	24.4	16.0	96.0
September	179.70	18	24.0	16.2	87.0
October	117.10	14	22.0	17.2	84.0
November	86.50	8	21.0	17.1	82.0
December	Nil	Nil	20.0	9.8	82.0

Jobner

Latitude : 23.52° N
Altitude : 90.6 m MSL

Longitude : 72.43° E
Soil type : Sandy Loam

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	
January	-	-	22.1	2.1	61
February	-	-	27.4	7.7	48
March	-	-	32.3	12.6	40
April	6.4	2	36.4	28.7	46
May	31.4	3	39.2	24.7	61
June	49.2	5	37.3	25.5	61
July	157.5	11	31.6	25.5	77
August	74.0	6	34.9	23.9	71
September	5.2	1	36.3	20.9	51
October	-	-	35.4	15.6	46
November	-	-	30.0	9.0	58
December	-	-	26.2	5.9	56

Jagudan

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)	
			Max.	Min.
January	-	-	27.3	11.2
February	-	-	31.4	11.3
March	-	-	34.7	17.2
April	-	-	36.4	24.3
May	16	1	39.6	25.2
June	178	3	36.8	26.2
July	306	18	29.8	26.1
August	228	5	31.1	26.4
September	-	-	33.4	25.3
October	11	1	36.3	22.3
November	-	-	33.7	16.0
December	-	-	28.7	12.4

Hisar

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	46.6	3	35.6	16.4	59.0	24
February	102.7	7	40.2	22.9	58.0	28
March	168.7	10	36.3	23.3	77.0	54
April	209.8	9	34.8	24.5	82.0	64
May	133.3	6	34.4	23.5	82.0	62
June	26.2	2	36.4	21.6	78.0	41
July	2.5	1	34.6	17.6	83.0	31
August	0	0	29.7	9.4	78.0	26
September	0	0	22.8	6.3	83.0	49
October	0	0	19.8	4.5	87.0	58
November	35.2	4	22.5	6.4	93.0	54
December	2.1	2	29.4	11.5	94.5	35

Dholi

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	7.5	2	7.6	20.8	89	39
February	0	0	10.6	25.9	88	42
March	0	0	14.1	31.2	80	33
April	6.0	1	20.4	36.1	73	32
May	190.6	12	24.6	33.0	82	57
June	287.5	12	26.5	33.2	87	67
July	342.5	15	27.2	33.4	86	70
August	222.5	12	27.2	34.0	90	74
September	411.0	15	26.1	32.1	90	75
October	264.5	5	23.9	30.9	90	65
November	0	0	17.3	28.8	92	55
December	0	0	11.1	21.2	91	65

Kumarganj

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

Month	Rainfall days (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Max.	Min.	
January	4.3	1.0	21.2	5.3	70.3
February	3.3	1.0	26.3	8.7	62.1
March	0.0	0.0	31.9	12.9	50.4
April	3.8	1.0	37.8	19.4	35.5
May	43.8	8.0	36.9	24.4	56.4
June	385.5	15.0	38.1	25.2	58.3
July	297.8	16.0	33.0	26.4	82.8
August	106.0	9.0	33.3	26.6	80.1
September	126.2	6.0	33.0	24.7	78.2
October	39.8	4.0	33.2	21.6	76.9
November	5.3	1.0	29.2	13.5	70.1
December	0.0	0.0	23.3	6.7	72.3

Pundibari

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	0	0	23.1	8.0	97.0	55.0
February	0	0	25.9	11.5	95.0	49.0
March	1	45.0	30.4	14.0	87.0	41.0
April	5	233.4	31.6	19.6	86.0	54.0
May	11	447.1	31.4	21.2	96.0	64.0
June	12	493.6	31.8	28.8	95.0	68.0
July	16	314.1	32.5	23.2	94.0	70.0
August	13	295.1	32.8	23.1	95.0	69.0
September	13	465.4	31.4	21.4	96.0	77.0
October	10	266.1	30.3	18.6	94.0	70.0
November	0	0	28.8	13.4	93.0	57.0
December	0	0	25.4	9.2	96.0	43.0

Dapoli

Month	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	Dry	Wet
January	0.0	30.2	13.6	97.0	59
February	0.0	30.6	11.6	96.0	74
March	0.0	30.3	14.8	93.0	79
April	0.0	33.9	19.9	94.0	79
May	80.1	32.2	22.0	87.0	64
June	410.0	29.2	23.2	92.0	83
July	882.5	27.5	22.7	93.0	88
August	741.4	26.3	21.4	97.0	83
September	233.8	28.7	22.0	98.0	81
October	61.6	31.8	20.4	92.0	68
November	0	33.4	17.2	92.0	48
December	0	32.8	14.2	94.3	45

