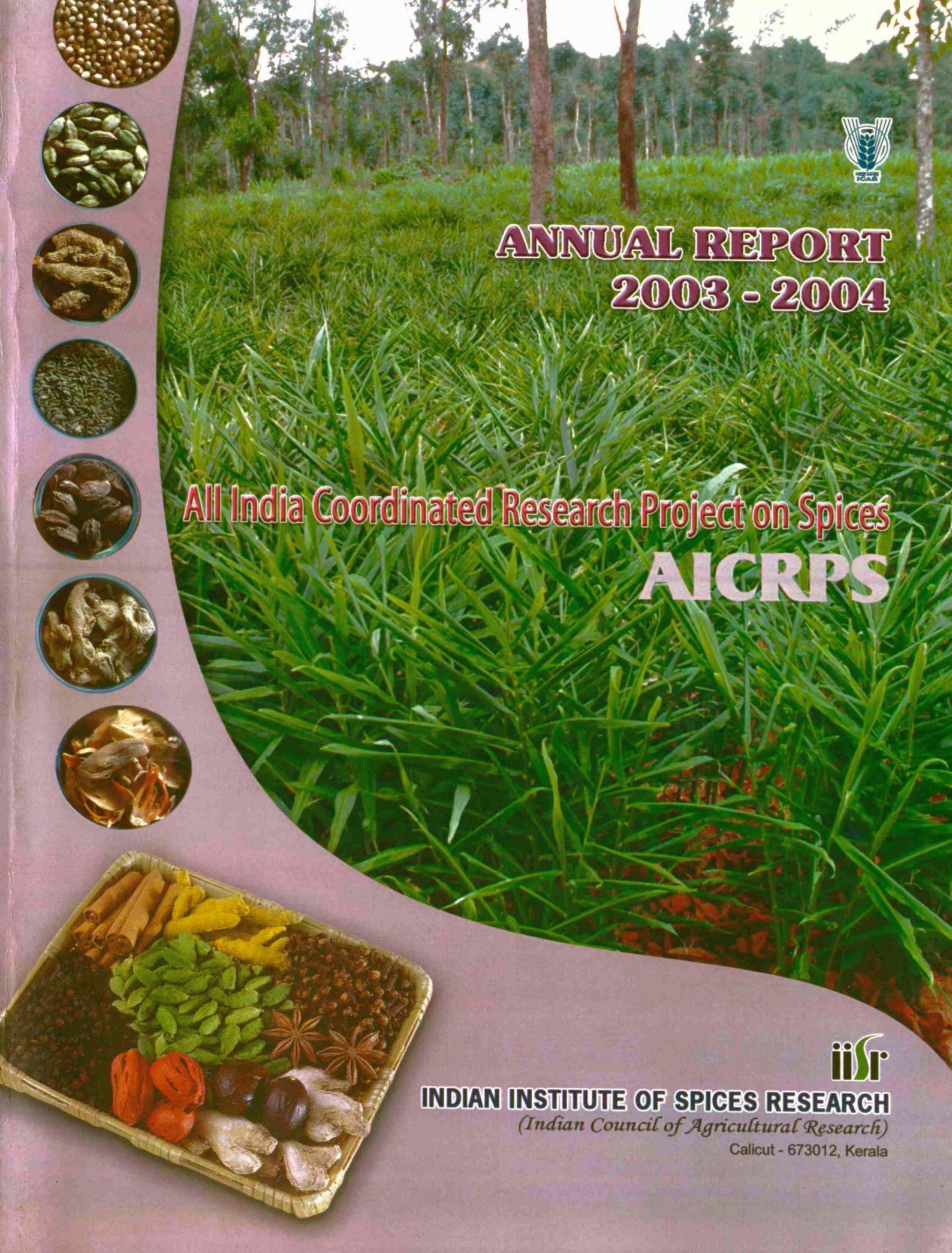

ANNUAL REPORT
2003 - 2004

All India Coordinated Research Project on Spices
AICRPS

INDIAN INSTITUTE OF SPICES RESEARCH
(Indian Council of Agricultural Research)
Calicut - 673012, Kerala

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

Published by

Dr V. A. Parthasarathy
Director & Project Coordinator (Spices)
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, 2004
Annual Report, 2003-2004
Indian Institute of Spices Research,
Calicut, Kerala

June 2005

Printed at
Ideal Printers
Calicut, Ph : 2301715

CONTENTS

परियोजना समन्वयक की रिपोर्ट

अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना (ए आई सी आर पी एस) देश के समाला अनुसंधान का सबसे बडा नेटवर्क होता हैं। यह परियोजना 1971 (IV योजना) म मसाले और काजू की संयुत्क परियोजना के रूप में शुरु हुई। यह दो अलग परियोजना के रूप में विभाजित किया जिनमें एक मसाले और काजू दोनों के लिए 1985 में शुरु हुई तब से भारतीय मसाला फसल अनुसंधान संस्थान (आई आई एस आर), कालिकट के सुख्यालय बनाकर एक पूर्णकालिक समान्वयक के साथ ए आई सी आर पी एस चालू हो गया।

ए आई सी आर पी एस अन्तर्गत आब 15 राज्यों में व्याप्त कृषि विश्व विघ्यालय के आधार पर केन्द्र चालू हो रहे हैं। इसके अलावा आठ सहकारी / स्वेच्छा से आये केन्द्र, जिसमें बडी इलायची के लिए आई सी ए आर रिसर्च काम्प्लक्स, गोआ भी शामिल है, इस परियाजना के साथ सहयोगी कार्य कर रहे है। एं आई सी आर पी एस का कुल स्टाफ 83 होता है जिसमें 51 वैज्ञानिक तथा 32 तकनीकी / सहकारी स्टाफ होते है। प्रत्येक केन्द्र का 75% व्यय भारतीय कृषि अनुसंधान परिषद से तथा बचे हूए व्यय संबन्धित राज्य कृषि विश्व विघालय से दिया जाता है। इस परियोजना के लिए वर्ष 2003-2004 की 163.66 बजट लाख रूपए है जिसमें 123.00 लाख रूपए आई सी ए आर का आंश होता हैं।

इस परियोजना का अधिदेश निम्नांकित द्वारा राज्य में मसालों का उत्पादन क्षेत्र, उत्पादन और उत्पादकता में वृद्धि लाना हैं।

१. विभिन्न कृषि पारिस्थितिक दशाओं केलिए उचित गुणवत्तावाले कीट या रोग सह्य उच्च उपजवाले किस्मों को विकसित करना।

२. विभिन्न कृषि - जलवायु की दशाओं को अन्तर्गत आनेवाले मसाला फसलों के लिए कृषि प्रविधियों को मानकीकृत करना।

३. मूल्य प्रभावित एवं कीट और रोगों के लिए कुशाल प्रबन्धन तरीकों को विकसित करना।

४. राज्य कृषि विश्व विध्यालय, आई आई एस आर एवं आई सी ए आर के बीच अन्तराफलक के रूप में काम करना।

ए आई सी आर पी एस ने मसाला फसलों के जननिक संसाधनों को प्रबल दिया तथा विभिन्न प्राचल (उपजता, गुणवत्ता, कीट / रोगों की प्रतिक्रिया) केलिए जर्मप्लासम का मूल्यांकन किया और प्रत्येक फसल के आशाजनक अक्सशनों की पहचान भी की गयी। ए आई सी आर पी एस के विभिन्न केन्द्रों के जर्मप्लासम में अब काली मिर्च -550, इलायची-386, अदरक-568, हल्दि-1252, वृक्ष मसाले-170, और बीज मासाले-3841, आदि उपलब्द है। केन्द्रों में उपजता के लिए पहचान किये आशजनक किस्मों / प्रविष्टियां निम्न प्रकार हैं।

ए आई सी आर पी एस के विभिन्न केन्द्रों में उपजता के लिए पहचान किये आशाजनक प्रविष्टियाँ (किस्में/प्रजातियाँ)

केन्द्र	फसल	प्रिविष्टि	उपजता	परिक्षण प्रकार
जोबनर	धनिया	यु डी - 480	1014.33 कि ग्राम / होक्टर	सी वी टी
		यु डी - 796	1259.33 कि ग्राम / होक्टर	आई ई टी
		यु डी - 797	1129.67 कि ग्राम / होक्टर	आई ई टी
		यु डी - 728	1029.33 कि ग्राम / होक्टर	आई ई टी
	जीरा	यु सी - 310	385.5 कि ग्राम / होक्टर	सी वी टी
		जो सी - 2000-02	275.5 कि ग्राम / होक्टर	सी वी टी
		यु सी - 345	382.0 कि ग्राम / होक्टर	आई ई टी
		सी एम बी - 79 & आर ईज़ड - 19	308.0 कि ग्राम / होक्टर	आई ई टी
	सैंफ	यु एक - 178	1675 कि ग्राम / होक्टर	सी वी टी
		यु एक - 177	1515 कि ग्राम / होक्टर	सी वी टी
	मेथी	यु एम - 351	1944.67 कि ग्राम / होक्टर	सी वी टी
		यु एम - 352	1797.00 कि ग्राम / होक्टर	सी वी टी
		एन एस - 4	2041.67 कि ग्राम / होक्टर	आई ई टी
		आर टी पी - 5	2013.67 कि ग्राम / होक्टर	आई ई टी
पोटांगी	आदरक	वी$_2$ ई$_5$ - 2 दुरिया लोकल	12.75 कि ग्राम 3 मीटर^2 / बेड	जर्मप्लासम
		वी$_1$ ई$_8$ - 2	21.85 टन / होक्टर (साफ़)	सी वी टी
		वी$_2$ ई$_5$ - 2	22.41 टन / होक्टर (साफ़)	आई ई टी
	हल्दी	पी टी एस - 11	25.19 टन / होक्टर (साफ़)	सी वी टी
		पी टी एस - 39	25.08 टन / होक्टर (साफ़)	आई ई टी
गुंटूर	धनिया	एल सी सी - 220	1152 टन / होक्टर (साफ़)	जर्मप्लासम
		एल सी सी - 216	1127 टन / होक्टर (साफ़)	आई ई टी
		एल सी सी - 174	1081 कि ग्राम / होक्टर	सी वी टी
		एल सी सी - 128	1075 कि ग्राम / होक्टर	सी वी टी
	मेथी	एल सी सी - 84	1175 कि ग्राम / होक्टर	आई ई टी
		जो एक - 244	1103 कि ग्राम / होक्टर	सी वी टी
पन्नियूर	काली मिर्च	वलियारा मुंडी	6.420 कि ग्राम / बेल (साफ़)	जर्मप्लासम
कुमानगंज	हल्दि	एन डी एच - 18	40.17 टन / होक्टर (साफ़)	सी वी टी
	धनिया	के - चयन	2170 कि ग्राम / होक्टर	सी वी टी
	सौंफ	एन डी एक - 5	2520 कि ग्राम / होक्टर	जर्मप्लासम
		जे फेन - 210	2060 कि ग्राम / होक्टर	सी वी टी

	मेथी	एच एम - 114	2214 कि ग्राम / होक्टर	सी वी टी
चिंतापल्ली	आदरक	सुप्रभा	13.8 टन / होक्टर	सी वी टी
अम्बलवयल	काली मिर्च	पंचमी	0.801कि ग्राम / बेल (साफ़)	सी वी टी
धपोली	काली मिर्च	पन्नियूर - 1	1050 कि ग्राम / बेल (सूखे)	सी वी टी
जगतियाल	हल्दी	आर एच - 5	41.66 टन / होक्टर (साफ़)	सी वी टी
		जे टी एस - 12	32.66 टन / होक्टर (साफ़) (लंबी अवधि)	सी वी टी
		जे टी एस - 612	27.66 टन / होक्टर (साफ़)	सी वी टी
हिसार	धनिया	डि एच - 242	2110 टन / होक्टर (साफ़)	आई ई टी
		डि एच - 205	1710 कि ग्राम / होक्टर	सी वी टी
राइगढ	हल्दी	आई टी - 1	25.51 टन / होक्टर	जर्मप्लासम
		आई टी - 1	24.94 टन / होक्टर	सी वी टी
हिसार	सौंफ	एच एफ - 125	2100 कि ग्राम / होक्टर	आई ई टी
		एच एम - 292	2920 कि ग्राम / होक्टर	आई ई टी
		हिसार सोनाली	1805 कि ग्राम / होक्टर	सी वी टी
येरकाड	काली मिर्च	पि एन - 2	11.6 कि ग्राम / बेल (साफ़) 3.55 कि ग्राम / बेल (सूखे)	जर्मप्लासम
कोयंबतोर	हल्दी	सी एल - 101	44.1 टन / होक्टर (साफ़)	जर्मप्लासम
	धनिया	सी एस - 104	870 कि ग्राम / बेल (सूखे)	जर्मप्लासम
		यू डी - 743	794.53 कि ग्राम / होक्टर	सी वी टी
	मेथी	जो एक - 270	567 कि ग्राम / होक्टर	सी वी टी
धोली	हल्दी	आर एच - 9/90	40.06 टन / होक्टर (साफ़)	आई ई टी
	धनिया	के चयन	1830 कि ग्राम / होक्टर	सी वी टी
	मेथी	एच एम - 444	1690 कि ग्राम / होक्टर	सी वी टी
		आर एस - 70	1680 कि ग्राम / होक्टर	आई ई टी
जगुदान	जीरा	जे सी - 2000-72 (जी सी - 4)	1063 कि ग्राम / होक्टर	सी वी टी
	सौंफ	जो एफ - 332	2233 कि ग्राम / होक्टर	सी वी टी
	मेथी	जे फेन - 239	2075	सी वी टी
पुंडिबारी	आदरक	गोरीबदन	15.69 टन / होक्टर (साफ़)	सी वी टी
	हल्दी	टी सी पि - 11	15.68 टन / होक्टर (साफ़)	सी वी टी

मसानो के लिए गुणवत्ता प्रचलों के लिए पहचान किये आशाजनक प्रिविष्टियों का विविरण निचे दिया जाता हैं।

ए आई सी आर पी एस केन्द्रों में गुणवत्ता प्राचलों के लिए पहचान किये आशाजनक प्रविष्टियाँ

केन्द्र	फसल	प्रिविष्टि	गुणवत्ता प्राचल
जोबनर	धनिया	डी एच - 234	0.55% (वाष्पशील तेल)
		एन डी - 2	0.55% (वाष्पशील तेल)
		यू डी - 118	0.53% (वाष्पशील तेल)
		यू डी - 92, यू डी - 529	0.50% (वाष्पशील तेल)
		यू डी - 42, यू डी - 796	
	जीरा	यू सी - 310	5.0% (वाष्पशील तेल)
		जो सी - 2000-21, जो सी - 2000-22	4.58% (वाष्पशील तेल)
		जो सी - 2000-72, आर ईजड़ - 19	
		यू सी - 231	4.5% (वाष्पशील तेल)
	सौंफ	एच एक - 116	2.50% (वाष्पशील तेल)
		यू एक - 117	2.42% (वाष्पशील तेल)
		एन डी एक - 6	2.33% (वाष्पशील तेल)
सोलन	आदरक	एस जी - 875	22.59% (सूखे उपज)
		एस जी - 686	6.00% (कच्चा तेल)
		एस जी - 686, 882 & 825	2.00% (सुगंधित तेल)
		एस जी - 882	8.00% (ओलिओरसिन)
	हल्दि	सी एल पुरम	22.59% (सूखे प्राप्ति)
		एस आई - 402	7.75% (सुगंधित तेल)
		बी डी जे आर - 1250	7.70% (ओलिओरसिन)
		सी एल पुरम	15.00% (ओलिओरसिन)
		बी डी जो आर- 1260	4.99% (कुरकुमिन)
कोयंबतोर	हल्दि	सी एल - 67	6.05% (कुरकुमिन)

फसल उत्पादन

काली मिर्च में जैवउर्वरक लगाने के परीक्षण में, 100% अजैव उर्वरक के साथ असोस्पिरिल्लम 50 ग्राम/पी सोलुबिलैसेर्स 50 ग्राम लगाने पर उच्चतम उपजता (क्रमशः) 7.13 कि ग्राम स्वच्छ / बेल और 6.91 कि ग्राम स्वच्छ / बेल) अंकित की है। जैव खेत परीक्षण में FYM 10 कि ग्राम के साथ जले हुए। कज्जलित मिट्टि 50 कि ग्राम लगाने पर सिरसी केन्द्र में 6.24 कि ग्राम स्वच्छ / बेल के दर में उच्चतम प्राप्त हुई। पन्नियूर में अजैव नाइट्रोजन 100% के साथ असोस्पिरिल्लम 50 ग्राम या पी सोलुबिलैसर्स 50 ग्राम और 10 कि ग्राम FYM लगाने पर अधिकतम स्पाइक उपजता प्राप्त हुई। फिर भी जैव खेत परीक्षण में संस्तुत POP अधिकतम स्पाइक उपजता (कि ग्राम/ बेल) देनेवाले पंजीकृत की। पोटांगी केन्द्र में, अदरक के लिए संस्पुत मात्रा में उर्वरक (RDF) (18.27 टन /

होक्टर) एवं उसके बाद अजैव नाईट्रोजन (100%) के साथ असोस्पिरिल्लम (50 ग्राम) और 5 कि ग्राम FYM (12.70 टन / होक्टर) लगाने पर उच्चतम राइसोम उपजता प्राप्त इई। फिर भी राइगढ और पुंडिबारी केन्द्रों में अजैव नाइट्रोजन उच्चतम उपजता (100%) के साथ असोस्पिरिल्लम (50 ग्राम) और 5 FYM (20.05 टन / होक्टर) की अधिकतम उपजता प्राप्त हुई। धोली में FYM (10 कि ग्राम) के साथ पोनागामिया ओयल कैक (250 ग्राम) और नीम तेल का कैक (250 ग्राम) और स्टरामील (250 ग्राम) और रॉक फॉस्फेट (250 ग्राम) और लकडी का राख (250 ग्राम) 3 मीटर^2 के प्रत्येक बेड़ में लगाने पर अधिकतम स्वच्छ उपजता (12.72 टन / हेक्टर) प्राप्त होता है। धेली की जलवायु में 10 कि ग्राम / होक्टर के दर में सिंक मिट्टी में लगाने पर अधिकतम उपजता (18.75 टन / होक्टर) उत्पादित होती है।

पत्रियूर और कुमारगंज केन्द्रों में 100% नाइट्रोजन और 5 ग्राम असोस्पिरिल्लम और 50 कि ग्राम FYM के साथ संस्तुत मात्रा में उर्वरक भी लगने पर उच्चतम स्वच्छ राइसोम उपजता अंकित की।

विभिन्न केन्द्रों के बीज मसालों में 100% आजैव नाइट्रोजन (60 कि ग्राम / हेक्टर) और असोस्पिरिल्लम (बीज उपचार के रूप में 5 कि ग्राम / हेक्टर) लगाने पर अधिकतम बीज उपजता प्राप्त होती है। कुमारगंज केन्द्र में धनिया के लिए $CuSo_4$ मिट्टी में (12.5 कि ग्राम / हेक्टर) लगाने और पत्तों पर (0.25%) छिडकने से उच्चतम बीज उपजता (1.94 टन / हेक्टर) प्राप्त होती है।

फसल संरक्षण

मुडिगरे केन्द्र में काली मिर्च में काली मिर्च में फाइटोफथोरा रोग के प्रति रिडोमिल MZ 72 WP (1.25 ग्राम / लिटर) 5 लिटर/बेल के दर में अकेले और टा हरडजियानम (50 ग्राम) एक कि ग्राम नीम कैक के साथ संयोग में प्रति बेल के लिए जून और सितंबर में छिडकने या भिगो देने पर अच्छा प्रभाव देखा गया।

कुमारगंज और पुंडिबारी केन्द्रों में, हल्दि में मानकोसेब और कारबन्डासिम के साथ बीज उपचार और 2-3 बार पत्तों पर छिडकाव (0.2%) करने से पर्ण दाग और पर्ण चित्ति रोग के प्रति बहुत प्रभाव देखा गया। जगतियाल केन्द्र में हल्दी में NPK 125:60:90 कि ग्राम/हेक्टर + FYM 10 टन / हेक्टर + टि विरिडे + प्स्यूडोमोनस फलूरोसन्स @40 ग्राम / कि ग्राम / हेक्टर बीज उपचार के रूप में लगाने के साथ + टी विरिडे + पी फलरोसन्स 5 कि ग्राम / हेक्टर मिट्टी में लगाने पर (तट पर और फसल में खाद विखेरने पर) उच्च उपजता (28.60 टन / हेक्टर) के साथ राइसोम गलन का कम आपतन (11.70%) भी देखा जाता है। कोयंपतोर केन्द्र में पी फलूरोसन्स @10 ग्राम/ कि ग्राम का बीज उपचार + पी फलूरोसन्स 5 कि ग्राम /हेक्टर मृदा में लगाने से धनिया के म्लानी रोग के प्रति प्रभावी जैव नियंत्रण एजेंट देखा गया।

कोयंबतोर में धनिया के पाउडरी मिल्ड्यू आपतन में नीम के बीज गारी सार (NSKE) (5%) तीन बार छिडकने पर, पहली बार रोग प्रभाव देखते ही छिडकना और दूसरी और तीसरी बार 15 दिन के अन्तराल में, प्रभावी फल देखा गया।

जोबनर केन्द्र में, धनिया में टी हरजियानम बीज उपचार एवं मृदा में लगाने पर अधिकतम बीज उपजता (819 कि ग्राम / हेक्टर) के साथ कम म्लानी आपतन (8.39%) अंकित किया। मेथी में प्रविष्टियों में यु एम - 351 और यु एम -3852 में मूल गलन डाउनी मिल्ड्यु और पाउडरी मिल्ड्यु के प्रति छान बीन परीक्षण करने पर कम आपतन के साथ अधिकतम बीज उपजता क्रमशः 1944 और 1797 कि ग्राम / हेक्टर अंकित किया।

कोयंबतोर में मेथी के लिए टि विरिडे (5 कि ग्राम / हेक्टर) और नीम केक 150 कि ग्राम / हेक्टर के दर में लगाने से मूल गलन आपतन कम होते देखा गया। विभिन्न केन्द्रों में कीट और रोग के प्रति पहचान किये प्रतिरोध / सह्य स्रोतें।

ए आई सी आर पी एस केन्द्रों में पहचान किये कीट और रोग के प्रतिरोधक / सह्य स्तोत

केन्द्र	फसल	कीट / रोग	प्रिविष्टि	प्रतिक्रिया
जगतियाल	हल्दि	राइसोम गलन	आर एच 5, एन डी एच 18 और टी सी पी - 2	प्रतिरोधक
			जे टी एस - 12, और जे टी एस -15 (दीर्ध अवधि)	प्रतिरोधक
			जे टी एस - 314, 320, 321, 235 & 319 (मध्यम अवधि)	प्रतिरोधक
			पी सी टी - 13, जे टी एस - 612 & 607 (ह्रस्व अवधि)	प्रतिरोधक
		कोलटोट्राइकम पर्ण दाग	पी टी एस - 11	प्रतिरोधक
			जे टी एस - 10 से 15 & Duggirala Red (दीर्ध अवधि)	प्रतिरोधक
			जे टी एस - 314 से 326 & सी एल आई 317 (मध्यम अवधि)	प्रतिरोधक
			जे टी एस - 607 से 612 & पी सी टि- 13 (ह्रस्व अवधि)	प्रतिरोधक
	तफ्रीना	पर्ण चित्ती	पी टी एस - 11, 15, 55, 52 & 59	प्रतिरोधक
			जे टी एस - 319 (मध्यम अवधि)	प्रतिरोधक
कोयंबतोर	हनदी	पर्ण दाग और पर्ण चित्ती	सी एल - 32, 34, 54 % 55	प्रतिरोधक
	धनिया	पाउडरी मिल्ड्यू	आक्स - 480 डी एच - 246, आर डी - 120 जे कोर - 3866,	प्रतिरोधक

इसके अलावा ए आई सी आर पी एस के विभिन्न केन्द्रो में विकसित २० तक नोलजियों के अलावा किसानों के खेत 14 समन्वय केन्द्रों द्वारा एक फ्रन्ड लाइन प्रदर्शनी आयोजित की। ए आई सी आर पी एस के अन्तर्गत एस ए यु / अन्य संधटन में आई सी ए आर ने छः आई सी ए आर तदर्थ योजना चालू की। हाल में चालू किये ए आई सी आर पी एस की कार्यशाला में, ए आई सी आर पी एस केन्द्रों की छः प्रविष्टियां / प्रजातियां नामतः धनिया में डी एच - 143 , जीरा में आर इजड -223 , सैंफ में एच एक -33 (हिसार), जी एक -11 (जगुदान) और आर एक -143 (जोबनर) और आर एम टी - 33 (जोबनर); छः प्रजातियां नामतः, काली मिर्च में आई आई एस आर - तेवम, आई आई एस आर - मलबार एक्सल, आई आई एस आर - गिरिमुंडा और पी - 24 और आई आई एस आर, कालिकट की हल्दी में आई आई एस आर - केदारम और आई आई एस आर - आलप्पी सुप्रीम; पाँच प्रविष्टियाँ नामतः कलौंजी में ए एन -01-1, सोआ में ए डी - 01-6 , एन आर सी बीज मसाला, अजमीर के अजवाइन में ए ए - 01-61 और ए ए - 01-19 आदि की पहचान की गयी और राज्य विमोचन के लिए संस्तुत किया।

PROJECT COORDINATOR'S REPORT

The All India Coordinated Research Project on Spices (AICRPS) is the largest network in the country in the spices research. 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.

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 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 25% of the expenditure is met by the respective State Agricultural Universities (SAUs). The budget of the project for the year 2003-2004 was Rs. 200.57 lakhs with Rs.151.00 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 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 centres under AICRPS and during the year 2003-04, the project made several achievements.

CROP IMPROVEMENT

The AICRPS strengthened the genetic resources of spice crops and the germplasm was subjected to evaluation of various parameters (yield, quality, reaction to pests / diseases) and promising accessions in each crop were identified. At present, the germplasm holdings of AICRPS centers consist of black pepper-550, cardamom-386, ginger-568, turmeric-1252, tree spices-170 and seed spices-3841. The promising lines/entries identified for yield at centers are given below:

Promising entries (varieties/lines) identified for yield at AICRPS centres

Centre	Crop	Entry	Yield	Trial type
Jobner	Coriander	UD-480	1014.33 kg ha^{-1}	CVT
		UD-796	1259.33 kg ha^{-1}	IET
		UD-797	1129.67 kg ha^{-1}	IET
		UD-728	1069.33 kg ha^{-1}	IET
	Cumin	UC-310	385.5 kg ha^{-1}	CVT
		JC-2000-22	275.5 kg ha^{-1}	CVT

Centre	Crop	Entry	Yield	Trial type
		UC-345	382.0 kg ha^{-1}	IET
		CMB-79 & RZ-19	308.0 kg ha^{-1}	IET
	Fennel	UF-178	1675 kg ha^{-1}	CVT
		UF-177	1515 kg ha^{-1}	CVT
	Fenugreek	UM-351	1944.67 kg ha^{-1}	CVT
		UM-352	1797.00 kg ha^{-1}	CVT
		NS-4	2041.67 kg ha^{-1}	IET
		RTP-5	2013.67 kg ha^{-1}	IET
Pottangi	Ginger	V_2E_5-2 & Turia local	12.75 kg 3m^2 bed^{-1}	Germplasm
		V_1E_8-2	21.85 t ha^{-1} (fresh)	CVT
		V_2E_5-2	22.41 t ha^{-1} (fresh)	IET
	Turmeric	PTS-11	25.19 t ha^{-1} (fresh)	CVT
		PTS-39	25.08 t ha^{-1} (fresh)	IET
Guntur	Coriander	LCC-220	1152 t ha^{-1} (fresh)	Germplasm
		LCC-216	1127 t ha^{-1} (fresh)	IET
		LCC-174	1081 kg ha^{-1}	CVT
		LCC-128	1075 kg ha^{-1}	CVT
	Fenugreek	LFC-84	1175 kg ha^{-1}	IET
		JF-244	1103 kg ha^{-1}	CVT
Panniyur	Black pepper	Valiyara mundi	6.420 kg $vine^{-1}$ (fresh)	Germplasm
Kumarganj	Turmeric	NDH-18	40.17 t ha^{-1} (fresh)	CVT
	Coriander	K-selection	2170 kg ha^{-1}	CVT
	Fennel	NDF-5	2520 kg ha^{-1}	Germplasm
		J.Fen-210	2060 kg ha^{-1}	CVT
	Fenugreek	HM-114	2214 kg ha^{-1}	CVT
Chintapalle	Ginger	Suprabha	13.8 t ha^{-1}	CVT
Ambalavayal	Pepper	Panchami	0.801 kg $vine^{-1}$ (fresh)	CVT
Dapoli	Pepper	Panniyur-1	1.050 kg $vine^{-1}$ (dry)	CVT
Jagtial	Turmeric	RH-5	41.66 t ha^{-1} (fresh)	CYT
		JTS-12 (long duration)	32.66 t ha^{-1} (fresh)	CVT
		JTS-314 (medium duration)	27.66 t ha^{-1} (fresh)	CVT
		JTS-612	27.66 t ha^{-1} (fresh)	CVT
Hisar	Coriander	DH-242	2110 kg ha^{-1}	IET

Centre	Crop	Entry	Yield	Trial type
		DH-205	1710 kg ha $^{-1}$	CVT
Raigarh	Turmeric	IT-1	25.51 t ha^{-1}	Germplasm
		IT-1	24.94 t ha^{-1}	CVT
Hisar	Fennel	HF-125	2100 kg ha^{-1}	IET
		HF-116	1880 kg ha^{-1}	CVT
	Fenugreek	HM-292	2920 kg ha^{-1}	IET
		Hisar Sonali	1805 kg ha^{-1}	CVT
Yercaud	Pepper	Panniyur-2	11.6 kg vine^{-1} (fresh)	Germplasm
			3.55 kg vine^{-1} (dry)	
		Panniyur-3	5.90 kg vine^{-1} (fresh)	
			1.6 kg vine^{-1} (dry)	CVT
Coimbatore	Turmeric	CL-101	44.1 t ha^{-1}(fresh)	Germplasm
	Coriander	CS-104	870 kg ha^{-1}	Germplasm
		UD-743	794.53 kg ha^{-1}	CVT
	Fenugreek	JF-270	567 kg ha^{-1}	CVT
Dholi	Turmeric	RH-9/90	40.06 tha^{-1} (fresh)	IET
	Coriander	K. Selection	1830 kg ha^{-1}	CVT
	Fenugreek	HM-444	1690 kg ha^{-1}	CYT
		RM-70	1680 kg ha^{-1}	IET
Jagudan	Cumin	JC-2000-72 (GC-4)	1063 kg ha $^{-1}$	CVT
	Fennel	JF-332	2233 kg ha $^{-1}$	CVT
	Fenugreek	J.Fenn-239	2075	CVT
Pundibari	Ginger	Gorubathan	15.69 tha^{-1} (fresh)	CVT
	Turmeric	TCP-11	15.68 t ha^{-1} (fresh)	CVT

The promising entries identified for quality parameters in spices are provided below:

Promising entries identified for quality parameters at AICRPS centres

Centre	Crop	Entry	Quality parameter
Jobner	Coriander	DH-234	0.55% (Volatile oil)
		ND-2	0.55% (Volatile oil)
		UD-118	0.53%(Volatile oil)
		UD-92,UD-529, UD-42&UD-796	0.50%(Volatile oil)

Centre	Crop	Entry	Quality parameter
	Cumin	UC-310	5.0%(Volatile oil)
		JC-2000-21 JC-2000-22	
		JC-2000-72 RZ-19	4.58%(Volatile oil)
		UC-231	4.5% (Volatile oil)
	Fennel	HF-116	2.50% (Volatile oil)
		UF-177	2.42% (Volatile oil)
		NDF-6	2.33% (Volatile oil)
Solan	Ginger	SG-875	22.59% (Dry matter)
		SG-686	6.00% (Crude fibre)
		SG-884	4.00 % (Max.) (Crude fibre)
		SG-686, 882 & 825	2.00 % (Essential oil)
		SG-882	8.00% (Oleoresin)
	Turmeric	CL-Puram	22.59% (Dry matter)
		SI-402	7.75% (Essential oil)
		BDJR-1250	7.70% (Oleoresin)
		CL-Puram	15.00 (Oleoresin)
		BDJR-1260	4.99% (Curcumin)
Coimbatore	Turmeric	CL-67	6.05% (Curcumin)

CROP PRODUCTION

In biofertilizer trials of black pepper, application of 100% inorganic fertilizers alongwith *Azospirillum* (50 g)/ P-solubilizers (50g) has recorded highest yield (7.13 kg fresh berry vine^{-1} and 6.91 kg fresh berry vine^{-1}, respectively). In an organic farming trial, FYM 10 kg + burnt/smoked earth 10 kg gave the highest yield of 6.24 kg fresh berry vine^{-1} at Sirsi Centre. At Panniyur, maximum spike yield was obtained with inorganic N 100% + *Azospirillum* (50 g)/P-solubilizers (50g) + 10 kg FYM. However, in organic farming trial, recommended POP registered maximum spike yield (6.067 kg vine^{-1}).

In ginger, highest rhizome yield was obtained with recommended dosage of fertilizers (18.27 t ha^{-1}), followed by inorganic N (100%) + *Azospirillum* (50 g) + 5 kg FYM (12.70 t ha^{-1}) at Pottangi centre. However, highest yield was obtained with inorganic N (100%) + *Azospirillum* (50 g) + 5 FYM (20.05 t ha^{-1}) at Raigarh and Pundibari centres. Application of FYM (10kg) + Pongamia oil cake (250 g) + neem oil cake (250g) + sterameal (250 g) + rock phosphate (250 g) + wood ash (250g) per 3 m^2 bed gave maximum fresh yield (12.72 t ha^{-1}) at Dholi. Also soil application of zinc @ 10 kg ha^{-1} produced maximum yield (18.75 t ha^{-1}) at Dholi conditions.

In turmeric, highest fresh rhizome yield was recorded with 100% N + 5g *Azospirillum* + 5 kg FYM, followed by recommended dose of fertilizers at Panniyur and Kumarganj centers.

Application of 100% inorganic N (60 kg/ ha) + *Azospirillum* (5 kg/ha as seed treatment) + FYM (5t/ha) gave maximum seed yield in

different seed spices at various centers. Application of $CuSO_4$ in soil (12.5 kg ha^{-1}) and foliar spray (0.25%) resulted in highest seed yield (1.94 t ha^{-1}) in coriander at Kumarganj centre.

CROP PROTECTION

Spraying and drenching with Ridomil MZ 72 WP (1.25 g/l) @ 5 litres/vine alone and in combination with *T. harzianum* (50g) alongwith one kg neem cake per vine during the first week of June and September was found effective against *Phytophthora* disease in black pepper at Mudigere centre.

In turmeric, treatment of seed rhizomes with mancozeb and carbendazim and 2-3 foliar sprays (0.2%) was found effective against leaf blotch and leaf spot diseases at Kumarganj and Pundibari centers. In turmeric, application of NPK 125:60:90 kg ha^{-1} + FYM 10 t ha^{-1} + *T. viride* + *Pseudomonas fluorescens* @ 4g kg ha^{-1} as seed treatment + *T. viride* + *P. fluorescens* applied to soil (12.5 kg & 25.0 kg ha^{-1} as basal and top dressing, respectively) resulted in lowest rhizome rot incidence (11.70%) with higher yield (28.60 t ha^{-1}) at Jagtial center. Seed treatment with *P. fluorescens* @ 10g kg^{-1} + soil application of *P. fluorescens* @ 5kg ha^{-1} was found effective biocontrol agents against coriander wilt at Coimbatore centre.

Spraying of neem seed kernel extract (NSKE) (5%) thrice, first spray immediately after the appearance of disease and second and third sprays at 15 days interval, thereafter was effective in checking the powdery mildew incidence in coriander at Coimbatore.

In coriander, minimum wilt incidence (8.39%) with maximum seed yield (819 kg/ha^{-1}) was recorded with the application of *T. harzianum* through seed treatment and soil application at Jobner center. In a screening test against root rot, downy mildew and powdery mildew diseases in fenugreek, the entries, UM-351 and UM-3852 were recorded minimum incidences with maximum seed yield of 1944 and 1797 kg ha^{-1}, respectively.

Soil application of *T. viride* (5 kg ha^{-1}) and neem cake @ 150 kg ha^{-1} was found effective in reducing root rot incidence in fenugreek at Coimbatore. The sources of resistance/tolerance identified at various centers against pests and diseases are given below:

Source of resistance/tolerance to pests and diseases identified at AICRPS center

Centre	Crop	Pest/disease	Entry	Reaction
Jagtial	Turmeric	Rhizome rot	RH-5, NDH-18, & TCP-2	Resistant
			JTS-12 & JTS-15 (long duration)	Resistant
			JTS-314, 320,321,325 & 319 (medium duration)	Resistant
			PCT-13, JTS-612 & 607 (short duration)	Resistant
		Colletotrichum leaf spot	PTS-11	Resistant
			JTS-10 to 15 & Duggirala	

Centre	Crop	Pest/disease	Entry	Reaction
			Red (long duration)	Resistant
			JTS-314 to 326 & CLI-317 (medium duration)	Resistant
			JTS-607 to 612 & PCT-13 (short duration)	Resistant
		Taphrina leaf blotch	PTS-11, 15,55,52 & 59	Resistant
			JTS-319 (medium duration)	Resistant
Coimbatore	Turmeric	Leaf spot & leaf blotch	CL-32, 34,54 & 55	Resistant
	Coriander	Powdery mildew	Acc.480 DH-246, RD-120, & JCor-387	Resistant

Apart from this, the 20 technologies developed under AICRPS were conducted at farmer's field as front-line demonstration trials by the 14 coordinating centers. Six ICAR ad-hoc schemes were also operated at SAUs/other organizations under AICRPS.

In the XVII Workshop of AICRPS, six entries/varieties namely DH-246 in coriander, RZ-223 in cumin, HF-33 (Hisar), GF-11 (Jagudan) and RF-143 (Jobner) in fennel and Rmt-305 (Jobner) of AICRPS centers; six varieties namely, IISR-Thevam, IISR-Malabar Excell, IISR-Girimunda and P-24 in black pepper and IISR-Kedaram and IISR-Alleppey Supreme in turmeric of IISR, Calicut; five entries namely, AN-01-1 in Nigella, AD-01-43 and AD-01-6 in dill, and AA-01-61 and AA-01-19 in ajowan of NRC Seed Spices, Ajmer were identified and recommended for state release.

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, Chintapalle, 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/3.2	CVT 1991 – Series IV	Yercaud and Dapoli
PEP/CI/3.3	CVT 2000 – Series V	Pampadumpara, Panniyur, Sirsi, Chintapalle and Ambalavayal
PEP/CM/2	**Nutrient Management Trial**	
PEP/CM/2.1	Effect of biofertilizer using *Azospirillum* on black pepper	Panniyur, Yercaud, Sirsi, Thadiyankudisai and Ambalavayal
PEP/CM/2.2	Effect 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/CP/1	**Disease Management Trial**	
PEP/CP/1.2	Management of *Phytophthora* disease in black pepper nursery	Pampadumpara, Chintapalle and Ambalavayal
PEP/CP/1.4	Control of *Phytophthora* disease of black pepper in farmers' field – observational trial	Panniyur, Pampadumpara, 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, Chintapalle and Dapoli

Project Code	Title	Centers
PEP/CP/2	**Pest Management Trial**	
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 OP progenies under intensive management	Mudigere
CAR/CI/3	**Coordinated Varietal Trial**	
CAR/CI/3.2	CVT 1991/1998 – Series III with Malabar Types	Shakleshpur
CAR/CI/3.3	CVT 1991/1998 –Series III with Mysore Types	Shakleshpur
CAR/C1/3.4	CVT 2000- Series IV	Pampadumpara, Mudigere, Myladumpara and Shakleshpur
CAR/CI/4	**Varietal Evaluation Trial (VET)**	
CAR/CI/4.3	Initial evaluation trial - I	Mudigere
CAR/CI/4.4	Initial evaluation trial - II	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	Effect of bio-fertilizer using Azospirillum on cardamom	Pampadumpara, Mudigere, Myladumpara, and Shakleshpur
CAR/CM/1.5	Effect of biofertilizer using P. solubilizers on cardamom	Pampadumpara, Mudigere, Myladumpara and Shakleshpur
CAR/CM/1.6	Effect of neem cake on productivity, pest and disease incidence in cardamom	Pampadumpara, Mudigere, Myladumpara and Shakleshpur
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

Project Code	Title	Centers
CAR/CP/2.2	Management of root grub of cardamom	Pampadumpara, Myladumpara, Shakleshpur 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 and Pampadumpara
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	Solan, Chintapalle, 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/3.3	Comparative yield trial (CYT-III)	Raigarh and Solan
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	Pottangi, Solan, Dholi, Pundibari, Ambalavayal and Raigarh
GIN/CM/1.2	Organic farming in ginger	Pottangi, Solan, Dholi and Raigarh
GIN/CP/1	**Disease Management Trial**	
GIN/CP/1.1	Disease surveillance and etiology of rhizome rot in ginger	Solan, Dholi and Pundibari
GIN/CP/1.2	Biocontrol studies on rhizome rot of ginger	Raigarh, Kumarganj, Pottangi, Ambalavayal and Dholi
GIN/CP/1.3	Effect of seed treatment on soft rot disease of ginger	Dholi and Pundibari
GIN/CP/1.4	Integrated management of *Pythium, Fusarium* and *Ralstonia* on ginger	Pundibari, Dholi, Kumarganj, Solan and Raigarh

Project Code	Title	Centers
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	Chintapalle, Jagtial, Pottangi, Kumarganj, Pundibari, Raigarh, and Coimbatore
TUR/CI/3	**Varietal evaluation trial**	
TUR/CI/3.1	Comparative yield trial (1999-2000)	Jagtial, Pottangi, Pundibari and Raigarh
TUR/CI/3.2	Initial evaluation trial	Solan, Jagtial, Dholi 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	Effect of biofertilizer using *Azospirillum* on turmeric	Coimbatore, Pottangi, Kumarganj, Solan, Raigarh, Ambalavayal and Pundibari
TUR/CM/1.2	Organic farming in 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 and Raigarh
TUR/CP/1.4	Investigations on the causal organism of rhizome rot of turmeric and screening of biocontrol agents for its management	Coimbatore, Jagtial, Dholi, Kumarganj, Pottangi, Pundibari and Raigarh

Project Code	Title	Centers
TREE SPICES		
TSP/CI/1	**Genetic Resources**	
TSP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon	Pechiparai and Dapoli
TSP/CI/2	**Coordinated Varietal Trial**	
TSP/CI/2.1	CVT 1992 in clove	Pechiparai
TSP/CI/2.2	CVT 1992 in cinnamon	Ambalavayal
TSP/CI/2.3	CVT 2001 in nutmeg	Dapoli, Sirsi, Pechiparai and Ambalavayal
TSP/CI/2.4	CVT 2001 in cassia	Dapoli, Sirsi, Pechiparai and Ambalavayal
TSP/CM/2	**Irrigation Trial**	
TSP/CM/2.1	Drip irrigation in clove and nutmeg	Pechiparai
TSP/CP/1	**Disease Management Trial**	
TSP/CP/1.1	Survey for disease incidence in tree spices	Pechiparai, Dapoli and Ambalavayal
SEED SPICES		
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/1.2	Inter varietal hybridization for evolving high yielding varieties	Jobner
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	Dholi and Kumarganj
COR/CI/2.4	CVT 2001 – Series V	Coimbatore, Guntur, Jobner, Jagudan, Hisar, Dholi, Raigarh and Kumarganj
COR/CI/3	**Varietal Evaluation Trial**	
COR/CI/3.2	Initial evaluation trial	Dholi, Guntur, Jobner, Jagudan and Hisar

Project Code	Title	Centers
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	Effect of biofertilizer using *Azospirillum* on coriander	Coimbatore, 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	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, Raigarh and Jagudan
CUM/CI/3	**Coordinated Varietal Trial**	
CUM/CI/3.3	CVT 2001-Series V	Jagudan
CUM/CI/4	**Varietal Evaluation Trial**	
CUM/CI/4.1	Initial evaluation trial	Jagudan and Jobner
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	Effect of biofertilizer using *Azospirillum* on cumin	Jobner and Jagudan
CUM/CP/2	**Pest Management Trial**	
CUM/CP/2.1	Integrated management of pests and disease of cumin	Jobner
FENNEL		
FEL/CI/1	**Genetic Resources**	
FNL/CI/1.1	Germplasm collection, characterization, evaluation, conservation and screening against diseases	Jobner, Jagudan, Hisar, Kumarganj and Dholi

Project Code	Title	Centers
FNL/CI/2	**Hybridization Trial**	
FNL/CI/2.1	Mutation studies and crossing programme in fennel	Jagudan
FNL/CI/2.2	Inter-varietal hybridization for evolving high yielding varieties	Jobner
FNL/CI/3	**Coordinated Varietal Trial**	
FNL/CI/3.2	CVT 2001– Series –IV	Jobner, Hisar and Kumarganj
FNL/CI/4	**Varietal Evaluation Trial**	
FNL/CI/4.1	Initial evaluation trial	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	Effect of biofertilizer using *Azospirillum* on fennel	Jobner 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, Kumarganj and Jobner
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	Kumarganj and Dholi
FGK/CI/3.3	CVT 2001 – Series V	Coimbatore, Guntur, Jobner, Jagudan, Hisar, Dholi and Kumarganj
FGK/CI/4	**Varietal Evaluation Trial**	
FGK/CI/4.1	Comparative yield trial	Dholi
FGK/CI/4.2	Initial evaluation trial	Hisar, Dholi, Guntur and Jagudan
FGK/CI/5	**Quality Evaluation Trial**	
FGK/CI/5.1	Quality evaluation in fenugreek	Jobner, Guntur, Jagudan, Hisar, Dholi and Kumarganj

Project Code	Title	Centers
FGK/CM/2	**Nutrient Management Trial**	
FGK/CM/2.2	Effect of biofertilizers using *Azospirillum/Rhizobium* on fenugreek	Coimbatore, Jagudan, Kumarganj and Jobner

b) Closed projects

BLACK PEPPER

PEP/CI/3.1	CVT 1987 - Series III	Sirsi
PEP/CI/3.2	CVT 1991 - Series IV	Ambalavayal, Panniyur
PEP/CM/1.1	Irrigation-cum-fertilizer requirements for black pepper and arecanut in a mixed cropping system	Sirsi

CARDAMOM

CAR/CI/3.2	CVT 1991/1998 –Series III with Malabar Types	Mudigere
CAR/CI/3.3	CVT 1991/1998 –Series III with Mysore types	Mudigere and Sakleshpur
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

GINGER

GIN/CM/1.3	Micronutrient on ginger	Dholi
GIN/CP/1.2	Biocontrol studies on rhizome rot of ginger	Pundibari

TURMERIC

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

TREE SPICES

TSP/CI/2.2	CVT – 1992 in Cinnamon	Pechiparai
TSP/CM/1.1	Vegetative propagation in cinnamon	Pechiparai

CORIANDER

COR/CI/2.3	CVT 1998 – Series IV	Guntur, Kumarganj
COR/CP/1.2	Management of wilt and powdery mildew diseases in coriander	Coimbatore

Project Code	Title	Centers
COR/CM/1.2	Efficacy of biofertilizer using *Azospirillum* on coriander	Guntur
CUMIN		
CUM/CI/2.1	Mutation studies and hybridization Programme in cumin	Jagudan
CUM/CI/3.2	CVT 1999-Series IV	Jobner
CUM/CP/1.2	Epidemiological study of *Alternaria* blight of cumin	Jobner
CUM/CP/2.1	Integrated management of pests and disease of cumin	Jagudan
FENNEL		
FNL/CI/3.1	CVT 1994 – Series –III	Jobner
FNL/CI/3.2	CVT 2001-Series –IV	Jagudan
FNL/CI/4.1	Initial evaluation trial	Jagudan
FENUGREEK		
FGK/CI/4.2	Initial evaluation trial	Jobner
FGK/CI/3.1	CVT 1995 – Series III	Kumarganj
FGK/CM/2.2	Effect of biofertilizers using *Azospirillum* / *Rhizobium* on fenugreek	Guntur
FGK/CP/1.1	Biocontrol of root rot in fenugreek	Coimbatore

c) New Research Programmes (2004-05)

PAPRIKA		
PAP/CI/1	**Genetic Resources**	
PAP/CI/1.1	Germplasm collection, characterization, evaluation and conservation of paprika alike chillies	Calicut, Coimbatore, Pechiparai, Yercaud, Guntur and Myladumpara
VANILLA		
VAN/CI/1	**Genetic Resources**	
VAN/CI/1.1	Germplasm collection, Characterization, evaluation and conservation of vanilla	Calicut, Coimbatore, Pechiparai, Myladumpara, Ambalavayal, Panniyur, Dapoli, Sirsi and Mudigere

Project Code	Title	Centers
BLACK PEPPER		
PEP/CM/2.4	Development of organic package for spices based cropping system – Observational trial	Chintapalle, Dapoli, Panniyur
PEP/CP/2.3	Management of scale-insects of Black pepper with organic products	Pampadumpara, Mudigere
CARDAMOM		
CAR/CI/3.5	CVT-2004	Myladumpara, Thadiyankudisai
CAR/CI/2.2	Hybridization in cardamom	Mudigere
CAR/CP/	Shoot fly infestation–observational trial	Sakleshpur, Myladumpara
GINGER		
GIN/CM/1.4	Effect of micronutrients on ginger	Dholi, Kumarganj
GIN/CP/1.5	Survey and monitoring of diseases in ginger	Dholi, Pottangi, Pundibari, Solan, Calicut
TURMERIC		
TUR/CI/2.3	CVT 2004	Jagtial, Pottangi, Pundibari, Raigarh, Coimbatore
TUR/CP/1.4	Investigation on the causal organism of rhizome rot of turmeric and screening of biocontrol agents for its management	Dholi, IISR, Calicut
CORIANDER		
COR/CI/2.5	CVT – Production of leafy type coriander during off-season	Hisar, Coimbatore, Guntur, NRCSS, Ajmer
COR/CM/1.3	Effect of bio-regulators on coriander	Hisar, Coimbatore, Guntur, Dholi, Jobner
COR/CM/1.4	Identification of drought/alkalinity tolerant source in coriander	Guntur, Coimbatore, NRCSS Ajmer
COR/CP/1.3	Management of powdery mildew and stem gall in coriander	Coimbatore, Dholi, Jagudan, Raigarh, Jobner
CUMIN		
CUM/CM/1.2	Identification of drought tolerancesource in cumin	NRCSS, Ajmer
CUM/CP/1.3	Management of wilt and blightin cumin	Jagudan, Jobner

Project Code	Title	Centers
FENNEL		
FNL/CI/3.3	CVT – 2004	Dholi, Hisar, Jagudan, Jobner
FNL/CM/1.3	Identification of drought/Alkalinity tolerance source in fennel	NRCSS, Ajmer, Kumarganj
FENUGREEK		
FGK/CM/2.3	Identification of drought/tolerance source in fenugreek	Guntur, Coimbatore, NRCSS, Ajmer

ACRONYMS

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

PROGRESS OF WORK AND ACHIEVEMENTS

The progress and achievements of AICRP on Spices during the year 2003-2004 are presented in this report.

1. BLACK PEPPER

In black pepper 12 projects are in progress at 44 centres of the AICRPS.

1.1 Genetic Resources and Crop Improvement (PEP/CI/1)

1.1.1 Germplasm collection, characterization, evaluation and conservation (PEP/CI/1.1)

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

1.1.1.1Panniyur

The trial was initiated at Panniyur centre during 1972 with a plot size of 6-10 plants under each accession. At present 147 accessions of cultivated types and 22 wild types of black pepper are being maintained in the station. The performance of these accessions for yield and yield attributing characters were studied. During the year 2002-03, the variety Valiyaramundi recorded the maximum green berry yield of 6.87 kg vine^{-1} followed by TMB X (5.7 kg).

During the year 2003-04, 89 accessions flowered. Data on yield and yield attributing characters of the few promising accessions during 2003-2004 are given in Table 1. The variety Valiyaramundi recorded the maximum green berry yield (6.420 kg vine^{-1}) and number of spikes vine^{-1} (2366) followed by Chendayar (4.075 kg vine^{-1} and 1790 spikes vine^{-1}). Among these genotypes, TMB IV, Balankotta I, Valli and Neelagiris recorded higher spike length (> 10 cm). The number of developed berries spike^{-1} was more in Valiyaramundi (41) followed by Balankotta I (34). The 100 berry weight was more in Neelagiris (18 g) followed by Balankotta I (15 g) and Valli (15g).

Table 1. Yield and yield attributing characters of promising germplasm lines (2003-2004) - Panniyur

Cultivar	Yield (kg vine^{-1}) (green)	No. of spikes vine^{-1}	Spike length (cm)	No. of developed berries	100 berry wt (g)
Valiyaramundi	6.420	2366	6.1	41	12
Chendayar	4.075	1790	9.1	32	13
TMB IV	3.890	1342	10.9	33	14
Kalluvally I	3.840	1475	8.4	31	14
Karimunda III	3.788	1076	8.2	24	12
Balankotta I	3.250	742	10.2	34	15
Angamali	3.180	1074	8.0	22	12
Valli	3.000	624	10.7	32	15
Neelagiris	2.295	885	10.4	13	18
Kottanadan	2.140	592	7.9	18	12

1.1.1.2 Sirsi

The trial was started during 1988-89. During 2003-04 four Uddakare accessions were collected and added to the germplasm making the total collections to 110. The Uddakare collections have long spikes (10-14 cm) with medium bold berries and are performing well under the shaded situations in the arecanut garden.

The accessions collected including Subhakara during 2000 and 2001-02 from IISR, Calicut showed the symptoms of badna viral infection. The passport data of the new accessions is being prepared for registration.

1.1.1.3 Chintapalle

The trial was initiated during 1987. A total of 58 varieties/hybrids of black pepper were collected during 2002-03, including 11 collections (Col.1041, PRS-17, PRS-21, PRS-22, Cul-5308, Cul-5489, HP-34, HP-105, HP-1411, HP-813, Karimunda O.P.) from IISR, Calicut.

During 2002-03 the crop experienced severe drought at flowering stage and as such only 30% flowering was recorded. However, Narayakkodi recorded highest yield of 5 kg vine^{-1} (dry pepper) followed by Thevarmundi (4 kg vine^{-1}). The number of spikes vine^{-1} was also maximum in Thevarundi (2795) followed by Narayakkodi (2650), whereas the recovery percentage was highest in Kuthirvalley. The spike length was highest in Panniyur-1 whereas number of berries spike^{-1} was high in Narayakkodi.

During 2003-04, out of the 22 varieties / hybrids / accessions studied, Malamundi recorded highest yield of 4 kg vine^{-1} (dry pepper). Number of spikes vine^{-1} (2800) and spike length (14.5 cm) were maximum in Malamundi. Dry recovery was high in Kottanadan (36%) followed by Narayakkodi (35%) (Table 2).

Table 2. Yield and yield attributing characters of promising germplasm lines (2003-2004) - Chintapalle

Entry	No. of spikes vine^{-1}	Spike length (cm)	No. of berries spike^{-1}	Yield (kg vine^{-1})		Recovery (%)
				Wet	Dry	
Neelamundi	760	10.8	59	4.5	1.5	33
Thevarmundi	1850	6.5	30	4.0	1.0	25
Aimpiryan	1290	9.4	37	3.0	0.9	30
Vellanamban	1520	10.5	52	6.0	2.0	33
Narayakkodi	1800	11.8	55	7.0	2.5	35
Uddaghere	350	8.7	48	1.1	0.3	33
Kureilmundi	420	8.0	51	1.0	0.4	25
Permabramundi	1700	8.2	21	2.5	0.8	32
Malamundi	2800	14.5	62	12.0	4.0	33
Kottanadan	1250	9.1	25	2.2	0.8	36
Panniyur - 1	1600	12.5	45	6.0	2.0	33
Karimunda	520	9.0	50	1.7	0.5	29

Entry	No. of spikes vine^{-1}	Spike length (cm)	No. of berries spike^{-1}	Yield (kg vine^{-1})		Recovery (%)
				Wet	Dry	
Kuthirvally	390	8.8	47	1.5	0.5	33
Arakulammunda	850	9.0	58	2.7	0.7	26
Balankottai	370	9.8	52	1.8	0.6	33
Kulluvally	80	8.5	41	0.5	0.1	20
Poonjarmunda	950	8.2	52	3.4	1.1	32
Sreekara	378	8.3	62	1.4	0.4	28
Subhakara	180	8.0	65	1.2	0.4	33
Panniyur - 2	380	12.2	68	0.9	0.3	33
Panniyur - 3	600	14.1	75	3.3	1.0	30
Panniyur - 5	150	10.4	51	0.7	0.2	28

1.1.1.4 Dapoli

A survey was conducted during 2003-2004 and two black pepper types were collected from Sindhudurg District of Konkan region. These are being multiplied for conservation in the germplasm block for further evaluation. At present 66 accessions are being maintained at this station.

1.1.1.5 Yercaud

The project was initiated during 1998-1999 at this centre and 106 germplasm accessions are being maintained. In the year 2003, out of 106 accessions, yield were obtained for 27 accessions. Among these accessions, PN - 2 recorded an yield of 11.6 (green) kg and 3.55 kg (dry) vine^{-1}.

1.1.1.6 Pundibari

Nine improved varieties of black pepper were collected from IISR, Calicut during the year 2000 and one genotype (Kottanadan) collected from CPCRI, Mohitnagar, Jalpaiguri in the year 2002 are now being maintained and multiplied. Trials are being laid out for characterization and evaluation.

1.2 Hybridization Trial (PEP/CI/2)

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

1.2.1.1Panniyur

The project was started in 1972. Progenies obtained from open pollinated and hybrid seeds are primarily screened for vegetative characters. These are later evaluated for yield and yield attributing characters. The promising lines are selected and advanced to multilocational trials.

Thirty one cross combinations were made during the year 2003-04 and the seeds obtained from these crosses (Table 3) were sown in pots. In the OP progeny, seeds of ten germplasm accessions were also sown for evaluation.

Inter species hybrids of promising pepper varieties with *Piper colubrinum* were planted in the field and the hybrids are being evaluated.

Table 3. Intervarietal hybridization in black pepper (2003-2004)-Panniyur

	Crosses		No. of seeds obtained
1.	Uthirankotta	x Karimunda III	11
2.	Uthirankotta	x Poonjarmunda	4
3.	Arikottanadan	x Balankotta I	-
4.	Balankotta I	x Kottanadan	3
5.	Balankotta I	x Chendayar	-
6.	Balankotta I	x Thulakodi	27
7.	Cul 406	x Kottanadan	12
8.	Cul 406	x Balankotta	10

1.3 Coordinated Varietal Trial (CVT) (PEP/CI/3)

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

1.3.1.1Sirsi

The trial was initiated in 1992-1993 with 11 released varieties/promising cultivars and the trial was concluded. During 1999-2000, Cul. 239 recorded highest yield of 1.92 kg of vine^{-1} (fresh) followed by Cul. 331 and Cul. 141 (1.51 kg vine^{-1}, fresh) each. During 2001-2002, Panniyur - 5 has recorded the highest yield (3.97 kg fresh berries vine^{-1}) followed by Panniyur - 1 (3.45 kg vine^{-1}). Dry recovery was more in variety KS - 27 (34.28%) followed by KS - 88 (34.10%) (Table 4).

Table 4. Performance of promising cultures of black pepper (CVT) (2003-2004) – Sirsi

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

The trial was laid out during September 2002 with fourteen entries replicated thrice in RBD. The vines were planted on arecanut standards and are establishing in the field. Initial bearing was started in a few accessions. However, it is found that most of the vines showing symptoms of badna virus in varying degrees. The rouging of the vines have been attended to. Among the cultivars under evaluation Panniyur - 5 recorded maximum plant height and number of laterals. (279.3 cm and 44.6 laterals vine^{-1}). Initial bearing also commenced in Malligesara, Uddakare, Panniyur - 1, Panniyur - 2, Panniyur - 3 and Panniyur - 5 during 1996-97. Panniyur - 5 recorded maximum fresh berry yield of 220 g vine^{-1} followed by Panniyur - 3 (216 g vine^{-1}) (Table 5).

Table 5. Performance of black pepper cultivars under CVT – Sirsi

Entries	Plant height (cm)	Laterals vine^{-1}	Spike length (cm)	Fresh yield (g vine^{-1})
Karimalligesara	184.5	10.0	9.71	145
Uddakare	141.0	7.4	12.81	124
C - 856	139.0	4.5	-	-
KS - 88	211.7	7.7	-	-
Shubhakara	164.0	6.8	-	-
Panniyur - 1	211.2	16.3	13.10	195
Panniyur - 2	272.8	36.8	8.21	106
Panniyur - 3	278.0	41.2	10.61	216
Panniyur - 5	279.3	44.6	11.10	220
CD at 5 %	22.35	9.34		

Among the cultivars under evaluation Culture 239 continued to record maximum plant height (328 cm) closely followed by Culture 331 (324 .60 cm) and Panniyur – 1 (311.5 cm). Pepper cultivars differ significantly with regards to yield, Culture 239 recorded the highest berry yield (625.70 g vine^{-1}) closely followed by Panniyur – 1 (586.70 g vine^{-1}) and the cultivar Uddakare recorded the lowest yield (192.50 g vine^{-1}) (Table 6).

Table 6. Performance of black pepper cultivars under MLT 1987 series III – Sirsi

Cultivar	Plant height (cm)	Spike length (cm)	Fresh yield (g vine^{-1})		
			1997-98	1998-99	Mean
Karimalligesara	213.5	9.71	145	233	189
Uddakare	198.5	12.81	124	193	158
Panniyur-1	311.5	13.1	195	587	390
Cul. 141	306.5	8.21	106	302	204
Cul. 331	324.6	10.61	216	243	229
Cul. 239	328.1	11.1	220	626	423
S.Em ±	19.63	—	—	52.9	—
CD at 5 %	58.83	—	—	159.3	—
CV (%)	13.9	—	—	29.1	—

1.3.2 CVT-1991- Series IV (PEP/CI/3.2) *(Dapoli and Yercaud)*

The trial was closed at Panniyur and Ambalavayal centres and was discontinued at Chintapalle since all the varieties were seriously affected by stunt disease.

1.3.2.1 *Dapoli*

The trial was started in 1996 with 11 entries. Morphological characters and yield for the year 2003-2004 are presented in Table 7. Panniyur - 1 recorded the highest yield 1050.00 g vine^{-1} followed by Panniyur - 3 (744 g vine^{-1}) which were planted in 1996. Though all the varieties were not planted in the same year, Panniyur - 1 seems to be a suitable cultivar to this location.

Table 7. Growth and yield of promising lines of black pepper under CVT – Dapoli

Entry	Time of planting	Mean vine length (m)	Yield (dry, g plant^{-1})
Panniyur - 1	Sept 1996	4.99	1050.00
Panniyur - 2	Sept 1996	5.01	566.15
Panniyur - 3	Sept 1996	5.23	744.00
Panniyur - 4	Sept 1996	3.91	481.50
Panniyur - 5	Sept 1996	3.83	516.65
Panchami	March 1997	3.13	315.50
Pournima	March 1997	2.59	258.50
Sreekara	July 1998	2.49	214.00
Shubhakara	July 1998	2.77	185.30
P - 24	May 2000	2.36	92.00
Karimunda (Cul.141)	May 2000	2.12	55.00
Mean		3.49	407.14
Range		2.12-5.23	55-1050
S.D.		1.11	287.60
C.V.		31.73	70.64

1.3.2.2 *Yercaud*

All the 14 accessions, yielded during 2003-2004. Among the accessions, Panniyur - 3 performed well with mean yield of 5.9 kg (green) and 1.6 kg (dry) vine^{-1}. Long spike length and spike intensity might have contributed for higher yield in Panniyur - 3. (Table 8).

Table 8. Performance of black pepper entries (2003-2004) – Yercaud

Entry	Spike length (cm)	No. of berries spikes^{-1}	Yield (kg vine^{-1})	
			Fresh	Dry
Sreekara	10.5	58.0	3.50	1.10
Subhakara	10.7	57.0	2.70	0.90
Panchami	9.8	60.0	1.90	0.52
Acc - 856	10.2	65.0	2.90	0.78
Acc - 2426	9.6	60.0	1.70	0.38
Acc - 2445	9.7	61.0	2.90	0.90
Panniyur - 1	10.9	70.0	4.50	1.50
Panniyur - 2	8.9	60.0	2.95	0.70
Panniyur - 3	12.0	73.0	5.90	1.60
Panniyur - 4	11.6	71.0	2.10	0.43
Acc - 239	10.9	66.0	2.70	0.63
Cul. 1558	9.2	71.0	3.20	0.70
Cul. 5128	10.4	65.0	3.20	0.70
Karimunda	8.9	57.0	3.60	1.10

1.3.3 CVT 2000 - Series V (PEP/CI/3.3)

(Pampadumpara, Sirsi, Panniyur, Chintapalle and Ambalavayal)

1.3.3.1 *Pampadumpara*

The experiment was started during 2001-02 with 12 black pepper entries with three replications in RBD so as to evaluate the performance of released varieties as well as promising selections of black pepper. The results for the period are presented in Table 9. All the entries survived, it was highest in Cul. 5489 (100%). Significantly higher number of leaves was observed in Col. 1041 (90.07) and it was lowest in HP 105 (22.13). Height of the vine ranged from 94.9 to 177.67 cm and the maximum was in PRS 22.

Infestation by marginal gall thrips ranged from 5.6 to 13.36%. Panniyur - 1 recorded the maximum incidence of thrips. Anthracnose and foot rot disease was highest for HP 105 while the incidence of the disease incidence was least in Panniyur - 1. Spike initiation was noticed is some of the entries during this year.

Table 9 . Growth and pest infestation in black pepper lines (CVT 2000) -Pampadumpara

Entry	Survival %	Leaves (no.)	Vine height (cm)	Marginal * gall thrips (%)	Foliar* anthracnose (%)	Foot rot* (%)
PRS 17	66.67	23.70	94.90	11.62 (3.52)	2.47 (1.72)	3.26 (1.98)
PRS 21	72.20	42.83	122.60	5.87 (2.62)	4.10 (2.24)	2.71 (1.89)
PRS 22	88.90	57.53	177.67	10.14 (3.32)	4.00 (2.21)	2.70 (1.92)
Cul. 5308	94.43	72.27	148.10	6.27 (2.70)	5.92 (2.56)	5.34 (2.38)

Entry	Survival %	Leaves (no.)	Vine height (cm)	* Marginal gall thrips (%)	* Foliar anthracnose (%)	* Foot rot (%)
Cul. 5489	100.00	60.90	136.17	12.24 (3.59)	2.65 (1.85)	2.10 (1.68)
Karimunda OP	77.77	61.77	127.50	7.50 (2.88)	1.48 (1.53)	2.12 (1.74)
HP 34	88.90	29.06	106.47	11.32 (3.48)	1.89 (1.62)	4.92 (2.41)
HP 813	55.53	27.13	99.20	9.60 (3.19)	1.26 (1.43)	5.18 (2.48)
HP 1411	88.90	48.77	163.43	7.94 (2.96)	2.59 (1.79)	5.22 (2.46)
HP 105	72.20	22.13	103.40	5.60 (2.37)	7.55 (2.75)	6.04 (2.57)
Col. 1041	77.77	90.47	157.23	6.51 (2.73)	1.99 (1.63)	2.99 (1.88)
Panniyur - 1	72.23	40.57	11.67	13.36 (3.64)	1.41 (1.85)	1.90 (1.68)
CD at 5%	—	35.00	49.65	NS	NS	NS

** Values in parenthesis are square root transformed.*

1.3.3.2 *Sirsi*

The trial was laid out at Sirsi during September 2002 with 14 entries replicated thrice in RBD (Table 10). The vines have been planted on arecanut standards and are establishing. Bearing was started in a few accessions. However, it is found that most of the vines showing symptoms of badna virus in varying degrees. The rouging of the vines have been attended to.