Raigarh

Latitude : 21° 15' N
Longitude : 82°55' E
Altitude : 237 m MSL
Soil type : Sandy Loam with acidic in nature

Month	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	Max.	Min.
January	0.762	28.77	9.54	78.03	39.61
February	Nil	32.82	10.28	74.57	29.21
March	4.064	35.67	20.19	80.77	36.51
April	1.27	40.1	24.2	72.46	27.76
May	2.032	42.42	28.12	70.48	28.51
June	43.973	33.03	26.13	82.4	68.03
July	54.86	31.06	25.12	87.51	33.19
August	22.85	31.64	25.67	86.54	75.74
September	7.62	33.46	25.73	85.43	66.87
October	6.096	32.66	21.80	83.12	64.64
November	Nil	29.77	19.36	82.3	63.9
December	Nil	29.48	17.29	79.09	64.03

Ambalavayal

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	0	Nil	27.6	89	47	16.0
February	47.2	3	29.4	94	51	18.2
March	12.0	2	30.7	90	49	18.7
April	206.2	8	29.9	93	62	19.1
May	101.6	9	28.6	94	69	19.5
June	232.0	21	24.9	94	80	18.6
July	312.4	19	24.5	94	83	18.3
August	194.1	19	24.3	97	85	18.7
September	140.8	9	26.8	93	73	18.4
October	100.2	11	26.3	95	74	18.7
November	88.8	9	26.8	94	66	17.8
December	Nil	Nil	26.6	86	50	16.0

COORDINATING CENTRES UNDER AICRP ON SPICES

HEADQUARTERS: **Project Coordinator (Spices)**
All India Coordinated Research Project on Spices
Indian Institute of Spices Research, Calicut-673 012, Kerala
Phone: Off. (0495) 2731794, Res. (0495) 2373973
Fax: 0091-495-2731794
E-mail: pcspices@yahoo.com/aicrps@iisr.org/
kvramana20@yahoo.co.uk/ramana@iisr.org/shiva@iisr.org

	AICRPS CENTRE	Telephone	Fax/E.mail/Grams
1	Cardamom Research Station Kerala Agricultural University PAMPADUMPARA-685 553 Dist. Idukki, Kerala	(04868) 236263 (O) (0471) 2479846 (R)	
2	Pepper Research Station Kerala Agricultural University PB No.113 Kanjirangadu (P.O) PANNIYUR - 670 142 Taliparamba, Dist. Cannanore, Kerala	(954982) 227287 (O) (954972) 2741821(R)	Fax: 04982-227287 E-mail: prcp@sify.com
3	Regional Research Station Univ. of Agrl.Sciences, Bangalore MUDIGERE-577 132 Dist. Chickmangalur, Karnataka	(08263) 328246 (O) (08263) 328008(R)	Fax: 91-803330277 (Director of Research)
4	Agricultural Research Station (Pepper), Univ. of Agril. Sciences Dharwad SIRSI-581 401 Dist. Uttara Kannada, Karnataka	(08384) 426767 (O) (08384) 482648 (R)	E-mail: arsp@sancharnet.in
5	Horticultural Research Station Tamil Nadu Agril. University YERCAUD – 636 602 Dist. Salem, Tamil Nadu	(04281) 222456 (O) (04182) 222456 (R)	Fax: (04281) 222387 Gram : Farmvar E-mail: krnarayanan_2001@yahoo.com Kr-narayanan@hotmail.com
6	Dept. of Spices & Plantation Crops Horticultural College and Research Institute Tamil Nadu Agril. University COIMBATORE – 641 003, Tamil Nadu	(0422) 2431222 – Extn.284 (O) (0422) 2456026 (R)	Fax: (0422) 2445414 Gram: FARMVAR E-mail: drnc_hort2002@yahoo.co.in

7	Regional Agrl. Research Station Acharya N G Ranga Agrl. University CHINTAPALLE - 531 111, Dist Visakha, Andhra Pradesh	(08937) 238244 (O) (08937) 238258 (R)	Fax: (08937) 238244 Gram : AGRIVARSITY
8	Regional Agril. Research Station Acharya N.G. Ranga Agril. University JAGTIAL-505 327 Dist. Karimnagar, Andhra Pradesh	(08724) 277281, 277283 (O) (08724) 277280 (R)	Fax: (08274) 277283 Gram: AGRIVARSITY Email: basireddy_angru@yahoo.com adrjgl@rediffmail.com
9	Regional Agril. Research Station Acharya N. G. Ranga Agril. University GUNTUR – 522 034 Andhra Pradesh	(0863) 2524053 (O) (0863) 2357896 (R)	Fax: (0863) 2524073 E-mail: adrlamfarm@redoffmail com adrlamfarm@yahoo.com
10	Department of Vegetable Crops Dr YS Parmar Univ. of Horticulture & Forestry, Nauni, SOLAN-173 230, Himachal Pradesh	(01792) 252329 (O) (01792) 229240 (R)	Fax: (01792) 252242 Gram: VANUDYAN, SOLAN Email: vgc@yspuhf hp nic.in
11	High Altitude Research Station Orissa Univ.of Agrl & Technology POTTANGI-764 039 Dist. Koraput, Orissa	(06853) 252565 (O) (06853) 223348 (DR)	Fax· (0674) 2407780 (VC)
12	Dept of Genetics & Plant Breeding, SKN College of Agriculture Rajasthan Agricultural University JOBNER-303 329 Dist Jaipur, Rajasthan	(01425) 254041 (O) (0141) 2341910 (R)	Fax (01425) 254022 Gram· AGRICOL, JOBNER
13	Main Spices Research Station Gujarat Agricultural University JAGUDAN – 382 710 Dist Mehsana, Gujarat	(02762) 285337 (O)	Fax. (02748) 278261 (VC) (079) 2865588 (DR)
14	Department of Vegetable Crops Chaudharay Charan Singh Haryana Agril University HISAR – 125 004, Haryana	(01662) 237720-26 (Ext. 4207) (O) (01662) 227196 (R)	Fax. 01662 234613 Gram: AGRIVARSITY, HISAR Email. vegcrops@hau.nic.in
15	Department of Horticulture Tirhut College of Agriculture Rajendra Agrl University DHOLI-843 121, Musaffarpur, Bihar	(0621) 2293227 (O)	Fax: (0621) 2293227 Gram: DHULI COLLAGRI

16	Department of Vegetable Science Narendra Dev University of Agril. & Technology, Narendra Nagar Post, KUMARGANJ, Faizabad-224 229, Uttar Pradesh	(05270) 262076, 262067, 262164(O) (05270) 262053, 262459 (R)	Fax: (05270) 262331 E-mail: nduat@up.nic.in
17	Department of Horticulture Uttar Banga Krishi Viswa Vidyalaya North Bengal Campus PUNDIBARI – 736 165 P.O, Dist., Cooch Behar, West Bengal	(03582) 270246/ 270249/270157 (O) (03582) 231945 (R)	Fax: 03582-270246/270249/225471 Gram: PUNDIBARI E-mail: slg_samrat3@sancharnet.in
18	Department of Horticulture Konkan Krishi Vidyapeeth DAPOLI – 415 712 Dist. Ratnagiri, Maharashtra	(02358) 282026, Ext.448 (02358) 282705 (R)	Fax: 02358-282074 Gram: PRINAGRI, DAPOLI
19	Regional Agril. Research Station Indira Gandhi Krishi Vishwa Vidyalaya Boirdadar Farm, RAIGARH – 496 001 Dist. Raigarh, Chattisgarh.	(07762) 222402 (O) (07762) 222402 (R)	Fax: (07762) 224886

VOLUNTARY CENTRES

1. Regional Agricultural Research station
   Kerala Agril. University
   AMBALAVAYAL – 673 593
   Dist. Wynadu, Kerala

2. Horticultural Research Station
   Tamil Nadu Agricultural University
   THADIYANKUDISAI – 624 212
   Tamil Nadu

3. ICRI Regional Station
   Spices Board (Govt. of India)
   Donigal Post, SAKLESHPUR – 573 134
   Karnataka

4. Agricultural Research Station
   Tamil Nadu Agricultural University
   BHAVANISAGAR – 638 451
   Tamil Nadu

5. Horticultural Research Station
   Tamil Nadu Agricultural University
   PECHIPARAI – 629 161
   Kanyakumari Dist., Tamil Nadu

6. Indian Cardamom Research Institute
   Regional Research Station
   THADIYANKUDISAI – 624 212
   Tamil Nadu

7. Indian Cardamom Research Institute,
   MYLADUMPARA
   Kailasanadu – 685 553
   Dist Idukki., Kerala

8. ICRI Regional Station
   Yakthung, Tadong,
   GANGTOK – 737 101
   Sikkim