Table 10. Comparative varietal trial of black pepper CVT 2000 – Series V- Sirsi

Entry	Survival %	Average height of vine (cm)	Incidence of badna virus
PRS - 17	88	68.00	Nil
PRS - 21	90	49.25	Nil
PRS - 22	90	56.50	Nil
C - 5308	88	40.10	Nil
C - 5489	60	42.25	Nil
C - 1041	90	41.25	Low
HP - 34	90	87.50	Low
HP - 813	88	78.50	High
HP - 1411	90	54.50	Medium
Karimunda OP	85	105.50	Low
P - 24	90	56.50	Nil
Panniyur - 1	88	70.10	Nil
Karimalligesara	90	90.50	Nil
Dodgya		105.00	Nil

1.3.3.3*Panniyur*

The trial was laid out during 2001 with 13 entries in RBD. Since the vines were affected by *Phytophthora* foot rot disease, gap filing was done during 2002. During the year 2002-03, morphological observations were recorded. *Kalluvally IV* recorded the maximum vine length (189 cm) followed by Karimunda (162 cm). Maximum number of laterals were produced in Coll.1041.During the year 2003-04, few of the vines produced spikes. Karimunda produced maximum spike yield of 250 g vine^{-1} followed by HP 813 (145 g vine^{-1}).

Table 11. Growth of black pepper cultivars (CVT 2000) – Panniyur

Entry	Height of vine (cm)
Karimunda III	126.80
Karimunda II	76.90
Kalluvally IV	189.10
Cul. 5308	75.80
Cul. 5489	81.60
HP 34	148.50
HP 105	62.80
HP 813	132.60
HP 1411	68.70
Karimunda OP	134.20
Coll.1041	148.60
Panniyur - 1	84.00
Karimunda (check)	162.10
CD at 5%	42.34

1.3.3.5 *Chintapalle*

The trial was started during 2002 with 12 entries, Coll.1041, PRS - 17, PRS - 21, PRS - 22, Cul - 5308, Cul - 5489, HP - 34, HP- 105, HP - 1411, HP - 813, Karimunda O.P. and Panniyur – 1 replicated thrice in RBD. Out of 12 entries, PRS - 22, PRS - 17 and Coll. - 1041 could not establish in the field as they were severely infected by foot-rot disease.

1.3.3.4 *Ambalavayal*

The trial was initiated with 13 entries in RBD during 2001. During 2003-2004, among the cultivars tested, Panniyur - 1 recorded the maximum vine height (2.31 m) and number of leaves (136.7) (Table 12).

Table 12. Biometric characters of black pepper cultures (CVT 2000) Ambalavayal

Entry	Vine height (m)	No. of leaves
PRS-17	1.87	116.4
PRS-21	1.13	44.6
PRS-22	0 98	14.7
Cul. 5308	1.04	86.7
Cul. 5489	1.47	49.1
HP-34	1.56	85.7
HP-105	1.06	39.7
HP-813	0.58	17.6
HP-1411	1.76	103.7
Coll. 1041	1.13	55.7
Karimunda OP	1.29	35.0
Panniyur - 1	2.31	136.7
Karimunda	0.60	20.1

During 2003-2004, among the established collections, data on plant height, number of branches and number of nodes vine^{-1} were recorded. Maximum plant height was recorded in HP - 105 (105 cm) with highest number of leaves vine^{-1}.

1.4 Irrigation Trial (PEP/CM/1)

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

1.4.1.1 Sirsi

The trial was laid out during 1992-1993 in arecanut and black pepper mixed cropping system with 3 levels of irrigation as main plot and 4 levels of manuring as sub plot treatments with two varieties of black pepper.

There was no significant difference in all the observations recorded with respect to irrigation levels (10 l, 20 l, 30l palm^{-1} vine^{-1}). The manurial treatments were significantly superior to control with respect to yield of black pepper. However, there was no significant difference within manurial treatments. Highest fresh berry yield of black pepper (535.1 g vine^{-1}) was recorded in the treatment receiving 150 g N, 60 g P_2O_5 and 210 g K_2O (M_3) per vine and the least was in control (403.5 g vine^{-1}) (Table 13). The XVII Workshop suggested for the closure of the trial as the requisite number of vines required for statistical analysis was not available. Hence the pooled data (1997-98 to 2000-2001) of the trial is given in Table 14, 15 & 16.

Table 13. Plant height and fresh yield of black pepper variety Panniyur - 1 in arecanut plantation mixed with black pepper (1997-98) - Sirsi

	Plant height (m)					Fresh berry yield (g vine^{-1})				
I/M levels	M-0	M-1	M-2	M-3	Mean	M-0	M-1	M-2	M3	Mean
I-1	2.04	2.15	2.58	2.35	2.28	388.3	453.9	471.1	493.5	451.7
I-2	1.90	2.03	2.15	2.32	2.10	416.7	481.4	496.2	563.1	489.4
I-3	2.17	2.33	2.47	2.01	2.25	405.7	508.4	518.9	548.6	495.0
Mean	2.04	2.17	2.40	2.33		403.5	481.3	495.4	535.1	

	S.Em ±	CD at 5%	S.Em ±	CD at 5%
Irrigation(I)	0.094	NS	9.95	NS
Manure (M)	0.118	NS	22.60	67.1
Interaction (I x M)	0.200	NS	35.30	NS

Irrigation levels (Main plot)

I-1 = IW/CPE=1.00, 30 mm water (30 litre plant^{-1}day^{-1})

I-2 =IW/CPE=0.66, 20 mm water (20 litre plant^{-1}day^{-1})

I-3=IW/CPE=0.33,10 mm water (10 litres plant^{-1}day^{-1})

Manurial levels (Sub Plot)

M-0 = Control,

M-1 = 50:20:70 g NPK vine^{-1},

M-2=100:40:140 g NPK vine^{-1},

M-3 = 150:60:210 g NPKvine^{-1}

Table 14. Plant height and fresh yield of black pepper variety Panniyur-1 in arecanut plantation mixed with black pepper (1998-99) - Sirsi

	Plant height (m)					Fresh berry yield (g vine^{-1})				
I/M levels	M-0	M-1	M-2	M-3	Mean	M-0	M-1	M-2	M3	Mean
I-1	275.7	281.1	303.0	299.2	289.7	0.459	0.536	0.542	0.556	.5238
I-2	272.0	290.5	295.3	299.9	289.4	0.483	0.528	0.568	0.600	.5451
I-3	281.3	287.0	312.1	300.0	295.1	0.486	0.549	0.560	0.593	.5475
Mean	276.3	286.2	303.5	299.7	291.4	0.476	0.538	0.557	0.583	.5389

	S.Em ±	CD at 5%	S.Em ±	CD at 5%
Irrigation(I)	0.094	NS	9.95	NS
Irrigation (I)	5.33	NS	15.5	NS
Manure (M)	8.48	NS	23.3	69.3'
I x M	13.79	NS	3 8.3	NS

Table 15. Plant height and fresh yield of black pepper variety Panniyur-1 in arecanut plantation mixed with black pepper (1999-2000)* - Sirsi

	Fresh berry yield (kg vine^{-1})				
I/M levels	M-0	M-1	M-2	M-3	Mean
I-1	0.72	0.78	0.80	0.86	0.79
I-2	0.75	0.80	0.83	0.88	0.81
I-3	0.81	0.93	1.17	1.39	1.07
Mean	0.76	0.84	0.93	1.04	
	Irrigation (I)		Manure (M)	Interaction (I x M)	
S.Em ±	0.004		0.02	0.04	
CD at 5 %	0.060		0.07	0.12	

* The analysis has been carried out for the variety Panniyur - 1 alone as the population of Karimalligesara was not satisfactory.

There was significant difference in yield of black pepper due to the effect of irrigation, manures and its interaction. Highest yield was recorded in irrigation treatment I - 3 (1.07 kg vine^{-1}) and manurial treatment M - 3 (1.04 kg vine^{-1}). There was also significant effect due to the interaction of irrigation and manure treatment (I3 XM 3) (1.39 kg vine^{-1}).

The vines irrigated with 10 liters in combination with fertilizer dose of 100:40:140 g vine^{-1} year^{-1} recorded highest fresh berry yield (2.29 kg vine^{-1}).

Table 16. Plant height and fresh yield of black pepper variety Panniyur-1 in arecanut plantation mixed with black pepper (2001-02) – Sirsi*

	Fresh berry yield (kg vine^{-1})				
I/M levels	M-0	M-1	M-2	M-3	Mean
I-1	1.68	1.85	2.29	2.21	2.00
I-2	1.08	1.31	2.04	1.90	1.58
I-3	1.10	1.15	1.93	1.73	1.48
Mean	1.28	1.44	2.09	1.95	1.69

*The observation has been recorded for the variety Panniyur–1 alone as the population of Karimalligesara was not satisfactory

Overall, among the irrigation levels, the vines irrigated with 10 litres vine^{-1} day^{-1} (I - 1) recorded the highest yield (2.00 kg vine^{-1}) and fertilizer dose of 100:40:140 g vine^{-1} year^{-1} (M – 2) recorded the highest yield (2.09 vine^{-1} year^{-1}), among the maurial doses. Moreover, combination of these two treatments (I – 1 X M - 2) recorded the highest yield (2.29 kg vine^{-1} year^{-1}, fresh) among the interaction levels.

1.5 Nutrient Management Trial (PEP CM / 2)

1.5.1 Efficacy of biofertilizer using *Azospirillum* in black pepper (PEP / CM / 2.1)

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

1.5.1.1 Panniyur

The trial was laid out during 2001 with 7 treatments in RBD. During the year 2003-04, the treatment T1 (inorganic N 100% + *Azospirillum* 50g +10 kg FYM) recorded the maximum spike yield of 5.813 kg vine^{-1} followed by T6 (package of practices) with 5.593 kg vine^{-1}. The treatments T1, T6, T2, T3 and T4 were statistically on par.

Table 17. Efficacy of biofertilizer, *Azospirillum* in black pepper – Panniyur

Treatment	Spike yield (kg vine^{-1})
T1 - Inorganic P 100% + P-solubilizers 50 g - 10 kg FYM	5.813
T2 - Inorganic P 75% + P-solubilizers 50 g +10 kg FYMf	4.590
T3 - Inorganic P 50% + P-solubilizers 50 g +10 kg FYM	3.663
T4 - FYM 10 kg + P-solubilizers 50g	3.527
T5 - FYM 10 kg alone	2.923
T6 - Recommended dose of fertilizer	5.593
T7 - Control	1.353
CD at 5%	2.400

1.5.1.2 Sirsi

The trial was laid out during 2000-01 with Panniyur – 1, trained on arecanut standards. During the initial two years there was no significant difference in yield. During 2002-03 the treatment receiving *Azospirillum* along with other manures recorded higher yields than FYM alone.

Analysis of the pooled data revealed that *Azospirillum* 50 g along with 100% recommended dose and 75% of recommended dose have recorded significantly higher yield of 7.13 kg vine^{-1} and 6.87 kg vine^{-1} fresh berries, respectively compared to recommended dose of fertilizer (6.58 kg vine^{-1}, Table 18).

Table 18. Efficacy of biofertilizer using *Azospirillum* in black pepper (2000-01 to 2003-04) - Pooled data - Sirsi

Treatment	Mean fresh yield (kg vine^{-1})				
	2000-01	2001-02	2002-03	2003-04	Pooled
Inorganic N 100% + *Azospirillum* 50 g + 10 kg FYM	6.49 (8.76)	6.20 (8.37)	6.25 (8.44)	7.98 (10.77)	7.13 (9.89)
Inorganic N 75%+ *Azospirillum* 50 g + 10 kg FYM	6.23 (8.41)	6.35 (8.57)	6.52 (8.80)	7.35 (9.92)	6.87 (9.27)
Inorganic N 50% + *Azospirillum* 50 g + 10 kg FYM	6.49 (8.76)	6.32 (8.53)	5.99 (8.09)	6.67 (8.99)	6.42 (8.68)
FYM 10 kg + *Azospirillum* 50 g	6.40 (8.64)	6.08 (8.21)	5.57 (7.52)	7.01 (9.46)	6.45 (8.71)
FYM 10 kg alone	6.83 (9.22)	5.67 (7.65)	5.27 (7.11)	5.77 (7.79)	5.76 (7.73)
Recommended dose of fertilizer	5.91 (7.98)	6.19 (8.36)	4.38 (5.91)	7.34 (9.91)	6.58 (8.88)
	0.46	0.27	0.23	0.57	0.11
	NS	NS	0.70	0.19	0.04

*Dryage is 28.32% **P 40 g vine^{-1} and K 140 g vine^{-1}

1.5.1.3 Yercaud

This trial was laid out during 2000-2001 with six treatments replicated four times in RBD. Treatment details are viz., T1 - Inorganic N 100% + *Azospirillum* 50 g + 10 kg FYM; T2 - Inorganic N 75% + *Azospirillum* 50 g + 10 kg FYM; T3 - Inorganic N 50% + *Azospirillum* 50 g + 10 kg FYM; T4 - FYM 10 kg + *Azospirillum* 50 g; T5 - FYM 10 kg alone and T6 - Recommended dose of inorganic fertilizers.

Azospirillum @ 25 g vine^{-1} + 5 kg FYM were applied as basal dose and the rooted cuttings of pepper were planted. Fifteen days after planting, the inorganic fertilizers viz., urea, rock phosphate and muriate of potash were applied according to the treatments. In the month of

November, top dressing with *Azospirillum* @ 25 g vine^{-1} + 5 kg FYM were applied and after 15 days, the inorganic fertilizers were applied according to the treatment.

The observation on vine length, number of leaves and leaf area were recorded and the vine length was high (100.6 cm) in the treatment T2. The number of leaves vine^{-1} was higher in the treatment T3 (37.5) and the leaf area was high in the same treatment (63.00 cm^2).

1.5.1.4 Ambalavayal

The experiment was started during the year 2003. The treatments did not show any significant difference in yield. However, T7 recorded the highest yield (3.346 kg vine^{-1}) followed by T1 (3.222 kg vine^{-1}).

Table 19 Efficacy of biofertilizer, *Azospirillum* in black pepper - Ambalavayal

Treatment	Dry weight of berries (kg vine^{-1})
	Mean
T1 - Inorganic N 100% + *Azospirillum* 50 g + 10 kg FYM	3.222
T2 - Inorganic N 75% + *Azospirillum* 50 g + 10 kg FYM	2.670
T3 - Inorganic N 50% +*Azospirillum* 50 g +10 kg FYM	2.570
T4 - *Azospirillum* 50 g +10 kg FYM	2.179
T5 - FYM 10 kg + 10 kg FYM	1.906
T6 - FYM 5 kg alone	2.108
T7 - Recommended dose of inorganic fertilizers	3.346
CD at 5%	

The treatments did not show any significant difference in yield. However, T7 recorded the highest yield (3.346 kg vine^{-1}) followed by T1 (3.222 kg vine^{-1}).

1.5.1.5 Thadiyankudisai

Report not received.

1.5.2 Efficacy of biofertilizer using P - solubilizer (Phosphobacteria) on black pepper (PEP/CM/2.2)

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

1.5.2.1 Panniyur

The trial was started in 2001. Among the treatments, T1 recorded the maximum spike yield of 4.9 kg vine^{-1} followed by T6 (4.467 kg vine^{-1}). The treatment T1 was significantly superior to all the treatments except T6 and T2 (Table 20).

Table 20. Efficacy of biofertilizer using P - solubilizer (Phosphobacteria) on black pepper (2003-2004) - Panniyur

Treatment	Dry weight of berries (kg vine^{-1})
T1 - Inorganic P 100% + P-solubilizers 50 g +10 kg FYM	4.900
T2 - Inorganic P 75% + P-solubilizers 50 g+10 kg FYM	2.833
T3 - Inorganic P 50% + P-solubilizers 50 g+10 kg FYM	1.833
T4 - FYM 10 kg + P-solubilizers 50g	2.500
T5 - FYM 10 kg alone	2.300
T6 - Recommended dose of fertilizer	4.467
T7 - Control	1.433
CD at 5%	2.270

1.5.2.2 Yercaud

This trial was laid out during 2000-2001 with 6 treatments replicated four times in RBD. Treatment details are viz., T1 - Inorganic P (100%) + Phosphobacteria (50 g) + 10 kg FYM; T2- Inorganic P (75%) + Phosphobacteria (50 g) + 10 kg FYM; T3- Inorganic P (50%) + Phosphobacteria (50 g) + 10 kg FYM; T4 - FYM (10 kg) + Phosphobacteria (50 g); T5 - FYM (10 kg) alone and T6 - Recommended dose of inorganic fertilizers.

The observations on vine length, number of leaves and leaf area were recorded and the vine length was high (88.7 cm) in the treatment T4. The number of leaves per vine was higher in the treatment T2 (29.0) whereas the leaf area was high in the treatment T1 (68.6 cm^2).

Table 21. Efficacy of biofertilizer using P – solubilizers in black pepper (2003-2004) - Ambalavayal

Treatment	Dry weight of berries (kg vine^{-1}) Mean
T_1 - Inorganic N (100 %) + Phosphobacteria (50g) +10 kg FYM	2.854
T_2 - Inorganic N (75%) + Phosphobacteria (50g) + 10 kg FYM	2.600
T_3 - Inorganic N (50%) + Phosphobacteria (50g) +10 kg FYM	2.508
T_4 - Phosphobacteria (50g) +10 kg FYM	1.892
T_5 - FYM 10 kg alone	1.591
T_6 - FYM 5 kg alone	2.007
T_7 - Recommended dose of inorganic fertilizers	3.017

1.5.2.3 Ambalavayal

The experiment was started during the year 2003 with 7 treatments in RBD. The treatments did not show any significant difference in yield. However, T7 recorded the highest yield (3.017 kg vine^{-1}) followed by T1 (2.854 kg vine^{-1}).

The treatments did not show any significant difference in yield. However, T7 recorded the highest yield (3.017 kg vine^{-1}) followed by T1 (2.854 kg vine^{-1}).

1.5.2.4 Sirsi

The trial was laid out during 2000-01 in RBD with 6 treatments and four replications. During the first two years there was no significant difference in yields by adding P - solublizer. However, during 2002-03, the treatments receiving P - solublizer recorded significantly higher yields than recommended dose of fertilizers alone.

The pooled data of four years (2000-2001 to 2003-2004) revealed that treatments T1 and T2 were on par and recorded higher yields compared to recommended dose of fertilizer alone (Table 22).

Table 22. Efficacy of biofertilizer using P - solublizers in black pepper – Pooled data (2000-2004) – Sirsi

Treatment	Mean fresh yield (kg vine^{-1})				
	2000-01	2001-02	2002-03	2003-04	Pooled
T1 - Inorganic P 100% + P – solublizer 50g +10 kg FYM	6.68 (9.02)	6.27 (8.46)	6.63 (8.95)	7.28 (9.83)	6.91 (9.33)
T2 - Inorganic P 75% + P – solublizer 50g+10 kg FYM	5.74 (7.75)	6.20 (8.37)	6.53 (8.81)	6.96 (9.40)	6.51 (8.79)
T3 - Inorganic P 50% + P – solublizer 50g + 10 kg FYM	6.31 (8.52)	6.00 (8.10)	6.57 (8.87)	6.30 (8.50)	6.33 (8.54)
T4 - FYM 10 kg + P – solublizer 50 g	6.00 (8.10)	6.31 (8.52)	6.13 (8.27)	6.02 (8.14)	6.08 (8.21)
T5 - FYM 10 kg alone	5.74 (7.75)	6.71 (9.06)	4.77 (6.44)	6.19 (8.36)	5.79 (7.82)
T6 - Recommended dose of fertilizer	6.28 (8.48)	6.06 (8.18)	4.82 (6.51)	7.11 (9.60)	6.30 (8.51)
S Em ±	0.37	0.35	0.29	0.06	0.04
CD at 5 %	NS	NS	0.86	0.17	0.11

* The dryage is 27.95

1.5.2.5 Thadiyankudisai

Report not received.

1.5.3 Organic farming in black pepper (PEP/CM/2.3)

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

1.5.3.1Sirsi

The trial was initiated during 2000-01 with 5 treatments in RBD. Treatment T3 recorded significantly higher yield during previous years. The pooled data (Table 23) revealed that highest green berry yield was recorded in T3 (6.24 kg vine^{-1}) gave approximately 2 kg green berries more than the yield obtained by local practice (T5).

Table 23. Performance of organic farming in black pepper (2000 to 2004) – Sirsi

Treatment	Mean fresh yield (kg vine^{-1})				
	2000-01	2001-02	2002-03	2003-04	Pooled
T1 - FYM 10 kg vine^{-1}	5.36	5.84	5.13	4.98	4.92
	(7.24)**	(7.88)	(6.92)	(6.72)	(6.64)
T2 - Vermi compost + wood ash	5.06	5.40	5.02	4.18	4.65
	(6.83)	(7.29)	(6.78)	(5.65)	(6.28)
T3 - FYM 10 kg +	6.74	6.52	5.94	6.20	6.24
Burnt/smoked earth 10 kg	(9.10)	(8.80)	(6.37)	(8.37)	(8.42)
T4 - FYM 10 kg + *Azospirillum*	5.05	5.62	4.72	4.70	4.86
50 g vine^{-1}	(6.82)	(7.59)	(6.37)	(6.34)	(6.56)
T5 - FYM 10 kg + Leaf manure	5.61	5.82	4.09	3.62	4.26
10 kg (Local practice)	(7.57)	(7.86)	(5.52)	(4.89)	(5.75)
S Em ±	0.27	0.16	0.18	0.06	0.03
CD at 5 %	0.85	0.49	0.55	0.17	0.09

* The dryage per cent age is 28.56

** Data in parenthesis is the projected yield as tones ha^{-1}

*** P 40 g as rock phosphate + K as 2 kg wood ash are common to all the treatments.

1.5.3.2 Yercaud

The trial was started during 2001-2002 with six treatments replicated four times in RBD. The treatments are viz., T1 - FYM 10 kg + 5 kg coir compost +50 g phosphobacteria; T2 - FYM 10 kg + 1 kg vermicompost + 50 g phosphobacteria; T3 - FYM 10 kg + 1 kg neem cake + 50 g phosphobacteria; T4 - FYM 10 kg + 50 g *Azospirillum* + 50 g phosphobacteria; T5 - FYM 10 kg + 50 g *Azospirillum* + 50 g phosphobacteria+ 200 g VAM and T6 - FYM 10 kg alone.

1.5.3.3 Panniyur

The trial was laid out in RBD with 6 treatments replicated four times at two locations in Mattannur and Kannur District. Among the treatments T6 (package of practices) recorded the maximum spike yield of 6.067 kg vine^{-1} followed by T1 (6.033 kg vine^{-1}). There was no significant difference between the treatments (Table 24).

Table 24. Performance of organic farming in black pepper (2000 to 2004) - Panniyur

Treatment	Mean yield (fresh, kg vine^{-1})
T1 - 10 kg FYM + P 40 g + wood ash 2kg	6.033
T2 - Vermicompost 2 kg +10 kg FYM + P 40 g + wood ash 2 kg	5.067
T3 - 10 kg FYM + burnt earth 10 kg	5.067
T4 - FYM 10 kg + *Azospirillum* 50 g + wood ash 2 kg	5.967
T5 - FYM-10 kg +leaf manure 10 kg + wood ash 2 kg	4.933
T6 - Package of practices recommendations	6.067
T7 - leaf mulch + zero tillage	3.000
CD at 5%	NS

1.5.3.4Ambalavayal and Thadivandudisai

Not reported.

1.6 Disease Management Trial (PEP / CP / 1)

1.6.1 Management of *Phytophthora* disease in black pepper – Nursery (PEP/CP/1.2)

(*Chintapalle, Pampadumpara* and *Ambalavayal*)

1.6.1.1Chintapalle

The project was initiated at Chintapalle center during 2002 with 10 treatments replicated thrice in RBD. Planting in solarized soil fortified with *Trichoderma harzianum* 50 g kg^{-1} of soil +100cc VAM kg^{-1} soil has recorded significantly lower disease incidence in the three parameters studied i.e., yellowing symptoms, defoliation and number of plants infected per treatment during 2002-2003. The trial is in progress for the year 2003-04.

1.6.1.2Pampadumpara

The trial was laid out at Pampadumpara with 8 treatments (200 poly bags with four vines per bag) in CRD with the treatments viz., T1 - Planting in solarized soil; T2 - Non solarized soil; T3 - Solarized soil fortified with *Trichoderma*@ 1g kg^{-1}+ VAM @ 100 cckg^{-1} of soil; T4 - Non solarized soil with *Trichoderma* and VAM; T5 - Ridomil spray and drench @ 1.25 gl^{-1} Ridomil MZ WP + T1; T6 - T5 + T2; T7 - COC @ 0.2% drench + T1 and T8 - COC @ 0.2% drench + T2.

The soil solarization was conducted during April 2004. Two noded cuttings of runner vines of the variety Panniyur-1 were planted and the observations are being recorded.

1.6.1.3 Ambalavayal

The trial was conducted with 8 treatments. Among the treatments, solarized soil fortified with *Trichoderma harzianum* and VAM recorded the maximum sprouting percentage (93.5 %) with least disease incidence (5.88%) (Table.25)

Table 25. Biological control of *Phytophthora* disease in black pepper nurseries – Ambalavayal

Treatment	Sporuting (%)	Infection (%)	Plant height	Biomass (g plant^{-1})
T1 - Planting in solarized soil	84.5	15.00		
	(67.075)	(22.690)	20.88	1.474
T2 - Planting in non-solarized soil	70.50	24.38		
	(57.360)	(29.540)	18.6	1.039
T3 - Solarized soil+*Trichoderma*	93.5	5.88		
harzianum + VAM	(75.340)	(13.990)	22.75	1.795
T4 - Non-solarized soil +*Trichoderma*	85.50	13.5		
harzianum + VAM	(67.915)	(21.530)	21.35	1.442
T5 - Ridomil spray and drench + T1	85.00	12.63		
	(67.815)	(20.77)	22.35	1.445
T6 - T5 + T2	80.3	18.88		
	(63.720)	(25.75)	22.07	1.326
T7 - Copper oxychloride + T1	84.75	11.63		
	(67.207	(19.9)	20.13	1.396
T8 - Copper oxychloride + T2	77.80	19.13		
	(61.955)	(25.920)	17.35	0.988
F-test	*	*	*	*
CD at 5%	6.656	2.601	3.045	0.1991

* The figures in parenthesis are transformed values

1.6.2 Control of *Phytophthora* foot rot disease of black pepper in farmers field – observational trial (PEP/CP/1.4)

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

1.6.2.1Sirsi

The trial was laid out during 2000-2001 in arecanut based multistoried cropping system in farmers' gardens in two locations (*viz.*, Edahalli and Hosabale villages) around Sirsi. There were seven treatments with twenty vines and two replications in RBD.

During 2000-2001, the *Phytophthora* foot rot of black pepper was least (15%) in the vines treated with Potassium phosphonate (@ 0.5 %) as spray (@ 2 l vine^{-1}) and drench (3 l vine^{-1}) and soil application of *T. harzianum* (@ 50 g of 10^7 cfu) in one kg of neem cake during first week of June and second week of August. This was followed by the black pepper treated as spray and drench with either metalaxyl gold MZ 68 WP (@ 100 ppm, 17.50%) or potassium phosphonate (@ 0.5%, 17.50%). The untreated black pepper vines showed disease incidence of 52.50%.

During 2001-2002, black pepper vines treated with Metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5gl^{-1}) as spray (2lvine^{-1}) and drench (3 l vine^{-1}) alone and in combination with

bioagent i.e., *Trichoderma harzianum* (@ 50 g of 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 vine^{-1}) twice in the season (June and August) showed least incidence of *Phytophthora* foot rot disease (15%) (Table 26). The disease incidence was highest in the untreated vines (62.50%).

During 2002-03, black pepper vines showed least incidence of disease (7.5%) where the vines treated twice in the season (June and August) with metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5 g l vine^{-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 of 10^7cfu vine^{-1}). Black pepper vines treated with potassium phosphonate (@ 5 ml l^{-1}) as spray and drench in combination with bio-agent i.e., *T. harzianum* (@ 50 g vine^{-1}) twice in the season showed reduced disease incidence (10%). The disease incidence was highest in the untreated vines (40%).

During 2003-2004, *Phytophthora* foot rot disease incidence in black pepper was least (7.5 per cent) in treatments where the vines were treated twice in the season (June and August) with metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5 g l^{-1}) as spray (2 l vine^{-1}) as well as drench (3 l vine^{-1}) alone or and in combination with bioagent i.e., *Trichoderma harzianum* (@ 50 g of 10^7cfu vine^{-1}). This was followed by application of potassium phosphonate (@ 5 ml l^{-1}) as spray as well as drench or and in combination with bio-agent i.e., *T. harzianum* (@ 50 g vine^{-1}) twice in the season to black pepper vines showed reduced disease incidence (12.50%). The disease incidence was highest in the untreated vines (45.00%).

The four years pooled data (2001-02 to 2003-04) is presented in Table 24. The studies indicated that the disease incidence of *Phytophthora* foot rot was minimum in the black pepper vines where the vines were treated twice in the season with metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5 g l^{-1}) either alone (11.87%) as spray (2 l vine^{-1}) and drench (3 l^{-1}) or in combination with bioagent i.e., *T. harzianum* (11.88%, @ 50 g of 10^7cfu vine^{-1}) along with one kg of neem cake as soil application. This was followed by potassium phosphonate application (@ 5 ml l^{-1}) as spray as well as drench or and in combination with bio-agent i.e., *T. harzianum* (@ 50 g vine^{-1}) twice in the season to black pepper vines showed reduced disease incidence (13.13% and 14.38%, Table 26). The disease incidence was highest in the untreated vines (50%).

Table 26. Management of *Phytophthora* foot rot disease of black pepper – (Pooled Data 2000-2001 to 2003-2004) – Sirsi

Treatment	Percent disease incidence				Pooled data
	2000-01	2001-02	2002-03	2003-04	
T1 - Metalaxyl gold MZ 68 WP (@ 100 ppm, 2.5g l^{-1}) as spray (2 l $vine^{-1}$) and drench (3 l $vine^{-1}$) twice	17.50 (24.16) *	15.00 (22.48)	7.50 (13.82)	7.50 (11.25)	11.87 (17.93)
T2 - Potassium phosphonate (Akomin, @ 0.5 percent) as spray and drench twice	17.50 (24.16)	17.50 (24.53)	10.00 (15.86)	12.50 (20.47)	14.38 (21.54)
T3 - 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)	25.00 (29.74)	32.50 (34.50)	33.75 (35.02)
T4 - Metalaxyl gold MZ 68 WP (@ 100 ppm, 2.5g l^{-1}) as spray (2 l $vine^{-1}$) and drench (3 l $vine^{-1}$) twice + Soil application of *Trichoderma harzianum* (10^7 cfu, @ 50g $vine^{-1}$) with 1 kg of neem cake twice	17.50 (24.53)	15.00 (22.50)	7.50 (13.82)	7.50 (13.82)	11.88 (18.67)
T5 - Potassium phosphonate (Akomin, 0.5 percent) 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)	10.00 (15.86)	12.50 (17.89)	13.13 (19.59)
T6 - Neem cake application @ 1 kg $vine^{-1}$	37.50 (37.72)	55.00 (47.89)	32.50 (36.06)	35.00 (33.97)	40.00 (38.91)
T7 - Untreated control	52.50 (46.50)	62.50 (52.34)	40.00 (39.17)	45.00 (42.11)	50.00 (45.03)
S Em ±	3.12	2.20	4.45	4.32	1.84
CD at 5 %	9.30	6.54	13.08	12.70	5.16

* figures given in parenthesis are angular transformed values

1.6.2.2Panniyur

The trial was initiated at Panniyur during 2001 in two locations (Valiampara and Padiyoor of Kannur Dt.) with 7 treatments replicated thrice in RBD.

In Padiyoor location, the disease Index recorded on leaf, branch and stem in the treatment Metalaxyl gold MZ and *Trichoderma harzianum* was 1.45, 1.32 and 0.00 respectively. In Valiampara location, the disease Index recorded on leaf, branch and stem in the treatment Metalaxyl gold MZ and *Trichoderma harzianum* was 1.55, 1.62 and 0.00 respectively (Table 27).

Table 27. Management of *Phytophthora* foot rot disease of black pepper– Panniyur

Treatment	Location : Valiamapara (%)			Location : Padiyoor (%)		
	Leaf infection	Branch infection	Death of vine	Leaf infection	Branch infection	Death of vine
T1 - Metalaxyl Gold MZ-2.5 g l^{-1} (Spraying and drenching)	2.42	2.19	2.47	0.00	2.58	0.00
T2 - Akomin (3 ml l^{-1})	3.52	3.39	3.88	0.00	3.91	0.00
T3 - *Trichoderma* harzianum–50g $vine^{-1}$	3.39	3.70	3.44	0.00	3.45	0.00
T4 - Metalaxyl Gold M.Z+ *Trichoderma harzianum*	1.55	1.45	1.32	0.00	1.55	0.00
T5 - Akomin + *Trichoderma harzianum*	2.38	2.25	2.41	0.00	2.52	0.00
T6 - Neem cake – 1 kg $vine^{-1}$	5.62	5.45	4.12	0.66	4.24	0.66
T7 - Control	8.57	8.61	5.76	2.00	5.24	2.00
CD at 5%	0.66	0.58	0.31	0.31	0.48	0.38

The results of the trial indicated that Metalaxyl Gold MZ (2.5 g l^{-1}) and *Trichoderma harzianum* was found to be effective in controlling the foot rot disease followed by application of Akomin (3 ml l^{-1}) and *Trichoderma harzianum.* The disease incidence was very low when Metalaxyl gold MZ fungicide was combined with the soil application of *Trichoderma harzianum.*

1.6.2.3 Pampadumpara

The experiment was started at Pampadumpara during 2003 with seven treatments and three replications in RBD so as to assess the compatibility of *Trichoderma harzianum* with Metalaxyl and Potassium phosphonate. The data related to disease reduction and yield is presented in Table 28. Least reduction in disease incidence was observed in vines sprayed with Metalaxyl. Disease reduction was highest in T_3 and T_6. A combined application of T. harzianum and potassium phosphonate resulted in the highest yield (1444 g.$plant^{-1}$). However, there was no significant difference among the treatments three months after application..

Table 28. Management of foot rot disease of black pepper -Pampadumpara

Treatment	% reduction in disease infection index* (3 months after treatment)	Dry berry yield (g.plant^{-1})
T1 - Metalaxyl/Metalxyl Gold =MZ68 100 ppm a.i. spray and drench	0.0 (1.0)	1155
T2 - Potassium phosphonate (5 ml l^{-1}) spray and drench	1.3 (1.4)	1403
T3 - Biocontrol agent *Trichoderma harzianum* (50 g (cfu 10^7) and 1kg Neem cake	4.0 (2.1)	1691
T4 - Soil application of *T. harzianum* and spray and drench with Ridomil	1.3 (1.4)	627
T5 - Biocontrol agent *T. harzianum* and Potassium phosphonate (5ml l^{-1}) spray and drench	2.7 (1.7)	1229
T6 - Neem cake application @ 1 kg per vine	4.0 (1.8)	1444
T7 - Control	1.3 (1.6)	660
	NS	NS

*Values in parenthesis are square root transformed (x+1)

1.6.2.4 Mudigere

The trial was started at Mudigere during 2000 with 8 treatments replicated thrice in RBD. T8 (Bordeaux mixture 1%) is added as local check from the year 2002.

The performance of spraying and drenching with Ridomil MZ 72 WP (1.25 g l^{-1}) 5 lit. per vine (T-2 alone) and its combinations with *Trichoderma harzianum* 50 g (T-5) during the first week of June and September was found effective in checking the disease and they are on par. However, the disease did not appear during the year 2002 and 2003 in both the locations. (Table 29).

Table 29. Management of foot rot disease of black pepper (pooled data) – Mudigere

Treatment	Mean PDI of 2 locations				
	2000	2001	2002	2003	Mean
T1- Akomin @ 5 ml l^{-1} 5 l vine^{-1}	SZ	25.00	0.00	0.00	7.75
T2 - Ridomil MZ-72 WP (1.25 g l^{-1}) 5 l vine^{-1}	3.23	0.00	0.00	0.00	0.81
T3 - *Trichoderma harzianum* 50g +1 kg Neem oil cake vine^{-1}	3.41	25.00	0.00	0.00	7.10
T4 - T3 + T1	6.04	12.50	0.00	0.00	4.64
T5 - T3 + T2	3.75	0.00	0.00	0.00	0.94
T6 - Neem oil cake (1 kg vine^{-1})	7.46	29.67	0.00	0.00	9.28
T7 - Control	8.61	33.84	0.00	0.00	10.61
T8 - Bordeaux mixture 1%	-	-	0.00	0.00	-
CD at 5%	3.21	1.75	-	-	-

PDI : Percent disease incidence

1.6.2.5Ambalavayal

The experiment was started during 2003 at Ambalavayal. During the current year the treatment T4 (*T. harzianum* + Neem cake + Ridomil) recorded the highest berry weight (2.575 kg vine^{-1}) followed by T5 (*T. harzianum* + Neem cake + Potassium phosphonate) (2.290 kg vine^{-1}).

The treatment T4 (*T. harzianum* + Neem cake+ Ridomil) recorded the highest berry weight (2.575 kg vine^{-1}) followed by T5 (*T.harzianum* + Neem cake+ Potassium phosphonate) (2.290 kg vine^{-1}) (Table 30).

Table 30. Management of *Phytophthora* foot rot disease of black pepper– Ambalavayal

Treatments	Treatments
T1	1.6170
T2	1.9180
T3	1.4600
T4	2.5750
T5	2.2900
T6	0.9980
T7	1.2380
F test	*
LSD	0.5657

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

(*Sirsi* and *Panniyur*)

1.6.3.1Sirsi

The trial was started during 2001-02 to evaluate *Phytophthora* foot rot incidence of black pepper under different densities in an arecanut garden. The black pepper cuttings were trained on standards of arecanut palms with four levels of population density of vines i.e., 25, 50, 75 and 100 per cent. There were twenty vines maintained in each level of population with four replications.

During 2002-03 the establishment of black pepper vines was highest in 25 per cent population (93.33%). The growth of black pepper vines was highest in 50 % population (1.88 m).

Table 31. *Phytophthora* foot rot incidence in black pepper under different densities in arecanut garden – Sirsi

Treatment	Plant height(m)	Yield (kg vine^{-1}) (t ha^{-1})	Disease incidence
T1 - Black pepper in 25% population of arecanut	3.21	0.61 (0.82)**	***
T2 - Black pepper in 50 % population of arecanut	3.23	0.59 (0.80)	-
T3 - Black pepper in 75% population of arecanut	2.94	0.43 (0.58)	-
T4 - Black pepper in 100 % population of arecanut	2.87	0.42 (0.57)	-
S Em ±	0.09	0.02	-
CD at 5 %	0.32	0.06	-

* Dry age was 28.83%

** Figures in parenthesis indicate yield in t ha^{-1}

*** No Disease incidence of *Phytophthora* foot rot

Growth of black pepper vines was more in 50% (3.23 m height) and 25% (3.21m h) population density under arecanut cropping system (Table 31). The disease incidence of *Phytophthora* foot rot was not noticed in any of the population densities. Initial bearing has started in all treatments. The initial fresh berry yield recorded in 50 and 25% population were higher (0.61 kg vine^{-1} and 0.59 kg vine^{-1}, respectively) as compared to 75 and 100% population of black pepper vines (4.3 kg vine^{-1} and 4.2 kg vine^{-1}, respectively).

1.6.3.2 Panniyur

The trial was started during 2001 with 4 treatments replicated 5 times in RBD. The data presented in Table 32 showed that seedling establishment and height of the vines were maximum for treatments T1 and T2. The disease index was minimum for T1 (0.95%) and maximum for T3 (2.11%). Generally less disease incidence was observed in the Pepper –Areca intercrop system.

Table 32. *Phytophthora* foot rot incidence in black pepper under different densities in arecanut garden – Panniyur

Treatment	Establishment	Height of vine (cm)	% Disease Index
T1 - Pepper in 25% population of Areca garden	94.4	302.6	0.95
T2 - Pepper in 50% population of Areca garden	93.0	226.0	1.88
T3 - Pepper in 75% population of Areca garden	85.5	191.0	2.11
T4 - Pepper in 100 % population of Areca garden	76.8	168.4	1.23
CD at 5%	3.42	7.3	1.64

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

1.6.4.1Pampadumpara

Thirteen panchayats were surveyed for the occurrence of foliar infection of anthracnose on black pepper at high ranges of Idukki District during the period under report. The data presented in Table 33 showed that occurrence of the disease ranged from 0.7 to 13.6%. The incidence of anthracnose was the highest in Vandenmedu panchayat (13.6%) followed by Chackupallom (12.3%). Disease occurred mainly on the older leaves and the new flushes and spikes were not infected. The disease was more prevalent at altitudes 1100 meters above MSL.

Table 33. Incidence of anthracnose disease in black pepper in the high ranges of Idukki - Pampadumpara

Panchayats	% Foliar infection	Elevation (m) MSL
Karunapuram	7.3	941
Pampadumpara	2.2	1100
Kattapana	4.5	1136
Vandanmedu	13.6	1246
Chakupallam	12.3	1118
Nedumkandam	0.7	900
Udumbanchola	0.9	1100
Senapathy	1.2	1100
Erattaiyar	1.2	900
Kamakshi	0.7	800
Vathikudy	2.6	850
Mariyapuram	1.1	850
Vazhathoppu	4.6	900

The experiment was started during 2003 with seven treatments and three replications in RBD. Data pertaining to disease reduction as well as yield are presented in Table 33. Percentage reduction of foliar anthracnose ranged from 16.8 to 95.3%. Highest reduction of the disease was recorded in T_5 (95.30%) followed by T_3 (92.7%), which is reflected from reduced spike infection also. However, the least spike infection was recorded in T_6 (3.83%). The reduction in the infection on spikes resulted in highest yield in T6 (742.7g Plant^{-1})) as evident from the data.

Table 34. Effect of various fungicides in the management of anthracnose of black pepper-Pampadumpara

Treatment	% Disease reduction on leaves *	% Spike infection**	Yield (g plant^{-1})
T1 - Bordeaux mixture1% Twic foliar spray	48.00 (43.82)	23.50 (4.95)	330.3
T2 - Bordeaux mixture1% Thrice foliar spray	90.67 (72.33)	11.17 (3.44)	412.7
T3 - Mancozeb@0.2% Twice foliar spray	92.70 (74.93)	7.17 (2.84)	379.7
T4 - Propiconazole @0.1 foliar spray	75.60 (61.77)	11.83 (3.43)	446.0
T5 - Carbendazim@ 0.1% foliar spray	95.30 (77.63)	6.17 (2.44)	616.3
T6 - Combination of Carbendazim and Mancozeb 0.1% foliar spray	91.00 (73.40)	3.83 (1.93)	742.7
T7 - Control	16.80 (22.80)	19.17 (4.45)	346.7
CD at 5%	12.9	1.303	126.7

*Values in parenthesis are arc-sine transformed ** Values in parenthesis are square root transformed

1.6.4.2Dapoli

It is revealed from the data presented in Table 35 that, slow wilt, foot rot, and *Phytophthora leaf blight* were the major diseases observed throughout the region. Anthracnose was of less sever. Maximum incidence of foot rot (5.40%) was observed at Shenale village at Ratnagiri District. The intensity of disease ranged from 0.33 to 5.40 per cent in the region. Maximum incidence of *slow wilt.* (*Rhizoctonia saloni*), *Radopholus similis, Meloidogyne incognita*) 9.70 per cent was observed at Dodamarg. Tal. of Sindhudurg district. The intensity of disease ranged from 0.56 to 9.70 per cent *Phytophthora* leaf blight of black pepper was observed throughout the Konkan region of which the intensity ranged from 0.75 to 18.25%. Anthracnose (*Colletotrichum gloeosporioides*) was observed only around Dodamarg (Dist. Sindhudurg) area on local variety (3.13%).

Table 35. Survey for incidence of diseases in black pepper - Dapoli

S.N.	Locations	Per cent diseases incidence		Percent disease index	
		Foot rot	slow wilt	*Phytophthora* leaf blight	Anthracnose
A	**Ratnagiri**				
	Dapoli	2.80	4.17	7.50	0.00
	Awashi	3.85	1.92	4.21	0.00
	Bhatye	2.70	2.70	5.50	0.00
	Lanja	0.00	0.00	0.75	0.00
	Shenale	5.40	6.86	5.40	0.00
	Mean	2.95	3.13	4.68	0.00
B.	**Sindhudurg**				
	Vengurla	2.22	2.08	5.00	0.00
	Khanoli	0.33	1.92	4.25	0.00
	Dodamarg	1.12	9.70	10.70	3.13
	Mean	1.22	4.57	6.65	1.04
C.	Raigad				
	Shrivardhan	2.50	0.00	3.25	0.00
	Revdanda	2.70	0.00	2.70	0.00
	Cahul	3.12	0.56	3.25	0.00
	Borli	4.62	0.00	7.25	0.00
	Diveagar	3.85	0.00	2.75	0.00
	Mean	3.36	0.11	3.84	0.00

1.6.4.3 Mudigere

The trial was started at Mudigere during 2002 with the following 5 treatments replicated 4 times in RCBD. The treatments are viz., T1 - 1 % Bordeaux mixture - Twice (May- June & August - September); T2 - 1 % Bordeaux mixture - Thrice (May, July and August); T3 - Mancozeb (Dithane M-45 (0.2%) Twice (May-June & August -September); T4 - Propiconozole (0.1%)

Twice (May- June & August - September) and T5 – Control.

The experiment did not give any result due to non-appearance of the disease during the year 2002. The disease incidence was recorded from 5.75% to 9.00% on leaves and no incidence was observed on spikes during the year 2003. During the period of disease initiation the epidemiological parameters like temperature ranging from 19.1 to 25.1° C with relative humidity of 84.9% coupled with rain fall of 368.1 mm prevailed during June. However, after imposing treatments disease incidence has been reduced to 5.24% in July, 4.04% in August and 2.76% in September (Tables 36 & 37).

Table 36. Anthracnose disease incidence with weather variables during 2003 - Mudigere

Month	Temp. (°C)		RH (%)	Rainfall (mm)	Rainy days (no.)	Percent Disease Incidence	
	Max	Min				Leaf	Spike
June	25.10	19.1	84.90	368.1	18	7.11	0.0
July	22.59	18.7	90.32	552.8	25	5.24	0.0
Aug.	22.51	18.7	90.87	261.6	22	4.04	0.0
Sep.	23.52	17.4	90.20	080.7	11	2.76	0.0

However, three sprays of Bordeaux mixture 1% during the last week of June, July and August can effectively checks the anthracnose disease of black pepper which is on par with two sprays of Propiconozole 0.1% during the last week of June and August month. But using 1% Bordeaux mixture as compared to Propiconozole, which is costlier.

Table 37. Incidence, epidemiology and management of anthracnose disease in black pepper (2003) - Mudigere

Treatment	Before spray during 2003	Per cent disease incidence	
		Leaf	Spike
T1 - Bordeaux mixture 1%	9.00	4.14	0.0
T2 - Bordeaux mixture 1%	7.00	2.74	0.0
T3 - Mancozeb (0.2%)	6.20	3.80	0.0
T4 - Propiconozole (0.1%)	5.75	2.80	0.0
T5 - Control	7.60	6.47	0.0
CD at 5%		0.56	-
CV%		9.10	-

1.6.4.4 Chintapalle

During 2002-03 disease incidence was low when spraying was done with 1% Bordeaux mixture thrice i.e., May, July and August and there was 55.5% decrease of disease incidence over control.

During 2003-04 the incidence of disease was reduced by 83 percent over control in the treatment with propiconazole spraying @ 0.1% at two intervals of may-June and August-September followed by spraying with 1% Bordeaux mixture thrice i.e., May, July and August with 62% reduction in disease incidence over control.

Table 38. Management of anthracnose of black pepper – Chintapalle

Treatments	Percent disease incidence	% reduction in disease incidence
T1- Bordeaux mixture 1% (twice)	17.5 (24.7)	46
T2- Bordeaux mixture 1% (thrice)	12.4 (20.6)	62
T3 - 0.2% Mancozeb (twice)	18.7 (25.6)	42
T4 - 0.1% Propiconazole (twice)	5.5 (13.5)	83
T5 - Control	32.8 (34.9)	—
SEM ±	2.2	—
CD at 5%	6.8	—
CV%	18.4	—

1.7 Pest Management Trial (PEP/CP/2)

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

(*Pampadumpara*)

1.7.1.1Pampadumpara

Thirteen panchayats were surveyed for the occurrence of insect-pests of black pepper in high ranges of Idukki District. Percentage incidence of insect-pests during the period is presented in Table 39. Scale-insects and marginal gall thrips were found to be the predominant insect-pests at high ranges of Idukki district and were recorded from all panchayats surveyed. Incidence of marginal gall thrips ranged from 8.87% in Vandenmedu to 30.93% in Erattaiyar. Infestation by scale insects (mussel scale) was very severe occurring to a maximum of 100% at Nedumkandam. Foliar two-tailed mealy bug was observed in eight panchayats, the maximum being at Vandenmedu (6.93%). Aphids were observed at Chakkupallam and top shoot borer was noticed at Pampadumpara panchayat.

Table 39. Percentage incidence of insect pests on black pepper at high altitudes of Idukki district – Pampadumpara

Panchayat	Marginal gall thrips	Scale insects	Mealy bug	Leaf miner	Leaf gall	Bag worm	Aphid	Top shoot borer
Karunapuram	10.43	30.00	3.33	—	—	1.33	—	—
Pampadumpara	22.50	38.13	1.47	—	—	—	—	2.67
Kattapana	14.17	37.50	3.67	—	1.33	—	—	—
Vandanmedu	8.87	20.00	6.93	—	—	—	—	—
Chakupallam	11.20	8.67	1.33	—	—	—	5.33	—
Nedumkandam	18.23	100.0	—	1.33	—	1.33	—	—
Udumbanchola	13.30	13.33	1.33	—	—	—	—	—
Senapathy	11.80	22.90	—	5.33	—	—	—	—
Erattaiyar	30.93	5.33	—	1.01	5.49	—	—	—
Kamakshi	24.32	14.67	0.69	1.07	1.76	—	—	—
Vathikudy	14.13	9.33	—	0.91	—	—	—	—
Mariyapuram	13.49	4.59	1.12	0.80	0.27	—	—	—
Vazhathoppu	16.05	6.67	—	0.53	0.53	—	—	-

2. CARDAMOM

In cardamom 16 projects are in progress at 35 centres of the AICRPS.

2.1 Genetic Resources (CAR/CI/1)

2.1.1 Germplasm collection, characterization, evaluation and conservation (CAR / CI / 1.1)

(*Mudigere* and *Pampadumpara*)

2.1.1.1Mudigere

The entire germplasm collections have been replanted during 2002 & 2003 for further evaluation, since the plants have become very old and twenty seedlings of N-Green Gold are included in to the germplasm during 2002-2003.

At present a total of 126 cardamom germplasm consisting of 195 Malabar type, 43 Mysore type and 18 vazhukka types are maintained at Mudigere centre. Out of 256 accessions, 157 accessions are evaluated. The remaining germplasm i.e., 99 accessions will be characterized.

2.1.1.2Pampadumpara

Cardamom germplasm collection was continued in Hill Reserves of Idukki District during 2003-2004 for superior clones with special emphasis to yield and tolerance to biotic and abiotic stresses. Seventeen accessions were collected during the reported period. A total of 121 accessions are presently conserved in the gene bank.

The data pertaining to top ten accessions based on their yield, tolerance to biotic stresses and quality parameters are presented in Table 40. The highest fresh yield (3054 g clump^{-1}) and dry yield (588 g clump^{-1}) of capsules was recorded in S-1, which was also found to be tolerant to thrips (6.5%). PS - 27 stood second in terms of fresh (2964 g clump^{-1}) and dry yield (552 g clump^{-1}) of capsules. The lowest yielder was PS - 3 (2066 g wet and 447 g dry capsules clump^{-1}).

Thrips infestation was observed to be high in MBP (23.5%) and BEP - 1 (22.6%). Infestation by borer was found to be lowest in PS - 22 (0.2%) and BEP - 2 (0.3%) and highest in MBP (3.8%). The volatile oil content was maximum in accessions S - 1 (7.2%) and PPK - 2 (7%). The oleoresin content was high in accessions PS - 27 (11.2%) and BEP - 1 (11%).

Table 40. Performance of promising cardamom germplasm accessions (2003 - 04) - Pampadumpara

Genotype	Fresh yield (g clump^{-1})	Dry yield (g clump^{-1})	100 capsule weight (g)	Thrips infestation (%)	Capsule borer infestation(%)	Volatile oil (%)	Oleoresin (%)
S - 1	3054	588	75	6.50	1.70	7.2	10.8
BEP - 2	2553	526	71	9.20	0.30	6.2	10.3
MCC- 34	2622	539	72	19.75	2.70	6.5	10.1
PS - 22	2406	523	67	15.30	0.20	6.3	10.2
PPK - 2	2344	495	69	10.25	0.80	7.0	10.8
PS - 10	2377	520	66	16.60	1.50	6.4	10.4
MBP	2246	506	64	23.50	3.80	6.2	10.5
PS - 27	2964	552	78	18.40	1.10	6.8	11.2
BEP-1	2132	428	73	22.60	2.30	6.8	11.0
PS - 3	2066	447	70	7.15	1.60	6.4	10.0

2.2 Hybridization and selection (CAR / CI / 2)

2.2.1 Evaluation of OP progenies under intensive management (CAR/CI/2.1)

(Mudigere)

2.2.1.1 Mudigere

Eight promising cardamom clones viz., Mudigere - 1, Mudigere - 2, CL - 692, HS - 1, SKP - 14, Sel. 98, CCS - 800, CL - 691, were found to be better general combiners, these clones were planted during 1995-96 with closer spacing (6'x3') and allowed for open pollination and OP seeds were collected. Total sixty one genotypes (OP seedlings) were identified from the crosses made by open pollination and these are planted in the main field during the year 2000. Due to higher mortality, gap filling was taken up during 2001. As the plants are yet to come for yielding observations on growth characters are being recorded.

2.2.2 CVT 1991/1998 - Series III with Malabar Types (CAR/CI/3.2)

(Mudigere and Shakleshpur)

2.2.2.1Mudigere

The CVT was laid out with 15 entries during 1998 with a spacing of 6' x 6' in RBD with 3 replications having 12 plants plot^{-1}. Yield data was recorded for three consequentive years. Accessions SKP - 72, CCS - 872 and CCS - 893 have given comparatively more yield over the local check (M -1) producing 90.10, 83.63 and 75.00 kg ha^{-1} respectively over 68.80 kg ha^{-1} of (M -1) during the third yielding year (2002). The pooled data of 3 years (2000, 2001, 2002) presented in Table 41. The result showed that CL - 692, produced more yield (139.60 kg ha^{-1}) followed by CL - 679, (138.70 kg ha^{-1}), CL - 683 (135.23 kg ha^{-1}) and CL - 726 (132.00 kg ha^{-1}) compared to the local check M - 1 with 116.20 kg ha^{-1}.

Table 41. Performance of promising cardamom clones (Malabar types) - Mudigere

Clone	Dry yield (kg ha^{-1})			
	2000	2001	2002	Average
CL - 679	259.80	89.00	67.30	138.70
CL - 683	228.10	117.20	60.40	135.23
CL - 692	282.60	90.00	46.23	139.60
CL - 726	225.10	103.40	67.40	132.00
CCS - 800	182.10	56.40	27.63	88.71
CCS - 872	154.50	109.00	83.63	115.71
CCS - 893	154.10	91.00	75.00	106.70
HS - 1	138.10	103.50	61.00	100.90
M - 1	180.10	99.60	68.80	116.20
MCC - 34	150.30	60.30	69.53	93.40
PV - 1	80.80	58.00	51.60	63.50
SKP - 14	207.50	127.50	65.20	133.40
SKP - 21	130.30	63.40	43.01	78.90
SKP - 72	207.80	103.00	90.10	133.63
SKP – 100	168.50	67.00	41.70	92.40
CD at 5%	84.30	51.44		
CV %	27.48	34.13		

2.2.2.2 Shakleshpur

The trial was initiated during 1997-1998 with 13 entries in RBD at Shakleshpur. Morphological and yield data were recorded, compiled and analyzed during 2003-2004 and are presented in Table 42. CL - 679 had significantly more number of tillers plant^{-1} (31.2) and panicles plant^{-1} (28.0). Bearing tillers were significantly more in SKP - 170 (14.4). Yield was significantly more in SKP 169 (394.0 kg ha^{-1}) and in ICRI - 3 (332.6 kg ha^{-1}). Maximum percentage of bold capsules (capsules retained in 8 mm sieve) are found in CL - 683 (46.0%) followed by CL - 726 (42.6%).

Table 42. Performance of promising cardamom clones (Malabar types) - Shakleshpur

Genotype	Plant ht. (cm)	No.of tillers	No.of bearing tillers	No.of panicles	Racemes panicle^{-1}	Capsules raceme^{-1}	Yield (kg ha^{-1})
CCS - 872	191.8	27.8	12.00	24.20	17.0	2.1	198.00
CCS - 893	161.0	16.0	7.00	11.00	17.1	2.1	96.60
CCS - 800	171.8	18.0	8.20	15.10	16.3	2.1	99.30
PV - 1	208.7	17.2	7.90	11.90	16.2	2.5	186.60
CL - 679	201.2	31.2	14.30	28.00	20.8	2.3	185.30
CL - 683	188.7	26.9	13.10	24.90	16.1	2.2	250.00
CL - 726	215.0	27.6	12.40	22.90	16.4	2.7	226.00
MUD - 1	202.8	21.0	8.70	22.90	18.9	2.3	172.30
MCC - 34	202.0	29.5	11.90	14.10	19.8	2.3	198.00
ICRI - 3	227.7	22.6	12.70	20.10	19.6	2.7	332.60
SKP - 72	246.3	22.3	11.30	24.20	18.3	2.3	146.60
SKP - 169	227.7	25.0	12.50	19.50	23.9	2.7	394.00
SKP - 170	221.7	25.2	14.40	24.70	22.5	2.6	313.00
CD at 5%	48.2	5.72	3.20	7.05	4.98	NS	72.69

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

(*Mudigere, Shakleshpur* and *Myladumpara*)

2.2.3.1Mudigere

The CVT was laid out with 5 entries during 1998 with a spacing of 6 x 6 in RCBD with 5 replications having 15 plants plot^{-1}. Five promising clones of Mysore types are studied under the trail for their yield performance. The data presented in Table 43 once again reiterates that Mysore types do not give economic yield compared to Malabar types in Karnataka conditions. However, during the last year, MCC - 21 yielded 45.30 kg ha^{-1} followed by MCC - 81 and MCC - 61 39.42 and 38.92 kg ha^{-1} respectively.

The pooled data over the last three yielding years, MCC - 21 produced comparatively higher yield (36.10 kg ha^{-1}) followed by MCC - 81, MCC - 61 and MCC - 12 with an average yield of 35.25 kg ha^{-1}, 33.91 kg ha^{-1} and 33.90 kg ha^{-1} respectively Table 43. Based on this trial, it may be once again concluded that the Mysore type does not give economic yield compared to the Malabar types in Karnataka. Thus this trial may be concluded at Mudigere.

Table 43. Performance of promising cardamom clones (Mysore types) - Mudigere

Clone	Yield ha^{-1} (kg)			Mean
	2000	2001	2002	
SKP - 51	22.08	14.40	26.82	22.76
MCC - 12	45.92	22.80	28.40	33.90
MCC - 21	35.28	18.60	45.30	36.10 *
MCC - 61	31.44	16.40	38.92	33.91
MCC - 81	36.48	25.80	39.42	35.26
CD at 5 %	-	13.60	30.37	-
CV %	-	17.20	63.35	-

2.2.3.2 Shakleshpur

The trial was initiated during 1997-1998 at Shakleshpur with 5 entries in RBD. During 2003-2004, morphological and yield data were recorded (Table 44). Number of panicles as maximum in MCC - 85 (22.4), followed by MCC - 12 (21.5). Yield was maximum in MCC - 85 (251.2. kg ha^{-1}) followed by MCC - 12 (158.9 kg ha^{-1}). The size of capsules among the promising genotypes, maximum percentage of bold capsules (capsules retained in 8 mm sieve) are found in MCC - 85 (46.9%) followed by MCC - 61 (26.0%).

Table 44. Performance of cardamom accessions (Mysore types) - Shakleshpur

Genotype	Height (cm)	No.of tilers	No.of bearing tillers	No.of panicles	Raceme panicle^{-1}	Capsules raceme^{-1}	Yield (kg ha^{-1})
MCC - 12	208.0	23.9	11.4	21.4	18.1	2.20	159.2
MCC - 21	201.5	24.4	10.8	18.5	17.1	2.30	125.7
MCC - 61	195.5	22.5	9.5	18.4	15.6	2.30	106.4
MCC - 12	208.0	23.9	11.4	21.4	18.1	2.20	159.2
MCC - 21	201.5	24.4	10.8	18.5	17.1	2.30	125.7
MCC - 61	195.5	22.5	9.5	18.4	15.6	2.30	106.4
MCC - 85	229.4	22.8	11.0	22.4	17.5	2.80	251.2
SKP - 51	214.5	25.9	9.2	18.7	21.8	2.10	123.8
CD at 5%	31.3	NS	NS	NS	NS	0.33	32.37

2.2.3.3 Myladumpara

Not reported.

2.2.4 CVT 2000 - Series IV (CAR/CI/3.4) (*Pampadumpara, Mudigere, Myladumpara* and *Shakleshpur*)

2.2.4.1 Pampadumpara

The experiment was started during 2001 at Pampadumpara with 12 entries and three replications in RBD and 18 plants as plot size so as to evaluate the performance of promising cardamom lines. The yield and yield attributing characters were recorded during 2003 (Table 45). Tiller number was maximum in Cl. 692 (45.66) closely followed by Mcc (43.88) that were on par and superior to other entries. Tiller height ranged from 162.55 to 309.44 cm. S-1 and PS-

44 were found to be the tallest accessions and were significantly superior to other entries. Tiller height was least in RR - 1 (162.55 cm). There existed significant difference in number of panicles among the entries evaluated. Significant in higher number of panicles was observed in SKP – 117, followed by S - 1 and Cl. 692. Though a couple of entries did not yield capsules during the period under report, highest dry yield was recorded in Cl. 692 followed by S - 1.

Table 45. Yield attributing characters of cardamom accessions – Pampadumpara

Entry	No. of tillers plant $^{-1}$	Plant height (cm)	No. of panicles plant^{-1}	Dry yield (g plot^{-1})
CL-692	45.66	233.77	64.33	2950
SKP - 170	41.44	223.44	70.10	1258
SKP - 165	39.88	231.88	53.22	815
PS - 44	40.99	297.33	43.33	900
S - 1	29.66	309.44	68.77	2400
MCC - 200	43.88	283.21	56.11	1525
GG (C)	24.66	269.66	39.44	395
MCC - 347	36.77	236.55	43.77	950
MCC - 18	28.33	258.33	31.21	380
MCC - 13	32.22	276.55	27.21	635
RR - 1	25.10	162.55	28.22	Not yielded
NKE - 19	31.00	178.88	25.88	Not yielded
CD at 5%	20.31	48.27	18.97	

2.2.4.2Mudigere

The CVT was laid out with 13 genotypes during 2001 with 3 replications in RCBD having 18 plants plot^{-1}. The entries are planted with a spacing of 6' x 6' and adopted the recommended package of practices. As there was more causality of plants, gap filling was done during the August 2002 and no observation could be recorded. Observations were recorded during 2003 produced nine numbers of tillers showed that Cl-692, MHC-10 & M-2 (local check). The data (38.00, 3.90 & 35.13 number of tillers clump^{-1}, respectively) (Table 46).

Table 46. Yield attributing characters of cardamom accessions – Mudigere

Entry	Plant height (cm)	No. of tillers plant^{-1}
M - 2	231.00	35.13
CL - 692	229.33	38.00
SKP - 165	177.73	24.00
SKP - 170	246.33	27.70
APG - 281	104.92	6.25
APG - 284	164.70	18.90
APG - 293	204.40	11.93

Entry	Plant height (cm)	No. of tillers plant^{-1}
MCC - 10	253.33	33.90
MCC - 13	171.33	15.10
MCC - 18	232.33	29.70
MCC - 200	209.50	25.20
S - 1	278.30	21.10
PS - 44	255.33	27.40

2.2.4.3 Myladumpara

Report not received.

2.2.4.3 Shakleshpur

The trial was initiated with 14 genotypes consisting of three from ICRI, Sakleshpur; four from IISR, Appangala; four from ICRI, Myladumpara; two from KAU, Pampadumpara; one from RRS, Mudigere during the year 2002. Morphological data have been recorded, and analyzed during 2003-2004 (Table 47).

The data revealed that plant height was significantly more in APG 298 (168.3 cm) followed by S1 M (167.6 cm). MHC 10 has the highest number of tillers (10.4) followed by MCC 200 (10.2).

Table 47. Performance of cardamom accessions (CVT Series IV - 2002) - Shakleshpur

Genotype	Plant height (cm)	No. of leaves	No. of tillers
Control	104.80	8.5	4.8
APG - 310	85.70	7.9	5.8
APG - 306	104.70	7.5	7.8
APG - 298	168.30	10.8	8.6
SKP - 165	141.70	9.4	9.8
SKP - 170	135.20	10.8	7.1
MCC - 200	146.80	8.1	10.2
MHC - 10	156.80	13.0	10.4
MCC - 13	137.10	12.6	7.8
MCC - 18	122.70	10.2	6.9
PS 44	160.50	11.1	8.4
S1	167.60	11.5	9.1
CL - 692	145.50	9.3	8.1
ICRI - 3	122.20	9.8	6.0
CD at 5%	31.93	2.2	2.7

2.3 Varietal Evaluation Trial (VET) (CAR/CI/4)

2.3.1 Yield evaluation of OP seedling progenies of promising cardamom selection (CAR/CI/4.1)

(*Mudigere*)

2.3.1.1. Mudigere

Final report not received.

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

(*Mudigere*)

2.3.2.1 Mudigere

Final report not received.

2.3.3 Initial evaluation trial-I
(*Mudigere*)

2.3.3.1 Mudigere

The progenies of open pollinated seedlings were multiplied and their suckers were planted during year 1999. As the plants are yet come to yielding, observations are recorded on number of tillers clump^{-1} and the results are presented in Table 48. Among 13 genotypes tested against local checks M - 1 and M - 2, clone 24-17-D10, 7-24-D11* 29-9-D11, were found promising with 26.7,26.30 and 26.3 tillers clump^{-1} respectively compared to M - 1 (22-7) and M - 2 *24.7).

Table 48. Performance of cardamom open pollinated progenies (2003) - Mudigere

Clone	Plant height (cm)	No. tillers plant^{-1}
7-24 - D11	192.40	26.3
8-4 - D11	178.60	25.3
26-16 - D11	187.60	19.7
23-8 - D11	199.60	19.0
29-9 - D11	199.20	26.3
2-4 - D11	209.60	18.7
12-7 - D11	231.60	21.3
2-5 - D11	207.00	14.3
10-6 - D10	217.40	17.3
24-17 - D10	225.80	26.7
7-10 - D11	217.00	18.3
7-12 - D11	147.60	7.3
10-5 - D11	257.20	13.3
Mudigere - 1	185.00	22.7
Mudigere - 2	252.60	24.7

2.3.4 Initial evaluation trial -II (CAR/CI/4.4)
(*Mudigere*)

2.3.4.1 Mudigere

Open pollinated seedlings of promising clones were evaluated. Promising seedling progenies were multiplied, and their suckers were planted during the year 1999. The observations recorded on the number of tillers clump^{-1} and plant height were presented in Table 49. Among sixteen clones tested against the local checks M-1 and M-2, OP seedlings of CL-691 has produced highest number of tillers clumps^{-1} (27.80) followed by OPS of CL-692 when compared to the local checks M-1 and M-2 with 21.2 and 25.2 number of tillers clump^{-1} respectively.

Table 49. Performance of promising cardamom OP seedlings -Mudigere

Clone	Plant height (cm)		No. of tillers plant^{-1}	
	2002	2003	2002	2003
HS - 1	244.30	131.00	23.7	11.80
CL - 668	158.33	179.00	23.7	26.80
CL - 691	194.00	201.60	29.3	27.80
MCC - 34	163.00	-	17.7	-
CCS - 800	182.00	161.20	13.7	15.00
Pink pseudostem	184.00	198.00	15.0	14.20
Sel. 98	187.70	189.20	19.3	22.60
CL - 722	221.30	192.60	20.7	13.40
SKP - 14	216.70	158.80	15.0	9.80
P - 8	121.00	106.00	9.0	6.00
P - 17	165.70	143.20	17.0	7.00
EB 1277-7	190.00	158.00	10.0	7.80
CL - 692	181.00	168.40	28.0	26.80
Pink capsule	67.50	120.50	10.5	5.50
CL - 726	156.50	111.00	24.0	6.20
Mudigere - 1 (check)	180.66	185.00	22.7	21.20
Mudigere - 2 (check)	200.33	252.60	24.7	25.20
CL - 730	162.30	-	20.3	-

2.3.5 Screening cardamom clones for abiotic stress (CAR/CI/5): I

(*Mudigere*)

2.3.5.1 Mudigere

Final report not received.

2.4 Nutrient Management Trial (CAR / CM / 1)

2.4.1 Integrated nutrient management in cardamom (CAR / CM / 1.3)

(Mudigere and *Pampadumpara)*

2.4.1.1 Mudigere

The experimental plot was replanted during second fortnight of July 2000 with 6 treatments, replicated 4 times with a spacing of ten clumps treatments^{-1} in RBD. Although the crop growth was good, it did not initiate the expected flowering during the season.

2.4.1.2Pampadumpara

Not reported.

2.4.2 Effect of biofertilizer using *Azospirillum* on cardamom (CAR / CM / 1.4)

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

2.4.2.1 Mudigere

This experiment was laid out during July 2000 with 9 treatments, replicated thrice with ten clumps under each treatment in RCBD. Although the crop growth was good, it did not initiate the expected flowering during the season. The plant samples drawn during October 2002 were analyzed for N-component. Results revealed that maximum accumulation of N was noticed in seeds (2.0 - 2.46%) followed by husk. Panicles do also contain a considerable amount of N followed by leaves of bearing suckers. The least N was found in pseudostems of bearing suckers ranging from 0.85 - 0.94%. No appreciable accumulation of N in any of the plant parts in different treatment was observed (Fig.1).

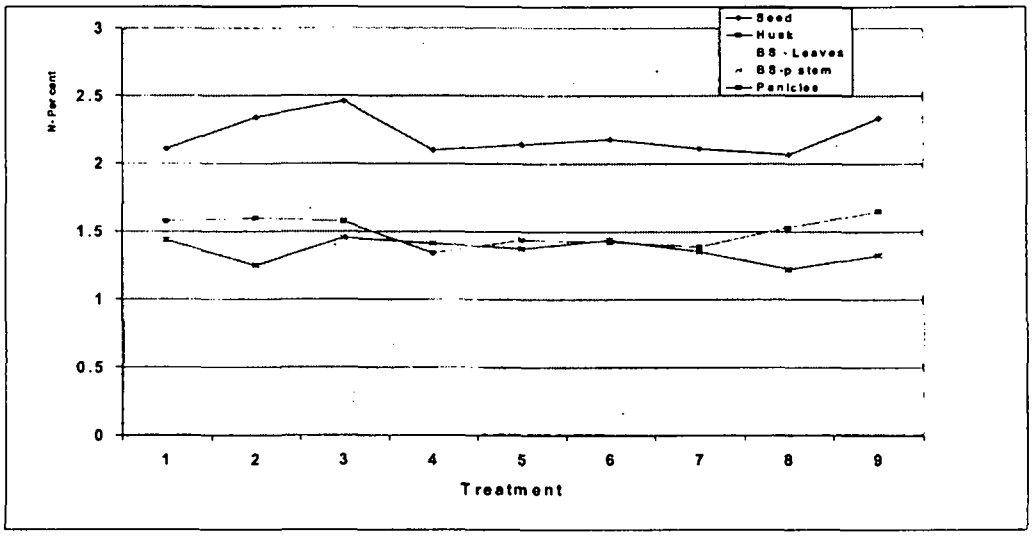

Fig. 1: Nitrogen content in different plant parts in cardamom

2.4.2.1 Pampadumpara

The experiment was started during 2001 with eight treatments and four replications in a randomized block design. The results for the period presented in Table 50. The highest dry yield of cardamom was observed in T_6 (0.361 kg plant^{-1}) followed by T_5 (0.337 kg plant^{-1}), T7 (0.298 kg plant^{-1}) and T_1 (0.252 kg plant^{-1}). The lowest yield was recorded in T_3 (0.116 kg plant^{-1}).

Infestation of capsule borer and thrips were also recorded (Table 50). Capsule borer infestation ranged from 3.25 to 7.5% and least infestation was recorded in plots treated with FYM @ 10 kg (T_7). However, the incidence of capsule borer and thrips was highest in FYM @ 5 Kg treated plots.

Table 50. Effect of *Azospirillum* on yield of cardamom – Pampadumpara

Treatment	Yield (kg plant^{-1})	Capsule borer infestation (%)**	Thrips infestation (%)*
T_1 - Inorganic nitrogen 100% + *Azospirillum* 50g + 5 kg FYM	0.252	4.25 (1.97)	25.00 (26.26)
T_2 - Inorganic nitrogen 75% + *Azospirillum* 50g + 5 kg FYM	0.217	3.50 (1.84)	33.25 (35.14)
T_3 - Inorganic nitrogen 50% + *Azospirillum* 50g + 5 kg FYM	0.116	5.25 (2.19)	33.00 (34.35)
T_4 - *Azospirillum* 50g + 5 kg FYM	0.216	5.00 (2.20)	36.25 (36.53)
T_5 - FYM 5 kg alone	0.337	7.50 (2.70)	37.75 (37.61)
T_6 - FYM 10 kg + *Azospirillum* 50 g	0.361	4.50 (2.03)	33.25 (37.52)
T_7 - FYM 10 kg alone	0.298	3.25 (1.71)	32.25 (34.52)
T_8 - Control	0.167	5.25 (2.25)	32.00 (34.25)
CD at 5%	0.131	NS	0.80

*Values in parenthesis are arc sine transformed. ** Values in parenthesis are square root transformed

2.4.2.1 Myladumpara

The trial was initiated during the year 2000 at ICRI, Myladumpara to know the efficacy of *Azospirillum* as nitrogen source in rainfed cardamom. The trial was laid out in RBD with seven treatments and four replications having 12 plants plot^{-1}. The variety used for the study was MCC - 260. The experiment was in third year of progress and current year was first bearing. Treatments were imposed as per the treatment schedules and observations on morphological and yield parameters recorded indicate that there were no significant differences on both growth and yield parameters between the treatments (Table 51). The soil and leaf samples were also collected during the year and they are under process of analysis for their nutrient content.

Table 51. Effect of biofertilizer, *Azospirillum* on the growth and yield of cardamom – Myladumpara

Treatment	Buds clump^{-1}	Total tillers clump^{-1}	Bearing tillers clump^{-1}	Panicles clump^{-1}	Racemes panicle^{-1}	Yield (kg ha^{-1})	
						Fresh	Dry
T1 - Inorganic N (100%) + *Azospirillum* 50 g + 5 kg FYM	0.62	39.94	11.56	17.37	16.08	1053	221.2
T2 - Inorganic N (75 %) + *Azospirillum* 50 g + 5 kg FYM	0.25	38.94	10.06	22.19	26.24	699	139.7
T3 - Inorganic N (50%) + *Azospirillum* 50 g + 5 kg FYM	1.12	41.19	11.12	24.25	16.23	1072	229.7
T4 - *Azospirillum* 50 g + 5 kg FYM	0.44	38.50	11.19	24.50	16.89	1402	303.7
T5 - 5 kg FYM	0.37	29.88	7.56	14.94	15.37	814	172.5
T6 - *Azospirillum* 50 g + 10 kg FYM	0.75	42.75	9.64	24.69	16.66	918	189.1
T7 - 10 kg FYM alone	0.56	40.25	14.44	29.56	18.20	1406	297.4
CD at 5 %	NS	NS	NS	NS	NS	NS	NS

2.4.2.1 *Shakleshpur*

Not reported.

2.4.3 Effect of biofertilizer using P - solubilizers on cardamom (CAR / CM / 1.5)

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

2.4.3.1 Mudigere

The experiment was replanted during second fortnight of July 2000 with 9 treatments, replicated thrice with ten clumps treatments^{-1} in RBD. Although the crop growth was good, it did not initiate the expected flowering during the season. Plant samples drawn during October 2002 were analyzed for P-component. Results

revealed that maximum accumulation of P was noticed in seeds (0.18 - 0.27 %) followed by husk. Leaves of bearing suckers do also contain a considerable amount of P followed by pseudostems of bearing suckers that range from 0.105 to 0.195. Different treatments applied did not show appreciable accumulation of P in any of the plant parts.

Table 52. Effect of P - solubilizers on the growth and yield of cardamom – Mudigere

Treatment	Capsule yield (g plant^{-1})	
	fresh	Dry
T_1 - Inorganic P 100% + P solubilizers 50g + 5 kg FYM	60.30	12.96
T_2 - Inorganic P 75% + P solubilizers 50g + 5 kg FYM	131.14	26.50
T_3 - Inorganic P 50% + P solubilizers 50g +5 kg FYM	105.90	23.97
T_4 - P solubilizers 50g + 5kg FYM	148.79	26.94
T_5 - FYM 5kg alone	218.23	42.85ü
T_6 - P solubilizers 50g + FYM 10kg	96.66	20.73
T_7 - FYM 10kg alone	163.26	29.36
T_8 - Inorganic P 100%	125.01	26.76
T_9 - Inorganic P 100%	77.59	13.62

2.4.3.2 Pampadumpara

The experiment has been initiated during the period under report in accordance with the technical programme and is in progress.

2.4.3.3 Myladumpara

A trial was initiated during 2000 to know the efficacy of Phosphobacteria as P-solubilizer in rainfed cardamom. The plots were laid out in RBD with seven treatments and four replications having 12 plants plot^{-1}. The variety used for the study was MCC - 21.

The experiment is in third year of progress and the plants yielded in the current year. Observations on morphological parameters and yield were recorded. The data showed no significant difference between the treatments (Table 53). The soil and leaf samples are under process of analysis for their nutrient content.

Table 53. Effect of P - solubilizers on the growth and yield of cardamom - Myladumpara

Treatment	Buds clump^{-1}	Total tillers clump^{-1}	Bearing tillers clump^{-1}	Panicles clump^{-1}	Racemes panicle^{-1}	Yield (kg ha^{-1})	
						Fresh	Dry
T1 - Inorganic N (100%) + Phosphobacteria 50 g + 5 kg FYM	1.94	41.12	21.14	25.62	16.09	952	222.4
T2 - Inorganic N (75 %) + Phosphobacteria 50 g + 5 kg FYM	1.44	43.44	13.06	27.71	16.29	1154	264.3

Treatment	Buds clump^{-1}	Total tillers clump^{-1}	Bearing tillers clump^{-1}	Panicles clump^{-1}	Racemes panicle^{-1}	Yield (kg ha^{-1})	
						Fresh	Dry
T3 - Inorganic N (50%) + Phosphobacteria 50 g + 5 kg FYM	1.44	38.19	11.75	25.94	17.08	1276	282.1
T4 - Phosphobacteria 50 g + 5 kg FYM	1.81	35 62	10.81	21.81	15.60	912	228.0
T5 – 5 kg FYM	1.94	32.62	9.62	18.25	15.73	785	186.4
T6 - Phosphobacteria 50 g + 10 kg FYM	1.69	33.44	13.31	28.75	16.56	1675	361.3
T7 - 10 kg FYM	2.37	40.69	12.37	27.31	17.25	1016	232.1
T8 - Control							
CD at 5 %	NS	NS	NS	NS	NS	NS	NS

2.4.3.3Shakleshpur

Not reported.

2.4.3 Effect of neem cake on the productivity, pest and disease incidence in cardamom (CAR/CM/1.6)

(Mudigere, Pampadumpara, Myladumpara and *Shakleshpur)*

2.4.3.1 Mudigere

This experiment was started during 2003 and is in progress.

2.4.3.2 Pampadumpara

The experiment has been initiated during the period under report.

2.4.3.3 Myladumpara and Shakleshpur

Not reported.

2.5 Pest Management Trial (CAR/CP/2)

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

(*Mudigere*)

2.5.1.1Mudigere

The experiment was started in 2000 with 7 treatments replicated thrice in RBD having 16 clumps/treatments plot size. Since the results of the experiment were not consistent the experiment is continued during the current year also. The data presented in Table 54 revealed that, minimum thrips damage was recorded in chemical treated plots (25.03%) followed by neem gold and Econeem plus (33.83% and 32.79%). Other treatments are on par with control. The chemical treatment gave minimum damage (17%). Maximum damage was recorded in case of neem oil applied plots compare to control. None of the neem based insecticides proved effective against thrips and capsule borer compared to chemical check. The recommended spray schedule of chemical insecticides was proved effective over neem based insecticides for controlling both thrips and capsule borers.

Table 54. Effect of neem based insecticides against the infestation of thrips, shoot and fruit borer in cardamom (pooled data 2000-01 to 2003-04) - Mudigere

Treatment	Dosage/ conc	2000-01 (%)		2001-02 (%)		2002-03 (%)		2003-04 (%)		Mean (%)	
		Thrips	Borer	Thrips	Borer	Thrips	Borer	Thrips	Borer	Thrips	Borer
Neem gold	0.03%	17.89	2.81	23.55	5.55	41.70	12.40	33.83	20.75	29.24	10.37
Neem oil cake (½kg plant^{-1})	22.65	1.05	31.35	6.55	57.00	17.80	34.78	19.79	36.44	11.29	
NSKE	4%	21.99	1.11	20.99	7.55	51.00	7.80	34.45	19.84	32.10	9.07
Neem oil	0.03%	16.79	1.77	21.55	5.20	42.30	8.20	35.55	23.03	29.04	9.55
Eco neem plus	0.03%	-	-	-	-	61.90	7.40	32.79	17.61	47.34	12.50
Monocroto phos / Phosalone	0.05	10.10	0.35	6.59	2.50	37.00	3.70	25.03	17.00	19.68	5.88
Control		18.39	2.39	29.55	7.50	54.00	18.90	37.05	21.48	34.74	12.56
CD at 5%		3.93	NS	5.74	1.86	13.55	2.84	12.83	8.17		

Mean number of capsules from single harvest

2.5.2 Management of root grub of cardamom (CAR/CP/2.2)

(*Pampadumpara* and *Mudigere*)

2.5.2.1 Pampadumpara

The experiment was laid out during 2001 with seven treatments replicated thrice in RBD to assess the efficacy of various insecticides including newer generation neonicotinoids on cardamom root grub. During the first season (April-May), the grub population ranged from 7.67 to 12.33 in one cubic foot of soil prior to the superimposition of treatments (Table 55). However, the grub population ranged from 2.00 to 8.67 after the application of treatments. The population was found to be lower in those plots treated with insecticides at higher concentration. All the insecticide treatments significantly reduced the grub population compared to that of control. The maximum reduction was observed in carbofuran @ 150 g plant^{-1} treated plots (80.73%) followed by those plots treated with chlorpyrifos 0.07% (78.86%) and imidacloprid 0.75 ml (73.15%). At lower concentration of insecticides, carbofuran @ 100 g plant^{-1} treated plots recorded the maximum suppression of root grub and plots drenched with chlorpyrifos 0.05% recorded the minimum. It is concluded all the insecticide treatments were effective in reducing the population of cardamom root grub to more than 50%.

Table 55. Effect of insecticides on cardamom root grubs (April-May) - Pampadumpara

Treatment	Initial grub* population	Grub population after treatment*	Reduction drenching ** (%)
T_1 - Chlorpyrifos 0.05%	8.33 (3.05)	3.67 (2.16)	55.04 (47.97)
T_2 - Chlorpyrifos 0.07%	10.00 (3.30)	2.00 (1.73)	78.86 (62.77)
T_3 - Carbofuran 100g plant $^{-1}$	11.00 (3.46)	3.00 (1.99)	73.08 (58.54)
T_4 - Carbofuran 150g plant $^{-1}$	10.00 (3.30)	2.00 (1.71)	80.73 (64.20)
T_5 - Imidacloprid 0.5 ml l^{-1}	12.33 (3.65)	4.33 (2.31)	64.96 (53.72)
T_6 - Imidacloprid 0.75 ml l^{-1}	7.67 (2.94)	2.00 (1.73)	73.15 (58.88)
T_7 - Control	9.33 (3.19)	8.67 (3.10)	9.09 (11.35)
CD at 5 %	NS	0.336	12.51

* Values in parenthesis are square root transformed (x+1)

** Values in parenthesis are arc sine transformed (Sin^{-1} x+1)

During the second season (September-October), the grub population ranged from 7.67 to 9.33 in one cubic foot of soil prior to the superimposition of treatments. However, the grub population ranged from 1.00 to 8.00 after the application of treatments (Table 56). The population was found to be lower in those plots treated with insecticides at higher concentration. All the insecticide treatments significantly reduced the grub population compared to that of control. The maximum reduction was observed in imidacloprid 0.75 ml litre^{-1} treated plots (89.67%) followed by those plots treated with chlorpyrifos 0.07% (83.33%) and carbofuran @ 150g plant^{-1} (74.74%). At lower concentration of insecticides, carbofuran @ 100 g plant^{-1} treated plots recorded the maximum suppression of root grub and plots drenched with Imidacloprid 0.5 ml litre^{-1} recorded the minimum. Therefore, it is concluded from the Table that all the treatments were effective in reducing the grub population to more than 60%. Highest yield of cardamom (466.67 g plant^{-1}) was realized in imidacloprid 0.75ml litre^{-1} treated plots and lowest in control (209.33 g plant^{-1}). Among the insecticide treatments, lowest yield was recorded in those plots drenched with chlorpyrifos 0.05% (266.67 g plant^{-1}). It is revealed that all the insecticide treatments at higher concentrations are as effective in reducing root grub, however, plots drenched with imidacloprid 0.75 ml litre^{-1} recorded the maximum yield of cardamom.

Table 56. Effect of insecticides on cardamom root grub – Pampadumpara

Treatment	Grub population		Reduction after treatment**(%)	Yield (g plant^{-1})
	Before treatment *	After treatment *		
T_1 - Chlorpyrifos 0.05%	8.33 (3.04)	2.67 (1.90)	68.15 (55.81)	266.67
T_2 - Chlorpyrifos 0.07%	7.67 (2.94)	1.33 (1.99)	83.33 (70.00)	353.33
T_3 - Carbofuran @ 100g plant^{-1}	9.33 (3.20)	3.00 (1.99)	68.35 (55.78)	346.67
T_4 - Carbofuran @150g plant $^{-1}$	8.00 (3.00)	2.00 (1.73)	74.74 (59.85)	358.33
T_5 - Imidacloprid 0.5 ml litre^{-1}	8.33 (3.05)	2.67 (1.91)	67.59 (55.46)	398.33
T_6 - Imidacloprid 0.75 ml litre^{-1}	8.33 (3.03)	1.00 (1.38)	89.67 (74.54)	466.67
T_7- Control	9.33 (3.21)	8.00 (2.95)	20.00 (17.78)	209.33
CD at 5%	NS	0.585	23.31	NS

* Values in parenthesis arc square root transformed
** Values in parenthesis are arc-since transformed

2.5.2.2 Mudigere

The above experiment is to be initiated 2004-05.

2.5.3 Bioecology of natural enemies of major pests of cardamom (CAR/CP/2.3)

(*Pampadumpara* and *Mudigere*)

2.5.3.1 Pampadumpara

The experiment on collection, identification and documentation of natural enemies against major pests under cardamom ecosystem was started at Pampadumpara during April-May 2001. The most important insect pests of cardamom are the thrips (*Sciothrips cardamomi)* shoot and capsule borer *Conogethes punctiferalis,* root grub (*Basilepta fulvicorne)* and whitefly (*Kanakarajiella cardamomi).* Two ichneumonid larval-pupal parasitoids and two dipteran parasitoids were recorded against cardamom shoot and capsule borer, *Conogethes punctiferalis.* The two ichnemonids were identified as *Agrypon* sp. and *Temelucha* sp. with morphometric characters detailed hereunder in Table 57.

Table 57. Morphometric characters of two ichneumonid identified against cardamom shoot & capsule borer -Pampadumpara

Characters	*Agrypon* sp.	*Temelucha* sp.
General body	Big with long ovipositor and petiolated abdomen	Small with long ovipositor and petiolated abdomen
Length of abdomen	9.5 mm	4.0 mm
Length of ovipositor	3.0 mm	3.0 mm
Length of antenna	12.0 mm	4.5 mm
Setae	Two on posterior part of abdomen	Absent
Nature of parasitism	Solitary	Solitary

One dipteran parasitoid was mosquito like and other resembled that of housefly. These parasitoids were found gregarious in nature that deformed the parasitized pupae of *Conogethes punctiferalis* typical to that of puparium. The antenna of mosquito-like parasitoid was plumose type and that of house fly-like was aristate. Identity of dipteran parasitoids is not yet confirmed.

Three entomopathogenic fungi were isolated from cardamom whitefly viz. orange coloured (*Aschersonia placenta*), white coloured (*Verticillium* sp.), black coloured unidentified fungi.

When sporulated *Verticillium* sp. produced two types of spores. Green lacewing fly, *Chrysoperla carnea* was recorded from plantation subjected to minimum insecticide application. Pedicellate eggs were observed from leaf tips of cardamom and the neuropteran fly was actively searching for the prey (*Sciothrips cardamomi*) on cardamom leaf sheaths.

The percentage parasitization of cardamom shoot and capsule borer on different months of 2003 is presented in Table 58. Shoot borer larvae could not be collected during November and December. Highest parasitization was observed in July (91.7%) and lowest in September (50%). Parasitization of cardamom shoot borer larvae by the dipteran house fly-like parasitoid ranged from 30.8 to 100% and occurred during all months under investigation. The incidence of parasitization was highest during October (100%). Parasitization by dipteran mosquito-like parasitoid was registered only on four months *viz.*, March, April, May and August. The occurrence of this parasitoid during monsoon phase was minimum, while the highest incidence was observed in August (53.8%). Except during October, parasitization by ichneumonid parasitoid was observed in all months ranging from 5 to 40%. Least incidence was recorded during June (5%).

Table 58. Parasitization of cardamom shoot and capsule borer - Pampadumpara

Period	Parasitization (%)	Parasitization (%) by		
		Dipteran (house fly like)	Dipteran (mosquito like)	Ichneumonids
February	88.9	93.75	-----	6.25
March	56.8	70.83	20.83	8.33
April	71.7	85.20	7.40	7.40
May	78.9	81.20	5.13	13.67
June	79.5	95.00	-----	5.00
July	91.7	80.45	-----	19.55
August	76.5	30.80	53.80	15.40
September	50.0	60.00	-----	40.00
October	62.5	100.00	-----	-----

2.5.3.2 Mudigere

This experiment is to be initiated at Mudigere during the year 2004-05.

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

(*Mudigere and Pampadumpara*)

2.5.4.1 Mudigere

This trial is to be initiated at Mudigere during the year 2004-05.

2.5.4.2 Pampadumpara

The trial is to be initiated during the year 2004-05.

3. GINGER

In ginger 12 projects are in progress at 44 centres of the AICRPS.

3.1 Genetic Resources (GIN/CI/1)

3.1.1 Germplasm collection, characterization, evaluation and conservation in ginger (GIN / CI / 1.1)

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

3.1.1.1 Solan

The Solan centre is maintaining 271 genotypes. The performance of the crop was poor because of the intermitant drought in the initial stage of growth, then by very heavy rain and again followed by the drought. The yield, quality and disease incidence of the promising lines were presented in Table 59. The yield per plot of the best lines varied from 4.625 kg (SG - 650) to 6.00 kg (SG - 1001) per plot. Dry matter was maximum in SG - 875 and SG - 850 while essential was in SG - 1026, SG - 999 and SG - 650. Maximum oleoresin contents were observed in SG - 1001.

Table 59. Performance of promising ginger lines /collections – Solan

Entry	Yield (kg plant^{-1})	Converted yield (t ha^{-1})	Disease incidence (%)	Dry matter (%)	Essential oil (%)	Oleoresin (%)
SG - 1001	6.00	12.06	10.5	20.40	1.50	9.00
SG - 875	5.45	10.95	7.5	22.59	1.50	6.75
SG - 1026	5.25	10.55	7.5	19.00	2.00	6.50
SG - 747	5.10	10.25	9.2	17.50	1.50	5.75
SG - 911	5.00	10.05	9.5	-	-	-
SG - 1079	4.90	9.85	6.0	17.00	1.50	5.90
SG - 850	8.50	9.75	8.0	20.50	1.50	6.75
SG - 999	4.80	9.65	6.0	20.00	2.00	7.50
SG - 934	4.65	9.34	5.0	-	-	-
SG - 650	4.62	9.29	5.5	19.50	2.00	8.50

3.1.1.2 Pottangi

The germplasm collection started during 1975 at Pottangi. Out of total 172 ginger accessions collected, 145 accessions were evaluated in two replications of which only 10 accessions yielded more than 7.5 kg/3 m^2, the range of yield being 0.4 kg to 9.47 kg/3 m^2. The highest fresh rhizome yield was recorded by V_2 E_5-2 (9.47) kg/3m$^{2)}$ followed by Sargiguda (9.1 kg/3m^2) and Gondoni (8.5 kg/3m^2) respectively (Table 60).

Table 60. Performance of ginger germplasm accessions - Pottangi

Characters	Range	Mean	Best 3 types with value in parenthesis
Plant height (cm)	38.6-64.4 (63.2) HP (62.3)	50.40	Gondoni (64.4) Zo.18
Number of tillers/clump	4.4 – 18.6	9.42	Sargiguda (18.6) Bansapal (17.2) PGS-28 (17.0)
Number of leaves/tiller	9.2 – 17.4	13.70	Bheja (17.4) Bardwan-1 (16.8) Gondoni (16.4)
Length of fully opened last leaf (cm)	11.0 – 20.6	14.60	S 558 (20.6)HP (20.2) S-641 (19.7)
Width of fully opened last leaf (cm)	1.2 – 2.4	2.01	S 558 (2.4) Kurmaput Local (2.3)Sargiguda (2.2)
Fresh rhizome yield (kg/3m^2)	0.40 – 9.47	5.02	V_2E_5-2 (9.47) Sargiguda (9.1) Gondoni (8.5)

3.1.1.3 Pundibari

Twenty seven genotypes were grown for evaluation in 2003-2004. The results obtained with respect to the growth and yield parameters are presented in Table 61 considering mean value for different characters it was found that GCP – 12 produced highest plant height (69.92cm) followed by GCP – 21 (69.42cm) and GCP – 8 (67.83)where as GCP-25 was found to be the dwarf (43.25). Highest number of tillers were observed in GCP- 23 (9.38) followed by GCP- 07 (8.70). Maximum leaf number was found in culture GCP-12 (20.2) whereas GCP-14 (13.00) recorded lowest leaf number. GCP-12 (24.82) and GCP-18 (13.46) was observed to be having highest and lowest leaf length respectively. Broadest leaf was observed in GCP – 12 (2.80cm) followed by GCP – 15 (2.62cm). Similarly narrowest leaf was found in GCP-17&24 (1.90) Highest rhizome yield/plant was recorded in GCP–23 (247.90g) followed by GCP-21 (241.82g), GCP-08 (235.11) and GCP-26 (231.24). Lowest rhizome yield/plant was recorded in GCP-15 (216.75g).

Table 61. Performance of ginger germplasm accessions – Pundibari

Entries	Plant height	Tiller no.	Leaf no.	Leaf length	Leaf breadth	Stem girth	Rhizome yield/plant
GCP-01	55.92	6.20	19.00	19.86	2.32	2.20	198.00
GCP-03	61.43	6.00	18.50	21.38	2.47	2.27	206.23
GCP-04	51.08	8.12	16.00	20.53	2.30	2.35	167.84
GCP-05	61.60	6.85	15.40	20.20	2.22	2.30	221.77
GCP-07	60.05	8.70	17.50	20.70	2.35	2.00	204.80
GCP-08	67.83	9.15	18.80	22.84	2.52	2.23	235.11

Entries	Plant height	Tiller no.	Leaf no.	Leaf length	Leaf breadth	Stem girth	Rhizome yield/plant
GCP-09	46.70	7.70	15.00	15.90	2.00	1.54	200.87
GCP-10	57.12	6.19	16.80	21.54	2.08	2.20	188.24
GCP-12	69.92	4.89	20.20	24.82	2.80	1.00	169.45
GCP-13	65.30	7.50	17.20	21.10	2.44	2.50	232.18
GCP-14	47.82	4.72	13.00	17.50	2.60	1.52	203.12
GCP-15	51.46	6.84	18.40	20.98	2.62	1.94	157.91
GCP-16	62.88	7.50	16.40	19.40	2.20	1.98	224.39
GCP-17	63.91	5.40	17.60	18.42	1.90	2.20	217.83
GCP-18	51.42	7.95	10.00	13.46	2.10	1.40	220.66
GCP-19	61.34	6.52	19.00	21.08	2.40	2.38	225.29
GCP-20	51.37	6.00	19.00	19.47	2.30	1.90	207.38
GCP-21	69.42	8.15	18.60	22.44	2.44	2.50	241.82
GCP-22	56.66	5.22	13.80	19.28	2.40	1.96	217.39
GCP-23	64.15	9.38	19.10	21.42	2.46	2.52	247.90
GCP-24	44.53	7.00	17.00	19.97	1.90	1.56	166.63
GCP-25	43.50	4.90	16.00	18.00	2.30	1.87	194.77
GCP-26	52.06	8.52	16.77	19.86	2.30	2.10	231.84
GCP-27	52.35	7.33	15.00	21.75	2.55	2.10	209.19

3.1.1.4 Kumarganj

The trial was started at Kumarganj during 1999-2000. Out of 40 early maturing germplasm screened, NDG - 28 produced maximum yield of 14.22 t ha^{-1} of fresh rhizome yield followed by NDG - 27 (12.54 t ha^{-1}) and NDG - 9 (12.26 t ha^{-1}) during the year 2003-2004 (Table 62). In three years pooled data presented in Table 63. NDG-6 produced fresh rhizome yield of 8.39 t ha^{-1}.

Table 62. Performance of ginger germplasm accessions - Kumarganj

Name of germplasm	Yield (t ha^{-1})
NDG - 6	12.03
NDG-9	12.26
NDG-28	14.22
NDG-27	12.54

Table 63. Performance of ginger germplasm (Pooled 2002 to 2004) – Kumarganj

Germplasm	Yield (fresh t ha^{-1})				
	2002	2003	2004	Total	Mean
NDG-1	27.67	18.61	18.70	64.98	21.66
NDG-2	39.00	20.83	20.80	80.63	26.87
NDG-3	18.33	16.38	15.10	49.81	16.60
NDG-4	18.00	17.49	16.80	52.29	17.43
NDG-5	66.00	17.22	15.30	98.52	32.84

Germplasm	Yield (t ha^{-1})				
	2002	2003	2004	Total	Mean
NDG-6	102.00	29.44	120.30	251.74	83.91
NDG-7	27.67	24.99	23.60	74.26	25.42
NDG-8	19.00	20.55	20.90	60.45	20.15
NDG-9	64.00	20.83	122.60	207.43	69.14
NDG-10	19.67	23.05	22.60	65.32	21.77
NDG-11	40.33	19.99	19.70	80.02	26.67
NDG-12	16.33	21.94	20.60	58.87	19.62
NDG-13	28.33	23.67	23.30	75.30	25.10
NDG-14	25.67	24.99	22.80	73.46	24.48
NDG-15	40.33	20.27	21.70	82.30	27.43
NDG-16	16.00	21.94	21.50	59.44	19.81
NDG-17	63. 33	19.99	76.80	160.12	53.37
NDG-18	27.67	23.60	22.50	73.77	24.59
NDG-19	21.00	24.99	24.20	70.19	23.39
NDG-20	29.67	24.16	24.40	78.23	26.07
NDG-21	18.00	22.22	21.70	61.92	20.64
NDG-22	47.00	21.94	22.50	91.44	30.48
CD at 5%	2.77	3.99	0.29	-	-
CV (%)	4.76	10.99	5.47	-	-

3.1.1.5 Raigarh

Twenty germplasm accessions were planted for evaluation but due to rhizome rot diseases, evaluation could not be done at Raigarh.

3.1.1.6 Dholi

The programme was initiated at Dholi in 1992 and is maintaining and conserving forty two accessions in ginger. Forty two germplasm of ginger were collected and planted for selecting promising line in respect of yield and quality of rhizome. Yield of germplasm varied from 0.90 kg (RG - 31) to 8.0 kg (RG - 23) in the area of 7.2 m^2.

3.2 Coordinated varietal trial (CVT) (GIN/ CI / 2)

3.2.1 CVT 2000 - Series V (GIN/CI/2.2)

(Solan, Chintapalle, Pottangi, Pundibari and *Raigarh)*

3.2.1.1 Solan

The trial was initiated at Solan during 2001 with 8 entries in RBD. During 2003-2004, non-significant differences were observed for yield per plot in the collections planted during the year (Table 64). None of the collection/entry showed increase over the local check- Himgiri. Similarly non- significant differences were observed for all the other horticultural characters like survival (%), plant height (cm), number of tillers, number of leaves, leaf length (cm), leaf breadth (cm), rhizome length (breadth cm) and yield per plot (g) as well as quality attributes (Table 65 & 66).

Table 64. Performance of ginger under CVT - Solan

Name	Yield (kg plot^{-1})	Converted yield (t ha^{-1})	Increase/ decrease over check (%)
SG - 682	5.50	11.05	-1.77
SG - 692	5.40	10.85	-3.55
Acc - 35	5.10	10.25	-8.88
Acc - 117	4.70	9.45	-16.00
V1S1 - 2	4.33	8.70	-22.66
V1C1 - 8	3.90	7.84	-30.31
SG - 54	5.30	10.65	-5.33
Himgiri	5.6	11.25	-
SE ±	0.73		
CD 5%	NS		

Table 65. Performance of ginger entries under CVT - Solan

Entry	Survival (%)	Plant height (cm)	No. of tillers	No. of leaves	Leaf length (cm)	Leaf breadth (cm)	Rhizome length (cm)	Rhizome breadth (cm)	Yield Plant^{-1} (g)
SG - 682	72.60	63.60	3.70	23.50	24.30	2.80	7.90	4.30	108.30
SG - 692	91.10	65.70	3.90	24.90	22.90	2.70	6.80	3.30	118.30
Acc - 35	92.60	63.70	4.10	24.70	23.10	2.90	7.50	3.60	110.00
Acc - 117	83.80	62.70	4.10	23.60	23.70	3.00	7.40	4.20	106.30
V_1S_1 - 2	81.50	64.60	4.10	23.60	21.50	3.10	7.60	3.60	142.00
V_1C_1 - 8	88.20	59.30	3.70	24.90	22.70	3.00	7.80	4.00	148.70
SG - 54	91.80	78.00	4.20	25.40	23.70	2.70	7.70	3.80	128.30
Himgiri	6.00	63.00	4.30	24.90	23.60	2.70	7.70	3.80	146.70
SE ±	7.08	9.39	0.34	1.16	1.29	0.31	0.59	0.77	17.59
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 66. Quality attributes of ginger entries under CVT - Solan

Genotype	Dry matter (%)	Oleoresin (%)	Essential oil (%)
SG - 682	17.50	5.29	1.25
SG - 692	17.00	5.09	1.00
Acc - 35	15.00	5.10	1.00
Acc - 117	20.50	6.00	1.50
*V_1S_1 - 2	22.20	7.56	2.00
V_1C_1 - 8	20.00	7.15	1.75
SG - 54	18.50	5.00	1.00
Himgiri	20.50	6.00	1.75

*Maximum dry matter, essential and oleoresins were noticed in V_1S_1-2

3.2.1.2 Chintapalle

The trial initiated at Chintapalle during 2001-02 with 8 varieties. The trial continued during 2003-2004, and the data provided in Table 67. Highest rhizome yield of 13.8 t ha^{-1} was recorded in Suprabha, followed by IISR Varada with 12 t ha^{-1} and both the varieties are on par with each other. However, plant height was more in Acc - 117 (IISR Mahima) and IISR Varada produced more no. of tillers/plant and Suprabha topped in producing more number of leaves.

Table 67. Performance of ginger accessions under CVT – Chintapalle

Variety	Plant height (cm)	No. of tillers $plant^{-1}$	No. of leaves $plant^{-1}$	Leaf length (cm)	Leaf width (cm)	Rhizome yield $plant^{-1}$ (kg)	Yield (t ha^{-1})	Increase in yield over local check (%)
Acc – 35	68.70	10.50	95.70	20.50	2.00	0.079	10.20	24
Acc – 117	76.50	8.50	81.30	22.20	2.10	0.075	9.70	18
V1-S1 – 2	72.30	9.70	94.30	20.50	2.10	0.088	10.50	28
V1C - 8	69.30	8.40	87.10	23.90	2.10	0.058	6.30	-23
IISR - Varada	63.90	10.80	101.00	21.30	2.00	0.086	12.00	46
Jaheerabad local	57.30	9.30	73.70	19.90	2.10	0.083	9.90	20
Suprabha	72.00	10.60	101.70	21.70	2.00	0.099	13.80	68
Chintapalle Local	49.40	4.90	44.00	17.00	2.00	0.069	8.20	check
Sem ±	3.38	1.17	8.91	1.29	0.05	17.890	0.90	—
CV %	8.84	22.26	18.20	10.71	3.96	38.730	30.28	—
CD	10.24	3.54	27.04	3.92	0.14	54.270	2.74	—

3.2.1.3 Pundibari

The trial was started during 2001-2002 with 7 treatments in RBD and continued during 2003-2004. Seven entries evaluated in randomized block design with three replications. Manure @ 20-25kg FYM/$3m^2$ plot and fertilizer N: P: K:: 60:80:80 per ha were applied. Observations on growth parameters and yield were recorded at 200 days after sowing and after harvesting respectively.

Results on growth parameters and yield of ginger entries under CVT are presented in Table 68. Significant difference between the entries was found for all the parameters except leaf number, leaf length, leaf breadth and pseudostem girth. Considering plant height ACC-35 (70.78 cm) was found to be the tallest culture followed by Gorubathan (67.64cm). V_1S_1-8 was found to be having lowest height (58.04cm). Similarly highest tiller number was found in ACC-35 (10.12) whereas lowest tiller was there in SG-692 (7.45). Highest rhizome yield was recorded in Gorubathan (15.69 t ha^{-1}) followed by ACC-35 (14.897 t ha^{-1}) and the lowest was recorded in case of SG-692 (9.13 t ha^{-1}). However the rhizome yield of Gorubathan, ACC-35 and ACC-117 were statistically at par.

Table 68. Performance of ginger accessions under CVT – Pundibari

Parameters/ Varieties	Plant height (cm)	No. of tillers plant^{-1}	No. of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Pseudo stem girth (cm)	Rhizome yieldplot^{-1} (kg/3m^2)	Projected yield (t ha^{-1})	Increase over check (%)
SG - 682	72.60	63.60	3.70	23.50	24.30	2.80	7.90	4.30	108.30
Gorubathan	67.43	8.73	22.30	22.05	2.596	2.38	7.807	15.690	14.36
SG-682	60.69	8.64	18.93	20.89	2.507	2.34	4.770	9.590	-
SG-692	61.36	7.45	20.26	20.20	2.477	2.13	4.543	9.130	-
V_1S_1-2	59.94	7.17	19.03	19.13	2.333	2.19	4.903	9.725	-
V_1S_1-8	58.04	7.50	18.53	20.23	2.407	2.08	4.653	9.353	-
ACC-35	70.79	10.12	21.47	22.35	2.453	2.42	7.243	14.897	8.58
ACC-117 (check)	65.23	9.33	23.40	22.55	2.573	2.51	6.827	13.720	-
SEm (±)	1.217	0.26	NS	NS	NS	NS	0.320	1.98	-
CD (at 5%)	7.466	1.179	-	-	-	-	1.245	2.82	-

3.2.1.4 Pottangi

The trial was started at Pottangi during 2000-2001 with 8 genotypes and 3 replications in RBD. The pooled data of 4 years presented in Table 69. There was significant different among the cultivars for fresh rhizome yield. Highest was fresh rhizome yield recorded by V_1E_8 -2 (23.30 t ha^{-1}) followed by V_3S_1-8 (22.23 t ha^{-1}).

Table 69. Performance of ginger accessions under CVT – Pottangi

Cultivars	Fresh Rhizome yield (kg / 3m^2)					Projected yield (t ha^{-1})
	2000	2001	2002	2003	Mean	
V1 E8 - 2	11.68	11.13	9.12	8.57	10.13	23.30
V3 S1 - 8	10.49	11.43	7.41	9.33	9.67	22.23
V1C -8	9.47	10.86	7.78	4.61	8.18	18.81
Acc - 35	7.70	7.84	6.28	4.59	6.60	15.19
Suprabha	8.20	8.68	6.65	6.72	7.56	17.39
Acc - 177	6.50	8.80	6.94	6.37	7.15	16.45
V1 S1 - 2	7.50	9.06	8.32	7.87	8.19	18.83
SG - 666	6.10	8.46	7.14	4.24	7.74	17.79
	N.S	1.14	1.34	4.13	2.20	5.06

3.2.1.5 Raigarh

Trial failed due to severe rhizome rot disease of ginger.

3.3 Varietal Evaluation Trial (GIN/CI/3)

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

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

3.3.1.1 Pottangi

The trial was started at Pottangi during 2000-2001 with 8 genotypes and 4 replications in RBD. The pooled data of four years presented in Table 70. There was no significant different among the cultivars for fresh rhizome yield. Highest fresh rhizome yield was recorded by V_2 E_5 -2 (21.85 t ha^{-1}) followed by ZO-17 646 (19.30 t ha^{-1}).

Table 70. Performance of ginger cultivars under CYT – Pottangi

Cultivars	Fresh rhizome yield (kg / 3m^2)					Projected yield (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
S - 646	10.60	8.63	7.04	7.10	8.34	19.19
V2 E5 - 2	8.90	10.9	8.51	9.68	9.50	21.85
Z0 - 17	8.10	9.05	7.86	8.55	8.39	19.30
V3 S1 - 8	6.20	9.88	8.56	8.75	8.35	19.21
S - 641	5.23	7.63	7.31	7.61	6.95	15.99
Singhjhara	5.51	9.03	6.88	7.78	7.30	16.73
Vengara	4.56	8.10	7.92	8.48	7.27	16.72
Suprabha	6.30	8.13	6.59	7.32	7.09	16.31
CD at 5%	1.64	1.99	1.02	N.S	1.55	3.57

3.3.1.2 Raigarh

Trial was considered to be failed due to severe rhizome rot disease of ginger.

3.3.1.3 Solan

Not reported

3.3.2 Initial evaluation trial (IET) (GIN / CI /3.2)

(*Solan* and *Pottangi*)

3.3.2.1 Solan

The trial was conducted at Solan with 14 entries in RBD. During 2003-2004, non-significant differences were observed in the collections for yield per plot. None of the collections out yielded the check cultivars-Himgiri. The decrease in yield over check varied from–10.83% to 15.70 %.

Table 71. Performance of ginger genotypes under IET – Solan

Name	Yield plot $^{-1}$ (kg)	Projected yield (t ha^{-1})	Yield increase/ decrease (%) over check
SG - 1075	4.40	8.84	-13.75
SG - 713	4.30	8.64	-15.70
SG - 823	4.45	8.94	-12.78
SG - 1088	4.40	8.84	-13.75
SG - 825	4.40	8.84	-13.75
SG - 709	4.45	8.94	-12.78
SG -785	4.50	9.04	-11.80
SG - 1071	4.55	9.14	-10.84
SG - 880	4.45	8.94	-12.78
SG - 723	4.45	8.94	-12.78
SG - 801	4.35	8.74	-14.73
21/93	4.40	8.84	-13.75
SDR11 - 01	4.45	8.94	-12.78
Himgiri	5.10	10.25	-
SE±	0.14	-	-
CD 5%	NS	-	-

3.3.2.2 Pottangi

The trial was started at Pottangi during 2000-2001 with 15 treatments and replicated thrice in RBD. The pooled data on yield (kg 3 m^2) over four years given in Table 72. Significant difference among the cultivars for fresh rhizome yield was recorded. Highest fresh rhizome yield was recorded by V_2E_5-2 (22.41 t ha^{-1}) followed by S-558 Suprabha (22.38 t ha^{-1}).

Table 72. Performance of ginger cultivars under IET – Pottangi

Cultivars	Fresh rhizome yield (kg / 3m^2)					Projected yield (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
S - 558	9.44	10.33	9.46	9.70	9.73	22.38
Zo - 17	6.92	8.65	10.46	7.10	8.29	19.06
Vengara	7.16	7.65	7.08	6.98	7.22	16.61
Raigarh	11.43	8.86	8.01	8.32	9.15	21.05
V2E5-2	8.67	9.85	10.36	10.09	9.75	22.41
Anamica	10.22	8.57	9.34	7.24	8.85	22.34
SS - 1	9.41	7.35	10.44	7.61	8.71	20.02
V1S1 - 8	7.30	9.87	9.56	8.27	8.75	20.13
V3S1 - 8	11.64	10.96	9.17	7.04	9.70	22.32

Jugijan	7.52	7.60	5.89	7.32	7.08	16.28
Zo - 2	9.81	6.71	10.58	7.08	8.54	19.65
S - 646	10.76	8.09	9.67	8.78	9.33	21.45
Nadia	8.63	6.98	10.29	6.23	8.65	19.88
S - 666	9.62	7.33	9.52	6.50	8.24	18.95
Suprabha	10.78	9.27	10.12	6.55	9.18	21.12
C D at 5%	1.94	2.54	0.99	3.61	2.27	5.24

3.3.3 Comparative yield trial (CYT) (GIN/ CI / 3.3)

(*Raigarh* and *Solan*)

3.3.3.1Raigarh

Not reported.

3.3.3.2 Solan

The trial was started with 6 entries in RBD during 2003-2004. The data on yield and quality are presented in Table 73. The results showed non-significant differences among collections for yield per plot. None of the collections gave yield more than the check. The decrease in yield over check varied from –4.69% to –13.23 %. The quality analysis indicated that dry matter was maximum in SG702 while essential oil and oleoresin contents were in Himgiri.

Table 73. Performance of ginger in the CYT (2003) – Solan

Name	Yield plot^{-1} (kg)	Converted yield (t ha^{-1})	Increase / decrease over check (%)	Dry matter (%)	Essential oil (%)	Oleoresin (%)
SG - 716	4.80	9.65	-9.38	18.50	1.50	5.50
SG - 889	4.92	9.89	-7.13	19.90	1.75	6.00
SG - 702	5.12	10.03	-5.82	20.10	1.75	6.50
SG - 861	4.60	9.24	-13.23	17.50	1.50	6.00
SG - 878	5.05	10.15	-4.69	19.00	1.50	5.75
Himgiri	5.30	10.65	-	20.00	1.75	6.80
SE ±	0.32					
CD 5%	NS					

3.4 Quality Evaluation Trial (GIN/CI/4)

3.4.1 Evaluation of germplasm for quality (GIN/CI/4.1)

(*Solan*)

3.4.1.1 *Solan*

The germplasm accessions of ginger harvested during December 2003–2004 were evaluated for different quality attributes viz., dry matter, essential oil, oleoresin and crude fiber content. The 161 accessions were evaluated and divided into three categories. These will again be evaluated along with the new accessions of ginger germplasm. The quality attributes of good performance of accessions were analysed for different quality attributes. Among good performers only 25 accessions maintained their

superiority over the check Himgiri. The data on quality of good performance given in Table 74. showed that dry matter content varied between 20.00 to 22.00 per cent, whereas, essential oil and oleoresin content ranged between 6.00 to 8.00 and 1.5 to 2.00 per cent respectively. Quality analysis work of remaining accessions is under progress.

Table 74. Quality attributes of good performers in ginger - Solan

Genotype	Essential oil (%)	Oleoresin (%)	Dry matter (%)	Crude fiber (%)
Himgiri	1.90	7.00	21.00	5.25
SG – 686	2.00	7.52	21.59	6.00
V1S1 – 2	1.50	6.50	20.95	4.25
PG – 370	1.75	7.00	21.99	4.50
SG – 671	1.75	7.59	21.40	4.75
PG – 823	1.75	7.35	21.59	4.85
SG – 610	1.75	7.50	21.00	4.00
SG – 826	1.80	7.90	22.35	5.00
SG – 875	1.50	6.95	22.59	5.15
SG – 824	1.75	7.50	21.40	5.60
BDJR - 1142	1.90	7.35	21.52	4.75
SG – 882	2.00	8.00	20.95	4.50
SG – 699	1.75	7.25	22.00	5.00
SDR – 21	1.75	7.59	20.90	4.15
No 44/95	1.75	7.00	21.10	4.00
SG – 610	1.50	6.98	22.00	5.35
SG – 247	1.50	6.90	22.57	5.50
BDJR - 1054	1.80	7.00	21.00	5.25
SG – 713	1.50	6.50	22.50	5.15
SG – 879	1.50	6.50	21.59	5.00
SG – 817	1.75	7.00	22.50	5.25
SG – 825	2.00	7.59	20.50	4.75
SG – 888	1.50	6.00	21.00	4.50
SG – 837	1.50	6.89	20.59	4.35
SG – 884	1.50	7.00	21.50	4.00

3.5 Nutrient Management Trial (GIN / CM / 1)

3.5.1 Efficacy of biofertilizer using *Azospirillum* on ginger (GIN /CM/1.1)

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

3.5.1.1 Pottangi

The trial was started during 2000-2001 with 8 treatments and 3 replications in RBD.

There was no significant difference among the treatments was recorded. The statistically analysed pooled data of four years and the

projected yield recorded significant difference among yield during 3 years (Table 75). During 2003-2004, highest fresh rhizomes yield was recorded by T_1 (100 % N + 50 g *Azospirillum* + 5 kg FYM) (18.33 ha) followed by T_8 (Recommended dose)(16.95 t ha^{-1}).

Table 75. Performance of ginger var. Suprabha - Pooled Data (2000 - 01 to 2003 - 04) – Pottangi

Treatment	Fresh rhizome yield (kg/3m^2)					Projected yield (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
T_1- Inorganic N (100%) + *Azospirillum* (50gm) + 5 kg FYM	7.23	9.23	6.23	9.18	7.97	18.33
T_2- Inorganic N (75%) + *Azospirillum* (50 gm) + 5 kg FYM	6.81	6.80	5.00	6.85	6.37	14.64
T_3- Inorganic N (30%) + *Azospirillum* (50 gm) + 5 kg FYM	6.68	5.76	4.42	6.22	5.77	13.27
T_4- 0 N + 0 + 5 kg FYM	5.53	4.87	2.73	5.43	4.64	10.67
T_5- 0 N + *Azospirillum* (50 gm) + 5 kg FYM 5.45	4.93	3.07	4.40	4.46	10.26	
T_6- 0 N + *Azospirillum* (50 gm) + 10 kg FYM 5.84	6.10	3.00	4.45	4.85	11.16	
T_7- 0 N + 0 + 10 kg FYM	5.22	4.76	3.03	3.63	4.16	9.57
T_8- 125 kg N + 100 kg P_2O_5 + 100 kg MOP (Recommended dose of fertilizer)	7.14	7.96	7.00	7.36	7.37	16.95
C.D. (0.05)	NS	1.20	0.88	N.S	1.04	2.45

3.5.1.2 Solan

The experiment was started at Solan during 2000-2001 with 8 treatments in RBD as detailed in Table 76. The seed materials of cv Himgiri was used and planted in a plot size of 3 x 1 m with a spacing of 30 x 20 cm. The observation was recorded on yield per plot. As per Trichur Workshop decision, five new treatments were added to the existing treatments (T8=100% N *Azospirillum* (seed application) + FYM 5 t ha^{-1}, T10-50% N + *Azospirillum* (seed application) + FYM 5 t ha^{-1}, T12 - FYM 10 t ha^{-1} + *Azospirillum* (seed application) and T13 control. *Azospirillum* as seed or soil application was applied @ 5 kg ha^{-1}. The composite sample of all the replications/ treatment was used for quality analysis different repeats.

The results comprising eight treatments were presented for four years while of 13 treatments for two years were presented in Table 76 and 77. The yield per plot was not found to be affected by the treatments irrespective of the fact whether there were 8 or 13 treatments in all the year. However, there were significant differences on the quality attributes with the application of different treatments (Table 76).

Table 76. Effect of biofertilizer, *Azospirillum* on yield of ginger (Pooled data) Solan

Treatment	Plot yield (kg)					Converted yield (t ha^{-1})
	2000	2001	2002	2003	Mean	
T1 - 100% N + *Azospirillum* soil application) + FYM (5 t ha^{-1})	5.7	4.5	4.97	5.32	5.12	10.29
T2 - 75% N+ *Azospirillum* (soil application) + FYM (5 t ha^{-1})	6.0	4.9	5.22	5.37	5.37	10.79
T3 - 50% N+ *Azospirillum* (soil application)+ FYM (5 t ha^{-1})	4.6	4.4	5.45	5.55	5.00	10.05
T4 - FYM (5 t ha^{-1}) +*Azospirillum* (soil application)	5.3	5.1	5.65	5.62	5.42	10.89
T5 - FYM (5 t ha^{-1}) alone	5.7	5.0	5.05	5.87	5.40	10.85
T6 - FYM (10 t ha^{-1}) + *Azospirillum* (soil application)	5.0	4.2	6.02	5.40	5.29	10.63
T7 - FYM (10 t ha^{-1}) alone	5.0	4.2	6.02	5.40	5.12	10.29
T8 - Control (Recommended dose of NPK, 100:50:50 kg ha^{-1})	5.3	4.9	4.82	5.41	5.11	10.27
SE±		0.47	0.43			

Table 77. Effect of biofertilizer, *Azospirillum* on the quality attributes of ginger – Solan

Treatment	Plot yield (kg)			Converted yield (t ha^{-1})	Oleoresin (%)	Essential oil(%)	Dry matter (%)
	2002	2003	Mean				
T1	4.97	5.32	5.15	10.35	7.00	2.00	16.95
T2	5.27	5.37	5.30	10.65	7.00	2.50	18.50
T3	5.45	5.65	5.53	11.15	6.90	1.00	16.95
T4	5.65	5.62	5.63	11.31	6.50	1.50	16.90
T5	5.05	5.87	5.46	10.97	6.00	1.50	16.80
T6	5.78	5.49	5.59	11.23	6.59	1.50	17.00
T7	6.02	5.40	5.71	11.47	7.00	2.00	18.00
T8	5.65	5.41	5.53	11.11	6.00	1.50	16.50
T9	5.43	5.37	5.40	10.85	6.00	1.50	16.50
T10	4.62	5.53	5.03	10.11	7.50	2.00	18.00
T11	4.73	5.40	5.06	10.17	7.50	1.50	16.50
T12	5.20	5.60	5.40	10.85	6.00	2.00	17.50
T13	4.82	5.17	5.00	10.05	5.50	1.00	17.00
CD at 5%	NS	NS			0.04	0.30	0.69

3.5.1.3Dholi

Not reported.

3.5.1.4Raigarh

The experiment started in 2001-2002 at Raigarh was continued for the last tree years. Eight treatment combinations of inorganic nitrogen and organic manures (FYM) with *Azospirillum* were laid out in RBD with three replications, having plot size of 3.0 x 1.0 M^2. The bio fertilizer and FYM was given at time of planting while in organic nitrogen was applied during 30, 55 and 90 DAP.

The 3 years pooled mean yield of the ginger presented in Table 78. Maximum fresh rhizome yield of 20.05 t ha^{-1} was recorded with the application of 100% inorganic nitrogen + *Azospirillum* + FYM followed by 19.19 t ha^{-1} with application of recommended dose of fertilizer, which were significantly superior over remaining treatments. The minimum yield of 9.84 t ha^{-1} was recorded in the treatment T5.

Table 78. Effect of biofertilizer, *Azospirillum* on yield and economics of ginger – Raigarh

Treatment	Plot yield (kg)	Yield of fresh rhizome(t ha^{-1})			Mean yield (t ha^{-1})	Production cost	Gross return	Net return
		2001-02	2002-03	2003-04		Rs in Lac		
T_1- Inorganic Nitrogen 100% + *Azospirillum* 50g + FYM 5 kg $Plot^{-1}$	8.01	24.30	19.76	16.10	20.05	1.12	2.40	1.28
T_2- Inorganic Nitrogen 75% + *Azospirillum* 50g + FYM 5 kg $Plot^{-1}$	6.38	21.62	15.20	12.80	16.54	1.10	1.98	0.88
T_3- Inorganic Nitrogen 50% + *Azospirillum* 50g + FYM 5 kg $Plot^{-1}$	6.06	19.76	14.93	12.20	15.63	1.08	1.87	0.79
T_4- FYM 5 kg + *Azospirillum* 50 g $plot^{-1}$	4.26	14.03	10.45	8.56	11.01	1.00	1.33	0.33
T_5- FYM 5 kg alone.	3.50	13.60	8.84	7.04	9.84	0.98	1.18	0.20
T_6- FYM 10 kg + *Azospirillum* 50 g $Plot^{-1}$	4.35	15.61	11.25	8.74	11.86	1.02	1.43	0.41
T_7- FYM 10 kg alone $Plot^{-1}$	3.60	14.94	8.96	7.35	10.42	1.01	1.25	0.24
T_8- Recommended dose (150+100+120) kg NPK ha^{-1})	7.50	23.11	18.75	15.07	19.19	1.11	2.30	1.19
CD at 5%		1.69	2.11	3.25				

3.5.1.5Ambalavayal

Not reported. (New trial)

3.5.1.6 Pundibari

The trial was initiated during 2002-2003 with 8 treatments, replicated thrice in RBD. The result showed that the maximum fresh rhizome yield of 23.2 t ha^{-1} was recorded with the application of inorganic N 100% + *Azospirillum* 50g + YFM 5 kg per 3 sq.m. plot, closely followed by T_8 (22.4 t ha^{-1}). Minimum yield of 10.1 t ha^{-1} was recorded with application of FYM @ 5 kg $plot^{-1}$. Table 79.

Table 79. Effect of biofertilizer, *Azospirillum* on yield of ginger (2003-2004)- Pundibari

Treatment	Fresh rhizome yield (g $plant^{-1}$)	Fresh rhizome yield (kg/3 sq m. plot	Projected fresh rhizome yield (t ha^{-1})	Disease incidence (%)
T_1 -100% inorganic nitrogen + *Azospirillum* (50 gm) + 5 kg FYM	85.4	8.7	23.2	19.5
T_2 - 75% inorganic nitrogen + *Azospirillum* (50 gm) + 5 kg FYM	75.6	6.8	18.1	21.2
T_3 -50% inorganic nitrogen + *Azospirillum* (50 gm) + 5 kg FYM	82.3	6.5	17.3	23.3
T_4 -*Azospirillum* (50 gm) + 5 Kg FYM	79.5	4.2	11.2	30.2
T_5 -*Azospirillum* (50 gm) + 10 Kg FYM	80.7	4.4	11.7	15.3
T_6 -5 kg FYM	73.8	3.8	10.1	24.7
T_7 -10 kg FYM	84.2	4.0	10.7	16.5
T_8 - Recommended dose of fertilizer (80:80:120 NPK kg ha^{-1})	76.8	8.4	22.4	25.4
CD at 5%	8.1	1.2	-	-

3.5.2 Organic farming in ginger (GIN/CM/ 1.2)

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

3.5.2.1Pottangi

The trial was started during 2000-2001 with 8 treatments and replicated thrice in RBD continued for four years. The pooled data on yield of ginger for the period 2000-2001 to 2003-2004 are presented in Table 80. The results showed significant difference in fresh rhizome yield among different treatments. Highest rhizomes yield was recorded by T_8 (Recommended inorganic dose) (18.27 t ha^{-1}) followed by T_1 (12.70 t ha^{-1})

Table 80. Effect of organic inputs on the yield of ginger – Pottangi

Treatment	Fresh rhizome yield (kg/3m²)					Projected yield (t ha⁻¹)
	2000-01	2001-02	2002-03	2003-04	Mean	
T_1 - A +B+C+D+E+F	7.48	6.61	4.50	4.01	5.52	12.70
T_2 - O+B +C+D+E+F	5.43	5.20	3.53	3.47	4.41	10.14
T_3 - O +A+C+D+E+F	5.47	5.09	3.54	3.95	4.51	10.37
T_4 - O+A+B+D+E+F	5.41	4.28	3.38	3.38	4.11	9.45
T_5 - O+A+B+C+E+F	5.89	4.48	3.87	2.64	4.22	9.71
T_6 - O+A+B+C+D+E+F	4.69	4.78	3.13	2,98	3.90	8.97
T_7 - O + A+B+C+D+F	5.21	4.35	4.62	3.58	4.44	10.21
T_8 - Inorganic recommend dose of Fertilizer	8.13	8.50	7.56	7.60	7.95	18.27
C.D at 5%		NS	1.32	0.82	N.S	1.01
2.32						

A = FYM 10 kg/3 m² C = Neem oil cake E= Rock phosphate
B = Pongamia oil cake D= Sterameal F= Wood Ash

3.5.2.2 Raigarh

The experiment was conducted during three years (2001 – 02 to 2003 - 04) in RBD consisting of eight treatments replicated thrice. The soil was sandy loam with acidic nature. The treatment consisted of four organic sources involving FYM, wood ash, neem cake and *Azospirillum* with rock Phosphate. A basal dose of above organic manure was applied as per treatment as basal dressing. In recommended dose of fertilizer, entire dose of phosphorus and half dose of potassium were applied at the time of sowing and half dose of potassium was applied 90 days after planting. The Inorganic nitrogen were applied in three splits at 30, 55 and 90 days after planting.

The three years pooled data on yield are presented in Table 81. Maximum yield of 19.36 t ha⁻¹ was recorded with application of recommended dose of fertilizer (T_8), followed by T_1 and T_2 which produced the yield of 17.50 and 17.10 t ha⁻¹, respectively which were significantly superior over remaining treatments.

Table 81. Effect of organic inputs on yield and economics of ginger – Raigarh

Treatment	Plot yield (kg Plot^{-1})	Projected yield (t ha^{-1}) 2001-02	2002-03	2003-04	Mean yield (t ha^{-1})	Production cost	Gross return	Net return
						(Rs. in lakhs)		
T_1 - FYM + Rock Phosphate+ Wood Ash	7.80	18.96	17.88	15.67	17.50	1.07	2.10	1.03
T_2 - Rock Phosphate Alone 500g Plot^{-1}	3.70	9.91	9.56	7.43	8.97	0.75	1.07	0.32
T_3 - Wood Ash Alone 2 kg plot^{-1}	2.80	9.78	8.70	5.62	8.03	0.75	0.96	0.21
T_4 - *Azospirillum* 50 g plot^{-1}	3.20	10.51	9.36	6.43	8.77	0.78	1.05	0.27
T_5 - Neem cake + Rock Phosphate + Wood Ash	7.50	18.76	17.48	15.07	17.10	1.07	2.05	0.98
T_6 - Neem cake alone 250 g plot^{-1} 0.41		4.80	11.32	10.57	9.64	10.51	0.85	1.26
T_7 - FYM alone 5 kg plot^{-1}	5.20	12.06	13.06	10.45	11.85	0.90	1.42	0.52
T_8 - Recommended dose (150+ 100+120 kg NPK ha^{-1})	7.70	22.31	20.30	15.47	19.36	1.10	2.32	1.22
CD at 5%		1.97	2.23	2.12				

3.5.2.3 Solan

The experiment was initiated at Solan during 2000-2001 with 8 treatments laid out in a randomized block design with three replications and conducted for 4 years (2000-2003). Each treatment was applied in a plot size of 3x1 m with a spacing of 30x 20 cm. The seed rhizome of cv. Himgiri was used in all the years of study. The observation was recorded on yield (rhizome).

The 4 years pooled yield data are presented in Table 82 showed non-significant differences amongst treatment for yield per plot in all the years of study. The trend of the data indicated

that overall mean of the four years was same in all the treatments. However, the quality attributes showed significant differences. Maximum dry matter (18.0%) was observed in T2 (*Azospirillum* +P+ wood ash) while was lowest in T3, T7 and T8. Essential oil (2.50%) and oleoresins (7.50%) were also maximum in T2.

Table 82. Effect of organic inputs on the yield of ginger (2000 to 2003) - Solan

Treatment	Yield per plot (kg)				Mean yield (t ha^{-1})	Projected yield (t ha^{-1})	Dry matter (%)	Essential oil (%)	Oleore-sin (%)
	2000	2001	2002	2003					
T1 - FYM (20 t ha^{-1}) + P (50 kg ha^{-1}) + wood ash (10 kg ha^{-1})	6.20	4.60	5.17	5.70	5.42	10.69	17.50	1.75	7.00
T2 - *Azospirillum* 5 kg ha^{-1} as the as soil application) + P +wood ash	6.00	4.10	6.00	5.60	5.43	10.89	18.00	2.50	7.50
T3 - P alone	5.80	4.90	5.75	5.41	5.46	10.97	16.00	1.50	6.00
T4 - wood ash alone	6.00	4.60	5.58	5.41	5.40	10.85	16.50	1.75	6.50
T5 - *Azospirillum* alone	7.00	4.90	5.41	5.35	5.41	10.87	17.00	1.75	6.50
T6 - Neem cake (20 t ha^{-1}) + P + wood ash	6.60	4.90	5.25	5.41	5.54	11.13	16.80	1.00	5.99
T7 - Neem cake alone	6.00	4.90	5.08	5.25	5.31	10.67	16.00	1.50	6.50
T8 - Recommended dose of fertilizer	6.50	5.10	5.01	5.55	5.54	11.13	16.00	1.50	6.00
SE±	0.57	0.49	0.35	0.22	-	-			
CD 5%	NS	NS	NS	NS					

3.5.2.4Dholi

The trial was started in Dholi in RBD during 2002-2003 with 8 treatments, replicated thrice having plot size, 3.0x 1.0 m. During 2003-2004, all the organic inputs except T_2 (Pongamia oil cake + neem oil cake + Sterameal + Rock phosphate + Wood ash) gave better result in comparison to inorganic farming (N:P:K) regarding plant height, number of tillers per plant, yield per plot and per hectare. Among all the treatments, T_1 (F.Y.M + Pongamia oil cake + neem oil cake + Sterameal + Rock Phosphate + Wood ash) gave maximum plant height, (46.60 cm), number of tillers per plant (12.80), yield (3.82 kg ha^{-1}) and (12.72 t ha^{-1}) followed by treatment T_7 (F.Y.M. + Pongamia oil cake + neem oil cake + sterameal + Rock phosphate). Table 83). So far increase in yield is concerned T_1 followed by T_7 (3.78 t ha^{-1} & 46.61%) was observed over control in organic fertilizers. Organic inputs except T_2 (Pongamia oil cake + neem oil cake + Sterameal + Rock Phosphate + Wood ash) gave the better result in comparison to inorganic (N:P:K). Among the organic and inorganic treatments T_1 (F.Y.M. + Pongamia oil cake + Neem oil cake + Sterameal + Rock phosphate + Wood Ash) produced maximum fresh rhizomes yield of ginger 12.72 t ha^{-1} (4.6 t ha^{-1} & 56.84%) followed by T_7 (F.Y.M. + Pongamic oil cake + Neem oil cake + Sterameal + Rock phosphate) 11.89 t ha^{-1} (3.78 t ha^{-1} & 46.61%) over control.

Table 83. Effect of different organic inputs on ginger yield (2003-04) - Dholi

Treatment	Plant height (cm)	No.of tillers per plant	Yield plot^{-1} (kg)	Yield (t ha^{-1})	Increase in yield over control (%)	
T_1 A+B+C+D+E+F	46.60	12.80	3.82	12.72	4.61	56.84
T_2 0+B+C+D+E+F | (A- Absent)	33.73	8.00	2.12	7.06	-1.05	-12.95
T_3 A+0+C+D+E+F (B- Absent)	33.80	9.13	3.33	11.11	3.00	36.99
T_4 A+B+O+D+E+F (C- Absent)	39.80	9.87	2.87	9.56	1.45	17.88
T_5 A+B+C+)+E+F (D-Absent)	40.33	10.60	3.12	10.39	2.28	28.11
T_6 A+B+C+D+O+F (E-Absent)	42.93	10.93	3.33	11.11	3.00	36.99
T_7 A+B+C+D+E+O (F-Absent)	44.40	11.80	3.57	11.89	3.78	46.61
T_8 Inorganic fertilizer (Recommended dose of N:P:K::80:60:100)	34.87	8.33	2.43	8.11	-	-
CD at 5%	5.37	1.05	0.52	1.73		
CV (%)	7.73	5.89	9.77	9.67		

A : F.Y.M (10 kg/3m^2)
B : Pogamia oil cake (250 g/3 m^2)
C : Neem oil cake (250 g/3m^2)
D : Sterameal (250g/3m^2)
E : Rock Phosphate (250 g/3m^2)
F : Wood Ash (250 g/3m^2)

3.5.2.5Ambalavayal

Not Reported.

3.5.3 Micronutrient on ginger (GIN/CM/1.3) (*Dholi*)

An experiment to study the effect of micronutrients on the yield of ginger was initiated during 2001-2002 at Dholi. Experiments were conducted for three consecutive years (2001-02 to 2003-04) in randomised block design with three replication. The plot size for each treatment was 3.0 m x 2.4 m and planting distance was 30 cm x 20 cm. The package of practices was followed as recommended by RAU, Bihar, Pusa.

3.5.3.1Dholi

The project has been concluded and final report submitted. An experiment to study the effect of micronutrients on the yield of ginger was initiated during 2001-2002 at Dholi.

The pooled data presented in Table 84 showed that all the micro-nutrients gave significant effect on plant height, number of tillers per plant and rhizome yield t ha^{-1} in comparison to control (T_1).

Two foliar spray of ferrous sulphate (T_{11}) @ 1.0 per cent at 45 and 55 days after sowing followed by (T_{12}) three spray of ferrous sulphate @ 1.0 per cent at 45, 55 and 65 days after sowing (51.07 cm) significantly increased the plant height (51.75 cm). However, there was no significant effect on number of tillers per plant. The maximum fresh rhizome yield was recorded (20.26 t ha^{-1}) with the treatment T_{11} (two foliar spray of ferrous sulphate @ 1.0 %) followed by T_4 (Soil application of zinc @ 10.0 kg ha^{-1}) and it was 12.51 and 11.96 per cent respectively higher over control. The cost benefit ratio of treatment (T_{11}) was quite higher i.e. 1:4.96. Table 85).

Table 84. Effect of micronutrients on giner yield and yield attributes (Pooled data, 2001-02 to 2003-04) – Dholi

	Character/Treatment	Plant height (cm)			Pooled mean	Number of tillers per plant			Pooled mean	Yield (t ha^{-1})			Pooled mean
		2001-02	2002-03	2003-04		2001-02	2002-03	2003-04		2001-02	2002-03	2003-04	
T_1	Control	37.35	58.20	33.33	42.96	10.25	22.20	16.00	16.15	3.40	13.89	9.70	9.00
T_2	2.5 kg ha^{-1} Zn	45.00	60.53	38.33	47.95	16.85	21.40	14.27	17.5	19.30	20.37	11.73	13.80
T_3	5.0 kg ha^{-1} Zn	45.00	62.07	37.33	48.13	18.75	26.27	17.00	20.67	10.54	21.76	14.70	15.67
T_4	10.0 kg ha^{-1} Zn	54.50	58.67	39.00	50.72	24.50	17.20	18.13	19.94	15.99	24.54	18.75	19.76
T_5	0.5 kg ha^{-1} B	40.45	57.47	30.67	42.86	13.75	20.13	15.53	16.47	5.67	18.08	10.30	11.65
T_6	1.0 kg ha^{-1} B	43.55	61.67	35.00	46,74	15,60	22.47	14,07	17,38	7.20	19.44	11.41	12.68
T_7	1.5 kg ha^{-1} B	43.80	61.80	33.67	46.42	15.90	20.60	14.00	16.83	8.16	19.91	11.41	12.92
T_8	2.0 kg ha^{-1} B	47.75	63.33	35.67	48.92	19.00	21.33	15.47	18.60	11.17	20.37	15.37	15.64
T_9	Two spraying of 0.5% zinc sulphate at 45 and 55 days after planting/ sowing	50.00	59.80	34.33	48.04	19.30	22.13	17.33	19.59	11.40	24.06	17.83	17.76
T_{10}	Three spraying of 0.5% zinc sulphate at 45,55 and 65 days after planting/ sowing	53.00	60.20	38.00	50.40	21.80	20.00	17.27	19.69	14.85	23.15	16.13	18.04
T_{11}	Two spraying of 1% ferrous sulphate solution at 45 and 55days after planting / sowing	55.00	60.93	39.33	51.75	27.90	21.07	17.73	22.23	17.63	24.54	18.61	20.26
T_{12}	Three spraying of 1% ferrous sulphate at 45, 55 and 65 days after planting/ sowing	54.00	61.53	37.67	51.07	22.50	19.80	16.87	19.72	15.02	23.15	16.30	18.16
	CD at 5%	4.75	NS	5.31	5.63(T)	3.49	NS	NS	NS	2.58	5.29	3.67	3.71(T)
	CV (%)	5.89	7.61	8.68	7.24	10.90	17.85	11.27	15.05	13.28	13.99	15.08	14.73

Table 85. Cost Benefit Ratio of micronutrient trail in ginger - Dholi

Character Treatments	Increased yield over control		Cost of cultivation	Gross income	Net income	Cost : benefit ratio
	(t ha^{-1})	(%)		(Rupees)		
T_1	-	-	80,000.00	1,80,000.00	1,00,000.00	1:2.25
T_2	4.80	5.33	82,700.00	2,76,000.00	1,93,300.00	1:3.34
T_3	6.67	7.41	85,400.00	3,13,400.00	2,28,000.00	1:3.67
T_4	10.76	11.96	90,800.00	3,95,200.00	3,04,400.00	1:4.35
T_5	2.65	2.94	80,540.00	2,33,000.00	1,52,200.00	1:2.89
T_6	3.68	4.09	81,080.00	2,53,600.00	1,71,920.00	1:3.13
T_7	3.92	4.36	81,620.00	2,58,400.00	1,76,780.00	1:3.17
T_8	6.64	7.38	82,160.00	3,12,800.00	2,30,640.00	1:3.81
T_9	8.76	9.73	83,900.00	3,55,200.00	2,71,300.00	1:4.23
T_{10}	9.04	10.04	85,850.00	3,60,800.00	2,74,950.00	1:4.20
T_{11}	11.26	12.51	81,700.00	4,05,200.00	3,23,500.00	1:4.96
T_{12}	9.16	10.18	84,650.00	3,63,200.00	2,78,550.00	1:4.29

(i) Cost of cultivation including seed - Rs. 80,000.00.

(ii) Cost of micro-nutrients included in each treatments.

(iii) Selling rate of fresh rhizome @ Rs. 2,000.00/quintal.

3.6 Disease Management Trial (GIN / CP / 1)

3.6.1 Integrated management on rhizome rot of ginger (GIN/CP/1.1)

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

3.6.1.1 Dholi

This experiment was not conducted due to vacant post of pathologist.

3.6.1.2 Pundibari

This project was not continued during 2003–2004 due to misunderstanding in project code and project title. However this project will be continued during 2004 – 2005.

3.6.1.3 Ambalavayal

The trial was started with 8 treatments in RBD during 2001. During 2003-2004, in the experiment on the effect of biofertilizer using *Azospirillum* on ginger. The treatments T1 (Inorganic N (100 %) + *Azospirillum* (50 g) +5 kg FYM) recorded the maximum yield (27.844 t ha^{-1}) and it was superior to all other treatments. The treatments, T2 and T8 were on par.

Table 86. Effect of biofertilizer on the yield ginger – Ambalavayal

Treatment	Yield (t ha^{-1})	Disease incidence %
T_1 - Inorganic N (100 %) + *Azospirillum* (50 g) + 5 kg FYM	27.844	14.23 (22.130)
T_2 - Inorganic N (75%) + *Azospirillum* (50 g) + 5 kg FYM	20.313	17.07 (24.213)
T_3 - Inorganic N (50%) + *Azospirillum* (50 g) + 5 kg FYM	17.063	18.36 (24.69)
T_4 - *Azospirillum* (50 g) + 5 kg FYM	13.563	20.71 (26.985)
T_5 - FYM (5 kg) alone	11.094	18.36 (25.198)
T_6 - FYM (10 kg) + *Azospirillum* (50 g)	15.688	13.75 (21.303)
T_7 - FYM (10 kg) alone	12.250	17.460 (24.492)
T8 - (KAU POP)	20.250	14.07 (21.690)
F- Test	*	NS
CD	3.571	-

3.6.1.4 Raigarh

Not reported.

3.6.1.5 Solan

Disease surveillance of ginger indicated that the incidence was maximum in Bilaspur (76.9%) followed by Shimla (40.0%) and Solan district (22.2%).

In integrated management of ginger against *Pythium, Fusarium* and *Ralstonia*, the results indicated that mancozeb, seed solarization and hot water treatments of ginger rhizomes were effective in increasing the emergence and yield of ginger and were at par with each other.

Table 87. Disease surveillance / survey in ginger - Solan

District	Disease incidence (%)
Bilaspur	76.9
Karot - Dhoba	
Asha majori - Jukhala	
KotalaTetoh - Sadar	
Shimla	40.0
Patshal	
Obru - Lhami	
Charangh"	
Charrolee	
NeeraTikri - MashahaPanesh	
Solan	22.2
Brahu - Ghaighat	
Khadeen - Nayagram	
KarolBaila - Ghaighat	
Rani Gaon - Jabkli	
Kiari - Khandaghat	
Tikkari - Khandaghat	
Palhesh - Khandaghat	
Basol - Syri	
Mahi - Palesh Khandaghat	
Naura Khandol - Deothi Solan	

3.6.2 Biocontrol studies on rhizome rot of ginger (GIN/CP/1.2)

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

3.6.2.1 Raigarh

Not reported.

3.6.2.2 Pundibari

The trial was started during 2001-2002 with 7 treatments was continued for three years. The experiment was laid out in Randomized Block Design (RBD) with three replications. The cultivar Gorubathan was taken for this experiment.

The results of the trial conducted during 2003-2004 presented in Table 88 indicated that seed treatment with hot water and *Trichoderma* mixed with neem cake (T6) was the most effective in reducing the disease incidence in different phase of crop growth. The same treatment recorded high yield in ginger.

Table 88. Management of rhizome rot of ginger (2003 – 2004) - Pundibari

Treatment	Germination (%)	Disease incidence (%)			Percent reduction over control (%)	Yield (kg/plot^{-1})	Projected yield (t ha^{-1})
		1st observation	2nd observation	3rd observation			
T_1	78.46	27.14 (31.40)	36.50 (37.17)	40.96 (39.79)	-	4.170	8.41
T_2	81.25	22.36 (28.22)	27.72 (31.77)	32.40 (34.70)	12.79	5.400	10.89
T_3	88.15	24.28 (29.52)	25.42 (30.28)	0.46 (33.50)	15.81	5.520	11.13
T_4	83.70	19.03	21.53 (25.86)	24.65 (27.65)	25.18 (29.77)	6.450	13.00
T_5	89.24	20.28 (26.77)	23.85 (29.23)	27.31 (31.51)	20.81	5.770	11.63
T_6	92.57	15.96	17.95 (23.55)	21.60 (25.07)	30.41 (27.69)	7.700	15.52
T_7	80.43	23.75	30.73 (29.17)	35.49 (33.67)	8.09 (36.57)	4.820	9.00
SEm ±		1.313	1.830	1.593		0.369	
CD (at 5%)		4.047	5.638	4.908		1.137	

(Figures in parenthesis are angular transformed value)

The three years pooled data (2001-2002, 2002-2003, 2003-2004) presented in Table 89. It is evident that seed treatment with hot water at 51° C for 10 minutes + bio-control inoculum mixed with 1 kg of neem cake in 3 m × 1m bed at the time of planting (T_6) was the best treatment in reducing the disease incidence at different phases of crop growth in all the three years. This treatment reduced 44%, 36.69% and 30.41% disease over control in 2001 – 2002, 2002 – 2003 and 2003 – 2004 respectively. Regarding yield it also recorded maximum yield (6.23, 5.77, 7.70 kg plot^{-1} in respective years) in all the 3 years. Other treatments like T_3, T_4 and T_5 also produced good results in respect of disease reduction and yield as compared to control

Table 89. Effect of fungicides/biocontrol agents on yield and disease incidence of ginger (2001-2002 to 2003-2004) - Pundibari

Treatments	Germination (%)	Disease incidence (%)	Reduction over control (%)	Yield (kg plot^{-1})	Projected yield (t ha^{-1})
T_1	84.39	49.81	-	3.560	7.18
T_2	86.85	40.43	18.83	4.670	9.41
T_3	90.58	37.07	25.58	5.040	10.16
T_4	90.17	34.45	30.84	5.410	10.91
T_5	92.15	35.22	29.29	5.430	10.95
T_6	93.02	31.15	37.46	6.460	13.02
T_7	85.38	41.00	17.69	4.330	8.73
SEm ±		1.361		0.267	
CD (at 5%)		4.194		0.823	

In pooled data analysis also, it was found that seed treatment with hot water at 51° C for 10 minutes + bio-control inoculum mixed with 1 kg of neem cake in 3 m × 1m bed at the time of planting (T_6) was the best treatment in reducing the disease incidence (Table 89). Regarding fresh rhizome yield, the maximum yield was obtained from T_6 (6.46 kg plot^{-1}). Followed by T_5 and T_4 with their yields of 5.43 kg and 5.41 kg plot^{-1} respectively. In case of yield there is significant difference between T_6 and all other treatments but T_4 and T_5 are statistically at par with each other.

3.6.2.3Kumarganj

The trial was started with 7 treatments and 3 replications during 2000-2001 with 7 treatments and 3 triplications in RBD. The result of the experiment conducted showed minimum incidence of rhizome rot disease in ginger was recorded in rhizome treated with hot water (51° C) for 10 min and seed treatment of rhizomes with *T. harzianum* mixed with neem cake with maximum yield and 192.54 % increase in yield over controls (Table 90) during 2003-04. Similar trend was observed in three years mean pooled data with 55.95 % change over controls (Table 91)

Table 90. Effect of fungicides and biocontrol agent on ginger seed rhizome germination (2001-02 to 2003 - 04) - Kumarganj

Treatment	Seed germination (%)			Mean	Change over control (%)
	2001-02	2002-03	2003-04		
T_1 - Seed sown directly	6.66	71.33	86.33	74.33	-
T_2 - S.T. hot water 51° C (10 min)	48.88	61.33	67.33	59.18	20.38
T_3 - S.T. Manco (3 g l^{-1}) for 30 min%	51.11	59.33	68.66	59.70	19.68
T_4 - S.T. - *T. harzianum* 100 g inoc/5 lit (30 min)	48.88	62.67	82.00	64.51	13.21
T_5 - S.T. hot water 51°C (10 min) + S.T. Manco S.T. (30 min)	53.33	60.00	74.00	62.44	15.99
T_6 - S.T. hot water 51° C (10min) + S.T. *harzianum* mixed with neem cake 63.33	35.55	52.00	61.33	49.62	33.24
T_7 - Soil appl. neem cake at the time of sowing & planting	48.88	63.33	75.33	62.51	15.90
CD (5 %)	9.09	6.28	10.27		
CV (%)	10.45	5.74	7.82		

S. T. = Seed treatment

Table 91. Effect of fungicides and biocontrol agent on the incidence of rhizome rot disease of ginger - Kumarganj

Treatment	Incidence of rhizome rot			Mean	Change over control (%)
	2001-02	2002-03	2003-04		
T_1- Seed sown directly	45.37	23.47	57.77	42.18	-
T_2- S.T. hot water 51° C (10 min)	35.18	29.33	71.0	45.17	7.08
T_3- S.T. Manco (3g l^{-1}) for 30 min%	30.55	29.40	66.66	42.18	-
T_4- S.T. - *T. harzianum* 100g inoc/ 5 lit (30 min)	59.25	23.31	56.60	46.38	9.95
T_5- S.T. hot water 51° C (10 min) + S.T. Manco S.T. (30 min)	63.88	24.55	73.3	53.91	27.80
T_6 - S.T. hot water 51° C (10 min) + S.T. *harzianum* mixed with neem cake	90.74	33.03	168.88	67..30	55..95
T_7 - Soil appl neem cake at the time of sowing& planting	63.88	24.00	62.10	49.99	18.51
CD (5 %)	16.02	3.09			
CV (%)	14.10	6.50			

S. T. = Seed treatment

3.6.2.4Pottangi

Not reported.

3.6.2.5Dholi

This experiment was not conducted due to vacant post of pathologist.

3.6.3 Integrated management of *Pythium, Fusarium* and *Ralstonia* (GIN/CP/1.4) (*Pundibari, Solan* and *Dholi)*

3.6.3.1Pundibari

The trial was started during 2003-2004 with 6 treatments replicated thrice in RBD. The treatment details are given in Table 92. It is clear that minimum disease incidence was recorded by seed treatment with *Trichoderma harzianum* (T_2) followed by solarization of rhizomes for 2 hours (T_3). T_2 and T_3 showed 43.53% and 30.44% disease reduction respectively. The highest yield was also obtained by T_2 (7.13 kg plot^{-1}) followed by T_3 (6.07 kg plot^{-1}). So, best treatment in this experiment was found to be T_2 followed by T_3, T_5, T_4 and T_1 (there is no significant difference between T_1 and T_4 in yield and disease incidence parameters) as compared to control.

Table 92. Effect of different treatments on *Pythium, Fusarium* and *Ralstonia* of ginger - Pundibari

Treatment	Germination (%)	Disease incidence (%) 1st observation	2nd observation	3rd observation	Percent reduction over control (%)	Yield (kg/ plot^{-1})	Projected yield (t ha^{-1})
T_1 - Mancozeb (0.3%)	86.67	10.19 (18.60)	16.17 (23.71)	19.31 (26.07)	21.90	4.23	8.53
T_2 - 250 g formulation of Trichoderma harzianum in 10 litre of water for 10 kg seed rhizomes	94.07	1.59 (7.20)	7.92 (16.35)	10.44 (18.85)	43.53	7.13	14.37
T_3 - Solarization of rhizomes in polythene bags of size 30×45cm for 1 kg seed rhizomes for 2 hours (9 a.m. to 11 a.m.) before sowing	88.89	2.50 (9.10)	11.98 (20.25)	15.54 (23.22)	30.44	6.07	12.24
T_4 - Hot water treatment at 51°C for 30 minutes	82.22	6.45 (14.70)	16.42 (23.90)	19.30 (26.06)	21.93	4.10	8.27

T_5- Aerated steam for 30 minutes	88.15	4.27 (11.90)	11.28 (19.62)	17.75 (24.92)	25.34	4.80	9.68
T_6- Control	77.04	12.53 (20.70)	27.32 (31.51)	30.27 (33.38)	-	2.77	5.58
SEm ±		1.752	1.289	0.551		0.195	
CD (at 5%)		5.521	4.063	1.735		0.615	

3.6.3.2 Solan

The experiment was started during 2001-2002 with 6 treatments in RBD replicated 4 times at Solan. It is obvious from the data presented in Table 93 that all the treatments were effective in increasing the emergence and yield of ginger with a simultaneous decrease in incidence of rhizome diseases of ginger. However, mancozeb, seed solarization and hot water treatments were effective in increasing the emergence and yield of ginger and were at par with each other. Moncozeb and copper oxychoride decreased the incidence of *Pythium* rot, copper oxychloride of *Fusarium* rot and seed solarization, copper oxychloride and hot water treatments reduced incidence of *Ralstonia* rot of ginger.

Table 93. Effect of seed treatment on sprouting, disease incidence and yield of ginger – Solan

Treatment	Emergence (%)	Disease incidence (%)				Yield (kg/3m²)
		Pythium	*Fusarium*	*Ralstonia*	Total	
T1 = Mancozeb (0.25 %)	92.42a	2.81a	6.87	11.12	20.80	4.337a
T2 = *Trichoderma harzianum* (2.5%)	86.05	3.87	7.5	6.75	18.12	2.819
T3 = Rhizome solarization (45°C/45 min)	90.82a	4.92	4.67b	4.42a	14.02b	4.119a
T4 = Hot water treatment (45°C/30 min)	90.90a	5.2a	4.62b	6.50	16.35c	4.600a
T5 = Copper oxychloride (0.3%)	87.35	3.10	3.50a	5.37b	11.97a	2.737
T6 = Control	83.95	6.37	8.35	13.45	28.17	2.556
CD (0.05)	1.71	0.5	0.76	0.68	1.1	1.07

Table 94. Seed Rhizome storage technology for the control of rhizome rot of ginger (Demonstration trial) - Solan

District	Location	Recovery (%)
Solan	Ladhi	95
	Kandha	90
	Tipra	90
Sirmaur	Sohal	92
Shimla	Panesh	85

Demonstrations on seed rhizome storage technology were given in three districts of H.P i.e Solan, Sirmaur and Shimla and the results obtained revealed more than 85 percent recovery of the seed rhizomes. Table 94.

3.6.3.3 Dholi

This experiment was not conducted due to vacant post of pathologist.

4. TURMERIC

In turmeric 12 projects are in progress at 54 centres of the AICRPS.

4.1 Genetic Resources (TUR/CI/1)

4.1.1. Germplasm collection, characterization, evaluation and conservation (TUR/CI/1.1)

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

4.1.1.1 Coimbatore

This project was started during 1999 at this centre, a total of 230 turmeric germplasm accessions were evaluated during 2002–2003 and these accessions showed wide variation in yield, which ranged from 7.35 to 45.37 t ha^{-1}. During the period under report (2003–2004) 255 germplasm accessions of turmeric were evaluated for their morphological and yield parameters. The yield data of promising 30 accessions are presented in Table 95. Considerable variations exist between these accessions for yield, which ranged from 7.7 to 44.1 t ha^{-1}. The highest yield of 44.1 t ha^{-1} was recorded by the accessions CL 101 followed by CL 147 which gave the yield of 42.9 t ha^{-1}. The yield was lowest (7.7 t ha^{-1}) in the accession CL 63. Seven accessions viz. CL 18, CL 26, CL 47, CL 48, CL 50, CL 154 and CL 169 registered the yield, which ranged from 36 – 39.4 t ha^{-1}. The yield of 13 accessions varied between 31 – 34.3 t ha^{-1} and 25 accessions between 25.4 – 29.7 and 47 accessions between 20 – 24.9 t ha^{-1}. Remaining 161 accessions showed the yield range of 7.7 to 19.75 t ha^{-1}.

Table 95. Yield performance of turmeric germplasm (2003–2004) - Coimbatore

Acc. No.	Yield $plot^{-1}$ (kg)	Yield (t ha^{-1})	Acc. No.	Yield $plot^{-1}$ (kg)	Yield (t ha^{-1})
CL.18	19.7	39.4	CL.101	22.05	44.1
CL.26	18.25	36.5	CL.147	21.45	42.9
CL. 47	18.50	37.0	CL.154	18.65	37.3
CL. 48	19.20	38.4	CL.155	18.65	37.3
CL.50	19.00	38.0	CL.169	18.00	36.0

4.1.1.2 Jagtial

The trial was started in the year 1987 at this centre. During the year 2003-2004, eighty four entries were added, which belongs to short, medium, long duration varieties. At present a total 273 genotypes are maintaining in the center. The varieties Suguna (PCT 13) and Sudarshana (PCT 14) short duration types were released from the center in the year 1993.

4.1.1.3 Dholi

The programme was initiated in 1992. The centre maintains and conserves 80 accessions of germplasm. Eighty germplasms were tested and the yield varied from 6.0 kg (Neeli Haldi) to 41 kg (RH-9/90) in the area of 7.2 m^2.

4.1.1.4 Pottangi

This programme initiated during 1975 at Pottangi. At present 193 accessions are being maintained.

Out of total 193 turmeric accessions, 173 were evaluated in two replications at Pottangi. Among 173 accessions evaluated during the year 155 were *Curcuma longa*, 20 were *Curcuma aromatica* and 4 were *Curcuma amada*. The range in fresh rhizome yield/3 m^2 in *C. longa* varied from 4.2 kg/3 m^2 to 13.4 kg/3m^2 and forty accessions gave more than 10 kg/3 m^2 in yield (Table 96). In *Curcuma aromatica* the range in fresh rhizome yield varied from 4.6 kg/3 m^2 to 11.4 kg/3 m^2 and five accessions gave more than 7.5 kg/3m^2 yield (Table 97). Out of four *C. amada* types the range in yield was 6.4 kg/3 m^2 to 12.6 kg/3 m^2.

Table 96. Performance of turmeric germplasm type *(Curcuma longa)* – Pottangi

Characters	Range	Mean	Best 3 types with value in parenthesis
Plant height (cm)	41.4 – 94.3	70.6	Phulbani Local (94.3) TU \ No - 6 (91.2)322 TekkurPatta (90.3)
Number of tillers $clump^{-1}$	1.6 – 4.6	3.41	ST-365 (4.6) T. Sunder (4.4)MundaPadar (4.2)
Number of leaves $tiller^{-1}$	4.2 – 9.4	6.1	328 Sugandham (9.4)Wynad Local (8.2) PTS-28 (7.6)
Length of fully opened last leaf (cm)	22.0 – 48.6	40.2	CLS-21 (48.6) PTS-62 (47.0)390 Rajapuri (46.5)
Width of fully opened last leaf (cm)	8.4 – 16.2	12.02	PTS-28 (16.2) PTS-51 (16.0) PTS-62 (15.5)
Fresh rhizome yield (kg/3m^2)	4.2 – 13.4	7.41	CLS-21 (13.4) 390 Rajpuri (12.6) TU No – 6 (12.0)

Table 97. Performance of turmeric germplasm *(Curcuma aromatica)* – Pottangi

Characters	Range	Mean	Best 3 types with value in parenthesis
Plant height (cm)	41 – 86.4	61.58	CAS – 56 (86.4) Bataguda (82.3) Chayapaspu – II (81.2)
Number of tillers $clump^{-1}$	2.2 – 4.4	2.61	CAS-55 (4.4) Phulbani Wild (4.1) CAS-56 (4.0)
Number of leaves $tiller^{-1}$	4.0 – 7.1	4.12	CAS-72 (7.1)Bataguda (7.0)Kalaramanar (6.6)

Length of fully opened last leaf (cm)	31.2 – 42.4	40.62	Chayapasupu-II (42.4)Raikia (41.2)Kalarmanar (40.6)
Width of fully opened last leaf (cm)	4.6 – 13.2	11.6	CAS-56 (13.2)CAS-72 (13.0)Bataguda (12.4)
Fresh rhizome yield (kg/3m^2)	4.6 – 11.4	6.6	Chayapasupu-II (11.4)CAS-54 (11.2)Bataguda (11.0)

4.1.1.5 Raigarh

Germplasm collection during 2001-2002 at Raigarh centre. The mean data of yield for the 3 years (2001-2002 to 2003-2004) given in Table 98 showed that IT-1 recorded the highest yield (25.51 t ha^{-1}), followed by IT-5, IT-3 and IT-2.

Table 98. Yield of promising turmeric germplasm (2001 - 02 to 2003 - 04)– Raigarh

Genotype	Yield (t ha^{-1})			Mean
	2003 – 04	2002 - 03	2001 - 02	
IT - 1	11.60	26.73	38.19	25.51
IT - 2	11.90	16.08	36.18	21.39
IT - 3	10.35	18.69	35.37	21.47
IT - 4	13.30	14.67	32.86	20.28
IT - 5	15.50	14.07	38.19	22.59
IT - 6	14.30	12.66	32.16	19.71
IT - 7	7.30	14.07	30.15	17.17
IT - 8	10.55	18.09	30.95	19.86
IT - 9	10.55	21.50	29.74	20.60
IT - 10	12.00	7.63	29.14	16.26
IT - 20	14.70	10.45	32.15	19.10
IT - 22	12.05	7.63	20.40	13.36
* Mean	8.89			
* CD at 5%	1.98			
* CV%	8.26%			

4.1.1.6 Pundibari

The programme was started during 1998-1999 at Pundibari. Terai region being a part of the centre of diversity for turmeric a large amount of variations in genotypes are found in adjoining foot hills of Himalayan range. The abundance and luxurious growth of shoti or Indian arrow root (*Curcuma angustifolia*) and wild turmeric (C. *aromatica*) in all fallow uplands and forest areas indicates that this region may be the natural habitat for turmeric. In this context, this centre plays an important role for collection, maintenance and evaluation of germplasm.

The accessions were evaluated and the data of 10 top performance for this year have been presented in Table 99. Considering plant height it was found that TCP-88 was the tallest culture (156.42cm) followed by TCP-89 (146.20cm) where as TCP-17 was the dwarf one (51.20 cm). Similarly highest ranking tillers wereTCP-51 (3.40), TCP-130 (3.0), TCP-73 and TCP-66 etc. Longest leave was found in genotype TCP-88 (60.2cm), TCP-28 (54.6 cm) and shortest in TCP-72 (27.0 cm). Broadest leave were recorded in entry TCP-32(17.90cm) followed by TCP-51(17.06) and narrowest in TCP-05(07.84cm). Highest number leaves were found in TCP-104 (11.8) followed by TCP-24 (11.6). Least number of leaves were counted inTCP-33 (7.0). Maximum pseudostem girth was recorded in TCP-28 (10.84) and lowest in TCP-114 (3.56). Rhizome yield of individual plant was maximum in TCP-140 (560.20gm) followed by TCP-104 (506.8gm), TCP-56 (483.60gm), TCP-51 (447.3 gm) and TCP-02 (446.0 gm) respectively in that order. Considering plot yield and projected yield the top scorers were TCP-140 (28.92 t ha^{-1}), TCP-51 (28.51 t ha^{-1}), TCP-97 (27.94 t ha^{-1}), TCP-104 (25.31 t ha^{-1}), TCP-118 (24.53 t ha^{-1}) and TCP-107 (23.63 t ha^{-1}) all out yielded Suranjana (TCP-2) projected yield of 23.51 t ha^{-1}.

Table 99. Performance of turmeric germplasm (2002 - 2003) - Pundibari

Entries	Plant height	Tiller no.	Leaf no.	Leaf length	Leaf breadth	Stem girth	Rhizome yield/plant
GCP-03	61.43	6.00	18.50	21.38	2.47	2.27	206.23
GCP-04	51.08	8.12	16.00	20.53	2.30	2.35	167.84
GCP-05	61.60	6.85	15.40	20.20	2.22	2.30	221.77
GCP-07	60.05	8.70	17.50	20.70	2.35	2.00	204.80
GCP-08	67.83	9.15	18.80	22.84	2.52	2.23	235.11
GCP-09	46.70	7.70	15.00	15.90	2.00	1.54	200.87
GCP-10	57.12	6.19	16.80	21.54	2.08	2.20	188.24
GCP-12	69.92	4.89	20.20	24.82	2.80	1.00	169.45
GCP-13	65.30	7.50	17.20	21.10	2.44	2.50	232.18
GCP-14	47.82	4.72	13.00	17.50	2.60	1.52	203.12
GCP-15	51.46	6.84	18.40	20.98	2.62	1.94	157.91
GCP-16	62.88	7.50	16.40	19.40	2.20	1.98	224.39
GCP-17	63.91	5.40	17.60	18.42	1.90	2.20	217.83
GCP-18	51.42	7.95	10.00	13.46	2.10	1.40	220.66

Entries	Plant height	Tiller no.	Leaf no.	Leaf length	Leaf breadth	Stem girth	Rhizome yield/plant
GCP-19	61.34	6.52	19.00	21.08	2.40	2.38	225.29
GCP-20	51.37	6.00	19.00	19.47	2.30	1.90	207.38
GCP-21	69.42	8.15	18.60	22.44	2.44	2.50	241.82
GCP-22	56.66	5.22	13.80	19.28	2.40	1.96	217.39
GCP-23	64.15	9.38	19.10	21.42	2.46	2.52	247.90
GCP-24	44.53	7.00	17.00	19.97	1.90	1.56	166.63
GCP-25	43.50	4.90	16.00	18.00	2.30	1.87	194.77
GCP-26	52.06	8.52	16.77	19.86	2.30	2.10	231.84
GCP-27	52.35	7.33	15.00	21.75	2.55	2.10	209.19

4.1.1.7 Solan

The Solan centre is maintaining 171 germplasm. The yield per plot of the promising collections varies from 4.20 kg plot^{-1} (TC-4) to 9.5 kg plot^{-1} (BSR-2). Dry matter was maximum (17.00%) in ST 34 while essential oil in BDS-634 (6.50%). ST 227 showed maximum curcumin contents while oleoresins were maximum (11.68%) in ST–34 (Table 100).

Table 100. Mean yield per plot of 10 top performing turmeric collections - Solan

Name	Yield plot^{-1} (kg)	Converted yield (t ha^{-1})	Dry matter (%)	Essential oil (%)	Oleoresin (%)	Curcumin (%)
BSR-2	9.50	19.09	15.50	4.00	10.50	3.00
ST-227	8.00	16.08	16.30	5.80	10.80	3.50
MNCH-92	6.50	13.00	17.00	5.00	9.81	2.50
DKH-26	6.00	12.06	19.44	5.50	10.86	2.44
ST-330	5.50	11.05	-	-	-	-
ST-445	5.00	10.05	-	-	-	-
ST-34	4.75	9.55	19.80	6.00	11.68	2.50
ST-47	4.50	9.14	17.00	6.00	10.80	2.75
BDS-634	4.30	8.64	18.50	6.50	11.00	3.20
TC-4	4.20	8.44	18.50	5.00	9.88	2.76

4.1.1.8 Kumarganj

The programme was started during 1997 at Kumarganj centre. During the year 2003 - 04, out of 30 early maturing germplasm, NDH-79 and NDH-86 out yield in yield producing 33.33 t ha^{-1} of fresh turmeric rhizomes followed by NDH-68 32.22 t ha^{-1}. Among 41 medium maturing germplasm of turmeric NDH-14 yielded 36.41 t ha^{-1} of fresh rhizomes followed by NDH-18 (35.26 t ha^{-1}) and late maturing germplasm NDH-9 produced 38.22 t ha^{-1} of fresh rhizome highest oleoresin content of 13.80% found in NDH-14.

4.2 Coordinated Varietal Trial (TUR/ CI/2)

4.2.1 CVT 2000 - Series V (TUR / CI / 2.2)

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

4.2.1.1 Pottangi

The trial was laid out during 2000-2001 in RBD with 3 replications and continued for three years. The pooled data of the 3 years are presented in Table 101.

There was no significant highest fresh rhizome yield was recorded by PTS-11 (25.19 t ha^{-1}) followed by PTS-52 (25.23 t ha^{-1}) followed by PTS-55 (23.99 t ha^{-1}).

Table 101. Performance of turmeric accessions under CVT (2000 - 01 to 2003 - 04) – Pottangi

Cultivar	Fresh rhizome yield (kg/3 m^2)					Projected (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
RH-5	8.99	11.83	9.10	10.87	10.20	23.46
PTS-52	10.24	13.39	8.49	11.75	10.97	25.23
PTS-55	8.46	11.93	9.76	11.57	10.43	23.99
PTS-11	11.33	11.74	9.43	11.29	10.95	25.19
PTS-59	9.32	11.62	8.64	11.19	10.19	23.44
NDH-18	5.81	9.62	6.86	11.34	8.42	19.36
TCP-1	7.89	7.24	7.00	9.78	7.98	18.35
TCP-2	6.25	7.08	7.47	8.50	7.33	16.86
Acc-585	7.29	8.83	6.79	10.43	8.34	19.18
Acc-584	6.08	7.66	6.76	11.78	8.07	18.56
Tu. No.1	7.10	12.78	8.36	9.91	9.54	21.94
Surama	9.21	11.69	8.44	9.31	9.63	22.15
Roma	8.13	11.15	8.67	10.46	9.61	22.10
PTS-15	7.32	10.64	8.83	12.53	10.20	23.45
PCT-8	7.96	9.67	7.07	8.50	8.30	19.09
CD at 5%	1.96	1.99	1.34	2.90	2.05	4.71

4.2.1.2Chintapalle

Not reported.

4.2.1.3Jagtial

The trial was started during 2000 with 15 cultures and three replications.

During 2003-04, RH 5 has given more fresh rhizome yield 41.66 t ha^{-1} followed by TCP 11 33.66 t ha^{-1} in comparison to check variety Duggirala 24.66 t ha^{-1}. (Table 102)

During 2002-03, out of 15 cultures tested RH 5 has given more fresh yield 34.50 t ha^{-1} followed by PTS 52 (24.10 t ha^{-1}) in comparison to check Duggirala 21.70 t ha^{-1}.

Table 102. Performance of the turmeric accessions under CVT (2003-2004) - Jagtial

Culture	Plant height (cm)	No of leaves	No of tillers	Fresh rhizome yield (kg/3 m^2)	Fresh rhizome yield (t ha^{-1})
TCP 1	46.00	16.13	2.06	5.8	19.33
TCP 2	43.16	15.36	1.96	7.0	23.33
ACC 584	31.33	10.00	1.60	3.0	10.00
PTS 59	55.00	16.30	1.60	7.5	25.00
PTS 11	46.80	13.50	1.63	4.0	13.33
PTS 55	54.00	14.33	2.23	3.7	12.33
PTS 52	51.86	16.26	2.13	7.2	24.00
ACC 593	41.66	14.00	1.60	3.0	10.00
ACC 585	29.91	9.90	1.60	6.0	20.00
ACC 657	30.60	10.20	1.60	3.2	10.66
RH 5	37.50	15.90	2.20	12.5	41.66
NDH-14	43.83	15.60	2.06	5.5	18.33
PTS-15	49.36	15.50	2.13	4.2	14.00
NDH-18	44.83	14.50	1.83	7.0	23.33
TCP-11	46.36	14.06	2.03	10.1	33.66
Duggirala Red (check)	47.16	14.20	1.83	7.4	24.66
S. Em. ±					0.34
CD at 5%					0.98
CV (%)					9.66

4.2.1.4 Raigarh

The trial was started with 15 entries in RBD during 2001-2002. The three years (2001-2002 to 2003-2004) data revealed that the highest rhizome yield of 33-47 t $ha^{-1}$was recorded with TCP-1, followed by TCP-2 (31.37 t ha^{-1}).

Table 103. Performance of turmeric accessions under CVT (2001-02 to 2003 - 04) – Raigarh

Genotype	Yield (t ha^{-1})			Mean
	2003 - 04	2002 - 03	2001 - 02	
TCP -2	22.40	34.87	36.84	31.37
TCP -1	21.90	41.40	37.10	33.47
Mean	11.35			
CD at 5%	2.08			
CV%	8.56%			

4.2.1.5 Pundibari

The trial was laid out during 2000-2001 in RBD with 3 replications. A coordinated varietal trial (CVT) on turmeric initiated during crop season 2000-2001 and was continued up to 2003-2004. The yield performance of the entries during 2003-2004 were provided in Table 104.

Table 104. Performance of turmeric accessions under CVT – Pundibari

Entries	Yield (kg plot^{-1})	Projected yield (t ha^{-1})
PTS-11	4.110	8.29
PTS-15	3.640	7.34
PTS-52	4.343	7.57
PTS-55	4.520	9.11
PTS-59	3.757	7.57
ACC-126	3.075	6.19
ACC-584	3.323	6.70
ACC-585	2.435	4.91
TCP-1	5.613	11.31
TCP-2	7.380	14.88
TCP-11	7.777	15.68
TU-1	4.920	9.92
RH-5	7.213	14.54
Pratibha	3.795	7.65
Prabha	3.983	8.03
SEm (±)	0.262	
CD at 5%	1.340	

Maximum weight of clump was obtained in TCP–2 (328.66 g) followed by TCP-1 (280.80 g), RH-5 (272.669 g) and TCP–11 (266.66 g). The lowest clump weight was found in ACC–584 (111.34 g) and PTS-15 (131.20 g). It was observed that entries having higher clump weight were also higher yielders.

The projected yield indicated highest rhizome yield in TCP–11 (15.68 t ha^{-1}) followed by TCP–2 (14.88 t ha^{-1}) and RH–5 (14.54 t ha^{-1}). Lowest yield was recorded in ACC- 585 (4.91 t ha^{-1}).

4.2.1.6 Dholi

Not reported.

4.2.1.7 Kumarganj

The trial was started at 2000 with three replications. In coordinated varietal trial study NDH-18 produced maximum fresh rhizome yield of 34.76 t ha^{-1} followed by NDH-14 (34.11 t ha^{-1}) during the year 2003-04 (Table 105), In four years varietal trial study the high yielder was NDH-18 (40.17 t ha^{-1}) followed by R. sonia showing 4.42% increase in yield over check of R. sonia where as R. sonia showed 38.47 t ha^{-1} of fresh rhizome yield (Table 106).

Table 105. Yield of turmeric under CVT - Kumarganj

Name of entries	Fresh rhizome yield (q ha^{-1})					
	2000-01	2001-02	2002-03	2003-04	Total	Mean
TCP-1	418.77	130.56	143.33	199.90	892.56	223.14
TCP-2	435.55	242.78	246.66	266.60	1191.59	297.89
ACC-585	459.90	134.22	311.11	277.70	1182.93	295.73
ACC-584	21.75	22.22	19.44	55.50	118.91	29.72
ACC-593	433.33	200.00	294.22	305.50	133.05	308.26
ACC-657	401.10	207.78	327.78	288.80	1225.46	306.26
PTC-55	401.22	169.44	244.44	249.90	1065.00	266.25
TU-1	383.33	157.68	285.55	289.90	1116.46	279.11
PTS-15	416.66	221.78	272.22	249.90	1160.56	290.14
PTS -59	419.99	207.78	224.44	230.00	1082.21	270.55
PTS -11	411.10	190.00	255.55	266.60	1123.25	280.81
PTS -52	412.21	208.33	248.89	238.80	1108.23	277.05
RH-5	408.88	245.56	400.00	303.30	1357.74	339.43
NDH-18	510.55	265.56	483.33	347.60	1607.04	401.76
R. Sonia(check)	498.95	253.33	480.00	306.60	1538.88	384.72
CD (5%)	27.76	9.32	64.05	4.71	-	-
CV (%)	-	20.14	12.42	10.24	-	-

Table 106. Pooled analysis of coordinated varietal trial on turmeric (2000 to 2004) - Kumarganj

Entries	Weight of fresh rhizome clump^{-1}	Yield (t ha^{-1})
AC-585	343.33	27.77
TCP-1	243.33	19.99
PTS-55	425.00	24.99
TU-1	348.33	28.99
ACC-657	340.00	28.88
ACC-593	275.00	30.55
PTS-11	300.00	26.66
PTS-59	398.33	23.00
ACC-584	283.33	5.55
TCP-2	290.00	26.66

Entries	Weight of fresh rhizome clump^{-1}	Yield (t ha^{-1})
RH-5	275.00	30.33
PTS-15	396.66	24.99
NDH-14	280.00	34.11
R-Sonia	256.66	30.66
PTS-52	303.33	23.88
TCP-11	236.66	27.22
NDH-18	286.66	34.76
CD at 5%	36.85	4.71
CV (%)	7.11	10.24

4.2.1.8 Coimbatore

Not reported.

4.3 Varietal Evaluation Trial (TUR/CI/3)

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

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

4.3.1.1 Jagtial

The CYT was started in the year 1999 at Jagtial centre with an objective to evaluate the long duration germplasm of different centers for yield and quality and disease resistance.

Table 107. Performance of turmeric accessions under CYT–Jagtial

Culture	Plant height (cm)	Number of leaves	Number of tillers	Fresh rhizome yield (kg/3 m^2)	Fresh rhizome yield (t ha^{-1})
JTS 10	37.20	10.56	1.96	7.8	26.00
JTS 11	45.00	10.33	2.10	8.8	29.33
JTS 12	46.16	10.90	2.13	9.8	32.66
JTS 13	37.46	10.86	1.96	7.2	24.00
JTS 14	45.53	10.73	2.10	8.9	29.66
JTS 15	42.10	10.83	2.13	9.2	30.66
Duggirala Red (check)	47.66	11.03	1.90	8.7	29.00
S.Em. ±					0.15
CD at 5%					0.46
CV (%)					2.97

During 2003-04, out of 7 cultures tested JTS 12 has given 32.66 t ha^{-1} followed by 30.66 t ha^{-1} when compared to check variety Duggirala Red 29.00 t ha^{-1}.

4.3.1.2Dholi

Not reported.

4.3.1.3Pundibari

The trial was relaid out as per XVII Workshop decisions during 2004-2005.

4.3.1.4Pottangi

The trial was initiated during 2000-2001 in RBD with 3 replications.

Table 108. Yield performance of turmeric cultivars under CYT (2000 - 01 to 2003 - 04) - Pottangi

Cultivar	Fresh Rhizome yield (kg/3 m^2)					Projected yield (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
PTS - 5	17.26	11.07	7.86	12.55	9.69	22.29
PTS - 50	8.43	11.09	9.08	11.09	9.92	22.82
Tu.No.6	6.24	11.81	8.16	12.14	9.59	22.06
PTS - 34	8.91	11.38	8.09	11.50	9.97	22.93
PTS - 39	8.67	11.27	9.97	11.28	10.30	23.69
PTS - 4	6.88	10.47	9.65	10.53	9.38	21.58
PTS - 16	6.57	9.72	8.72	11.80	9.21	21.17
Roma	7.92	10.10	8.22	12.47	9.68	22.26
CD at 5%	NS	NS	1.01	N.S		

The three years pooled data presented in Table 108. There was no significant highest fresh rhizomes yield was recorded by PTS-39 (23.69 t ha^{-1}) followed by PTS-34 (22.93 t ha^{-1}) and PTS-50 (22.82 t ha^{-1}).

4.3.1.5Raigarh

The trial was initiated during 1999-2000 with 10 entries in RBD replicated thrice. The projected yield data presented in Table 109. The project yield data presented in Table 109. During the years (1999-2000 to 2002-2003). IT-1 registered the highest yield (24.94 t ha-1) followed by IT-2 (21.75 t ha-1), IT-3 (20.73 t ha-1).

Table 109. Yield performance of turmeric accessions under CYT (1999-2003) – Raigarh

Genotype	Yield (t ha^{-1})					Mean
	2003-04	2002-03	2001-02	2000-01	1999-2000	
Prabha	9.14	13.4	12.30	12.3	23.60	14.15
Pratibha	10.18	11.6	20.10	11.3	22.10	15.06
ACC - 584	7.70	8.6	6.50	10.6	22.00	11.08
ACC - 585	11.38	6.7	6.10	11.2	20.60	11.20
ACC - 126	2.61	10.0	12.10	12.7	20.40	11.56
IT - 1	11.12	24.5	39.20			24.94
IT - 2	12.46	16.0	36.80			21.75
IT - 3	10.38	17.4	34.40			20.73
IT - 4	12.00	15.2	32.30			19.83
IT - 5	14.50	13.2	35.40			21.03
Mean	10.15					
CV%	11%					
CD at 5%	2.01					

4.3.2 Initial Evaluation Trial (IET) (TUR/CI/ 3.2)

(*Pottangi, Dholi, Jagtial* and *Solan*)

4.3.2.1 Pottangi

The trial was initiated at this centre during 2000-2001 in RBD with 3 replications.

Table 110. Yield performance of turmeric cultivars under IET (2000 - 01 to 2003 - 04) Pottangi

Cultivar	Fresh rhizome yield (kg/3 m^2)					Projected yield (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
PTS-39	9.43	12.80	9.71	11.66	10.90	25.08
Tu.No.6	6.46	9.95	7.39	10.44	8.56	19.68
PTS-51	7.21	11.29	6.61	11.71	9.21	21.17
PTS-29	6.59	9.60	7.73	10.31	8.56	19.68
PTS-50	8.21	8.27	7.62	10.39	8.62	19.83

Cultivar	Fresh rhizome yield (kg/3 m²)					Projected yield (t ha⁻¹)
	2000-01	2001-02	2002-03	2003-04	Mean	
Tu.No.3	10.61	8.51	11.05	11.76	10.49	24.13
Alleppey	6.11	9.95	7.08	8.78	7.98	18.35
PTS-13	7.21	11.58	8.50	10.27	9.39	21.16
PTS-47	6.13	12.89	10.12	12.75	10.47	24.08
PTS-27	5.84	7.59	5.57	10.83	7.46	17.15
PTS-4	7.32	10.93	7.77	10.15	9.04	20.79
PTS-16	6.75	8.24	7.37	7.18	7.38	16.98
PTS-34	9.93	11.50	8.25	9.46	9.78	22.50
Ranga	9.12	8.51	7.97	10.46	8.84	20.34
Roma	8.21	10.01	6.58	13.01	9.46	21.75
CD at 5%	2.42	2.30	1.39	N.S	2.21	5.08

Pooled data of these years 2000-2001 to 2003-2004 is presented in Table 110. There was no significant highest fresh rhizomes yield was recorded by PTS-39 (25.08 t ha⁻¹) followed by Tu.No.3 (24.13 t ha⁻¹) and PTS-47 (24.08 t ha⁻¹).

4.3.2.2Jagtial

The trial was started at this centre in the year 1999 with an objective to evaluate the medium duration turmeric germplasm.

Table 111. Performance of turmeric accessions under CVT (2003-2004) – Jagtial

Culture	Plant height (cm)	No. of leaves	No. of tillers	Fresh rhizome yield (kg/3 m²)	Fresh rhizome yield (t ha⁻¹)
JTS 314	40.66	9.50	2.26	8.30	27.66
JTS 315	35.23	9.00	2.03	7.40	24.66
JTS 316	40.80	9.36	1.96	7.16	23.87
JTS 317	40.60	9.40	2.13	7.36	26.80
JTS 318	42.86	9.23	2.13	7.13	23.76
JTS 319	38.06	9.36	2.10	6.73	22.44
JTS 320	39.23	9.03	2.13	8.00	26.70
JTS 321	39.46	9.06	2.10	7.43	24.76
JTS 322	40.06	9.40	2.16	7.13	23.77
JTS 323	42.16	9.30	2.23	7.63	25.44
JTS 324	42.13	9.00	2.10	7.26	24.20
JTS 325	43.20	9.86	2.16	8.10	27.00
JTS 326	39.36	9.90	2.26	8.16	27.20
CLI 317 (check)	41.66	10.00	2.16	7.36	24.53
S.Em. ±					0.43
CD at 5%					NS
CV (%)					9.88

Out of 14 cultures tested during 2003-2004, JTS - 314 has given more fresh rhizome yield 27.66 t ha^{-1} followed by JTS 326 (27.20 t ha^{-1}) followed by 27.00 t ha^{-1}. (Table 111). During 2002-03, out of 14 cultures tested JTS - 319 gave more fresh rhizome yield (26.7 t ha^{-1}) followed by JTS - 316 (26.6 t ha^{-1}) in comparison to check CLI - 317 (19.9 t ha^{-1}).

A trial with short duration accessions was started in the year 1999 at Jagtial.

Table 112. Performance of turmeric accessions under CYT (2003-04) - Jagtial

Culture	Plant height (cm)	No. of leaves	No. of tillers	Fresh rhizome yield (kg/3 m^2)	Fresh rhizome yield (t ha^{-1})
JTS 607	33.74	11.16	2.23	7.5	25.00
JTS 608	32.36	10.50	2.13	6.3	21.00
JTS 609	35.55	10.70	2.10	7.0	23.33
JTS 610	34.75	11.13	2.16	7.8	26.00
JTS 611	35.24	10.80	2.10	7.1	23.66
JTS 612	33.22	10.20	2.03	8.3	27.66
PCT 13 (check)	33.61	10.30	2.13	8.2	27.33
S.Em. $\pm$					0.12
CD at 5%					0.38
CV (%)					2.84

The performance of the germplasm accession during 2003-2004 are presented in Table 112. Out of 7 short duration cultures tested JTS 612 has given more fresh rhizome yield (27.66 t ha^{-1}) followed by JTS 610 (26.00 t ha^{-1}) when compared to check variety PCT 13 (27.33 t ha^{-1}). During 2002-03, out of 7 cultures tested JTS 607 gave more fresh rhizome yield (26.5 t ha^{-1}) followed by JTS 612 (25.3 t ha^{-1}) in comparison to check Suguna (PCT 13) recorded maximum fresh rhizome yield (27.3 t ha^{-1}).

4.3.2.3 Dholi

The trial was initiated with 9 entries in RBD during 2003-2004 at Dholi. Nine genotypes including check (Rajendra Sonia) were tested under Initial evaluation trial (Table 113). There was non significant differences among the genotypes regarding plant height and number of tillers per plant while maximum plant height was recorded (107.33 cm) with genotype RH-17 followed by RH-13/90 (102.93 cm). However, genotype RH-9/90 gave the maximum yield (43.06 t ha^{-1}) followed by RH-13/90 (40.74 t ha^{-1}), which is 34.82 per cent and 27.55 per cent higher over check (Rajendra Sonia).

Table 113. Initial evaluation trial of turmeric (2003-04) – Dholi

Characters Genotypes	Plant height (cm)	No. of tillers per plant	No. of days to maturity (days)	Yield plot $^{-1}$ (kg)	Yield (t ha^{-1})	Increase in yield over control	
						(t ha^{-1})	(%)
RH-14	90.53	4.33	227.67	22.00	30.56	-1.38	-4.32
RH-16	84.87	4.20	219.33	20.33	28.24	-3.70	-11.50
RH-17	107.33	3.60	213.33	26.83	37.27	5.33	16.61
RH-24	82.67	3.33	213.00	21.33	29.63	-2.31	-7.23
RH-50	94.80	4.13	212.33	24.50	34.03	2.09	6.54
RH-80	89.93	5.00	229.33	26.67	37.04	5.10	15.97
RH-9/90	84.40	5.33	222.33	31.00	43.06	11.12	34.82
RH-13/90	102.93	3.40	208.67	29.33	40.74	8.80	27.55
R. Sonia (check)	91.86	4.53	212.33	23.00	31.94	-	-
CD at 5%	NS	NS	3.42	4.26	5.88		
CV %	9.86	17.77	0.90	9.83	9.86		

4.3.2.4 Solan

The trial was initiated at Solan with 16 medium duration entries in RBD during 2002-2003. During 2003-2004, non-significant differences were observed for yield per plot (Table 114). However, expect for the collections viz., ST 645 and T no. 138 all other collections showed increase in yield over the check (Armoor). Maximum increase to the extent of 9.77% was obtained in ST 616.The dry matter content was maximum in PCT-2 and minimum in DKH-26 while essential oil (Cls-29 and PCT-24) and oleoresin contents were maximum in PCT-2.The curcumin content were maximum in Cls-29 and minimum in ST - 365.

Table 114. Performance of turmeric accessions under CVT (2003-2004)-Solan

Name	Yield plot^{-1} (kg)	Projected yield (t ha^{-1})	Dry matter (%)	E.oil(%)	Oleoresin (%)	Curcumin (%)
ST 323	4.52	9.08	17.50	5.69	10.50	3.50
ST 247	4.37	8.78	16.50	6.00	11.00	3.00
ST 54 M	4.70	9.45	18.00	6.50	12.50	3.59
T. No 262	4.31	8.66	19.00	4.25	9.78	2.27
ST 645	4.20	8.44	18.00	5.50	9.81	2.00
CLS 24	4.76	9.57	17.20	4.0o	10.80	3.06
ST 616	4.86	9.77	16.50	5.50	9.50	3.67
ST 365	4.53	9.10	16.40	6.00	11.21	1.70
Anamica	4.51	9.04	17.50	5.00	10.20	2.50
Cls-29	4.39	8.82	18.50	7.50	13.20	4.40
PCT-2	4.60	9.25	21.40	6.50	15.17	3.37
PTS-24	4.50	9.04	20.00	7.50	14.00	3.59

ST760	4.51	9.04	19.44	5.50	10.86	2.44
DKH-26	4.62	9.28	16.00	4.42	10.13	2.50
T.No 138	4.10	8.24	15.87	4.00	9.30	2.98
Armoor (check)	4.28	8.60				
SE±	0.32					
CD at 5%	NS					

4.4 Quality Evaluation Trial (TUR/CI/4)

4.4.1 Quality evaluation of germplasm (TUR/CI/4.1)

(*Solan* and *Coimbatore*)

4.4.1.1 Solan

All the three categories of turmeric genotypes which were divided on the basis of curcumin content during last year i.e. good performers (≤ 3.00% curcumin), average performer (≤ 2.00 % curcumin) and poor performers (≥ 1.00% curcumin) kept for further evaluation kept for further evaluation with 27 new accessions of turmeric. About 62 collections, which regarded as good performers during last year were evaluated for different quality attributes viz. dry matter, essential oil, oleoresin and curcumin content. Among 62 accessions only 52 were maintained their superiority in terms of above mentioned quality parameters (Table 115). The results indicated that dry matter content varied from 15.50 to 22.59 per cent. The oleoresin and essential oil content ranged between 6.91 to 14.50 and 3.50 to 8.50 per cent respectively. The quality estimation of remaining accessions /collections is under progress.

Table 115. Quality atributes of turmeric germplasm - Solan

Good performers	Dry matter (%)	E.oil (%)	Oleoresin (%)	Curcumin (%)
Acc 360	18.50	6.00	13.00	3.50
Rajendra Sonia	19.50	6.50	12.50	3.12
JTS-2	17.50	7.00	14.50	4.00
BSR-3	16.45	5.50	11.50	3.50
BDJR-1242	17.65	5.00	10.50	4.01
PCT-1	22.50	7.00	12.50	4.00
BDJR-1025	17.00	5.80	13.00	3.35
BDJR-1244	16.73	6.50	14.80	4.00
PTS-38	19.00	4.50	12.53	4.05
PTS-53	17.75	4.00	11.35	4.05
BDJR-1133	17.00	4.90	12.75	4.75
PCT-1	16.00	3.50	10.00	3.25
C.L Puram	22.59	7.00	15.00	3.53
T.No-323	18.50	5.90	13.00	4.25
Ammamigada	20.50	5.98	13.25	4.35
Sugandham	19.00	5.00	12.50	3.50
BDJR-1055	17.00	5.50	12.00	3.75

Good performers	Dry matter (%)	E.oil (%)	Oleoresin (%)	Curcumin (%)
TC-2	17.00	5.80	11.50	3.25
ST-691	20.89	4.50	9.50	3.75
ST-85	18.50	6.50	11.00	3.15
Armoor	16.99	4.50	10.30	3.00
BSR-2	15.50	4.00	10.50	3.00
Thabyama	15.50	5.50	11.00	4.75
BDJR-1235	16.00	6.00	11.50	3.82
CIS-1182	17.50	4.50	11.00	3.00
PTS-7	18.50	6.50	11.50	3.50
Alleppey finger	16.80	5.73	11.00	4.85
BDJR-1260	16.50	5.99	11.55	4.99
No. 1260	17.50	7.09	13.50	4.00
No. 2A	22.00	5.50	10.11	3.95
BDJR-1035	20.10	8.00	12.80	3.50
BDJR-1125	18.50	5.50	11.80	4.59
BDJR-1151	19.90	6.75	12.00	3.50
CLS-22	22.00	8.50	14.50	3.25
BDJR-1224	20.50	6.50	10.50	3.75
BDJR-1250	21.51	7.70	11.80	4.50
BDJR-1216	17.50	5.50	10.55	3.59
BDJR-1072	16.50	4.80	9.53	3.50
ST-29M	18.50	5.50	10.85	3.70
ST-43	17.50	6.00	12.00	4.50
BDJR-1172	17.70	6.50	11.50	3.70
BDJR-1082	17.00	7.05	13.05	4.50
BDJR-1116	17.50	6.00	12.55	3.50
PTS-16	18.00	6.50	12.75	3.75
ST-402	20.00	7.75	13.00	4.00
BDJR-1247	19.00	6.00	11.50	4.35
ST-44M	20.00	8.00	12.00	3.25
BDJR-1280	19.00	6.00	10.00	3.15
PCT-13	17.00	6.95	11.50	3.95
PCT-14	18.50	6.50	11.50	3.50
ST-832	19.75	7.50	14.50	3.98
BDJR-1160	18.11	6.00	12.50	3.98

4.4.1.2 Coimbatore

This project was started at this centre during 1999 with the aim of identifying turmeric variety with high curcumin content. The curcumin content of all the 230 accessions were estimated during 2002-2003. Curcumin content of these accessions varied between 1.02 to 6.04 per cent.

During 2003–2004, curcumin content of 255 germplasm were analysed (Table 116). Among these, the accession CL 67 recorded the highest curcumin content of 6.05 per cent followed by CL 18 (6.0 %) while the lowest curcumin was observed in CL 87 (1.5%). Thirteen accessions recorded more than 5.0 per cent ranged from 5.01–5.50, and 117 accessions yielded more than 4.0 per cent curcumin varied between 4.0–4.88. (Table 116).

Table 116. Curcumin content of turmeric germplasm accessions (2003 – 2004) - Coimbatore

Acc. no	Curcumin (%)	Acc. no	Curcumin (%)	Acc. no	Curcumin (%)
CL.11	5.27	CL.51	3.82	CL.91	1.52
CL.18	6.00	CL.58	4.03	CL.98	3.80
CL.19	5.07	CL.59	3.07	CL.99	3.68
CL.26	5.09	CL.66	4.43	CL.106	3.89
CL.32	5.05	CL.72	4.30	CL.112	3.35
CL.124	5.20	CL.164	4.08	CL.204	3.97
CL.133	4.62	CL.173	5.01	CL.213	4.06
CL.138	5.05	CL.178	4.34	CL.218	3.75
CL.146	5.37	CL.186	4.08	CL.226	3.93
CL.147	5.50	CL.187	3.94	CL.227	4.01
CL.153	5.03	CL.193	5.06	CL.233	3.71

4.4.2 Impact of environment on quality of turmeric (TUR/CI/4.2)

(*Pottangi* and *Coimbatore*)

4.4.2.1 Coimbatore

The project was started during 1999 and it is in 4th year of progress at Coimbatore. During 2003 – 2004, the impact of environment on quality of turmeric was ascertained by laying trail with six accessions. The observations were recorded on yield, curing percentage and curcumin content and presented in Table 117. The results revealed the same trend as that of previous year. The cv. Suguna gave the highest yield of 35.5 t ha^{-1} and it was the lowest in Rajendra sonia (20.90 t ha^{-1}). The curing percentage was the highest (24.3%) in JTS-2. With regard to the curcumin content the Acc. 360 recorded the highest curcumin content of 5.10 per cent.

Table 117. Impact of environment on quality of turmeric (2003–2004) –Coimbatore

Accession	Yield (kg $plot^{-1}$)	Yield (t ha^{-1})	Curing percentage	Curcumin (%)
131 (Suguna)	17.75	35.50	20.5	4.60
151 (Acc. 360)	16.00	30.20	22.3	5.10
141 (Rajendra sonia)	10.45	20.90	22.7	4.00
140 (JTS 2)	13.65	27.30	24.3	4.50
2 (BSR 2)	14.35	28.70	21.0	4.60
133 (Roma)	11.70	23.40	23.4	4.40
CD at 5%		3.50		

4.4.2.2 Pottangi

The trial was initiated during 2000-2001 in RBD with 4 replications. The results showed non significant difference for fresh and dry rhizome yield. Highest fresh rhizome yield was recorded by JTS-2 (21.31 t ha^{-1}) with 14.0 % dry recovery followed by Rajendra Sonia (20.70 t ha^{-1}) with 14.0 % dry recovery. However, highest dry recovery was recorded in cultivar Roma (26.0%) with a fresh rhizome yield of 20.34 t ha^{-1}.

Table 118. Yield performance of turmeric cultivars - Pottangi

Cultivar	Fresh rhizome yield (kg/3 m^2)							Projected (t ha^{-1})	Dry recovery (%)	Dry yield (t ha^{-1})
	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	Mean			
Roma	8.76	5.50	9.50	11.29	8.15	9.85	8.84	20.34	26.0	5.62
R. Sonia	12.66	5.37	7.80	11.39	7.22	9.56	9.00	20.70	14.0	3.11
Alleppey	10.77	5.67	8.21	11.05	7.63	7.45	8.47	19.47	20.0	4.33
JTS-2	13.28	6.95	6.71	10.29	10.28	8.08	9.26	21.31	14.0	3.33
Acc-360	8.12	3.80	7.42	10.13	7.77	9.56	7.80	17.94	21.0	3.91
BSR-2	9.30	4.79	6.84	10.71	7.52	11.96	8.52	19.59	19.0	3.72
CD at 5%	NS	2.38	NS	NS	0.89	N.S				

4.4.3 Effect of raised and flat beds on yield of turmeric (TUR/CI/)

4.4.3.1Dholi

The pilot trial was conducted at Dholi during 2002-2003 in the area of 150 square meter with a spacing 30 cm x 20 cm, to study the effect of raised beds and flat beds. The raised bed method produced 311 kg/150 sq. m. while 240 kg yield was recorded in flat bed method in the same area. Similarly, raised bed method produced 71 kg (11.25 %) more yield as compare to flat bed method.

4.5 Nutrient Management Trial (TUR / CM / 1)

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

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

4.5.1.1 Kumarganj

The trial was started at this centre during 2000-2001 with 8 treatments and three replications and was continued upto 2003-2004. The morphological and yield and yield attributing characters were studied. During the year 2003-04, maximum yield of 37.77 t ha^{-1} was obtained in T_1 treatment with application of 100% inorganic nitrogen + *Azospirillum* 5 kg ha^{-1} +5 t ha^{-1} FYM followed by T6 ie. 10 t ha^{-1} FYM + 5 kg ha^{-1} *Azospirillum* (Table 119). Four years pooled yield data for 2000-2001 to 2003-2004 presented in Table 119 showed 41.13 t ha^{-1} in T_1 treatment gave the highest yield.

Table 119. Effect of NPK, FYM and *Azospirillum* on yield in Turmeric-Pooled data (2000 - 01 to 2003 - 04) - Kumarganj

Treatment	Fresh rhizome yield (q ha^{-1})					Mean (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Total	
T_1 = Inorganic N (100% + *Azospirillum* (50g)+5kg FYM	498.33	394.44	375.00	377.70	1645.47	41.36
T_2 = Inorganic N (75% + *Azospirillum* (50 g) +5 kg FYM	481.65	345.56	336.11	340.50	1503.82	37.59
T_3 = Inorganic N (50%) + *Azospirillum* (50g)+5 kg FYM	435.16	338.84	319.42	327.70	1442.12	35.53
T_4 = FYM (5 kg) + *Azospirillum* (50g)	408.33	309.44	297.22	291.60	1306.59	32.66
T_5 = FYM (5 kg) + *Azospirillum* (50 g)	376.66	353.89	322.00	325.00	1377.75	34.44
T_6 = FYM (10 kg) + *Azospirillum* (50 g)	416.66	357.22	344.44	347.20	1472.14	36.80
T_7 = FYM (10 kg) *Azospirillum* (50 g)	405.50	375.00	344.44	347.20	1472.14	36.80
CD at 5 %	24.60	42.36	28.65	2.93	-	-
CV (%)	-	6.35	4.83	5.53	-	-

The experiment was started during 2002-2003 with 13 treatments at Solan centre. The results presented in Table 119 showed non significant differences were observed amongst treatments for yield per during both the years 2002-2003. However, the yield per plot was comparatively more during first year (2002) than second year (2003). Overall yield of both the years indicated that it was comparatively more in the control. T9, T10 and T11 also gave the yield equal to the control.

4.5.1.2Solan

Turmeric is valued for curcumin content extracted from the rhizomes and used extensively by all classes of people for flavouring and colouring kitchen preparations. It is also used in various religious and ceremonial functions, in medicine, cosmetics in textiles. It is also a good foreign exchange earner of the country. It is estimated that during 2003-04, the country export of turmeric will be 33,000 mt with a value of Rs.10560.00 lacs. Being natural colorant, it is gaining importance in many parts of the world mainly because of a ban on the use of synthetic dye in food and drugs. Its value further has to be enhanced by supplying non-chemical raised or organic cultured turmeric both domestically and

internationally. Keeping this in mind the present experience was proposed. The experiment was proposed during 2002-03 with 13 treatments. Non-significant differences were observed amongst treatments for yield per during both the years. However, the yield per plot was comparatively more during first year (2002) than second year (2003). Overall yield of both the years indicated that it was comparatively more in the control. T9, T10 and T11 also gave the yield equal to the control.

Table 120. Effect of biofertilizer, *Azospirillum* on yield of turmeric - Solan

Treatment	Yield plot^{-1} (kg)		Mean	Converted yield (t ha^{-1})
	2002	2003		
T1	5.10	4.80	4.55	9.14
T2	5.10	4.83	4.92	9.89
T3	4.15	4.87	4.51	9.06
T4	4.80	4.27	4.53	9.10
T5	4.65	4.57	4.56	9.16
T6	5.50	4.60	5.05	10.15
T7	6.20	4.40	5.30	10.65
T8	5.55	4.43	4.99	10.03
T9	7.60	4.23	5.92	11.90
T10	7.20	4.03	5.62	11.29
T11	7.30	4.27	5.78	11.62
T12	3.15	4.40	3.68	7.39
T13	6.85	5.07	5.96	11.98
SE±	0.34	0.60	-	
CD 5%	NS	NS	-	

4.5.1.3Raigarh

The field experiment was conducted at RARS Raigarh during three years (2001-02, 2002- 03, and 2003-04). Eight treatment combinations of inorganic nitrogen and organic manures (FYM) with *Azospirillum* were laid out in RBD with three replications, having plot size of 3.0 X 1.0 M^2. The bio fertilizer and FYM was given at time of planting while in organic nitrogen was applied during 30, 55 and 90 DAP.

Table 121. Effect of biofertilizer, *Azospirillum* on yield of turmeric - Raigarh

Treatments	Plot yield (kg/3m²)	Projected yield (t ha⁻¹)			Mean yield (t ha⁻¹)
		2001-02	2002-03	2003-04	
JTS 10	37.20	10.56	1.96	7.8	26.00
T_1 Inorganic Nitrogen 100% + *Azospirillum* 50 g + FYM 5 kg Plot⁻¹	12.60	39.65	30.06	25.32	31.67
T_2 Inorganic Nitrogen 75% + *Azospirillum* 50 g + FYM 5 kg Plot⁻¹	10.30	32.42	25.44	20.70	26.18
T_3 Inorganic Nitrogen 50%+ *Azospirillum* 50 g + FYM 5 kg Plot⁻¹	9.40	30.50	24.18	18.89	24.52
T_4 FYM 100 Q ha⁻¹ + *Azospirillum* 50 g Plot⁻¹	8.80	24.32	20.90	17.68	20.96
T_5 FYM 5 kg Plot⁻¹	6.50	21.30	19.09	13.06	17.82
T_6 FYM 10 kg + *Azospirillum* 50 g Plot⁻¹	8.50	27.53	22.43	17.08	22.34
T_7 FYM 10 kg alone	7.10	22.83	19.81	14.27	18.97
T_8 Recommended dose (150+100+120) kg NPK ha⁻¹	11.80	37.84	28.80	23.71	30.12
CD at 5%		2.65	2.37	4.36	

Maximum yield of 31.67 t ha⁻¹ was recorded with application of Inorganic Nitrogen 100% + FYM + *Azospirillum* followed by 30.12 t ha⁻¹ with recommended dose of fertilizer and significantly superior over remaining treatments (Table 21)

4.5.1.4Pottangi

The trial was initiated in RBD with replications at Pottangi during 2000-2001 and continued upto 2003-2004. The pooled yield data of the four years study is presented in Table 122.

Table 122. Effect of biofertilizer (*Azospirillum*) on yield of Turmeric (2000-2001 to 2003-2004) - Pottangi

Treatments	Plot yield (kg)					Projected yield (t ha⁻¹)
	2000-01	2001-02	2002-03	2003-04	Mean	
T_1 100 % N + Azospirillum + 5 kg FYM	8.41	8.290	5.83	9.12	7.91	18.20
T_2 75 % N + Azospirillum + 5 kg FYM	7.10	6.760	4.47	7.40	6.43	14.80
T_3 50% N +Azospirillum + 5 kg FYM	6.64	5.930	4.07	6.59	5.81	13.34
T_4 0 N + Azospirillum + 5 kg FYM	5.44	4.950	3.77	4.86	4.76	10.94

T_5	0 N	+ 0	+ 5 kg FYM	6.21	4.800	2.50	5.78	4.82	11.09
T_6	0 N	+ Azospirillum	+10 kg FYM	6.42	5.270	2.27	4.89	4.71	10.84
T_7	0 N	+ 0	+10 kg FYM	6.21	5.300	2.80	4.69	4.75	10.93
T_8	Recommended dose of inorganic fertilizer			7.34	9.560	5.33	6.80	7.26	16.69
	CD at 5%			NS	0.967	1.02	2.01	1.30	3.06

Significant highest fresh rhizomes yield was recorded by T_1 (100 % N + 50 g *Azospirillum* + 5kg FYM) (18.20 t ha^{-1}) followed by T_8 (Recommended dose) (16.69 t ha^{-1}).

4.5.1.5 Raigarh

The trial was conducted with 13 treatments in RBD during 2002-2003 at Raigarh. Non-significant differences were observed for yield per plot (Table 123). None of the treatments gave yield more than the check. The experiment is closed as per the decision taken at XVI I workshop of the AICRP on Spices held at Calicut.

Table 123. Effect of *Azospirillum* and graded levels of nitrogen on yield of turmeric (2002-2003) – Raigarh

Treatment	Yield $plot^{-1}$ (kg)	Projected yield (t ha^{-1})
T1	4.80	9.65
T2	4.83	9.71
T3	4.87	9.79
T4	4.27	8.56
T5	4.57	9.24
T6	4.60	9.24
T7	4.40	8.84
T8	4.43	8.70
T9	4.27	8.58
T10	4.03	8.10
T11	4.27	8.58
T12	4.40	8.84
T13	5.07	10.25
SE±	0.60	
CD 5%	NS	

4.5.1.6Ambalavayal

Not reported.

4.5.1.7 Pundibari

The trial was started during 2002-2003. The experiment was conducted with eight treatments and three replications in RBD to find out the effect of *Azospirillum* on yield of turmeric. The results presented in table 124 revealed that application of 75% recommended in organic nitrogen with *Azospirillum* @ 5 kg ha^{-1} and FYM @ 15 t ha^{-1} T_2 gave the highest yield of 26.1 t ha^{-1} as against 23.7 t ha^{-1} in the control of recommended dose of fertilizers at the rate of 80:80:120 kg N, P_2O_5 and K_2O per hectare. This was closely followed by the combined application of 50% recommended inorganic nitrogen with *Azospirillum* @ 5 kg ha^{-1} and FYM @ 15 t ha^{-1} (T_3) with on yield of 25.3 t ha^{-1}. The lowest yield of 17.1 t ha^{-1} was recorded in the treatment of sole application of FYM @ 15 t ha^{-1}. Drying percentage and curcumin content were also maximum in the treatment T_2.

Table 124. Effect of biofertilizer using *Azospirillum* on turmeric – Pundibari

Treatment	Fresh rhizome yield (g plant^{-1})	Fresh rhizome yield (kg/3 sq. m. plot)	Projected fresh rhizome yield (t ha^{-1})	Drying percentage	Curcumin (%)
T_1: 100% N+B.F.+M	159.2	9.2	24.5	26.1	4.98
T_2: 75% N+B.F.+M	174.3	9.8	26.1	26.5	5.05
T_3: 50% N+B.F.+M	153.7	9.5	25.3	25.6	5.04
T_4: B.F.+M	129.8	7.0	18.7	26.2	5.01
T_5: B.F. + 2M	138.6	7.8	20.8	25.5	5.03
T_6: M	115.4	6.4	17.1	25.9	4.85
T_7: 2M	130.1	7.6	20.3	26.2	5.00
T_8: Recommended Fertilizer Dose	160.3	8.9	23.7	25.8	4.82
CD (5%)	24.4	1.26	2.64	-	-

4.5.1.8 Coimbatore

The experiment was started during 2000 with the aim of studying the effect of graded levels of *azospirillum* on yield and quality of turmeric and was continued during the fourth year at Coimbatore. During the period under report also (2003 – 04) the experiment was repeated with the same set of treatment for the confirmation of the results. The observations were recorded on morphological and yield attributes and presented in Table 125. The results exhibited the similar trend as that of previous year. The results showed that the treatment (T_3) i.e. the plant that received inorganic N (50%) + *azospirillum* (5 kg ha^{-1}) soil application + FYM (5 t ha^{-1}) registered the highest weight of mother rhizome (129.8 g plant^{-1}), primary rhizome (119.7 g plant^{-1}) and secondary rhizome (85.5 g plant^{-1}). This treatment also gave the highest fresh rhizome yield of 35.5 t ha^{-1} against 28.20 t ha^{-1} in the control (recommended dose of fertilizer). This worked out to an yield increase of 25.88 per cent. The treatment (T_7) i.e. application of azospirillum (5 kg ha^{-1} soil application) alone recorded the lowest yield of only 12.7 t ha^{-1}.

Table 125. Effect of *Azospirillum* and graded levels of nitrogen on yield of turmeric (2003–2004) - Coimbatore

Treatment	Weight of primary rhizome (g plant^{-1})	Weight of mother rhizome (g plant^{-1})	Weight of secondary rhizome (g plant^{-1})	Yield (t ha^{-1})
T1- Inorganic N (100%) + Azospirillum (5 kg ha^{-1}) Soil application + 5 t FYM	104.50	109.50	82.6	29.30
T2- Inorganic N (75%) + Azospirillum (5 kg ha^{-1}) Soil application + 5 t FYM	125.70	118.40	83.4	34.70

T3- Inorganic N (50%) + Azospirillum (5 kg ha^{-1}) Soil application + 5 t FYM	129.80	119.70	85.5	35.50
T4- FYM (5 t ha^{-1}) + Azospirillum (5 kg ha^{-1}) Soil application	90.10	100.70	64.2	19.65
T5- FYM (5 t ha^{-1}) alone	77.80	90.50	57.1	15.50
T6- FYM (10 t ha) + Azospirillum (5 kg ha) Soil Application	85.40	96.40	62.5	23.40
T7- FYM (10 t ha^{-1}) alone	78.50	93.20	60.4	19.20
T8- Azospirillum (5 kg ha) Soil Application alone	69.40	77.50	54.1	12.70
T9- Urea (100%) alone	70.50	80.10	55.7	14.50
T10- Control	93.80	106.20	73.3	28.20
SEd	3.70	3.50	2.4	3.00
CD at 5%	9.25	8.65	5.8	7.30

4.5.2 Organic farming in turmeric (TUR / CM / 1.2)

(Raigarh, Pottangi, Pundibari and *Bhavanisagar)*

4.5.2.1Raigarh

The experiment was conducted during three years (2001–02 to 2003 - 04) in RBD consisting of eight treatments replicated thrice. The treatment consisted of four organic sources involving FYM, Wood ash, Neem cake Azospirillum with Rock Phosphate. A basal dose of above organic manure was applied as per treatment as basal dressing. In recommended dose of fertilizer, entire dose of phosphorus and half dose of potassium were applied at the time of sowing and half dose of potassium was applied 90 days after planting. The Inorganic nitrogen were applied in three splits at 30, 55 and 90 days after planting.

Table 126. Effect of organic inputs on the yield of turmeric (2000-2001 to 2003-2004) – Raigarh

Treatments	Plot yield (kg)	Projected yield (t ha^{-1})			Mean yield (t ha^{-1})	Cost (Rs.Lac)	Projected yield (t ha^{-1})
		2001-02	2002-03	2003-04			
T_1- FYM + Rock Phosphate + Wood Ash	8.50	24.99	20.90	17.09	20.99	0.89	1.36
T_2- Rock Phosphate Alone 500 g Plot^{-1}	4.00	12.46	10.91	8.04	10.47	0.85	0.68
T_3- Wood Ash Alone 2 kg Plot^{-1}	3.80	11.39	10.45	7.64	9.83	0.86	0.64

T_4	Azospirillum 50 g Plot^{-1}	4.50	14.67	11.85	9.05	11.85	0.85	0.77
T_5	Neem cake + Rock Phosphate + Wood Ash	7.00	21.64	17.88	14.07	17.86	0.88	1.16
T_6	Neem cake alone 250 g Plot^{-1}	4.20	15.61	11.17	8.44	11.74	0.86	0.76
T_7	FYM alone 5 kg Plot^{-1}	6.80	19.55	17.68	13.67	16.96	0.88	1.10
T_8	Recommended dose (150+100+120 kg NPK ha^{-1})	11.60	31.15	26.93	23.32	27.25	0.91	1.77
	(CD at 5%)		01.41	2.07	2.39			

Maximum yield of 27.25t ha^{-1} was recorded with application of recommended dose of fertilizer (T8), which was significantly superior over remaining treatments (Table 26). Among organic inputs, maximum yield of 20.99 t ha^{-1} was recorded with application of FYM + Rock phosphate + Wood ash (T1) followed by T_5 which produced the yield of 17.86t which were significantly superior over remaining treatments.

4.5.2.2Pottangi

The trial was initiated during 2000-2001 in RBD with 4 replications. The data presented in Table 127 gives no significant difference among the treatments. Highest fresh rhizomes yield was recorded in T8 (17.85 t ha^{-1}) followed by T6 (15.44 t ha^{-1}).

Table 127. Effect of organic inputs on the yield of turmeric (2000 - 01 to 2003 - 04) - Pottangi

Treatments*	Fresh rhizome yield (kg/3 m^2)					Projected yield (t ha^{-1})
	2000-01	2001-02	2002-03	2003-04	Mean	
T_1 a+b+c+d+e+f	8.00	7.56	4.18	6.41	6.54	15.04
T_2 b+c+d+e+f	6.32	6.04	3.19	4.54	5.02	11.55
T_3 a+c+d+e+f	6.54	6.36	3.07	4.84	5.20	11.97
T_4 a+b+d+e+f	8.56	5.67	3.05	4.80	5.52	12.70
T_5 a+b+c+e+f	8.47	5.28	2.77	5.75	5.57	12.80
T_6 a+b+c+d+f	9.75	6.20	3.04	4.86	6.71	15.44
T_7 a +b+c+d+e	9.71	5.27	2.70	4.75	5.61	12.90
T_8 Inorganics	8.54	8.90	6.09	7.51	7.76	17.85
CD at 5%	NS	1.65	0.62	N.S	1.14	2.61

*a = Pongamia cake (250gm / 3 m^2)d = Sterameal (250 gm / 3 m^2)
b = FYM (10 kg / 3 m^2)e = Rock phosphate (500 gm /3 m^2)
c = Neem oil cake(250gm / 3 m^2)f = Wood ash (250gm / plot)

4.5.2.3Bhavanisagar

Not reported.

4.5.2.4Pundibari

The trial was started at Pundibari during 2002-2003 with 8 treatments replicated thrice in RBD. Significant differences were observed for plant height, number of leaves per plant, clump weight and weight and volume of mother and finger rhizomes and non-significant differences for other characters including fresh rhizome yield. Application of all the organic inputs except rock phosphate (T_5) resulted maximum clump weight (98.0 gm) that was statistically similar with the treatments of application of recommended dose of fertilizer (T_8) and application of all organic inputs (T_1) Table 128.

Table 128. Effect of different organic matters on yield and quality parameters of turmeric (2002-2003) – Pundibari

Treatments	Fresh rhizome yield (g plant^{-1})	Fresh rhizome yield kg / 3 sq. m. plot	Projected fresh rhizome yield (t ha^{-1})	Drying percentage	Curcumin content (%)
T_1 = A+B+C+D+E+F	120.8	9.6	25.9	28.3	5.3
T_2 = B+C+D+E+F	69.5	5.6	14.9	29.1	4.9
T_3 = A+C+D+E+F	88.4	7.4	19.7	29.3	4.8
T_4 = A+B+D+E+F	92.8	8.1	21.6	30.1	4.9
T_5 = A+B+C+E+F	87.0	7.7	20.5	29.4	4.6
T_6 = A+B+C+D+F	84.6	7.5	20.0	28.5	4.5
T_7 = A+B+C+D+E	80.3	6.5	17.3	27.7	5.0
T_8 = Recommended dose of fertilizer	131.4	10.8		28.8	
CD (5%)	12.8	1.1			

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

4.6 Disease Management trial (TUR / CP / 1)

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

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

4.6.1.1Jagtial

The project was started at Jagtial in the year 1997 with an object to identify source of resistance against *Colletotrichum* leaf spot disease in turmeric.

Among 15 cultures tested TCP-1, TCP-2 NDH-18 recorded less percent of rhizome rot and all the cultures showed resistant to *Colletotrichum* leaf spot (table 129). The long duration cultures showed nil incidence of *Taphrina* leaf blotch short and medium duration varieties showed moderately susceptible reactions.

Table 129. Incidence of leaf blotch, leaf spot and rhizome rot of turmeric – Jagtial

Entry	Rhizome rot index (%)	Leaf spot incidence (0-9 scale)	Leaf blotch (0-6) Scale
TCP 1	25.00	2.0	4.0
TCP 2	10.00	1.0	4.0
ACC 584	70.00	3.0	4.0
PTS 59	25.00	4.0	0
PTS 11	50.00	2.0	0
PTS 55	40.00	2.0	0
PTS 52	30.00	1.0	0
ACC 593	25.00	4.0	0
ACC 585	30.00	3.3	0
ACC 657	40.00	2.3	0
RH 5	18.10	0.0	2.0
NDH 14	24.00	0.0	0
PTS 15	50.50	0.0	3.5
NDH 18	10.10	0.0	4.0
TCP 11	50.20	0.0	0.0
Duggirala Red (check)	0.00	1.0	0.0

Among seven long duration cultures tested JTS-12 and JTS-15 showed less incidence of rhizome rot. All the cultures showed moderately resistant to resistant reaction to *Colletotrichum* leaf spot and complete resistant to leaf blotch. (Table 130).

Table 130. Incidence of leaf blotch, leaf spot and rhizome rot in turmeric - Jagtial

Entry (Lond Duration)	Rhizome rot index (%)	Leaf spot incidence (0-9 scale)	Leaf blotch (0-6) Scale
JTS 10	34.2	3.1	0.0
JTS 11	32.1	2.2	0.0
JTS 12	10.3	3.2	0.0
JTS 13	48.1	3.5	0.0
JTS 14	39.1	4.0	0.0
JTS 15	10.2	3.5	0.0
Duggirala Red (check)	30.0	1.0	0.0

Out of fourteen medium duration cultures JTS-319, JTS-325 have recorded less percent of rhizome rot incidence and all cultures showed nil incidence of leaf spot and moderately susceptible reactions to leaf blotch (Table 131).

Table 131. Incidence of leaf blotch, leaf spot and rhizome rot in turmeric CVT- Jagtial

Name of the variety (Medium duration)	Rhizome rot index (%)	Leaf spot incidence (0-9 scale)	Leaf blotch (0-6 scale)
JTS 314	15.6	0.0	3.5
JTS 315	43.2	0.0	4.0
JTS 316	49.0	0.0	5.0
JTS 317	52.1	0.0	3.5
JTS 318	35.3	0.0	5.0
JTS 319	10.4	0.0	4.0
JTS 320	15.2	0.0	3.0
JTS 321	18.4	0.0	4.2
JTS 322	36.7	0.0	3.5
JTS 323	40.2	0.0	4.2
JTS 324	32.3	0.0	5.0
JTS 325	14.2	0.0	3.5
JTS 326	37.8	0.0	4.2
CLI 317 (check)	55.0	0.0	1.8

Out of seven short duration cultures JTS-607 has recorded less percent of rhizome rot, nil incidence of leaf spot and moderately susceptible reaction to leaf blotch (Table 132).

Table 132. Incidence of leaf blotch, leaf spot and rhizome rot in turmeric CVT - Jagtial

Name of the variety (Short duration)	Rhizome rot index (%)	Leaf spot incidence (0-9 scale	Leaf blotch (0-6 scale)
JTS 607	12.1	0.0	4.0
JTS 608	29.2	0.0	5.2
JTS 609	27.2	0.0	6.1
JTS 610	35.4	0.0	4.4
JTS 611	50.6	0.0	4.3
JTS 612	15.4	0.0	4.8
PCT 13 (check)	10.2	0.0	1.0

4.6.1.2Coimbatore

This trial was started during 1999 and is in 5th year of progress. During 2003 – 2004 the survey was conducted in turmeric growing areas of Coimbatore, Erode and Salem district to determine the extent of incidence of blotch, leaf spot and rhizome rot. The results are presented in Table 133. High incidence of leaf blotch (33.3%) was observed at Venkiapuram of Erode district while it was low (15.4%) in Aasarikadu of Salem district. With regard to the leaf spot, the incidence was found to be high in Uonjalur

of Erode district (37.5%) and it was noticed to be low in Tuiruvalluvar Nagar (20.5%) of the same district. The rhizome rot incidence was more (40.75%) in Kodumudi and it was less in (18.5%). Thiruvalluvar nagar of the same district. The plant pathogens causing rhizome rot was found to be *Pythium aphanidermatum.*

Table 133. Assessment of incidence of leaf blotch, leaf spot and rhizome rot in turmeric in three location (2003 – 2004) - Coimbatore

Places	Leaf blotch (% disease index)	Leaf spot (% disease index)	Rhizome rot incidence (%)
	COIMBATORE		
Thondamuthur	17.50	21.75	27.20
Kaliyananpudur	23.20	21.40	25.70
Devarayapuram	21.70	26.50	26.10
Mathampatti	26.50	31.30	36.50
	ERODE		
Uonjalur	30.00	37.50	33.45
Thanaraipalayam	24.30	23.30	30.40
Kuzhathupalayam	28.10	27.50	32.90
Kodumudi	24.50	24.10	40.75
Kalvettypalayam	21.00	26.30	32.30
Bhavani	30.40	33.50	29.50
Bangalapudur	27.10	26.40	25.50
Bhavanisagar	20.50	21.70	28.70
Kondayampalayam	23.40	26.50	19.50
Kallipatti	28.90	24.30	20.70
Thiruvalluvarnagar	22.10	20.50	18.50
Athani	27.50	24.20	22.50
Kasipalayam	25.40	21.70	20.40
Venkiapuram	33.30	35.70	27.50
	SALEM		
Aasarikottam	15.40	35.50	20.70
Mylampalayam	17.5	21.30	25.30

All the 255 germplasm accessions were screened for their resistance against both leaf spot and leaf blotch diseases at Coimbatore. Similar to that of previous year, the four accessions CL 32, CL 34, CL 54 and CL 55 showed resistance to both leaf blotch and leaf spot diseases. Among the others 50% accessions showed moderate resistance reaction, 112 were susceptible and 32 were highly susceptible to leaf blotch disease. Further 110 accessions were found to be moderately resistant - 123 accessions were susceptible and 20 accessions were highly susceptible to the leaf spot disease (Table 134).

Table 134. Screening of turmeric accessions against leaf blotch and leaf spot diseases (2003 – 2004) – Coimbatore

Turmeric Accessions	Leaf blotch			Leaf spot		
	Disease grade	Disease Index (%)	Disease reaction	Disease grade	Disease Index (%)	Disease reaction
CL 32	1.5	30	R	1.6	32	R
CL 34	1.9	38	R	1.5	30	R
CL 54	1.4	28	R	1.7	34	R
CL 55	1.5	30	R	2.0	40	MR
CL 58	1.4	28	R	2.7	54	MR

R: Resistant, MR: Moderately resistant

4.6.1.3Raigarh

Not reported.

4.6.1.4 *Dholi*

This experiment was not conducted at Dholi centre since the Pathologist post is vacant.

4.6.1.5 Pundibari

The trial started during 2002-2003 at Pundibari centre. A survey was conducted within the district of Cooch behar to identify the diseases occurring in turmeric. Three major diseases were found to be prevalent in this area, namely, leaf blotch (*Taphrina spp.*), leaf spot (*Colletotrichum spp.*) and rhizome rot. Another type of leaf spot was also noticed and found that the causal organism of this disease is *Helminthosporium* sp. Most of the area is covered with local varieties which are highly susceptible to leaf blotch disease and some of the area is highly susceptible to leaf spot disease too (Table 135). In the survey it was found that when no fertilizer is given to the field the disease incidence becomes higher.

Table 135. Severity of turmeric diseases in West Bengal - Pundibari

Name of village	No. of places	Leaf blotch	Leaf spot	Rhizome rot
Bararangras	1st location	66.67%	60%	
	2nd location	34.44%	51.11%	
	3rd location	51.11%	5%	
	4th location	25.93%	24.48%	
	5th location	14.81%	33.33%	
	6th location	0%	3.70%	
	Average	32.16%	29.60%	
Patlakhawa	1st location	70%	15%	5%
	2nd location	70%	5%	5%
	3rd location	80%	10%	-
	4th location	5%	5%	-
	5th location	75%	15%	-

Name of village	No. of places	Leaf blotch	Leaf spot	Rhizome rot
	6th location	5%	30%	-
	7th location	75%	10%	-
	8th location	65%	15%	-
	9th location	30%	40%	-
	10th location	5%	35%	-
	Average	48%	18%	1%
Madhupur	1st location	23.33%	15.56%	
	2nd location	25.22%	50%	
	3rd location	15%	25%	
	4th location	5%	60%	
	5th location	10%	25%	
	6th location	28.89%	5%	
	Average	17.91%	30.09%	
Pundibari	1st location	15%	40%	
	2nd location	10%	55%	
	3rd location	25%	45%	
	4th location	10%	20%	
	5th location	40%	5%	
	6th location	15%	20%	
	Average	19.17%	30.83%	

Screening of the germplasms were also done at Pundibari for their response against diseases and a few germplasms were found to be tolerant to leaf blotch disease such as TCP 1, 5, 11, 22, 28, 48, 52, 56, 81, 118, 120, etc.

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

4.6.2.1Pundibari

Not reported.

4.6.3 Effect of seed treatment on leaf blotch and leaf spot diseases of turmeric (TUR/CP/1.3)
(*Dholi, Pundibari, Raigarh* and *Kumarganj*)

4.6.3.1Pundibari

Not reported.

4.6.3.2Raigarh

The trial was initiated with 7 treatments during 2001-2002 and continued for three years. The pooled data revealed that the treatments tested in the present experiment were statistically superior than the untreated control with the maximum reduction of disease severity of *Taphrina* leaf blotch and production of higher yield in the treatment T3 followed by T2 (Table 136).

Table 136. Effect of bioagents and fungicides on the *Taphrina* leaf blotch and yield of turmeric (Kharif 2001-2002 to 2003-2004) - Raigarh

Treatments	Disease severity of leaf blotch				Yield per plot (3 m^2) (kg)			
	2001	2002	2003	Pooled	2001	2002	2003	Pooled
T_1 - Mancozeb (0.3%)-spray	42.7	14.0	41.6	35.6	4.90	3.70	1.71	3.40
T_2 - Carbendazim (0.2%)-spray	33.0	12.8	39.9	30.4	5.70	5.13	2.47	3.90
T_3 - Mancozeb (0.3%) and Carbendazim (0.3%) - alternative spray	28.7	09.3	38.3	27.7	6.40	5.63	2.63	4.50
T_4 - Seed + Soil treatment with *Trichoderma* (100 g) + Neem cake (1.0 kg $plot^{-1}$)	67.5	23.1	53.6	49.9	6.00	3.70	1.57	3.60
T_5 - Mancozeb (0.3%) as seed treatment + *Trichoderma* as soil application	65.3	26.7	58.4	52.7	4.10	3.67	1.43	2.90
T_6 - Carbendazim (0.2%) as seed treatment + *Trichoderma* as soil application	62.5	24.4	60.2	51.7	2.30	3.47	1.27	2.90
T_7 - Un treated control	66.8	43.2	71.0	61.6	2.60	2.67	0.77	1.60
CD at 5%	17.5	03.2	04.3	9.96	2.07	1.15	0.33	1.14

4.6.3.3Dholi

This experiment was not conducted due to vacant post of pathologist.

4.6.3.4Kumarganj

Minimum incidence of leaf blotch and leaf spot disease was observed in seed treatment of rhizome with carbendazim and foliar spray (0.2%) with maximum disease control showing 32.64 and 29.48% increase in yield over controls in R. sonia & RH-5 respectively (Table 137) in 2003-04. Similar trend was observed in four years pooled data for leaf spot & leaf blotch disease in the same treatment with 38% increase in yield over controls (Table 138).

Table 137. Effect of fungicides and bioagent on germination of turmeric during 2003-2004 – Kumarganj

Treatment	Germination (%)		Incidence of leaf spot (%)		Incidence of leaf blotch (%)		Yield (t ha^{-1})		% Increase over control	
	R. Sonia	RH-5	R. Sonia	RH-5	R. Sonia	RH-5	R. Sonia	RH-5	R. Sonia	RH-5
T1= Manco.S.T. + spray (0.2%)	98.00	92.66	49.37	45.42	58.44	44.87	35.42	35.55	21.20	14.30
T2= Carben S.T.+ spray (0.2%)	96.00	94.00	48.14	46.59	63.94	46.21	37.77	35.55	28.41	14.30
T3= Manco + carben S.T.+ spray (0.2%)	94.00	92.00	38.88	35.50	41.09	34.55	38.60	40.27	32.64	29.48
T4= S.T. of T. harzianum + soil appl. + neem cake	93.33	96.66	45.30	40.25	60.77	54.17	34.88	35.25	19.84	13.34
T5= Manco S.T.+ T. harzianum soil appl.	96.66	98.66	50.75	53.61	59.82	49.11	33.48	33.69	16.42	8.32
T6= Carben S.T.+ T. harzianum soil appl.	95.53	94.00	49.37	47.88	55.23	53.30	33.88	33.61	16.42	8.09
T7= Control (no treatment)	91.33	94.66	71.00	64.81	65.56	66.48	29.10	31.10	-	-
CD at 5%	5.40	7.46	6.32	6.99	4.63	6.07	5.78	5.29		
CV (%)	3.20	4.43	7.05	8.22	4.50	6.87	9.34	8.50		

Manco = Mancozeb: carben = carbendazim; S.T. = Seed treatment

Table 138. Effect of fungicides and bioagent on incidence of leaf blotch and leaf spot diseases of turmeric (2002 to 2004) (Pooled data)-Kumarganj

Treatment	Incidence of leaf spot (%)		Incidence of leaf blotch (%)		R. Sonia		RH–5	
	R. Sonia	RH-5	R. Sonia	RH-5	Yield (t ha^{-1})	% Increase over control	Yield (t ha^{-1})	% Increase over control
T1= Manco. S.T. + spray (0.2%)	47.76	50.67	50.22	48.01	34.21	30.22	32.95	26.24
T2 = Carben. S.T.+ spray (0.2%)	45.63	47.75	51.21	44.28	35.79	36.23	33.47	28.23
T3 = Manco + carben S.T. + spray (0.2%)	40.50	40.91	42.30	38.86	36.35	38.37	36.31	38.86
T4 = S.T. of T. *harzianum* + soil appli. + neem cake	52.00	51.40	52.96	52.16	3372	28.35	30.29	39.11
T5 = Manco S.T. + T. *harzianum* soil appli.	45.905167		48.48	44.70	3446	31.17	3154	2084
T6 = Carben S.T. + T. *harzianum* soil appli.	45.69	48.69	44.88	44.09	36.03	37.15	34.92	3379
T7 = Control (no Treatment)	64.74	63.63	61.40	63.10	26.27	-	26.10	-

Carben. = Carbendazim, S.T. = Seed treatment, Manco. = Mancozeb

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

(*Jagtial, Coimbatore* and *Pundibari*)

4.6.4.1 Jagtial

The project was started in the year 1997 with an objective to identify suitable bio-control agents for the management of turmeric rhizome rot. The causal agent of turmeric rhizome rot was tentatively identified as *Pytnium* fungs. The pathogen *Pythium* sp. was isolated from the rhizome rot turmeric and on inoculation it was found causing rhizome rot disease. *Fusarium* spp. was also isolated from roots and rhizome of diseased plants of Duggirala turmeric in farmers' fields. *Rhizoctonia* spp. was isolated from diseased rhizomes. *Fusarium* spp. was isolated from diseased rhizome and roots of diseased plants of rhizome rot on Armoor,

Duggirala red and Duggirala white, JTS 1, JTS 2 turmeric varieties and cultivated grains of maize, wheat, jowar, potato tubers and on inoculation it was found causing rhizome rot in turmeric, pure culture of Fusarium spp. was identified as *Fusarium solani.*

Table 139. Effect of biocontrol agents for the management of rhizome rot disease of turmeric - Jagtial

Treatment	Rhizome rot incidence (%)	Disease reduction (%)	Yield (kg plot^{-1})	Yield (t ha^{-1})
T1- Recommended NPK (Control)	37.00 (37.45)		5.17	10.33
T2- Recommended NPK+FYM	37.04 (35.69)	8.0	6.23	12.45
T3- Recommended NPK + *T.viridae* + *Pseudomonas flourescens* @ 4 g kg^{-1} seed as seed treatment	25.16 (30.03)	32.00	8.82	17.63
T4- Recommended NPK + *T. viridae* + *Pseudomonas fluorescens* to be applied to soil @ 12.5 kg ha^{-1} and 25.0 kg ha-1 as basal and top dressing respectively	24.26 (29.43)	34.43	12.38	24.75
T5- Recommended NPK+FYM+ *T.viridae* + *Pseudomonas flourescens* @ 4g kg^{-1} seed as seed treatment.	23.40 (28.87)	36.75	7.57	15.13
T6- Recommended NPK + FYM + *T.viridae* + *Pseudomonas fluorescens* to be applied to soil @ 12.5 kg ha^{-1} and 25.0 kg ha-1 as basal and top dressing respectively	22.57 (28.35)	39.00.	9.62	19.24
T7- Recommended NPK+FYM+*T.viridae* + *Pseudomonas flourescens* @ 4 g kg^{-1} seed as seed treatment + *T.viridae* + *Pseudomonas fluorescens* to be applied to soil @12.5 kg ha^{-1} and 25.0 kg ha^{-1} as basal and top dressing respectively	11.70 (19.99)	68.38	14.30	28.60
T8- *Bacillus subtilis* (Bio-stat) @ 1ml l^{-1} of water	27.50 (31.43)	25.67	6.60	13.20
CD at 5%	2.00			1.77

* Figures in parenthesis are transformed values

During 2003-04, the treatment T7 (application of NPK 125:60:90 kg ha^{-1} + FYM 10 t ha^{-1} + *Trichoderma viridae* + *Pseudomonas flourescens* @ 4 g kg ha^{-1} seed treatment + *Trichoderma viridae* + *Pseudomonas flourescens* applied to soil (12.5 kg and 25.0 kg ha^{-1} as basal and top dressing respectively) recorded the lowest rhizome rot incidence of 11.70 per cent (68.38% disease reduction) with higher yield of 28.60 t ha^{-1}. Application of NPK 125:60:90 kg ha^{-1} + FYM 10 t ha^{-1} + *Bacillus sublitis* (Biostat) @ 1 ml l^{-1} (T8) reduced the disease incidence to the extent of 25.67 per cent. The control treatment (T1) recorded 37 per cent rhizome rot incidence with an yield of 10.30 t ha^{-1} (Table 139).

4.6.4.2Pundibari

The trial was started during 2001-2002 with 7 treatments replicated thrice in RBD. The data on disease incidence, percent disease reduction over control, yield (kg/3 m^2 plot) and projected yield (kg ha^{-1}) is presented in Table 140. The disease incidence was low in general. However, the best treatment was T_7 i.e. seed treatment as well as soil application of *Trichoderma viride* and *Pseudomonas flourescens* with application of recommended NPK and FYM. T_7 is closely followed by T_5 and T_4. The percent disease reduction over control was 64.59, 57.97 and 54.73 in T_7, T_5 and T_4 respectively. T_7 produced highest yield (9.78 kg $plot^{-1}$) followed by T_5 (8.82 kg $plot^{-1}$) and T_6 (8.73 kg ha^{-1}). The trial initiated at Pundibari during 2001-2002 in RBD and continued during 2002-2003 & 2003-2004.

Table 140. Effect of biocontrol and bioagents for the management of rhizome rot disease of turmeric (2003-2004) – Pundibari

Treatments	PDI at 90 days	PDI at 150 days	Percent reduction over control	Yield (kg $plot^{-1}$)	Projected yield (t ha^{-1})
T_1= Recommended NPK (control)	9.55 (18.00)	12.14 (20.39)	-	7.00	14.11
T_2= Recommended NPK + Farm yard Manure	7.98 (16.41)	8.63 (17.08)	16.23	7.87	15.87
T_3= Recommended NPK + *Trichoderma viride* + *Pseudomonas fluorescens* as seed treatment	1.74 (7.58)	4.30 (11.97)	41.29	8.47	17.08
T_4= Recommended NPK + *Trichoderma viride* + *Pseudomonas fluorescens* to be applied to soil @ 12.5kg ha^{-1} and 25.0 kg ha^{-1} as basal and top dressing respectively.	2.22 (8.57)	2.57 (9.23)	54.73	8.23	16.59
T_5= T_2 + T_3	1.77 (7.65)	2.22 (8.57)	57.97	8.82	17.78

$T_6 = T_2 + T_4$	2.48 (9.06)	2.87 (9.75)	52.18	8.73	17.60
$T_7 = T_2 + T_3 + T_4$	0.50 (4.05)	1.58 (7.22)	64.59	9.78	19.72
SEm ±	1.073	1.570		0.212	
CD at 5%	3.305	4.839		0.653	

(Figures in parenthesis are angular transformed value)

5. TREE SPICES

In tree spices 7 projects are in progress at fivecentres of the AICRPS.

5.1 Genetic Resources (TSP / CI / 1)

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

(*Dapoli, Ambalavayal* and *Yercaud/ Pechiparai*)

5.1.1.1Dapoli

Five different local types have been collected from Konkan region of Maharashtra State and their multiplication is being done by soft wood grafting for maintaining in the germplasm block and further evaluation.

Nutmeg

The trial was started during 1996-1997. It was noticed that in general the morphological characters of nutmeg genotypes in year 2003-2004 showed non significant variation. The height ranged from 2.68m to 3.43m. Maximum height was recorded in genotype 'Bulk' (3.43m), while minimum height was recorded in A-9/12 (2.68m). The average girth ranged from 14.19cm (A-9/12) to 19.26cm (A-11/70). The average spread ranged from 2.06 m (A – 9/12) to 2.59m A–9/4. The no. of branches produced per plant ranged from 28.55 (A-9/12) to 34.89 (A-11/70). In general the genotype 'A-9/12' showed dwarfing symptoms among the genotypes under study. In all genotypes fruiting was observed. The characters of fruits will be recorded during harvesting season i.e. July-August 2004.

Cinnamon

The trial was laid out during 1996-1997 with 9 treatments. The morphological and yield characters of cinnamon types are observed. The morphological characters like average height (m.) and average spread (m) did not differed significantly among different genotypes. The height ranged from 4.04 to 5.59. The maximum height was recorded in accession 'A-65' (5.59m). Among all accessions maximum spread was recorded in Accession 'A-5' (3.40m). During the year under report (i.e. 2003-2004) few branches were harvestable (easy for peeling) and harvestable branches very from accession to accession. The fresh wt and dry wt of harvested bark recorded in different genotypes are also recorded. There were no significant differences among fresh wt and dry wt yield of bark among different accessions.

The bark and leaf samples have been sent for analysis at NRC for mushroom (ICAR) Solan H.P. and IISR Calicut during last year. The results are awaited from both the places.

Clove

The morphological characters of clove types planted in 1997 at Dapoli are presented in Table 141, IISR Calicut seedling types of clove recorded vigorous growth, recording maximum height (3.79m), maximum girth (16.26cm) highest number of branches (37.83) and highest spread (2.85m). Eleven plants of IISR Calicut type recorded flowering and average yield of dry berries were as 67.22 g/plant. Yield record of these accessions is being maintained.

Table 141. Performance of clove accessions (2003-2004) – Dapoli

Accession number	Average height (m)	Average girth (cm)	No. of branches	Average spread (m)	Dry bud yield (g plant^{-1})
IISR Calicut	3.79	16.26	37.83	2.85	67.22 of 11 plants
Kallar types	1.60	6.00	7.00	1.72	—
Yercaud	—	—	—	—	Died in field
Mean	2.70	11.13	22.41	2.28	
S.D	1.09	5.13	15.41	0.56	
CV	40.63	46.09	68.77	24.72	

5.1.1.2Ambalavayal

Not reported.

5.1.1.3Yercaud / Pechiparai

Clove :

This trial was initiated with 22 genotypes during 1992 with an objective to collect, maintain, characterize and catalogue the germplasm of clove. Morphological characteristics, yield and yield attributing traits are being evaluated to identify promising accessions. In clove 22 accessions are being maintained and among which sel.7

performed well both in growth and yield parameters.

Table 142. Performance of clove accessions (2003-2004) – Yercaud/Pechiparai

Accessions	Plant height (m)	Stem girth (cm)	Brano.)	Mean dry bud yield / tree (g)
Sel.6	6.06	23.66	34.33	692
Sel.7	7.00	27.03	31.33	274

Among the 22 accessions, Sel.7 registered the highest plant height of 7.0 m., stem girth of 27.03 cm. and number of branches (31.33 nos.) with a dry flower yield of 274 g/tree, whereas Sel.6 has recorded the maximum dry flower yield of 692g / tree.

Nutmeg

This trial was initiated with 20 genotypes during 1992 with an objective to collect, maintain, characterize and catalogue the germplasm of nutmeg. Morphological characteristics like yield attributing traits and yield are being evaluated to identify promising accessions. In nutmeg 20 accessions are being maintained, among which Sel.2 performed well both in growth parameters. (Table 143)

Table 143. Performance of nutmeg accessions (2003-2004) – Yercaud/Pechiparai

Accessions	Plant height (m)	Stem girth (cm)	Branches (no.)	Mean dry nut yield / tree (g)
Sel.2	5.30	27.23	28.66	56
Sel.5	4.05	18.75	41.00	-

Twenty accessions are maintained and being evaluated. Among the accessions, Sel.2 has recorded the highest plant height of 5.3 m., stem girth of 27.23 cm number of branches (28.66) with 56 numbers of fruit/tree.

Cinnamon

This trial was initiated with 12 genotypes during 1992. Morphological characteristics, yield and yield attributing traits are being evaluated to identify promising accessions. In cinnamon, 12 accessions are being maintained, among which Sel. 5 performed well both in growth and yield parameters (Table 144).

Table 144. Performance of cinnamon accessions (2003 - 2004) – Yercaud / Pechiparai

Accessions	Tree height (m)	Stem girth (cm)	No. of branches
Sel.5	2.93	7.43	18.00
Sel.44	2.50	6.20	23.00
Sel.53	2.60	12.00	20.00
Sel.63	1.96	4.80	16.00
Sel.65	5.36	17.80	17.00
Sel.139	1.86	4.70	30.60
Sel.203	2.30	7.90	14.33
Sel.310	2.50	6.33	17.66
Sel.312	2.60	6.30	28.00
Konka	3.03	7.00	19.33
Bhavani	3.30	12.25	9.00
Pechiparai local	3.40	11.46	13.60
SED	0.29	1.08	0.98
CD (p=0.05)	0.62	2.42	1.96

Twelve elite accessions are being maintained and evaluated. Among the accessions, Sel.5 has recorded the highest plant height (5.36 m), stem girth (17.80 cm.) and number of branches whereas Sel.6 has recorded the maximum number of branches (30.60 nos.).

5.2 Coordinated Varietal Trial (CVT) (TSP / CI / 2)

5.2.1 CVT 1992 in clove (TSP/CI/2.1)

(*Yercaud / Pechiparai* and *Dapoli*)

5.2.1.1 Yercaud/Pechiparai

The programme was started with 9 genotypes and replicated thrice in RBD. Nine genotypes collected from IISR, Calicut is being maintained at this station and growth parameters are studied. The suitability of elite lines of CVT is being evaluated under this climatic zone for its yield and yield attributes. Among the types Sel.7 was found to be promising in terms of growth and yield characters.

Table 145. Performance of clove accessions Yercaud / Pechiparai

Accessions	Plant height (m)	Stem girth (cm)	Branches (No.)	Dry bud yield / tree (g)
Sel.3	5.23	31.68	37.60	88.00
Sel.4	6.33	23.53	31.33	68.00
Sel.5	6.16	19.83	33.00	64.00
Sel.6	5.75	19.50	24.00	-
Sel.8	5.53	19.26	29.60	40.00
Sel.9	6.06	23.66	34.33	692.00
Sel.10	7.00	27.03	31.33	274.00
Sel.11	5.80	23.53	28.66	318.00
Sel.12	4.80	18.00	19.66	-
Sel.10 (local check)	3.80	14.26	21.00	-
SEd	0.22	1.36	1.79	10.63
CD (p=0.05)	0.46	2.72	3.28	22.26

Among the ten selections, Sel.7 was found to be promising with highest plant height (7.00 m.) stem girth (27.03 cm.) number of branches (31.33) with the dry flower yield of 274 g/tree whereas the local check registered a plant height of 3.80 m., stem girth of 14.26 cm. and the number of branches being 21.00 (Table 145). The selection has not flowered yet.

5.2.1.2Dapoli

Not reported.

5.2.2 CVT 1992 in cinnamon (TSP/CI/2.2)

(*Yercaud/Pechiparai* and *Ambalavayal*)

5.2.2.1 Yercaud/Pechiparai

The programme was started with 6 genotypes in RBD with 6 Nos. of replication. The present investigation was carried out at HRS, Pechiparai during the year 1991-2001. The material comprised of ten elite cinnamon accessions and among which 9 accessions collected from Indian Institute of Spices Research, Calicut and one from local Pechiparai region of Kanyakumari district. These cinnamon types were grown in a RBD with three replications. In each replications ten plants were maintained. The plants were coppiced four years after planting *i.e.* during 1995 and thereafter once in two years. Observations on sprouting/ regeneration capacity, bark yield, leaf yield, bark recovery, bark oil recovery, leaf oil recovery and bark oleoresin were recorded for four coppiced years (1995, 1997, 1999 and 2001) and statistically analysed. The mean values of yield and quality parameters for 4 coppiced years were presented in tables 146 and 147. The traits exhibited significant differences among them and out of the ten accessions cv.7 recorded maximum bark recovery percentage of 34.67 and bark yield of 980 kg ha^{-1}. The accession cv.2 recorded the lowest yield of 587.33 kg ha^{-1}. The leaf yield was also maximum (8665.8 kg ha^{-1}) in cv.7. Studies on the quality parameters showed that cv.7 recorded maximum bark oil (recovery 2.90 %, cinnamaldehyde 72 % and eugenol 6.6 %), leaf oil (recovery 3.3 %, cinnamaldehyde 78 % and eugenol 15 %) and bark oleoresin 10 %. From this study it was concluded that the cinnamon accession cv. 7 was found to be best for lower elevations ranging from 100 - 500m with high rainfall.

Table 146. Yield performance of cinnamon accessions under CVT (pooled data 1995 - 2001) - Yercaud / Pechiparai

Acc. No.	Bark Recovery (%)	Bark yield (kg ha^{-1})			
		Chips +dust (kg ha^{-1})	Quills (kg ha^{-1})	Total yield (kg ha^{-1})	Leaf yield (kg ha^{-1})
cv.1	28.35	417.23	198.12	615.35	4399.97
cv.2	28.02	377.58	209.75	587.33	3999.60
cv3	26.66	453.28	217.23	670.51	5266.14
cv.4	30.87	562.50	232.13	794.03	5677.21
cv.5	30.81	563.81	242.12	805.93	6099.39
cv.6	28.83	397.68	208.12	605.80	4066.26
cv.7	34.65	731.58	248.42	980.00	8665.80
cv.8	30.75	694.20	227.16	921.36	6810.43
cv.9	28.76	605.13	219.20	824.33	6532.68
Local	29.87	565.12	235.15	800.27	5654.99
CD at 5%	0.79	35.85	6.59	41.28	328.47

Table 147. Quality parameters of cinnamon accessions under CVT - (pooled data 1995 - 2001) - Yercaud / Pechiparai

Acc. No.	Bark oil			Leaf oil		
	% recovery	CA %	EG %	% recovery	CA %	EG %
cv. 1	2.60 (9.28)	57 (49.02)	5.5 (13.56)	2.80 (9.63)	66 (54.53)	13 (21.10)
cv. 2	2.30 (8.72)	65 (53.73)	6.0 (14.18)	2.20 (8.53)	68 (55.55)	14 (21.90)
cv.3	2.50 (9.10)	68 (55.55)	6.5 (14.77)	2.80 (9.63)	75 ((60.0)	15 (22.79)
cv. 4	2.50 (9.10)	73 (58.69)	6.0 (!4.18)	2.80 (9.63)	62 (51.94)	15 (22.79)
cv.5	2.50 (9.10)	52 (46.15)	5.0 (12.92)	2.50 (9.10)	60 (50.77)	12 (20.27)
cv. 6	2.20 (8.53)	58 (49.60)	5.0 (12.92)	2.30 (8.72)	78 (62.03)	14 (21.97)
cv.7	2.90 (9.81)	72 (58.05)	6.6 (14.89)	3.30 (10.47)	78 (62.03)	15 (22.79)
cv.8	2.80 (9.63)	53 (46.72)	5.5 (13.56)	3.00 (9.98)	68 (54.55)	14 (21.97)
cv.9	2.80 (9.63)	58 (49.60)	5.8 (13.94)	3.00 (9.98)	63 (52.53)	14 (21.97)
Cv.10 PPI Local	2.20 (8.53)	54 (47.29)	5.0 (12.92)	2.60 (9.28)	67 (54.94)	13 (21.13)
CD at 5%	0.10 (1.83)	2. 0(10.5)	1.2 (2.8)	0.10 (1.9)	1.4 (11.39)	2.7 (4.3)

*CA - Cinnamaldehyde, EG - Eugenol

5.2.2.2 Ambalavayal

The trial initiated during 1992 with 7 entries. Pooled analysis of wet and dry weight of quills/plant was done and the data are given in Table 148.

Table 148. Yield data of cinnamon under CVT- pooled data - Ambalavayal

Entries	Wet weight (kg plant^{-1})	Dry weight (kg plant^{-1})
SL-44	0.362	0.147
SL-203	0.617	0.258
SL-63	0.531	0.246
SL-189	0.541	0.249
SL-53	0.564	0.251
Acc. No.1	0.321	0.130
Acc. No.2	0.172	0.076

SL-203 recorded the highest wet (0.617Kg) and dry (0.258 Kg) weight of quills/plant.

Table 149. Quality parameters of cinnamon under CVT (pooled data) – Ambalavayal

Entries	Leaf oil %	Bark oil %
SL-44	4.0	0.5
SL-203	3.2	0.5
SL-63	2.0	1.1
SL-189	2.0	0.7
SL-53	3.0	2.0
Acc. No.1	2.0	1.5
Acc.No.2	3.0	1.5

SL-44 recorded maximum leaf oil percentage (4.0) followed by SL-203 (3.2). SL-53 recorded maximum bark oil percentage (2.0) followed by Acc. No.1 and 2 (1.5%).

5.2.3 CVT 2001 in nutmeg (TSP/CI/2.3)

(*Dapoli, Sirsi, Yercaud/Pechiparai* and *Ambalavayal*)

5.2.3.1Dapoli

The trial was started in 2003 with 8 treatments replicated thrice in RBD. The morphological characters CVT on nutmeg during 2003-2004 are presented in Table 150. The height recorded by different genotypes ranged from 0.32-0.49m. The genotypes 'A-9/71' and 'Male' recorded significantly highest height over all the genotypes except Shrivardhan bold and "A-9/150'. The genotype Konkan Sugandha recorded lowest height (0.32m) among all genotypes. There were no significant differences for girth (cm), branches (no) and spread (m) among the genotypes under study. The girth ranged form 2.83-4.66m. The average no. of branches observed per plant ranged from 1.83-4.17. The maximum branches were produced by 'A-9/150' (4.17). The average spread recorded by different genotypes ranged from 0.08-0.38m. The maximum spread was recorded in 'Shriwardhan bold' (0.38m) and it was closely followed by A-9/150 (0.34m).

Table 150. Morphological characters of nutmeg of CVT - Dapoli

Accession number	Average height (m)	Average girth (cm)	Average branches	Spread (m)
A – 9/4	0.34	4.08	3.67	0.24
A – 9/20	0.45	4.58	2.50	0.27
A – 9/25	0.39	4.33	3.00	0.26
A – 9/71	0.49	4.33	3.67	0.27
A – 9/150	0.46	4.58	4.17	0.34
Male	0.49	4.33	2.83	0.28
Konkan Sugandha	0.32	2.83	1.83	0.08
Shrivardhan Bold	0.46	4.66	3.17	0.38
Range	0.32-0.49	2.83-4.66	1.83-4.17	0.08-0.38
Mean	0.43	4.22	3.10	0.26
SE ±	0.03	0.44	0.61	0.06
CD @ 5%	0.09	N.S.	N.S.	N.S.

5.2.3.2Sirsi

The experiment was initiated during September 2003 with nine entries. The established plants are provided with drip irrigation system. The initial growth of graft is slow.

5.2.3.3 Yercaud/Pechiparai

Six nutmeg genotypes collected from IISR, Calicut along with a local check is being maintained at this station and growth parameters are studied. The suitability of elite lines of CVT is being evaluated under this climatic zone for its yield and yield attributes. Among the types A9/20 was found to be promising in terms of growth and yield characters. (Table 151)

Table 151. Growth performance of nutmeg – Yercaud / Pechiparai

Accessions	Plant height	Stem girth	No. of branches
A9/4	55.50	5.60	3.00
A9/20	56.14	7.50	7.00
A9/25	48.24	4.50	5.00
A9/71	46.14	4.20	3.00
A9/150	60.24	3.80	3.30
M.L.	54.14	4.20	4.30
Local check	48.12	3.72	4.60
SED	2.35	0.61	0.66
CD (p=0.05)	5.60	1.22	2.12

Six accessions were collected from IISR, Calicut and are being maintained and evaluated. Among the accessions, A9/20 has recorded the highest plant height (56,14 cm.), stem girth (7.50 cm.) and number of branches (7 nos.).

5.2.3.4Ambalavayal

The experiment was started during June 2003. The stand of the crop is satisfactory.

5.2.4 CVT 2001 Series in Cassia (TSP / CI / 2.4)

(*Yercaud/Pechiparai*, *Ambalavayal*, *Dapoli* and *Sirsi*)

5.2.4.1Yercaud/Pechiparai

Four genotypes collected from IISR, Calicut is being maintained at this station and growth parameters are studied. The suitability of elite lines of CVT is being evaluated under this climatic zone for its yield and yield attributes. Among the types C1 was found to be promising in terms of growth and yield characters (Table 152).

Table 152. Growth performance of cassia – Yercaud / Pechiparai

Accessions	Plant height (cm)	Stem girth (cm)	No. of branches
C1	72.30	6.20	4.30
D1	68.50	5.20	3.20
D3	48.50	4.21	4.10
D5	39.60	6.16	3.40

Among the four selections, C1 was found to be promising with highest plant height (72.30 cm), stem girth (6.20 cm) and number of branches (4.3).

5.2.4.2Ambalavayal

The experiment was started in June 2003. The stand of the crop is satisfactory.

5.2.4.3Dapoli

The trial was laid out in RBD with 6 treatments and 4 replications during 2003. The morphological characters of cassia genotypes recorded during 2003-04 are presented in Table 153. The height recorded by different genotypes ranged from 1.75 to 4.44 m. The genotypes D3 recorded significantly highest height (4.44m) over all other genotypes. The minimum height was recorded in KVCTSH2 (1.75m). The genotype D3 observed to be fast growing among all genotypes. It also recorded significantly more girth (17.85cm) over all the genotypes under study. The spread (m) and branches (no.) recorded by different genotypes did not differed significantly during first year of growth. The spread ranged from 0.86-1.68m and branches ranged from 9.00 to 19.25 among the genotypes under study (Table 153).

Table 153. Morphological characters of cassia under CVT (2003 – 2004) - Dapoli

Genotypes number	Average height (m)	Average girth (cm)	Average branches	Spread (m)
C_1	2.69	14.60	17.00	1.62
D_1	2.11	16.05	19.25	1.68
D_3	4.44	17.85	11.00	1.21
D_5	1.92	11.70	9.00	0.86
$KKVCTSH_1$	2.14	15.00	13.00	1.27
$KKVCTSH_2$	1.75	14.92	19.00	1.61
Range	1.75-4.44	11.70-17.85	9.00-19.25	0.86-1.68
Mean	2.51	15.02	14.71	1.38
SEm ±	0.03	0.23	0.67	0.07
CD @ 5%	0.09	0.72	N.S.	N.S.

5.2.4.4Sirsi

The experiment was initiated during September 2003 with four entries. The established plants are provided with drip irrigation system.

5.3 Propagation/Multiplication Trial (TSP/ CM /1)

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

(*Yercaud/Pechiparai* and *Dapoli*)

5.3.1.1Dapoli

Not reported.

5.3.1.2Yercaud/Pechipara

This experiment was conducted at the experimental farm of Horticultural Research Station, Pechiparai, Kanyakumari. Twenty cuttings were planted in each treatment in poly bags. The observations on percentage of rooting, percentage of sprouts, number of roots, length of longest root, length of shoot were recorded after 60 days of planting the cuttings. The results of the experiment (Table 154) showed significant difference among the treatments in respect of both rooting and sprouting characters in cinnamon. Among the treatments, the treatment T_2 i.e. semi hard wood cuttings planted in coir pith medium was found to be the best with the highest mean values in respect of percentage of rooting (92.34), percentage of sprouting (75.69), length of longest root (10.5 cm.), length of shoot (4.33 cm.) and number of roots (6.2). The coir pith medium was found to be the most suitable medium as it facilitates aeration and drainage. The lowest percentage of rooting (32.76) and sprouting (36.68) was observed in T6-Soft wood cuttings planted in sand medium.

Table 154. Effect of different rooting media and type of cutting on rooting of cinnamon

(60 days after planting)

Treatment	Percentage of rooting	No. of roots	Percentage of sprouting	Length of longest root (cm)	Length of shoot (cm)
T1- Coir pith + hard wood	77.89	5.5	57.84	9.33	3.39
T2- Coir pith + semi hard wood cuttings	92.34	6.2	75.69	10.5	4.33
T3- Coir pith + soft wood cuttings	39.48	3.5	46.78	6.34	3.64
T4- Sand + hard wood cuttings	56.37	4.6	50.17	6.92	4.05
T5- Sand + Semi hard wood cuttings	82.06	5.6	70.33	6.33	3.69
T6- Sand + soft wood cuttings	32.67	2.67	36.68	5.54	3.34
T7- Pot mixture + hard wood cuttings	50.14	3.05	57.78	4.49	4.02
T8- Pot mixture + semi hard wood cuttings	73.88	5.47	71.33	6.39	4.12
T9- Pot mixture + soft wood cuttings	32.69	2.85	46.77	7.00	3.39
CD at 5%	6.78*	0.458*	4.33*	0.669*	0.121*
SEd	14.05	0.837	8.63	1.486	0.296

* Significant at 1%

5.4 Irrigation Trial (TSP/CM/2)

5.4.1 Drip irrigation in clove and nutmeg (TSP/CM/2.1)
(*Yercaud/Pechiparai*)

5.4.1.1 Yercaud/Pechiparai
Not reported.

5.5 Disease Management Trial (TSP / CP / 1)

5.5.1 Survey for disease incidence in tree spices (TSP/CP/1.1)
(*Dapoli, Yercaud/Pechiparai* and *Ambalavayal*)

5.5.1.1Dapoli

***Cinnamon*:** In all 7 cinnamon orchards were visited low incidence of leaf blight and leaf spot was observed. The leaf blight incidence ranged from 0.34 to 2.06%. The incidence of leaf spot ranged from 0.34 to 1.03 per cent (Table 155).

Table 155. Survey of cinnamon crop for the incidence of different diseases – Dapoli

Name of the Farmer/Location	Percent disease index	
	Leaf blight	Leaf spot
Nursery, Dept. of Hort. College of Agriculture, Dapoli 0.68	0.68	
Spices Block, Asond, Central Farm, Wakawali	0.68	0.68
R.C.R.S. Bhatye, Ratnagiri	0.68	0.34
Agril. School, Lanja, Ratnagiri	2.06	0.34
R.F.R.S., Vengurla, Sindhudurg	0.34	0.00
Shripansure, Alibaug, Raigad	0.68	0.34
Shri. Deshmukh, Shenale, Mangangad, Ratnagiri	2.06	1.03

Clove: In all five clove orchards were visited during the survey, leaf rot, leaf spot and die back of branches were the most common and serious diseases observed throughout the region. In future, die back branch drying disease (maximum disease incidence 2.73%) may cause severe losses in the region in future. Maximum incidence of leaf rot was recorded 8.95 per cent at Dapoli. The disease intensity ranged from 4.04 to 18.95 per cent. The leaf spot disease intensity ranged from 1.04 to 3.65 per cent (Table 156).

Table 156. Survey of clove crop for the incidence of different diseases - Dapoli

Name of the Farmer / Location	Percent disease index		Percent disease incidence
	Leaf rot	Leaf spot	Die back
Nursery, Dept. of Hort. College of Agri., Dapoli	18.95	3.13	1.17
R.C.R.S. Bhatye, Ratnagiri	16.00	1.60	2.73
R.F.R.S., Vengurla, Sindhudurg	9.11	1.04	1.50
Shri. Desai, Dodamarg, Sindhudurg	12.69	1.50	1.81
Shri. Nagvekar, Bhoighar Borli, Raigad	4.04	3.65	1.03

Nutmeg: Shot hole disease (*Colletotrichum gloeosporioides*) was prevalent in all orchard, visited where in low disease incidence ranged from 0.26 to 1.53 per cent. Sudden death of branch/twig/wither tip disease. (*Fusarium solani* + *Rhizoctonia bataticola*) was observed in each orchard visited. The intensity of disease ranged from 0.13 to 9.27 percent. Maximum incidence 9.27 per cent of disease observed at Bhatye.

Table 157. Survey for major diseases of nutmeg in Konkan - Dapoli

Name of the Farmer/Location	Percent disease incidence	Percent disease index
	Die back / Sudden wilt	Shot hole
Nursery, Dept. of Hort., A.C. Dapoli	5.14	0.76
Spice block, Asond, C.E.S. Wakawali	0.00	0.76
A.R.S. Awashi, Ratnagiri	0.00	0.00
R.C.R.S. Bhatye, Ratnagiri	9.27	1.53
Agril. School, Lanja	0.00	0.00
R.F.R.S. Vengurla, Sindhudurg	2.14	0.51
Mr. Barve-Talkat, Dodamarg, Sindhudurg	0.24	0.51
Mr. Manerikar, Zolambe, Dodamard, Sindhudurg	0.13	0.26
Mr. Marathe, Talkat, Dodamarg, Sindhudurg	0.14	0.26
Mr. Gadgil, Zolambe, Dodamarg, Sindhudurg	0.30	0.26
Mr. Desai, Kudase, Dodamarg, Sindhudurg	0.40	0.51
Mr. Desai, Walwal, Kudal	0.00	0.51
A.R.S. Shriwardhan, Raigad	0.66	1.53
Mr. Bapat, Diveagar, Raigad	0.30	1.20
Mr. Mahadik, Bhoigher, Muurud-Janjira, Raigad	4.36	1.50
Mr. Nagvekar, Bhoigher, Muurud- Janjira, Raigad	0.31	0.51
Mr. Mukadam, Revdanda, Alibaug, Raigad	0.31	0.70
Mr. Patil, Revdanda, Alibaug, Raigad	1.04	1.02
Mr. Railkar, Chaul, Revdanda, Alibaug, Raigad	0.26	0.77
Mr. Joshi, Murdi, Dapoli, Ratnagiri	0.22	0.51
Mr. Bapat, Murdi, Dapoli, Ratnagiri	1.45	0.00
Mr. Paramjpe, Kelshi, Dapoli, Ratnagiri	0.29	0.26
Mr. Joshi, Kelshi, Dapoli, Ratnagiri	0.15	0.26
Mr. Gadgil, Guhaghar, Chiplun, Ratnagiri	0.42	0.26
Mr. Agarkar, Kolthare, Dapoli, Ratnagiri	0.42	0.70
Mr. Godbole, Kolthare, Dapoli, Ratnagiri	0.44	0.26
Mr. Joshi, Murud, Dapoli, Ratnagiri	0.28	0.51
Mr. Bal, Murud, Dapoli, Ratnagiri	0.78	0.77
Mr. Ketkar, Murud, Dapoli, Ratnagiri	6.78	0.77

5.5.1.2Ambalavayal

The experiment will be started in 2004.

5.5.1.3Yercaud/Pechiparai

Clove: Surveillance of sudden death disease of clove caused by *Valsa eugeniae* was carried out in five major clove growing areas of Kanyakumari District during 2003-04 by the Pechiparai centre. It was observed that maximum incidence of 4.9 per cent was recorded at Keeriparai village. Minimum mean incidence was recorded at Pechiparai village. Leaf spot of clove was also high in Keeriparai area (12.8 per cent) when compared to Pechiparai area (1.4 per cent). Seedling wilt caused by *Rhizoctonia* sp. was maximum at Thadikarankonam (11.0 per cent) followed by Keeriparai (9.0 per cent). Among the 7 clove types collected from different estates of Kanyakumari District, type 5 and type 6 have recorded less incidence of 4.9 per cent and 5.0 per cent respectively whereas 7.3 per cent was recorded in type 3.

Nutmeg: Fruit rot incidence of nutmeg was noticed during 2003 at Balamore estate (2.4 per cent).

Cinnamon: Survey was conducted in the Cinnamon gardens at Bethany estate by Pechiparai centre. Stripe canker caused by *Phytophthora cinnamomii* recorded only 0.2 per cent in 11/2 year old seedling.

6. CORIANDER

In coriander 11 projects are in progress at 36 centres of the AICRPS

6.1 Genetic Resources (COR/CI/1)

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

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

6.1.1.1 Coimbatore

This project is started as early as 1975 during 2003–2004, rabi season all 224 germplasm accessions were evaluated for their morphological and yield parameters. The results of the promising accessions presented in Table 158 showed that the highest yield of 870 kg ha^{-1} was registered in the germplasm accessions 103 followed by CS 76 (865 kg ha^{-1}) and CS 131 (860 kg ha^{-1}).

These promising accessions were screened for their resistance against powdery mildew. Eleven accessions were moderately resistance 34 were moderately susceptible, 133 were susceptible and 46 were highly susceptible to the disease (Table 159).

Table 158. Performance of promising germplasm accessions of coriander (2003 – 2004) - Coimbatore

Acc. No.	Yield (g $plot^{-1}$)	Yield (kg ha^{-1})	Acc. no.	Yield (g $plot^{-1}$)	Yield (kg ha^{-1})	Acc. no.	Yield (g $plot^{-1}$)	Yield (kg ha^{-1})
CS. 4	332.5	665	CS.44	250.0	500	CS.84	262.5	735
CS. 6	310.5	621	CS.46	285.0	570	CS.86	310.0	731
CS. 7	278.5	557	CS.47	299.0	598	CS.87	365.5	720
CS. 18	426.5	853	CS.58	272.5	545	CS.98	232.0	540
CS. 23	243.5	487	CS.63	260.0	520	CS.103	325.0	870
CS. 30	303.5	607	CS.70	270.0	540	CS.110	294.5	710
CS. 34	335.0	670	CS.74	280.0	560	CS.114	317.5	780
CS. 35	315.0	630	CS.75	255.0	510	CS.115	390.0	857
CS. 36	325.0	650	CS.76	432.5	865	CS.116	428.5	651
CS. 38	275.0	550	CS.78	295.0	590	CS.118	297.5	850
CS. 39	325.0	650	CS.79	325.0	650	CS.119	425.0	820
CS. 131	430.0	860	CS.171	327.5	655	CS.211	277.0	554
CS. 141	348.5	697	CS.181	402.5	805	CS.221	265.0	530
CS. 152	247.5	495	CS.192	407.5	815			

Table 159. Screening of coriander accessions against powdery mildew disease (2003 – 2004) – Coimbatore

Acc. No.	Disease grade	Percent Disease Index	Disease reaction*
CS.1	1.2	24	MR
CS.2	1.5	30	MR
CS.39	1.8	36	MR
CS.49	1.9	38	MR
CS.52	1.4	28	MR
CS.76	1.5	30	MR
CS.77	1.7	34	MR
CS.104	1.3	26	MR
CS.159	1.3	26	MR
CS.160	1.9	38	MR
CS.161	1.7	34	MR

6.1.1.2Jagudan

During the year 89 entries were raised and evaluated with G.cori-1 and G.cori-2 as a check. Promising entries among the whole germplasm are identified, classified, and found promising to different characters (Table 160). Two entries were dwarf type. The 26 entries have more branches per plant. The 15 entries have more umbels per plant than check G.cori-2. The 3 entries recorded more umbellate (≥ 7). The 11 entries were higher in number of seed per umbellate. Twelve entries were more or less early type of habit. The maximum grain yield was recorded by 10 entries.

Character	Range	G. Cori-2 (check)	Plant height (cm)	No. of Entries	Promising entries identified
Plant height (cm) (Dwarf)	47-113	87	< 60	2	Lam-69 and Iran
No. of Branches / Plant (More branches)	4-12	8	>10	26	Lam-5, 23, 73, 87, JCori-376, 377, 379, 380, 383, 387, 394, 396, 401, EC-243370, 709047, 350690, 350691, 357849, 363966, 363971, 363980, 363972, 343362, Egyptian, Bulgarian and Russian

Character	Range	G. Cono-2 (check)	Plant height	No. of Entries	Promising entries identified
No. of Umbels / Plant (More umbels)	8-60	33	≥ 40	15	Lam-4, 5, 57, 73, 87, JCori-375, 395, 396, 398, 400, 383, EC-350690, 350691, Egyptian and Bulgarian
No. of Umbellates / Umbel (More umbellates)	3-7	5	≥7	3	JCori-360, 379 and 396
No. of Seeds / Umbellate (More seeds)	4-17	6	≥10	11	UD-240, 90, 51, Lam-4, 73, JCori-375, 376, 384, 387 and EC-357849
Maturity days (Early)	100-139	108	≤105	12	UD-217, 184, 357, JCori-327, 330, 333, 342, 360, EC-363966, 363971, 363972 and 343365
Grain yield (kg ha^{-1})	278-2833	1500	>2200	10	UD-240, 309, 290, Dhana-89, JCori-340, 372, EC-350691, 357849, 363965 and 363974

A total of 33 new coriander accessions were collected from farmer's field of Saurashtra region of the state and market of the Dahod during the year for different characters viz. early type, bold seeded, compact seed in umbellate, none branches and umbels, umbellets and seeds. The six genotypes were selected from coriander field of this station for more seed per umbellate, earliness, bold seed, compact seed in umbel, small seed etc. Seeds of individual plant were harvested and individual plant progeny will raised in Rabi 2004-05 for further study.

6.1.1.3 Hisar

Ninety-three accessions of coriander were evaluated in two row plots of 2.5 meter length (2.5 sq. m.) each using Hisar Anand, Narnaul Selection and Pant Haritima as checks during 2002-2003. The mean seed yield of the germplasm material ranged from 200g (DH-249) to 520g (DH-236). Forty-one lines gave higher seed yield than Hisar Anand, 51 higher than Narnaul Selection and 72 out yielded Pant Haritima. The most promising lines for seed yield were given in Table 161.

Eighty five germplasms of coriander were tested for selecting promising line in respect of yield and quality. The seed yield of germplasm varied from 1.0 g per plant (UD-46) to 11.5 g per plant (UD-241).

Table 161. Performance of promising germplasm accessions of coriander – Hisar

Accession Number	Seed yield (g plot^{-1})			Mean
	2000 – 01	2001 - 02	2002 - 03	
DH-204	445	290	510	415
DH-209	485	350	460	432
DH-220	550	390	470	470
DH-228	450	420	460	443
DH-236	515	390	520	475
DH-242	570	390	530	497
DH-244	515	400	480	465
DH-254	540	380	510	477
DH-288	420	370	510	433
DH-290	325	290	500	372

6.1.1.4 Guntur

The centre has initiated the collection during 1975. Hundred and twenty coriander accessions were evaluated in augmented block design during 2003-2004, rabi season. The yield attributes and growth parameters of all accessions were recorded. Among the one hundred and twenty four accessions evaluated LCC-220 recorded highest yield (1152 kg ha^{-1}) followed by LCC-225 (1149 kg ha^{-1}), LCC-218 (1146 kg ha^{-1}), LCC-229 (1129 kg ha^{-1}) and LCC-181 (1109 kg ha^{-1}). The check Sadhana has recorded an yield of 825 kg ha^{-1}.

6.1.1.5 Jobner

Out of 23 entries of coriander screened against stem gall disease at farmers field (Danta), only variety UD-118, UD-480 and DH-234 were found Immune and rest others were found resistant to highly susceptible at Jobner (Table 162).

Table 162. Evaluation of coriander entries against stem gall disease (2002-2003) -Jobner

Categories	Nature of disease reaction	Entries
Immanue (I)	0	UD-118, UD-480 and DH-234
Resistant (R)	1	RCr-41, RCr-435, RCr-436, RCr-446, RCr-684, UD-685 and UD-686
Moderate resistant (MR)	2	K Sel, ND-2, J.Cori.-328 and J.Cori-360
Susceptible	3	UD-340, UD-742, UD-743, UD-476 and UD-749
Highly susceptible	4	LCC-128, LCC-174, LCC-225 and Local

6.1.1.6Kumarganj

The trial was started during 1997-1998. During the year 2003-04 coriander germplasm K. selection produced 2.0 t ha^{-1} of seed yield followed by NDCor-2 and Pant haritma producing 1.90 t ha^{-1} and 1.87 t ha^{-1} respectively (Table 163).

Table 163. Performance of promising germplasm accessions of coriander–Kumarganj

Germplasm accession	Yield (t ha^{-1})	Germplasm accession	Yield (t ha^{-1})
ND Cor - 1	1.81	ND Cor- 35	1.54
ND Cor - 2	1.90	ND Cor- 36	1.46
ND Cor - 3	1.23	ND Cor- 37	1.62
ND Cor - 4	1.23	ND Cor- 38	1.39
ND Cor - 5	1.15	ND Cor- 39	1.53
ND Cor - 6	1.25	ND Cor- 40	1.44
ND Cor - 7	1.56	ND Cor- 41	1.74
ND Cor - 8	1.37	ND Cor- 42	1.56
ND Cor - 9	1.29	ND Cor- 43	1.37
ND Cor - 10	1.44	ND Cor- 44	1.46
ND Cor - 11	1.44	ND Cor- 45	1.67
ND Cor - 12	1.52	ND Cor- 46	1.50
ND Cor - 13	1.37	ND Cor- 47	1.06
ND Cor - 14	1.81	ND Cor- 48	1.57
ND Cor - 15	1.44	ND Cor- 49	1.56
ND Cor - 16	1.59	ND Cor- 50	1.33
ND Cor - 17	1.62	ND Cor- 51	1.50
ND Cor - 18	1.44	ND Cor- 52	1.56
ND Cor - 19	1.64	ND Cor- 53	1.14
ND Cor - 20	1.65	ND Cor- 54	1.33
ND Cor - 21	1.59	ND Cor- 55	1.43
ND Cor - 22	1.48	ND Cor- 56	1.67
ND Cor - 23	1.79	ND Cor- 57	1.69
ND Cor - 24	1.21	ND Cor- 58	1.67
ND Cor - 25	1.36	ND Cor- 59	1.45
ND Cor - 26	1.74	ND Cor- 60	1.15
ND Cor - 27	1.31	ND Cor- 61	1.12
ND Cor - 28	1.34	ND Cor- 62	1.06
ND Cor - 29	1.72	ND Cor- 63	1.42
ND Cor - 30	1.74	K. Selection	2.00
ND Cor - 31	1.78	Pant haritma	1.87
ND Cor - 32	1.73	CD at 5%	0.15
ND Cor - 33	1.81	CV (%)	6.44
ND Cor - 34	1.71		

6.1.1.7 Dholi

The trial was started during 2002-03 in RBD. Out of eighty five genotypes evaluated, six accessions RD - 120, RD - 121, RD - 154, RD - 366, RD - 365 and RD - 373 were found to be promising for yield and hence were selected for IET.

The programme was started in 1992. The centre maintains 85 accessions in coriander. Eighty five germplasms of coriander were tested for selecting promising line in respect of yield and quality. The seed yield of germplasm varied from 1.0 g per plant (UD - 46) to 11.5 g per plant (UD - 241).

6.2 Coordinated Varietal Trial (CVT) (COR/CI/2)

6.2.1 CVT 1998 Series IV (COR/CI/2 .3)

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

6.2.1.1 Jagudan

Not reported.

6.2.1.2 Guntur

The trial was conducted for four years during, 2000-2001, 2001-2002, 2002-2003 and 2003-2004 in vertisols with nine promising Coriander genotypes in RBD with three replications. A perusal of the data in table given below revealed that genotypes varied significantly with respect to growth and grain yield. The pooled data over four years indicated that LCC-128 recorded significantly more plant yield followed by LCC-133 while lowest was in UD-744.

The pooled data over four years indicated that there are significant differences for all the characters studied. Maximum plant height was recorded in LCC-128 (60.0 cm) and JCO-283 (60.0 cm) which were significantly superior check Sadhana (53.0 cm). Number of primary branches was maximum in LCC-128 (6.9) followed by LCC-133 (6.6) which were on par with each other and significantly superior to all other entries including check Sadhana (5.8). Lowest number of primary branches was recorded in UD-743 (4.0). Number of secondary branches was maximum in LCC-128 (11.2) followed by LCC-133 (10.8) which were on par with each other and significantly superior to all other entries including check Sadhana (9.1). Lowest number of secondary branches was recorded in UD-744 (6.3). Number of umbels per plant was highest in LCC-128 (21.0) followed by LCC-133 (19.8) which were on par with each other and significantly superior to all other entries including check Sadhana (16.0).

LCC-128 recorded highest number of umbellets per umbel (8.0) and significantly superior to all other entries. This was followed by LCC-133 (7.1), which is superior to all other entries except LCC-128. Maximum number of mericarps per umbel was recorded in LCC-128 (36.2) which was superior to all other entries including check Sadhana (27.2). This was followed by LCC-133 (30.9) which was superior to all other entries except LCC-128.

Four years pooled data indicated that LCC-128 recorded significantly maximum yield (753 kg ha^{-1}) followed by LCC-133 (679 kg ha^{-1}) which were superior to all other entries. The check Sadhana recorded an yield of 524 kg ha^{-1}. Lowest yield was recorded in UD-744 (205 kg ha^{-1}). The tables regarding yield and yield attributes of pooled data are presented below.

Table 164. Performance of coriander accessions under CVT - Jagudan

Entry	Plant height	No. of primary branches	No. of secondary branches	No. of days to 50% flowering	No. of umbels per plant	No. of umbellets per umbel	No. of mericarps per umbel	Days to maturity	Yield per ha (kg ha^{-1})	% increase
LCC - 128	60.00	6.90	11.20	55.30	21.00	8.00	36.20	95.30	753.00	43.7
LCC - 133	57.30	6.60	10.80	55.70	19.80	7.10	30.90	92.70	679.00	29.6
DH - 208	52.10	4.90	8.20	71.30	12.50	5.90	24.30	102.70	297.00	-43.4
DH - 246	51.60	4.50	7.90	73.00	12.00	5.20	22.60	100.70	220.00	-58.0
JCO - 283	60.00	5.40	8.60	74.30	15.10	5.90	20.10	102.70	459.00	-12.3
JCO - 387	58.00	5.10	8.00	75.70	15.20	5.40	21.30	103.30	390.00	-25.6
UD - 743	43.50	4.00	6.70	79.70	10.60	4.70	20.70	101.30	216.00	-58.7
UD - 744	44.30	4.20	6.30	80.30	12.00	4.70	24.30	102.00	206.00	-60.8
Sadhana (C)	53.00	5.80	9.10	55.70	16.00	5.90	27.20	92.70	524.00	
CD at 5%	3.53	0.48	0.88	0.98	1.45	0.35	3.20	3.38	56.40	
CV%	3.83	5.22	5.94	0.82	5.61	3.43	7.31	1.96	7.83	

6.2.1.3 Hisar

Not reported.

6.2.1.4 Jobner

Not reported.

6.2.1.5 Dholi

Not reported.

6.2.2 CVT 2001 Series V (COR/CI/2.4)

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

6.2.2.1 Raigarh

Trial was considered to be failed due to severe infection of stem gall disease of coriander.

6.2.2.2 Dholi

Fourteen entries were tested at this centre and the genotype Kumarganj selection produced maximum grain yield per plot (1.31 kg) and per hectare (1.83 tonns) followed by RD-120 (1.22 kg per plot and 1.69 t ha^{-1}). However, grain yield of Kumarganj selection was 0.25 t ha^{-1} and 15.82 per cent higher over check (Pant Haritima) and remaining entries were observed as lower yielder.

The trial was initiated during 2002-2003 with 14 entries in RBD with 3 replications. Data presented in Table 165 revealed that all the genotypes had significant differences for all the characters under study. The maximum plant height was recorded (118.67 cm) with Pant Haritima (check) followed by (108.27 cm) with ND Cor-2 while maximum number of branches per plant (10.23) was recorded with Pant Haritima followed by Kumarganj Sel (9.13). However, genotype Kumarganj selection was found superior regarding number of umbels per plant (43.13), number of grains per umbel (45.33), grain yield (1.31 kg $plot^{-1}$ & 1.83 t ha^{-1}) though it was not significantly superior to RD-120 and check i.e. Pant Haritima. Moreover, genotype Kumarganj selection gave 15.82 percent more yield over check (Pant Haritima).

Table 165. Performance of coriander entries under CVT - Dholi

Characters / Genotypes	Height of the plant (cm)	No. of branches per plant	No. of umbels per plant	No. of grains per umbel	No. of days to maturity	Yield $plot^{-1}$ (kg)	Projected yield (t ha^{-1})	Increase in yield over check	
								(t ha^{-1})	(%)
LCC-128	82.67	8.27	36.73	29.00	124.00	0.76	1.06	-0.52	-32.91
LCC-133	81.73	7.53	31.33	18.93	128.00	0.79	1.10	-0.48	-30.38
LCC-174	79.07	7.93	34.20	14.07	124.00	0.76	1.06	-0.52	-32.91
LCC-225	81.87	7.67	33.33	20.40	124.00	0.77	1.06	-0.52	-32.91
JCO-328	97.40	7.87	33.47	33.47	138.00	0.91	1.27	-0.31	-19.62
JCO-360	88.07	8.53	36.07	33.13	135.00	0.74	1.03	-0.55	-34.81
DH-205	87.47	7.40	29.40	38.33	140.00	0.77	1.07	-0.51	-32.28
DH-234	92.40	8.67	36.00	24.80	140.00	1.02	1.42	-0.16	-10.13
RD-120	109.60	7.20	41.87	37.40	124.00	1.22	1.69	0.11	6.96
RD-121	105.07	8.93	41.53	33.40	128.00	1.01	1.40	-0.18	-11.39
RD-154	94.33	8.80	37.40	35.27	127.00	1.02	1.42	-0.16	-10.13

ND Cor.-2	108.27	8.20	45.20	32.87	136.00	1.09	1.51	-0.07	-4.43
Kumarganj Sel	104.73	9.13	46.13	45.33	136.00	1.31	1.83	0.25	15.82
Pant Hartima check	118.67	10.23	41.13	41.40	142.00	1.14	1.60	-	-
CD at 5%	15.79	1.05	5.90	4.65	3.11	0.18	0.23		
CV (%)	9.88	7.52	9.39	8.67	1.40	7.35	10.71		

6.2.2.3 Guntur

The trial was started with 11 entries including Sadhana as check during 2002-2003. The results of the eleven entries, evaluated during 2003-2004 rabi season are presented in Table 166, LCC-174 recorded significantly maximum plant height of 73.9 cm, compared to check Sadhana (63.1 cm). Number of primary branches were highest in LCC-174 (7.3) followed by LCC-225 (7.2), which were on par with each other and significantly superior to check Sadhana (5.63). Number of secondary branches were significantly higher in KS (21.0) followed by LCC-174 (18.0) which were on par with each other. The check Sadhana recorded 12.5 numbers of secondary branches only. Umbels per plant were highest in LCC-174 (30.7) followed by LCC-225 (28.9) which were on par with each other and significantly superior to all other entries including check Sadhana (20.8). Umbellets per umbel were significantly high in LCC-174 (8.56) followed by LCC-225 (8.10) which were on par with each other and significantly superior to all other entries including check Sadhana (6.10). Number of mericarps were highest in LCC-174 (24.6) followed by LCC-225 (21.5) which were on par with each other and significantly superior to all other entries including check Sadhana (16.2). Among the eleven genotypes evaluated LCC-174 recorded highest yield of 1081 kg ha^{-1} being on par with LCC-225 (1038 kg ha^{-1}) and significantly superior to the check variety Sadhana (799 kg ha^{-1}).

Table 166. Performance of coriander entries under CVT – Guntur

Name of the entry	Yield (kg ha^{-1})	% increase over check
LCC-174	1081.0	35.3
LCC-225	1038.0	29.9
JCO-360	479.0	-40.1
JCO-328	498.0	-37.7
DH-234	600.0	-24.9
DH-205	619.0	-22.5
NDC-2	121.0	-84.9
KS	350.0	-56.2
UD-480	65.0	-91.9
UD-118	645.0	-19.3
Sadhana (C)	799.0	
CD at 5%	122.7	
CV%	12.4	

6.2.2.4 Hisar

The trial was started during 2002-2003 with 12 entries, replicated thrice in RBD. The significant differences were obtained for all the parameters (Table 167). Plant height ranged from 78.2 to 108.2 cm; number of branches from 5.2 to 7.0; umbel per plant 38.4 to 71.6; umbellets per umbel 5.0 to 6.1 and seeds per umbel 25.7 to 37.6. Maximum seed yield (1710 kg ha^{-1}) was recorded in DH-205 which was statistically at par with DH-234, UD-480 and JCO -360.

Table 167. Performance of coriander entries under CVT – Hisar

Entries	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per Umbel	Seeds Per umbellet	Seed yield (kg ha^{-1})	Seeds Per umbel
LCC-174	78.2	5.2	38.7	5.4	6.1	30.3	1473
LCC-225	80.8	5.3	38.4	5.0	5.3	25.7	1057
DH-205	94.6	7.0	66.5	6.1	5.9	34.8	1710
DH-234	104.0	6.6	71.6	5.9	6.2	34.9	1680
JCO-328	85.3	6.3	41.6	5.7	5.5	32.1	1493
JCO-360	86.3	6.4	50.0	6.0	6.1	35.3	1647
UD-118	82.1	6.5	48.6	6.1	6.2	34.6	1292
UD-480	108.2	6.6	58.6	6.0	6.3	37.6	1663
K. Selection	102.5	6.5	45.4	5.8	5.9	35.8	1265
NDC-2	96.1	6.6	49.0	5.9	5.4	35.1	1548
Hisar Anand	89.0	6.6	55.2	5.4	5.6	30.2	1503
Narnaul Selection (C)	102.1	6.7	45.0	5.9	5.8	31.4	1390
CD at 5 %	6.5	0.5	5.7	0.4	0.3	3.7	158

6.2.2.5*Kumarganj*

The trial was started in 2001 with three replications in RBD. During the year 2003-04 out of 27 entries tested, NDCor-2 produced maximum seed yield of 2.17 t ha^{-1} showing 8.66% increase in yield over control (Pant haritma as check). This was followed by K. selection (2.08 t ha^{-1}) and DH-234, Rcr-41 (2.06 t ha^{-1}). In four year's pooled data study maximum yield was obtained in K. selection (2.10 t ha^{-1}) used as check. The yield lower to K. selection was obtained in Rcr-41 (2.05 t ha^{-1}) and in UD-743 (2.04 t ha^{-1}), which were at par (Table 168).

Table 168. Performance of coriander entries under CVT (Pooled data - 2000 - 01 to 2003 - 04) - Kumarganj

Entries	Yield (q ha $^{-1}$)					
	2000 - 01	2001 - 02	2002 - 03	2003 - 04	Total	Mean
Rcr-41	18.88	22.78	20. 13	20.60	82.39	20.59
UD-743	16.19	26.68	19.44	19.67	81.98	20.49
LCC-133	10.41	14.12	13.88	13.42	51.83	12.95
LCC-128	11.80	12.96	12.22	12.26	49.24	12.31
UD-744	18.79	20.16	18.79	18.98	76.72	19.18
JCO-387	15.92	22.45	17.36	17.58	73.31	18.32
JCO-283	15.73	22.45	14.58	14.34	67.10	16.77
DH-208	16.46	20.83	18.28	18.51	74.08	18.52
DH-246	16.94	15.24	16.66	16.89	65.73	16.43
K.Selection (ch.)	19.71	22.68	20. 87	20.83	84.09	21.02
CD at 5%	1.05	4.11	7.50	-	-	-
CV (%)	16.05	5.07	-	-	-	-

6.2.2.6 Jobner

The trial was initiated with 16 entries during Rabi 2002-2003 in RBD. The character wise mean indicated that entries different significantly for all the characters studied. The mean days to flowering ranged from 54 (LCC-133) to 78.33 days (UD-118), plant height from 49.33 (LCC-225) to 87.07 cm (UD-480), branches per plant from 4.47 (LCC-174) to 9.2 (ND-2), umbels per plant from 21.07 (LCC-128) to 37.13 (RCr-20 Check), umbellets per umbel from 3.53(J.Cori-328) to 4.73 (UD-480 & RCr-435 check), seeds per umbel from 17.6 (LCC-128) to 45.8 (K.Sel.), test weight from 8.79 (K. Sel.) to 18.16 gm (LCC-174). The entry UD-480 recorded the maximum seed yield of 1014.33 kg ha^{-1} followed by UD-118 (889 kg ha^{-1}), DH-234 (888.67 kg ha^{-1}), RCr-435 check (867.67 kg ha^{-1}) and RCr- 684 check (854.33 kg ha^{-1}), while lowest yield of 222.33 kg ha^{-1} was recorded in LCC-174. Out of the 16 entries evaluated under CVT minimum wilt percentage (3.0%) recorded in UD - 480 followed by UD - 118 (3.66%) with the seed yield of 1014.33 kg ha^{-1}, 889.0 kg ha^{-1} respectively, while maximum percentage of wilt was recorded in LCC - 174 (13.33%) with the minimum yield of 222.33 kg ha^{-1}.

Table 169. Performance of coriander entries under CVT – Jobner

Entry	Seed yield (kg ha^{-1})	Wilt (%)
UD - 118	889.00	3.660
UD - 480	1014.33	3.000
DH - 205	630.00	4.330
DH - 234	888.67	4.000
J.Cori - 328	743.33	5.000
J.Cori - 360	705.33	5.330
K.Sel.	801.67	4.660
ND - 2	847.00	5.330
LCC - 128	378.67	9.660
LCC - 133	455.00	8.000
LCC - 174	222.33	13.330
LCC -225	333.33	12.000
RCr - 20 check	453.33	10.366
RCr - 435 checl	867.67	3.660
RCr - 684 check	854.33	4.000
Local check	371.33	13.000
CV%	8.05	
CD at 5%	87.76	

6.2.2.7 Coimbatore

An experiment was conducted with 14 coriander entries including the check CO 3 in RBD design with three replications during rabi 2001 – 2002.

Twenty one accessions collected from various coordinating centers along with local check CO - 3 were evaluated for their growth and yield characters during 2003 - 2004 rabi season. These accessions were obtained from Dholi (RD - 120, RD - 121 and RD - 154) Hisar (DH - 205, DH - 234, DH - 208 and DH - 246) LAM Guntur (LCC - 133, LCC - 174, LCC - 225) Jobner (UD - 118, UD - 480, UD - 744 and UD - 743) Jagudan (J. Cor 328, J. Cor 283, J. Cor 228, J. Cor 360, J. Cor 387) and Kumarganj (K selection and ND coriander). The cultivar CO - 3 is used as the local check. The data recorded on yield revealed that the acc. UD 743 recorded the highest yield of 794.53 kg ha^{-1}. This was followed by J Cor 283 and DH 208, which recorded an yield of 789 and 766.67 kg ha^{-1} respectively. DH 205 recorded the lowest yield of 422 kg ha^{-1} (Table 170).

All the entries including local check cv. were screened for their resistance against powdery mildew disease incidence using 0 – 5 scale. The accessions UD 480 is completely free from powdery mildew disease. Three accessions viz., DH 246, RD 120 and J. cor 387 were found to be resistant to powdery mildew. Three accessions viz. DH 205, UD 118 and DH - 234 were showed moderate resistant reaction. Among the other, 13 accessions were moderately susceptible and two accessions were susceptible to the disease (Table 170).

Table 170 . Performance of coriander entries under CVT – Coimbatore

Acc. No.	Yield (kg ha^{-1})	Yield increase (% over local check)	Percent disease index	Disease reaction
J Cor. 328	566.77	14.00	50	MS
DH 205	422.00	-	28	MR
LCC 133	439.00	-	46	MS
UD 480	385.67	-	0.0	HR
J Cor. 128	485.67	-	74	S
UD 743	794.53	59.76	42	MS
LCC 225	455.67	-	68	S
UD 118	450.00	-	24	MR
J Cor 360	616.67	24.08	34	MS
LCC 174	322.33	-	28	MS
UD 744	747.00	50.30	30	MS
J Cor 283	789.00	58.75	46	MS
K selection	766.00	54.26	44	MS
DH 208	766.67	54.25	56	MS
DH 246	722.33	45.34	14	R
RD 120	388.87	-	10	R
J cor 387	727.77	46.43	8	R
ND coriander	633.33	27.43	50	MS
DH 234	494.43	-	22	MR
RD 121	483.33	-	46	MS
RD 154	433.33	-	54	MS
CO 3 local check	497.00	-	50	MS
SEd	12.10			
CD	30.25			

6.2.2.8 Jagudan

The trial was started during 2002-03 with 12 entries and 4 replications in RBD. This is the second year of the experiment. During previous year none of the entry found significantly superior over check. However an entry J.Cori-360 give 1591 kgha^{-1} yield. The significant differences among entries were observed for yield. But none of the entry gave significant superior yield over check. However an entry J.Cori-328 gave higher yield (1939 kgha^{-1}) than check. Which was 5.67 per cent higher than check.

The pooled over two years data presented in Table 171 showed significant yield differences due to treatments. But none of the entry gave significant superior yield over check. However, an entry JCori-328 gave higher yield (1756 kgha^{-1}) than check and it was 3.54 per cent higher above check.

Table 171 . Performance of coriander entries under CVT – Jagudan

Treatment	Yield (kg ha^{-1})		
	2002-03	2003-04	Mean
J.Cori-328	1573	1939	1756
J.Cori-360	1591	1835	1713
LCC-174	950	1250	1100
LCC-225	1005	1090	1048
UD-118	1223	1545	1384
UD-480	982	1337	1160
NDCo-2	1127	1219	1173
K. Selection	1181	1403	1292
DH-205	1256	1542	1399
DH-234	1401	1550	1475
GCo-2 check	1558	1835	1696
GCo-1 check	1442	1748	1595
S.Em. ±	87	103	65
CD at 5%	251	298	184
CV %	13.68	13.58	13.67

6.2.3 Initial evaluation trial (COR/CI/3.2)

(Dholi, Jobner, Guntur, Hisar and Jagudan)

6.2.3.1Dholi

The trial was started in RBD with 7 entries in RBD during 2002-2003. All the genotypes had significant differences among themselves for plant height, number of branches per plant, number of umbels per plant and yield. The highest plant height (117.07 cm) were recorded with genotype RD-365 followed by RD-366 (109.47 cm). However, genotype RD-366 proved it superiority to all the genotypes for all the characters except plant height. So far increase in yield is concerned it was higher with RD 366 (171%) followed by RD 154 (153.73%) over check (Rajendra Swati). Out of seven genotypes, RD-366 proved its superiority to all the genotypes for all the characters studied except plant height and the percent yield increased over check (Rajendra swati) was 171.64 per cent followed by RD-154 with 153.73 per cent " (Table 172).

Table 172. Performance of coriander accessions under IET - Dholi

Characters Genotypes	Height of the plant (cm)	No. of branches per plant	No. of umbels per plant	Yield per plot (kg)	Yield (t ha^{-1})	Increase in yield over check	
						(t ha^{-1})	(%)
RD - 120	104.87	8.33	26.67	0.77	1.08	0.41	61.19
RD - 121	97.93	9.27	31.20	1.04	1.44	0.77	114.93
RD - 154	98.20	10.07	45.07	1.23	1.70	1.03	153.73
RD - 365	117.07	8.93	31.73	1.11	1.55	0.88	131.34
RD - 366	109.47	10.33	52.00	1.31	1.82	1.15	171.64
RD - 373	98.13	9.13	40.40	1.17	1.62	0.95	141.79
R.Swati (check)	101.00	8.20	20.47	0.49	0.67	-	-
CD at 5%	8.07	0.93	4.65	0.25	0.31		
CV (%)	4.37	5.66	7.42	13.86	12.28		

6.2.3.2Hisar

The initial evaluation trial (IET) in coriander was conducted in RBD with ten accessions along with Hisar Anand as check during 2001-2002 and 2002-2003 in plots measuring 3.0 x 2.0 m. The result indicated that DH-206 and DH-242 gave significantly better yield over Hisar Anand (check) showing 27.1 and 31.6% increase in yield, respectively (Table 173).

Table 173. Performance of coriander accessions under IET – Hisar

Accession number	Seed yield (q ha^{-1})			% increase over check
	2001 - 02	2002 - 2003	Mean	
DH-206	2005	2070	2038	27.1
DH-210	1660	1795	1728	07.8
DH-221	1695	1860	1778	10.9
DH-227	1730	1930	1830	14.2
DH-235	1700	1940	1820	13.5
DH-242	2050	2170	2110	31.6
DH-247	1640	1680	1660	03.5
DH-251	1560	1780	1670	04.2
DH-270	1585	1735	1660	03.5
Hisar Anand	1520	1685	1603	-
CD at 5%	146	155	-	-

6.2.3.3Jagudan

The IET was started during 2002-03 with 10 entries in RBD replicated thrice. But none of the entry had given more yield then G. Cori-2 in previous year.

The significant yield differences were observed among entries, but none of the entry had recorded superior yield than the check G.Co-2. Only an entry JCori-340 had given maximum yield (2200 kgha^{-1}) than check, which was 10.78

per cent higher above check.

Two year pooled data showed significant yield differences among entries, but none of the entry gave significantly superior yield than the check GCo-2. However, an entry J.Cori-340 gave maximum yield (1747 kgha^{-1}) than check. (Table 174).

Table 174. Performance of coriander accessions under IET – Jagudan

Treatment	Yield (kg ha^{-1})		Mean
	2002-03	2003-04	
JCori.-333	1087	1889	1488
JCori.-340	1295	2200	1747
JCori.-342	997	1637	1317
JCori.-375	1258	1877	1568
JCori.-376	997	1870	1433
JCori.-391	919	1562	1241
JCori.-393	1217	1789	1503
JCori.-402	1160	1573	1366
JCori.-403	1336	1877	1607
GCo.-2 (C)	1340	1986	1663
S.Em. ±	53	108	64
CD at 5%	157	320	182
CV %	7.86	10.23	9.84

6.2.3.4Guntur

The trial was started with 11 entries in RBD during 2001-02. During 2003-2004, ten promising coriander accessions selected from germplasm were tested having Sadhana as check in RBD replicated thrice. The yield attributes and growth parameters of all entries were given in Table 175.

Among the eleven entries evaluated LCC-216 recorded highest plant height of 75.5 cm, which was on par with LCC-212 (74.1 cm), LCC-170 (71.8 cm) and LCC-173 (70.7 cm) where as check Sadhana recorded 64.0 cm only. LCC-170 recorded significantly more number of primary branches (9.7) which was on par with LCC-216 (9.2) and LCC-212 (8.6). Check Sadhana has recorded 6.6 only. Number of secondary branches was significantly more in LCC-216 (19.8) and LCC-212 (18.1) while check Sadhana recorded 10.6. Number of umbels was more in LCC-216 (32.3) and LCC-212 (28.4) which were on par with each other and significantly superior to check Sadhana (22.0) while lowest in LCC-143 (16.3). Umbellets per umbel ranged from 4.6 (LCC-143) to 9.1 (LCC-216). Number of umbellets were significantly high in LCC-216 (9.1) followed by LCC-212 (8.8) and LCC-170 (8.3) which were on par with each other and significantly superior to the rest of the others including check Sadhana (5.2). Among the eleven entries tested LCC-216 recorded significantly highest yield of 1127 kg ha^{-1} followed by LCC - 212 and LCC-170 with 1033 and 1031 kg ha^{-1} respectively which were superior over check Sadhana (749 kg ha^{-1}).

Table 175. Performance of coriander accessions under IET – Guntur

Name of the entry	Yield (kg ha^{-1})	% increase over check
LCC-143	625	-16.6
LCC-144	700	-6.6
LCC-147	674	-10.0
LCC-151	666	-11.1
LCC-170	1031	35.8
LCC-172	813	8.6
LCC-173	869	16.0
LCC-192	804	7.4
LCC-212	1033	37.9
LCC-216	1127	50.5
Sadhana (check)	749	
CD at 5%	177.5	
CV%	12.5	

6.2.3.5Jobner

The analysis of variance revealed significant differences among entries for all the characters studied. The mean days to flowering ranged from 57.7 (UD-530) to 95.3 (UD-728), plant height from 47.8 (UD-317) to 72.2 cm (UD-728), branches per plant from 4.33 (UD-530) to 7.93 (RCr-684 check), umbels per plant from 15.33 (Local check) to 32.0 (UD-310), umbellets per umbel from 3.67 (UD-510) to 5.87 (UD-748), seeds per umbel from 16.67 (local check) to 58.27 (UD-748) and test weight from 7.61 (UD-728) to 15.04 g (UD-92). During 2002-2003, the entry UD-796 recorded the maximum seed yield of 1259.34 kg ha^{-1} followed by UD-797 (1129.73 kg ha^{-1}), UD-728 (1069.34 kg ha^{-1}), RCr-435 check (990.67 kg ha^{-1}), RCr-684 check (989.67 kg ha^{-1}) and UD-42 (907.33 kg ha^{-1}), while, lowest yield of 542 kg ha^{-1} was recorded in UD-530.

Table 176. Performance of coriander accessions under IET (2001-02 to 2002-03)– Jobner

Entry	Yield (kg ha^{-1})			Wilt (%)
	2001 - 02	2002 - 2003	Mean	
UD-797	868	1129.7	998.85	3.66
UD-728	764	1069.3	916.65	3.33
RCr-435 check	830	990.67	910.34	4.33
RCr-684 check	483	989.67	736.34	5.00
UD-796	208	1259.3	733.65	5.00
RCr-446 check	555	843.33	699.17	4.00
UD-42	469	907.33	688.17	5.00
UD-36	486	847.00	666.50	4.66
UD-317	417	842.33	629.67	5.00
UD-748	326	874.67	600.34	5.00
UD-380	417	731.00	574.00	12.00
UD-426	382	740.33	561.17	3.66
UD-92	469	639.00	554.00	4.00
RCr-436 check	277	818.33	547.67	3.00
UD-529	330	708.33	519.17	3.00
UD-119	277	754.67	515.84	3.33

UD-310	260	754.33	507.17	3.66
UD-483	277	721.67	499.34	3.66
UD-530	313	542.00	427.50	3.33
Local check	243	581.67	412.34	11.00

The trial was started during Rabi 2001-2002 with 20 entries in RBD. Mean performance of the entries evaluated in IET over 2001-2002 and 2002-2003 revealed superior performance of UD-797 yielding 998.95 kg ha^{-1} followed by UD-718 (916.65 kg ha^{-1}), RCr-435 check (910.34 kg ha^{-1}) and RCr-684 (736.34 kg ha^{-1}), while lowest mean yield of 412.34 kg ha^{-1} was recorded in local check (Table 176). Out of the 20 entries in IET evaluated, minimum wilt incidence (3.0%) was recorded in NS-1 and NS-2 with the maximum seed yield of 1259.34 kg ha^{-1} and 1129.73 kg ha^{-1} respectively, while maximum disease incidence (11%) was recorded in UD-530 with the seed yield of 542.0 kg ha^{-1}.

6.3 Quality Evaluation Trial (COR / CI / 4)

6.3.1 Quality evaluation in coriander (COR / CI / 4.2)

(Jobner)

6.3.1.1 Jobner

Sixteen entries of coriander under CVT were tested for volatile oil content, which was analysed using cleveger apparatus. The volatile oil content in the entries of CVT ranged from 0.35% to 0.55%. The maximum volatile oil of 0.55% was observed in DH-234 and ND-2 followed by 0.53% in UD-118, 0.50% in UD-480, DH-205, and LCC-174. 0.48% in RCr-435, 0.466% in LCC-128 and LCC-225, 0.45% in J.Cori-328 and minimum of 0.35% in RCr-20. The entriesUD-480, DH-234, UD-118 and ND-2 have shown better performance as compare to best check variety RCr-435 with respect to volatile oil content as well as seed yield (Table 177).

Table 177. Volatile oil content of entries of coriander (CVT) - 2002 - 2003 - Jobner

Entry	Seed yield (kg ha^{-1})	Volatile oil (%)	Volatile oil yield (l ha^{-1})
UD-118	889	0.530	4.71
UD-480	1014	0.500	5.07
DH-205	630	0.500	3.15
DH-234	889	0.550	4.88
J.Cori-328	743	0.450	3.34
J.Cori-360	705	0.416	2.93
K.Sel.	802	0.400	3.20
N.D.2	847	0.550	4.65
LCC-128	379	0.466	1.76
LCC-133	455	0.416	1.89
LCC-174	222	0.500	1.11

Entry	Seed yield (kg ha^{-1})	Volatile oil (%)	Volatile oil yield (l ha^{-1})
LCC-225	333	0.466	1.55
RCr-20	453	0.350	1.58
RCr-435	868	0.480	4.16
RCr-684	854	0.350	2.98
Local	371	0.400	1.48

Table 178. Volatile oil content of entries of coriander (IET) (2002 - 2003) - Jobner

Entry	Grain yield (kg ha^{-1})	Volatile oil (%)	Volatile oil yield (l ha^{-1})
UD-36	847	0.475	4.02
UD-42	907	0.50	4.53
UD-92	639	0.50	3.19
UD-119	755	-	-
UD-310	754	0.35	2.64
UD-317	842	0.40	3.36
UD-380	731	0.40	2.92
UD-426	740	0.40	2.96
UD-483	722	0.40	2.88
UD-529	708	0.50	3.54
UD-530	542	0.45	2.43
UD-728	1069	0.425	4.54
UD-748	875	0.35	3.06
UD-796	1259	0.50	6.29
UD-797	1130	0.45	5.08
RCr-435	991	0.45	4.45
RCr-436	818	0.30	2.45
RCr-446	843	0.40	3.37
RCr-684	990	0.40	3.96
Local	582	0.40	2.32

The volatile oil content in the entries of IET ranged from 0.30 to 0.50%. The maximum volatile oil of 0.50% was recorded in UD-42, UD-92, UD-529, UD-796 followed by 0.475% in UD-36, 0.45% in UD-530, UD-797, and RCr-435, 0.425% in UD-728 and minimum of 0.30% in RCr-436. The entries UD-796, UD-797, UD-728 and UD-42 have shown better performance than the best check, RCr-435 with respect to volatile oil and seed yield (Table 178).

Table 179. Volatile oil content of coriander entries evaluated in IET (2001- 02 and 2002 – 03) - Jobner

Entry	Mean seed yield (kg ha^{-1})	Volatile oil (%)			Mean volatile oil yield (l ha^{-1})
		2001	2002	Mean	
UD-36	667	0.460	0.475	0.470	3.13
UD-42	688	0.540	0.500	0.520	3.57
UD-310	507	0.415	0.350	0.380	1.92
UD-317	630	0.485	0.400	0.440	2.77
UD-380	574	0.575	0.400	0.487	2.79
UD-483	500	0.550	0.400	0.475	2.37
UD-728	917	0.450	0.425	0.440	4.03
UD-748	601	0.420	0.350	0.380	2.28
RCr-435	911	0.470	0.450	0.460	4.19
RCr-436	548	0.500	0.300	0.400	2.19
RCr-446	699	0.575	0.400	0.487	3.40
RCr-684	737	0.410	0.400	0.400	2.94
Local	413	0.500	0.400	0.450	1.85

The mean performance of two years data indicate that the mean volatile oil content in these entries ranged from 0.38% to 0.52%. The promising entries for volatile oil content with respect to best check RCr-446 are found to be UD-42 and UD-380 (Table 180).

The experiment on, effect of biofertilizer (*Azospirillum*) on yield of coriander was conducted. These entries were evaluated for volatile oil contents to know the effect of bio-fertilizer on volatile oil content. On observing the Table 180 it may be concluded that bio-fertilizer does not affect the volatile oil content in coriander.

Table 180. Effect of bio-fertilizer on volatile oil content of coriander (2001 - 02 and 2002 - 03) - Jobner

Treatment	Volatile oil (%)		
	2001 - 02	2002 - 03	Mean
T_1 - 100% N + A + 5t FYM	0.500	0.500	0.500
T_2 - 75% N + A + 5t FYM	0.425	0.450	0.438
T_3 - 50% N + A + 5t FYM	0.450	0.425	0.438
T_4 - 0 + A + 5t FYM	0.466	0.450	0.458
T_5 - 0 + 0 + 5t FYM	0.450	0.425	0.438
T_6 - 0 + A + 10t FYM	0.500	0.510	0.505
T_7 - 0 + 0+ 10t FYM	0.460	0.450	0.455
T_8 - 100% N + 0 + 0	0.400	0.410	0.405
T_9 - 0 + A + 0	0.400	0.400	0.400
T_{10} - 0 + 0 + 0	0.425	0.400	0.413

N= Inorganic Nitrogen A= *Azospirillum*

6.4 Nutrient Management Trial (COR / CM / 1)

6.4.1 Response of coriander to micronutrients (COR / CM / 1.1)

(Kumarganj)

6.4.1.1 *Kumarganj*

This trial was laid out in RBD with 13 treatments with 3 replications during 2001. Application of copper sulphate @ 12.5 kg h^{-1} and foliar application of copper sulphate @ 0.25% (T 13 treatment) showed maximum yield of 2.13 t ha^{-1} during 2003-04. Yield lower to T13 treatment was obtained in T4 treatment (1.95 t ha^{-1}) by application of Zinc Sulphate @ 10 kg ha^{-1} + 0.25% foliar spray (Table 181). However, four years pooled data presented in Table 181 showed that treatment T13 out yielded other treatment in yield, producing 1.94 t ha^{-1} of coriander seeds.

Table 181. Effect of micronutrients on seed yield and ancillary observations on coriander (2000 – 2004) – Kumarganj

Treatment	2000 - 01	2001 - 02	2002 - 03	2003 - 04	Total	Mean
T1= Control	13.35	19.76	19.20	15.90	68.21	17.05
T2= Zinc sulp 20kg ha^{-1} as soil appl	14.25	17.45	16.68	16.70	65.08	16.27
T3= Zinc sulph 0. 5 % as foliar spray	14.30	19.53	16.19	17.80	67.82	16.95
T4= Zinc sulph 10 kg ha^{-1} + 0.25 % foliar appl	15.50	18.61	17.58	19.50	71.19	17.79
T5= Ferr sulph 10 kg ha^{-1} as soil appl	14.65	19.30	18.51	18.10	70.56	17.64
T6= Ferr sulph 0.25 % as foliar appl	14.46	19.07	16.42	16.40	66.35	16.58
T7= Ferr sulph 5 kg ha^{-1} + 0.125 % as foliar app l	15.85	22.54	17.12	17.50	73.01	18.25
T8= Magnese sulph 25 kg ha^{-1} as soil appl	14.56	22.08	16.43	16.60	69.67	17.41
T9= Mangnese Sulph 0.25% as foliar appl	14.20	21.85	18.51	18.00	72.56	18.14
T10= Mangnese sulph 12.5 kg ha^{-1} + 0.25 % as Foliar appl.	14.65	19.53	16.20	16.60	66.98	16.74
T11= Copp sulph 25 kg ha^{-1} as soil appl	13.30	20.92	17.81	17.40	69.43	17.35
T12= Copp sulph 0.5 % foliar Appl	13.45	19.53	18.28	17.80	69.06	17.26
T13= Copp sulph 12.5 kg ha^{-1} + 0.25 % foliar appl.	13.20	22.20	21.05	21.40	77.85	19.46
CD at 5%	0.15	2.68	4.45	0.15	-	-
CV (%)	-	19.00	14.91	5.17	-	-

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

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

6.4.2.1Jobner

The experiment was started with 10 treatments in RBD during Rabi 2000-2001. During the third year (2002-2003) application of 100, 75 and 50% of recommended dose of inorganic N + *Azospirillum* 1.5 kg ha^{-1} + 5 t FYM ha^{-1} and 100% inorganic N alone produced significantly higher number of umbels/plant and grains/umbel, plant height, biological and seed yield ha^{-1} over rest of the treatments. The application of 10 t FYM ha^{-1} + *Azospirillum* and 10 t FYM ha^{-1} alone also increased the plant height and biological yield of coriander over control.

Pooled analysis of three years data (Table 182) showed that application of 100% inorganic N (60 kg ha^{-1}) + *Azospirillum* + 5 t FYM ha^{-1} recorded maximum mean seed yield of 8.44 q ha^{-1} and remained at par with 75% and 50% N through inorganic source + *Azospirillum* + 5 t FYM ha^{-1} and 100% N through inorganic source alone but proved superior to rest of the treatments.

Table 182. Effect of biofertilizer using *Azospirillum* on seed yield of coriander (pooled data 2000 to 2003) - Jobner

Treatment	Seed yield (kg ha^{-1})			
	2000-2001	2001-2002	2002-2003	Mean
Inorganic N (100%) + *Azospirillum* + 5 t FYM ha^{-1}	662	918	952	844
Inorganic N (75%) + *Azospirillum* + 5 t FYM ha^{-1}	586	941	853	793
Inorganic N (50%) + *Azospirillum* + 5t FYM ha^{-1}	555	926	819	767
Azospirillum + 5 t FYM ha^{-1}	509	732	700	647
5 t FYM ha^{-1} alone	477	648	690	605
Azospirillum + 10 t FYM ha^{-1}	601	730	763	698
10 t FYM ha^{-1}	555	707	710	757
Inorganic N (100%) alone	623	810	888	774
Azospirillum 1.5 kg ha^{-1} alone	524	633	635	597
Control	431	602	553	529
CD at 5%	094	100	199	140

6.4.2.2Coimbatore

This project was started during 2000 and is in 4th year of progress at Coimbatore. During the Rabi season of 2003–2004, the results obtained are similar to that of previous year. The plants of T_3 treatment, gave the highest yield of 720.5 kg ha^{-1} as against 575 kg ha^{-1} in the control (T_{10}). This was followed by T_2 and T_1 with the yield of 703.4 and 697.5 kg ha^{-1} respectively. The lowest yield of 243 kg ha^{-1} was registered by the treatment T_8 (Table 183).

Table 183. Effect of biofertilizer, *Azospirillum* on yield of coriander (2003 - 2004) – Coimbatore

Treatment	Yield (kg ha^{-1})
T_1 - Inorganic N (100%) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment + 5 t FYM	697.5
T_2 - Inorganic N (75%) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment + 5 t FYM	703.4
T_3 - Inorganic N (50%) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment + 5 t FYM	720.5
T_4 - FYM (5 t ha^{-1}) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment	465.0
T_5 - FYM (5 t ha^{-1}) alone	398.0
T_6 - FYM (10 t ha^{-1}) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment	460.0
T_7 - FYM (10 t ha^{-1}) alone	410.0
T_8 - *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment alone	243.0
T_9 - Urea (100%) alone	265.0
T_{10} - Control	575.0
Seed	19.70
CD at 5%	49.25

6.4.2.3Kumarganj

The trial initiated in 2000-2001 and was laid out in RBD with 7 treatments and 3 replications. The trial was continued during 2003-2004. Application of *Azospirillum* @ 1.5 kg ha^{-1} as seed treatment and application of FYM @ 10 t ha^{-1} showed maximum seed yield 2.48 t ha^{-1} with 35.78% increase in yield over controls, followed by use of inorganic nitrogen (50%) + *Azospirillum* 1.5 kg ha^{-1} + 5 t ha^{-1} FYM yield 2.44 t ha^{-1} of seed yield. Mean data of four years observation showed that maximum yield of 2.19 t ha^{-1} was obtained by application of 10 t ha^{-1} of FYM with 27.38% increase in yield over other treatments (Table 184).

Table 184. Effect of micronutrients on yield performance of coriander (pooled data- 2000 to 2004) - Kumarganj

Treatment	2000 - 01	2001 - 02	2002 - 03	2003 - 04	Total	Mean
T_1 = Inorganic N (100%+ *Azospirillum* (50g)+5kg FYM	18.05	12.96	20.60	20.09	71.70	17.92
T_2= Inorganic N (75% + *Azospirillum* (50g) + 5kg FYM	17.85	10.88	23.14	22.92	71.70	18.69
T_3= Inorganic N (50%)+ *Azospirillum* (50g) + 5kg FYM	17.72	17.59	24.53	24.40	84.40	21.11

Treatment	2000 - 01	2001 - 02	2002 - 03	2003 - 04	Total	Mean
T_4= FYM (5kg)+ *Azospirillum* (50g)	15.97	18.98	22.68	22.63	80.26	20.06
T_5= FYM (5kg)+ *Azospirillum* (50g)	15.65	15.74	24.30	24.15	79.84	19.96
T_6= FYM (10kg)+ *Azospirillum* (50g)	15.66	19.90	24.76	24.87	85.19	21.29
T_7= FYM (10kg)+ *Azospirillum* (50g)	15.80	25.50	23.15	23.33	87.78	21.94
CD at 5%	1.65	4.35	3.81	0.30	-	-
CV %	-	9.50	9.31	8.42	-	-

6.4.2.4Guntur

The trial was conducted for three years 2001-2002, 2002-2003 and 2003-2004 rabi seasons. Ten treatment combinations containing three levels of N (100, 75 and 50 % of recommended dose) and two levels of FYM (5 t ha^{-1} and 10 t ha^{-1}) with and without *Azospirillum* were evaluated in RBD with three replications. Using variety Sadhana *Azospirillum* was applied as seed treatment. Observations on plant height, number of primary and secondary braches, number of umbels per plant, umbellets per umbel were recorded and subjected to statistical analysis.

The results of the investigation were presented in the Table 185. *Azospirillum* inoculation and FYM @ 5 t ha^{-1} applied along with recommended dose of inorganic Nitrogen @ 100 % N, 75 % N and 50 % N had shown significant influence on growth parameters. Plant height, number of primary and secondary branches were significantly more in treatments with 100 % N (T1), 75 % N (T2) and 50 % N (T3) applied in combination with *Azospirillum* and FYM @ 5 t ha^{-1} than control. Similar trend concerning yield attributing characters were observed in the treatments receiving inorganic Nitrogen along with *Azospirillum* inoculation and FYM @ 5 t ha^{-1}. Significantly more number of umbels/plant and umbellets/umbel were observed in 100 % N, 75 % N, and 50 % N applied in combination with *Azospirillum* and FYM @ 5 t ha^{-1} than control. Among all the treatment combinations, treatment with 100 % N, 75 % N and 50 % N applied along with *Azospirillum* inoculation and FYM @ 5 t ha^{-1} produced maximum seed yield (557, 541, 521 kg ha^{-1} respectively) which are on par with each other but significantly superior than control (332 kg ha^{-1}).

Table 185. Efficacy of biofertilizer, *Azospirillum* on the yield of coriander - Guntur

Name of the treatment	Yield (kg ha^{-1})
T_1 - 100% N + *Azospirillum* + 5 t ha^{-1} FYM	557
T_2 - 75% N + *Azospirillum* + 5 t ha^{-1} FYM	541
T_3 - 50% N + *Azospirillum* + 5 t ha^{-1} FYM	521
T_4 - *Azospirillum* + 5 t ha^{-1} FYM	462
T_5 - 5 t ha^{-1} FYM Alone	431
T_6 - *Azospirillum* + 10 kg FYM	484
T_7 - 10 kg FYM Alone	445
T_8 - 100% N	454
T_9 - *Azospirillum* only	349
T_{10} - Absolute control	332
CD at 5%	38.2
CV%	4.9

6.5 Disease Management Trial (COR/CP/1)

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

(*Dholi*)

6.5.1.1Dholi

This experiment could not be taken up at Dholi centre, since the post plant pathologist lying vacant.

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

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

6.5.2.1Coimbatore

Wilt disease: This trial was started during 2000-01 with 7 treatments in RBD and it is in 4th year of progress. During the year 2003–2004 rabi season, the experiment was conducted with seven treatment and three replications in RBD design. The observations were recorded on wilt incidence from germination to harvest at regular intervals. The yield was also registered and presented in Table 186. The lowest disease incidence of (14.46 %) recorded by seed treatment with *Pseudomonas fluorescence* @ 10 g kg^{-1} + SA of *P. fluorescence* (5 kg ha^{-1}) as against 36.66 per cent in the control. This was followed by seed treatment with *Trichoderma viride* @ 4 g kg^{-1} soil application of *T. viride* @ 5 kg ha^{-1} which reduced the disease incidence by 58.07 per cent. The above mentioned two treatments registered the yield of 603 and 575 kg ha^{-1}. The control treatment recorded the yield of 423 kg ha^{-1}.

Table 186. Effect of biocontrol agents on coriander wilt disease – Coimbatore

Treatment	Wilt disease incidence (%)	Disease reduction (%)	Yield (kg ha^{-1})
T_1 - ST with carbendazim (2 g kg^{-1})	15.70 (23.85)	57.17	550
T_2 - ST with *Trichoderma viride*(4 g kg^{-1}) + SA (5 kg ha^{-1})	15.37 (23.07)	58.07	575
T_3 - ST with *T. harzianum* (4 g kg^{-1}) + soil application (5 kg ha^{-1})	20.51 (26.80)	44.05	520
T_4 - ST with *Bacillus subtilis* + soil application	25.55 (32.24)	30.31	487
T_5 - ST with *Pseudomonas fluorescens* 10 g kg^{-1} + SA (5 kg ha^{-1})	14.46 (22.32)	60.55	603
T_6 - ST carbendazim (2 g kg^{-1}) + Soil drenching (0.1%)	13.34 (21.36)	63.61	620
T_7 - Control	36.66 (37.26)	-	410
CD at 5%	2.3	-	27.5

ST – Seed treatment, SA – Soil application, Values in parantheses arc arc sine transformed values

Powdery mildew disease: A field trial started at Coimbatore centre during 2003-2004 at three locations to evolve effective disease management strategy using botanicals for powdery mildew in coriander. Observations on disease incidence and yield were recorded and presented in Table 187 a, 187 b, 187 c.

The results of pooled analysis of three location (Table 187 d) showed that NSKE 5% spray thrice recorded the disease index of 30.87 as against 78.63 in control which accounted for the disease reduction of 60.74 per cent. The same treatment also gave a seed yield of 496.6 kg ha^{-1} and with a C:B ratio of 1 : 2.83. Maximum disease reduction was observed with Tridemorph 0.1% with 78.00 percent disease reduction and an yield of 84.20 per cent with a C:B ratio of 1:3.72.

Table 187 a. Effect of plant products on powdery mildew of coriander (Location Saravanampatti 2003 – 2004)

Treatment	Percent incidence (PDI)	Disease reduction (%)	Yield (kg ha^{-1})	Yield (%)	Cost benefit ratio
NSKE 5%	27.50 (31.62)	67.45	654.65	81.62	1 : 3.56
Vitex negundo leaf extract (10%)	35.00 (36.24)	58.57	587.34	62.94	1 : 2.03
Tridemorph (0.1%)	20.40 (26.84)	75.85	690.70	91.62	1 : 4.28
Control	84.50 (66.89)	-	360.45	-	-
CD at 5%	5.83		35.34		

Values in parentheses are arc sine transformed values, PDI : Percent Disease Incidence

Table 187 b. Effect of plant products on powdery mildew of coriander (Location Udumalaipettai 2003 – 2004)

Treatment	Percent incidence (PDI)	Disease reduction (%)	Yield (kg ha^{-1})	Yield (%)	Cost benefit ratio
NSKE 5%	30.70(33.24)	63.00	570.00	86.88	1 : 3.15
Vitex negundo leaf extract (10%)	37.50(37.76)	53.93	525.00	72.13	1 : 1.92
Tridemorph (0.1%)	20.75(27.05)	74.50	623.00	104.26	1 : 4.08
Control	81.40(64.57)	-	305.00	-	-
CD at 5%	4.48		30.28		

Values in parentheses are arc sine transformed values, PDI : Percent Disease Incidence

Table 187 c. Effect of plant products on powdery mildew of coriander (Location Aruppukottai 2003 – 2004)

Treatment	Percent incidence (PDI)	Disease reduction (%)	Yield (kg ha^{-1})	Yield (%)	Cost benefit ratio
NSKE 5%	34.40	50.85	265	26.19	1 : 1.8
Vitex negundo leaf extract (10%)	50.50	28.57	228	8.57	1 : 0.8
Tridemorph (0.1%)	10.80	84.57	300	42.85	1 : 2.8
Control	70.00	-	210	-	

PM: Powdery mildew

Table 187 d. Effect of plant products on powdery mildew of coriander (Pooled analysis for three locations 2003 – 2004)

Treatment	Percent incidence (PDI)	Disease reduction (%)	Yield (kg ha^{-1})	Yield (%)	Cost benefit ratio
NSKE 5%	30.87 (33.72)	60.74	496.55	70.02	1 : 2.83
Vitex negundo leaf extract (10%)	41.00 (39.17)	47.85	446.78	52.83	1 : 1.58
Tridemorph (0.1%)	17.32 (24.55)	77.97	537.90	84.18	1 : 3.72
Control	78.63 (62.50)	-	292.05	-	-
CD at 5%	5.25		43.40		

Values in parentheses are arc sine transformed values, PDI : Percent Disease Incidence

6.5.2.2Kumarganj

The trial was started during 2000-2001 with 7 treatments replicated thrice in RBD. During the year 2003-04, maximum reduction in incidence of wilt disease was observed in seeds treated with carbendazim (0.2%) and drenching of soil with carbendazim (T_6) showing 173.22% increase in seed yield over controls (Table 188). Similar trend was observed in four years mean pooled data study in percent disease reduction and yield also (Table 189). During the year 2003-04 powdery mildew disease was not observed.

Table 188. Effect of bioagent and fungicides on the incidence of wilt and yield in coriander (2003 - 04) – Kumarganj

Treatment	Seed yield (t ha^{-1})	Wilt (%)	Reduction in disease incidence (%)	Increase in yield (%)
T_1 = Seed treatment with carbendazim (0.2%)	1.52	15.00	50.00	114.08
T_2 = Seed treatment with *T. viride* & soil application.	1.38	22.50	25.00	94.37
T_3 = Seed treatment with *T. harzianum* & soil application.	1.66	12.50	58.33	133.80
T_4 = Seed treatment with *Bacillus subtilis* & soil application.	1.32	20.00	33.33	85.92
T_5 = Seed treatment with *Pseudomonas fluorescens* & soil application	1.11	25.00	16.67	56.34
T_6 = Seed treatment with carbendazim (0.2 %) & soil drenching	1.94	8.33	72.23	173.22
T_7 = Untreated control	0.71	30.00	—	—
CD at 5%		4.00		

Table 189. Effect of bioagent and fungicides on the wilt incidence and yield of coriander (2000 - 01 to 2003 - 04) - Kumarganj

Treatment	Wilt (%)				Mean
	2000 - 01	2001 - 02	2002 - 03	2003 - 04	
T_1 = Seed treatment with carbendazim (0.2 %).	6.00	6.00	9.16	15.00	9.04
T_2 = Seed treatment with *T. viridae* & soil application.	3.80	7.80	14.16	22.50	12.06
T_3 = Seed treatment with *T. harzianum* & soil application.	3.50	8.10	11.66	12.50	8. 94

Treatment	Wilt (%)				Mean
	2000 - 01	2001 - 02	2002 - 03	2003 - 04	
T_4 = Seed treatment with *Bacillus subtilis* & Soil application.	3.40	9.20	12.50	20.00	11.27
T_5 = Seed treatment with *Pseudomonas florescens* & soil application	4.00	10.00	14.60	25.00	13.40
T_6 = Seed treatment with *carbendazim* (0.2 %) & soil drenching.	4.20	2.50	5.83	8.33	5.21
T_7 = Untreated control	9.50	1.5.40	19.50	30.00	18.60
CD at 5%	0.95	3.28	6.66	4.00	3.58
CV (%)		11.98	16.73	11.80	23.39

Table 190. Effect of bioagent and fungicides on the incidence of wilt in coriander (pooled data 2000 - 01 to 2003 - 04) - Kumarganj

Treatment	Percentage of wilt incidence				Mean
	2000 - 01	2001 - 02	2002 - 03	2003 - 04	
T_1 = S.T. *Carben* (0.2 %)	15.00	18.75	20.13	15.27	17.28
T_2 = S.T with *T.viridae* & soil application	15.70	18.75	18.05	13.88	16.59
T_3 = S.T with *T. harzianum* & Soil application	17.05	18.29	18.97	16.60	17.72
T_4 = S.T with *Bacillus subtilis* & soil application	16.10	16.29	18.79	13.22	16.25
T_5 = S.T with Psuedomonas fluorescence & soil application	15.35	15.91	17.82	11.11	15.04
T_6 = S.T. carbon (0.2 %) & soil drenching	15.28	19.21	21.06	19.44	18.74
T_7 = Untreated control	14.47	13.20	14.38	7.16	12.30
CD at 5%		3.03	2.80	3.07	
CV (%)		12.88	8.52	2.43	

S.T. = Seed treatment

6.5.2.3Jobner

On the basis of 3 years (2000-2001 to 2002-2003) data the minimum wilt incidence i.e. 8.39% with the maximum seed yield of 819.0 kg ha^{-1} was recorded in the treatment where *Trichoderma harzianum* applied through seed treatment and soil application followed by seed treatment and soil drenching with carbendazim having 7.35% wilt with the seed yield of 766.0 kg ha^{-1}. The control resulted in maximum disease incidence 16.44% and lowest seed yield 470.0 kg ha^{-1} as compared to all other treatment.

Table 191. Effect of fungicides and biocontrol agents on wilt of coriander (pooled data 2000 to 2002) - Jobner

Treatment	Disease (%)				Yield (kg ha^{-1})			
	2000	2001	2002	Mean	2000	2001	2002	Mean
Treatment with Carbendazim	16.33	6.75	7.0	10.03	625	626	798	683
Treatment with *Trichoderma viride* + soil application	14.67	5.00	5.5	8.39	645	710	753	703
Treatment with *T. harzianum* + soil application	10.67	3.50	3.0	5.72	688	863	906	819
Treatment with *Bacillus subtilis* + soil application	21.67	8.00	8.5	12.72	480	585	671	579
Treatment with *Pseudomonas flourescens* + soil application	23.33	7.00	8.25	12.86	480	576	626	561
Seed Treatment and soil drenching of Carbendizim	13.33	4.0	5.25	7.53	668	810	820	766
Control	28.33	10.0	11.0	16.44	355	531	525	470
CD at 5%	3.06	1.06	1.74		36.0	54.0	46.2	
CV (%)	11.0	11.0	14.9		8.70	5.31	3.7	

6.5.2.4Dholi

This experiment was not conducted due to lack of the Pathologist.

6.5.2.5Raigarh

Not reported.

6.5.2.6Jagudan

Twenty five entries of coriander were screened for the resistance against powdery mildew disease. None of the entries was found free from the disease under natural condition. The minimum incidence was reported in J.Co - 403 (6.25 %) and followed by J.Co - 402 (7.50 %), J.Co - 391 (8.75 %) and EC-377 (10.00 %). The higher incidence was showed in LCC - 174 (75.00 %) and LCC - 225 (73.95 %).

7. CUMIN

In cumin 6 projects are in progress at 10 centres of the AICRPS

7.1 Genetic Resources (CUM/CI/1)

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

(*Jobner* and *Jagudan*)

7.1.1.1Jagudan

The 214 entries of cumin were compared with three checks i.e. GC-1, GC-2 and GC-3 during rabi season at Jagudan. The Germplasm entries were classified based on yield and yield attributing characters (Table 192). Among them ten entries had less than 26 cm plant height observed as dwarf type. Six entries had good branches i.e. more than six branches per plant, more than 30 umbels per plant were recorded by 11 entries. Thirteen entries were promising with more seeds per umbellate i.e. 6.5 umbellate per umbel. Thirteen entries observed more or less early maturity (100 days). Thirteen entries were identified as high yielder with more than 800 $kgha^{-1}$ grain yield.

Table 192. Classification of Cumin germplasm - Jagudan

Character	Range	GC-2 (check)	Plant height (cm)	No.of entry	Promising entries identified
Plant height (cm) (Dwarf)	22.7 - 42.6	35.6	≤ 26	11	JC-99-16, JC-2000-4, 20, 27, 28, 31, 46, 54, 55, JC-2002-16 & 37
No. of Branches / Plant (More branches)	2.6 - 6.3	4.3	≥ 6	22	JC-94-61, 188, JC-95-28, 30, 71, 131, JC-96-8, 18, 38, JC-2000-9, 19, 21, 22, 27, 33, 40, 46, 58, 68, 72, JC-2002-13 & 17
No. of Umbels/Plant (More umbels)	9.0-37.3	30.0	≥ 30	22	JC-94-167, JC-95-10, 30, 128, 131, JC-96-26, 27, 38, 47, JC-99-34, 43, 45, JC-2000-22,27, 40, 60, 61, 63, 72, JC-2002 - 4, 9 & EC-279081
No.of Umbellates/Umbel (More umbellates)	3.0-6.0	5.3	³ 5.5	5	JC-94-188, JC-95-30, 72, JC-2000-11 & 17
No. of Seeds/Umbellate (More seeds)	4.3-7.3	6	³ 6.5	14	JC-94-188, JC-95-9, 10, 11, 24, 25, 72, 75, 110, 114, JC-96-8, 57, JC-99-45 & JC-2000-72

Character	Range	GC-2 (check)	Plant height (cm)	No.of entry	Promising entries identified
Maturity days (Early)	90-115	106	≤ 100	15	JC-94-262, 276, JC-95-71, 108, JC-96-16, 46, JC-99-3, 4, 7, 12, 16, JC-2000-58, 61, 70 & JC-2002-32
Test Weight (gm) (Bold seeded)	3.76-6.48	5.48	≥ 5.80	20	White flower, JC-94-262, 76, 95-12, 28, 36, 114, 131, 96-7, 18, 19, 99-8, 17, 32, 41, 45, 2000-58, 2002-17, 28, 39
Grain Yield (kg ha^{-1}) (High yield)	283-894	802	> 800	15	JC-94-167, JC-95-12, 114, 123, JC-96-2, 38, 47, JC-2000-21, 22, 27, 72, JC-2002-4, 20, GC-3 & EC-279081

During the reporting year, 17 collections were made from the farmer's field of Mehsana, Ahmedabad and Sabarkantha districts of the state during this year. They were collected based on characters viz. less leafy, bold seed, early maturity, blight escape/tolerant.

During the year, selection was made from F2 of GC-3 white flower crosses. Among the materials 10 plants were selected for non-splitting seed habit type with white flower. Second group of 10 plants were selected for non-splitting seed habit with pink flower. All individual plants were harvested and they will tested in wilt sick plot for wilt resistant and also in normal filed for segregation study.

During the year under report, 71 entries of cumin mentioned below were screened for the resistant against blight disease. The germplasm entries were screened against *Alternaria burnsi* powdery mildew and wilt diseases. None of the entries were found free from the disease incidence. The minimum incidence of blight was reported in JC-2000-53 (5.00 %) followed by JC-2000-54 (5.50 %), JC-2000-71 (5.50 %), JC-2000-47 (6.00 %), JC-2000-72 (6.00 %), GC-4 (6.00 %), JC-2000-22 (6.50 %), JC-2000-68 (6.50 %), JC-2000-31 (7.50 %), JC-2000-28 (8.00 %), GC-3 (8.00 %), JC-2000-21 (8.50 %), JC-2000-40 (9.00 %), JC-2000-27 (9.50 %) and JC-2000-46 (10.00 %). Whereas, entries GC-2 © (76.00 %), UC-341 (55.00 %), JC-95-104 (54.50 %), JC-2000-62 (53.50 %) and UC-342 (52.00 %) reported the higher incidence of blight disease.

Out of 71 entries of cumin, none of the entries was found free from the incidence of powdery mildew disease. The minimum incidence was reported in JC-2000-71 and JC-2000-72 (23.75 %) and followed by JC-2000-11 (36.25 %), JC-2000-22 (36.25 %), JC-2000-28 (37.50 %), JC-2000-4 (38.00 %) and JC-2000-53 (38.75 %). While other entries were

showed higher incidence of powdery mildew disease.

During the year, following 15 entries were screened for the resistant against wilt disease under wilt sick plot. Only GC-3 (48.53 %), JC-2000-3 (58.08 %) and JC-2000-72 (56.90 %) showed lower incidence of wilt. Other entries showed higher incidence of wilt.

7.1.1.2Jobner

Not reported.

7.2. Hybridization Trial (CUM/CI/2)

7.2.1 Mutation studies and hybridization programme in cumin (CUM/CI/2.1)

(Jagudan)

The new CVT was started during 2002-03 with 8 entries including two local checks and four replications in RBD to find out high yielding, non-splitting habit of seed and wilt resistant variety. The previous year (2003- 2004) results shown and entry JC-200-72 gave significantly superior yield (1126 kg ha^{-1}) than GC-2. During the year 2003-2004, the yield differences among the entries were found significant. An entry JC-2000-72 gave significantly superior yield (997 kg ha^{-1}) than GC-2 and GC-3(WR), which was 20.27 and 16.47 per cent higher yield over GC-2 and GC-3(WR), respectively. (Table 193). The yield of JC-2000-72 was at par with UC-341, JC-2000-21, JC-2000-22 and JC-2000-27. An entry JC-2000-72 has good characters viz; non-splitting grain habit, resistant against wilt disease and good lustre.

The pooled data over two years revealed non-significant yield differences among entries. However, an entry JC-2000-72 recorded maximum yield (1062 kg ha^{-1}) than checks, which was 18.00 and 13.10 per cent higher above the GC-2 and GC-3, respectively (Table 193).

Table 193. Performance of cumin accessions under CVT-Jagudan

Treatment	Yield (kgha^{-1})			Percent of increase over control	
	2002-03	2003-04	Mean	GC-2	GC-3
JC-2000-21	963.00	943.00	953	5.78	1.49
JC-2000-22	978.00	940.00	959	6.56	2.13
JC-2000-27	1035.00	903.00	969	7.67	3.19
JC-2000-72	1126.00	997.00	1062	18.00	13.10
UC-341	856.00	946.00	901	-	-
UC-342	951.00	863.00	907	0.080	-
GC-2 ©	971.00	829.00	900	-	-
GC-3 ©	1021.00	856.00	939	4.22	-
S.Em ±	24.00	35.00	43		
C.D. at 5%	69.00	103.00	NS		
C.V. %	4.78	7.72	6.31		

7.2.3 CVT 2001 – Series V (CUM/CI/3.3)

7.2.3.1Jobner

The trial was started with 10 entries in RBD with 4 replications each during Rabi 2002-2003. The first year data indicated significant difference for all the characters studied. The mean days to flowering ranged from 90 (Local check) to 94.5 days (UC-310), plant height from 21.9 (JC-2000-22) to 28.7 cm (Local check), branches per plant from 3.65 (Local check) to 5.90 (JC-2000-22), umbels per plant from 10.43 (Local check) to 15.53 (UC-310), umbellets per umbel from 4.10 (Local check) to 4.6 (JC-200-22, JC-2000-21), seeds per umbel from 21.2 (Local check) to 26.2 (UC-231 & UC-341), and test weight from 4.2 (local check) to 5.60 gm (JC-2000-22). The entry UC-310 recorded the maximum seed yield of 385.50 kg ha^{-1} followed by JC-2000-22 (275.50 kg ha^{-1}), JC-2000-21 (262.75 kg ha^{-1}) and UC-341 (260.25 kg ha^{-1}), while lowest yield of 170.75 kg ha^{-1} was recorded in local check.

These ten entries were evaluated for wilt under field condition, minimum wilt incidence was in UC-310 (7.50%) & blight (0.00%) with the maximum grain yield of 385.50 kg ha^{-1} followed by JC-2000-22, wilt incidence 7.50%) with the seed yield of 275.50 kg ha^{-1}, where as maximum wilt (20.00%) and blight (10.25%) respectively was recorded in local check with the minimum seed yield of 170.75 kg ha^{-1}. Powdery mildew disease did not appear in all the entries during this year.

7.3 Varietal Evaluation Trial (CUM / CI / 4)

7.3.1 Initial evaluation trial (CUM/CI/4.1) (*Jagudan* and *Jobner*)

7.3.1.1Jagudan

The trial was initiated with 12 entries in RBD. Non-significant differences for yield were observed among entries. However, the entries JC-95-30 (1106 $kgha^{-1}$), JC-95-12 (1096 $kgha^{-1}$), JC-96-18 (1083 $kgha^{-1}$) and JC-96-38 (1062 $kgha^{-1}$) were found promising.

7.3.1.2Jobner

The trial was initiated with 10 entries during rabi 2002-2003 in RBD. The character wise mean presented in Table 195 indicated that entries differed significantly for all the characters studied. The mean days to flowering ranged from 82.67 (CMB-134) to 86.67 days (UC-345), plant height from 30.27 (Local check) to 39.87 cm (CMB-88), branches per plant from 4.2 (UC-343) to 6.2 (CMB-90), umbels per plant from 16.33 (Local check) to 35.27 (CMB-79), umbellets per umbel from 3.93 (Local check) to 4.87 (CMB-134), seeds per umbel from 20.9 (Local check) to 29.8 (CMB-79), and test weight from 5.10 (local check) to 5.97 gm (CMB-88). The entry UC-345 recorded the maximum seed yield of 382 kg ha^{-1} followed by CMB-79 and RZ-19 check (308 kg ha^{-1}), UC-343 and CMB-90 (294.33 kg ha^{-1}) and UC-344 (287 kg ha^{-1}), while lowest yield of 132 kg ha^{-1} was recorded in local check.

Out of the ten entries evaluated minimum wilt (6.33%) and blight (0.00%) was recorded in UC-345 with the maximum seed yield of 382.0 kg ha^{-1} followed by CMB 79, wilt (7.00%) and blight (4.33%) the seed yield of 308.0 kg ha^{-1}, whereas maximum wilt (20.00%) and blight (11.67%) respectively was recorded in local check with the minimum seed yield of 132.0 kg ha^{-1}. Powdery mildew disease did not appear in all the entries during this year.

7.4 Quality Evaluation Trial (CUM / CI / 5)

7.4.1 Quality evaluation in cumin (CUM / CI 5.1)

(*Jobner*)

7.4.1.1Jobner

The volatile oil content in ten cumin accessions under CVT was evaluated which ranged from 3.92% to 5.0% (Table 194). The maximum volatile oil of 5.0% was observed in UC- 310 followed by 4.58% in JC-2000-22; 4.0% in JC-2000-21, JC-2000-72 and RZ-19 check, 4.5% in UC-231 and minimum of 3.92% UC-341 and in local check (Table 194). The entries UC- 310, JC-2000-22, JC-2000-21, JC-2000-72 and UC-341 performed better as compare to best check; RZ-19 with respect to volatile and seed yield.

The volatile oil contents of 10 entries of cumin tested under IET ranged from 3.500 to 4.5%. The maximum volatile of 4.5% was recorded in UC-343 followed by UC-344 CMB-79 and CMB-88 (4.25%), UC-345, CMB-90, RZ-19 and RZ-209 (4.0%) and CMB-134 (3.75%) and minimum of 3.50% in local check (Table 195).

Table 194. Volatile oil contents of entries of cumin under CVT (2002 - 2003) - Jobner

Entry	Seed yield (kg ha^{-1})	Volatile oil (%)	Volatile oil yield (l ha^{-1})
UC-231	214	4.50	9.63
UC-310	386	5.00	19.30
UC-341	260	3.92	10.19
UC-342	225	4.29	9.65
JC-2000-21	263	4.58	12.04
JC-2000-22	276	4.58	12.64
JC-2000-27	222	4.33	9.61
JC-2000-72	225	4.58	10.30
RZ-19	216	4.58	9.89
Local	171	3.92	6.70
CD at 5% = 0.397			
CV (%) = 5.34			

Table 195. Volatile oil contents of cumin entries evaluated in IET- (2002 - 2003) - Jobner

Entry	Seed yield (kg ha^{-1})	Volatile oil (%)	Volatile oil yield (l ha^{-1})
UC-343	294.33	4.50	13.24
UC-344	287.00	4.25	12.19
UC-345	382.00	4.00	15.28
CMB-79	308.00	4.25	13.09
CMB-88	261.67	4.25	11.12
CMB-90	294.33	4.00	11.77
CMB-134	203.33	3.75	7.62
RZ-19 (check)	308.00	4.00	12.32
RZ-209 (check)	220.00	4.00	8.80
Local (check)	132.00	3.50	4.62
CD at 5% = 33.49			
CV (%) = 8.38			

7.5 Nutrient Management Trial (CUM / CM / 1)

7.5.1 Efficacy of biofertilizer using *Azospirillum* on cumin (CUM/CM/1.1)

(*Jobner* and *Jagudan*)

7.5.1.1Jobner

The experiment was initiated with 10 treatments in RBD during rabi 2000-2001 and continued during 2001-2002 & 2002-2003. The data revealed that during the reported year (2002-2003) maximum seed yield of 547 kg ha^{-1} obtained with the application of 100% of recommended dose of inorganic N + *Azospirillum* + 5 t FYM ha^{-1} and remained at par with 75% inorganic N + *Azospirillum* + 5 t FYM ha^{-1} and 100% inorganic N alone but significantly higher over rest of treatments.

Pooled analysis of three years yield provided in Table 196 revealed that all the treatments except 10 t FYM alone recorded significantly higher seed yield over control. The maximum seed yield of 3.20 q ha^{-1} recorded with the application of inorganic N (100%)+ *Azospirillum* + 5 t FYM ha^{-1}.

Table 196. Effect of biofertilizer, *Azospirillum* on growth and yield of cumin - Jobner

Treatment	Seed yield (kg ha^{-1})			
	2000-2001	2001-2002	2002-2003	Mean
Inorganic N (100%) +*Azospirillum*+ 5 t FYM ha^{-1}	196	218	547	320
Inorganic N (75%) + *Azospirillum*+ 5 t FYM ha^{-1}	183	198	500	294
Inorganic N (50%) + *Azospirillum* + 5t FYM ha^{-1}	183	190	397	257
Azospirillum + 5 t FYM ha^{-1}	142	196	391	243
5 t FYM ha^{-1} alone	114	145	374	211
Azospirillum + 10 t FYM ha^{-1}	153	169	397	240
10 t FYM ha^{-1}	144	182	379	235
Inorganic N (100%) alone	178	188	436	267
Azospirillum 1.5 kg ha^{-1} alone	198	200	351	250
Control	144	107	264	172
CD at 5%	025	031	139	083

7.5.1.2Jagudan

Not reported.

7.6 Pest Management Trial (CUM/CP/2)

7.6.1 Integrated Management of pests and disease of cumin (CUM/CP/2.1)

(*Jagudan* and *Jobner*)

7.6.1.1*Jagudan*

Not reported.

7.6.1.2 *Jobner*

Not reported.

8. FENNEL

In fennel 8 projects are in progress at 16 centres of the AICRPS.

8.1 Genetic Resources (FNL/CI/1)

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

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

8.1.1.1Kumarganj

The germplasm collection and evaluation started during 1996-1997 at Kumarganj. Out of 36 germplasm screened maximum yield of 2.52 t ha^{-1} was observed in NDF-5 and the lowest yield of 0.93 t ha^{-1} in fennel was observed in NDF-17 (Table 197).

Table 197. Yield of promising fennel germplasm (2003 - 04) - Kumarganj

Germplasm	Yield (t ha^{-1})
NDF – 5	2.52
NDF – 6	2.24
NDF – 12	2.15
NDF – 13	1.02
NDF – 14	1.41
NDF – 15	1.43
NDF – 24	1.63
NDF – 25	2.20
NDF – 31	1.65
NDF – 32	2.24
NDF – 33	2.31
NDF – 34	2.29

8.1.1.2 Jagudan

The centre maintains 97 germplasm in fennel. The 20 accessions having good characters viz. early type, dwarf type, erect plant habit, more branches, more umbels, big umbel type, double umbel type, more umbellates, compact seed in umbellate and sterile habit were collected from field of fennel (Kheda, Sabarkantha & Saurashtra region of the state) during the year. They will be sown in next season and evaluate 89 indigenous and 4 exotic entries of fennel were compared with three checks i.e. PF-35, GF-1 and GF-2 for yield and other attributes. Among them following entries were found promising Table 198. The ten entries found dwarf type. The nine entries have more than 15 branches per plant. The eleven entries have more umbels (> 100). The maximum umbellate per umbel were observed in nine entries. The eight entries having more seed and compact seed habit. The five entries recorded early type habit. As far as yield is concerned, fourteen entries were gave higher yield than all checks.

Table 198. Classification of fennel germplasm - Jagudan

Character	Range	GF-2	Plant height (cm)	No.of entry	Promising entries identified
Plant height (cm) (Dwarf)	92-196	162	< 125	10	JF-351-1-3, 412, 423-1, 478, 493, 501-1, 515, 519, 544 and 563

Character	Range	GF-2	Plant height (cm)	No.of entry	Promising entries identified
No. of Branches/ Plant (More branches)	5-24	13	>15	9	JF-275, 497-1, 516, 523, 531-1, 546, 570, 572 and 574
No. of Umbels/ Plant (More umbels)	9-195	77	> 100	11	JF-484, 485-1, 494, 497-1, 501-2, 529-3, 546, 566, 574, EC-206924 and 323055
No. of umbellates/ Umbel (More umbellates)	22-120	55	> 75	9	JF-351-1-1, 420-3-2, 420-3-5, 423-1, 497-1, 503, 512-1, 513-2 and 570
No. of Seeds/Umbellate (More seeds)	5-121	42	> 60	8	JF-420-3-1, 420-3-3, 460, 494, 499, 530, 539-1 and 592-1
Maturity days(Early)	163-219	178	< 175	5	JF-423-1, 500-1, 501-1, 515 and 544
Grain Yield (kg ha^{-1}) (High yield)	759-7500	3980	> 5600	14	JF-456-1, 456-2, 472-5, 472-2-3, 485-1, 494, 497-1, 501-2, 514-2, 529-1, 546, 572, EC-206924 and 323053

Variability was observed in the fennel at field of breeding materials raised during kharif 2003-04. Among them, 62 entries were selected for different useful characters viz., early, erect plant habit, dwarf, more umbel, more umbellates, more branches, long or bold seeded, sweet, waxy type, high yielder, variant in umbel, stem, less leaf, synchronized maturity and other useful characters. Seeds were harvested from open pollination field for further study.

The research need for as fennel kharif and short durated crop. Hence, 32 selections were made in the kharif nursery for earliness, dwarf ness synchronize maturity, good quality seed etc.

The 85 entries of fennel were screened against *Ramularia* blight disease during kharif season. None of the entries was found free from the disease. The minimum incidence was reported in Acc-1449 and Acc-1502 (4.00 %) and followed by Acc-1514 (5.00 %), Acc-1411 (7.00 %), Acc-1402 (8.00 %), Acc-1469 (8.00 %), JF-1451 (9.00 %), Acc-1430 (9.00 %), Acc-1513 (9.00 %) and GF-2 © (10.00 %). Other entries showed moderate to higher incidence of *Ramularia* blight.

The 47 entries of fennel were screened against *Ramularia* blight disease during rabi season. Disease was not observed during the season.

8.1.1.3Hisar

Eighty six accessions of fennel were evaluated in two row plots of 2.5 m length (3.0 sq. m.) each using PF-35, GF-1 and Local as checks in RBD during 2002-2003. The seed yield of the germplasm ranged from 250 g (HF-153) to 850 g (HF-125) per plot. On the basis of average umbels per plant and yield performance, 48 lines gave higher seed yield than the highest yielding check GF-1 (Table 199). The most promising lines on the basis of yield performance during 2000-01 to 2002-03 were given in Table 199. These lines were maintained by sib mating under muslin cloth and self seed of all the lines have been harvested.

Table 199. Performance of fennel genotypes (2000-01 to 2002-03) - Hisar

Accession Number	Seed yield (g plot^{-1})			Mean
	2000 - 01	2001 - 2002	2002 - 2003	
HF-102	800	790	700	763
HF-107	850	885	800	845
HF-108	500	600	750	617
HF-113	540	400	700	547
HF-116	800	870	750	807
HF-118	520	680	700	633
HF-125	680	695	850	742
HF-126	620	420	750	597
HF-143	-	-	700	700
HF-155	600	605	800	668
HF-172	590	675	750	672

8.1.1.4Jobner

Not reported.

8.1.1.5Dholi

The programme was initiated in 1992. 44 accessions of germplasm are being maintained at this centres. The experiment was failed although after planting the growth and development of the crop was satisfactory but conceives of flowering insect attack (semi-looper) took place and the infestation of insect was so sever that repeatedly spraying of insecticide did not prove effective hence crop damaged badly.

8.2 Hybridization trial (FNL/CI/2)

8.2.1 Mutation studies and crossing programme in fennel (FNL/CI/2.1)

(*Jagudan*)

8.2.1.1Jagudan

Not reported.

8.2.2 Intervarietal hybridization for evolving high yielding varieties (FNL/CI/2.2)

(*Jobner*)

8.2.2.1Jobner

The hybridization breeding programme was started in fennel at Jobner and is in progress. The crossing technique in both the crops has been standardized.

8.3 Coordinated Varietal Trial (FNL/CI/3)

8.3.1 CVT 2001 - Series V (FNL/CI/3.2) (*Jagudan, Jobner, Hisar* and *Kumarganj)*

8.3.1.1 Jagudan

(Final report)

The trial was conducted during rabi season of 2001-02 to 2003-04 with fourteen entries i.e. JF-234, JF-303 & JF-332 from Jagudan; UF-177, UF-178 & UF-179 from Jobner; HF-107 & HF-116 from Hisar; RF-21 & RF-31 from Dholi and NDF-5 & NDF-6 from Kumarganj including two checks GF-2 and GF-11. The trial was laid out in a randomized block design with four replications. The observation were recorded for plant height, 50% flowering days, maturity day, branches per plant, umbels per plant, umbellate per umbel, seeds per umbellate, test weight, volatile oil and yield. The yield differences were found significant among entries. But none of the entry gave significantly superior yield than check. However, an entry JF-332 gave maximum yield (2181 kg ha^{-1}). It was 5.67 per cent higher over check.

The mean data of three years (2001-02 to 2003-04) on different yield attributing and other characters is presented in Table 200. The mean days to 50 % flowering ranged from 89 (GF-2) to 101 days (RF-21), plant height from 144.8 (NDF-5) to 168.1 cm (HF-116), branches per plant from 6.7 (JF-234) to 8.4 (NDF-6 & GF-2), umbels per plant from 13.9 (HF-107) to 22.6 (UF-178), umbellates per umbel from 23.4 (NDF-6) to 31.2 (RF-21), seeds per umbellate from 22.8 (HF-116) to 32.1(RF-21), maturity days from 134 (JF-303) to 165 (NDF-5), test weight from 6.51 (NDF-5) to 8.36 gm (GF-2) and volatile oil from 1.68% (JF-303) to 2.90% (NDF5).

The significant yield differences among entries were observed. But, none of the entry had given significantly superior yield than check. However, entry JF-332 had recorded maximum yield (2233 $kgha^{-1}$) than check GF-2 & GF-11 which was 13.70 and 10.11 per cent higher over GF-2 and GF-11, respectively (Table 200).

The pooled over three years data showed significant result for yield among entries. But none of the entry gave significant higher yield over check. However, an entry JF-332 gave more yields (2233 kg ha^{-1}) than check, which was 13.70 per cent higher than check (Table 201).

Table 200. Performance of fennel accessions under CVT (Mean of three years) - Jagudan

Entry	50% flowering	Maturity (days)	Plant height (cm)	Branches/ plant	Umbels/ plant	Umbellate/ Umbel	Seed / Umbellate	Volatile oil (%)	Test weight (gm)	Yield (kg ha^{-1})	% of increase over control	
											GF2	Gf11
JF-234	94	135	161.2	6.7	19.0	26.9	26.3	1.73	8.34	2031	3.41	1.48
JF-303	92	134	155.3	7.2	18.8	26.3	25.0	1.68	7.78	1958	-	-
JF-332	92	136	162.3	7.1	16.2	29.7	27.5	1.94	8.15	2233	13.70	10.11
UF-177	100	145	154.7	7.7	14.5	27.4	23.5	2.33	7.63	1590	-	-
UF-178	96	146	149.5	7.8	22.6	24.7	25.5	1.89	8.07	1787	-	-
UF-179	95	139	146.9	8.2	19.6	28.2	26.7	1.97	8.12	1926	-	-
HF-107	99	157	165.7	7.5	13.9	30.7	29.5	2.40	8.14	1621	-	-
HF-116	100	145	168.1	7.3	16.8	29.9	22.8	2.25	7.05	1672	-	-
RF-21	101	148	159.5	7.2	14.8	31.2	32.1	2.05	7.18	1453	-	-
RF-31	95	145	149.3	7.1	16.8	27.6	30.2	2.40	7.13	1760	-	-
NDF-5	100	166	144.8	8.3	14.2	26.3	26.0	2.90	6.51	930	-	-
NDF-6	92	161	147.6	8.4	18.8	23.4	28.6	2.15	6.73	1390	-	-
GF-11 (C)	93	138	156.2	7.3	18.4	28.0	24.8	1.87	8.32	2028	3.26	-
GF-2 (C)	89	140	149.8	8.4	20.8	26.0	24.9	1.80	8.36	1964		
S.Em. ±										168		
CD at 5%										493		
CV %										13.58		

* Mean of two years (2001-02 & 2003-04)

Table 201. Performance of fennel accessions under CVT (2001-02 to 2003-04) - Jagudan

Treatment	Yield (kg ha^{-1})				% Increase over check	
	2001 - 02	2002 - 03	2003 - 04	Average	GF-2	GF-11
JF-234	1949	2155	1990	2031	3.41	1.48
JF-303	1810	2198	1866	1958	-	-
JF-332	2201	2318	2181	2233	13.70	10.11
UF-177	1649	1599	1522	1590	-	-
UF-178	1669	1619	2074	1787	-	-
UDF-179	1944	1912	1922	1926	-	-
HF-107	*	1682	1561	1621	-	-
HF-116	1797	1717	1503	1672	-	-
RF-21	1393	1504	1463	1453	-	-
RF-31	1749	1934	1599	1760	-	-
NDF-5	* *	1011	849	930	-	-
NDF-6	* *	1408	1372	1390	-	-
GF-11 (check)	2049	1973	2064	2028	3.26	-
GF-2 (check)	1875	2031	1986	1964		
SEm±	104	147	110	168		
CD at 5%	300	423	313	493		
CV%	12.47	15.57	12.80	13.58		

* Seeds were not germinated ** Seeds were not available

8.3.1.2Kumarganj

The trial initiated at this centre during 2001. The observations were recorded on yield and yield attributing characters. NDF-5 out yielded other 20 germplasm tested yielding 1.94 t ha^{-1} of fennel seeds followed by RF-31 (1.83 t ha^{-1}) during 2003-04. The per cent increase in yield was 30.87% over local check in NDF-5. The mean seed yield of three years yield were pooled and analysed presented in Table 202. Maximum yield of 2.67 t ha^{-1} was obtained in J.Fenu-210 in four years mean pooled data.

Table 202. Performance of fennel accessions under CVT (2000 - 01 to 2003 - 04) - Kumarganj

Entry	Seed yield (q ha^{-1})				Total	Mean
	2000 - 01	2001 - 02	2002 - 03	2003 - 04		
RMT-1	19.00	16.67	19.79	19.30	74.76	18.69
J.fenu-195	21.91	18.40	11.10	11.90	63.31	15.82
J.fenu-204	20.67	14.93	13.19	13.40	62.19	15.54
J.fenu-210	21.75	22.22	19.44	19.30	82.71	20.67
K. Selection (check)	21.88	13.19	12.84	13.50	60.91	15.22
CD at 5%	0.90	4.23	4.21	-	-	-
CV %	-	18.84	15.48	-	-	-

8.3.1.3Jobner

The trial was initiated at Jobner with 12 entries in RBD during Rabi 2001-2002. The analysis of variance revealed significant differences among the entries for all the characters studied. The mean days to flowering ranged from 118 (UF-178 UF-179) to 128.3 days (Local check), plant height from 107 (RF-101 check) to 153.3 cm (HF-107), branches per plant from 4.87 (Local check) to 7.73 (UF-178), umbels per plant from 9.40 (NDF-5) to 22.6 (UF-178), umbellets per umbel from 15.73 (Local check) to 25.2 (UF-178), seeds per umbel from 168.7 (Local check) to 361.9 (UF-178) and test weight from 3.67 (NDF-5) to 6.49 gm (RF-101). During 2002-2003, the entry UF-178 recorded maximum seed yield of 1675 kg ha^{-1} followed by UF-177 (1675 kg ha^{-1}), Rf-101 check (1425 kg ha^{-1}), HF-107 (1410 kg ha^{-1}) and UF-179 (1408.33 kg ha^{-1}). The lowest yield of 1226.67 kg ha^{-1} was recorded in Local check.

Mean performance of the entries over 2001-2002 and 2002-2003 presented in Table 203 revealed superior performance of UF-178 yielding 1677 kg ha^{-1} followed by UF-177 (1451 kg ha^{-1}), HF-107 (1410 kg ha^{-1}) and NDF-5 (1392.32 kg ha^{-1}), while lowest mean yield of 929.84 kg ha^{-1} was recorded in Local check.

Table 203. Performance of fennel accessions under CVT (2001-02 to 2002-03) - Jobner

Entries	Yield (kg ha^{-1})		
	2001 - 2002	2002 - 2003	Mean
UF-178	1680	1675.00	1677.50
UF-177	1387	1515.00	1451.00
HF-107	NG	1410.00	1410.00
NDF-5	-	1392.33	1392.32
JF-332	1390	1390.00	1390.00
RF-101 check	1333	1425.00	1379.00
UF-179	1283	1408.33	1345.67
NDF-6	-	1315.00	1315.00
HF-116	1200	1387.67	1293.84
JF-234	1183	1358.33	1270.67
JF-303	1100	1369.67	1234.84
Local check	733	1126.67	929.84
CD at 5%	119	190.34	
CV (%)	5.67	10.722	

8.3.1.4Hisar

The CVT was started with 14 entries in RBD during 2001-2002. During 2002-2003, the significant differences were obtained for all the parameters. Plant height ranged from 114.0 to 133.6, number of branches 7.1 to 8.7, umbels per plant 22.5 to 31.8, umbellets per umbel 18.5 to 24.5 and seeds per umbel 200.9 to 293.0. On the basis of average yield of two years (2001-02 & 2002-03) at Hisar (Table 204) the maximum seed yield was recorded as 1900 kg ha^{-1} in UF-178 followed by RF-15 and HF-116.

Table 204. Yield performance of fennel accessions under CVT (Pooled data 2001 - 02 to 2002 - 03) - Hisar

Entries	Seed yield (kg ha^{-1})			% increase over check
	2001 - 2002	2001 - 2002	Mean	
RF-13	1595	-	1595	4.04
RF-15	1833	-	1833	19.57
RF-16	1687	-	1687	10.04
RF-21	-	1250	1250	-18.46
RF-31	-	1625	1625	6.00
HF-107	1883	1643	1763	15.00
HF-116	1677	1880	1778	15.98
JF-234	1572	1557	1564	2.02
JF-303	1330	1553	1441	-6.00
JF-332	1450	1620	1535	0.13
UF-177	1500	1587	1543	0.65
UF-178	2000	1800	1900	23.94
UF-179	1625	1607	1616	5.41
NDF-5	-	1542	1542	0.59
NDF-6	-	1565	1565	2.09
Local check	1562	1505	1533	—
GF-2	1521	1548	1534	0.06
CD at 5%	218	113	—	—

8.4 Varietal Evaluation Trial (FNL/CI/4)

8.4.1 Initial evaluation trial (FNL/CI/4.1) (*Hisar, Jobner* and *Jagudan*)

8.4.1.1 Hisar

The initial evaluation trial (IET) in fennel was conducted with ten accessions along with GF-1 as check during 2001-2002 and 2002-2003 in plots measuring 3.0 x 2.4 m in RBD. The results indicated that HF-118 and HF-125 gave significantly better yield over GF-1 (check) showing 27.9 and 36.4% increase in yield, respectively (Table 205).

Table 205. Performance of fennel germplasm accessions (IET) - Hisar

Accession number	Seed yield (kg ha^{-1})			% increase over check
	2001 - 2002	2001 - 2002	Mean	
HF-118	20.40	19.00	19.70	27.9
HF-119	19.60	19.40	19.50	26.6
HF-120	18.00	18.00	18.00	16.9
HF-125	20.80	21.20	21.00	36.4
HF-131	21.00	16.20	18.60	20.8
HF-135	20.10	17.20	18.60	20.8
HF-138	16.20	16.50	16.30	5.8
HF-155	18.10	20.00	19.00	23.4
HF-162	19.80	19.00	19.40	26.0
HF-170	17.70	15.20	16.40	6.5
GF-1 (check)	*15.80*	*15.10*	*15.40*	-
CD at 5%	1.40	1.10	-	-

8.4.1.2Jobner

The trial was started with 12 entries in RBD during Rabi 2002-2003. The analysis of variance revealed significant differences among the entries for most of the characters studied except days to flowering, plant height and umbellets per umbel. The mean days to flowering ranged from 69.7 (UF-33, UF-131 and Local check) to 72.7 days (UF-136), plant height from 93.5 (UF-33) to 104.9 cm (HF-175), branches per plant from 4.0 (Local check) to 6.23 (UF-128), umbels per plant from 7.0 (Local check) to 20.5 (UF-95), umbellets per umbel from 12.33 (Local check) to 27.33 (UF-136), seeds per umbel from 130.1 (Local check) to 190.7 (UF-136) and test weight from 4.10 (UF-175) to 6.73 gm (RF-101 check). The entry UF-175 recorded maximum seed yield of 986.33 kg ha^{-1} followed by UF-131 (979.33 kg ha^{-1}), UF (M)-1 (918.33 kg ha), UF-145 (812.67 kg ha^{-1}), UF-119 (798.33 kg ha^{-1}) and UF-176 (743.33 kg ha^{-1}). The lowest yield of 481 kg ha^{-1} was recorded in Local check.

8.4.1.3Jagudan

The trial was undertaken with ten entries i.e. JF-311, JF-341, JF-376, JF-391, JF-421, JF-444-1, JF-444-2, JF-450, JF-472, from germplasm of this station for three years including GF-2 as a check at Main Spices Research Station, SDAU, Jagudan during 2001-02 to 2003-04 in randomized block design with three replications.

Data were collected on days to 50 % flowering, plant height, number of branches per plant, umbels per plant, umbellates per umbel, seeds per umbellate, volatile oil %, test weight, maturity days and grain yield.

The mean data of different characters were presented in Table 206 during the year 2001-02 to 2003-04. The mean days to 50 % flowering ranged from 89 (JF-391 & JF-311) to 105 days (GF-11), plant height from 149.3 (GF-2) to 163.7 cm (GF-11), branches per plant from 5.3 (GF-11) to 8.3 (GF-2), umbels per plant from 8.1 (GF-11) to 19.4 (GF-2), umbellates per umbel from 26.2 (JF-341) to 32.7 (JF-472), seeds per umbellate from 24.4 (JF-444-1) to 29.2 (JF-450), maturity days from 133 (GF-1) to 149 days (JF-472), test weight from 6.55 (JF-376) to 7.95 gm (JF-341) and volatile oil from 1.59 (JF-376) to 2.11% (JF-472).

The average data shown significant yield differences due to entries. An entry JF-421 recorded significantly higher yield (2829 kgha^{-1}) than checks GF-2 & GF-11 followed by JF-444-1, JF-376, JF-391 and JF-341 (Table 206). On the bases of the results, the entries JF-421, JF-444-1 and JF-376 have been proposed for inclusion in CVT during 2004-05.

Table 206. Performance of fennel germplasm accessions under IET- Jagudan

Entry	50% flowering	Maturity (days)	Plant height (cm)	Branches/ plant^{-1}	Umbels/ plant^{-1}	Umbellate/ Umbel^{-1}	Seed / Umbellate^{-1}	Volatile oil (%)	Test weight (gm)	Yield (kg ha^{-1})	% of increase over control	
											GF2	Gf11
JF-311	89	135	155.6	7.3	13.9	28.7	25.3	2.05	7.19	2515	-	20.33
JF-341	90	137	159.1	7.9	16.2	26.2	25.8	1.85	7.95	2586	2.17	23.73
JF-376	90	138	153.3	7.3	16.7	30.5	27.4	1.59	6.55	2758	8.97	31.96
JF-391	89	134	154.5	6.4	14.0	28.8	28.2	1.64	7.24	2687	6.16	28.56
JF-421	92	137	151.0	7.0	14.1	30.2	27.1	1.63	7.02	2829	11.77	35.36
JF-444-1	92	138	160.2	7.3	15.6	28.5	24.4	1.80	7.36	2788	10.15	33.40
JF-444-2	93	143	151.8	6.4	12.9	29.0	25.8	1.65	7.17	2470	-	18.18
JF-450	98	148	156.1	6.7	12.1	32.3	29.2	1.73	7.71	2216	-	6.03
JF-472	97	149	152.9	6.7	10.5	32.7	28.6	2.11	7.19	2185	-	4.55
GF-2 (check)	91	146	149.3	8.3	19.4	27.2	25.6	1.60	7.67	2531	-	21.10
GF-11 (check)	105	142	163.7	5.3	8.1	28.6	26.7	1.95	7.34	2090	-	-
GF-1 (check)	93	133	157.0	5.5	9.1	31.3	28.9	1.40	7.70	1860	-	-
SEm ±										92		
CD at 5%										261		
CV %										10.85		

The mean days to 50 % flowering ranged from 89 (JF-391 & JF-311) to 105 days (GF-11), plant height from 149.3 (GF-2) to 163.7 cm (GF-11), branches per plant from 5.3 (GF-11) to 8.3 (GF-2), umbels per plant from 8.1 (GF-11) to 19.4 (GF-2), umbellates per umbel from 26.2 (JF-341) to 32.7 (JF-472), seeds per umbellate from 24.4 (JF-444-1) to 29.2 (JF-450), maturity days from 133 (GF-1) to 149 days (JF-472), test weight from 6.55 (JF-376) to 7.95 gm (JF-341) and volatile oil from 1.59 (JF-376) to 2.11% (JF-472).

The average data shown significant yield differences due to entries. An entry JF-421 recorded significantly higher yield (2829 kgha^{-1}) than checks GF-2 & GF-11 followed by JF-444-1, JF-376, JF-391 and JF-341. On the bases of the results, the entries JF-421, JF-444-1 and JF-376 have been proposed for inclusion in CVT during 2004-05.

The trial was started during 2001-02 for find out high yielding variety of fennel. The results of previous years data shown that an entry JF-421 gave significantly superior yield (3119 kg ha^{-1}) than check JF-2.

The significant yield differences were observed due to entries. But none of the entry recorded significant superior yield than check. However, the entries JF-376 (2271 kg ha^{-1}), JF-421 (2247 kg ha^{-1}) and JF-444-1 (2194 kg ha^{-1}) found promising than other entries.

Pooled over three years data showed that an entry JF-421 gave significantly superior yield (2829 kg ha^{-1}) than GF-2, which was 11.77 per cent higher above GF-2. The yield of an entry JF-421 was at par with JF-444-1, JF-376 and JF-391 (Table 207).

Table 207. Performance of fennel accessions under IET (pooled data) – Jagudan

Treatment	Yield (kg ha^{-1})				% Increase over check	
	2001 - 02	2002 - 03	2003 - 04	Mean	GF-2	GF-11
JF-311	2569	2838	2138	2515	-	20.33
JF-341	2650	2905	2203	2586	2.17	23.73
JF-376	2928	3076	2271	2758	8.97	31.96
JF-391	2517	3330	2214	2687	6.16	28.56
JF-421	2876	3362	2247	2829	11.77	35.36
JF-444 - 1	3038	3131	2194	2788	10.15	33.40
JF-444 - 2	2668	2937	1806	2470	-	18.18
JF-450	2049	2569	2030	2216	-	6.03
JF-472	2211	2688	1657	2185	-	4.55
GF-2 (check)	2506	3024	2064	2531	-	21.10
GF-11 (check)	-	-	2090	2090	-	-
GF-1 (check)	-	-	1860	1860	-	-
SEm ±	100	233	112	92		
CD at 5%	297	NS	327	261		
CV%	6.65	13.49	9.36	10.85		

8.4.2 Comparative yield trial (CYT) (FNL / CI / 4.2)

(*Dholi*)

8.4.2.1 *Dholi*

This experiment was also failed due to sever attack of the above insect.

8.5 Quality Evaluation Trial (FNL/CI/5)

8.5.1 Quality evaluation in fennel (FNL / CI / 5.1)

(*Jobner*)

8.5.1.1 Jobner

The volatile oil content in the 11 entries of CVT estimated during 2002-03 ranged from 2.08% to 2.50%. The maximum volatile oil of 2.50% was observed in HF-116 followed by 2.42% in UF-177, 2.33% in NDF-6 and local check, 2.29% in JF-303 and minimum of 2.08% in UF-178 and RF-101 (Table 208). The entries UF-177, F-116 and UF-178 have shown better performance as compare to best check; RF-101 with respect to volatile oil content and seed yield.

The mean performance of two years data indicate that the mean volatile oil content ranged from 2.24% to 2.65%. The promising entries for volatile oil content with respect to best checks local, are found to be HF-116 and UF-177 (Table 208).

Table 208. Volatile oil content of entries of fennel under CVT (2002 & 03) - Jobner

Entry	Mean grain yield (kg ha^{-1})	Volatile oil %			Mean volatile oil yield (l ha^{-1})
		2001	2002	Mean	
UF-177	1451	2.80	2.42	2.61	37.87
UF-178	1678	2.50	2.08	2.29	38.42
UF-179	1346	2.60	2.16	2.38	32.03
JF-234	1271	2.60	2.16	2.38	30.24
JF-303	1235	2.46	2.29	2.38	29.39
JF-332	1390	2.53	2.25	2.39	33.22
HF-116	1294	2.80	2.50	2.65	34.29
RF-101	1382	2.40	2.08	2.24	30.95
Local	930	2.46	2.33	2.40	22.32

The volatile oil content of the entries in IET at Jobner ranged from 2.3% to 2.8%. The maximum volatile oil content of 2.8% was recorded in UF-175 and UF-176 followed by UF-128 (2.6%), UF-145, UF-33. UF-95 (2.5%) and minimum of 2.3% was in UF-131. Entries grown at Hisar.

Eleven (11) entries of fennel were also received from Hisar centre for evaluating the volatile oil contents. The volatile oil content was found in the range of 2.2% to 2.4%. Some of the common entries, which were also grown at Jobner, were compared for volatile oil contents (Table 209). The volatile oil content was found to be much higher in entries grown at Jobner as compared to entry grown at Hisar.

Table 209. Comparison of volatile oil in fennel grown at Jobner and Hisar

Entry	Volatile oil (%)	
	Jobner	Hisar
UF-177	2.80	2.40
HF-116	2.80	2.40
UF-179	2.60	2.20
JF-234	2.60	2.15
JF-332	2.53	2.25
UF-178	2.50	2.40
JF-303	2.46	2.40
Local	2.46	2.20
GF-1	-	2.30
PF-35	-	2.30
HF-107	-	2.20

The experiment on, effect of bio-fertilizer (*Azospirillum*) on yield of fennel was conducted at Jobner. These entries were evaluated for volatile oil contents to know the effect of bio-fertilizer on volatile oil content. On observing the Table 210, it may be concluded that bio-fertilizer does not affect the volatile oil content in coriander as well as in fennel.

Table 210. Effect of biofertilizer on volatile oil of fennel - Jobner

Treatment	Volatile oil %		
	2001-02	2002-03	Mean
T_1 - 100% N + A + 5t FYM	2.00	2.00	2.000
T_2 - 75% N + A + 5t FYM	2.00	2.00	2.000
T_3 - 50% N + A + 5t FYM	2.10	2.15	2.125
T_4 - 0 + A + 5t FYM	2.00	2.05	2.025
T_5 - 0 + 0 + 5t FYM	1.90	2.00	1.950
T_6 - 0 + A + 10t FYM	2.00	2.00	2.000
T_7 - 0 + 0+ 10t FYM	2.00	2.00	2.000
T_8 - 100% N + 0 + 0	2.06	2.15	2.105
T_9 - 0 + A + 0	2.00	2.00	2.000
T_{10} - 0 + 0 + 0	2.00	2.00	2.000

N= Inorganic Nitrogen A= *Azospirillum*

8.6 Nutrient Management Trial (FN L/ CM / 1)

8.6.1 Efficacy of biofertilizer using *Azospirillum* and Psolubiliser in fennel (FNL CM/1.2)

(*Kumarganj, Jobner* and *Jagudan*)

8.6.1.1Kumarganj

The trail was initiated during 2001 in RBD with 8 treatments with 3 replications. The trial continued during 2003-2004 and yield and yield attributing characters were recorded. Application of 10 t ha FYM alone (T6 treatment) in field gave maximum yield of 1.34 t ha^{-1} of fennel seeds showing an

increase of 36.66% of seed yield over controls. In four years mean pooled data, 2000-2001 to 2003-2004 presented in Table 211 also confirmed that application of 10 kg FYM (T6 treatment) alone gave maximum yield of 1.26 t ha^{-1} which was higher than yield (1.26 t ha^{-1}) by application of inorganic nitrogen (50%) + *Azospirillum* + 5 t ha^{-1} of FYM (T3 treatment). There was no significant difference in yield in both treatment (Table 211).

Table 211. Effect of biofertilizer, *Azospirillum* on yield of fennel (Pooled data 2000-01 to 2003-04) - Kumarganj

Treatment	Seed yield (q ha^{-1})				Mean
	2000-01	2001-02	2002-03	2003-04	
T_1 = Inorganic N (100% +*Azospirillum* (50g) + 5 kg FYM	17.52	10.06	7.29	11.040	11.47
T_2= Inorganic N (75% + *Azospirillum* (50g) + 5 kg FYM	16.94	8.19	8.67	10.900	11.47
T_3= Inorganic N (50%) +*Azospirillum* (50g) + 5kg FYM	16.66	9.37	11.80	11.250	12.27
T_4= FYM (5kg)+ *Azospirillum* (50g)	16.38	8.54	9.72	10.830	11.36
T_5= FYM (5kg)+ *Azospirillum* (50g)	13.61	6.25	15.27	12.780	11.97
T_6= FYM (10kg)+ *Azospirillum* (50g)	16.65	5.55	14.92	13.470	12.64
T_7= FYM (10kg)+ *Azospirillum* (50g)	14.00	5.20	13.19	12.500	11.22
CD at 5%	1.01	1.89	NS	0.047	-
CV (%)	-	20.29	27.61	0.130	-

8.6.1.2 Jobner

The experiment was started with 10 treatments in RBD during 2000-2001. During 2002-2003 the maximum seed yield of fennel was recorded with the application of inorganic N (100%) + *Azospirillum* + 5 t FYM/ha and at par with that of 75% inorganic N + *Azospirillum* + 10 t FYM/ha and 100% inorganic N alone but significantly higher over rest of the treatments.

Three years pooled data followed similar trend with an exception wherein 50% inorganic N + *Azospirillum* + 5 t FYM ha^{-1} also recorded seed yield at par with 100% inorganic N + *Azospirillum* + 5 t FYM ha^{-1} (Table 212).

Table 212. Effect of biofertilizer, *Azospirillum* on yield of fennel - Jobner (2000-2001to 2002-2003)

Treatment	Seed yield (q ha^{-1})			Mean
	2000-01	2001-02	2002-03	
Inorganic N (100%) +*Azospirillum* + 5 t FYM ha^{-1}	1141	1111	1392	1215
Inorganic N (75%) + *Azospirillum* + 5 t FYM ha^{-1}	1086	1173	1178	1146
Inorganic N (50%)+ *Azospirillum* + 5t FYM ha^{-1}	1051	1065	1130	1082
Azospirillum + 5 t FYM ha^{-1}	999	895	1071	988
5 t FYM ha^{-1} alone	919	903	1059	960
Azospirillum + 10 t FYM ha^{-1}	1188	872	1166	1075
10 t FYM ha^{-1}	1077	880	1083	1013
Inorganic N (100%) alone	925	895	1333	1051
Azospirillum 1.5 kg ha^{-1} alone	879	826	1059	921
Control	801	733	916	817
CD at 5%	104	114	242	166

8.6.1.3 Jagudan

Not reported

9. FENUGREEK

In fenugreek 9 projects are in progress at 35 centres of the AICRPS

9.1 Genetic resources (FGK/CI/1)

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

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

9.1.1.1Hisar

Seventy nine germplasm collections of fenugreek were evaluated using local, Pusa Early Bunching and Hisar Sonali as checks during 2002-03. The seed yield ranged from 1.11 q ha^{-1} (GC-51) to 22.24 q ha^{-1} (GC-14 and GC-113). Twenty five lines gave higher yield than Pusa Early Bunching and 11 genotypes out yielded Hisar Sonali. The most promising lines were given in Table 213.

9.1.1.2Guntur

The project was initiated during the year 1975-1976. During 2003-04 rabi fifty four accessions of fenugreek were evaluated in simple observational plots. The yield data and growth parameters of all the accessions were recorded. Among the accessions evaluated LFC-85 recorded highest yield of 1082 kg ha^{-1} followed by LFC-108, LFC-80, LFC-72 and LFC-114 with 1075, 1062, 1045 and 1038 kg ha^{-1} respectively. The check variety Lam Selection -1 recorded an yield of 851 kg ha^{-1}.

9.1.1.3Kumarganj

The trial was started during 1997-98. At present the centre maintains 60 accessions. Among them maximum yield of 2.68 t ha^{-1} was observed in NDM-25 followed by NDM-19 (2.27 t ha^{-1}) during 2003-04 (Table 214).

Table 213. Yield of promising fenugreek germplasm accessions - Hisar

Accession number	Yield
GC - 14	22.24
GC - 16	20.85
GC - 36	06.04
GC - 44	11.12
GC - 45	15.29
GC - 46	03.26
GC - 74	21.40
GC - 76	24.19
GC - 78	20.85
GC - 79	20.85
GC - 95	03.47
GC - 97	09.45
GC - 111	18.05
GC - 113	22.24
GC - 115	20.85
GC - 129	21.41
GC - 201	04.57
GC - 203	07.79
GC - 205	03.89
GC - 206	07.23

Table 214. Yield of promising fenugreek germplasm accessions - Kumarganj

Germplasm	Yield (t ha^{-1})
NDM - 1	2.04
NDM -7	2.12
NDM - 9	2.06
NDM - 16	2.02
NDM - 17	2.09
NDM - 19	2.27
NDM - 25	2.68
NDM - 26	2.07
NDM - 57	2.07
NDM - 59	2.18
CD at 5%	0.24
CV (%)	9.02

9.1.1.4Jobner

Out of the 23 entries screened against powdery mildew at farmers field at Danta, variety UM-305 and UM-351 found free from disease and rest others were found resistant to highly susceptible (Table 215).

Table 215. Screening of fenugreek varieties against powdery mildew at farmers field - (2002-2003) - Jobner

Mildew Score	Nature of infection	Varieties
0	No disease observed	UM-305 and UM-351
1	A few scattered plants mildewed; no more than 1 or 2 patches per plant	NS-4, RTP-5, RTP-8, RMt-303 and RTP-2,
2	Upto 10 patches per plant	AL-47 and AL-48
3	Above 50 patches per plant	NS-2 and UM-352
4	Nearly every leaflet infected	UM-143 and RMt-1
5	Every plant affected, field appears green flecked with brown patches	HM-376 and NS-3
6	About 75% of plants infected	JF-244 and JF-270
7	Only some leaves on plants not infected but stems green	HM-65 and HM-376
8	Leaves, leaflets and stem are infected	NS-7 and HM-372
9	All plants infected with mildew	NS-6 and Local

9.1.1.5Dholi

The programme was initiated in 1992. Ninety seven accessions of fenugreek germplasm were tested for selecting promising line in respect of yield and quality. The seed yield of germplasm varied from 1.9 g per plant to 7.2 g (RM-15) per plant.

Twenty two genotypes were tested at the centre for un-irrigated area. Genotype RM-5/90 gave significantly higher yield i.e. 0.78 t ha^{-1} than other entries in (un-irrigated) rainfed area. The grain yield of all entries varied between 0.50 t ha^{-1} to 0.78 t ha^{-1}.

The trial was initiated in RBD with 22 entries during 2002-2003. During 2003-2004, the genotypes have significant differences for all the characters under study. The genotype RM-5/90 proved its superiority to all other characters regarding number of branches per plant (5.67), number of pods per plant (45.87), number of grains per pod (16.20), seed yield per plot (0.56 kg) and per hectare (0.78 t) followed by genotype RM-15. The maximum plant height (84.73 cm) was recorded with RM-15 followed by RM-5/90 (82.47 cm).

9.1.1.6Jagudan

The 63 entries including GM-1 as check were evaluated as per morphological characters and the germplasm were classified (Table 216). Among them 7 entries were found dwarf type having less than 55 cm plant height. Eleven entries had recorded more than 7

branches per plant. Thirteen entries were found more than 60 pods per plant. Long pod length i.e. > 11 cm and more seed per pod i.e. > 17 were found 4 and 6 entries, respectively. The nine entries were matured before 115 days. Seven entries were bold seeded type i.e. more than 14 g weight of thousand seeds. Five entries recorded highest yield i.e. more than 2122 kg ha^{-1}.

Table 216. Classification of fenugreek germplasm - Jagudan

Character	Range	*GM-1	Plant height (cm)	No. of entry	Promising entries identified
Plant height (cm)(Dwarf)	42-83	65	£ 55	7	JFenu-196, 205, 206, 209, 210
Length of Pods (cm) (Long pods)	8-13	9	> 11	4	JFenu-15, 52, 191, 213
No. of Seeds/Pod (More seeds)	10-19	14	> 17	6	JFenu-52, 180, 191, 210, 212, 215
Maturity days (Early)	109-137	120	< 115	9	Anantpur, 7, 181, 183, 184, 185, 240, 241, 249
Test Weight (gm) *(Bold seeded)*	*11-15*	*13.5*	*> 14*	7	*JFenu-148, 212, 215,* 217, 219, 239, 247
Harvest Index	23-39	25	> 35	6	JFenu-77, 178, 194, 205, 241, 249
Grain Yield (kg ha^{-1}) (High yield)	894-3200	2122	> 2667	5	Anantpur, JFenu-7, 77, 178, 221

* check

Four collections during the year were made from farmer's field of Saurashtra and Market of Panchmahal districts of the state for their useful characters. During the season following selections were made from the field of this station for their morphological characters (Table 217). Seeds of single plant were harvested and will be sown in the next season for further evaluation.

Table 217. New fenugreek germplasm collections – Jagudan

Characters	No. of entry
Early type	2
Dwarf type	2
More branches	3
More pods	4
Bold seeded	4
More leaf	6
Two pods per node	2
High yield	4
Others	5
Total	32

During the year, 32 entries were screened for the resistance against powdery mildew disease (caused by: *Erysiphe polygoni* and *Leveillula taurica*). Only the entry, Kasuri was found free from the disease incidence and followed by JFenu-193 (7.50 %), JFenu-272 (8.75 %), Acc-275 (8.75 %) and HM-444 (10.00%). The other entries showed moderate incidence of powdery mildew.

9.2 Hybridization Trial (FGK/CI/2)

9.2.1 Evolving varieties resistant to powdery mildew (FGK/CI/2.1)
(*Jagudan* and *Jobner*)

9.2.1.1Jagudan

Not reported.

9.2.1.2*Jobner*

The hybridization breeding programme was started in fenugreek. The crossing technique in both the crops has been standardized. In fenugreek the crosses were made among adaptable varieties vs resistance lines and also among determinate vs. indeterminate type to get good transgressive segregants. By pedigree method few lines were identified as promising one and will be included in IET. Besides this inheritance of multipodedness and determinate type was also determined. Further work on hybridization/heterosis is in progress in fenugreek.

9.3 Coordinated Varietal Trial (FGK/CI/3)

9.3.2 CVT - 1995 Series III (FGK/CI/3.1)
(***Guntur***)

9.3.2.1Guntur

Not reported.

9.3.3 CVT 1999 - Series IV (FGK/CI/3.2)
(*Hisar, Kumarganj* and *Dholi*)

9.3.3.1Hisar

During 2002-2003, the trial was started with 12 entries in RBD, replicated thrice. The significant differences were obtained for all the parameters studied. Plant height ranged from 64.2 to 76.3, number of branches 5.6 to 8.2, number of pods per plant 48.4 to 74.7, length of pods 10.1 to 12.4 and number of seeds per pod 14.7 to 17.4. The results revealed that all the entries significantly increased seed yield over local check except JF-270, UM-351, UM-352 and NDM-25. Maximum seed yield was recorded in Hisar Sonali which was statistically at par with HM-372 and HM-444.

9.3.3.3Kumarganj

Not reported.

9.3.3.4*Dholi*

Not reported.

9.3.4 CVT 2001 Series V (FGK/CI/3.3)
(*Guntur, Kumarganj, Coimbatore, Jobner, Jagudan, Dholi*)

3.4.1 *Guntur*

Eleven promising fenugreek genotypes from other coordinating centers were evaluated in RBD replicated thrice. The yield attributes of all the entries were given in Table 218. Among the entries tested, JF-244 recorded maximum plant height (53.3 cm) and was on par with check Lam Selection -1 (50.9 cm). Number of branches were highest in JF-244 (6.5) followed by check Lam Selection-1 (5.8) which were on par with each other. Numbers of pods were more in JF-244 (31.3) followed by Lam Selection-1 (28.9) which was on par with each other. Lowest number of pods was recorded in HM-444 (16.1). JF-244 recorded maximum pod length (12.1 cm) followed by Lam Selection-1 (11.8 cm) which were on par with each other. Maximum pod

length was recorded in JF-244 (12.1 cm) followed by Lam Selection-1 (11.8 cm) and the lowest was recorded in NDM-19 (9.3 cm). Number of seeds per pod was more in JF-244 (16.4) which was on par with check Lam Selection-1 (15.6) and low in HM-444 (11.5). Among the entries tested, JF-244 recorded significantly highest yield of 1102 kg ha^{-1}. Remaining all the entries recorded lower yield than the check Lam Selection-1 (953 kg ha^{-1}).

9.3.4.2Kumarganj

The trial was laid out in 2001 in RBD with three replications. Out of 22 entries tested, NDM-19 produced maximum seed yield of 2.12 t ha^{-1} with 24.70% increase in yield over check (PEB) HM-25 was next to NDM –19 in seed yield (2.09 t ha^{-1}) during 2003-04. In 4 years pooled study of the most promising accessions compared with the Karimunda selection (check) J.fenu-210 showed maximum seed yield of 2.06 t ha^{-1} followed by RMT-1 (Table 219).

Table 218. Performance of fenugreek accessions under CVT Guntur

Name of the entry	Yield (kg ha^{-1})	% increase over check
HM-65	748.00	-21.5
HM-372	949.00	-0.5
HM-376	940.00	-1.3
HM-444	785.00	-17.6
NDM-19	935.00	-1.9
NDM-25	763.00	-20.0
JF-244	1102.00	15.7
JF-270	846.00	-11.2
UM-351	782.00	-18.0
UM-352	713.00	-25.2
LS-1	953.00	
	142.60	
	9.66	

Table 219. Performance of fenugreek accessions under CVT (2002 to 04)–Kumarganj

Name of entries	2000-01	2001-02	2002-03	2003-04	Total	Mean
RMT-1	19.00	16.67	19.79	19.30	74.76	18.69
J.fenu-195	21.91	18.40	11.10	11.90	63.31	15.82
J.fenu-204	20.67	14.93	13.19	13.40	62.19	15.54
J.fenu-210	21.75	22.22	19.44	19.30	82.71	20.67
K. Selection (check)	21.88	13.19	12.84	13.50	60.91	15.22

9.3.4.3Coimbatore

This project was started during 2001 in RBD and is 3rd year of progress. A total of 22 fenugreek accessions were evaluated for their growth and yield performance during rabi season of 2003 – 2004. CO 2 fenugreek was used as a local check. Observations were taken on growth and yield traits and the results are presented in Table 220.

Among these 21, the acc. JF 270 gave the highest yield of 567 kg ha^{-1}. It was followed by NDM 25 and JF 244 and which recorded an yield of 550.00 and 548 kg ha^{-1} respectively. The acc. UM 352 produced the lowest yield of 370 kg ha^{-1}.

All these accessions were evaluated for their resistance against powdery mildew and root rot diseases. None of entries were resistant

to both the diseases. The accessions PE 13 found to be moderately resistant to root rot, 10 accessions were moderately susceptible and nine accessions were susceptible to the disease. In case of powdery mildew disease four accessions viz. RM 18, UM 352, JF 246 and JF 270 were moderately resistant, seven accessions were moderately susceptible and 11 accessions were susceptible (Table 220).

Table 220. Performance of fenugreek accessions under CVT (2003 - 04) Coimbatore

Acc. No.	Yield (kg ha^{-1})	Yield increase (%)	Root rot		Powdery mildew		
			Incidence (%)	Disease reaction	Disease grade	Disease index	Disease reaction
RM 18	500.00	10.37	35	S	1.5	30	MR
RM 28	545.00	20.30	70	S	3.8	76	S
HM 65	490.00	8.17	57	S	3.5	70	S
HM 372	525.00	15.89	45	S	3.7	74	S
HM 376	510.00	12.58	36	MS	2.5	50	MS
HM 444	537.00	18.54	60	S	2.8	56	MS
UM 351	474.00	4.60	70	S	3.4	68	S
UM 322	440.00	-	83	HS	3.7	74	S
UM 352	370.00	-	32	MS	1.3	26	MR
UM 305	420.00	-	30	MS	2.5	50	MS
UM 321	473.00	20.00	37	MS	3.3	66	S
JF 246	515.00	13.69	35	MS	1.4	28	MR
JF 210	505.00	11.48	60	S	3.6	72	S
JF 270	567.00	25.17	40	MS	1.7	34	MR
JF 244	548.00	20.97	64	S	3.8	76	S
Rajendra kanda	490.00	8.17	55	S	2.3	46	MS
NDM 19	510.00	12.58	80	HS	2.2	44	MS
NDM 25	550.00	21.41	36	MS	2.7	54	MS
K selection	525.00	15.89	35	MS	2.8	56	MS
PE 13	503.00	11.03	20	MR	3.7	74	S
PMT 1	475.00	4.80	37	MS	3.2	64	S
CO 2 local check	453.00		30	MS	3.1	62	S
SEd	9.40						
CD at 5%	23.50						

9.3.4.4Jobner

The trial was initiated with 12 entries in RBD during Rabi 2001-2002. The entry UM-351 recorded the maximum seed yield of 1944.67 kg ha^{-1} followed by Um-352 (1797 kg ha^{-1}), NDM-25 (1745 kg ha^{-1}), JF-244 (1736.33 kg ha^{-1}) and RMt-1 check (1649.67 kg ha^{-1}), while lowest yield of 1146 kg ha^{-1} was recorded in HM-65. Mean performance of the entries evaluated in CVT over 2001-2002 and 2002-2003 revealed superior performance of UM-351 yielding 1806.34 kg ha^{-1} followed by UM-352 (1773.50 kg ha^{-1}), NDM-25 (1745.0 kg ha^{-1}) and JF-244 (1668.17 kg ha^{-1}), while lowest mean yield of 1138 kg ha^{-1} was recorded in local check.

Out of the 12 entries evaluated in CVT, minimum root rot (0.0%), Downy mildew 2 and Powdery mildew 0 score in (0-9 score) in UM-351 followed by UM-352 with the minimum root rot (2.0%), Downy mildew 3 and powdery mildew 2 score was observed with the maximum seed yield of 1944.67 and 1797.00 kg ha^{-1} respectively. Whereas maximum root rot 6% and downy mildew 4 and Powdery mildew 5 was recorded in local check with the minimum seed yield of 1276.0 kg ha^{-1}.

Table 221. Performance of fenugreek entries in CVT – Jobner (2001 - 02 to 02 - 03)

Entries	Yield (kg ha^{-1})			Root-rot(%)	Downy mildew (0-9)	Powdery mildew (0-9)
	2001-02	2002-03	Mean			
UM-351	H 1668	1944.67	1806.34	0.0	2	0
UM-352	1750	1797.00	1773.50	2.0	3	2
NDM-25	-	1745.00	1745.00	2.0	5	3
JF-244	1600	1736.33	1668.17	3.0	3	4
RMt-1 (check)	1667	1649.67	1658.34	10.0	6	5
JF-270	1500	1554.00	1527.00	5.0	4	3
HM-444	-	1519.00	1519.00	8.0	5	4
NDM-19	-	1354.33	1354.33	4.0	3	4
HM-372	-	1345.33	1345.33	6.0	5	3
HM-376	-	1293.33	1293.33	3.0	3	2
HM-65	-	1146.00	1146.00	2.0	4	4
Local check	1000	1276.00	1138.00	6.0	4	5
CD at 5%	137	224.80				
CV (%)	5.01	11.57				

9.3.4.5Jagudan

The trial was started during 2002-03 with 12 entries in RBD to find out high yielding variety of fenugreek. The results of previous years shown that an entry JFenu-244 had given significantly higher yield (2049 kg ha^{-1}) than check, G.Methi-1. Among the entries yield differences were found significant. An entry J.Fenu-270 gave significantly superior yield (2030 $kgha^{-1}$) than control GM-1. It was 15.34 per cent higher over control during 2003-04.

Pooled over two years data showed non-significant differences. However, an entry JFenu-244 gave more yield (1977 $kgha^{-1}$) and was 9.77 per cent higher over check (Table 222).

Table 222. Performance of fenugreek accessions under CVT - Jagudan

Treatment	Yield (kg ha^{-1})		
	2002-03	2003-04	Mean
J.Fenu-244	2049.00	1906.00	1977.00
J.Fenu-270	1838.00	2030.00	1934.00
UM-351	1822.00	1575.00	1698.00
UM-352	1809.00	1674.00	1741.00
HM-65	1361.00	1734.00	1548.00
HM-372	1544.00	1730.00	1637.00
HM-376	1880.00	1947.00	1913.00
HM-444	1931.00	1900.00	1915.00
NDM-19	1657.00	1678.00	1668.00
NDM-25	1649.00	1683.00	1616.00
GM-1 (C)	1838.00	1760.00	1801.00
SEm ±	71.00	80.00	91.00
CD at 5%	205.00	231.00	NS
CV %	8.08	8.98	8.55

9.3.4.6Dholi

Not reported.

9.4 Varietal Evaluation Trial (FGK/CI/4)

9.4.1 Comparative yield trial (CYT) (FGK/CI/4.1)

(Dholi)

9.4.1.1Dholi

The trial was initiated with 13 entries in RBD during 2002-2003. During 2003-2004 the genotypes had significant differences among themselves for plant height, number of branches per plant, number of pods per plant, number of days to maturity and yield. However, for number of grains per pod, the differences were non-significant. The highest plant height 119.92 cm with genotype HM-65 followed by 94.33 cm with genotype J. Fenu-244 was observed. Genotype HM-444 had maximum no. of branches (8.77) followed by 7.40 with genotype HM-65 but maximum number of pods per plant (54.93) was higher with genotype HM-444 followed by 46.87 with genotype NDM-25. The genotype HM-65 was late in maturity (147.0 days) while genotype J. Fenu-270 was earlier (125.0 days). Among the thirteen genotype including check (Rajendra kanti), HM-444 produced higher grain yield (1.69 t ha^{-1}) in comparison to other genotypes and gave 20.71 per cent higher grain yield over check (Rajendra kanti).

9.4.2 Initial evaluation trial (FGK/CI/4.2)

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

9.4.2.1Dholi

The trial was started during 2002-2003 with 8 entries in RBD. During 2003-2004, that there was non significant difference among the genotypes for plant height, number of branches per plant and number of grains per pod. However, significant differences had been recorded for number of pods per plant and grain yield. The maximum number of pods per plant

(45.97) followed by 36.93 and grain yield (1.21 kg plot^{-1} & 1.68 t ha^{-1}) followed by 1.11 kg per plot and 1.50 t ha^{-1} was recorded with genotype RM-70 and RM-18 respectively. The best yielder genotype RM-70 had 19.15 per cent followed by RM-18 (9.22 %) over check (Rajendra kanti). Out of eight entries, RM-70 out yielded (1.68 t ha^{-1}) among all the entries and it gave 19.15 per cent more yield over check (Rajendra kanti).

9.4.2.2Hisar

The initial evaluation trials (IET) in fenugreek was conducted with nine accessions along with Hisar Sonali as check during 2000-2001 to 2002-2003 in plots measuring 3.0 x 1.2 m in RBD. The results given in Table 223 indicated that maximum seed yield was recorded in HM-292 (29.2 q ha^{-1}) followed by HM-232 (25.91 q ha^{-1}) showing an increase of 33.9 & 18.9 % respectively.

Table 223. Performance of fenugreek accessions under IET - Hisar

Accession number	Yield (kg ha^{-1})				% Increase over check
	2000 - 01	2001 - 02	2002 - 03	Mean	
HM-202	21.50	27.00	24.00	24.17	10.80
HM-214	23.00	20.25	21.53	21.59	-0.01
HM-219	20.00	30.00	25.62	25.21	15.60
HM-232	22.50	29.00	26.22	25.91	18.90
HM-241	20.50	20.00	21.25	20.58	-5.60
HM-247	19.00	25.00	22.50	22.17	1.69
HM-292	29.00	30.00	28.60	29.20	33.90
HM-325	21.00	28.50	25.40	24.97	14.50
HM-348	25.50	22.50	24.25	24.08	10.50
Hisar Sonali (C)	21.70	23.20	20.60	21.80	-
CD at 5%	2.10	3.20	1.90	-	-

The trial was started during 2002-2003 with 8 entries in RBD. During 2003-2004, that there was non significant difference among the genotypes for plant height, number of branches per plant and number of grains per pod. However, significant differences had been recorded for number of pods per plant and grain yield. The maximum number of pods per plant (45.97) followed by 36.93 and grain yield (1.21 kg plot^{-1} & 1.68 t ha^{-1}) followed by 1.11 kg per plot and 1.50 t ha^{-1} was recorded with genotype RM-70 and RM-18 respectively. The best yielder genotype RM-70 had 19.15 per cent followed by RM-18 (9.22 %) over check (Rajendra kanti).

9.4.2.3Jobner

The IET of fenugreek was started in *Rabi* 2000-2001 and was concluded in *Rabi* 2002-2003.

The trial consisted of 27 entries and with five checks. The observations were recorded on all the morphological characteristics viz. days to 50% flowering, plant height (cm), branches per plant, pods per plant, pod length, seeds per pod, test weight (g) and seed yield (kg ha^{-1}).

The character wise mean of the year 2002-2003 indicated that entries different significantly for all the characters studied. The mean days to

flowering ranged from 54.0 (NS-3) to 68.3 days (Local check), plant height from 63.9 (UM-305) to 93.9 cm (AL-8 and AL-18), branches per plant from 2.87 (RTP-4) to 7.37 (NS-5), pods per plant from 19.2 (AL-21) to 40.2 (AL-2), pod length from 9.07 (NS-7) to 11.3 (UM-305 check), seeds per pod from 12.6 (Local check) to 16.6 (UM-305 check), test weight from 10.3 (Local check) to 14.5 gm (RTP-6). The entry NS-4 check recorded the maximum seed yield of 2041.67 kg ha^{-1} followed by RTP-5 (2013.67 kg ha^{-1}), RTP-8 (2000 kg ha^{-1}), RTP-2 (1986 kg ha^{-1}) and AL-48 (1930.67 kg ha^{-1}), while lowest yield of 1021 kg ha^{-1} was recorded in NS-6.

The mean seed yield performance of the entries evaluated during 2000-2001, 2001-2002 and 2002-2003 indicated superior performance of RTP-4 i.e. 1518.33 kg ha^{-1} followed by RTP-8 (1477.67 kg ha^{-1}), RTP-9 (1471.33 kg ha^{-1}), AL-48 (1449.22 kg ha^{-1}) and RMt-303 check (1447.22 kg ha^{-1}), while lowest yield of 785.11 kg ha^{-1} was recorded in Local check (Table 224).

Table 224. Mean performance of fenugreek entries evaluated in IET (2000-01 to 2002-03) - Jobner

Entries	Yield (kg ha^{-1})			
	2000-2001	2001-2002	2002-2003	Mean
RTP-4	1010	1670	1875.00	1518.33
RTP-8	1100	1333	2000.00	1477.67
RTP-9	1442	1187	1785.00	1471.33
Al-48	750	1667	1930.67	1449.22
RMt-303 check	1050	1630	1661.67	1447.22
AL-1	1169	1390	1583.33	1380.78
AL-18	1218	1147	1736.33	1367.11
AL-49	896	1390	1798.67	1361.56
UM-305 check	952	1447	1611.00	1336.67
AL-21	742	1550	1632.00	1308.00
AL-47	616	1440	1861.00	1305.67
AL-51	462	1870	1569.67	1300.56
RTP-5	756	1130	2013.67	1299.89
AL-31	770	1500	1611.33	1293.78
RTP-2	644	1093	1986.00	1241.00
AL-45	616	1440	1646.00	1234.00
RTP-1	854	1407	1354.00	1205.00
AL-2	629	1130	1700.00	1153.00
NS-4	434	977	2041.67	1150.89
RTP-6	672	1163	1569.67	1134.89
RMt-143 check	864	1053	1458.33	1125.11
RTP-7	476	1187	1701.33	1121.44
NS-7	868	1297	1194.33	1119.78

Entries	Yield (kg ha^{-1})			
	2000-2001	2001-2002	2002-2003	Mean
RMt-1 check	602	1153	1598.33	1117.78
AL-83	728	923	1666.67	1105.89
AL-103	750	850	1713.00	1104.33
AL-106	588	1297	1423.67	1102.89
AL-8	842	1147	1319.33	1102.78
NS-5	462	1090	1701.67	1084.56
NS-1	413	1297	1514.00	1074.67
RTP-11	434	1443	1180.67	1019.22
RTP-10	448	833	1562.67	947.89
NS-2	602	467	1729.33	932.78
NS-6	378	1147	1021.00	848.67
NS-3	616	787	1090.33	831.11
Local check	560	740	1055.33	785.11
CD at 5%	131	165	167.09	
CV (%)	11.0	8.25	6.38	

The trial was started with 36 entries in RBD having plot size of 4 x 0.6 m during Rabi 2000-2001. During 2002-2003, the entry NS-4 check recorded the maximum seed yield of 2041.67 kg ha^{-1} followed by RTP-5 (2013.67 kg ha^{-1}), RTP-8 (2000 kg ha^{-1}), RTP-2 (1986 kg ha^{-1}) and AL-48 (1930.67 kg ha^{-1}), while lowest yield of 1021 kg ha^{-1} was recorded in NS-6.

Out of the 36 entries evaluated in IET, entry NS-4, RTP-5, RTP-8, RTP-2 and AL-48 found free from root rot, downy mildew and powdery mildew disease, while maximum disease incidence Root rot (10.0%) 5 and 5 score Downy mildew and Powdery mildew in the (0-9 scale) was recorded with the minimum seed yield of 1021.0 kg ha^{-1} in NS-6 followed by local check, Root rot (5.0%), Downy mildew, Powdery mildew 4 & 5 score with the seed yield of 1055.33 kg ha^{-1} (Table 225).

Table 225. Performance of fenugreek entries under IET – Jobner

Entry	Downy mildew (0-9)	Powdery mildew (0-9)	Yield (kg ha^{-1})
AL-1	2	3	1583.33
AL-2	1	2	1700.00
AL-8	3	3	1319.33
AL-18	1	2	1736.33
AL-21	2	2	1632.00
AL-31	2	3	1611.33

Entry	Downy mildew (0-9)	Powdery mildew (0-9)	Yield (kg ha^{-1})
AL-45	2	2	1646.00
AL-47	1	1	1861.00
AL-48	1	0	1930.67
AL-49	1	1	1798.67
AL-51	2	3	1569.67
AL-83	2	3	1666.67
AL-103	3	2	1713.00
AL-106	1	4	1423.67
RTP-1	1	4	1354.00
RTP-2	2	0	1986.00
RTP-4	3	0	1875.00
RTP-5	0	0	2013.67
RTP-6	2	3	1569.67
RTP-7	1	2	1701.33
RTP-8	0	0	2000.00
RTP-9	1	1	1785.00
RTP-10	2	3	1562.67
RTP-11	3	5	1180.67
NS-1	2	3	1514.00
NS-2	1	2	1729.33
NS-3	4	5	1090.33
NS-4	0	0	2041.67
NS-5	2	3	1701.67
NS-6	5	5	1021.00
NS-7	3	5	1194.33
RMt-1 (check)	2	4	1598.33
RMt-143 (check)	3	3	1458.33
RMt-305 (check)	2	2	1611.00
UM-303 (check)	1	0	1447.22
Local (check)	4	5	1055.33

The mean seed yield performance of the entries evaluated during 2000-2001, 2001-2002 and 2002-2003 indicated superior performance of RTP-4 i.e. 1518.33 kg ha^{-1} followed by RTP-8 (1477.67 kg ha^{-1}), RTP-9 (1471.33 kg ha^{-1}), AL-48 (1449.22 kg ha^{-1}) and RMt-303 check (1447.22 kg ha^{-1}), while lowest yield of 785.11 kg ha^{-1} was recorded in local check.

9.4.2.4Guntur

The trial was started with 11 entries replicated thrice in RBD during 2002-2003. Eleven promising Fenugreek genotypes from existing germplasm were selected and were evaluated.

Among the entries evaluated, LFC-84 recorded maximum plant height (48.2 cm) followed by LFC-87 (47.6 cm) and LFC-82 (46.7 cm), which were on par with LFC-84. Lowest plant height was recorded in LFC-77 (37.5 cm) Maximum number of branches was recorded in LFC-84 (5.5) followed by LFC-87 (5.2) which were on par with each other. Lowest number of branches were recorded in LFC-74 (2.8). Number of pods and number of seeds were maximum in LFC-84 (25.6 and 15.6 respectively) followed by LFC-84 (23.2 and 14.1), which were on par with each other and significantly superior to check Lam Selection-1 (18.2 and 9.1 respectively). Regarding pod length, check Lam Selection-1 recorded maximum pod length (14.2 cm) followed by LFC-90 (13.9 cm) and LFC-84 (13.5 cm) were on par with the check. Regarding yield, LFC-84 recorded highest yield of 1175 kg ha^{-1} followed by LFC - 87 (1068 kg ha^{-1}) and significantly superior to check Lam Selection-1 (896 kg ha^{-1}).

9.4.2.5 Jagudan

The trial was started during 2002-2003 with 10 entries, replicated thrice in RBD, of fenugreek to find out high yielding variety. The non-significant yield differences observed among entries during previous years.

The results were found non-significant yield differences among the entries. However, the entries JFenu-273 (1881 kg ha^{-1}) and JFenu-182 (1879 kg ha^{-1}) gave higher yield. Which were 7.00 and 6.88 per cent higher above check, respectively.

The two years pooled results showed non-significant yield differences among entries. However, the entries JFenu-239 (2075 $kgha^{-1}$) and JFenu-273 (2055 $kgha^{-1}$) were found promising. (Table 226).

Table 226. Yield performance of fenugreek entries under IET (2002-03 to 2003-04) - Jagudan

Treatment	Yield (kg ha^{-1})			% increase over check
	2002 - 03	2003 - 04	Mean	
JFenu-182	1898	1879	1889	-
JFenu-193	2213	1746	1980	2.59
JFenu-228	2192	1848	2019	4.66
JFenu-232	1988	1608	1798	-
JFenu-236	2071	1600	1836	-
JFenu-239	2370	1780	2075	7.51
JFenu-258	2071	1793	1932	0.10
JFenu-272	2154	1659	1907	-
JFenu-273	2228	1881	2055	6.48
GM-1 (check)	2102	1758	1930	
SEm ±	93	82	66	
CD at 5%	NS	NS	NS	
CV %	7.60	8.08	7.83	

9.5 Quality Evaluation Trial (FGK/CI/5)

9.5.1 Quality evaluation in fenugreek (FGK / CI / 5.1)

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

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

Not reported.

9.6 Nutrient Management Trial (FGK / CM / 2)

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

(Jobner, Guntur, Coimbatore, Kumarganj, Jagudan)

9.6.1.1 Jobner

The experiment was initiated with 10 treatments in RBD during Rabi 2000-2001 at Jobner. Third years (2002-2003) experimental findings revealed that the maximum grain yield of 19.63 q ha^{-1} recorded with the application of 100% inorganic N which was at par with 100% inorganic N + *Rhizobium* + 5 t FYM ha^{-1} but significantly higher over rest of the treatments.

Pooled analysis of three years data revealed that application of 100% inorganic N (40 N kg ha^{-1}) alone recorded maximum mean yield 13.74 q ha^{-1} which remained at par with 100, 75 and 50% N through inorganic source + 5 t FYM + *Rhizobium*, 10 t FYM + *Rhizobium* and 10 t FYM alone but proved superior to 5 t FYM ha^{-1} *Rhizobium*, 5 t FYM ha^{-1} alone, *Rhizobium* alone and control. (Table 227).

Table 227. Effect of N, FYM and biofertilizer on yield of fenugreek - Jobner

Treatment	Seed yield (kg ha^{-1})			
	2000-01	2001-02	2002-03	Mean
Inorganic N (100%) +*Rhizobium* + 5 t FYM ha^{-1}	801	1451	1844	1365
Inorganic N (75%) + *Rhizobium* + 5 t FYM ha^{-1}	796	1346	1725	1289
Inorganic N (50%) +*Rhizobium* + 5t FYM ha^{-1}	870	1420	1714	1335
Rhizobium + 5 t FYM ha^{-1}	685	1315	1666	1222
5 t FYM ha^{-1} alone	633	1296	1606	1178
Rhizobium + 10 t FYM ha^{-1}	833	1435	1666	1311
10 t FYM ha^{-1}	679	1324	1690	1231
Inorganic N (100%) alone	801	1358	1963	1374
Rhizobium 1.5 kg ha^{-1} alone	648	1250	1547	1148
Control	555	1147	1583	1095
CD at 5%	102	126	204	150

9.6.1.2 Guntur

The experiment was carried out during rabi seasons of 2001-2002, 2002-2003 and 2003-2004 with ten different treatment combinations replicated thrice in R B D.

The pooled data of results of investigation for three years was presented in Table 228. Similar trend in all the treatments was observed for the growth parameters, yield and yield attributing characters. The data indicated that

100%, 75% and 50% N applied along with Rhizobium and FYM @ 5 t ha^{-1} significantly recorded maximum height, more number of pods/plant, maximum pod length and more number of seeds/pod over control.

Among the ten treatments *Rhizobium* inoculation applied along with 100% N and FYM @ 5 t ha^{-1} (T1) gave significantly higher yield (788 kg ha^{-1}) than control (T10) (509 kg ha^{-1}). However, it is on par with 75 % N (T2) (780 kg ha^{-1}) and 50% N (T3) (755 kg ha^{-1}) applied along with 5 t ha^{-1} FYM and *Rhizobium*.

The results revealed that 100 %, 75 % and 50 % of N applied along with *Rhizobium* inoculation and FYM had recorded significant beneficial effect on seed yield due to increase in growth and yield attributing characters in Fenugreek. Among the ten treatments studied *Rhizobium* applied along with 100 % N and FYM @ 5 t ha^{-1} gave significantly higher yield (788 kg ha^{-1}) than control (509 kg ha^{-1}). However, it is on par with 75 % (780 kg ha^{-1}) and 50 % (755 kg ha^{-1}) recommended dose of Nitrogen applied along with 5 t ha^{-1} FYM and *Rhizobium*.

Table 228. Effect of N, FYM and biofertilizers on growth and yield of fenugreek (Pooled data) – Guntur

Name of the treatment	Plant height (cm)	No. of branches	No. pods per plant	No. of seeds per pod	Pod length (cm)	Yield (kg ha^{-1})
T_1- 100% N + Rhizobium + 5 t ha^{-1}FYM	42.62	5.67	25.64	14.54	10.95	788
T_2- 75% N + Rhizobium + 5 t ha^{-1} FYM	42.04	5.42	24.23	13.61	10.75	780
T_3- 50% N + Rhizobium + 5 t ha^{-1} FYM	39.90	5.30	23.73	13.07	10.49	755
T_4- Rhizobium + 5 t ha^{-1} FYM	35.66	4.34	16.37	11.29	9.64	626
T_5- 5 t ha^{-1} FYM Alone	34.88	4.12	13.58	10.74	9.49	558
T_6- Rhizobium + 10 kg FYM	37.39	4.91	18.82	12.33	9.78	647
T_7- 10 kg FYM Alone	35.51	4.51	14.80	11.02	9.85	590
T_8- 100% N	36.58	4.74	13.87	11.82	9.92	617
T_9- Rhizobium only	32.70	3.91	13.40	9.88	9.33	527
T_{10}-Absolute control	31.92	3.83	12.74	9.41	8.99	509
CD at 5%	3.12	0.40	1.79	0.89	1.06	74.53
CV%	4.93	4.98	5.88	4.41	6.22	6.80

9.6.1.3Coimbatore

This project was started during 2000 in RBD with 8 treatments and it is in 4th year of progress. During the period under report 2003–2004 the highest yield of 685.4 kg ha^{-1} was recorded in the treatment (T_1) as against 549 kg ha^{-1} in the control (recommended dose of fertilizer) followed T_2 (632.5 kg ha^{-1}) and T_3 (621.0 kg ha^{-1}). The treatment T_8 recorded the lowest 201.7 kg ha^{-1} (Table 229).

Table 229. Effect of *Azospirillum* and different levels of nitrogen on growth and yield of fenugreek (2003–2004) - Coimbatore

Treatment	Grain yield (kg ha^{-1})
T_1 - Inorganic N (100%) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment+ 5 t FYM	685.4
T_2 - Inorganic N (75%) +*Azospirillum* (1.5 kg ha^{-1}) Seed Treatment + 5 t FYM	632.5
T_3 - Inorganic N (50%) +*Azospirillum* (1.5 kg ha^{-1}) Seed Treatment + 5 t FYM	621.0
T_4 - FYM (5 t ha^{-1}) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment	291.0
T_5 - FYM (5 t ha^{-1}) alone	249.5
T_6 - FYM (10 t ha^{-1}) + *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment	297.1
T_7 - FYM (10 t ha^{-1}) alone	255.3
T_8 - *Azospirillum* (1.5 kg ha^{-1}) Seed Treatment alone	201.7
T_9 - Urea (100%) alone	213.7
T_{10} - Control	549.0
SEd	17.2
CD at 5%	43.0

9.6.1.4Kumarganj

The trial initiated during 2001 was laid out in RBD at Kumarganj. Maximum seed yield of fennel was observed by application of 10 t ha^{-1} of FYM and seed treatment of *Azospirillum* (T6 treatment) yielding 2.13 t ha^{-1} of seed yield during 2003-04 (Table 230). This was followed by application of 75% of inorganic nitrogen + 5 t ha^{-1} of FYM and seed treatment of *Azospirillum* (T2 treatment) producing 1.87 t ha^{-1} seed yield. After four years of study, the mean seed yield was highest (1.94 t ha^{-1}) in T6 treatment by application of 10 t ha^{-1} of FYM and *Azospirillum* (Table 230).

Table 230. Effect of NPK, FYM and *Azospirillum* on yield performance in fenugreek (2000 to 04) - Kumarganj

Treatment	2000-01	2001-02	2002-03	2003-04	Mean
T_1 = Inorganic N (100% + *Azospirillum* (50 g) + 5 kg FYM	20.20	5.56	15.27	15.62	14.16
T_2 = Inorganic N (75%+ *Azospirillum* (50 g) + 5 kg FYM	20.00	10.42	19.44	18.77	17.15
T_3 = Inorganic N (50%) + *Azospirillum* (50 g) + 5 kg FYM	19.85	12.85	15.27	15.61	15.89
T_4 = FYM (5 kg) + *Azospirillum* (50 g)	19.05	14.58	15.96	16.99	16.64
T_5 = FYM (5 kg) + *Azospirillum* (50 g)	17.55	10.42	16.31	15.65	14.98
T_6 = FYM (10 kg) + *Azospirillum* (50 g)	18.45	16.32	21.52	21.39	19.42
T_7 = FYM (10 kg) + *Azospirillum* (50 g)	18.65	14.24	19.00	18.38	17.56
CD at 5%	1.40	2.67	2.79	0.24	-
CV (%)	-	10.53	8.92	8.93	-

9.6.1.5Jagudan

Not reported.

9.7 Disease Management Trial (FGK/CP/1)

9.7.1 Biocontrol of root rot in fenugreek (FGK/CP/1.1)

(Coimbatore)

9.7.1.1Coimbatore

The experiment was initiated during 1999 with 8 treatments, RBD and it is in 5th year of progress. During 2003-04, treatment T_6 i.e soil application of *Trichoderma viride* (5 kg ha^{-1}) + soil application of neem cake (150 kg ha^{-1}) was found to be effective in reducing the disease intensity by 66.63 per cent. This was followed by seed treatment with *Trichoderma viride* (4 g kg^{-1}) + soil application of neem cake (150 kg ha^{-1}) which reduced the disease incidence by 65.13 per cent. This two treatments reordered the yield of 561.5 and 548.9 kg ha^{-1} as against 312.5 kg ha^{-1} in the control. (Table 231).

Table 231. Effect of biocontrol agent and neem cake on the incidence of root rot in fenugreek (2003-04) - Coimbatore

	Treatment	Root rot disease incidence (%)	Disease reduction (%)	Yield (kg ha^{-1})
T_1	S.T with carbendazim (2 g kg^{-1}) + soil drenching (0.1%)	18.52 (25.44)	67.74	545.2
T_2	S.T with *Trichoderma viride* (4 g kg^{-1})	24.08 (29.30)	58.06	527.7
T_3	S.A. of *Trichoderma viride* 20 DBS	21.28 (27.34)	62.93	536.7
T_4	S.A. of neem cake (150 kg ha^{-1})	27.33 (31.52)	52.40	514.0
T_5	S.T with *Trichoderma viride* + S.A. of neem cake	20.02 (26.56)	65.13	548.9
T_6	S.A of *Trichoderma viride* + S.A. of neem cake	19.16 (25.96)	66.63	561.5
T_7	S.T with Carbendazim, soil drenching + S.A. of neem cake	14.78 (22.15)	74.26	563.9
T_8	Control	57.42 (49.27)	-	312.5
	CD at 5%	1.49		41.4

ST – Seed treatment, SA – Soil application Values in parentheses are arc sine transformed value

GENETIC RESOURCES OF SPICES AT AICRPS CENTRES

(AS ON 31-03-2004)

Crop / Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Black pepper				
Panniyur	144	22	3	169
Sirsi	110	6	1	117
Chintapalle	56	-	-	56
Yercaud	116	8	-	124
Pundibari	11	-	-	11
Dapoli	66	-	-	66
Dholi	7	-	-	7
Total	**510**	**36**	**4**	**550**
Cardamom				
Pampadumpara	121	-	-	**121**
Mudigere	263	2	-	265
Total	**384**	**2**		**386**
Ginger				
Pottangi	167	2	3	172
Solan	271	-	2	273
Dholi	42	-	-	42
Kumarganj	29	-	-	29
Pundibari	34	-	-	34
Raigarh	15	-	-	15
Dapoli	3	-	-	3
Total	**561**	**2**	**5**	**568**
Turmeric				
Pottangi	171	22	-	193
Jagtial	273	-	-	273
Dholi	78	2	-	80
Bhavanisagar	-	-	-	-
Raigarh	42	-	-	42
Kumarganj	108	-	-	108
Pundibari	116	14	-	130
Solan	171	-	-	171
Coimbatore	255	-	-	255
Total	**1214**	**38**	-	**1252**

Crop / Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Clove				
Pechiparai	22	-	-	22
Thadiyankudisai	-	-	-	-
Dapoli	3	-	-	3
Total	**25**	**-**	**-**	**25**
Nutmeg				
Pechiparai	20	-	-	20
Thadiyankudisai	-	-	-	-
Dapoli	92	-	-	92
Total	**112**	**-**	**-**	**112**
Cinnamon				
Pechiparai	12	-	-	12
Thadiyankudisai	-	-	-	-
Dapoli	11	-	-	11
Total	**23**	**-**	**-**	**23**
Cassia				
Pechiparai	4	-	-	4
Dapoli	6	-	-	6
Total	**10**	**-**	**-**	**10**
Coriander				
Jobner	683	-	112	795
Jagudan	71	-	20	91
Coimbatore	224	-	-	224
Guntur	243	-	5	248
Hisar	179	-	-	179
Dholi	85	-	-	85
Raigarh	20	-	-	20
Kumarganj	65	-	-	65
Total	**1570**	**-**	**137**	**1707**
Cumin				
Jobner	366	-	10	376
Jagudan	210	-	7	217
Kumarganj	19	-	-	19
Total	**595**	**-**	**17**	**612**

Crop / Center	Indigenous		Exotic	Total
	Cultivated	Wild and related sp.		
Fennel				
Coimbatore	3	-	-	3
Jobner	191	-	12	203
Jagudan	93	-	4	97
Hisar	74	-	-	74
Dholi	44	-	-	44
Kumarganj	36	-	-	36
Total	**441**	**-**	**16**	**457**
Fenugreek				
Jobner	357	-	8	365
Jagudan	63	-	-	63
Coimbatore	255	-	-	255
Guntur	125	1	-	126
Hisar	86	-	-	86
Dholi	97	-	-	97
Raigarh	13	-	-	13
Kumarganj	60	-	-	60
Total	**1056**	**1**	**8**	**1065**
Paprika				
Coimbatore	27	-	-	*27*
IISR, Calicut	26	-	21	*47*
Total	**53**	**-**	**21**	**74**
Vanilla				
Coimbatore	2	-	-	*2*
IISR, Calicut	53	12	-	*65*
ICRI, Myladumpara	35	-	-	*35*
Total	**90**	**12**	**-**	**102**
Grand Total				**6943**

Major spices	-	2756
Tree spices	-	170
Seed spices	-	3841
Other spices (Paprika & Vanilla)	-	176
Grand Total	-	**6943**

ICAR – ADHOC PROJECTS

I. 1. Project title : Identification and evaluation of bioactive peptide - A biotechnological approach towards controlling the fungal pathogen of the quick wilt disease of black pepper

2. Sanction No. : F. No. 15 (2)/99–Hort. I dated 14–08–2000

3. Date of start : 05 – 02 – 2001

4. Year of progress/ date of termination : 04 – 05 – 2004

5. Total cost of the scheme : Amount sanctioned : 6, 64, 305

Amount spent : 7,50,810

6. Investigator (s) : Dr. George Thomas
Mr. Manoj Kurian Jacob

7. Name of the Institution/ University and Address : Plant Molecular Biology Group Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram–695 014, Kerala

8. Objectives :

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

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

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

9. Progress of work (Final report) :

Foot rot and root rot caused by the fungal pathogen *Phytophthora capsici* is a major constraint in black pepper production. Developing disease resistant cultivar through conventional crop improvement protocol is seriously limited due to the lack of disease resistant varieties in the cultivated germplasm. Antimicrobial peptides, both natural and synthetic, have yielded promising results in disease management of crop plants. This ad-hoc project envisaged the development of synthetic peptides with inhibitory properties against *P. capsici.*

Peptides were designed based on the available information on the characteristics of the antimicrobial peptides, which include cationicity, conformation and hydrophobicity. The designed peptides were synthesized following Fmoc solid phase peptide synthesis strategy on a polyethylene glycol-polystyrene solid support. Authenticity and purity of the synthesized peptides were assessed by HPLC and MALDI TOF MS analysis. Inoculum concentrations and growth conditions, which can yield balanced growth and low optical variability, were determined using *P. capsici* zoospores, following the microtitre plate method. Concentrations ranging from 7×10^4 to 7×10^5 zoospores/ml were optimum and were used for assay experiments. Histatin-5, a human salivary peptide with strong fungicidal properties *in vitro* and 'FRLKFK', a synthetic hexapeptide reported earlier, with strong activity against *Pythium ultimatum*, were used as control peptides. The standard chemical fungicides, amphotericin B and actidione were used as chemical controls.

Antifungal properties of the designed peptides and the control molecules were evaluated by assaying the zoospores of *P. capsici*. The minimum inhibitory concentration of the compounds used was determined. Among the different molecules tested, the two peptides designed in the present study, peptide A and peptide B, were highly potent in inhibiting the growth of *P. capsici* zoospores. The MIC value of both the peptides was 10μM and was the lowest among the molecules tested, including the reported antifungal peptide and chemical fungicide controls.

Fluorescent microscopy studies using the membrane impermeable nucleic acid dye Propidium Iodide indicated that the cellular membranes, both cell and nuclear, were compromised in peptide treated mycelia. Permeabilization and subsequent cell lysis may be the cause of cell death in peptide treatment. The peptides showed no lytic or lethal effects on human erythrocytes and black pepper leaves. In studies using detached pepper leaves, the peptides completely prevented the growth of *P. capsici,* indicating their potential in disease control under *in vivo* conditions.

10. Technologies/protocol/prototype/model/process/product developed :

The ad-hoc project has resulted in the development of two synthetic peptides with high antifungal activity against *P. capsici*, the causative agent of the *Phytophthora* foot rot disease of black pepper. The MICs of these designed peptides are lower than that of already reported synthetic and natural peptides and chemical fungicides. To the best of our knowledge, the sequences of these peptides have not been reported earlier and are novel. Though the direct field application of the peptide is not economically feasible and practical, the sequence information of the peptide and its characteristic features would help in designing the active protein domains and its transgenic expression in black pepper.

II. 1.	Project Title	:	Organization of ginger and turmeric germplasm based on molecular characterization
2.	Sanction No.	:	15 (4) / 99 – Hort. I /14.08.2000
3.	Date of start	:	04 – 01 – 2001
4.	Year of progress/ date of termination	:	03 – 04 – 2004
5.	Total cost of the scheme	:	Rs. 14,41,153.00
6.	Investigator(s)	:	Dr. B. Sasikumar Dr. T. John Zachariah
7.	Name of the institution/ University and Addres	:	Indian Institute of Spices Research, Calicut-12
8.	Objectives	:	(a) Characterization of ginger and turmeric germplasm using molecular markers. (b) Build up a core collection of ginger and turmeric germplasm based on molecular and morphological features. (c) DNA Profiling of improved varieties of ginger and turmeric as their cultivars.

9. Progress of work (Final report):

a. Isolated DNA from leaf tissues of 200 accessions/varieties/open pollinated progenies of turmeric and 100 accessions of ginger conserved in the Indian Institute of Spices Research (IISR) gene bank.

b. Isolation of DNA from rhizomes of local varieties/released varieties of turmeric and ginger and their RAPD analysis were done so as to fingerprint the varieties/cultivars.

c. Grouped ninety six accessions each of turmeric and ginger into five different groups by the dendrograms constructed using NTSys programme based on the similarity of the RAPD banding pattern in these accessions.

d. A protocol for the isolation and amplification of DNA from rhizomes of turmeric and ginger is perfected. The yield of isolated DNA ranged from 10.83 – 14.44 µg per gram of fresh mature rhizome tissue of turmeric and 10.13 – 13.38µg per gram of fresh mature rhizome tissue for ginger. The average molecular weight of the DNA was 20,000.00 – 22,000.00 bp. The isolated DNA was amenable to restriction digestion

in addition to PCR amplification. This will help in identifying genuine seed rhizomes of improved varieties of ginger and turmeric from spurious samples.

e. A DNA bank is established with 350 DNA samples from turmeric and ginger and stored at -80° C for further molecular analysis.

f. Developed first ever protocol for the isolation and amplification of DNA from dried powdered samples of turmeric. This protocol will help in PCR based detection of adulteration in marketed turmeric powder using molecular markers. The yield of DNA isolated from the samples using the protocol ranged from 2 µg to 4 µg/g dried powder of turmeric with a molecular weight of about 22,000. 00 bp.

g. Developed a database for *Curcuma* species

10. Technologies/protocol/prototype/model/process/product developed:

a) An efficient protocol for the isolation and amplification of DNA from mature rhizomes of turmeric and ginger is perfected. This will help in the identification and elimination of spurious market samples/seed materials and thereby restricting unscrupulous seed trade practice in these crops. This has more relevance in crops like ginger and turmeric which are not easily discernable based on rhizome morphology

b) Grouped ninety six accessions each of turmeric and ginger into five different groups by the dendrograms constructed using NTSys programme based on the similarity of the RAPD banding pattern in these accessions.

c) Developed a protocol for isolation and amplification of DNA from dried powdered samples of turmeric. This protocol will help in PCR based detection of adulteration in marketed turmeric powder using molecular markers.

d) Developed a *Curcuma* species database based on floral characters (qualitative & quantitative), aerial morphology and under ground rhizome features - the distinguishing features of the *Curcuma* species.

III. 1.	Project Title	:	Micropropagation and development of seedless malabar tamarind through *in vitro* techniques.
2.	Sanction No.	:	F. No. 16 (34)/99 Hort. I dt. 18/8/2000
3.	Date of start	:	18-12-2000
4.	Year of progress/ date of termination	:	17-12-2003
5.	Total cost of the scheme	:	Rs. 7,91,370/-
6.	Investigator (s)	:	Dr. P.C. Rajendran Dr. A. Augustin
7.	Name of the Institution/ University and Address	:	College of Horticulture, Kerala Agricultural University, Vellanikkara, Trichur, Kerala
8.	Objectives	:	(a) To standardise the culture conditions for large-scale multiplication through in vitro techniques.
			(b) Standardisation of protocol for developing triploid plantlets through *in vitro* endosperm culture.
			(c) To develop haploids through anther culture from male trees of *Garcinia gummi-gutta.*
			(b) 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.
			(c) Isozyme studies, protein patterns and ribosomal DNA banding patterns in haploid, diploid and triploid plantlets.
			(d) Induction of somatic embryogenesis from triploid calli cultures and development of synthetic seeds.
			(e) To isolate and purify the protoplasts from haploids and diploid females.
			(f) To fuse the protoplasts of haploid and diploid females for the development of triploid plantlets.

9. Progress of work (Final report):

a. *In vitro* germination of the 3/4th maturity seed was obtained within 7 days (otherwise taking 7-8 months for germination using fully mature seeds without seed treatment and/ or 10-12 days with seed treatment).

b. Regeneration from shoot-tips and nodal segments, induction of multiple shoots from nodal segments and rooting were noticed within 60 days of culture.

c. Induction of multiple shoots from calli masses of ¾ maturity endosperm with ten shoots was obtained within seven months of culture.

d. Induction of somatic embryogenesis was achieved from triploid endosperm calli cultures within four months of culture. Development of seedless fruit bearing trees would be a reality, if the methodology is perfected.

e. Isozyme banding pattern using Esterase to identify the male and female at seedling stage was standardised. (Pioneer work would be patented in *Garcinia gummi- gutta* var. gummigutta).

f. Isolation of protoplasts from diploid explants and haploid explants were standardised.

10. Technologies/protocol/prototype/model/process/product developed :

Isozyme banding pattern using Esterase to identify the male and female at seedling stage was standardised. (Pioneer work would be patented in *Garcinia gummi- gutta* var. gummigutta).

IV. 1.	Project title	:	Identification and development of diagnostics for the viruses causing stunted disease in black pepper
2.	Sanction No.	:	F. No.15(5)/2002-Hort-I dated 30th May 2003; Code No. 3030775015
3.	Date of start	:	1-7-2003
4.	Year of progress/ date of termination	:	First year
5.	Total cost of the scheme	:	Rs.15, 29,616/-
6.	Investigator (s)	:	Dr. A. Ishwara Bhat Dr. R. Suseela Bhai
7.	Name of the Institution/ University and Address	:	Indian Institute of Spices Research, Calicut
8.	Objectives	:	(a) Identification of the causal viruses associated with the stunted disease of black pepper (b) Production of polyclonal antisera (b) Production of sero-diagnostic kit (c) Development of virus-free planting material (certification program)

9. Progress of work:

a) Random surveys of black pepper plantations in the major black pepper growing regions of Karnataka and Kerala states were taken up. Five districts each in Karnataka and Kerala were surveyed for the occurrence and distribution of stunted disease. The incidence of the disease was highest in Wyanad District (45.4%) followed by Idukki District (29.4%) in Kerala. In Karnataka, Kodagu District (14.9%) had the highest incidence of the disease followed by Hassan District (5.2%). In general, disease incidence and severity were more in Kerala than in Karnataka. Among the areas surveyed in Kerala, incidence and severity were more in the black pepper plantations situated at higher altitudes such as Idukki and Wyanad.

b) Mosaic, reduction in leaf size and internodal length leading to the stunting and bright yellow mottling along the veins were the two types of symptoms observed on diseased vines. All cultivars and improved varieties including hybrids were found susceptible to the disease under natural conditions. Vines of all ages are affected by the disease.

c) A few of the weeds found in and around black pepper plantations showed typical virus symptoms, which might act as potential virus source. Although twelve species of insects were observed, none was specifically associated with diseased vine.

d) Forty-seven isolates of black pepper showing distinct symptoms of disease representing various geographical areas were collected. In addition, *Piper longum* showing mosaic and mottling symptoms coupled with stunting of entire plants were also collected. Few isolates of *Piper colubrinum* showing mild mottle symptoms were also collected. All the collected isolates are being maintained under insect proof glass house through vegetative propagation.

e) The isolates were subjected to immunological analysis through enzyme linked immunosorbent assay (ELISA) using antisera to different viruses. Results showed that majority of the isolates reacted either to *Cucumber mosaic virus* (CMV) (Genus: Cucumovirus) or *Banana streak virus* (BSV) (Genus: Badnavirus) indicating the involvement of at least two viruses with the stunted disease of black pepper.

f) Cucumber mosaic virus (CMV) isolated from naturally infected black pepper was propagated on *Nicotiana benthamiana* and *N. glutinosa* under insect-proof glass house conditions. CMV particles were purified from these hosts by differential centrifugation and sucrose density gradient centrifugation, which resulted in a clean virus preparation. Electron microscopy of negatively stained purified preparations showed the presence of isometric particles of about 28 nm in diameter. The antiserum against CMV was produced in New Zealand white rabbit. Immunoglobulin G (IgG) was purified from the crude polyclonal antiserum and coupled with the enzyme alkaline phosphatase. Double antibody sandwich (DAS) ELISA method was standardized for the detection of CMV in diseased black pepper leaves collected from different regions of Karnataka and Kerala.

g) Virus elimination through meristem culture is being attempted from the green house-grown infected plants as well as from the *in vitro* grown shoot tips. Though some undifferentiated growth was observed with the meristem culture, complete regeneration of the plantlet is yet to be established. In order to avoid the contamination, virus infected plants are micro propagated to serve as the source of meristems for further regeneration.

10. Technologies/protocol/prototype/ model/process/product developed :

Nil

V. 1. Project title : Bioecology and integrated management of root mealybug *Planococcus* sp. infesting black pepper

2. Sanction No. : F.No. 15 (2) / 2001- Hort. I dated 5 June, 2003

3. Date of start : 1-7-2003

4. Year of progress/ date of termination : First year

5. Total cost of the scheme : Rs.10,84,616/-

6. Investigator (s) : Dr. S. Devasahayam
Mr. K.M. Abdulla Koya
Dr. M. Anandaraj

7. Name of the Institution/ University and Address : Indian Institute of Spices Research, Calicut.

8. Objectives :
(a) Distribution of root mealybug in major black pepper areas.
(b) Nature of damage caused by root mealybug and its interaction with other organisms.
(c) Bioecology of root mealybug.
(d) Integrated management of root mealybug.

9. Progress of work:

a) Surveys conducted in black pepper plantations in Idukki, Kozhikode, Kannur and Kasaragod districts in Kerala and Dakshina Kannada, Udupi, Uttara Kannada and Hassan districts in Karnataka indicated that seven gardens in Idukki District and five gardens in Hassan District were infested with root mealybugs. The mealybug species infesting roots and basal portions of stems of black pepper were identified as *Planococcus* sp., *Planococcus citri* and *Ferrisia virgata.*

b) Root mealybugs were observed to infest rooted cuttings/vines in the nursery and plantations and the pest infestation caused yellowing, defoliation and wilting of cuttings/vines. Many of the vines infested with root mealybugs were also infected with *Phytophthora capsici* and nematodes in the field and experiments to study the interaction of these pathogens were set up under green house and simulated field conditions.

c) Methods for studying the biology of root mealybugs in the laboratory were standardized and the duration and morphometrics of various stages were determined. Standardization of procedures for mass culturing of root mealybugs on various vegetables/fruits/tubers in the laboratory were carried out.

d) Surveys were carried out in the field at Wyanad for recording the alternate hosts of root mealybugs; the pest was observed to infest roots/basal portions of stems of banana, coffee, *Erythrina* sp. and 12 weed species. The seasonal incidence of root mealybugs in the field is being monitored at Wyanad.

10. Technologies/protocol/prototype/model/process/product developed :

Nil.

VI. 1.	Project title	:	Conservation and evaluation of ajwain (*Trachyspermum ammi* L.) germplasm for identification of high yielding quality oil genotypes
2.	Sanction No.	:	15 (1)/2002-Hort. I dated 9 June, 2003 of Asstt. Director General (PC), ICAR, New Delhi
3.	Date of start	:	9-6-2003
4.	Year of progress/ date of termination	:	First year
5.	Total cost of the scheme	:	Rs. 8, 62,000/-
6.	Investigator (s)	:	Dr. R.V. Paliwal Dr. Rajesh Pandya
7.	Name of the Institution/ University and Address	:	Agricultural Research Substation, Maharana Pratap University of Agriculture & Technology, Pratapgarh Dist., Chittorgarh
8.	Objectives	:	(a) Collection and evaluation of ajwain germplasm (b) Conservation and documentation of superior genotypes (c) Utilization of genetic variability for identification of high yielding quality oil genotypes (d) Study of traditional material

9. Progress of work:

a) Survey of different areas/villages of Rajasthan and Gujarat states was carried out and collected. Seventy nine local germplasm from farmer's fields on the basis of morphological characters. The germplasm has been catalogued for evaluation in the coming kharif season.

10. Technologies/protocol/prototype/model/process/product developed :

Nil

STAFF

PROJECT COORDINATOR'S CELL

Indian Institute of Spices Research
Calicut – 673 012, Kerala

Project Coordinator	:	Dr K V Ramana
Scientist SS (Hort.)	:	Dr K N Shiva
Technical Information Officer	:	Dr Johny A Kallupurackal
Personal Assistant	:	Ms Alice Thomas
Supporting Staff	:	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.)	:	Dr K Vasantha Kumar
3.	Asst. Professor (Ag. Entomology)	:	Dr A Joseph Rajkumar
4.	Farm Assistant Sel. Gr.	:	Mr C G Pradeep
5.	Lab Assistant Grade II	:	Mr C S Manoj
6.	Peon	:	Mr Paulose Mathew

2. Pepper Research Station, KAU, Panniyur

1.	Assoc. Professor (Pl. Pathology)	:	Dr K P Mammootty
2.	Asst. Professor (Pl. Pathology)	:	Dr G Sivakumar
3.	Asst. Professor (Pl. Breeding)	:	Dr V P Neema
4.	Asst. Professor (Agro)	:	Vacant

5.	Farm Assistant Gr. II	:	Mr A Sasidharan Mr K A Kurien Mr P.P. Muralidharan
6.	Lab Assistant Gr. III	:	Ms Nirmala Chellath
7.	Peon	:	K Rajeev

3. Regional Research Station, UAS (Bangalore), Mudigere

1.	Pathologist	:	Mr L Arasumallaiah
2.	Agronomist (Hort.)	:	Dr M Dinesh Kumar
3.	Breeder	:	Mr M Narayanaswamy
4.	Jr. Entomologist	:	Mr D Jemla Naik
5.	Technical Assistant	:	Mr Narayana
6.	Technical Assistant	:	Mr V Mallikarjunappa
7.	Messenger	:	Ms Savithri

4. Agricultural Research Station, UAS (Dharwad), Sirsi

1.	Jr. Horticulturist (Asst. Prof.)	:	Dr H G Hegde
2.	Jr. Pathologist (Assoc. Prof.)	:	Dr M S Lokesh
3.	Technical Assistant	:	Mr G V Heregowder

5. Horticultural Research Station, TNAU, Yercaud/Pechiparai

1.	Agronomist (Hort.)	:	Dr V Lakshmanan
2.	Jr. Breeder (Hort.)	:	Dr Prem Jousha/Pechiparai
3.	Lab Assistant	:	Mr P Pappu \

6. Department of Spices & Plantation Crops, TNAU, Coimbatore

1.	Breeder (Horticulturist)	:	Dr S Subramanian
2.	Jr. Pathologist (Posted a Research Associate)	:	Dr E Rajeswari
3.	Agricultural Assistant	:	Mr R Swaminathan

7. Regional Agricultural Research Station, APAU, Chintapalle

1. Horticulturist	:	Mr M M Naidu (upto 19-1-2004) Sri D Lakshminarayana (w.e.f 19-1-2004)
2. Junior Pathologist	:	Smt V Prasanna Kumari
3. Technical Assistant	:	Vacant

8. Regional Agricultural Research Station, ANGRAU, Jagtial

1. Jr. Pathologist	:	Dr M. Padma Sri
2. Jr. Horticulturist	:	Mr M Raja Naik
3. Technical Asst./Sub Asst.	:	Mr A Dubbarajam

9. Regional Agricultural Research Station, APAU, Guntur

1. Horticulturist	:	Smt C Sarada
2. Jr. Breeder (Scientist in position)	:	Sri K Giridhar
3. Sub Assistant	:	Mr V Veerabhadra Rao

10. 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 (Mrs) Neerja Rana
4. Jr. Technical Assistant	:	Mr Rajeshwar Chauhan

11. High Altitude Research Station, OUAT, Pottangi

1. Breeder (Olericulturist)	:	Dr. S. Rath (ADR in-charge)
2. Jr. Breeder	:	Dr D K Dash
3. Jr. Technical Assistant	:	Mr R C Dash
4. Jr. Technical Assistant	:	Mr B N Sahoo

12. 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 (upto 14-02 2003)
	:	Dr N L Jat (w.e.f 14-02-2003)
2. Jr. Plant Pathologist	:	Mr M P Jain
3. Jr. Biochemist	:	Dr S Agrawal
4. Sr. Technical Assistant	:	Mr S S Rajput
5. Jr. Technical Assistant	:	Mr S R Kumawat

13. 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

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	:	Dr S P Singh Jr. Pathologist Vacant
2. Technical Assistant	:	Vacant

16. Najendra Dev University of Agriculture and Technology, Kumarganj

1. Horticulturist	:	Dr J Dixit (upto 27-04-2004) Dr V P Pandey (w.e.f. 28-04-2004)
2. Jr. Breeder	:	Vacant
3. Jr. Pathologist	:	Dr R P Saxena
4. Technical Assistant	:	Mr R K Gupta
5. Technical Assistant	:	Mr V K Singh

17. Uttar Banga Krishi Viswa Vidhyalaya, Pundibari

1. Horticulturist	:	Vacant from 20-11-2003
		Dr J C Jana (in-charge)
2. Jr. Breeder	:	Dr S K Dash (w.e.f. 03-05-2002)
3. Jr. Pathologist	:	Dr P M Bhattacharya (upto 20-03-2003)
		Mr S Bandyopaday (w.e.f. 21-03-2003)
4. Technical Assistant	:	Mr B Mazumdar (w.e.f. 01-08-1997)
5. Technical Assistant	:	Vacant

18. Konkan Krishi Vidya Peeth, Dapoli

1. Horticulturist	:	Dr P M Haldankar
2. Jr. Pathologist	:	Dr V S Pande
3. Junior Spice Breeder	:	Prof R G Khandekar
4. Technical Assistant	:	Mr S D Tambe
5. Technical Assistant	:	Mr A B Jadhav

19. 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 D S Kshatri
5. Technical Assistant	:	Vacant

BUDGET PROVISION 2003-04

(Rs. in lakhs)

Name of the center	Pay & Allowances						Tech. Assmt. (100 % ICAR share)	NRC	ICAR share	Grand Total	ICAR share	SAU Share
	Estt.	ICAR share	TA	ICAR share	RC	ICAR share						
Pampadumpara (KAU)	6.879	5.159	0.392	0.294	1.783	1.337		1.000	0.750	10.054	7.540	2.514
Panniyur (KAU)	11.627	8.720	0.523	0.392	2.376	1.782	0.200	4.180	3.135	18.906	14.229	4.677
Mudigere (UAS-B)	14.240	10.680	0.523	0.392	2.376	1.782		3.810	2.858	20.949	15.712	5.237
Sirsi (UAS-D)	5.427	4.070	0.261	0.196	1.188	0.891		2.100	1.575	8.976	6.732	2.244
Yercaud (TNAU)	4.520	3.390	0.261	0.196	1.188	0.891		1.000	0.750	6.969	5.227	1.742
Coimbatore (TNAU)	4.293	3.220	0.261	0.196	1.188	0.891	0.200	1.000	0.750	6.942	5.257	1.685
Chintapalle (APAU)								1.500	1.125	1.500	1.125	0.375
J: _ ial (APAU)	3.427	2.570	0.261	0.196	1.188	0.891	0.100	2.780	2.085	7.756	5.842	1.914
Guntur (APAU)	4.004	3.003	0.261	0.196	1.188	0.891	0.100	1.250	0.937	6.803	5.127	1.676
Solan (YSPUHF)	0.549	0.412	0.392	0.294	1.783	1.337	0.100	3.100	2.325	5.924	4.468	1.456
Pottangi (OUAT)							0.200	1.000	0.750	1.200	0.950	0.250
Jobner (RAJAU)	18.440	13.830	0.656	0.492	2.965	2.224	0.300	7.156	5.367	29.517	22.213	7.304
Jagudan (GAU)	7.533	5.650	0.261	0.196	1.188	0.891	0.200	3.800	2.850	12.982	9.787	3.195
Hisar (HAU)	6.881	5.161	0.261	0.196	1.188	0.891	0.200	2.100	1.575	10.630	8.023	2.607
Dholi (RAU)			0.000		0.000		0.100	2.000	1.500	2.100	1.600	0.500
Kumarganj (NDUAT)	6.967	5.225	0.392	0.294	1.783	1.337		1.000	0.750	10.142	7.606	2.536
Pundibari (BCKVV)	6.961	5.221	0.392	0.294	1.783	1.337	0.100	2.000	1.500	11.236	8.452	2.784
Dapoli (KKV)	10.300	7.725	0.392	0.294	1.783	1.337	0.100	3.700	2.775	16.275	12.231	4.044
Raigarh (IGKVV)	6.967	5.225	0.392	0.294	1.783	1.337	0.100	2.190	1.643	11.432	8.599	2.833
Coordinator's cell					0.280	0.280				0.280	0.280	
Grand Total	**119.015**	**89.261**	**5.883**	**4.412**	**27.009**	**20.327**	**2.000**	**46.666**	**35.000**	**200.573**	**151.000**	**49.573**
ICAR Share	89.261		4.412		20.327		2.000	35.000		151.000		
State Share	29.754		1.471		6.682			11.667		49.573		

ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES

Statement of fund released during 2003-2004 (ICAR share)

Centre	RE Amount released			NRC released	Add. fund released	Grand total released
	2003 - 04	I half	II half			
Pampadumpara (KAU)	8.816	3.780	3.010	0.750	-	7.540
Panniyur (KAU)	11.729	4.060	4.534	3.135	2.500	14.229
Mudigere (UAS-B)	13.712	5.090	5.764	2.858	2.000	15.712
Sirsi (UAS-D)	5.232		3.657	1.575	1.500	6.732
Yercaud (TNAU)	5.227	2.070	2.407	0.750	-	5.227
Coimbatore (TNAU)	5.587	2.350	2.157	0.750	-	5.257
Chintapalle (APAU)	5.762			1.125	-	1.125
Jagtial (APAU)	5.842	1.760	1.997	2.085	-	5.842
Guntur (APAU)	5.674	2.250	1.940	0.937	-	5.127
Solan (YSPUHF)	8.711	0.100	2.043	2.325	-	4.468
Pottangi (OUAT)*	6.147	0.200		0.750	-	0.950
Jobner (RAJAU)	17.613	0.300	11.946	5.367	4.600	22.213
Jagudan (GAU)	7.687	2.350	2.487	2.850	2.100	9.787
Hisar (HAU)	7.352	2.820	2.828	1.575	0.800	8.023
Dholi (RAU)*	6.237	0.100		1.500	-	1.600
Kumarganj (NDUAT)	7.606		6.856	0.750	-	7.606
Pundibari (BCKVV)	8.456	0.100	6.852	1.500	-	8.452
Dapoli (KKV)	9.731	3.280	3.676	2.775	2.500	12.231
Raigarh (IGKVV)	8.599	3.280	3.676	1.643	-	8.599
PC-cell **	0.280				-	0.280
Grand Total	**156.000**	**33.890**	**65.830**	**35.000**	**16.000**	**151.000**

* The BE is 156.00 lakhs and an amount of Rs. 21.00 lakhs obtained as savings from various centres, out of which Rs. 5.00 lakhs has been surrendered an additional amount of Rs. 16.00 lakhs has been released to seven centres under pay and allowances from overall savings obtained and the RE limited to Rs.151.00 lakhs including Rs. 2 lakhs spent for technological assessment.

** An amount of Rs.0.28 lakhs has been spent in the coordinator's cell for XVII AICRPS Workshop etc.

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METEOROLOGICAL DATA 2003

Pampadumpara

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	0.80	0	27.0	13.2	90.74	53.22
February	8.80	1	29.0	15.6	89.50	45.57
March	159.00	4	30.4	15.4	91.48	45.96
April	57.80	4	31.5	17.5	90.33	54.90
May	86.80	6	29.0	18.0	85.25	42.64
June	181.20	12	29.2	17.4	96.56	74.50
July	223.00	19	25.5	16.5	92.56	82.40
August	148.80	16	27.0	16.0	94.68	77.39
September	33.20	3	29.0	16.5	94.70	67.47
October	428.00	19	29.0	16.0	95.55	79.45
November	103.80	10	28.2	15.4	95.60	75.87
December	4.80	1	27.2	13.6	90.90	60.83

Panniyur

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)
			Maximum	Minimum	
January	-	-	34.5	29.2	84
February	-	-	35.8	24.5	87
March	7.6	1	37.2	25.8	83
April	65	4	36.7	27.4	81
May	55.8	4	35.7	27.3	78
June	972.3	20	31.4	25.4	90
July	888.9	28	28.9	24.5	94
August	459.9	24	29.8	25.0	92
September	105	9	31.0	24.3	90.3
October	260.5	12	31.2	24.5	90.1
November	31.1	4	34.0	24.5	87.5
December	-	-	34.5	21.9	92.4

Mudigere

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	-	-	27.9	14.6	89.5	66.9
February	001.4	-	29.5	18.0	84.7	56.7
March	010.2	01	31.0	17.7	80.3	50.3
April	052.9	06	30.3	18.8	78.5	50.5
May	020.8	02	30.1	19.9	78.8	44.3
June	368.1	18	25.1	19.1	84.9	72.4
July	552.8	25	22.6	18.7	90.3	79.5
August	261.6	22	22.5	18.7	90.9	81.5
September	080.7	11	23.5	17.4	90.2	75.2
October	172.6	09	25.2	17.8	89.8	69.6
November	003.0	-	26.4	16.8	88.5	58.0
December	-	-	26.2	16.1	88.5	56.5

Sirsi

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	0	0	32.44	15.10	84.27	67.517
February	0	0	35.11	16.48	85.74	66.148
March	2.9	1	36.96	19.24	85.03	64.00
April	16.0	4	37.43	21.26	86.53	65.533
May	0	0	36.48	22.06	83.41	63.323
June	503.2	20	30.43	21.57	88.93	81.83
July	571.2	28	26.97	21.55	90.00	89.00
August	276.8	22	26.74	21.90	90.00	87.81
September	97.8	11	27.33	22.73	89.70	85.17
October	226.4	10	30.90	23.00	89.17	80.13
November	0	0	31.90	20.90	86.77	72.43
December	0	0	30.70	19.40	79.57	64.77

Yercaud

Latitude : 11.4' N
Altitude : 1450m MSL

Longitude : 78.5' E
Soil type : Clay loam

Month	Rainfall days (mm)	No. of rainy days	Max. temperature (°C)	Min. temperature (°C)	Relative humidity (%)
January	77.6	3	Data is not available	Data is not available	Data is not available
February	61.3	3			
March	97.6	3			
April	94.5	3			
May	17.0	6			
June	84.3	4			
July	168.6	10			
August	431.1	9			
September	149.2	7			
October	278.4	8			
November	10.6	1			
December	31.0	1			

Coimbatore

Latitude : 11°N
Altitude : 426.72m MSL

Longitude : 77 E
Soil type : Clay loam

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	M 07.22	E 14.22
January	-	-	30.8	18.5	85	38
February	25.0	3	33.0	21.7	85	37
March	119.1	4	34.4	21.8	87	35
April	63.7	4	35.5	23.6	86	42
May	19.5	3	35.5	24.4	86	43
June	34.0	4	32.5	23.7	81	49
July	43.9	4	31.2	22.9	83	58
August	24.6	1	32.6	22.9	83	47
September	13.6	1	33.3	21.9	85	42
October	210.1	12	31.1	22.3	91	58
November	99.2	5	29.1	21.1	90	59
December	6.0	1	29.7	18.3	89	44

Chintapalle

Latitude : 17^0.13' Noth latitude
Longitude : 84^0.33' East Longitude
Altitude : 772-820 MSL
Soils Type : Red sandy loam

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	2.0	-	27.8	8.8	78.9	40.8
February	22.2	2	28.6	13.2	79.0	46.5
March	32.6	4	31.0	16.9	80.3	46.7
April	9.5	1	34.3	19.2	68.3	42.7
May	45.0	5	36.3	21.1	64.6	44.2
June	58.6	5	33.1	22.3	68.4	52.6
July	530.0	19	26.3	21.2	88.9	82.8
August	322.0	15	26.6	20.6	85.7	80.3
September	146.0	11	27.5	20.9	87.1	76.8
October	333.4	9	27.0	18.7	90.6	78.4
November	17.4	1	27.4	12.6	90.4	59.8
December	125.2	3	25.8	9.9	83.8	53.5

Jagtial

Latitude :
Longitude :
Altitude :
Soils Type :

Month	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	AM.	PM
January	0.0	30.4	15.2	73.0	37.0
February	4.6	33.4	20.0	75.0	41.0
March	0.0	36.6	21.0	65.0	32.0
April	8.0	38.9	24.6	58.0	33.0
May	0.0	43.1	26.9	13.0	51.0
June	100.8	38.4	27.4	63.3	44.0
July	300.2	31.6	24.3	86.0	68.0
August	571.8	30.5	24.1	88.0	71.0
September	79.8	31.9	24.3	86.0	75.0
October	73.0	31.9	21.8	85.2	70.3
November	0.0	31.1	16.7	82.3	43.9
December	0.0	29.8	13.4	76.8	41.5

Guntur

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	0.00	12.00	31.17	17.50	85.96	55.64
February	0.00	0.00	33.65	21.06	85.82	60.67
March	46.10	2.00	35.46	22.81	87.12	55.80
April	0.00	0.00	38.58	26.15	73.50	39.70
May	0.00	0.00	42.24	28.70	60.25	29.22
June	197.60	8.00	38.50	28.06	70.93	44.83
July	326.30	18.00	32.32	25.66	87.96	67.87
August	69.20	8.00	32.64	24.48	84.48	68.41
September	142.00	8.00	33.98	24.57	78.36	58.40
October	232.90	11.00	31.42	23.70	91.74	74.35
November	29.30	1.00	31.34	20.31	88.43	61.10
December	131.40	4.00	28.76	16.83	92.06	62.54

Solan

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

Month	Rainfall days (mm)	No. of rainy days	Temperature(°C)		Relative humidity (%)
			Max.	Min.	
January	39.6	4	19.9	1.8	58
February	101.6	6	19.6	5.0	67
March	57.6	5	23.5	8.3	56
April	43.4	4	29.2	12.3	49
May	33.0	3	31.8	15.6	38
June	102.6	6	32.3	19.7	56
July	318.2	16	28.7	20.5	95
August	192.4	9	29.7	20.2	85
September	131.0	7	29.1	18.2	82
October	Nil	Nil	27.8	11.8	62
November	4.8	1	23.5	4.8	64
December	37.0	2	20.0	3.4	66

Pottangi

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

Month	Rainfall days (mm)	No. of rainy days	Temperature(°C)		Relative humidity (%)
			Max.	Min.	
January	Nil	Nil	32	11	70.5
February	37.0	2	31	15	73.0
March	127.0	6	33	18	72.0
April	62.0	5	35	22	61.0
May	Nil	Nil	38	26	72.5
June	81.5	4	40	32	75.0
July	450.0	22	28	19	85.0
August	471.0	20	26	20	90.0
September	402.5	16	27	20	87.0
October	456.0	8	28	19	82.0
November	20.0	1	28	14	75.0
December	123.0	2	26	12	75.0

Jobner

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max	Min.
January	0.40	1	21.02	4.80	85.60	37.20
February	6.83	2	25.43	9.88	75.00	33.25
March	000	-	32.25	13.45	67.75	25.75
April	1.62	1	39.62	20.20	44.60	27.60
May	000	-	41.60	24.10	49.25	25.25
June	2.25	2	40.00	28.55	61.25	33.00
July	36.00	10	32.94	24.80	85.80	66.80
August	31.65	10	32.90	24.55	88.00	69.75
September	8.80	5	33.65	22.98	84.50	53.50
October	000		34.08	13.54	71.80	24.40
November	000		29.03	8.93	71.50	25.50
December	000		25.15	5.65	73.50	34.75

Jagudan

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

Month	Rainfall days (mm)	No. of rainy days	Temperature(°C)		Humidity (%)
			Max.	Min.	
January	-	-	27.6	10.7	67.25
February	-	-	29.7	12.5	57.25
March	-	-	33.6	14.9	38.19
April	-	-	39.4	22.7	42.80
May	-	-	42.2	23.5	45.26
June	2	41	37.7	28.3	83.30
July	14	387	31.9	25.3	92.65
August	6	184	30.9	25.9	88.90
September	3	41	31.9	25.3	86.90
October	-	-	34.1	21.4	64.9
November	-	-	32.5	19.4	56.9
December	-	-	43.4	12.9	28.6

Hisar

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	6.4	4	16.4	3.7	97	74
February	30.2	3	22.2	7.2	91	53
March	2.0	1	28.2	11.1	87	36
April	0.0	0	37.2	17.4	58	19
May	39.3	2	39.8	21.6	47	18
June	7.2	1	41.3	28.2	66	40
July	279.5	15	33.8	25.7	90	73
August	119.6	8	34.3	25.5	89	65
September	25.2	2	34.1	23.0	90	57
October	0.0	0	32.5	14.4	88	36
November	0.0	0	27.3	8.4	87	30
December	8.6	1	19.9	7.3	95	65

Dholi

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	6.0	1	16.5	7.1	90	64
February	61.0	4	24.0	13.8	89	57
March	19.0	2	29.2	16.8	83	51
April	67.5	4	34.9	22.4	81	42
May	42.5	5	35.2	24.0	75	45
June	309.0	11	33.8	26.0	86	65
July	178.0	12	32.2	27.4	89	74
August	299.8	12	32.4	27.4	86	71
September	265.0	7	32.4	26.8	88	74
October	146.5	5	30.4	22.9	90	62
November	0.0	0	28.4	16.6	87	49
December	8.0	1	23.7	11.0	90	53

Note : The meteorology of the Institute is lacking informations about wind-speed and sunshine hours

Kumarganj

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January						
February						
March						
April	12.4	3.0	37.6	20.2	42.1	89.5
May	0.0	0.0	38.9	23.9	32.0	82.1
June	122.4	11.0	38.4	25.4	47.4	82.6
July	237.8	15.0	32.7	25.2	66.1	84.1
August	388.6	14.0	33.6	26.3	73.7	90.5
September	300.3	16.0	29.9	26.6	78.3	91.6
October	0.0	0.0	31.5	18.7	57.1	88.5
November	0.0	0.0	28.6	11.8	51.5	85.1
December	21.9	2.0	23.8	9.1	62.9	89.5

Pundibari

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	-		22.1	8.4	93	75
February	19.0		22.5	9.9	80	64
March	95.0		27.7	13.6	91	67
April	225.0		30.5	19.5	90	76
May	344.6		32.1	21.1	91	83
June	689.0		33.9	22.6	93	80
July	734.0		32.7	24.2	93	82
August	269.0		34.4	25.6	91	80
September	112.0		34.5	24.5	92	80
October	211.0		31.3	21.6	91	80
November	-		28.9	17.2	92	82
December	41.0		25.6	12.6	89	59

Dapoli

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Dry	Wet
January	0.0	0	31.1	14.0	95	60
February	3.0	1	32.8	14.0	93	49
March	0	0	33.8	16.4	89	49
April	0.2	0	34.1	20.5	86	61
May	0	0	33.4	22.1	87	63
June	978.6	16	30.9	24.6	92	87
July	1196.5	30	28.4	24.0	96	91
August	597.3	30	28.4	23.0	96	91
September	247.0	21	27.6	22.7	96	88
October	6.4	2	32.1	20.7	95	80
November	0.0	0	33.4	18.0	95	59
December	0.0	0	32.3	13.5	94	57

Raigarh

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

Month	Rainfall days (mm)	Temperature(°C)		Relative umidity (%)	
		Max.	Min.	Max.	Min.
January					
February					
March					
April	-	43.0	19.0	74.5	23.0
May	-	46.0	22.0	68.0	17.0
June	293.74	45.0	21.5	92.0	29.0
July	325.10	32.5	24.5	92.0	61.0
August	418.80	31.5	24.0	92.0	78.5
September	435.90	31.0	23.5	92.0	74.5
October	91.40	32.5	20.0	92.0	60.5
November	-	29.5	12.0	91.0	49.0
December	22.86	26.0	9.5	89.5	34.0

Ambalavayal

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

Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	AM	PM
January	004.8	1	28.5	17.0	90.0	57.0
February	016.0	2	29.7	16.5	95.0	69.0
March	104.4	6	30.4	18.3	96.0	57.0
April	131.4	10	29.5	19.9	94.0	66.0
May	74.6	8	29.5	19.9	92.0	65.0
June	208.0	13	27.0	18.7	98.0	80.0
July	281.4	21	24.9	18.1	97.0	88.0
August	211.8	17	24.8	18.8	98.0	86.0
September	055.6	6	26.5	17.7	91.0	75.0
October	349.5	13	26.1	18.9	97.4	88.2
November	083.2	3	26.8	17.1	92.0	74.0
December	000.0	Nil	27.4	15.4	88.5	59.1

Raigarh

Latitude :
Altitude :
Longitude :
Soil type :

Month	Rainfall days (mm)	No. of rainy days	Temperature(°C)		Humidity (%)
			Max.	Min.	
January	0	-	34.7	27.2	72.2
February	17.1	2	33.8	26.0	70.3
March	67.2	6	35.3	27.0	68.6
April	208.4	12	35.6	27.3	69.0
May	34.2	6	34.8	26.0	72.0
June	124.0	8	32.5	24.8	77.8
July	79.5	7	31.3	23.0	77.0
August	62.8	6	32.8	23.0	76.7
September	35.2	3	34.6	27.0	71.0
October	422.4	18	30.8	22.6	84.0
November	155.0	11	30.4	22.0	84.8
December	1.2	2	31.8	22.3	78.3

LIST OF 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
Fax: 0091-495-2731794
E-mail: pcspices@yahoo.com/aicrps@iisr.org/

AICRPS CENTRES	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) PANNIYUR, PB No.113 Kanjirangadu (P.O)Karimbam (Via), Taliparamba -670 142, 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) 328135 (O)	Fax: 91-803330277 (Director of Research)
4. Agricultural Research Station (Pepper) (Univ. of Agril. SciencesDharwad) SIRSI-581 401Dist. Uttara Kannada, Karnataka	(08384) 426797 (O)	E-mail: arsp@sancharnet.in
5. Horticultural Research Station 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 & Research Institute (Tamil Nadu Agril. University) COIMBATORE – 641 003 Tamil Nadu	(0422) 2431222 (0422) 5511284 Extn. 284 (O) (0422) 5589082 (R)	Fax: (0422) 2445414 Gram: FARMVAR E-mail: gbalki2001@yahoo.com

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 (08724) 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)	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) 262066, 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 P.O, Dist. Cooch Behar, West Bengal – 736 165	(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. Chattisgarh	(07762) 222402 (O) (07762) 222402 (R)	Fax: (07762) 224886

VOLUNTARY CENTRES

1. The Associate Director
Regional Agricultural Research Station
(Kerala Agril University)
AMBALAVAYAL – 673 593
Dist. Wynad, Kerala

2. The Professor & Head
Horticultural Research Station
(Tamil Nadu Agricultural University)
PECHIPARAI – 629 161
Kanyakumari Dist., Tamil Nadu

3. The Professor & Head
Horticultural Research Station
(Tamil Nadu Agricultural University)
THADIYANKUDISAI – 624 212
Tamil Nadu

4. The Scientist-in-charge
Regional Research Station
(Indian Cardamom Research Institute)
THADIYANKUDISAI – 624 212
Tamil Nadu

5 The Scientist-in-charge
ICRI Regional Station
Spices Board (Govt. of India)
Donigal Post, SAKLESHPUR
Karnataka – 573 134

6 The Director
Indian Cardamom Research Institute
MYLADUMPARA,
Kailasanadu – 685 553,
Idukki Dist., Kerala

7 The Professor & Head
Agricultural Research Station
(Tamil Nadu Agricultural University)
BHAVANISAGAR – 638 451
Tamil Nadu

8 Scientist-in-charge
ICRI Regional Station (Spices Board)
Yakthung, Tadong,
GANGTOK – 737 101
Sikkim